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Vegetative and Generative Growth Responses of Eban Local Cultivar Shallots Treated with Gibberellins (GA3) and P Fertilizers

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Abstract: One strategy to increase shallot productivity is to use fertilizers and growth regulators. The aim of the study was to determine the response of vegetative and generative growth of shallots to local Eban cultivars through the application of gibberellins and P fertilizers in the middle plains of North Central Timor District. This study used a factorial randomized block design (RBD). The first factor was the application of gibberellins (GA3), consisting of three treatments, namely without application of GA3 (control), application of 100 ppm GA_3 and application of 200 ppm of GA_3. The second factor was P fertilizer treatment which consisted of three treatments, namely without P fertilizer (P0), P fertilizer 50 kg/ha (P1) and P fertilizer 100 kg/ha (P2). The results showed that the 200 ppm gibberellin treatment had an effect on plant height. Treatment of 100 ppm gibberellins affected tuber diameter, tuber fresh weight and tuber dry weight. Treatment of P 200 kg/ha had an effect on plant height and number of leaves, treatment of P 100 kg/ha had an effect on the number of tillers. Generative growth did not occur in all the treatments tried, this was due to the influence of environmental factors such as high temperatures during the study.

Keywords: Eban Local Red Onion; Generative; Gibberellins; Phosphate; Vegetative

Introduction

The Eban area is located in West Miomaffo District, North Central Timor Regency, East Nusa Tenggara Province (Taena et al., 2022), which is a highland area and is very suitable for cultivating horticultural crops, including shallots. The local cultivar Eban shallot is a plant that has been cultivated by farmers for generations, with an adaptation area of ±750 m asl. Shallots, the local cultivar of Eban, almost experiences extinction due to extreme weather every year so that many farmers experience yield loss due to tuber rot. Shallots in North Central Timor Regency are generally imported from neighboring Regencies, for example from Rote, Kupang and Malacca Regencies.

One of the ways to save the germplasm of the local Eban shallot cultivar is to plant it in the middle plains because the middle lands have lower rainfall than the highlands. In addition, it is necessary to innovate cultivation by using true shallot seed (TSS) (Sumarni et al., 2013) because planting material is relatively easy and does not take up much space for storage, producing healthy tubers free of pathogens and increasing productivity. higher (Nurjanani & Djufry, 2019). One of the obstacles in TSS production is the problem of flowering which is still low (Rosliani et al., 2016). The influence of environmental factors on flowering events is very important to understand plant adaptation to climate change.The problem of onion flowering The red onion cultivar Eban can also produce flowers like several

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other local varieties in Indonesia, namely the Bima Brebes variety, the Maja Cipanas variety and the Rubaru variety from Sumenep district Eban local cultivar Shallot is able to produce flower formation into ka capsules and seeds.

Increasing vegetative and generative growth in shallots can be done by adding growth regulators such as gibberellins and P fertilizers. Gibberellins are plant hormones known biochemically as tetracyclic diterpenoid acids which can have a real effect on plant behavior including being able to replace the low temperatures needed to flowering of many species and increasing the C/N ratio in leaves through the activity of hydrolytic enzymes (Cardoso et al., 2012). According to Wittwer & Bukovac (1958), gibberellins play a role in cell enlargement (extension), root growth and enlargement, cambium activity, protein synthesis and induction of flowering. Gibberellins can stimulate vegetative growth such as stimulating the transition from the early leaf stage to juvenile maturity, the vegetative stage to flowering, fruit formation and seed development (Tütünoğlu et al., 2019).

The addition of P elements in organic and inorganic forms needs to be done to increase the P content in the soil into a form available to plants, namely in the form of phosphate (Siebers et al., 2012). Absorption of elemental P can increase flower formation (Schoebitz et al., 2013), as biocontrol (Trujillo et al., 2007) and produce phosphatase enzymes to hydrolyze organic P and inorganic P (Quiquampoix & Mousain, 2004). According to (Sumarni et al., 2013), phosphorus plays an important role in enzyme reactions, proteins and metabolic regulation in the cytosol and chloroplasts.The aim of this study was to increase the vegetative and generative growth of the local variety Eban red onion through the application of gibberellin and P fertilizer in the middle plains of North Central Timor Regency .

