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Exogenous Zinc Application and Generative Traits of Three Local Shallot Varieties

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ABSTRACT

Increasing shallot (*Allium ascalonicum* L.) production can be done by application of botanical or true shallot seeds (TSS). Meanwhile, it is well understood that botanical seeds are difficult to produce due to shallots' low flowering capacity. This study aimed to evaluate the generative traits of three local shallot varieties affected by various doses of zinc (Zn). This study was structured using a split-plot design, where the main plots were varieties (Lokana, Rubaru, and Ambassador 3 Agrihorti). In addition, the sub-plot treatment, the dose of zinc (0, 0.5, 1, and 1.5 kg ha^{-1}), was repeated three times. There is an effect of the main factor (variety) where Rubaru and Ambassador 3 Agrihorti show the fastest umbel emergence. In addition, our data show the interaction effects on the age of sheat breaking, flower blooming (DAP), morphology traits of generative organs, and leaf traits. In detail, Lokana with a Zn dose of 1.5 ha^{-1} shows the best results on the length and diameter of the umbel stalk; Rubaru with Zn 1 kg ha^{-1} on the age of broken sheath and chlorophyll index; and the Ambassador 3 Agrihorti with Zn 0.5 kg ha^{-1} on the number of flowers. On the one hand, it can be concluded that each variety responded differently to the dose of Zn. Concerning seed production, on the other hand, the Ambassador 3 Agrihorti with Zn 0.5 kg ha^{-1} has better potential to be developed for TSS, as seen from the number of flowers per umbel, a higher percentage of flowering plants and a relatively fast flowering time than other varieties.

1. Introduction

Shallots (*Allium ascalonicum* L.) are classified as one of the vegetable commodities with high economic potential because the community at large needs them, ranging from the household scale to the industrial scale in various culinary businesses as a seasoning with an average consumption per capita per week reaching 0.58 ons (Central Bureau of Statistics of Indonesia 2022a). Shallots also contain nutrients and active chemical compounds to prevent and treat diseases such as hypertension, cancer, and heart problems (Aryanta 2019). Shallot production in Indonesia in 2021 is 2,004,590 tons, an increase of 10.42% from 2020 which was only 1,815,445 tons (Central Bureau of Statistics of Indonesia 2022b), with production centers covering Central Java, West Java, East Java, West Sumatera, West Nusa Tenggara, and South Sulawesi which contribute 94.1% of the total national shallot production (Laili and Fauziyah 2022). Even though statistically, there has been an increase in production, the high demand for shallots still often results in an imbalance between demand and supply, considering that shallots are seasonal and perishable, which then have an impact on fluctuations in the market (Apriyani *et al.* 2021).

Various efforts are still being made to increase shallot production, one of which is switching planting materials from bulbs to true shallot seeds (TSS). True shallot seed has more advantages than bulbs; therefore, developing it for future use as a higher-quality planting material is critical to resolving problems with bulb planting materials. However, TSS production in Indonesia still has obstacles, such as the low percentage of plants that produce flowers and the formation of flowers that need to be synchronized (Nurjanani and Djufry 2018). Several varieties have percentages of flowering, only around 30% (Pandiangan *et al.* 2015). Increased flowering

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capacity of shallot plants is critical because it is closely related to true seed production. According to Wibowo and Purwaningsih (2018), because seeds are produced as a result of flower pollination, the number of flowers produced is directly proportional to the yield of seeds; the more flowers produced, the more seeds produced. The planting material used for TSS production comes from shallot bulbs cultivated for further flowering and directed to produce botanical seeds or TSS.

