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The Effect of Potassium Fertilizer and Eco-Enzyme on the Growth and Production of Shallots (*Allium ascalonicum* L.)

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ABSTRACT: This study aimed to determine the effect of potassium fertilizer and eco enzyme on the growth and production of Shallots (Allium et al.). The study used a Factorial Randomized Block Design (RAK) with two factors studied. The first factor was KCL fertilizer (K) with four levels, namely: K0 = No Application, K1 = 10 grams/plot (equivalent to 100 kg/ha), K2 = 15 grams/plot (equivalent to 150 kg/ha), K3 = 20 grams/plot (equivalent to 200 kg/ha), The second factor Eco Enzyme (P) 3 levels, namely: P1 = 7 ml/liter of water, P2 = 10 ml/liter of waterP3 = 13 ml/liter of water. The results showed that potassium treatment significantly affected plant height 5 MST but had no significant impact at the ages of 2, 3, and 4 MST and the number of bulbs per sample. Eco-enzyme treatment had no significant effect on plant height or number of bulbs per sample. The interaction between potassium fertilizer and eco-enzyme had no significant effect on plant height and number of tubers per sample.

Keywords*:* Shallots, Potassium Fertilizer, Eco-Enzyme

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INTRODUCTION

Shallots are bulbous plants that represent the most esteemed product in several locations of Indonesia. Shallots are used as a culinary spice that includes compounds advantageous to bodily wellness. Furthermore, shallots possess anti-cancer properties, function as antibiotics, lower blood pressure and cholesterol, and decrease blood sugar levels. Researchers indicate that shallots include calcium, phosphate, iron, carbohydrates, and vitamins A and C (Anshori, 2018).

Fertiliser is necessary to increase the production of shallots. The more diverse content of liquid organic fertilizer is very good for plant growth and development. Information on the use of liquid organic fertilizer still needs to be improved while the consumption of shallots is increasing, so there needs to be technology to improve the quality and quantity of shallots (Fatirahma & Kastono, 2020; Tuhuteru & Nurdin, 2020). With advancements in agricultural technology, natural organic fertilizers have been created to address the limitations of Shallots cultivation. Liquid organic fertilizer is a completely natural fertilizer derived from organic materials, including animal and poultry manure, certain plants, and other natural compounds, processed using ecologically sustainable technology (Simanjuntak et al., 2013).

The Central Statistics Agency (BPS) noted that Indonesia produced 1.97 million tons of shallots in 2022. This figure decreased by 1.51% compared to the previous year when it reached 2.00 million tons. Looking at the trend, Indonesia's shallot production tends to increase and recorded a record of 2 million tons in 2021. However, this trend did not continue last year. Based on its region, Central Java became the largest shallot-producing region in Indonesia in 2022. This can be seen from its production, which reached 556,058 tons. Last year, East Java followed second with a shallot production of 473,989 tons. Then, West Sumatra produced 209,100 tons of shallots. On the other hand, DKI Jakarta is the province that produces the least shallots, namely one ton. After that, North Kalimantan and West Kalimantan had shallot production of seven tons and 30 tons, respectively.

(Jahung et al., 2022) The thaprovidinglizer with the correct dose significantly affects tuber weight, fresh/plant, number of tubers/plots, and sweet tuber plant yield index. Sufficient potassium doses in plants will increase the synthesis of high molecular weight molecular compounds such as protein, starch, and cellulose. Potassium elements in shallot plants can also stimulate root development and increase the size, number, and yield of fruits and tubers. Potassium elements also increase the transport of sugar and acid to the storage organs of plants (Ramadhani et al., 2019).

Eco-enzyme is produced by the fermentation of organic kitchen waste, including fruit and vegetable residues, together with sugar (such as brown sugar or cane sugar), over a period of three months. The production of this eco-enzyme exerts a significant global environmental impact and economic implications. It is characterised by a dark brown hue and a pronounced sweet and sour fermentation scent. This eco-enzyme, purported to release ozone gas (O3), has the potential to diminish atmospheric carbon dioxide (CO2), thereby obstructing heat in the clouds, which may mitigate the greenhouse effect and global warming. Eco-enzyme aids the natural cycle by promoting plant development via fertilisation, soil maintenance, and the purification of contaminated water. Eco-enzyme aids in soil and plant fertilisation, insect eradication, and enhancement of the quality and flavour of cultivated fruits and vegetables (Arman et al., 2024; Kartikasari et al., 2024; Zulyetti et al., 2023).