Method

This research was carried out from May to August 2021 at the Experimental Garden of the Faculty of Agriculture, University of Timor, Sasi Village, Kota Kefamenanu District. The tuber seeds selected have several criteria, namely having a weight of >5g/tuber, free from pests and diseases, not experiencing decay and having hard tubers. After the tuber seeds were prepared, GA3 was applied by soaking for 30 minutes according to the treatment.

Planting using planting media in the form of a mixture of soil and compost in polybags measuring 30 cm x 40 cm. Each polybag was planted with three tubers with a spacing of 10 cm between tubers. Polybags are placed on beds and shaded with UV plastic with a thickness of 1 mm. Phosphorus (P) fertilization is given twice, namely one week before planting together with the preparation of planting media and the second fertilization after the plants are 30 HST.

The experimental design used was a factorial randomized block design (RBD). The first factor is the application of GA3(G) consisting of three levels: G0 = Without GA3 (control), G1 = GA3 100 ppm, G2 = GA3 200 ppm. The second factor was the concentration of P fertilizer (P) consisting of three levels, namely P0 = (control), P1 = P fertilizer 100 kg/ha, P2 = P fertilizer 200 kg/ha. The treatment combinations were G0P0, G0P1, G0P2, G1P0, G1P1, G1P2, G2P0, G2P1, G0P2 with 3 replications, resulting in 27 experimental units. Observational data were analyzed using Anova analysis of variance with the statistical analysis system (SAS) program.

Result and Discussion

Result

The results of the analysis showed that the effect of the gibberellin treatment on plant height variables showed no significant effect on the gibberellin treatment, while the effect of P fertilizer on plant height showed a significant effect on the treatment without P fertilizer (P0) and the P fertilizer treatment of 200 kg/ha (Table 1).

Table 1. Effect of gibberellin treatment and P fertilizer on plant height (cm)

Treatment	P0	P1	P2
G0	34.22 aA	37.15 aA	37.06 aA
G1	28.95 aB	33.34 aA	33.52 aAB
G2	30.28 aB	33.64 aA	32.35 abB

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of P fertilizer.

The results of the analysis showed that the effect of gibberellin treatment on the number of leaves variable showed a significant effect on the treatment without gibberellins (G0), while the effect of P fertilizer on the number of leaves showed a significant effect on the treatment of P fertilizer 200 kg/ha (P2) (Table 2).

The results of the analysis showed that the effect of gibberellin treatment on the number of tillers had no significant effect, while the effect of P fertilizer on the number of tillers showed a significant effect on the treatment without fertilizer (P0), while the effect of P fertilizer was 100 kg/ha (P1) (Table 3).

Table 2. Effect of gibberellin treatment and P fertilizer on the number of leaves (strands)

Treatment	P0	P1	P2
G0	20.73 bA	25.14 aA	22.77 abB
G1	21.58 aA	23.45 aA	24.25 aAB
G2	22.57 aA	26.72 aA	26.70 aA

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of P fertilizer

Table 3. The effect of P fertilizer was 100 kg/ha (P1)

Treatment	P0	P1	P2
G0	4.60 aB	5.63 aB	5.77 aA
G1	6.57 aA	5.50 aB	6.87 aA
G2	6.10 aA	7.27 aA	6.47 aA

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of P fertilizer.

The results of the analysis showed that the effect of gibberellin treatment on tuber diameter variables had a significant effect on 100 ppm gibberellin treatment (G1) while the effect of P fertilizer on tuber diameter showed a significant effect on treatment without fertilizer (P0) (Table 4).

