



RESEARCH ARTICLE

Open Access

Increasing the Growth and Yield of Tomato Plants (*Lycopersicum esculentum* Mill.) by Providing Potassium and Paclobutrazol



Nora Zubaidi¹, Djarwatiningsih^{1,*}, Agus Sulistyono¹

Abstract

Tomatoes (*Lycopersicum esculentum* Mill.) are a horticultural commodity with high economic value, but their productivity is often hampered by flower and fruit loss. Increasing growth and yield can be achieved through potassium fertilization, which plays a role in photosynthesis and fruit formation, and through the application of the growth regulator paclobutrazol, which suppresses vegetative growth and stimulates the generative phase. This study aims to evaluate the effects of potassium fertilizer dose and paclobutrazol concentration, and their interactions, on tomato growth and yield. The study was conducted in Surabaya from November 2024 to February 2025 using a factorial Randomized Block Design with two factors: potassium fertilizer doses (110, 125, 140, 155 kg/ha) and paclobutrazol concentrations (0, 100, 125, 150 ppm), each factor repeated three times. The results showed that the combination of 140 kg/ha potassium fertilizer and 125 ppm paclobutrazol produced the highest number of leaves (37), number of bunches (6.78), total number of fruits (37.67), and total fruit weight per plant (1,509.27 g). Potassium fertilizer at 140 kg/ha alone produced the highest number of flowers (69.41), while paclobutrazol at 125 ppm accelerated flower emergence (34.53 days), increased the number of flowers (69.77), and increased fruit weight per harvest period. Thus, using 140 kg/ha of potassium fertilizer combined with 125 ppm paclobutrazol is recommended as the most effective treatment to optimize tomato plant growth and yield.

Keywords: Horticulture, Photosynthesis, Plant Growth Regulators, Plant Nutrition, Productivity

1. Introduction

Tomatoes (*Lycopersicum esculentum* Mill.) are seasonal fruit vegetables from the Solanaceae family that have high economic value. This commodity is widely used as a food ingredient, cooking spice, food coloring, cosmetics, and medicine. In addition, tomatoes contain important nutrients, including protein, vitamins, carbohydrates, fats, and minerals, which are beneficial for health (Fatah, 2013). Tomato production in East Java has increased from 60,719 tons/ha in 2016 to 102,108 tons/ha in 2022 (BPS, 2022). However, productivity still faces obstacles in the form of flower and fruit loss, which impacts yield decline.

One cause of flower and fruit drop is a lack of potassium (K). Potassium plays an important role in strengthening stems, preventing leaf, flower, and fruit loss, and accelerating the flowering process through its function as an enzyme activator and regulator of the translocation of photosynthesis products (Maulani *et al.*, 2019; Hati &

Susila, 2016). Several previous studies have shown that potassium fertilization can increase the number of bunches and fruit weight in chili plants (Kusumiyati *et al.*, 2022) and improve the quality of tomato fruit by accelerating ripening (Amin *et al.*, 2024). Potassium deficiency can inhibit bud growth, cause necrosis in old leaves, and increase a plant's susceptibility to damping-off (Simanungkalit *et al.*, 2006). However, these studies generally only tested the effect of potassium alone. The novelty of this research lies in combining potassium fertilizer with paclobutrazol, enabling a more comprehensive assessment of the interaction between the two on vegetative and generative growth and tomato yield.

In addition to fertilization, increased production can also be achieved through the application of plant growth regulators (PGRs). Paclobutrazol is a triazole PGR that inhibits gibberellin biosynthesis, thereby suppressing vegetative growth and directing assimilates to generative organs (Castro-Camba *et al.*, 2022). Application of

*Correspondence: djarwatiningsihps@gmail.com

1) Universitas Pembangunan Nasional "Veteran" Jawa Timur - Jl. Raya Rungkut Madya, Gn. Anyar, Kec. Gn. Anyar, Kota Surabaya, Jawa Timur, Indonesia

paclobutrazol at appropriate concentrations has been reported to increase flowering and fruiting in tomato plants, as well as improve the efficiency of photosynthate utilization (Nazibah *et al.*, 2022). Similar research was also reported on chili plants, where the application of 100-150 ppm paclobutrazol increased the number of flowers and suppressed plant height (Chávez-mejía *et al.*, 2019). In mangoes, paclobutrazol accelerated flowering and increased the percentage of mature fruit (Rahman *et al.*, 2023). These studies indicate that paclobutrazol is effective in directing assimilates to generative organs and increasing plant productivity. However, previous studies generally only tested paclobutrazol alone. The novelty of this study lies in its combination with potassium fertilizer, thereby determining the synergy between the two in increasing generative growth and tomato yield.

