Interaction of growth environmental and aplication of GA3 concenration on shallot productivity

by Fachirah Ulfa

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Abstract. The purpose of this study was to evaluate the combination of technology using GA3 and agro-climate-based growing environment to increase shallot production in the lowlands. The study was designed with a nested factorial design, where the replicates were nested in an agro-climatic environment. The growing environment used consists of three conditions, namely open nature (e1), screen house (e2), UV plastic (e3). Meanwhile, the GA3 concentration (g) factor used consists of 4 levels, namely 0 ppm (g0), 100 ppm (g1), 200 ppm (g2) and 300 ppm (g3). This research design will be repeated 3 times for each treatment, so that the total experimental plot is 36 experimental units. The characters observed consisted of six characters, namely the number of leaves, absorption, reflection, tuber fresh weight, tuber diameter and tuber production. The results of this study indicate that GA3 treatment and UV application are very influential in increasing the productivity of shallots. The combination of 200 ppm GA3 concentration with the use of UV is the recommended technology in shallot cultivation. The fresh weight character of the tuber is a recommended secondary character in evaluating the potential of shallot cultivation technology. Hasanuddin University, Jl. Perintis Kemerdekaan No. KM.10, Tamalanrea Indah, Kec. Tamalanrea, Kota Makassar, Sulawesi Selatan 90245.

1. Introduction

Shallots (*Allium ascalonicum* L.) are included in the tuber vegetable group which is useful for maintaining and improving the health of the human body, because shallots contain nutrients that can add value and complement nutrition[1]. The national production of shallots in 2017 reached 1,470,154 tons. The provinces of Central Java, East Java, West Nusa Tenggara, West Java and South Sulawesi are the largest shallots producing provinces with production reaching 1.27 tons or 86.68 percent of national production. However, increasing population growth requires an increase in shallot production every year. According to BPS (2019)[2] shallots production in 2018 reached 1.5 million tons compared to 2017, which was 1.47 million tons. However, this production is more focused on the extension program. On the other hand, the productivity of shallots has decreased annually, namely in 2017, namely 9.29 tonnes ha^{-1}, in 2016 which was 9.67 tonnes ha^{-1} compared to 2015 shallots productivity which was 10.06 tonnes ha^{-1}. This indicates that increasing production through intensification programs is important. One of them is through setting the growing environment and giving growth regulators.

The effort to plant shallot seeds in order to grow and produce greatly is done by giving growth regulators (PGR). PGR is a substance that plays a role in plant metabolism. According to Sumarni (2012)[3] one of the PGR that can increase the germination of shallot seeds is the hormone Giberellic Acid (GA3). GA3 plays a role in cell growth and division, breaks seed dormancy and mobilizes the endosperm during early embryonic growth [4]. The response of plants to GA3 was influenced by the concentration and timing of administration. This is proven by Haq and Iskandar (2014)[5], that the

application of GA3 as much as 100 ppm by soaking for 30 minutes in manjung varieties can increase plant height and the number of leaves in shallots.

Growing environment settings such as sunlight intensity, temperature and precipitation are important in shallot cultivation. Shallots planted with shade, either using UV plastic or in a screen house, can reduce and filter the intensity of solar radiation so as to maximize the photosynthetic process for plants. The use of screen houses in horticultural cultivation is designed to manipulate the environment for optimum plant development and growth. Reduction in light intensity due to the use of screen houses affects the vegetative and generative growth of plants [6]. Therefore, this research on agro-climate patterns through building adjustment on shallot cultivation in the lowlands is important to do.

Based on the description above, the use of GA3 and environmental adjustment for growth is important in shallot cultivation. However, the interaction between the two has not been studied in more depth. Therefore, development and research related to the interaction between the two becomes an interesting topic to study. The purpose of this study was to evaluate the combination of technology using GA3 and agro-climate-based growing environment to increase shallot production in the lowlands.

2. Method

This research was carried out in Experimental Farm Land, Hasanuddin University, Makassar. The research was carried out from September to December 2020.

2.1 Research Design

The study was designed with a nested factorial design, where the replicates were nested in an agro-climatic environment. The growing environment used consists of three conditions, namely open nature (I1), screen house (I2), UV plastic (I3). Meanwhile, the GA3 concentration (g) factor used consists of 4 levels, namely 0 ppm (g0), 100 ppm (g1), 200 ppm (g2) and 300 ppm (g3). This research design repeated 3 times for each treatment, so that the total experimental plot is 36 experimental units.

2.2 Research Implementation

Soil processing was done using a tractor with the size of each bed is 1.2 m x 1.6 m with a distance between beds of 30 cm. For each bed, a planting hole is made using a bag with a spacing of 15 cm x 10 cm therefore there are ± 60 planting holes per plot. Each hole is planted with 1 seed. Fertilization is done by sowing around the growing point of the shallot plant. Urea, SP36 and NPK fertilizers were given 3 times, at the age of 15, 30, and 45 days. Plant maintenance includes irrigation, weeding, soil loosening, thinning and controlling pests and diseases. Harvesting is done when 70-80% of the stems are soft, the plants fall, and the leaves turn yellow, the tubers are fully formed and compact. It was done manually by pulling the onion plants and then processed to observe the production components.