THEORETICAL REVIEW

Potassium Fertilizer

Fertilization is one of the determining factors in efforts to increase plant yields. Fertilizer used as recommended is expected to provide economically profitable results. Thus, the expected impact of fertilization is increasing yields per unit area and efficient use of fertilizer (Susanti et al., 2018). (Jahung et al., 2022) stated that giving KCl fertilizer at the correct dose significantly affected tuber diameter, weight, freshness/plant, number of tubers/plot, and yield index of sweet tubers. Apart from using organic fertilizer to support the growth and production of shallot plants, it is necessary to add inorganic fertilizer. Applying inorganic fertilizer to the soil can increase the rapid availability of nutrients for plants because the nutrient content is high and quickly available. Potassium in plants functions in photosynthesis reactions, increasing the activity of photosynthetic enzymes, absorbing CO2 through stomata and assisting phosphorylation in chloroplasts.

Chemical fertilisers contribute to enhancing shallot yield. The chemical fertiliser used to optimise output is potassium fertiliser. Potassium is integral to metabolic processes including photosynthesis, respiration, enzyme cofactor activity, stomatal regulation, sugar translocation for starch and protein synthesis, enhancing plant resistance to pests and diseases, and fortifying the plant structure to prevent the abscission of leaves, flowers, and fruit (Amir et al., 2021). KCl fertilizer is a source of potassium (K) for plants. Its principal role is to facilitate the synthesis of proteins and carbohydrates. Potassium fertiliser is readily leached and transported by water movement in sandy soil with wide pores. KCl fertiliser has volatile characteristics; thus, its application should occur when the soil is moist, rather than during drainage, since research indicates an evaporation rate of 30% per day (Parnata, 2004).

Eco-Enzyme

Eco-enzyme is an organic solution generated by a simple fermentation process using vegetable leftovers and fruit peels, combined with brown sugar and water. Eco-enzymes serve as botanical insecticides and fertilisers for vegetation. Eco-enzyme may also serve as a liquid organic fertiliser (Soverda et al., 2023) The eco-enzyme liquid may transform ammonia into nitrate (NO3), serving as a natural hormone and nutrition for plants, therefore functioning as a liquid organic fertiliser (POC) due to its macro and micronutrient content.

Eco-enzymes in agriculture may serve as liquid organic fertilisers and botanical insecticides. The hue is deep brown, accompanied by a pronounced sweet and sour fermented fragrance. This ectoenzyme purportedly generates ozone gas (O3) to diminish atmospheric carbon dioxide (CO2), which obstructs heat in clouds, thus mitigating the greenhouse effect and global warming. Eco-enzymes enhance natural cycles by promoting plant development by fertilisation, ameliorating soil conditions, and purifying contaminated water. Eco-enzymes enhance soil and plant fertilisation, eradicate pests, and elevate the quality and flavour of cultivated fruits and vegetables (Gultom et al., 2022). Organic fertiliser is classified as solid organic fertiliser and liquid organic fertiliser. Eco-enzyme fertiliser is a feasible alternative liquid organic fertiliser. Eco-enzymes are produced by the fermentation of organic kitchen waste, including fruit and vegetable remnants, sugar (such as brown sugar or cane sugar), and water. Eco-enzyme employs readily available and cost-effective raw materials. The three-month fermentation process requires patience. Nevertheless, the resulting system has several benefits (Vika, 2024).

METHODOLOGY

The study used a Factorial Randomized Block Design (RAK) with two factors studied. The first factor was KCL fertilizer (K) with four levels, namely: K0 = No Application, K1 = 10 grams/plot (equivalent to 100 kg/ha), K2 = 15 grams/plot (equivalent to 150 kg/ha), K3 = 20 grams/plot (equivalent to 200 kg/ha), The second factor was Eco Enzyme (P) 3 levels, namely: P1 = 7 ml/liter of water, P2 = 10 ml/liter of waterP3 = 13 ml/liter of water. The parameters observed in this study were plant height and number of tubers per sample. An analysis of variance was used to evaluate the impact of the therapy. Mean differences between treatments were assessed using honest significant difference testing, regression analysis, and correlation, all conducted at a significance level of 5%.