The ability of plants to flower is strongly influenced by the type of variety used (Idhan 2016) because not all shallot varieties can flower and produce seeds. Hence, variety is a crucial factor to note. Variety significantly affects flowering time, height and diameter of flower stalks, number of umbels per plant, umbel diameter, and seed yield per hectare in onion plants (Fufa *et al.* 2021). It is important to develop varieties that have high production potential, one of which is increasing the ability to flower, which will then be in line with TSS production so that it will become more profitable in the future, especially for local varieties, because apart from increasing the existence of these varieties, another advantage gained is suppressing seed imports, increasing national income, having a more positive impact on increasing the welfare of farmers, increasing the existence of producing regions, as well as proving the potential of local varieties that can compete with foreign varieties and deserve to be hosts in their own country. Some of these high-yielding local varieties include the Lokana variety from Bantaeng, the Rubaru variety from Sumenep, and the Ambassador 3 Agrihorti variety produced by the Vegetable Crops Research Institute (Balitsa), West Bandung, which still needs to be improved.

Flowering in shallot plants can be optimized through the application of zinc (Zn), which is one of the crucial micronutrients involved in compiling and activating more than 150 enzymes and hormones (Mohammed *et al.* 2018), including enzymes related to carbohydrate metabolism, auxin metabolism, as well as being able to increase the number of flowers, fruit as well as plant resistance to pathogens (Khan *et al.* 2022). In addition, Zn has various other functional roles in plants, such as cytochrome synthesis, influencing dehydrogenase activity, and playing an essential role in forming chlorophyll (Kumar *et al.* 2021). Zn deficiency decreases photosynthesis by 50–70% (Rudani *et al.* 2018), inhibits nitrogen metabolism, reduces flowering and fruit development, extends the growth period, and reduces plant quality and yield (Prasad and Subbarayappa 2018). The research results by Zaman *et al.* (2019) reported that the application of Zn significantly affected the number of flowers in onion plants. Ahmad *et al.* (2019), through their research, also reported that Zn significantly affected flowering in flax plants (*Linum usitatissimum* L.). Zn can be absorbed by plants through the leaves (Herniwati 2022), so applying Zn through the leaves is more effective because it is efficient, needs less, and plants respond to nutrients more quickly (Kumar *et al.* 2015). Information on the generative characteristics or their relationship to the flowering ability of the local varieties used in this study is still very limited, and some of them do not yet exist, so it is critical to investigate them more. This study aimed to evaluate the treatment of three shallot varieties and doses of zinc (Zn) on generative traits of local shallots.

2. Materials and Methods

2.1. Study Area

The research was conducted in an open field in Muntea, Bonto Lojong Village, Ulu Ere District, Bantaeng Regency, South Sulawesi, coordinates -5°26'1.53658" S 119°56'53.97911" E, at an altitude of 1348 m above sea level from October 2022 to January 2023. Data related to average air temperature, soil temperature, air humidity are presented in Table 1, while data from soil analysis before the research are presented in Table 2

2.2. Plant Materials

In this study, three varieties of local shallot were used, namely, the Lokana variety obtained from Bantaeng Regency, South Sulawesi; the Rubaru variety obtained from Sumenep Regency, East Java; and the Ambassador 3 Agrihorti variety obtained from the Vegetable Crops Research Institute (Balitsa), West Bandung. Apart from that, other materials used are UV plastic (14%), zinc sulfate heptahydrate ($ZnSO_4 \cdot 7H_2O$) (Merck®), chicken manure, NPK fertilizer, SP-36 fertilizer, benzyl amino purine (BAP), distilled water, potassium hydroxide (KOH) 1 M.

Table 1. Air temperature, soil temperature, and humidity at the research location

Month	Air temperature (°C)	Soil temperature (°C)	Humidity (%)
October	19.52	23.48	83.00
November	20.14	23.78	79.65
December	19.64	23.61	81.52
January (early)	20.50	22.62	74.38

Table 2. Chemical properties of soil

Parameters	
pH	5.87
Carbon	1.15%
Nitrogen	0.10%
C/N Ratio	12
Phosphorus	11.37 ppm
Potassium	0.15 cmol (+)/kg
Zinc	62.15 ppm

2.3. Experimental Design

This study was structured using a split-plot design, where the main plots were varieties (V): Lokana (v1), Rubaru (v2), and Ambassador 3 Agrihorti (v3). In addition, sub-plot treatment, namely the dose of zinc (Z): 0 kg ha^{-1} (z0); 0.5 kg ha^{-1} (z1); 1 kg ha^{-1} (z2); and 1.5 kg ha^{-1} (z3), which was repeated three times, so there were 36 experimental units.