Table 4. Effect of gibberellins and P fertilizer treatment on tuber diameter

Treatment	P0	P1	P2
G0	2.01 aA	1.90 aA	2.13 aA
G1	1.42 bC	2.03 aA	1.78 aA
G2	1.72 aB	1.72 aA	1.64 aA

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of fertilizer.

The results of the analysis showed that the effect of gibberellin treatment on fresh weight of tubers planted had a significant effect on 100 ppm gibberellin treatment (G1), while the effect of P fertilizer on fresh weight of planted tubers showed a significant effect on treatment without fertilizer (P0) (Table 5).

Table 5. Effect of gibberellin treatment and P fertilizer on fresh weight of tubers planted (g)

Treatment	P0	P1	P2
G0	44.46 aA	40.95 aA	39.23 aA
G1	24.14 bB	45.90 aA	33.94 abA
G2	36.57 aAB	38.46 aA	31.73 aA

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of P fertilizer.

The results of the analysis showed that the effect of the gibberellin treatment on the tuber dry weight variable had a significant effect on the 100 ppm gibberellin treatment (G1), while the P fertilizer treatment had no significant effect on all the treatments tried (Table 6).

Table 6. Effect of gibberellin treatment and P fertilizer on tuber dry weight (g)

Treatment	P0	P1	P2
G0	41.34 aA	38.55 aA	38.65 aA
G1	21.43 bA	39.81 aA	32.94 abA
G2	31.41 aA	35.77 aA	28.01 aA

Information: G0 = without GA3, G1 = GA3 100 ppm, G2 = GA3 200 ppm, P0 = without P fertilizer, P1 = P fertilizer 100 tons/ha, P2 = P fertilizer 200 tons/ha. Numbers followed by the same letter in the same column or row show results that are not significantly different based on the DMRT test at α = 5%. Lower case letters to the side (in one row) indicate the effect of gibberellin treatment while capital letters down (in one column) indicate the effect of P fertilizer.

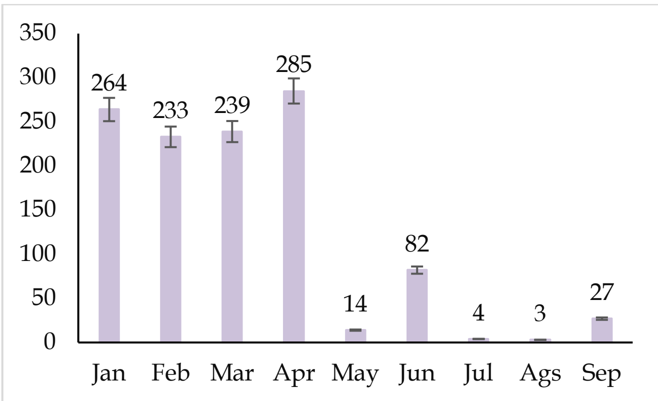

Figure 1. Data on the amount of monthly rainfall (mm) of Sasi Village, Kota Kefamenanu District in Year 2021 (Sumber : Stasiun Klimatologi Lasiana Kupang, Nusa Tenggara Timur).

Discussion

The effect of gibberellins on vegetative growth, namely plant height, tuber diameter, tuber fresh weight and tuber dry weight showed that gibberellin, apart from stimulating flower formation, also stimulated generative growth. According to (Cardoso et al., 2012), gibberellins play a role in plant physiological processes by activating hydrolytic enzymes, stimulating cell elongation and making plant tissues and organs such as leaves and stems longer.

