

The Effect of Polysulfate and Compost on the Growth and Yield of Shallots (*Allium ascalonicum* L.)

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Abstract

The topic of this research is the Effect of Polysulphate and Compost on the Growth and Yield of Shallots (*Allium ascalonicum* L.). The study aims to determine the effect of Polysulphate and Compost fertilizers on the Growth and Yield of Shallots (*Allium ascalonicum* L.). The study used a Factorial Randomized Block Design consisting of two factors: Factor I: Application of Polysulphate fertilizer "P" consisting of 4 treatment levels per plant: P0 = Control, P1 = 5 g, P2 = 10 g, P3 = 15 g, and Factor II: Application of compost fertilizer with the symbol "K" consisting of 4 levels per plant: K0 = Control, K1 = 25 g, K2 = 50 g, and K3 = 75 g. Overall, the parameters of plant height growth showed that P1 26.7 cm and K1 26.9 cm were the optimum treatments. The number of tubers per sample P3 4.4 pieces was significantly different from P0 3.8 pieces and P1 4.1 pieces but not significantly different from P2 4.2 pieces. P1 4.1 pieces was significantly different from P0 3.8 pieces and P3 4.4 pieces but not significantly different from P2 4.2 pieces. The effect of compost on the number of tubers per sample K3 5.8 pieces was significantly different from K0 2.5 pieces and K1 2.5 pieces but not significantly different from K2 5.5 pieces. The effect of polysulfate on production per sample P3 35.8 g was significantly different from P0 10 g, P1 13 g, and P2 21.2 g. The effect of compost fertilizer K3 34.6 g was significantly different from K0 11.1 g, K1 14.1 g and K2 22.3 g. The yield per plot of 868.3 g polysulfate P3 was significantly different from 698.1 g P0, 770.6 g P1, and 829.2 g P2; and the effect of 1529.3 g K3 compost was significantly different from 216.2 g K0, 658.4 g K1, and 808.7 g K2. The interaction of P and K factors resulted in a yield per plot of 1590.2 g P3K3, significantly different from the other treatment combinations but not significantly different from the 1599 g P3K2 treatment combination.

Keywords: Onion, Yield, Compost, Growth, Polysulfate

INTRODUCTION

Shallots (*Allium ascalonicum* L.) are a horticultural crop widely consumed by humans as a cooking spice, following chili peppers. As a widely consumed horticultural commodity, shallots have ample potential for development, meeting not only domestic but also international needs (Suriani, 2012). Shallot bulbs are also used as a traditional medicine to treat various ailments, such as stomach aches or bloating, boils, sore throats, coughs, acne, and lowering blood sugar levels (Sumarni and Hidayat, 2005).

Shallots (*Allium ascalonicum* L.) are a popular spice in Indonesia. They have high economic value, serve as a flavoring and can be used in traditional medicine. The prospects for shallot development are excellent, as evidenced by the increasing consumption of shallots in line with population growth (Department of Agriculture, 2009).

Karo Regency in Figures (2020) shows that in 2019, shallot productivity for Tanah Karo Regency came from 7 sub-districts, namely: Mardinding District 733 tons, Kutabuluh 12 tons, Payung 1,237.40 tons, Tiganderket 1,587 tons, Naman Teran 7 tons, Barus Jahe 14.50 tons and Merek 2,450 tons, with total shallot production in 2019 for Karo Regency being 6,040.90 tons. When compared to 2018, shallot production in 2019 experienced an increase with total production in Tanah Karo Regency only 3,876.40 tons (BPS Karo, 2020).

Batu Ijo is a superior shallot variety developed for decades in Batu, East Java. Currently, several superior shallot varieties are available in East Java, including the Bauji variety, originating from Nganjuk and suitable for planting during the rainy season. The Batu Ijo variety, commonly grown in highlands and medium altitudes, the Monjung variety from Pamekasan, the Biru Lancur variety from Probolinggo, and several others. The Super Philip variety, introduced from the Philippines, has been established in nearly all shallot production centers in Indonesia (Baraswati, 2009).

Currently, increased shallot production is generally highly dependent on inorganic fertilizers, which provide high yields but also cause numerous environmental problems. Inorganic fertilizers can disrupt soil life and balance, increasing the decomposition of organic matter, which then leads to soil structure degradation, increased susceptibility to drought, and reduced yield efficiency (Syamsuwirman et al. 2025). Therefore, efforts are necessary to maintain and improve soil aggregation. One important effort is to apply organic fertilizer to the soil. This ensures adequate nutrient replenishment from those absorbed by plants, prevents soil compaction due to the presence of organic matter, and increases water retention, thus reducing soil erosion (Isnaini, 2006).

