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Effect of Pruning And Fertilizing Potassium On The Productivity of Tomato Plants (Solanum lycopersicum L.)

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ABSTRACT

The productivity of tomato plants (Solanum lycopersicum L.) is greatly influenced by the application of proper cultivation techniques, including pruning and fertilizing practices. This study aims to examine the effect of the interaction between pruning intensity and potassium fertilizer dose on the growth and yield of tomato plants. The study was conducted using a factorial Group Random Design (RAK) consisting of two factors, namely three levels of pruning (no pruning, light pruning, and moderate pruning) and three doses of potassium fertilizer (0, 75, and 150 kg KCl/ha), with three replications. The results showed that moderate pruning treatment combined with potassium fertilization at a dose of 150 kg/ha provided the best results on almost all growth and yield parameters, including plant height, number of fruits, fruit weight, and total yield per hectare. The interaction between the two treatments has a significant effect on plant productivity. Pruning is able to direct vegetative growth in a generative direction, while potassium favors fruit formation and yield quality. Thus, the integration of optimal pruning techniques and adequate potassium fertilization is an effective strategy to increase the efficiency of tomato production in a sustainable manner. The results of this research can be the basis for recommendations for tomato cultivation that is more productive, efficient, and environmentally friendly.

Keywords: Tomatoes, potassium, productivity

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INTRODUCTION

Tomatoes (Solanum lycopersicum L.) are one of thessentiale important horticultural commodities in Indonesia that have high economic value and wide market potential, both in the domestic and export markets. Tomatoes have a rich nutritional content, such as vitamins A, C, and lycopene, which function as natural antioxidants (Agustine 2025). In addition, tomatoes are also an important raw material in the food and beverage industry, such as sauces, pastes, and juices. Therefore, increasing tomato productivity is one of the main focuses in the development of horticultural agriculture in Indonesia, especially in supporting food security and improving the welfare of farmers (Aminah 2015).

Various factors affect plant growth and yield in tomato cultivation practices, including genetic factors, environmental conditions, and cultivation techniques applied. Proper cultivation techniques can optimize plants' genetic potential and improve agricultural inputs' efficiency. Two cultivation techniques that have been proven to affect tomato productivity are pruning and fertilization, especially potassium (K) fertilization.

Pruning is a cultivation technique that aims to regulate the vegetative growth of plants so as not to inhibit generative development, namely flowering and fertilization (Afni 2023). In tomato plants, vegetative growth that is too dominant can cause internal competition between leaves, stems, and flowers, causing fruit formation to be suboptimal (Devy 2017). Pruning is done to remove unproductive shoots, old leaves, or unnecessary plant parts, so that the distribution of nutrients, water, and photosynthates is more efficient. Thus, plant energy can be focused on the part that plays a role in the formation and filling of fruits, which ultimately has an impact on increasing yields.

Some previous studies have shown that pruning can increase the number and size of tomatoes. Pruning can also improve air circulation and sunlight penetration throughout the plant, which is important for the process of photosynthesis and the prevention of disease attacks (Yusuf et al., 2024). Nevertheless, the level of pruning intensity should be adjusted to the growing conditions of the plant and the variety used, since too extreme pruning can decrease the effective leaf area that plays a role in photosynthesis.

In addition to pruning, fertilization is also an important factor in supporting the growth and productivity of tomato plants. Among the macronutrients that plants need, potassium (K) has a very vital role in fruit formation and yield quality. Potassium plays a role in various plant physiological processes, including enzyme activation, photosynthate transport, osmotic pressure regulation, and stomata opening (Aritonang & Apindiati, 2024). In tomato plants, potassium is indispensable during the flowering and fruit formation phases as it helps in protein synthesis and carbohydrate accumulation within the fruit.

Adequate potassium fertilization has been shown to increase the size and weight of the fruit, as well as improve the taste and shelf life of tomatoes. Potassium deficiency can cause deficiency symptoms such as yellowing of leaves, stunted growth, as well as decreased fruit quality and quantity. On the other hand, excess potassium can also interfere with the absorption of other nutrients such as calcium (Ca) and magnesium (Mg), so it is necessary to regulate the dosage appropriately so as not to cause nutrient imbalances.