The combination of potassium fertilizer and paclobutrazol is expected to enhance tomato yields more effectively than either treatment alone. Previous research has demonstrated that the interaction between potassium fertilizer and paclobutrazol application significantly influences the growth and yield of various horticultural crops (Suud *et al.*, 2023). Based on this, the present study was conducted to examine the effects of potassium fertilizer dosage and paclobutrazol concentration, as well as their interaction, on tomato plant growth and yield.

2. Material and Methods

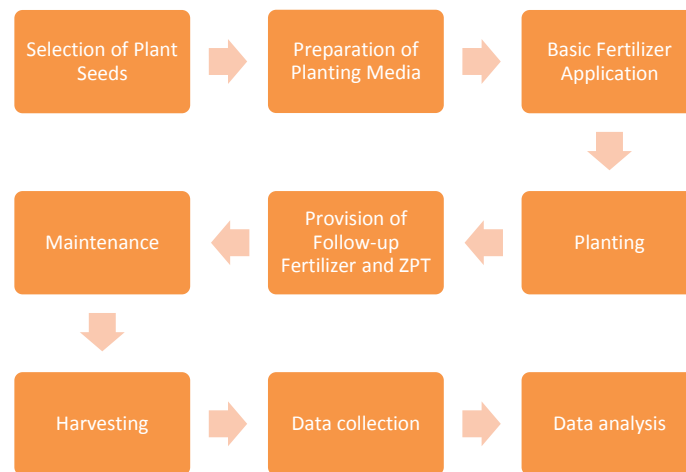


Figure 1. Research Flow Diagram

Observed variables included plant height, number of leaves, flowering age, number of flowers, number of bunches, number of fruits, fruit weight per harvest, total fruit weight per plant, and fruit set. Plant height was measured from the surface of the planting medium to the highest growing point using a meter, every 7 days from 7 days after planting until the generative phase. The number of leaves was calculated based on fully opened leaves with the same observation interval. Flowering age was recorded from the day of planting until the appearance of the first

The research was conducted from November 2024 to February 2025 on the land of the Food Security and Agriculture Service of Surabaya, East Java. It is located at coordinates 7 ° 19 ' 57.44" South Latitude and 112 ° 42 ' 43.40" East Longitude, at an altitude of 7.16 meters above sea level. This research used 40 x 40 cm polybags containing a mixture of soil and rice husk charcoal (2:1) materials.

The materials used include Servo variety tomato seeds, basic fertilizers (Urea, SP-36, ZA), potassium fertilizer (KCl), growth regulator paclobutrazol, and pesticides as needed.

The experiment was arranged in a factorial Randomized Block Design (RBD) with two factors and three replications. The first factor was a potassium fertilizer dose of 110 kg/ha, 125 kg/ha, 140 kg/ha, 155 kg/ha. The second factor is the concentration of paclobutrazol: 0 ppm, 100 ppm, 125 ppm, 150 ppm. The combination of the two factors yielded 16 treatments with three replications, for a total of 48 experimental units.

Fertilization is carried out in stages according to treatment, while paclobutrazol is applied by spraying at 21, 35, and 49 days after planting. Maintenance includes watering, staking, pruning water shoots, and pest and disease control as needed. Harvesting takes place from 62 days after planting until the end of the fruiting period at three-day intervals.

flower. The number of flowers per plant was counted every 7 days during the generative phase, while the number of bunches was calculated from the first bunch appearing until the end of the generative period. The number of fruits was observed throughout the harvest period by counting the total number of fruits per plant. Fruit weight was weighed using an analytical balance at each harvest to obtain the weight per harvest period, while the total weight per plant was calculated from the accumulated weight throughout the harvest period. Fruit set was calculated as the percentage of

fruits formed relative to the number of flowers, using the formula described by Kusumayati et al. (2015). Data were analyzed using Microsoft Excel software using analysis of variance (ANOVA) according to the design. If there is a real influence, a further Honest Significant Difference (BNJ) test is carried out at the 5% level.

3. Results and Discussion

3.1. Plant Height (cm)

Table 1. Average Height of Tomato Plants Age 42 HST on Combination Treatment of Potassium Fertilizer and ZPT Paclobutrazol

Plant Age (HST)	Paclobutrazol concentration (ppm)	Plant Height (cm)			
		Potassium Fertilizer Dosage (Kg/ha)			
		110	125	140	155
42	0	64.44 ± 4.25 b	81.50 ± 11.85 c	73.17 ± 5.85 bc	77.28 ± 1.26 c
	100	44.50 ± 0.33 a	45.06 ± 0.20 a	45.56 ± 0.68 a	44.78 ± 0.09 a
	125	41.31 ± 5.47 a	44.89 ± 0.35 a	45.11 ± 1.29 a	42.22 ± 4.24 a
	150	44.72 ± 0.19 a	43.17 ± 3.91 a	44.00 ± 0.17 a	44.61 ± 0.38 a
BNJ 5%		11.84			

Description: Numbers followed by the same letter indicate results that are not significantly different in the 5% BNJ test.