According to Sutedjo (2010), the use of organic fertilizer can loosen the topsoil, increase the population of microorganisms, enhance water absorption and retention, and overall improve soil fertility. One type of organic fertilizer is

compost. According to Soeryoko (2011), compost is the result of the decomposition, decay, and decomposition of organic materials such as animal manure, leaves, and other organic materials.

The benefits of compost include improving soil structure, water-holding capacity, and porosity; increasing organic matter in the soil; and improving the life of soil microorganisms. Protects the soil from erosion and contains plant growth regulators (PGRs) such as auxin, gibberellin, and cytokinin (Sutedjo, 2010).

Super compost contains the following macronutrients: Nitrogen (N) 3.14%; Phosphorus (P) 2.41%; Potassium (K) 1.57%; Calcium (Ca) 0.90%; and Magnesium (Mg) 1.54%; while its micronutrient content is: Manganese (Mn) 0.0006%; Zinc (Zn) 0.015%; Boron (B) 0.043%; Organic Carbon 43.36%; pH 6.25%; and water content 44.02% (Syamsuwirman et al. 2025).

METHOD

This research will be conducted in Jaranguda Village, Berastagi, Karo Regency, North Sumatra, at an altitude of + 1,500 m above sea level. This research will be conducted from March to August 2026.

This research uses a factorial randomized block design (RBD) method consisting of two treatment factors and three replications:

Factor I: Application of Polysulphate fertilizer "P", consisting of four treatment levels:

P0 = Control

P1 = 5 g

P2 = 10 g

P3 = 15 g

Factor II: Application of organic compost fertilizer with the symbol "K", consisting of four levels:

K0 = Control

K1 = 25 g

K2 = 50 g

K3 = 75 g

Observed Parameters

The growth and production of shallots (*Allium ascalonicum* L.) observed were as follows:

1. Plant height (cm)

Plant height (cm) was measured from the base of the plant above the soil surface to the tip of the tallest leaf. Measurements began 2 weeks after planting (WAP) and continued until the 7th week after planting. Measurements were conducted at weekly intervals.

2. Number of tubers per sample

After harvest, the number of tubers per sample was counted and the data

recorded according to their respective treatment codes.

3. Plant Production/Sample (grams)

Plant mass/sample (grams) was calculated at harvest time, 60-70 days after planting. The calculation was performed after the plants were cleaned. Afterward, the plants were weighed, including their roots.

4. Plant Production/Plot (kg)

Plant mass/plot (kg) was calculated at harvest time, 60-70 days after planting. The calculation was performed by adding up all the plant masses in the plot.

3.6. Data Analysis Method

The data analysis method used was a Randomized Block Design (RBD) with the following equation:

$$Y_{ijk} = \mu + \rho_i + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \varepsilon_{ijk}$$

where:

Y_{ijk} = observation results from the i-th replication and the j-th treatment level

μ = effect of the mean

ρ_i = effect of the i-th block

α_j = effect of the onion bulb size treatment at the j-th level

β_k = effect of the pesticide application treatment at the k-th level

$(\alpha\beta)_{jk}$ = interaction effect between bulb size at the j-th level and pesticide application at the k-th level

ε_{ijk} = effect of error in the i-th replication, bulb size difference treatment at the j-th level, and pesticide application at the k-th level

The results of treatments with significant effects were further tested using Duncan's Multiple Range Test (Gomez & Gomez 1995).

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A. RESULTS AND DISCUSSION

1. Plant Height

The influence of polysulfate fertilizer and compost on onion plant height is presented in Table 1 below.

Table 1. Results of Data Analysis on Onion Plant Height Growth: Effect of Polysulfate (P) and Compost (K).

Polysulphate	Plant Height Average				
	2 Wap	3 Wap	4 Wap	5 Wap	6 Wap
P0	6,4 a	7,8 b	15,7 b	18,6 b	20,8 b
P1	7,1 a	13,0 a	25,1 a	26,7 a	29,9 a
P2	6,8 a	12,7 a	24,8 a	26,3 a	29,2 a
P3	7,2 a	13,1 a	24,9 a	26,3 a	29,3 a
Compost	Plant Height Average				

	2 Wap	3 Wap	4 Wap	5 Wap	6 Wap
K0	6,1 a	10,9 a	21,4 b	22,9 b	25,1 c
K1	7,4 a	14,1 a	26,9 a	28,4 a	31,2 ab
K2	7,2 a	12,1 a	24,5 a	26,1 a	28,8 bc
K3	7,9 a	13,9 a	26,6 a	28,3 a	33,1 a

