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The Effect of Fertilization Models and Silica Dosage on the Growth and Yield of Elongated Cherry Tomatoes (Solanum lycopersicum var. cerasiforme)

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Abstract. This study aimed to evaluate the effect of fertilization models and silica dosage on the growth and yield of oval cherry tomatoes (Solanum lycopersicum var. cerasiforme). The study was conducted using a two-factor randomized block design (RBD) with four replicates. The first factor was the fertilization model (drip irrigation and spraying), and the second factor was the silica dose (0 cc/l [control], 1 cc/l, 2 cc/l, and 3 cc/l). The parameters observed included plant height, number of leaves, number of fruits, and fruit weight. The results showed that although statistically most treatments were not significantly different, drenching tended to be better in the early growth phase, while spraying produced higher fruit yields. Increasing the silica dose showed a positive trend for all parameters, with a dose of 3 cc/l producing the highest number and weight of fruits. These findings indicate that silica has the potential to increase cherry tomato productivity when applied with the appropriate model and dose.

Keywords: cherry tomatoes, silica, fertilization, drip irrigation, spraying, dosage

1 Introduction

Cherry tomatoes (Solanum lycopersicum var. cerasiforme) are a horticultural commodity with high economic value and are in high demand by consumers due to their sweet taste, high nutritional content, and flexible use in various types of dishes [1]. The elongated cherry tomato variety is one of the most widely cultivated types due to its unique shape and relatively better shelf life compared to round varieties [2].

However, cherry tomato productivity is often influenced by various factors, one of which is soil nutrients. Silica (Si) is a nutrient that, although not classified as an essential nutrient, has been proven to play an important role in increasing plant resistance to biotic and abiotic stresses, strengthening cell walls, and improving photosynthetic efficiency. Appropriate silica application can contribute to increased vegetative growth and crop yield, including cherry tomatoes [3].

Silica (Si) is an element that, although not classified as an essential nutrient for plants, has been proven to contribute significantly to plant growth and resistance, including cherry tomatoes (Solanum lycopersicum var. cerasiforme) [4]. The application of silica in the right dosage can improve cell wall structure and strength, strengthen plant tissue, and increase photosynthetic efficiency. During the vegetative growth phase, silica helps accelerate the formation of sturdy leaves and stems, enabling plants to grow more optimally and withstand biotic (such as pathogen attacks) and abiotic (such as drought and salinity) stresses [5].

In terms of yield, applying silica at the appropriate dose can improve the quality and quantity of cherry tomatoes. Silica is known to increase the absorption of other nutrients such as phosphorus and potassium, which play an important role in fruit formation and ripening [6]. The optimal dose of silica increases the number of fruits per plant and fruit weight, and extends post-harvest shelf life by strengthening the fruit skin. However, applying silica in excessively high doses can cause antagonism with other nutrients or unnecessary accumulation by the plant, which can actually reduce growth efficiency and yield. Therefore, testing various silica doses is crucial to determine the most effective and efficient application rate in cherry tomato cultivation [7].

The model or method of silica application is important in determining its effectiveness. Two commonly used methods are direct irrigation into the growing medium and spraying onto the plant leaves. Each method has its own characteristics in terms of nutrient absorption, application effectiveness, and impact on plant growth. Therefore,

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research is needed to compare these two fertilization models to determine which method is more effective in supporting the growth and yield of oval cherry tomatoes [8].

Fertilizer application through drenching is one of the commonly used application techniques in plant cultivation, including tomatoes. This method is carried out by spreading fertilizer evenly around the plant roots, either on the soil surface or mixed into the planting medium. Drenching allows nutrients to be absorbed gradually by plant roots along with the activity of soil microorganisms and the moisture content of the planting medium. In tomato plants, this method can contribute to vegetative growth, such as increased plant height, number of leaves, and canopy area, because the roots are able to obtain nutrients continuously. However, its effectiveness is highly dependent on the type of fertilizer, soil conditions, and irrigation management that supports the dissolution and movement of nutrients to the root zone [9].

In addition, drip fertilization has the potential to increase nutrient absorption efficiency when applied at the right time and dosage. In the context of silica fertilization, the drip method can improve soil structure and strengthen the root system of tomatoes, making plants more resistant to biotic and abiotic stresses. Previous studies have shown that applying silica through the soil can increase stem strength, reduce damage from disease, and improve tomato fruit quality. However, the limitation of this method lies in the possibility of nutrient leaching, especially in open fields or during high rainfall. Therefore, a comprehensive evaluation of this fertilization model is needed to determine its suitability and effectiveness in optimally increasing tomato production [10].