The increase in plant height at a potassium dose of 125 kg/ha without paclobutrazol indicates that potassium plays a crucial role in supporting physiological processes, particularly stem elongation through the regulation of cell turgor and photosynthate transport. This finding aligns with that of Assadiyah et al. (2023), who reported that optimal potassium availability accelerates tomato vegetative growth.

Conversely, administration of paclobutrazol at various concentrations significantly reduced plant height. Paclobutrazol inhibits gibberellin biosynthesis (Novita, 2022), thereby reducing cell elongation and vegetative growth rates. These results are consistent with the findings of Nazibah et al. (2018) that paclobutrazol can suppress tomato height growth, as well as with research by Sugiharto et al. (2022) showing that a concentration of 150 ppm effectively suppressed stem elongation.

The treatment combinations showed that plant responses varied with potassium dose and paclobutrazol concentration. Although potassium supports vegetative growth, paclobutrazol primarily suppressed plant height. This finding indicates that paclobutrazol application tends to shift photosynthetic distribution to generative organs.

3.2. Number of Leaves (Sheets)

The combination of potassium fertilizer and paclobutrazol concentration significantly affected the number of tomato leaves at 49 and 56 days after planting (Table 2). The highest number of leaves was observed in the K2P0 treatment (125 kg/ha KCl without paclobutrazol), with an average of 65.11 leaves recorded 56 days after planting. In contrast, the lowest number of leaves was found in the K1P2 treatment (110 kg/ha KCl + 125 ppm paclobutrazol), averaging 42.22 leaves. Overall, plants treated with paclobutrazol exhibited fewer leaves than untreated plants, indicating suppression of vegetative

growth. The combination treatment of potassium fertilizer and paclobutrazol concentration significantly affected tomato plant height at 42 HST (Table 1). The highest plant height was obtained in the combination K2P0 (125 kg/ha KCl without paclobutrazol), while the lowest was obtained in K1P2 (110 kg/ha KCl + 125 ppm paclobutrazol) of 41.31 cm. In general, the treatment without paclobutrazol produced taller plants than the treatment with paclobutrazol, indicating that ZPT suppressed vegetative growth.

growth.

Potassium fertilizer application can increase leaf number because potassium plays a role in photosynthesis, protein synthesis, and enzyme regulation, which support leaf cell division and enlargement. These results align with research by González-Cortés et al. (2023), which reported that an optimal potassium dose of 140–150 kg/ha promotes increased vegetative growth in horticultural crops.

Conversely, paclobutrazol application reduces leaf number by inhibiting gibberellin biosynthesis, thereby suppressing new cell division. This condition limits the formation of vegetative organs and directs photosynthate to generative organs. This finding is consistent with those of Rahmawati et al. (2022), who reported that paclobutrazol at 125–150 ppm suppresses vegetative growth but promotes flower and fruit formation in tomatoes.

The combined results showed that the treatment without paclobutrazol was more effective at promoting leaf growth, whereas the treatment with paclobutrazol, particularly at 125 ppm, suppressed leaf number. This result indicates that paclobutrazol effectively shifts assimilate distribution to the generative phase, reducing leaf number but potentially increasing yield.

3.3. Amount of Interest

The number of flowers is an important parameter of the generative phase because it determines the potential fruit yield that will be formed. Nutritional factors and growth regulators significantly influence flowering. The results of this study indicate that paclobutrazol significantly affects the number of flowers, with a concentration of 125 ppm (P2) producing the most flowers, namely 69.77 flowers/plant, higher than the control without paclobutrazol (66.81 flowers) or a higher concentration of 150 ppm (P3), which only reached 66.36 flowers/plant. This finding

indicates that moderate concentrations of paclobutrazol are more effective than either too low or too high concentrations. The average number of flowers for the

potassium fertilizer dose and paclobutrazol concentration treatments is shown in Table 3.

Table 2 Average Number of Leaves of Tomato Plants at 49 and 56 HST in Combination of Potassium Fertilizer Dose and Paclobutrazol PGR Concentration Treatments

Plant Age (DAP)	Paclobutrazol Concentration (ppm)	Number of Leaves (Sheets)			
		Dosis Pupuk Kalium (Kg/ha)			
		110	125	140	155
49	0	25.11 ± 0.38 a	25.44 ± 0.51 ab	26.78 ± 0.77 ab	25.67 ± 0.00 ab
	100	25.44 ± 0.39 ab	27.11 ± 1.07 ab	27.44 ± 0.84 ab	26.00 ± 0.67 ab
	125	25.72 ± 0.25 ab	25.89 ± 1.17 ab	27.11 ± 1.68 ab	26.11 ± 1.02 ab
	150	26.44 ± 0.51 ab	27.67 ± 0.88 b	25.00 ± 0.33 a	26.00 ± 0.67ab
	BNJ 5%	2.49			
56	0	35.11 ± 0.38 ab	35.78 ± 0.84 ab	36.00 ± 0.58 ab	35.67 ± 0.00 ab
	100	35.44 ± 0.39 ab	36.22 ± 0.69 b	36.89 ± 0.70 ab	35.89 ± 0.51 ab
	125	35.72 ± 0.25 ab	35.00 ± 0.88 a	37.00 ± 0.67 b	35.89 ± 0.51 ab
	150	36.22 ± 0.69 ab	36.67 ± 0.88 ab	35.00 ± 0.33 a	36.00 ± 0.58 ab
	BNJ 5%	1.95			