Wap: Weeks after planting

The results of the study (Table 1) showed that the effect of polysulphate fertilizer at 2 weeks post-planting was not significantly different from other P treatments. Differences began to be found at 3 weeks post-planting, namely P3 13.1 cm was significantly different from P0 7.8 cm but not significantly different from P1 13 cm, and P2 12.7 cm. The same trend was found at 4 weeks post-planting, 5 weeks post-planting, and 6 weeks post-planting. At 4 weeks post-planting, P3 24.9 cm was significantly different from P0 15.7 cm but not significantly different from P1 25.1 cm and P2 24.8 cm. At 5 weeks post-planting, P3 26.3 cm was significantly different from P0 18.6 cm but also not significantly different from P1 26.7 cm, and P2 26.3 cm. In the last observation, 6 weeks post-planting, P3 29.3 cm was significantly different from P0 20.8 cm but not significantly different from P1 29.9 cm and P2 29.2 cm. Overall, the data can be concluded that P1 is the optimum treatment and is recommended based on the results of this study.

Furthermore, Table 1 shows that no significant differences were found between the compost treatments at 2 and 3 weeks post-planting. At 2 weeks post-planting, K3 (7.9 cm) was not significantly different from K0 (6.1 cm), K1 (7.4 cm), and K2 (7.2 cm). Similarly, at 3 weeks post-planting, K3 (13.9 cm) was not significantly different from K0 (10.9 cm), K1 (14.1 cm), and K2 (12.1 cm). A new difference was found at 4 weeks post-planting, where K3 (26.6 cm) was significantly different from K0 (21.4 cm) but not significantly different from K1 (26.9 cm) and K2 (24.5 cm). The same trend was found at 5 weeks post-planting, where K3 (28.3 cm) was significantly different from K0 (22.9 cm) but not significantly different from K1 (28.4 cm) and K2 (26.3 cm). In the final observation before the plants were harvested, K3 (33.1 cm) was significantly different from K0 (25.1 cm) and K2 (28.8 cm) but not significantly different from K1 (31.2 cm). Overall, from these data, it can be concluded that K1 is the optimum treatment that can be applied based on the results of this study.

2. Number of Bulbs per Sample

Table 2. Effect of Polysulfate (P) on the Number of Bulbs in Onion Plants

	Polysulphate	N	Average
Duncan ^{a,b}	P0	12	3.8 c
	P1	12	4.1 b
	P2	12	4.2 ab

	P3	12	4.4 a
	Sig.		1.000

Table 2 shows the results of the test on the effect of polysulfate fertilizer on the number of onion bulbs. The table shows that P3 yielded 4.4 bulbs, significantly different from P0 yielding 3.8 bulbs and P1 yielding 4.1 bulbs, but not significantly different from P2 yielding 4.2 bulbs. P1 yielded 4.2 bulbs, significantly different from P0 and P3 yielding 4.4 bulbs, but not significantly different from P2 yielding 4.2 bulbs. Overall, it can be concluded that P1 yields the optimum and recommended treatment based on the results of this study.

Table 3. Effect of Compost Level (K) on the Number of Bulbs Per Sample

	Compost	N	Average
Duncan ^{a,b}	K0	12	2.5 b
	K1	12	2.5 b
	K2	12	5.5 a
	K3	12	5.8 a
	Sig.		1.000

Table 3 shows that K3 (5.8 fruits) is significantly different from K0 (2.5 bulbs) and K1 (2.5 bulbs) but not significantly different from K2 (5.5 5 bulbs). Thus, the research results can be concluded that the K2 treatment is the most optimal.

3. Production Per Sample (g)

The production per sample, based on the effects of polysulfate (P) and compost (K) fertilizers, can be seen in Table 4 below.

Table 4. Duncan Test Results: The Effect of Polysulfate (P) Levels on Crop Production Per Sample

	Polysulphate	N	Average
Duncan ^{a,b}	P0	12	10,0 d
	P1	12	13.0 c
	P2	12	21.2 b
	P3	12	35.8 a
	Sig.		1.000

Table 4 shows that P3 (35.8 g) is significantly different from P0 (10 g), P1 (13 g), and P2 (21.2 g). All treatments were significantly different from each other. However, P3 produced the highest crop production per sample due to the influence of Polysulfate fertilizer. Therefore, P3 is the best and recommended treatment based on the research results. Furthermore, the effect of compost fertilizer on production per sample can be seen in Table 5 below..