2.3 Observation Parameters

Number of leaves (foliage), Absorption (%), Reflection (%). Observation of the components of sunlight energy, namely the amount of radiation reflected (%) and the amount of radiation absorbed (%), was done using the Miniature Leaf Spectrometer C1-710 / 720. Observations were made 40 DAS after 2 times of treatment applications. Fresh Bulbs Weight (g), Tuber Diameter (cm) and Tuber Production ($t.ha^{-1}$).

2.4 Data analysis

Observation data were analyzed using analysis of variance. Characters that have significant interactions are then analyzed by correlation analysis and cross-examination analysis. The results of this analysis will get secondary characters that support potential productivity characters. The best secondary characters and productivity were analyzed more deeply by the LSD test at the 5% level. The software used is STAR 2.0.1

3. Result and Discussion

The results of the analysis of variance showed that the characters of number of leaves (LN), absorption, reflection, fresh weight of tubers (FTW), diameter of tubers (TD), production of tuber (ton/ha) were significantly influenced by GA3 treatment, environmental conditions and the interaction between the two (Table 1). This indicates that GA3 treatment and environmental differences affect almost all plant phases, both vegetative and generative, especially onion productivity. The effect of both treatments independently has also been reported by Berson et al. (2015), Triharyanto et al. (2018), Fahrianty et al. (2020) on GA3 [7-9] on agro-climate or the growing environment. Meanwhile, the real variety of interactions indicates that there is an optimal combination pattern between fertilizer treatment and the environment on shallot growth, so evaluation of this combination is important. The evaluation of the combination between the two treatments will be more effective in terms of productivity and productivity supporting character[. This was also reported that stated the use of a combination of the main character and production supporting characters can increase the effectiveness of selection and evaluation. One of the methods that can be used in determining the supporting character is correlation analysis and cross-examination. [10-11].

The results of the correlation analysis are shown in Table 2. The correlation is focused on the main character, namely tuber productivity (ton/ha). Based on this correlation, tuber productivity has a significant correlation with tuber diameter (0.50), tuber fresh weight (0.67), absorption (0.74) and reflection (0.62). The results of this correlation are also in line with the statement of Vivi et al. (2010)[13] the size of the tuber weight and diameter are indirectly influenced by the number of tubers formed. Each average crop only forms 1–1.12 tubers so that the use of the resulting photosynthate is only focused on an average of one tuber, so it can be said that the tubers formed have relatively no different weight and diameter. In general, the results of correlation analysis are widely used in determining the supporting characters of the main characters [11] However, the results of this correlation cannot explain the more specific effect between the diversity of productivity and the diversity of correlated characters. The analysis that can be used to predict variance patterns that affect productivity is cross-examination.

Table 1. The results of analysis of variance on the treatment of different environmental conditions and the concentration of GA3

Characters	GA3	Replication:GA3	Environment	GA3: Environmet	Error
LN	1.78*	0.38tn	2.93**	2.07**	0.27
ABSORPTION	0.0025**	0.0001tn	0.0134**	0.0017**	0.0002
REFLECTION	0.0013**	0.0001tn	0.003**	0.0031**	0.0002
FTW	2441.01**	117.64tn	15680.53**	148.34*	53.47
TD	0.2650**	0.0002tn	0.0794**	0.0067**	0.0008
TP	0.5386**	0.0583tn	1.2793**	0.1850*	0.0518

Note: LN = Number of Leaves, Absorption, Reflection, FTW = Fresh Weight of Tuber, TD = Diameter of Tubers, TP = Production of Tubers

Table 2. Correlation analysis of several shallot characters against different environments and GA3 concentrations

	LN	ABSORPTION	REFLECTION	FTW	TD	TP
LN	1.00					
ABSORPTION	0.21	1.00				
REFLECTION	0.11	0.79	1.00			
FTW	0.48	0.35	0.09	1.00		
TD	0.43	0.38	0.00	0.90	1.00	
TP	0.04	0.74*	0.62*	0.67*	0.5	1

Note: * significant at 5% error, LN = Number of Leaves, Absorption, Reflection, FTW = Fresh Weight of Tuber, TD = Diameter of Tubers, TP = Production of Tubers

The results of the cross-examination in Table 3 show that the character of the fresh weight of the tubers is the only character that has a significant direct effect on productivity. In general, cross-examination is an analysis used to divide correlation into direct and indirect effects[11]. Direct influence is the independent influence of a character that affects the diversity of the main characters [14]. Therefore, this analysis is often used in finding secondary characters, both for the selection process and for the evaluation process. Based on the results of cross-examination analysis, the character of tuber fresh weight can be used as the best secondary character along with productivity in evaluating the use of combination GA3 hormone treatment to differences in the growing environment.