2.4. Procedures

2.4.1. Cultivation Process

Preparation for planting included making beds measuring 90 cm × 300 cm and 30 cm high, primary fertilization with SP-36 at a dose of 280 kg ha^{-1}, and chicken manure at 10 tons ha^{-1}, done three days before planting. Then, installing plastic mulch, shading with ultraviolet (UV) plastic (14%), and soaking bulbs with 100 ppm BAP (Kurniasari *et al.* 2017) 1 hour before planting. The planting material used was a single bulb with uniform weight and shelf life. The spacing used is 20 × 20 cm.

2.4.2. Application of Zinc

Zinc fertilizer application was carried out by spraying on the leaves using a sprayer when the shallot plants were 15, 30, and 45 days after planting (DAP) according to the treatment dose, namely 0 kg ha^{-1}; 0.5 kg ha^{-1} (0.045 g for one-time application); 1 kg ha^{-1} (0.09 g for one-time application); and 1.5 kg ha^{-1} (0.135 g for one-time application) with a constant volume of 16.66 ml per clump for each application. Spray application is carried out at 9 AM.

2.4.3. Plant maintenance

Plant maintenance includes watering, replanting, fertilizing, and controlling plants and pests.

2.5. Parameters

Parameters observed in this study included generative phase parameters, namely of umbel emergence (DAP), age of sheath breaking (DAP), age of blooming >75% (DAP) (calculated when 10% of the plants in the experimental plots have shown these characters). All of those parameters are counted since planting day. Also, the percentage of flowering plants (%) was counted at 130 DAP. Morphological parameters include number of umbels per clump (stalk), umbel stalk length (cm), umbel stalk diameter (cm), number of flowers per umbel. These parameters were measured when the pollen was ripe in each umbel sample.

Leaf trait parameters (chlorophyll index, stomata density (mm^2), and stomata opening area (µm^2) were measured after zinc application at the plant age of 50 DAP. In addition, the percentage of flowering plants was calculated using the formula Marlin *et al.* (2018):

$$\%\ \text{Flowering plant} = \frac{\text{Number of flowering plant}}{\text{Total plant}} \times 100\%$$

2.6. Data Analysis

The data obtained were analyzed using analysis of variance. If it is significant, the least significant difference test (LSD) with α 0.05 was performed. All data analysis processes were carried out using Microsoft Excel 2021 software.

3. Results

3.1. Umbel Emergence (DAP)

According to the analysis of variance, there was no significant interaction between the varietal treatment and the Zn dose. In contrast, the single variety treatment significantly affected the age of the umbels on shallot plants (Table 3). The fastest average umbel age emergence is the Rubaru variety (30.17 DAP), which is not significantly different from Ambassador 3 Agrihorti (32.17 DAP) (Table 3).

3.2. Age of Sheat Breaking and Flower Blooming (DAP)

There was an interaction between the treatment of shallot varieties and the dose of Zn, which had a very significant effect on the age of sheath breaking and the age of flower blooming. The fastest average sheat breaking on the Rubaru and Zn at a dose of 1.5 kg ha^{-1} (55.33 DAP), which is not significantly different from the interaction between the Ambassador 3 Agrihorti variety and zinc at a dose of 1.5 kg ha^{-1} (58.33 DAP). The fastest average age of blooming was Rubaru and Zn at a dose of 1 kg ha^{-1} (78.00 DAP), which is not significantly different from other doses of zinc (Table 4).