Description: Numbers accompanied by the same letter in the same column show no significant difference in the 5% BNJ test.

Table 3 Average Number of Flowers on Tomato Plants with Potassium Fertilizer Dose Treatment and Paclobutrazol PGR Concentration

Treatment	Average Amount of Interest (interest)
Potassium Fertilizer Dosage	
110	66.03 ± 3.39 a
125	67.56 ± 3.99 ab
140	69.41 ± 2.71 b
155	68.45 ± 2.78 ab
BNJ 5%	3.08
Paclobutrazol Concentration (ppm)	
0	66.81 ± 3.26 ab
100	68.50 ± 3.44 ab
125	69.77 ± 2.51 b
150	66.36 ± 4.14 a
BNJ 5%	3.08

Description: The average values followed by the same letter in the same column for each treatment are not significantly different in the 5% BNJ test; tn: not significantly different.

Physiologically, paclobutrazol inhibits gibberellin biosynthesis, suppressing vegetative growth and diverting more photosynthate to generative organs. Furthermore, paclobutrazol can increase cytokinin and abscisic acid levels, which play important roles in flowering induction (Sitompul *et al.*, 2024). Meanwhile, potassium fertilizer did not significantly affect flower number, although doses of 140-155 kg/ha (K3-K4) tended to produce higher average flower counts than the lowest dose of 110 kg/ha (K1). This finding is in line with Saputra *et al.* (2017), who reported that 125 ppm paclobutrazol increased the number of chili flowers by up to ±65 flowers/plant, but was still lower than the results of this study on tomatoes. In terms of fertilization, Kesumawati *et al.* (2022) found that a potassium dose of 150 kg/ha can increase flower viability in horticultural crops, although in this study, the effect of potassium on flower number was not significant. The differences in figures between these studies are likely influenced by the varieties used, environmental conditions,

and differences in plant physiological factors across experimental locations.

3.4. Number of Bunches Per Plant

The number of bunches is an important factor because it determines the potential number of fruits that can be harvested. The results of this study indicate an interaction between potassium fertilizer and paclobutrazol. The combination of K3P2 (140 kg/ha KCl + 125 ppm paclobutrazol) produced the highest number of bunches, namely 6.89 bunches/plant, significantly higher than the K1P0 treatment (110 kg/ha KCl + 100 ppm paclobutrazol), which reached only 4.78 bunches/plant. In general, medium to high potassium doses (140–155 kg/ha) combined with a medium concentration of paclobutrazol (125 ppm) were more effective at increasing the number of bunches than low potassium doses or high paclobutrazol concentrations. This mechanism can be explained by potassium facilitating assimilate translocation, while paclobutrazol suppresses

vegetative growth, diverting energy to the formation of generative organs. The average number of bunches per tomato plant at 49–63 HST for the combination of

potassium fertilizer doses and paclobutrazol concentrations is shown in Table 4.

Table 4 Average Number of Bunches per Tomato Plant at 49-63 Days After Planting in Combination of Potassium Fertilizer Dose and Paclobutrazol PGR Concentration

Plant Age (DAP)	Paclobutrazol Concentration (ppm)	Number of Bunches (Clutch)			
		Potassium Fertilizer Dosage (Kg/ha)			
		110	125	140	155
49	0	5.33 ± 0.34 ab	5.33 ± 0.34 ab	5.11 ± 0.19 a	5.67 ± 0.34 ab
	100	4.78 ± 0.51 a	5.78 ± 0.19 ab	4.89 ± 0.19 a	5.11 ± 0.19 a
	125	5.44 ± 0.51 ab	5.67 ± 0.34 ab	6.89 ± 0.19 b	6.00 ± 0.88 ab
	150	6.00 ± 0.88 ab	5.22 ± 1.07 a	6.00 ± 0.33 ab	5.78 ± 0.69 ab
	BNJ 5%	1.62			
56	0	5.33 ± 0.34 a	5.44 ± 0.51 a	5.11 ± 0.19 a	5.78 ± 0.19 ab
	100	5.11 ± 0.38 a	5.78 ± 0.19 ab	4.89 ± 0.19 a	5.11 ± 0.19 a
	125	5.67 ± 0.58 ab	5.78 ± 0.39 ab	6.89 ± 0.19 b	6.22 ± 0.51 ab
	150	6.00 ± 0.88 ab	5.45 ± 0.69 a	6.11 ± 0.19 ab	5.78 ± 0.69 ab
	BNJ 5%	1.40			
63	0	5.67 ± 0.34 ab	5.67 ± 0.34 ab	5.44 ± 0.51 a	5.78 ± 0.19 ab
	100	5.44 ± 0.20 a	5.78 ± 0.19 ab	5.33 ± 0.34 a	5.56 ± 0.20 ab
	125	5.89 ± 0.19 ab	5.89 ± 0.19 ab	6.89 ± 0.19 b	6.22 ± 0.51 ab
	150	6.44 ± 0.20 b	5.78 ± 0.19 ab	6.11 ± 0.19 ab	5.78 ± 0.69 ab
	BNJ 5%	0.99			

