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Yield and Yield Components of Red Onion (Allium ascalonicum L.) Influenced by Application of Amino Acid Fertilizer and Triacontanol

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KEYWORDS

Yield;
Yield components;
Amino Acid Fertilizer;
Triacontanol.

Abstract Red onions are one of the agricultural products with a relatively high demand for the consumer market in Indonesia, but the productivity figure is quite low when compared to other countries (FAO, 2021). This study seeks to explore the effectiveness of the application of amino acid fertilizer and triacontanol in increasing the yield and yield components of red onions. Employing a randomized block design, this study used 2 factors, which are amino acid fertilizers (A1: 1000 ppm; A2: 3000 ppm; A3: 5000 ppm) and triacontanol (T0: 0 ppm; T1: 5ppm; T2: 10 ppm). Each combination is repeated 3 times. As a results, amino acid fertilizers can significantly affect the number of red onions bulbs, yields per hectare, economic weight, and economic weight loss. The interaction of characters of bulb length was shown in the combination of 5-10 ppm triacontanol with amino acid fertilizer. The best response, which ranged from 10.64% to 11.67%, was noted in fertilizer with 5000 ppm of an amino acid fertilizer. As the concentration of amino acid fertilizer in combination with triacontanol increased, the total bulb fresh weight increased as well, in which, 5000 ppm of amino acid fertilizer could increase the weight by 45,23-45,43 g clump^{-1}, which was greater than the response of the 1000 ppm amino acid fertilizer combination.

Introduction

Red onions are one of the agricultural products with a considerable high demand in the Indonesian consumer market. Referring to BPS-Statistics Indonesia (2020), for the past three years (2019–2016), red onion productivity in Indonesia 9,31-9,93 t ha^{-1}. This is quite low compared to other countries. According to the Food and Agricultural Organization (2021), Thailand had the highest red onion productivity among ASEAN nations in 2019 with a total of 26.23 t ha^{-1}, followed by Myanmar (14.46 t ha^{-1}) and the Philippines (11.13 t ha^{-1}). Given its advantages in terms of agricultural land area, Indonesia has a high potential to boost productivity by engaging in agricultural intensification.

One of the alternatives for intensification strategies is optimizing the additional nutrients, namely amino acid fertilizers. The application of amino acid fertilizers can help maximize plant growth and productivity (Bader et al., 2019). Amino acids can serve as precursors and building blocks of proteins that are closely related to cell growth. Baqir et al. (2019) added that common amino acids function in plants for the biosynthesis of various nitrogen compounds including vitamins, coenzymes, pigments, purine, and pyrimidine bases. A study carried out by Khalel and Sultan (2019) indicates that the use of 3-4 mL L^{-1} of amino acid fertilizer to red onions increases bulb diameter, bulb weight, and total yield. The effectiveness of the application of amino acid fertilizer on red onions was also reported by Shehata et al. (2017). Their

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study reports that it significantly increased bulb weight and total yield while lowering segregation yield compared to the control treatment.

It has been suggested that combining fertilizers with amino acid fertilizers and other nutrients will increase their effectiveness in influencing plant growth and productivity. Shafeek et al. (2018) reported that when red onions were given an amino mix and a biofertilizer, the bulb weight changed significantly. Combining various nutrients can result in a reaction that enhances the characteristics of plants. One of them is triacontanol which functions as a plant growth regulator (PGR). Triacontanol promotes plant growth by modifying multiple metabolic procedures that speed up the processes of chlorophyll synthesis, photosynthesis, and water uptake (Naeem et al., 2019). Therefore, it can be inferred that it has the ability to boost the activity of several important enzymes in the nutritional status of minerals. Amino acid fertilizers and triacontanol have the potential to be used as substitute nutrients in the growing of red onions. This study intends to explore the effectiveness of the application of amino acid fertilizer and triacontanol in increasing the yield and yield components of red onions. It is anticipated that the findings of this study will serve as the most recent standard for Indonesian red onions farming innovations.