3.3. Morphology Traits of Generative Organs

There was an interaction between the treatment of shallot varieties and the dose of Zn, which had a very significant effect on the umbel stalk length and number of flowers per umbel and had a significant effect on the number of umbels per clump, umbel stalk diameter, and flowering plant percentage (Table 5). The interaction between the Ambassador 3 Agrihorti variety and the application of zinc at a dose of 1.5 kg ha^{-1} recorded the highest number of umbels per clump (6.89), which was not significantly different from other application doses, the Rubaru variety with 1.5 kg ha^{-1} (5.94). The umbel with the most extended stalk was recorded in the interaction between the Lokana variety and the application of zinc at a dose of 1.5 kg ha^{-1} (74.44 cm), significantly different from the other doses and varieties. Accordingly, the interaction of the Lokana variety with the application of zinc at a dose of 1.5 kg ha^{-1} also recorded the widest tuber diameter (0.74 cm), significantly different from other doses and varieties but significantly different from the other two varieties.

The highest number of flowers per umbel was recorded in the interaction treatment between Ambassador 3 Agrihorti varieties and the application of zinc at a dose of 1.5 kg ha^{-1} (129.61), which was not significantly different at doses of 1 kg ha^{-1} and 0.5 kg ha^{-1} also with the other two varieties. In observing the percentage of plants that successfully flowered, the highest number of plant populations that successfully flowered was recorded, namely the interaction between the Ambassador 3 Agrihorti variety and zinc application at a dose of 1 kg ha^{-1} (97.78%), which was not significantly different from other doses of zinc application, also with the interaction between the Rubaru variety and the application of zinc at a dose of 1 kg ha^{-1}.

Table 3. Average of umbel emergence

Variety	Umbel emergence (DAP)
Lokana	60.92^{a}
Rubaru	30.17^{b}
Ambassador 3 Agrihorti	32.17^{b}
LSD (α 0.05)	4.06

Table 4. The average age of sheats breaking and blooming

Variety	Zinc 0.0 kg ha^{-1}	0.5 kg ha^{-1}	1.0 kg ha^{-1}	1.5 kg ha^{-1}
Age of sheath breaking (DAP)				
Lokana	75.33^{a}_{p}	74.67^{a}_{p}	68.67^{a}_{q}	68.33^{a}_{q}
Rubaru	57.33^{c}_{p}	57.00^{b}_{p}	55.67^{b}_{q}	55.33^{b}_{q}
Ambassador 3 Agrihorti	61.33^{b}_{p}	60.33^{b}_{p}	59.00^{b}_{q}	58.33^{b}_{q}
LSD variety (α 0.05)	3.41			
LSD zinc (α 0.05)	1.25			
Age of blooming (DAP)				
Lokana	102.67^{a}_{p}	100.33^{a}_{pq}	98.00^{a}_{q}	95.67^{a}_{q}
Rubaru	79.67^{b}_{p}	80.33^{b}_{p}	78.00^{c}_{p}	79.00^{b}_{p}
Ambassador 3 Agrihorti	81.67^{b}_{p}	78.67^{b}_{q}	82.00^{b}_{p}	79.00^{b}_{q}
LSD variety (α 0.05)	3.40			
LSD zinc (α 0.05)	2.42			

means followed by the same letter in columns (a, b, c) and rows (p, q) are not significantly different according to the least significant different test (LSD α 0.05).

Table 5. The average number of umbels per clump, umbel stalk length, umbel stalk diameter, number of flowers per umbel, and percentage of shallot flowering plants