Description: Numbers followed by the same letter indicate results that are not significantly different in the 5% BNJ test.

Physiologically, paclobutrazol application inhibits gibberellin biosynthesis, thus suppressing vegetative growth, particularly stem elongation. This suppression of vegetative growth causes the plant’s photosynthate production to be allocated more to the generative organs. This condition promotes increased flower and bunch formation, as the energy and carbohydrates produced by photosynthesis are more directed toward flower differentiation than toward stem growth. Furthermore, paclobutrazol also increases photosynthetic efficiency and carbohydrate accumulation, which directly contribute to the number of bunches formed.

This result is in line with research by Salta et al. (2023) on shallots: paclobutrazol at 125 ppm increased the number of bunches by up to 6.5 per plant, almost equivalent to the results of this study. Meanwhile, Rahmatika et al. (2024) reported that the combination of 150 kg/ha of KCl fertilizer with 100 ppm of paclobutrazol increased bunch formation in chili plants, although the number was only around 5 bunches/plant, lower than in this study. This difference indicates that a dose of 125 ppm paclobutrazol with 140 kg/ha potassium is optimal for supporting bunch formation in tomatoes.

3.5. Total Number of Fruits Per Plant

The total number of fruits is the main generative parameter because it is directly related to the harvest yield. Combination treatments significantly affected the number of tomato fruits. The combination of K3P2 (140 kg/ha KCl + 125 ppm paclobutrazol) produced the highest number of fruits, namely 37.67 fruits/plant, while the K1P0 treatment

(110 kg/ha KCl without paclobutrazol) only produced 27.45 fruits/plant. The increase in fruit number was observed alongside increases in the potassium dose from 110 to 140 kg/ha and the application of 125 ppm paclobutrazol. However, at a higher concentration (150 ppm), the number of fruits decreased again, indicating an optimal dose of 125 ppm. The average total number of fruits per plant across the combination of potassium fertilizer doses and paclobutrazol concentrations is shown in Table 5.

This result is higher than the report of Nazibah et al. (2018), which recorded the number of tomato fruits at around 34 fruits/plant when applying 125 ppm paclobutrazol, as well as research by Sugiharto et al. (2022), who found an average of 35–36 fruits/plant with similar treatment. On the other hand, Ahmad et al. (2015) showed that a potassium dose of 150 kg/ha increased the number of fruits in paprika to around 32 fruits/plant, although this figure is still lower than the results of this study, which is 37.67 fruits/plant in the combination of potassium 140 kg/ha and paclobutrazol 125 ppm. This difference of 5-6 fruits per plant confirms that the combination of potassium fertilizer and paclobutrazol produces more fruits than the single potassium treatment in the previous study. In addition, although the potassium dose used in the study was higher (150 kg/ha), the results of this study show that adding paclobutrazol at 125 ppm can increase potassium utilization efficiency, resulting in greater fruit number per plant.

Table 5 Average Number of Fruits per Tomato Plant in Combination of Potassium Fertilizer Dose and Paclobutrazol PGR Concentration Treatments

Paclobutrazol Concentration (ppm)	Average Total Number of Fruits per Plant (Fruit)			
	Potassium Fertilizer Dosage (Kg/ha)			
	110	125	140	155
0	27.45 ± 2.36 a	30.00 ± 0.67 ab	30.11 ± 0.50 ab	31.90 ± 1.07 bc
100	30.67 ± 2.65 ab	31,11 ± 1,17 ab	34,56 ± 1,07 bc	30,56 ± 0,51 ab
125	32,78 ± 1,54 bc	35,89 ± 0,19 bc	37,67 ± 2,19 c	36,11 ± 0,83 c
150	31,78 ± 1,27 b	31,78 ± 1,92 b	33,67 ± 0,88 bc	34,11 ± 1,35 bc
BNJ 5%	4.32			

Description: Numbers followed by the same letter indicate results that are not significantly different in the 5% BNJ test.