Material and methods

This study used a soil meter, sprayer, ruler, stationery, knife, analytical scale, weighing scale, oven, caliper, and camera. The materials also involved red onions of the Tajuk variety, raffia, silver mulch, triacontanol TC powder (purity 98%), 20% Amino Acid fertilizer (Amino Power), chicken manure, P2O5 fertilizer (Fertiphos), NPK Pearl 16:16:16, KCl fertilizer (Kujang), KNO3 (White; N: 13% K2O: 45%), KNO3 (Red; N: 15%, N: 15%, K2O: 14%, Na: 18%; B: 0.05%) and fungicides (mancozeb & azoxystrobin), insecticides (abamectin, emamectin, and imidacoprid), and aquadest.

The harvest index is calculated using the following formula:

The experiment was conducted in Ngenep Lor, Ngenep Village, Karangploso District, Malang Regency, Indonesia from April 2021 to August 2021. This study used a randomized block design with 2 factors, namely amino acid fertilizer concentration (A1: 1000 ppm; A2: 3000 ppm; A3: 5000 ppm) and triacontanol concentration (T0: 0 ppm; T1: 5ppm; T2: 10 ppm). Each combination was repeated 3 times. Triacontanol and amino acid fertilizer were mixed with 1L of water in a sprayer, and the mixture was evenly sprayed into each treatment plot. Plants received the treatments four times at 10, 24, 38, and 52 DAP. When all of the plants are at 65 DAP, harvesting is completed. After the bulbs were cleaned of any remaining dirt, their number, length, and total fresh weight were measured. Yield per hectare is calculated using the following formula. Yield per hectare is calculated using the following formula.

$$Yield = \frac{1\ ha\ (land\ area)}{harvest\ plot\ area} \times \sum no.of\ plant\ \times bulbs\ fresh\ weight$$

In a storage room at room temperature, the bulbs were tied to the leaves and hung on shelves. The bulbs were stripped of leaves and weighed after one week of storage to determine their economic weight (EW). The following formula was used to determine the percentage of weight loss that occurred while these bulbs were in storage:

$$EW\ loss = \ 100\% \times \frac{EW}{FW}$$

notes:

EW : Economic weight of bulbs

Fw : Fresh weight

$$HI = WE/W \times 100\%$$

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Notes:
We : Economic component weight
W : Dry weight

Result and Discussion

The application of amino acid fertilizer and triacontanol had a significant effect on several yield characters and yield components of red onions (*Allium ascalonicum* L.). The number of bulbs and yields per hectare responded favorably to amino acid fertilizers, while triacontanol significantly increased yields per hectare (HPPH) as displayed in Table 1.

Amino acid fertilizer at a concentration of 1000 ppm resulted in the lowest yield of 2.92 clump^{-1}. The number of bulbs increased when the concentration of the given amino acid fertilizer was increased. Khalel and Sultan (2019) reported that treating 3-4 mL L^{-1} amino acid fertilizer to red onion increases the total bulb harvest by 4.51-17.75%. These results are consistent with those from this study.

The application of 3000 ppm and 5000 ppm amino acid fertilizers showed no different yield responses, but when compared to 1000 ppm amino acid fertilizers, there was an increase of 35.78-53.56%. Application of amino acid fertilizer can increase the yield per hectare and number of bulbs per clump, which can increase the potential yield of red onions. The harvest index character to the application of amino acids fertilizer showed no difference.

It has been demonstrated that using amino acid fertilizers increases red onion and bulb yields. Shafeek et al. (2018) also reported an increase in the potential yield of red onions grown with fertilizers containing amino acids. Physiological processes like cell division, morphogenesis, and senescence are significantly influenced by amino acid fertilizers (Bader et al., 2019). Shehata et al. (2017) explained that the improvement of cell structure, particularly plastids in mesophyll tissue, which increases photosynthetic efficiency and produces more assimilate needed for new cell formation, might be the cause of amino acids' beneficial effects on red onion growth. The yield and yield components of red onions can be positively impacted by physiological improvements made during the growth period.

Triacontanol 0 ppm (without triacontanol) showed a different response when compared to triacontanol 10 ppm which increase the potential yield of yields per hectare by 28.95% (see Table 1). The application of 5 ppm triacontanol increased potency by 25.71%. However, it did not have a different impact when compared to the response of red onions that were not given triacontanol. The character of the number of bulbs and the yield index of red onions were not affected by the application of triacontanol.

