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Plant Performance and Storability Tomato (*Solanum lycopersicum* L.) Fruit With the Application of Calsium Chloride ($CaCl_2$)

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ABSTRACT

This study was conducted to determine the interaction of $CaCl_2$ concentration and application technique on the tomato plant performance and storability of tomatoes. The $CaCl_2$ concentration (K) consisting of k_0 (0 mL L^{-1}), k_1 (0.5 mL L^{-1}), k_2 (1.0 mL L^{-1}), k_3 (1.5 mL L^{-1}), k_4 (2.0 mL L^{-1}) and application technique (T) consisting of t_1 (sprayed on the plant) and t_2 (watered into the growing media). The results shows that k_2t_2 combination obtained the maximum number of flowers with an average 24.33 florets and obtained height of tomato plant. The maximum number of fruits was obtained by k_3t_2 combination (11.33 florets), followed by k_4t_2 combination (11.00 florets). The minimum number of flowers fall off was obtained by k_0t_2 combination (1.00 florets) and the maximum number of flowers fall off was obtained by k_3t_1 combination (4.67 florets). The combination of k_4t_1 and k_4t_2 gave the best results on blossom end-rot diseases (zero diseases) and storability of tomatoes (up to 30 days).
Key words: tomato, calcium chloride ($CaCl_2$), performance, storability

INTRODUCTION

The tomato plants are part of horticultural crops, and their fruits are considered agricultural products. Tomatoes are one of the agricultural products that are widely consumed by household in Indonesia. According to the Central Statistics Agency, in 2021 consumption of tomatoes by household in Indonesia reached 670.970 Mg (Badan Pusat Statistik 2021). Tomatoes have a relatively low shelf life, and their storage at temperature between 25– 30^{o}C usually only lasts for 4–6 days (Khatir *et al.* 2019). Providing calcium is thought to increase fruit quality and fruit shelf life. Calcium can extend the fruit shelf life by inhibiting fruit ripening (Ferguson and Drobak 1988). The calcium in the fruit tissue plays a significant role in strengthening cell walls of the tomatoes. Apart from that, the availability of calcium in tomato plants can also reduce the incidence of blossom end-rot diseases. Therefore, giving calcium to tomatoes is expected to increase the quality of tomatoes and tomatoes storability. One form of calcium that can be applied is calcium chloride ($CaCl_2$).

Calcium is not mobile, so the calcium translocation to fruit tissue is quite limited. Giving the calcium into growing medium (xylem pathway) will be stored in the leaves, so it is necessary to give calcium directly to the surface of the fruit (phloem pathway) (Salisbury and Ross 1995). However, previous studies have proven that giving calcium to the growing media can increase the quality of tomatoes (Mulya 2019). Other studies also said that giving calcium by spraying to the fruit can increase the tomatoes quality (Wulandari 2019). So that, this study was conducted to determine the combination of $CaCl_2$ concentration treatment and application techniques on tomato plant performanceand sotrability of tomatoes.

MATERIALS AND METHODS

This research was carried out at the green house, Faculty of Agriculture, Mulawarman University from September 2022 to February 2023. The tomato seed used in this research was Servo Variety. Seeds are sown in seedling trays containing soil and sprinkled with Furadan to prevent pest attacks. After 20 days of seeding, the seeds are transferred to polybags measuring 40 cm x 40 cm containing soil and bokashi fertilizer in a ratio of 1: 1. NPK fertilizer as much as 1 g is applied to each tomato plant on the first day of planting and the 25th day after planting. Plants are treated every day by watering in the morning or afternoon, also weeding weeds that grow around tomato plants.

The research consisted of two factors, which are $CaCl_2$ concentration and application technique. The concentration of $CaCl_2$ consists of five treatments, which are k_0 (0 mL^{-1}), k_1 (0.5 $mL\ L^{-1}$), k_2 (1.0 $mL\ L^{-1}$), k_3 (1.5 $mL\ L^{-1}$), and k_4 (2.0 $mL\ L^{-1}$) and application techniques consist of two treatments, which are t_1 (spraying to the plants) and t_2 (watering to growth media), so that there are 10 combinations with three replications. 40 mL of $CaCl_2$ solution was applied to each tomato plant according to the treatment on day 7 and day 14 after anthesis, so that 80 mL of $CaCl_2$ solution was given to tomato plants. This research used Completely Randomized Design (CRD) and data were analyzed by Analysis of Variance (ANOVA) and further tested using Duncan's Multiple Range Test (DMRT) at a 5% significant level.

RESULTS AND DISCUSSION

Results

Effect of Combination $CaCl_2$ Concentration and Application Technique on Tomato Plant Performance

The tomato plant performance observation is carried out during the planting period such as that number of flowers, number of fruits, number of flowers fall off, number of blossom end-rot diseases, and tomato plant height. Base on ANOVA, the results shows that the combination of $CaCl_2$ concentration and application technique significantly different on tomato plant performance, except on number of blossom end rot diseases. The recapitulation data, and the results of data analysis percentage the performance of tomato plants, are presented in figures 1, 2, 3, 4, and 5.