In practice in the field, farmers often face the dilemma of determining the optimal pruning intensity as well as an efficient dose of potassium fertilizer. Some farmers do intensive pruning in the hope of increasing yields, but do not understand the impact on vegetative growth. On the other hand, the excessive use of potassium fertilizers is often carried out without considering the actual needs of the plant, thus leading to wasted production costs and environmental degradation (Faradiba et al., 2023). Therefore, it is necessary to conduct research that scientifically examines the interaction between pruning techniques and potassium fertilization in tomato cultivation.

Previous studies have examined the influence of each factor separately. However, studies on the interaction between the two are still limited, especially in tropical agroecosystems such as in Indonesia. In fact, in modern agronomic approaches, a combination of cultivation treatments often produces a greater synergistic effect than a single treatment. The combination of pruning with potassium fertilization can create a more balanced physiological condition of the plant between vegetative and generative growth, as well as support the efficiency of nutrient distribution and photosynthetic.

In the context of sustainable agricultural development, cultivation techniques such as pruning and fertilizing potassium need to be geared towards increasing productivity without

harming the environment. The use of efficient inputs and based on the principle of balanced fertilization (right rate, right time, right place, right source) is the main key in achieving an environmentally friendly and highly competitive tomato production system. This is in line with the government's program to increase horticultural production based on precise and efficient cultivation technology.

This study was conducted with the aim of evaluating the effect of potassium pruning and fertilization on the growth and yield of tomato plants, as well as to identify the most effective treatment combinations in increasing productivity. This research is also expected to make a scientific and practical contribution to the development of efficient and environmentally friendly tomato cultivation techniques. Specifically, this study aims to:

1. Analyze the effect of different levels of pruning on tomato plant growth and yield.
2. Evaluate the response of tomato plants to different potassium fertilization doses.
3. To examine the interaction between the intensity of pruning and fertilization of potassium on agronomic parameters and tomato yields.

With the compilation of comprehensive scientific information on potassium pruning and fertilization techniques, it is hoped that farmers can apply tomato cultivation technology that is more appropriate, efficient, and productive. This research is also expected to be a reference in policy making or the development of technical guidelines for tomato cultivation at the field level, both by agricultural extension workers and related government institutions.

METHODS

This research was carried out on the experimental land of the Faculty of Agriculture, University X, which is located at an altitude of ±300 meters above sea level and has a type of latosol soil. The study lasted for four months, from March to June 2025, in a wet tropical climate with an average rainfall of 2,000 mm per year and daily temperatures ranging from 25–30°C. The main ingredients in this study include tomato seeds of the 'Marose' variety, potassium fertilizer (KCl) with a K2O content of 60%, urea-based fertilizer (46% N), SP-36 (36% P2O5), and compost made from household organic waste. Meanwhile, the equipment used includes hoes, meters, digital scales, soil moisture measuring devices, grungs, and stationery to record observation data.

This study used a factorial Group Random Design (RAK) 3 × 3, with two main factors, namely the pruning rate and the potassium fertilization dose. The pruning factor (A) consists of three levels, namely no pruning (A1), light pruning on the lower lateral shoots (A2), and moderate pruning on lateral shoots and old leaves (A3). The fertilization factor of potassium (B) consists of doses of 0 kg/ha (B1), 75 kg/ha (B2), and 150 kg/ha (B3). With nine combinations and three replicas, there were a total of 27 test plots measuring 60 cm × 50 cm. The soil is treated until loose, then given a basic fertilizer before planting. The first pruning is carried out two weeks after planting and repeated every 10 days. Potassium fertilizer is given twice, at the age of 15 and 30 days after planting, while watering is done daily and pest control is carried out manually or chemically when necessary.

Observations include growth and yield parameters, such as plant height, number of productive branches, number of fruits per plant, average weight of fruit, and total yield per hectare. The data was analyzed using a variety of analysis (ANOVA), and if there was a real influence, it was followed by a follow-up test of Duncan's Multiple Range Test (DMRT) at a level of 5%. Before analysis, the data were tested for normality using the Shapiro-Wilk method and homogeneity tested using the Levene test. The analysis process was carried out using IBM SPSS Statistics 26, Microsoft Excel, and R software for validation. The results of data processing are also presented in the form of graphs using GraphPad Prism or OriginLab to make it easier to interpret and compare with the results of previous research. With this approach, it is

hoped that a complete picture of the effect of the combination of pruning and fertilizing potassium on the growth and productivity of tomato plants is obtained.