3.6. Total Fruit Weight Per Plant

Total fruit weight is a direct indicator of plant productivity. The results showed that the combination of potassium and paclobutrazol significantly affected tomato fruit weight. The K3P2 treatment (140 kg/ha KCl + 125 ppm paclobutrazol) produced the highest fruit weight, namely 1509.27 g/plant, while the K1P0 treatment (110 kg/ha KCl without paclobutrazol) produced the lowest fruit

weight, namely 1010.95 g / plant. Increasing the potassium dose from 110 to 140 kg/ha increased fruit weight, but at 155 kg/ha the increase was no longer significant. A medium concentration of paclobutrazol (125 ppm) was more optimal than a high concentration (150 ppm). The average total fruit weight per plant for the combination of potassium fertilizer doses and paclobutrazol concentrations is shown in Table 6.

Table 6 Average Total Fruit Weight per Tomato Plant in Combination of Potassium Fertilizer Dose and Paclobutrazol PGR Concentration Treatments

Paclobutrazol Concentration (ppm)	Average Total Fruit Weight per Plant (grams)			
	Potassium Fertilizer Dosage (Kg/ha)			
	110	125	140	155
0	1010.95 ± 14.22 a	1121.04 ± 53.92 ab	1129.70 ± 69.58 ab	1142.49 ± 62.23 ab
100	1104.35 ± 57.11 ab	1140.56 ± 123.56 ab	1319.36 ± 57.43 bc	1116.56 ± 35.07 ab
125	1198.59 ± 69.98 b	1305.30 ± 29.50 bc	1509.27 ± 33.32 c	1224.77 ± 81.95 bc
150	1219.87 ± 51.12 bc	1228.45 ± 38.40 bc	1376.34 ± 41.35 c	1160.60 ± 24.96 ab
BNJ 5%	176.84			

Description: Numbers followed by the same letter indicate results that are not significantly different in the 5% BNJ test.

These results support the findings of (2023), who reported tomato fruit weight of around 1450 g/plant with a potassium application of 150 kg/ha. Research by Sugiharto *et al.* (2022) showed that 125 ppm paclobutrazol increased tomato fruit weight by up to 1480 g/plant, a result that approaches those of this study. Meanwhile, Usmedi *et al.* (2023) reported that the combination of 150 kg/ha of KCl fertilizer with 100 ppm paclobutrazol only produced fruit weight of around 1,300 g/plant. This result is lower than that of this study, which showed that the combination of 140 kg/ha of potassium with 125 ppm of paclobutrazol on tomatoes produced a total fruit weight of 1,509.27 g/plant. Thus, there is a difference of around 209 g/plant (around 16% higher) compared to the results on chilies. This difference confirms that the combination of potassium and paclobutrazol on tomatoes is more effective in increasing fruit weight, possibly because the physiological response of tomatoes to paclobutrazol is more optimal in diverting photosynthates from vegetative growth to fruit formation compared to chilies.

3.7. Fruit Set

Fruit set is an important parameter because it describes the percentage of flowers that successfully develop into

fruit. The results showed that the combination of treatments significantly affected fruit set. The K4P2 treatment (155 kg/ha KCl + 125 ppm paclobutrazol) produced the highest fruit set rate at 53.04%, while the K1P0 treatment (110 kg/ha KCl without paclobutrazol) only achieved 34.72%. This finding indicates that increasing the potassium dose to 155 kg/ha is necessary to support flower and pollen viability, while moderate paclobutrazol concentrations (125 ppm) help synchronize flowering. The average fruit-set percentages for the combination of paclobutrazol concentration and potassium fertilizer dose are shown in Table 7.

A study by Rahmawati *et al.* (2022) reported that 125 ppm paclobutrazol increased tomato fruit set by up to 50%. Meanwhile, (2024) reported that the application of 150 ppm paclobutrazol reduced fruit set in tomato plants by approximately 45%. These results differ from this study, in which 125 ppm paclobutrazol produced a fruit set of 53.04%. This finding shows a difference of around 9% between 125 ppm and 150 ppm. This difference confirms that a dose of paclobutrazol that is too high can suppress fruit formation, whereas 125 ppm is optimal because it suppresses vegetative growth without inhibiting flowering and fruiting. Thus, the combination of high potassium (155

kg/ha) and 125 ppm paclobutrazol proved to be the most effective in increasing tomato fruit set.