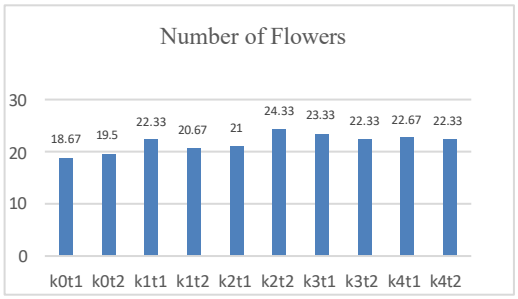


Figure 1. Effect of treatment on the number of flower

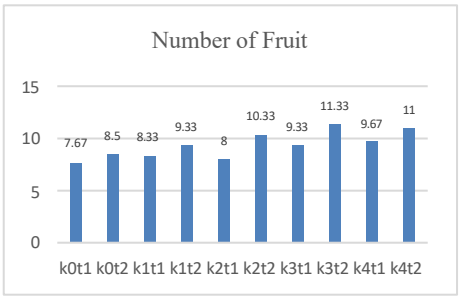


Figure 2. Effect of treatment on the number of fruit

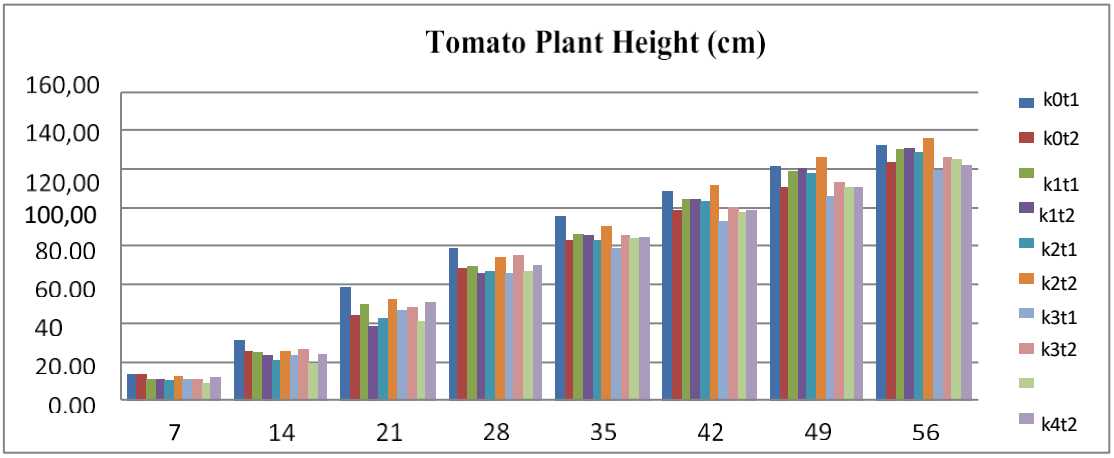


Figure 5. Effect of combination $CaCl_2$ concentration and application technique on tomato plant heigh

Effect of Combination Between $CaCl_2$ Concentration and Application Technique on Storabilityof Tomatoes

Storability of tomatoes observation is carried out by calcuting the weight, diameter, and color of tomatoes for 30 days of storage. However, if the tomatoes has rotted or wrinkled and has soft texture then the observation is stop. Base on ANOVA, the results shows that the combination of $CaCl_2$ concentration and application technique significantly different on storability of tomatoes. The recapitulation and results of data analysis percentage storability of tomatoes are presented in figures 6, 7, 8, and 9.

Fig 6. Tomatoes weight for 30 days of storage

Fig 7. Transversal diameter of tomatoes for 30 days of storage

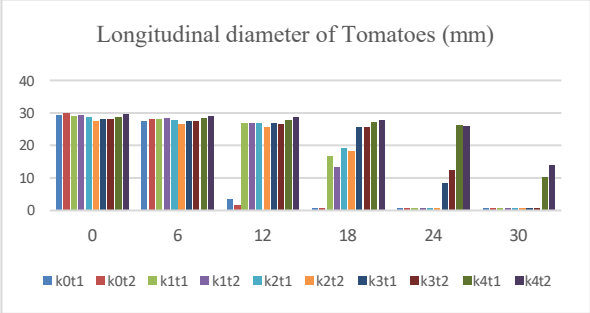


Fig 8. Longitudinal diameter of tomatoes for 30 days of storage

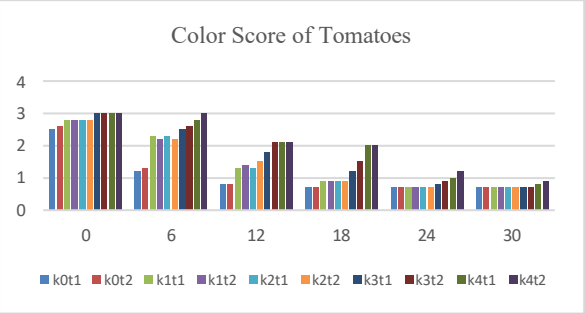


Fig 9. Color score of tomatoes for 30 days of storage

The color score of tomatoes means that 2 – 3 = pink, 1 – 2 = light red, <1 = red

Discussion

Effect of Combination $CaCl_2$ Concentration and Application Technique on Tomato PlantPerformance