Variety	Zinc 0.0 kg ha^{-1}	0.5 kg ha^{-1}	1.0 kg ha^{-1}	1.5 kg ha^{-1}
Number of umbels per clump (stalk)				
Lokana	1.72^{b}_{q}	1.39^{b}_{q}	2.11^{b}_{pq}	3.06^{b}_{p}
Rubaru	5.56^{a}_{q}	6.83^{a}_{p}	6.06^{a}_{pq}	5.94^{a}_{pq}
Ambassador 3 Agrihorti	6.33^{a}_{p}	6.11^{a}_{p}	6.44^{a}_{p}	6.89^{a}_{p}
LSD variety (α 0.05)	1.08			
LSD zinc (α 0.05)	0.99			
Umbel stalk length (cm)				
Lokana	67.28^{ab}_{q}	61.56^{b}_{r}	67.78^{a}_{q}	74.44^{a}_{p}
Rubaru	70.67^{a}_{p}	69.39^{a}_{p}	66.56^{a}_{p}	67.00^{b}_{p}
Ambassador 3 Agrihorti	64.00^{b}_{p}	65.00^{ab}_{p}	66.33^{a}_{p}	63.39^{b}_{p}
LSD variety (α 0.05)	4.52			
LSD zinc (α 0.05)	4.92			

Table 5. Continued

Variety	Zinc 0.0 kg ha^{-1}	Zinc 0.5 kg ha^{-1}	Zinc 1.0 kg ha^{-1}	Zinc 1.5 kg ha^{-1}
Umbel stalk diameter (cm)				
Lokana	0.54^{a}_{r}	0.56^{a}_{qr}	0.63^{a}_{q}	0.74^{a}_{p}
Rubaru	0.44^{ab}_{q}	0.46^{a}_{pq}	0.54^{ab}_{p}	0.52^{b}_{pq}
Ambassador 3 Agrihorti	0.41^{b}_{p}	0.46^{a}_{p}	0.45^{b}_{p}	0.47^{b}_{p}
LSD variety (α 0.05)	0.10			
LSD zinc (α 0.05)	0.08			
Number of flowers per umbel				
Lokana	62.06^{b}_{r}	59.72^{b}_{r}	79.56^{b}_{q}	111.28^{a}_{p}
Rubaru	108.89^{a}_{q}	122.67^{a}_{p}	122.50^{a}_{p}	128.94^{a}_{p}
Ambassador 3 Agrihorti	107.67^{a}_{q}	121.28^{a}_{p}	116.94^{a}_{pq}	129.61^{a}_{p}
LSD variety (α 0.05)	20.94			
LSD zinc (α 0.05)	13.52			
Flowering plant percentage (%)				
Lokana	21.11^{b}_{p}	10.00^{b}_{q}	22.22^{b}_{p}	28.89^{b}_{p}
Rubaru	93.33^{a}_{p}	94.44^{a}_{p}	93.89^{a}_{p}	93.33^{a}_{p}
Ambassador 3 Agrihorti	97.22^{a}_{p}	96.67^{a}_{p}	97.78^{a}_{p}	96.67^{a}_{p}
LSD variety (α 0.05)	9.67			
LSD zinc (α 0.05)	8.25			

means followed by the same letter in columns (a, b) and rows (p, q, r) are not significantly different according to the least significant different test (LSD α 0.05)

3.4. Leaf Traits

There was an interaction between the shallot variety treatment and the Zn dose, which had a significant effect on the chlorophyll index and stomata density with the highest average chlorophyll index in the Rubaru and Zn varieties at a dose of 1.5 kg ha^{-1} (48.50), which is not significantly different from Lokana, also application of zinc at 1 kg ha^{-1}. The highest average density of stomata was in the Ambassador 3 Agrihorti variety with a Zn dose of 0 kg ha^{-1} (71.34 mm^2), which is not different from 0.5 and 1 kg ha^{-1}, also with the Lokana variety (Table 6). The treatment of shallot varieties and Zn doses had no significant effect on the stomatal opening area (Table 7).

The highest average stomata opening area in the single treatment variety was Lokana (177.34 µm^2), while the highest average stomata opening area was in the Zn single treatment at a dose of 1.5 kg ha^{-1} (175.40 µm^2).