The ability of triacontanol to increase physiological processes is thought to be responsible for its ability to have a positive impact on yields per hectare. Ali and Perveen (2020) describe that plant treated with triacontanol had better growth, more chlorophyll content, and high gas exchange capacity. Pang et al. (2020) added that strawberry treated with triacontanol (50 µM) shows an increase in fruit development by up-regulating factors related to the growth and development of strawberries in the ripening process.

Figure 1 illustrates how various concentrations of amino acid fertilizer and triacontanol demonstrate a significant effect on the bulb length. This study indicated that at 0 ppm triacontanol, the combination with amino acid fertilizer shows no effect. The difference in bulb length was seen by giving triacontanol concentrations of 5 and 10 ppm. Triacontanol concentrations at two different concentrations varied by 10.64–11.67% when combined with 5000 ppm.

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Table 1. Number of bulbs, Yield per Hectare, and Harvest Index after the application of Amino Acid Fertilizers and Triacontanol

Treatments	Number of Bulbs		Yield (t ha^{-1})		Harvest index (%)
			Amino Acid		
1000 ppm	2.92	A	4.50	A	6.84
3000 ppm	5.12	B	6.11	B	7.59
5000 ppm	6.46	c	6.91	B	8.10
			Triacontanol		
0 ppm	4.51		4.94	A	7.42
5 ppm	4.94		6.21	AB	7.39
10 ppm	5.05		6.37	B	7.71
CV (%)	18.05		19.65		14.74

remarks: The mean value of the treatment followed by the same letter and column showed no significant difference based on Tukey's test at the 5% significance level

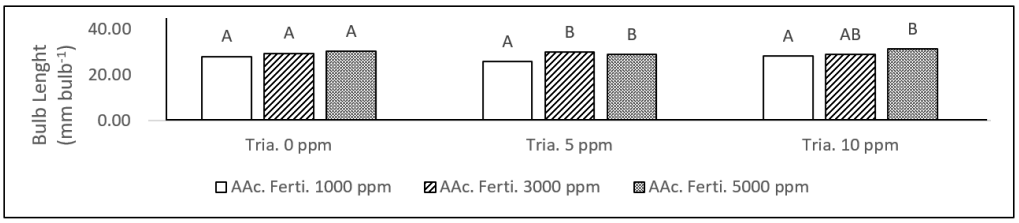

Figure 1. Bulb Length (mm bulb^{-1}) of red onions in Various Concentration of Amino Acid Fertilizers and Triacontanol. (bars followed by letters in the same column show no significant difference based on Tukey's test at a 5% significant level).

From a study conducted by Bonhomme et al. (2000), Triacontanol will trigger the synthesis response of 9-β-L (+) adenosine, a compound whose structure resembles cytokinin. Another study conducted by Satuhu et al. (2021) shows that the application of cytokinins or BAP can improve the quality of red onion. These results are in line with this study, where amino acid fertilizers had no effect on bulb length under non-triacontanol treatment. Adding 5-10ppm triacontanol combined with amino acid fertilizer allows an increase in length as one of the quality parameters of red onion.

Triacontanol and amino acid fertilizer together had a significant impact on the bulb's total fresh weight, as shown in Figure 2. At each triacontanol concentration, adding more amino acid fertilizer had a different result. The combination of amino acid concentrations of 5000 ppm at each concentration of triacontanol resulted in the highest increase in the total fresh weight of bulbs. This combination increased the average total fresh weight of bulbs by between 45.23 and 45.43 g clump^{-1}.

Triacontanol applied to red onions increased the ability of amino acid fertilizers to affect the bulb length. Triacontanol triggers physio-biochemical enhancement (Ali & Perveen, 2020). Increased nutritional requirements are necessary for improving the physio-biochemical processes in plants. It is believed that adding fertilizer with amino acids can give red onions the substance they need to grow more quickly. Shekari and Javanmardi (2017) proffer that Amino acids might be crucial

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for plant metabolism and the uptake of proteins needed for cell formation. The potential total fresh weight of red onion bulbs can be increased with this combination.