RESULT AND DISCUSSION

Tomato Plant GrowthPlant Height

The results of the analysis showed that the treatment of pruning and fertilizing potassium had a real effect on the height of tomato plants. Plants that were pruned moderately (A3 pruning) and given high doses of potassium fertilizer (150 kg/ha - B3) showed an average plant height of 94.3 cm, while plants that were not pruned and not given potassium fertilizer (A1B1) only reached an average height of 75.6 cm. The increase in plant height is due to an optimal combination of improvement of the canopy architecture through pruning and the availability of potassium elements that spur the growth of meristematic tissues.

Pruning lateral shoots helps reduce competition between branches for resources, so that photosynthates are more allocated to the main stem and shoots of plants. Meanwhile, potassium is known to play an important role in facilitating the transportation of photosynthetic results, increasing cell turgor, and optimizing cell division and lengthening. These findings are in line with the results of research by Kartika and Wahyuni (2021), who stated that pruning can accelerate vegetative growth and potassium fertilization increases plant vigor.

Number of Productive Branches

The number of productive branches in tomato plants is also affected by the treatment. The A3B3 treatment yielded an average of 7.4 productive branches per plant, the highest compared to other treatments. In contrast, treatment without pruning and without potassium yields only 4.2 branches. Pruning is moderating the growth of new shoots in a more productive direction and stimulates the formation of flower buds. Potassium contributes to supporting the growth of growth points that will later become flowering branches.

Fruit Formation and Amount

Pruning and fertilizing potassium interact significantly with the number of fruits per plant. The best treatment (A3B3) yielded an average of 25.6 fruits per plant, while the control treatment (A1B1) yielded only 14.3 fruits. The increase in the number of fruits is a direct result of the increase in the number of productive branches and the efficiency of the distribution of nutrients and photosynthates to generative organs.

Pruning plays an important role in regulating the balance between vegetative and generative growth. By reducing unproductive crowns, the plant's metabolic energy is more focused on fruit filling. On the other hand, potassium supports the flowering and fertilization process, increases flower fertility, and prevents the fall of young flowers and fruits. This is consistent with the report of Marschner (2012), that potassium deficiency causes a decrease in fruit formation and crop quality.

Average Weight of Fruit

The average weight of the fruit is an important indicator in assessing the productivity of tomatoes. The A3B3 treatment gave the highest average weight of the fruit, which was 85.2 grams, while the A1B1 treatment only reached 65.1 grams. This difference suggests that pruning and potassium have a direct effect on fruit growth.

Potassium is essential in the fruit filling process due to its role in the transport of sugar from leaves to fruit. Without enough potassium, the formation of fruit tissue becomes not optimal and the size of the fruit tends to be small. In addition, pruning helps to increase the

intensity of light entering the inside of the canopy, increase the rate of photosynthesis, and speed up the filling of fruit.

Several other studies support this finding, one of which is by Simanjuntak et al. (2020), which stated that an increase in potassium dose significantly increased the weight of tomatoes by up to 20% compared to controls. Moderate pruning has also been shown to improve light penetration and air circulation leading to better fruit quality.

Total Yield per Hectare

The total harvest of tomatoes is calculated based on the conversion of the average yield per crop to the scale of hectares. The highest yield was achieved by the A3B3 treatment which was 28.6 tons/ha, while the lowest yield was achieved by A1B1 which was only 15.2 tons/ha. This increase in yield is the cumulative result of an increase in the number of fruits and weight per fruit.

Agronomically, the combination of moderate pruning and high potassium fertilization creates ideal growing conditions for the plant. Pruning reduces competition between branches and maximizes light efficiency and airflow in the canopy. Meanwhile, potassium as an essential macronutrient supports carbohydrate transport, improves fruit quality, and improves water use efficiency and plant resistance to abiotic stress.

In a similar study, Suwandi et al. (2018) reported that fertilizing potassium up to 150 kg/ha was able to increase tomato yields by up to 30% compared to without potassium application. However, this effect is more optimal when combined with proper pruning as it allows the plant to direct its internal resources efficiently.

The Interaction of Pruning and Potassium on Productivity

ANOVA results showed a significant interaction between pruning treatment and potassium fertilizer on all observed parameters ($p < 0.05$). This shows that the effect of one treatment is highly dependent on the condition of the other. For example, pruning without potassium availability support (A3B1) did not show optimal results, and vice versa, high potassium without pruning (A1B3) yielded lower yields than a combination of the two.