RESULTS

Plant Height (cm)

The observational data about the height of shallot plants at 2, 3, 4, and 5 MST, derived from the analysis of variance, indicated that potassium treatment significantly influenced the height of shallot plants at 5 MST, whereas it had no significant impact at 2, 3, and 4 MST. The eco-enzyme treatment and the interaction between the two treatments had no significant impact on plant height at any observed age. The average height of shallot plants due to potassium and eco-enzyme fertilizer treatments can be seen in Table 1.

Table 1. Average Plant Height (cm) of Shallots Due to Potassium Fertilizer and Eco-enzyme Treatment at Ages 2, 3, 4 and 5 MST

Treatment	(cm)			
	2 MST	3 MST	4 MST	5 MST
K0	14.83	19.99	25.16	30.33c
K1	17.63	22.80	27.97	33.13b
K2	17.70	22.87	28.03	33.20b
K3	18.32	23.49	30.37	35.53a
P1	18.05	23.22	28.38	33.55
P2	16.25	21.42	27.13	32.30
P3	17.06	22.23	28.13	33.30

K0P1	12.93	18.10	23.27	28.43
K0P2	14.28	19.45	24.62	29.78
K0P3	17.27	22.43	27.60	32.77
K1P1	19.97	25.13	30.30	35.47
K1P2	14.30	19.47	24.63	29.80
K1P3	18.63	23.80	28.97	34.13
K2P1	19.13	24.30	29.47	34.63
K2P2	18.80	23.97	29.13	34.30
K2P3	15.17	20.33	25.50	30.67
K3P1	20.17	25.33	30.50	35.67
K3P2	17.63	22.80	30.13	35.30
K3P3	17.17	22.33	30.47	35.63

Description: Numbers followed by the same letter in the same column mean that they are not significantly different in the Duncan test at the 5% test level.

Table 1 shows that in the Potassium fertilizer treatment at 5 MST, the tallest plants were in the K3 treatment, significantly different from K0, K1, and K2. The plant height in the K2 treatment differed significantly from K0 but not from K1. The plant height in the K1 treatment was significantly different from K0. The effect of Potassium fertilizer doses on the height of shallot plants at 5 MST can be seen in Figure 1.

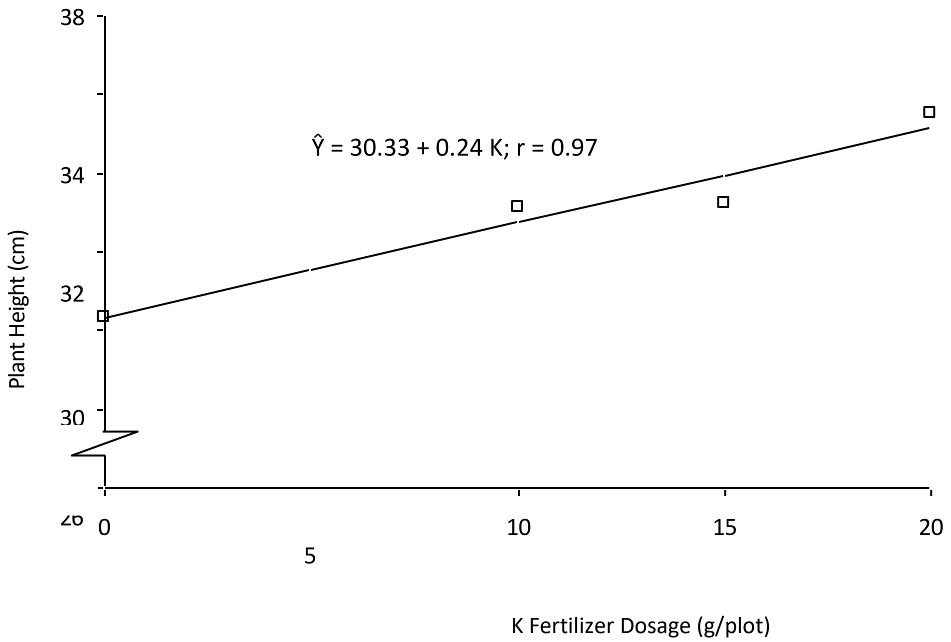

Figure 1. Effect of Potassium Fertilizer Dosage on the Height of Shallots Plants at 5 MST