Number of Flower

The combination of $CaCl_2$ concentration and application technique has a good effect on the tomato plants performance, except for the number of flowers fall off. The combination of k_2t_2 and k_3t_1 obtained the maximum number of flowers, which was 24.33 and the minimum number of flowers was obtained by k_0t_1 combination (19.00) (Table 1). Previous research stated that giving calcium to the tomato plant (xylem pathway) had not significantly effect on the number of flowers (Pertiwi 2020). However, in previous studies there was no control as a treatment, so there was no comparison of the number of flowers between tomato plants given calcium with tomato plants that were not given calcium (control).

Number of Fruit

The maximum number of fruits was obtained by the combination of k_3t_2 (11.33), followed by the combination of k_4t_2 (11.00) and the minimum number of fruits was obtained by the combination of k_0t_1 (7.67) (Table 1). Calcium has a role in fruit growth (Ayyub 2012). The combination of k_3t_2 and k_4t_2 makes the role of calcium effective in increasing fruit growth so that more fruit is produced than the other combinations.

Number of Flowers Fall off

The maximum number of flowers fall off was obtained by the combination of k_3t_1 (4.67) and the minimum number of flowers fall off was obtained by the combination of k_0t_2 (1.00) (Table 1). Application of $CaCl_2$ has the potential to cause flowers fall off. The combination of k_3t_1 produces not good interaction on number of flowers fall off, so the response of tomato plants produces more flowers fall off.

Number of Blossom End-rot

The minimum number of blossom end-rot diseases was obtained by the combination of k_4t_1 and k_4t_2 (zero diseases). Giving $CaCl_2$ produces healthier fruit (Ayyub 2012). According to that statement, the higher the $CaCl_2$ concentration given shows that reduces the occurrence of blossom end-rot diseases (Table 1). This is similar to previous studies that showed the higher the dose of calcium fertilizer give shows that reduces the occurrence of blossom end-rot diseases (Rachmah 2017)..

Plant Height

The highest tomato plants on day 42 to day 56 were obtained by combination of k_2t_2 (fig. 1). Calcium plays a role in cell division and cell extension of tomato plants (Pertiwi 2020). According to that statement, the combination of k_2t_2 makes the role of calcium effective in the extension of tomato plant cells, so that the provision of calcium with the combination makes tomato plants grow well.

Effect of Combination Between $CaCl_2$ Concentration and Application Technique on Storabilityof Tomatoes

Weight for 30 Days of Storage

The combination of $CaCl_2$ concentration and application technique has a good effect on the storability of tomatoes. The heaviest tomatoes from day 0 to day 30 was obtained by the combination of k_4t_2 and the combination of k_4t_1 and k_4t_2 can be stored for 30 days (fig. 2). Calcium plays a role in maintaining cell wall structure in the middle lamella and can prevent cell wall disintegration (Marschner 2012). $CaCl_2$ concentration of 2 mL^{-1} with both technique can strengthen the tomatoescell walls structure, so that can help reduce the reduction in tomatoes weight and increase the storability of tomatoes.

Transversal and Longitudinal Diameter of Tomatoes for 30 Days of Storage

The largest diameter of tomatoes was obtained by k_4t_2 combination and the combination of k_4t_1 and k_4t_2 can be stored for 30 days (fig. 3 and fig. 4). In this researsch $CaCl_2$ is able to reduce the reduction in tomatoes diameter. Similarly, the previous studies show that a $CaCl_2$ concentration of 12% (the highest concentration given) was able to

maintain the hardness of tomatoes for 16 days of storage (Breemer 2015). Calcium in the cell wall can play a role as a polycation forming ionic bonds with pectin in the

Color Score of Tomatoes for 30 Days of Storage

Tomatoes color observation, the combination of k_4t_1 and k_4t_2 occurs slow color change (fig. 5). In accordance from Sosrohardjo's statement, calcium can bind the lipoxygenase enzyme into an inactive enzyme (Sosrohardjo 1987). The binding of lipoxygenase enzyme will inhibit the fruit ripening process. Inhibition of tomatoes ripening also can slow down pigment breakdown so that it can maintain the color of tomatoes for a longer period. That is why $CaCl_2$ concentration of 2 mL^{-1} can slow down the tomatoes color change during the storage period.

CONCLUSION

Based on the results and discussion, it can be concluded that the combination of $CaCl_2$ concentration and application techniques can increase the tomato plant performance and the storability of tomatoes, except for the number of flowers fall off. This is suspected by giving $CaCl_2$ to the plants (sprayed to the tomato plants) resulting in a not good response so that there are many flowers fall off.

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