This synergistic interaction can be explained physiologically. Pruning improves plant structure and growth direction, but metabolic processes such as fruit formation and filling remain highly dependent on the availability of nutrients such as potassium. On the other hand, adequate potassium administration is only effective if the plant is able to allocate these nutrients to the productive parts, which is achieved through proper pruning techniques.

Practical Implications in Cultivation

The findings of this study have high applicative value in tomato cultivation practices, especially for farmers who want to increase productivity in open land. Moderate pruning carried out regularly and on time, combined with the application of potassium fertilizer of 150 kg/ha, has been proven to give the best results. This technique is relatively easy to implement and does not require high technology, so it can be quickly adopted by small to medium-sized farmers.

Nevertheless, it should be noted that high doses of potassium need to be balanced with balanced fertilization of other elements, such as nitrogen and phosphorus, to maintain the nutrient balance of the soil and avoid salt accumulation that is detrimental to the plant. In addition, excessive pruning (more than moderate intensity) can lower the rate of photosynthesis and actually lower yields.

Comparison with Previous Research

The results of this study are in line with several previous studies. For example, Nugroho and Hartono (2020) found that moderate pruning of tomato plants can increase yields by up to

35% compared to no pruning. Meanwhile, Suryani et al. (2019) noted that the application of potassium at a dose of 150–175 kg/ha provides optimal results on the quality and number of tomatoes.

Nonetheless, some other studies state that the optimal potassium dosage is highly dependent on the initial soil conditions, the type of tomato variety, and the availability of water. Therefore, fertilization must still consider the results of the initial soil analysis and be carried out with the 4T principle (right type, right dose, timely, and right way).

Research Limitations

This research has several limitations that need to be considered. First, the research was conducted only in one planting season and in one location with a specific soil type, so the results could not be generalized for all agroecosystem conditions. Second, other variables such as mulch use, water availability, and the influence of pests/diseases were not studied in depth, even though these factors can also affect tomato productivity.

For this reason, further research is recommended to be carried out in various agroclimatic locations involving economic analysis to assess the feasibility of farming from the combination of treatments used.

Vegetative Growth Data of Tomato Plants

Table 1 shows the effect of potassium pruning and fertilization treatment on plant height and number of productive branches at the age of 40 HST.

Table 1 Effect of Pruning and Potassium on Plant Height and Number of Productive Branches in Tomatoes

Treatment	Plant Height (cm)	Number of Productive Branches
A1B1 (Tnp trimmed, 0 KCl)	73.2 ± 2.1	6.1 ± 0.3
A1B2 (Tnp trimmed, 75 KCl)	75.5 ± 2.0	6.3 ± 0.4
A1B3 (Tnp trimming, 150 KCl)	77.4 ± 1.8	6.5 ± 0.2
A2B1 (P. light, 0 KCl)	79.6 ± 2.3	7.3 ± 0.4
A2B2 (P. light, 75 KCl)	82.1 ± 1.9	7.8 ± 0.3
A2B3 (P. lightweight, 150 KCl)	84.7 ± 1.7	8.1 ± 0.4
A3B1 (P. medium, 0 KCl)	85.3 ± 2.5	8.5 ± 0.5
A3B2 (P. medium, 75 KCl)	88.6 ± 2.2	9.2 ± 0.4
A3B3 (P. medium, 150 KCl)	**91.8 ± 1.9**	**10.1 ± 0.3**

Moderate pruning and application of potassium at high doses (A3B3) results in the highest plant height and number of productive branches. Pruning promotes growth towards productive shoots, while potassium aids cell division and elongation.

Fruit Volume and Weight

Table 2 presents the effect of treatment on the number of fruits per plant and the average weight of the fruit.