Table 6. Average chlorophyll index and stomata density of shallot plants

Variety	Zinc 0.0 kg ha^{-1}	Zinc 0.5 kg ha^{-1}	Zinc 1.0 kg ha^{-1}	Zinc 1.5 kg ha^{-1}
Chlorophyll index				
Lokana	25.16^{ab}_{q}	45.35^{a}_{p}	46.92^{a}_{p}	44.74^{a}_{p}
Rubaru	25.78^{a}_{q}	28.53^{b}_{q}	42.33^{ab}_{p}	48.50^{a}_{p}
Ambassador 3 Agrihorti	15.08^{b}_{q}	28.50^{b}_{pq}	35.20^{b}_{p}	24.37^{b}_{q}
LSD variety (α 0.05)	10.66			
LSD zinc (α 0.05)	10.17			
Stomata density (mm^2)				
Lokana	59.45^{a}_{p}	40.76^{b}_{q}	40.76^{b}_{q}	49.26^{a}_{pq}
Rubaru	44.16^{b}_{q}	54.35^{ab}_{pq}	61.15^{a}_{p}	47.56^{a}_{pq}
Ambassador 3 Agrihorti	71.34^{a}_{p}	57.75^{a}_{pq}	61.15^{a}_{pq}	52.65^{a}_{q}
LSD variety (α 0.05)	14.94			
LSD zinc (α 0.05)	14.22			

means followed by the same letter in columns (a, b) and rows (p, q) are not significantly different according to the least significant different test (LSD α 0.05)

Table 7. The average stomata opening area of shallot plants

Treatment	Stomata opening area (µm^2)
Variety	
Lokana	177.34
Rubaru	162.63
Ambassador 3 Agrihorti	135.61
LSD (α 0.05)	ns
Zinc doses	
0.0 kg ha^{-1}	157.52
0.5 kg ha^{-1}	132.40
1.0 kg ha^{-1}	168.78
1.5 kg ha^{-1}	175.40
LSD (α 0.05)	ns

ns (non-significant) based on analysis of variance

4. Discussion

The interaction between varieties and Zn had the best effect on several parameters, including the length and diameter of the umbel stalk, the age of the broken sheath, the chlorophyll index, and the number of flowers. Each shallot variety gives a different response to the Zn application. The generative characters shown between shallot varieties tested had differences, such as the Lokana variety, with Zn showing characteristics of the highest umbel length and stalk diameter compared to the Rubaru and Ambassador 3 Agrihorti varieties.

In contrast, the Ambassador 3 Agrihorti variety had more flowers than the Lokana and Rubaru varieties. Each variety has a different ability to express genetic characteristics, so that morphological diversity will be found between varieties. This follows the opinion of Kusmana *et al.* (2016) that one of the causes of morphological diversity in plants is due to differences in genetic makeup between these plants. The significant results shown by these parameters cannot be separated from the role of Zn as a nutrient, which plays an essential role in various plant metabolic processes Saleem *et al.* (2022), that Zn contributes to various physiological activities that can increase growth, development and yield in plants. Zn positively affected plant morphological characters, which proved far better than Zn without treatment. The same thing was also proven through research conducted by Ahmad *et al.* (2019), who reported that the application of Zn had a positive effect on several flowering parameters of Flax plants (*Linum usitatissimum* L.) including plant height, stalk diameter, number of branches, number of tillers and number of flowers per plant. The same thing was also expressed by Dogra *et al.* (2019) through the results of their research, which reported that Zn applied together with boron gave maximum results, including the parameters of the number of umbels and the number of flowers per plant in onions which among others were influenced by Zn's ability to synthesize proteins which led to much more plant growth and development.