Table 5. Duncan Test Results: Effect of Compost Level (K) on Crop Production Per Sample (g)

	Compost	N	Average
Duncan ^{a,b}	K0	12	11,1 d
	K1	12	14.1 c
	K2	12	22.3 b
	K3	12	34.6 a
	Sig.		1.000

Table 5 shows that K3 (34.6 g) is significantly different from K0 (11.1 g), K1 (14.1 g), and K2 (22.3 g). All treatments are significantly different from each other. However, K3 produced the highest production per sample, namely 34.6 g. Therefore, K3 is the treatment that produces the best production per sample and is recommended based on the research results..

4. Production Per Plot (g)

The results of the Duncan test on the effect of polysulfate (P) fertilizer on onion production per plot are shown in Table 6 below.

Table 6. Effect of P Factor Levels on Shallot Production per Plot (g)

	Polysulphate	N	Rata-rata
Duncan ^{a,b}	P0	12	698.1 d
	P1	12	770.6 c
	P2	12	829.2 b
	P3	12	868.3 a
	Sig.		1.000

Table 6 shows that P3 (868.3 g) is significantly different from P0 (698.1 g), P1 (770.6 g), and P2 (829.2 g). All treatments produced different weights per plot. However, because P3 was significantly different from all other treatments, P3 is the best and is recommended based on the results of this study. Further details on the effect of compost (K) on plant production per plot can be seen in Table 7 below.

Table 7. The Effect of K Factor Levels on Shallot Productivity Per Plot (g)

	compost	N	Average
Duncan ^{a,b}	K0	12	216.2 d
	K1	12	658.4 c
	K2	12	808.7 b

	K3	12	1529.3 a
	Sig.		1.000

Table 7 shows that K3 (1529.3 g) is significantly different from K0 (216.2 g), K1 (658.4 g), and K2 (808.7 g). All treatments were significantly different from each other. The K3 treatment produced the largest yield per plot, namely 1529.3 g. Therefore, K3 is the optimum and recommended treatment based on the research results. The effect of the P x K interaction can be seen in Table 8 below.

Table 8. The Effect of Interaction of P and K Factors (P x K) on Shallot Productivity per Plot

Duncan ^{a,b}		
P* K	N	Average
P0K0	3	170.2 i
P0K2	3	242.4 h
P1K1	3	613.5 g
P2K0	3	669.6 f
P1K3	3	755.7 e
P2K2	3	861.6 d
P3K0	3	1355,0 c
P3K1	3	1518.6 b
P3K2	3	1599,0 a
P3K3	3	1590,2 a

Table 8 shows that the combination of P3K3 1590.2 g is significantly different from other treatment combinations but not significantly different from the combination of P3K2 1599 g. Therefore, the combination of P3K2 treatment is the optimum treatment. In addition, the data in Table 8 also shows the combination of P3K0 1355 g and P3K1 1518.6 g, which means that polysulphate fertilizer combined with compost can increase onion plant production per plot.

Nugroho et al. (2017) recorded shallot growth at 28 days after planting (DAP) of 42.23 cm, medium 39.85 cm, and small 37.85 cm. Uke et al. (2015) measured shallot plant height at 45 days after planting and found it to be 29.12 cm, while small seeds produced a plant height of 21.54 cm. Sufyati (2006) recorded shallot plant height at 45 days after planting of 39.07 cm, medium 35.49 cm, and small 31.29 cm.

The results (Table 1) show that the effect of polysulfate fertilizer at 2 weeks after planting was not significantly different from the other P treatments. Differences began to be found at 3 weeks after planting (DAP), with P3 at 13.1 cm significantly different from P0 at 7.8 cm but not significantly different from P1 at 13 cm and P2 at 12.7 cm. The same trend was found at 4, 5, and 6 weeks post-planting. At 4 weeks post-planting, P3 was 24.9 cm, significantly different from P0 (15.7 cm), but not significantly different from P1 (25.1 cm), and P2 (24.8 cm).

At 5 weeks post-planting, P3 was 26.3 cm, significantly different from P0 (18.6 cm), but also not significantly different from P1 (26.7 cm), and P2 (26.3 cm). In the final observation, 6 weeks post-planting, P3 was 29.3 cm, significantly different from P0 (20.8 cm), but not significantly different from P1 (29.9 cm) and P2 (29.2 cm). Overall, from these data, it can be concluded that P1 is the optimum treatment and is recommended based on the results of this study.