Figure 1 shows that increasing doses of Potassium fertilizer will increase the height of shallot plants. Increasing K fertilizer administration of 1 g/plot can increase plant height by 0.24 cm.

Table 1 shows that the eco-enzyme treatment had no significant effect on the height of the shallot plants. The tallest plants were found in treatment P1 and the lowest in P2.

Table 1 also shows that the interaction between Potassium fertilizer and eco-enzyme has no significant effect on plant height. The tallest plant was found in the K3P3 treatment combination, 35.63 cm, and the lowest was found in the K0P1 treatment combination, 28.43 cm.

Number of Bulbs per Sample (cloves)

Data on the number of tubers per sample due to Potassium fertilizer and eco-enzyme treatments The analysis of the variance list shows that Potassium fertilizer treatment significantly affects the number of tubers per sample. In contrast, eco-enzyme treatment and the interaction between the two treatments have no significant effect on the number of tubers per sample. The average number of tubers per sample due to Potassium fertilizer and Eco-enzyme treatments is shown in Table 2.

Table 2. Average Number of Shallots Bulbs Due to Potassium Fertilizer and Eco-enzyme Treatment

Potassium Fertilizer	Eco-enzyme Fertilizer			Average
	P1	P2	P3	
K0	8.03	6.92	9.36	8.11c
K1	10.70	10.26	8.91	9.96bc
K2	10.19	10.14	9.79	10.04b
K3	9.92	11.81	12.48	11.40a
Average	9.71	9.78	10.13	

Table 3 indicates that under the Potassium fertiliser treatment, the K3 treatment exhibited the largest tuber count per sample, which was substantially distinct from K0, K1, and K2. The quantity of tubers per sample in the K2 treatment exhibited a significant difference from K0, but not from K1. The quantity of tubers per sample in the K1 treatment did not change substantially from that in K0. The effect of Potassium fertilizer doses on the number of tubers per sample can be seen in Figure 2.

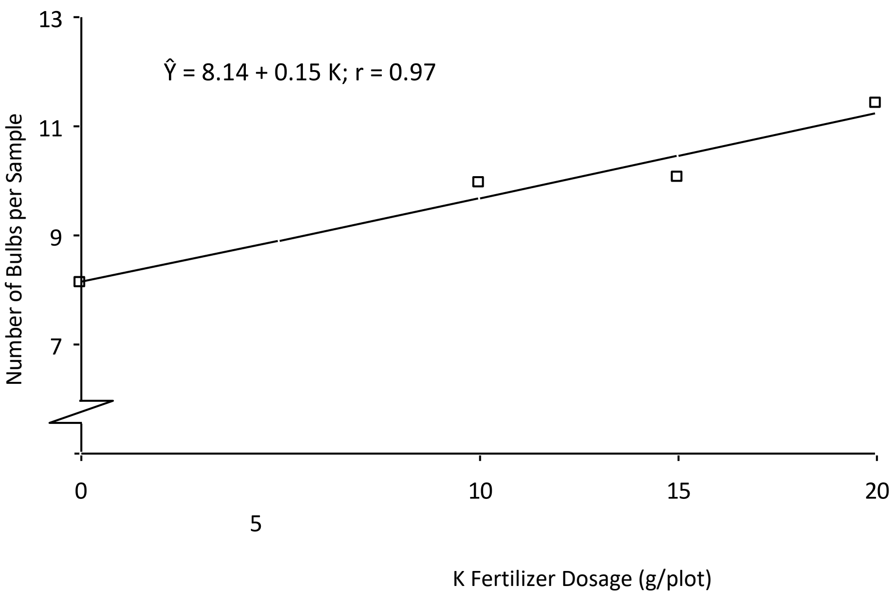

Figure 2. Effect of Potassium Fertilizer Dosage on the Number of Bulbs per Sample

Figure 2 shows that increasing doses of K fertilizer will increase the number of tubers per sample. Every increase in K fertilizer administration of 1 g/plot can increase the number of tubers per sample by 0.15 tubers.