The treatment of P fertilizer on vegetative growth in the variables of plant height, number of leaves and number of tillers, showed the effect of nutrient availability in the soil. Shahen et al. (2007), stated that the addition of P doses in shallot plants could increase tuber yields. Evidently, P fertilizer treatment of 100 kg/ha had a significant effect on the number of tubers, namely 7.27. The results of the research by Tefa, 2022), the local variety Eban shallot plants grown in the highlands were able to increase the number of leaves by 26.47, the fresh weight of the tubers planted to 23.85 g and the dry weight of the planted tubers to 17.89 g, while the results of the study (Triharyanto et al., 2018). According to Kim & Li (2016), if there is a deficiency of P in shallot plants it can cause a decrease in the development of roots, leaves, stems and tuber size. The results of research by Sumarni, Suwandi et al. (2013) shallot varieties of Bangkok and Kuning which were treated with P fertilizer on soils that had high P status showed a significant effect on the area of shallot leaves. Phosphorus is an essential nutrient that is very important and cannot be replaced with other nutrients, so plants must get enough P for their growth and development. Element P plays a role in the character of vegetative growth because phosphorus absorption is related to the fact that one of the main elements is nucleoprotein which plays a major role in photosynthesis, cell division and tissue formation (Rajan et al., 2019).

The results showed that there was no flowering of the local cultivar Eban shallot which was planted in the Midlands of Sasi Village, North Central Timor Regency. This is in line with the results of research (Jasmi et al., 2013; Sorensen et al., 2014), shallots treated with gibberellin and vernalization did not produce flowers. Likewise the results of the research of Siswadi et al. (2022), Shallots treated with ZPT at several levels did not form capsules. The results of a study by (Fahrianty et al., 2020), Shallot seeds soaked with 200 ppm gibberellins in the lowlands, the percentage of flowering plants only reached 20%.

The results of this study indicate that gibberellin treatment for initiation of flowering is not optimal. According to (Triharyanto et al., 2022), shallots can flower if they contain endogenous gibberellin in a sufficiently high concentration. The concentration of gibberellins in this study was still low with a very short soaking time of only 30 minutes, so it has not been able to optimize the physiological processes for flowering initiation.

According to Sumarni et al. (2013), apart from genetic factors, the flowering of shallots is influenced by environmental factors (climate), especially the air temperature around the plants. The gibberellin and P fertilizer treatments did not specifically affect the flowering process because the vegetative growth was expressed more dominantly. The physiological effects of gibberellins depend on the plant species or cultivar. The response can be positive, neutral or negative in the induction of flowering, generally the response induction of flowering by gibberellin is more common in long-day plants and plants that require a period of low temperature to flowering (Cardoso et al., 2012). The flowering problem for most allium species other than the photoperiod is ambient temperature. Flowering failure is thought to be due to the influence of environmental factors such as temperature, altitude, air humidity and bulk. According to data from the Meteorology, Climatology and Geophosics Agency for 2021 (Table 7), rainfall from May to August 2021 is 14 mm, 82 mm, 4 mm and 3 mm per month, respectively. Temperatures during the study ranged from 24-29 ^{o}C, humidity ranged from 40-77%, altitude 300-400 meters above sea level. According to Hilman et al. (2016), to increase the flowering and formation of shallot seeds requires a temperature of 17-19 ^{o}C, whereas this temperature is only found in the highlands. Furthermore, according to Hilman et al. (2016), shallot plants grown in the highlands have great potential for the development of shallot seed production, where the shallot seeds produced are much better than the seed bulbs circulating in the market. In addition to environmental factors, the failure to flower was probably caused by the non-optimal concentration of gibberellins and the fast-soaking time of 30 minutes. In the highlands, the local Eban shallot cultivar can produce flowers and seeds. The results of the research by (Tefa, 2022), local Eban shallots can flower 49 days after planting at 19 ^{o}C. This shows that not all shallots can adapt outside their adaptation area. Flowering time is one of the main factors determining plant adaptation to climate change. Environmental factors such as photoperiod and temperature control the timing of first bud or flowering from the perspective of the physiology of the whole plant. Higher rising temperatures result in a significant decrease in the number of flowers and seed production (Jagadish et al., 2016).

Conclusion

Based on the results of the study, it was concluded that gibberellin treatment affected plant height, tuber diameter, tuber fresh weight and tuber dry weight. P fertilizer treatment affected plant height, number of leaves and number of tillers. Gibberellin and P fertilizer treatment did not affect the generative growth of shallots in the middle plains of North Central Timor District.

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