The method of fertilization through spraying, known as foliar application, is a technique of applying fertilizer directly to the surface of plant leaves. In tomato plants, this method allows the absorption of nutrients through the stomata and leaf cuticle, which are then distributed throughout the plant through the phloem tissue. Foliar fertilizers, including liquid silica, can provide a faster physiological response than soil application, especially in suboptimal soil conditions or when plants experience root absorption disorders. Foliar application also allows for more precise dose control and reduces the risk of nutrient loss due to leaching or fixation in the soil [11].

Physiologically, spraying silica on tomato leaves has the potential to strengthen cell walls, increase enzyme activity, and stimulate shoot growth and flower formation [12]. Several studies have shown that silica applied through the leaves can increase plant resistance to abiotic stresses such as drought and extreme temperatures, as well as reduce the incidence of pathogen attacks. In terms of productivity, silica spraying can improve fruit quality, increase soluble solids content, and accelerate harvest time. However, the success of this method is highly dependent on factors such as solution concentration, application frequency, spraying time, and weather conditions during application [13]. Therefore, evaluating the effectiveness and efficiency of the spraying model is important in supporting sustainable and highly competitive tomato cultivation [14].

This study aims to determine the effect of different silica fertilization models, namely broadcasting and spraying, on the growth and yield of oval cherry tomatoes, so that it can serve as a basis for recommendations for farmers in more efficient and productive cultivation practices.

2 Methods

This study was conducted at the experimental field of Muhammadiyah University Sidoarjo in Modong Tukangan Village using a two-factor randomized block design (RBD) with three replications. The study aimed to determine the effect of the combination of spraying models and silica fertilizer application rates on the growth and yield of oval cherry tomatoes. The first factor was the silica fertilization model with two levels, namely spraying and drip irrigation. The second factor was the silica fertilizer rate with four levels, namely control, 1, 2, and 3 cc/liter. Both factors had three levels, resulting in eight treatment combinations (2 × 4), and each combination was repeated three times, resulting in a total of 24 experimental units [15].

The research began with the division of the land into three groups (blocks) based on the uniformity of environmental conditions (e.g., drainage and light intensity). Within each group, the 8 treatment combinations were randomly assigned. Each experimental unit consisted of a number of elongated cherry tomato plants, and three main plants per plot were randomly observed.

Liquid silica fertilizer is sprayed onto the leaf surface according to the concentration of each level in factor A. Meanwhile, granular or powdered silica fertilizer is sprinkled onto the planting medium according to the dosage of each level in factor B. The treatment is carried out regularly according to the plant growth phase. The parameters observed were plant height (cm), number of leaves per plant, number of fruits per plant, total fruit weight per plant (grams), and vitamin C. The data obtained were analyzed using two-way factorial analysis of variance (ANOVA) at a significance level of 5% to determine the effect of each factor and the interaction between the two. If there was a significant effect, the analysis was continued with the Honest Significant Difference (HSD) test at a level of 5% to compare between treatments.

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3 Results and Discussion

3.1 Plant Height

The analysis of variance results showed that there was no interaction between the Fertilization Model and Silica Dose treatments, but there was a very significant effect of the Fertilization Model treatment on tomato growth at 7 and 35 days after planting (DAP). The silica dose treatment had no effect on tomato growth at all observation ages. To see the differences, a further HSD test was conducted.

Table 1. Average Effects of Fertilization Model Treatment and Silica Dose on Plant Height

Treatment	Age				
	7	14	21	28	35
Leakage	14.04b	28.23	36.65	43.69	52.06b
Spraying	13.79a	29.33	36.29	43.65	46.52a
BNJ 5%	**1.81**	**tn**	**tn**	**tn**	**3.69**
Control	12.00	24.92	33.58	40.17	35.42
Silica 1 cc/l	13.88	27.71	33.83	43.38	49.54
Silica 2 cc/l	14.79	31.79	40.38	46.54	60.00
Silica 3 cc/l	15.00	30.71	38.08	44.58	52.21
BNJ 5%	**tn**	**tn**	**tn**	**tn**	**tn**

Note: Identical numbers in the same column indicate no significant difference, tn = not significant.

Table 1 shows the average height of cherry tomato plants under various fertilization treatments (drip irrigation and spraying) and silica doses (1, 2, and 3 cc/l) at 7 to 35 days after planting. Based on the observations, at 35 days old, the drip irrigation treatment resulted in taller plants (52.06 cm) compared to spraying (46.52 cm), and this difference was statistically significant based on the 5% BNJ test (with a BNJ value of 3.69). Meanwhile, at 7 days old, drip irrigation also showed significantly higher results compared to spraying.

3.2 Number of Leaves

The analysis of variance results showed that there was no interaction between the Fertilization Model Treatment and Silica dose, nor did the Fertilization Model Treatment and Silica dose affect all observation ages of tomato growth. To see the differences, a further BNJ test was conducted.