The Rubaru variety combined with Zn gave the best results for a faster-breaking sheath age. The shorter the sheath breaks, the more likely it is to affect the time the flowers bloom and the time to harvest the seeds later, which can happen more quickly. The ability to flower faster in the Rubaru variety is inseparable from the genetic potential supported by a suitable environment. This is in line with the opinion of Marlin *et al.* (2021) that genetic abilities and appropriate environmental conditions influence the ability to flower shallot plants; the same thing was stated by Fairuzia *et al.* (2022), that each variety has a different flowering time and ability, depending on genetic abilities and interaction with the environment. The Rubaru variety showed a flowering character: the sheath breaking time faster than the Lokana and Ambassador 3 Agrihorti varieties. According to Marlin *et al.* (2018), the process of rupture of the umbel is closely related to the process of maturation of other flower organs in the umbel so that the time when the sheath bursts quickly can be closely related to the time when the flowers bloom and harvest time which also occurs faster. The ability of the Rubaru variety is also inseparable from the role of the Zn nutrient. Zn has various functional roles, including its relation to accelerating flowering time in plants. This follows the opinion of Khosa *et al.* (2011), who said that applying Zn to leaves can increase the rate of photosynthesis, which is in line with increasing cell enlargement and elongation so that plants can flower earlier. Zaman *et al.* (2019) also added that increasing the Zn dose showed a faster flowering time in onion plants.

The Zn-applied Rubaru variety also showed the best results on the chlorophyll index. Chlorophyll is a factor that influences the process of photosynthesis (Nur *et al.* 2020), so the chlorophyll content will align with the process of photosynthesis. Optimization of the increase in chlorophyll content is influenced by the application of Zn, which has various roles that affect the morphological and physiological components in plants, one of which is increasing the chlorophyll content. This is supported by the opinion of Rudani *et al.* (2018) that Zn plays an essential role in plant disease resistance, photosynthesis, cell membrane integrity, protein synthesis, and pollen formation and increases antioxidants and chlorophyll in plant tissues.

Alone, the Rubaru variety had the best effect on the faster age of the umbel. The Rubaru variety can flower and shows a faster flowering character than the Lokana and Ambassador 3 Agrihorti varieties. The results of this study are inversely proportional to the results of a study conducted by Fairuzia *et al.* (2022), who reported that the Rubaru variety could not form flowers in both the long and short-day treatments. Flowering in shallot plants is influenced by various factors, one of which is temperature, and the temperature for flowering in plants is also different for each variety. This follows the opinion of Fahrianty *et al.* (2020) that each variety has specific temperature criteria to initiate its flowering. The average air temperature of the study sites from the beginning of planting until the appearance of the umbel was 19.52°C to 19.64°C (October-December), which is probably the appropriate temperature to initiate faster flowering on the Rubaru. Temperature plays a critical role in determining the flowering of shallot plants. As stated by Kamsurya *et al.* (2022), temperature considerably influences the duration of plant development because it is related to photosynthesis and respiration in plants.

Ambassador 3 Agrihorti and Rubaru have the same potential in the flowering plant percentage (%) parameter. Lokana and Rubaru have the same potential in the shallot plants' average chlorophyll index and stomata density parameter. Overall, it can be concluded that each variety applied to Zn gave various responses to various parameters. Shallot varieties and Zn doses accelerated the age of sheaths breaking and blooming flowers. They increased the number of umbels, umbel stalk length, umbel stalk diameter, number of umbels and flowers, percentage of flowering plants, chlorophyll index, and stomata density. Concerning seed production, the Ambassador 3 Agrihorti has better potential to be developed, as seen from the number of flowers per umbel and a higher percentage of flowering plants than the Rubaru and Lokana varieties. Ambassador 3 Agrihorti also has a relatively fast flowering time, which statistically differs from the Rubaru variety insignificantly, so it has the potential to be developed for botanical seed production.

Each variety, Lokana, Rubaru, and Ambassador 3 Agrihorti, gave a different response to each given Zn treatment, so in the future, it is imperative to determine the Zn dose according to the shallot variety to be used, especially concerning the purpose of flowering and shallot seed production. Overall, a Zn dose of 0.5 kg ha^{-1} is sufficient to increase the number of flowers on the Ambassador 3 Agrihorti variety, where the number of flowers is closely related to the later true shallot seed (TSS) production. However, further research in this regard still needs to be carried out to determine the potential of these three local varieties to produce true shallot seeds.

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