Table 3. Cross-Examination of several characteristics of growth on productivity

Characters	Direct Influence	Indirect Influence				Residual
		Absorption	Reflection	FTW	TD	
Absorption	0.29		0.21	0.24	-0.08	0.20
Reflection	0.29	0.21		0.07	0.00	0.17
FTW	0.68	0.10	0.03		-0.19	0.43
TD	-0.22	0.11	0.00	0.59		-0.10

Note: Absorption, Reflection, FTW = Fresh Weight of Tuber, TD = Diameter of Tubers

Based on the results of the LSD test, treatment of 300 ppm GA3 and UV plastic showed the best average fresh weight of tubers (145.6 g) in this study (Table 4). Although the best combination productivity character is shown by the combination of 200 ppm GA3 concentration and UV application (2.33 ton/ha), this value is not significantly different from the combination of 300 ppm GA3 and UV application (2.05 ton/ha). In general, application of gibberellin at a concentration of 200-300 ppm can initiate cell division which correlates with an increase in the amount of solute in the tuber. This is also consistent with the report of Helaly et al. (2016)[14] which states that increasing the concentration of gibberellin to 250 ppm can increase the components of shallot production. In addition,, application GA3 will trigger the growth of lateral shoots which correlates with bulb formation in shallots, [15]so that the higher the concentration of GA3 can stimulate bulb growth in shallots. Therefore, it is important to appply GA3.

Table 4. Average fresh weight of harvested tubers/hill under various environmental conditions

GA3	Open Nature	Screen House	UV Plastic
0 ppm	46.80 b	54.47 d	111.43 c
100 ppm	53.43 b	71.70 c	132.50 b
200 ppm	58.83 b	84.97 b	128.23 b
300 ppm	76.73 a	110.03 a	145.60 a

Note: GA3 = Giberrelin Acid

The use of UV plastics also provides an optimal growing environment for tuber fresh weight and productivity characteristics. Greenhouse environments can be better controlled than open and screen environments, particularly for soil moisture content and soil moisture. An environment without UV applications will make it easier for excess precipitation to enter the soil in large quantities. This can induce rot in the formation of shallot bulbs, so that fruit productivity decreases [16]. According to Pejić et al. (2011)[17] and Schmidt and Zinkernagel (2017)[18], regular irrigation can increase the productivity of onions. In addition, according to the Adnan (2019)[19] regulation of water content through the provision of ogranics and spacing plays a role in increasing shallot production. Based on this, environmental regulation, especially moisture content, temperature and humidity, is the key to increasing onion production.

Table 5. Average tuber production tonnes / ha under various environmental conditions

GA3	Open Nature	Screen House	UV Plastic
0 ppm	1.28 a	1.52 b	1.44 b
100 ppm	1.25 a	1.51 b	1.50 b
200 ppm	1.27 a	2.00 a	2.33 a
300 ppm	1.20 a	2.17 a	2.05 a

Note: GA3 = Giberrelin Acid

The results of the regression analysis showed that the fresh weight of the tubers had a fairly good linear regression on productivity (Figure 1). Even in this figure, the linear projection shows a sloping gradient. This is because productivity is a character that is strongly influenced by many genes or many factors. However, with the results of this study, the weight of fresh tubers can be a reference in increasing or evaluating the potential productivity of a shallot cultivation line or technology. Based on the overall results of the study, the combination of gibberellin, especially 200 ppm GA3, and UV application is very important in increasing the productivity of onions.

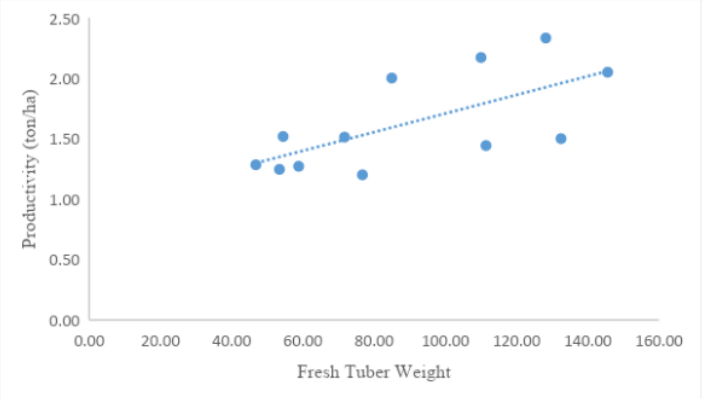

Figure 1. Linear regression

4. Conclusion

GA3 treatment and UV application were very influential in increasing the productivity of shallots. The combination of 200 ppm GA3 concentration with the use of UV is the recommended technology in shallot cultivation. The fresh weight character of the tuber is a recommended secondary character in evaluating the potential of shallot cultivation technology.

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