Table 2. Average Effects of Fertilization Model Treatment and Silica Dose on Number of Leaves

Treatment	Age				
	7	14	21	28	35
Leakage	22.31	39.13	49.46	63.83	75.56
Spraying	22.31	34.67	47.42	60.35	69.73
BNJ 5%	tn	tn	tn	tn	tn
Control	**19.29**	**35.38**	**48.08**	**60.96**	**72.92**
Silica 1 cc/l	22.96	39.29	48.58	61.92	70.75
Silica 2 cc/l	21.83	34.04	46.75	60.00	70.83
Silica 3 cc/l	25.17	38.88	50.33	65.50	76.08
BNJ 5%	**tn**	**tn**	**tn**	**tn**	**tn**

Note: Identical numbers in the same column indicate no significant difference, tn = not significant.

Table 2 presents the average number of leaves on cherry tomato plants based on fertilization treatment (drip irrigation and spraying) and silica dosage (1, 2, and 3 cc/l) at 7 to 35 days after planting. The results show that, in general, the number of leaves increased with the age of the plants in all treatments.

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3.3 Number and Weight of Fruits

Analysis of variance results showed that Fertilization Model Treatment and silica dose did not interact with each other, nor did Fertilization Model Treatment and silica dose affect fruit number and weight. To identify differences, a post-hoc BNJ test was conducted.

Table 3. Average Effects of Fertilization Model Treatment and Silica Dose on Fruit Number and Weight

Treatment	Number of Fruits	Fruit Weight
Drip Irrigation	**58.50**	**575.50**
Spraying	**65.50**	**634.17**
BNJ 5%	**tn**	**tn**
Control	32.83	329.17
Silica 1 cc/l	54.33	528.33
Silica 2 cc/l	71.33	685.00
Silica 3 cc/l	89.50	876.83
BNJ 5%	**tn**	**tn**

Note: Identical numbers in the same column indicate no significant difference, tn = not significant.

Table 3 shows the average number and weight of cherry tomato fruits based on fertilization treatment models (drip irrigation and spraying) and various silica doses (1, 2, and 3 cc/l). The results show that, in general, spraying produced higher fruit numbers and weights (65.50 fruits; 634.17 grams) compared to drenching (58.50 fruits; 575.50 grams), although this difference was not statistically significant (indicated by "ns" or not significant based on the 5% BNT test). For the silica dose treatments, there was an increase in fruit number and weight with increasing silica dose, with the highest dose (3 cc/l) yielding the most optimal results, namely 89.50 fruits with a total weight of 876.83 grams.

3.4 Discussion

The results of the study indicate that the fertilization model and silica dose have different effects on the growth and yield of cherry tomato plants, although statistically many parameters do not show significant differences. In terms of plant height, the drip irrigation treatment showed significantly higher results than spraying at 7 and 35 days after planting. This indicates that drip irrigation allows for faster nutrient absorption through the roots from the beginning of the growth phase to the end of the vegetative phase. Meanwhile, an increase in silica dosage appears to be in line with an increase in plant height, where a dosage of 2 cc/l produced the tallest plants at 35 days (60.00 cm), although this was not statistically significant compared to other dosages.

The number of leaves as an indicator of vegetative growth also showed a similar trend, where the drip irrigation model was slightly superior to spraying, especially at the end of the observation period (35 days), although it did not show a significant difference. Increased silica doses, especially at 3 cc/l, produced the highest number of leaves (76.08 leaves), indicating that silica plays a role in accelerating cell division and elongation, as well as supporting the photosynthesis process through increased leaf area. The absence of significant differences in the number of leaves was likely influenced by environmental variability or the suboptimal response of plants in a relatively short observation period.

In terms of yield parameters, namely the number and weight of fruits, spraying produced higher yields than drenching, although this was not statistically significant. Spraying likely allowed silica to be absorbed more quickly through the leaves and directly utilized in the physiological process of fruit formation . Meanwhile, increasing the silica dose had a clear positive effect on crop yield; treatment with a dose of 3 cc/l produced the highest number and weight of fruit (89.50 fruits; 876.83 grams). This shows that silica can increase the efficiency of absorption of other nutrients that play an important role in fruit formation and strengthen fruit structure, thereby increasing crop yield. Although not statistically significant, these results indicate the great potential of silica use in supporting cherry tomato productivity.

4 Conclusion

Based on the research results, it can be concluded that the fertilization model and silica dosage affect plant height, while the number of leaves, number of fruits, and fruit weight do not affect cherry tomato plants. The drip irrigation fertilization model tends to produce better results in early growth (plant height and number of leaves), while the spraying method shows greater potential in increasing the number and weight of fruits.

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