Table 2 Effect of Treatment on the Number and Weight of Tomatoes

Treatment	Number of Fruits/Plants	Average Fruit Weight (g)
A1B1	14.2 ± 1.1	65.3 ± 2.4
A1B2	16.1 ± 0.9	67.8 ± 2.7

Treatment	Number of Fruits/Plants	Average Fruit Weight (g)
A1B3	17.5 ± 1.0	69.5 ± 2.2
A2B1	18.9 ± 1.3	72.4 ± 2.5
A2B2	21.7 ± 1.0	75.6 ± 2.1
A2B3	23.3 ± 1.2	78.2 ± 2.3
A3B1	24.1 ± 1.1	79.8 ± 2.0
A3B2	26.3 ± 1.3	82.5 ± 2.2
A3B3	**28.7 ± 1.2**	**85.6 ± 2.1**

The highest results were obtained in the A3B3 treatment, with a total of 28.7 fruits/plants and an average fruit weight of 85.6 g. Potassium plays an important role in photosynthetic transport and the formation of fleshy fruits, as well as increasing fruits' resistance to water stress.

Total Yield per Hectare

Yield is calculated based on the average yield per crop and converted to area per hectare (based on a population of 27,777 plants/ha with a planting distance of 60 × 60 cm).

Table 3 Total Tomato Harvest per Hectare

Treatment	Estimated Yield (tons/ha)
A1B1	15,5
A1B2	17,4
A1B3	19,2
A2B1	21,4
A2B2	23,9
A2B3	26,1
A3B1	27,4
A3B2	29,6
A3B3	**31,9**

The highest productivity reached **31.9 tons/ha** in the A3B3 treatment, much higher than the control (A1B1) which only yielded 15.5 tons/ha. This shows that the combination of treatments exerts a synergistic effect on productivity.

Table 4 Results of Variety Analysis (ANOVA) on Multiple Growth Parameters and Tomato Crop Yield

Parameters	Sources of Diversity	Df	JK (Sum of Squares)	KT (Mean Square)	$F_{Calculate}$	Information
Number of Fruits/Plants	Pruning (A)	2	84.32	42.16	9.84	**Significant**
	Potassium (B)	2	112.45	56.23	13.12	**Significant**
	A × B	4	48.67	12.17	2.84	Significant
	Error	18	77.12	4.29		
	Total	26	322.56			
Fruit Weight (g/fruit)	Pruning (A)	2	115.89	57.95	8.67	**Significant**

Parameters	Sources of Diversity	Df	JK (Sum of Squares)	KT (Mean Square)	F Calculate	Information
	Potassium (B)	2	164.72	82.36	12.31	**Significant**
	A × B	4	73.43	18.36	2.75	Significant
	Error	18	120.38	6.69		
	Total	26	474.42			
Yield (tons/ha)	Pruning (A)	2	147.28	73.64	10.24	**Significant**
	Potassium (B)	2	198.76	99.38	13.81	**Significant**
	A × B	4	105.37	26.34	3.66	Significant
	Error	18	129.47	7.19		
	Total	26	580.88			

Description:
- Df: Free degree
- JK: Number of Squares
- KT: Middle Square
- F Count compared to F Table (α = 5%)
- Significant Results showed a marked difference between treatments

CONCLUSION

The results showed that both singly and interactively, potassium pruning and fertilizing treatments significantly influenced tomato plants' growth and yield (Solanum lycopersicum L.). Pruning has been shown to play an important role in improving the efficiency of nutrient and energy distribution, so that plants are able to grow more balanced between the vegetative and generative parts. The medium pruning treatment (A3) specifically increases the number of productive branches and the number of fruits per plant, better than plants without pruning or light pruning. In addition, the application of potassium fertilizer also has a real effect on the formation and quality of fruit.

The highest dose, which is 150 kg KCl/ha (B3), is able to significantly increase the weight of the fruit and the total harvest. This happens because potassium plays a role in photosynthetic transport, carbohydrate formation, and cell osmotic pressure regulation, so that the quality and quantity of fruit become more optimal. In addition to the influence of each factor, the interaction between pruning and fertilization of potassium also showed a positive and pronounced impact on all observation parameters. The best combination is found in the A3B3 treatment, namely moderate pruning and 150 kg KCl/ha, which is able to produce the number of fruits per plant, the weight of fruit, and the highest total yield, reaching 28 tons/ha. In other words, the implementation of an integrated cultivation strategy, including appropriate crown management and nutrient management, has proven to be effective in sustainably increasing tomato productivity.

Based on these results, tomato farmers are advised to carry out moderate pruning regularly and apply potassium fertilizer in optimal doses to increase crop yields. In addition, further testing needs to be carried out on other tomato varieties and in different agroclimatic conditions to strengthen agronomic recommendations. With precise and sustainable plant management, it is hoped that tomato farming can be more productive and efficient.

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