Table 2 shows that the eco-enzyme treatment did not significantly affect the number of tubers per sample. The highest number of tubers per sample was in treatment P3, and the lowest was in P1. This shows that there is an increase in the number of tubers per sample with increasing eco-enzyme administration.

Table 2 also shows that the interaction between K fertilizer and eco-enzyme has no significant effect on the number of tubers per sample. The highest number of tubers per sample was found in the K3P3 treatment combination, 12.48 cloves, and the lowest was in the K0P2 treatment combination, 6.92 cloves.

DISCUSSION

The Effect of Potassium Fertilizer on the Growth and Production of Shallots (Allium ascolonicum L.)

The analysis of variance revealed that potassium treatment significantly influenced plant height at 5 MST, but had no significant impact at 2, 3, and 4 MST. Additionally, there was no significant effect on the number of tillers, number of tubers per sample, fresh weight of tubers per sample, fresh weight of tubers per plot, storage weight of tubers per sample, and storage weight of tubers per plot.

The study's findings indicated that the use of potassium fertiliser significantly influenced the height of shallot plants at 5 MST. The use of potassium fertiliser enhanced plant height growth. This pertains to the function of potassium fertiliser in enhancing photosynthesis and the efficiency of nutrient transport in plants. As per (Efendi et al., 2017), Meeting the nutritional requirements of nitrogen and potassium in plants enhances growth and development, hence positively influencing vegetative growth and ultimately improving output outcomes (Prastya et al., 2016) It also asserts that plants need enough and balanced nutrition. Excessive or insufficient fertiliser application results in aberrant plant development. Insufficient or excessive nutrient supply to plants impairs the photosynthesis process, resulting in less photosynthate production and a subsequent reduction in the translocation of photosynthate. The balanced availability of nutrients in the soil facilitates proper plant development and output. It also asserts that plants need enough and balanced nutrition. Excessive or insufficient fertiliser application results in aberrant plant development. Insufficient or excessive nutrient supply to plants impairs the efficiency of photosynthesis, resulting in less photosynthate production and a subsequent reduction in the translocation of photosynthate. The balanced availability of nutrients in the soil facilitates proper plant development and output.

The study's results also showed that the provision of potassium fertilizer significantly affected the number of bulbs per sample. The formation of shallot bulbs is influenced by the availability of potassium elements derived from potassium fertilizers. Potassium plays a role in maintaining the osmotic potential of plants, such as regulating the opening and closing of stomata so that plants can maintain water conditions in plants which has a positive impact on increasing photosynthesis and the distribution of assimilates from leaves to all parts of the plant. Potassium acts as an activator of various enzymes essential in photosynthesis and respiration reactions, as well as increases the activity of enzymes involved in protein and starch synthesis. The metabolic process in the plant body will run well if the nutrient needs are met, increasing the number of bulbs. Plant growth and yield are closely related to the availability of nutrients absorbed by plants used in the plant's metabolic process. By increasing the plant's metabolic process, it will have a positive impact on the formation of shallot bulbs (Alfian et al., 2015). According to(Ernita, 2021), the potassium element influences the composition and translocation of carbohydrates in the plant body, accelerates nitrogen metabolism, prevents flowers and fruits from falling off, and enlarges the bulbs. Sihombing and Simanjuntak (2022) stated that the provision of potassium fertilizer of as much as 150 kg/ha is the best dose to increase the growth and yield of shallots. Supriyatna et al. (2016), The presence of a considerable inorganic content and the use of potassium fertiliser results in an increased quantity of bulbs, since the roots function to collect nutrients from the soil for distribution throughout the plant, so influencing bulb production.

The Effect of Eco-enzyme on the Growth and Production of Shallots (Allium ascolonicum L.)