Table 7 Average Fruit Set of Tomato Plants in Combination of Potassium Fertilizer Dose and Paclobutrazol PGR Concentration Treatments

Paclobutrazol Concentration (ppm)	Average Fruit Set (%)			
	Potassium Fertilizer Dosage (Kg/ha)			
	110	125	140	155
0	43.04 ± 3.35 a	46.47 ± 1.67 ab	43.73 ± 1.69 ab	45.58 ± 0.78 ab
100	44.96 ± 4.85 ab	45.63 ± 6.29 ab	51.42 ± 0.43 ab	43.90 ± 1.88 ab
125	47.20 ± 3.25 ab	51.96 ± 1.75 b	52.20 ± 3.99 b	53.04 ± 3.32 b
150	50.82 ± 0.51 ab	46.94 ± 1.17 ab	48.57 ± 1.11 ab	51.79 ± 2.97 ab
BNJ 5%	8.79			

Description: Numbers followed by the same letter indicate results that are not significantly different in the 5% BNJ test.



Figure 2. Tomato Plant Harvest Results for Each Treatment, K: Potassium Fertilizer Treatment, P: Paclobutrazol PGR Treatment.

4. Conclusion

Paclobutrazol at 125 ppm was the most effective in enhancing tomato generative growth, resulting in the highest number of flowers (69.77 per plant) and fruits (37.67 per plant). The interaction of 140–155 kg/ha of potassium fertilizer with 125 ppm paclobutrazol produced the best outcomes in terms of the number of bunches (6.78 bunches per plant), fruit weight (1509.27 g per plant), and fruit set (53.04%). Therefore, this combination is recommended to increase tomato productivity. A key

strength of this study is its demonstration that using a lower potassium fertilizer dose (140 kg/ha) combined with 125 ppm paclobutrazol can achieve higher productivity than similar treatments reported in previous studies. This finding confirms that the combination of these two treatments not only improves fertilizer use efficiency but also optimizes the translocation of assimilates to the generative phase, making it a practical strategy for farmers to increase tomato yields sustainably.

References

- Ahmad, N., Sarfraz, M., Farooq, U., Arfan-ul-Haq, M., Mushtaq, M. Z., & Ali, M. A. (2015). Effect of potassium and its time of application on yield and quality of tomato. *International Journal of Scientific and Research Publications*, 5(9), 1-4. <https://d1wqtxts1xzle7.cloudfront.net/114273880/ijsrp-p45120-libre.pdf>
- Amin, A., Sholihah, A., & Djuhari, D. (2024). Pengaruh dosis pupuk KNO₃ terhadap pertumbuhan dan kualitas hasil tanaman tomat (*Solanum lycopersicum* L.). *Jurnal*, 11(2), 476-485.
- Assadiyah, A. N., Dewanti, F. D., & Sulistyono, A. (2023). Respon hasil tanaman tomat (*Solanum lycopersicum* L.) terhadap macam media tanam dan konsentrasi pupuk organik cair limbah kulit buah. *Agro Bali: Agricultural Journal*, 6(1), 93-104. <https://doi.org/10.37637/ab.v6i1.1079>
- Castro-Camba, R., Sánchez, C., Vidal, N., & Vielba, J. M. (2022). Plant development and crop yield: The role of gibberellins. *Plants*, 11(19). <https://doi.org/10.3390/plants11192650>
- Chávez-Mejía, A. C., Magaña-López, R., Durán-Álvarez, J. C., & Jiménez-Cisneros, B. E. (2019). International journal of environment, agriculture and biotechnology. *International Journal of Environment, Agriculture and Biotechnology*, 1878(November), 86-90. <https://doi.org/10.22161/ijeab>
- Fatah, A. (2013). *Jurnal AGRIFOR. Jurnal Agrifor*, 12(2), 96-109. <http://ejournal.untag-smd.ac.id/index.php/AG/article/view/326>
- González-Cortés, A., Robledo-Torres, V., Luna-García, L. R., Mendoza-Villarreal, R., & Pérez-Rodríguez, M. Á. (2023). Yield and antioxidant quality of habanero chili pepper by supplementing potassium with organic products. *Horticulturae*, 9(7). <https://doi.org/10.3390/horticulturae9070797>
- Hati, H. A. P., & Susila, A. D. (2016). Optimasi dosis pemupukan kalium pada budi daya tomat (*Lycopersicon esculentum*). *Buletin Agrohorti*, 4(2), 173-179.