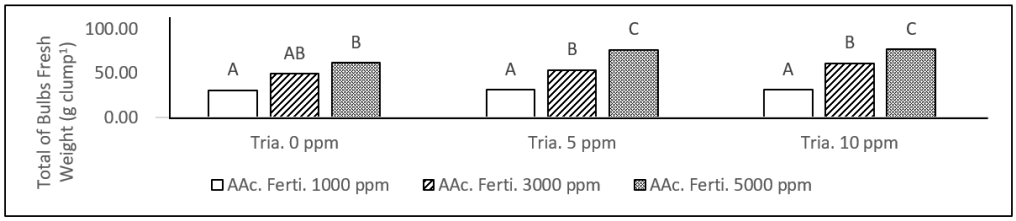

Figure 2. Total of Bulbs Fresh Weight (g clump^{-1}) of red onions on Various Consentration of Amino Acid Fertilizers and Triacontanol. (bars followed by letters in the same column show no significant difference based on Tukey's test at a 5% significance level).

The economic weight of bulbs is the final weight of red onions before entering the consumer market. Table 2 shows how the application of amino acid fertilizers and triacontanol affected the economic weight of the bulbs and their shrinkage in red onion (*Allium ascalonicum* L.). In comparison to the other two concentrations, amino acid fertilizer at 1000 ppm produced bulbs with the lowest economic weight of 29.32 g clump^{-1}. This can be increased up to 73.67% by increasing the concentration of amino acid fertilizer by 2000 ppm. Increasing the concentration of amino acid fertilizer to 5000 ppm showed a difference in the economic weight of bulbs by 66.95 g clump^{-1}. The economic weight loss of bulbs due to the application of 5000 and 3000 ppm amino acid fertilizers did not show any difference. However, both concentrations demonstrate a higher response when compared to the 1000 ppm amino acid fertilizer concentration of 2.15-3 g clumps^{-1}

Table 2. Economic Weight and Economic Weight loss of bulbs resulted from the application of Amino Acid Fertilizers and Triacontanol

Treatment	Economic Weight (g plant^{-1})		Weight Loss of Bulb (%)	
		Amino Acid		
1000 ppm	29.32	A	1.89	A
3000 ppm	50.92	B	4.04	B
5000 ppm	66.95	c	4.89	B
		Triacontanol		
0 ppm	44.09	A	3.51	ns
5 ppm	50.30	B	3.54	ns
10 ppm	52.79	B	3.77	ns
CV (%)	8.93		32.99	

remarks: The mean value of the treatment followed by the same letter and column showed no significant difference based on Tukey's test at the 5% significance level.

Mutia (2019), elaborates that The rate of transpiration as the result of cells' action to maintain metabolic processes is what causes the red onion bulbs to shrink. The quality of red onion bulbs can be elevated by using amino acid fertilizers that can enhance growth characters (Abdel-Rahim et al., 2019). The amount of shrinkage that occurs tends to correlate with the rise in the economic weight of bulbs brought on by amino acid fertilizers. Although the potential economic weight of red onion bulbs could be increased by amino acid fertilizer, weight loss during the post-harvest treatment

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process was still unabated. Temperature and humidity levels during storage can have an impact on how quickly bulbs shrink (Mutia, 2019).

Triacontanol can increase the economic weight of red onion bulbs. The potential economic weight of the bulbs could increase by 25.71–28.95% when concentrations of 5 and 10 ppm were given using the foliar-spray method. The application of triacontanol has no significant effect on these characters when measured by the economic weight loss of bulbs. Triacontanol can increase the economic weight of bulbs and reduce weight loss during storage. This is because Triacontanol slows down the respiratory rate. The ability of triacontanol to influence bio-physiological processes was also reported by Khanam and Mohammad (2018) that 1 µM triacontanol spray increased the menthol and essential oil of *Mentha piperita* L. under saline stress.

Conclusion

Amino acid fertilizers can significantly affect the number of bulbs, yields per hectare, economic weight, and economic weight loss of red onion bulbs. Triacontanol administration yielded significant results in terms of hectare yields and economic weight of bulbs. Combining amino acid fertilizer at a concentration of 5000 ppm with triacontanol at a concentration of 5-10 ppm resulted in the best response, which ranged from 10.64 to 11.67% for the bulb length. Combining amino acid fertilizer with triacontanol increased the total fresh weight of the bulbs, and the response to 5000 ppm of amino acid fertilizer was higher than that of 1000 ppm, increasing the weight by 45.23–45.43 g clump^{-1}. Future studies on the application of triacontanol or amino acid fertilizers as a substitute fertilizer for red onions (*Allium ascalonicum* L.) or other plants are anticipated.

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