Furthermore, Table 1 shows that no significant differences were found between the compost fertilizer treatments at 2 and 3 weeks post-planting. At 2 weeks after planting, K3 7.9 cm was not significantly different from K0 6.1 cm, K1 7.4 cm, and K2 7.2 cm. Likewise, at 3 weeks after planting, K3 13.9 cm was not significantly different from K0 10.9 cm, K1 14.1 cm, and K2 12.1 cm. New differences were found at 4 weeks after planting, namely K3 26.6 cm was significantly different from K0 21.4 cm but not significantly different from K1 26.9 cm and K2 24.5 cm. The same trend was found at 5 weeks after planting, namely K3 28.3 cm was significantly different from K0 22.9 cm but not significantly different from K1 28.4 cm and K2 26. cm. In the last observation before the plants were harvested, K3 33.1 cm was significantly different from K0 25.1 cm and K2 28.8 cm but not significantly different from K1 31.2 cm. Overall, the data can be concluded that K1 is the optimal treatment that can be applied based on the results of this study.

Ruhimat et al. (2023) stated that test results showed that compost application generally improved soil chemical properties, including pH, electrical conductivity (EC), organic carbon, total nitrogen, available phosphorus, C/N ratio, CEC, bases (K, Ca, Mg, and Na), and micronutrients (Fe, Mn, Cu, and Zn) compared to the same parameters in the control treatment (100% soil). Organic carbon content, an important indicator of soil fertility, showed the highest concentration in treatment T2 (75% soil + 25% K1 compost), at 4.4%, followed by T3 and T5 at 4.3% and 4.0%, respectively (Table 1). The combination of compost and synthetic fertilizer showed a significant effect on improving soil chemical composition and soil microbial populations. These results are consistent with research by Wan et al. (2021) reported that a combination of organic and synthetic fertilizers containing 46.7% N, 12% P₂O₅, and 51% K₂O improved the physical, chemical, and biological properties of the soil. Compost is classified as a soil conditioner capable of improving soil physical and chemical properties, such as structure, nutrient absorption, cation exchange capacity, stimulating biological activity in the soil, and increasing crop productivity and quality (Wan et al. 2021). The quality of compost as a soil conditioner is determined by the raw materials used during the composting process.

Polysulfate is a fertilizer that functions to increase crop yields. Polysulfate contains four nutrients: 48% SO₃ as sulfate, 14% K₂O as sulfate, 6% MgO as sulfate, and 17% CaO as sulfate. It was first described in 1818 for specimens from its type site in Austria. The results of this study showed that P3 (35.8 g)

significantly differed from P0 (10 g), P1 (13 g), and P2 (21.2 g). All treatments were significantly different from each other. However, P3 produced the highest yield per sample under the influence of polysulphate fertilizer. Therefore, P3 is the best treatment and is recommended based on the results of the study. Table 5 shows that K3 (34.6 g) significantly differed from K0 (11.1 g), K1 (14.1 g), and K2 (22.3 g). All treatments were significantly different from each other. However, K3 produced the highest yield per sample, at 34.6 g. Therefore, K3 is the treatment that produced the best yield per sample and is recommended based on the results of the study.

The yield per plot of P3 was 868.3 g significantly different from P0 (698.1 g), P1 (770.6 g), and P2 (829.2 g). All treatments produced different weights per plot. However, because P3 was significantly different from all other treatments, P3 was the best and recommended based on the results of this study. Table 7 shows that K3 1529.3 g was significantly different from K0 216.2 g, K1 658.4, and K2 808.7 g. All treatments were significantly different from each other.

CONCLUSION

Overall, the parameters of plant height growth showed that P1 26.7 cm and K1 26.9 cm were the optimum treatments. The number of tubers per sample of P3 4.4 was significantly different from P0 3.8 and P1 4.1 but not significantly different from P2 4.2. P1 4.1 was significantly different from P0 3.8 and P3 4.4 but not significantly different from P2 4.2. The effect of compost on the number of tubers per sample of K3 5.8 was significantly different from K0 2.5 and K1 2.5 but not significantly different from K2 5.5. The effect of polysulfate on production per sample of P3 35.8 g was significantly different from P0 10 g, P1 13 g, and P2 21.2 g. The effect of compost fertilizer of K3 34.6 g was significantly different from K0 11.1 g, K1 14.1 g, and K2 22.3 g. The production per plot of the influence of polysulphate P3 868.3 g was significantly different from P0 698.1 g, P1 770.6 g and P2 829.2 g; and the effect of compost fertilizer K3 1529.3 g was significantly different from K0 216.2 g, K1 658.4, and K2 808.7 g. The interaction of P and K factors resulted in a production per plot of P3K3 1590.2 g which was significantly different from other treatment combinations but not significantly different from the treatment combination P3K2 1599 g.

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