- <https://doi.org/10.29244/agrob.v4i2.15017>
- Kesumawati, N., Jafrizal, & Saputra, A. (2022). Respon tanaman tomat terhadap pemberian pupuk kandang dan pupuk kalium. *Jurnal Agribis*, 15(2), 2019-2030. <https://doi.org/10.36085/agribis.v15i2.3566>
- Kusumiyati, K., Syifa, R. J., & Farida, F. (2022). Effect of various varieties and dosage of potassium fertilizer on growth, yield, and quality of red chili (*Capsicum annuum* L.). *Open Agriculture*, 7(1), 948-961. <https://doi.org/10.1515/opag-2022-0151>
- Maulani, N. W., Subang, U., Wanareja, K., Subang, K., & Subang, K. (2019). Pengaruh kombinasi dosis pupuk organik dan pupuk kalium terhadap pertumbuhan dan hasil tanaman melon (*Cucumis melo* L.) varietas Madesta F1. *Jurnal Agrotektan*, 6(2), 59-76. <https://ejournal.unsub.ac.id/index.php/agrotektan/article/view/1010>
- Nazibah, M. S. S., Karno, & Lukiwati, D. R. (2018). Respon pertumbuhan dan perkembangan tanaman tomat (*Solanum lycopersicum*) terhadap paklobutrazol dan komposisi media tanam. *Journal of Agro Complex*, 2(3), 199-205. <https://doi.org/10.14710/joac.2.3>
- Novita, A. (2022). The effect of gibberellin (GA₃) and paclobutrazol on growth and production of tomato (*Lycopersicon esculentum* Mill.). *IOP Conference Series: Earth and Environmental Science*, 1025(1). <https://doi.org/10.1088/1755-1315/1025/1/012037>
- Rahman, M. H., Rahman, M. H., Halder, B. C., Ahmed, M., & Nishi, N. J. (2023). Applying paclobutrazol and flower bud pruning modify the fruiting time and fruit quality of 'Amrapali' mango (*Mangifera indica* L.). *Horticulture Journal*, 92(3), 255-260. <https://doi.org/10.2503/hortj.QH-061>
- Rahmatika, W., Wasito, W., Wibawa, B. S., Handayani, T., & Fitriyah, N. (2024). Pupuk kotoran kelinci dan pupuk anorganik pada tanaman tomat (*Lycopersicon esculentum* Mill.). *Innofarm: Jurnal Inovasi Pertanian*, 26(1), 61-68. <https://doi.org/10.33061/innofarm.v26i1.10032>
- Rahmawati, R., Sulistyono, A., et al. (2022). Response growth and yield of tomato plants (*Solanum lycopersicum* L.) to the application concentrations paclobutrazole and various liquid organic fertilizers. *Jurnal Pertanian Agros*, 24(2), 811-818.
- Sakanti, P. D., Karno, K., & Rosyida, R. (2024). Efek konsentrasi paklobutrazol dan pemangkas pada pertumbuhan dan hasil tanaman tomat ceri (*Lycopersicon esculentum* var. *cerasiforme*). *J-Plantasimbiosa*, 6(1), 74-90. <https://doi.org/10.25181/jplantasimbiosa.v6i1.3558>
- Salta, L. A., Nikmatullah, A., & Nurrachman, N. (2023). Pengaruh konsentrasi dan waktu aplikasi paclobutrazol terhadap pertumbuhan dan hasil bawang merah (*Allium ascalonicum* L.) asal TSS. *Agroteksos*, 33(3), 769. <https://doi.org/10.29303/agroteksos.v33i3.878>
- Saputra, I., Nurbaiti, & Gunawan, T. (2017). Pengujian beberapa konsentrasi paclobutrazol dengan waktu aplikasi berbeda pada tanaman tomat (*Lycopersicon esculentum* Mill.). *Jurnal Faperta*, 4(1), 1-14.
- Simanungkalit, R. D. M., Suriadikarta, D. A., Saraswati, R., Setyorini, D., & Hartatik, W. (2006). *Pupuk organik dan pupuk hayati*. Balai Besar Litbang Sumberdaya Lahan Pertanian.
- Sitompul, L., Padmini, O. S., & Sasmita, E. R. (2024). Aplikasi giberelin (GA₃) dan paklobutrazol untuk meningkatkan pertumbuhan dan hasil tanaman tomat (*Solanum lycopersicum* L.). *Agro Wiralodra*, 7(2), 48-52. <https://doi.org/10.31943/agrowiralodra.v7i2.120>
- Sugiharto, N. O., Sulistyono, A., & Kusumaningrum, N. A. (2022). Pengaruh konsentrasi paclobutrazol dan dosis pupuk NPK terhadap pertumbuhan dan hasil tanaman tomat (*Lycopersicon esculentum*). *Plumula: Berkala Ilmiah Agroteknologi*, 10(1), 55-69. <https://doi.org/10.33005/plumula.v10i1.79>
- Suud, M., Mimik, U. Z., & Yunus. (2023). Respon pematangan umbi dan konsentrasi paclobutrazol terhadap pertumbuhan dan hasil tanaman bawang merah (*Allium ascalonicum* L.). *Jurnal Pertanian Agros*, 25(4), 3994-4003. <http://dx.doi.org/10.37159/jpa.v25i4.3542>
- Usmadi, U., Elfrida, T. L., & Hartatik, S. (2023). Aplikasi paclobutrazol dan pupuk kalium terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* var. *saccharata* Sturt). *Jurnal Penelitian IPTEKS*, 8(2), 205-213. <https://doi.org/10.32528/ipteks.v8i2.17146>