The analysis of the variance test showed that the eco-enzyme treatment had no significant effect on plant height, number of tillers, and fresh weight of bulbs per sample. This is because the provision of eco-enzymes has yet to optimally increase the growth and production of shallots. The lack of N elements means that the growth of tillers is less than optimal, so a smaller yield will be obtained at harvest time. The lack of potassium (K), which activates various enzymes in photosynthesis and respiration reactions, prevents plants from growing optimally and does not produce higher bulbs. If the nutrients are sufficient, it can increase the fresh weight of the plant, and the amount increases with increasing doses of inorganic fertilizers (Maemunah et al., 2015). The study's results also showed that the provision of eco-enzyme had no significant effect on the formation of shallot bulbs. This is because the nutrient content in eco-enzyme is still relatively low, whereas eco-enzyme functions more as a biocatalyst. This substance accelerates reactions but does not participate in the reaction. The function of eco-enzyme as a biocatalyst is also to decompose soil and help the physical properties of soil that has been polluted. It has been previously known that organic matter plays a vital role in increasing plant growth, including improving the physical properties of the soil, increasing the soil exchange capacity so that nutrient absorption is more optimal, and encouraging better soil biological activity. Plants need nutrients in sufficient and balanced amounts. If the dose of nutrients is too high or too low, the weight of the bulbs will decrease. Deficiencies and excesses of plant nutrients cause the photosynthesis process to run poorly. Plant growth and production can occur appropriately if the soil contains nutrients and is available and balanced (Lubis et al., 2022).

The Effect of Potassium Fertilizer and Eco-enzyme Interaction on the Growth and Production of Shallots (Allium ascolonicum L.)

The analysis of variance showed that the interaction of potassium fertilizer and eco-enzyme had no significant effect on plant height or number of bulbs per sample. This is likely due to the provision of eco-enzyme not being able to optimally improve the physical properties of the soil, so the absorption of nutrients through the provision of Potassium fertilizer has not been able to run optimally. The provision of eco-enzyme, a product of organic waste fermentation, can increase plant growth by increasing soil microorganisms' activity and providing nutrients. However, in this study, eco-enzymes did not significantly affect the growth and production of shallots. This may be due to inadequate nutrient content or the unavailability of optimal environmental conditions for the enzyme activity (Kumar et al., 2022). Eco-enzyme also contains potassium (K) nutrients that play a role in the growth and quality of shallot bulbs. Potassium is one of the macronutrients that is important for plant growth and development. In shallots, potassium can provide better bulb yields, higher quality, and storage life of bulbs, which remain solid even when stored for a long time. The higher the potassium given, the higher the bulb weight. The low bulb yields obtained on soil with low potassium are caused by plants lacking potassium nutrients, which play an important role in increasing bulbs' size, number, and yield per plant. Potassium requirements increase with increasing plant yields because the function of potassium is related to photosynthesis (Priyadi et al., 2021; Rosliani & Basuki, 2013).

CONCLUSIONS AND RECOMMENDATIONS

Potassium treatment significantly affected plant height at 5 MST but had no significant effect on plant height at 2, 3, and 4 MST or the number of tubers per sample. Eco-enzyme treatment had no significant effect on plant height or the number of tubers per sample. The interaction of potassium fertilizer and eco-enzyme did not significantly affect plant height and number of bulbs per sample. Suggestion: Further research is needed to increase the dose and method of application of potassium fertilizer and eco-enzyme to obtain maximum growth and production of shallots.

FURTHER STUDY

Future research should focus on optimizing the dosage and application methods of potassium fertilizer and eco-enzyme to enhance shallot growth and productivity. Investigating a wider range of potassium levels, including foliar and soil applications, could provide insight into the most effective delivery method for promoting plant height and tuber development. Additionally, exploring eco-enzyme concentrations and application timing might help uncover potential synergies with potassium treatments. Advanced studies could integrate controlled environmental conditions, such as varying soil types and moisture levels, to better understand the interaction between these treatments. Incorporating molecular and physiological analyses could also reveal the underlying mechanisms by which potassium and eco-enzyme influence shallot growth, paving the way for precision agriculture practices tailored to maximize yield.

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