FJARD VOL. 37, NO. 4. PP. 736.-759(2023)

Fayoum Journal of Agricultural Research and Development
ISSN:1110- 7790
On Line ISSN:2805-2528

Potassium silicate and calcium chloride improve production and shelf-life of strawberries

Shereen S. F. EL-Sayed[1], Mohamed M. EL-Mogy[1] and Gehan A. Mahmoud[2]
[1]Department of Vegetable Crops, Faculty of Agriculture, Cairo University.
[2]Fruit Crops Handling Research Department, Horticulture Research Institute (HRI), Agricultural Research Center (ARC)

سيليكات البوتاسيوم وكلوريد الكالسيوم لتحسين إنتاج الفراولة ومدة صلاحيتها للتداول

ABSTRACT

The short shelf-life of strawberry fruits is the main challenge for transportation over long distances during export and import around the world. Adding postharvest treatments could increase fruits decay during transportation. Thus, the purpose of this study is to evaluate the effect of pre-harvest applications with different rates of calcium chloride (0.5, 1, and 2 %) and potassium silicate (0.4, 0.6, and 0.8 %) on growth, yield, fruit characteristics, shelf-life for 7 days at 10°C on the content of bioactive compounds, and the activity of enzymes in strawberries. The results indicated that calcium chloride and potassium silicate significantly increased leaves number, plant fresh weight, chlorophyll percentage, plant leaf area, and dry matter compared to the control. Additionally, calcium chloride and potassium silicate significantly increased total yield, marketable yield, fruit length, fruit weight, and fruit diameter. Calcium chloride was the most effective treatment for decreasing weight loss and increasing fruit firmness and total anthocyanin compared to other treatments. Moreover, potassium silicate was the most effective treatment for enhancing vitamin C. Both compounds significantly increased total sugar, antioxidant capacity, and peroxidase (POD) activity. Our results offer crucial data for commercial producers to increase production, enhance postharvest quality, and extend shelf life, thus permitting a wider range of strawberry retail marketing.

KEYWORDS: storage; quality; anthocyanin; phenolic compounds; polyphenol oxidase; peroxidase

*Corresponding author Email: **Sherine.fathy@agr.cu.edu.eg**
Received : 2 /8/ 2023
Accepted : 10/9/ 2023

1-INTRODUCTION:

Strawberry (*Fragaria x ananassa* Duch.) is the most prominent member of the family *Rosaceae* worldwide because it has a considerable amount of nutritional value, sweet taste, and high aroma. However, the strawberry fruits shelf-life is limited related to their high moisture content, respiration level, sensitive epidermis, and exposure to bruising and mechanical damage. Between harvest and consumption, strawberries are thought to decay by 30% **(Amiri et al., 2022).** Calcium and potassium elements mainly affect the storage ability and quality of strawberry fruits. Some previous postharvest applications were used to increase the content of calcium in fruits such as dipping in calcium chloride solution **(Liu et al., 2023; Niazi et al., 2021)** and adding calcium to several edible coating materials **(Alharaty and Ramaswamy, 2020; Nguyen et al., 2020)**. Additionally, potassium was applied to strawberry fruits as postharvest treatment by dipping in some potassium salts such as potassium sorbate **(Al-Kuraieef et al., 2019).** However, the previous applications are not used as commercial applications during export and import of strawberry fruits due to the risk of the fruits decay and proliferation of pathogens. Thus, the pre-harvest application could be the ideal technique for enhancing calcium content and potassium in the strawberry fruits, leading to a longer shelf-life.

Calcium is considered as one of the most significant mineral components that affects fruit quality since it plays a significant role in cell functioning, helps prevent fruit ripening and softening, and minimizes fruit senescence **(Cvelbar Weber et al., 2021).** The best way to apply calcium to plants is not through the soil since calcium is not easily movable inside of plants **(Danner et al., 2009).** Pre-harvest calcium treatments increase the calcium content of the fruit cell wall, which is useful for postponing senescence and resulting in firmer fruit as well as higher quality **(Serrano et al., 2004).** Because calcium binds to the central lamella of the cell wall, calcium therapies are also beneficial in preventing fruit softening **(Eklund and Eliasson, 1990; Hocking et al., 2016a).** Additionally, it stimulates the production of a number of cell wall components, which inhibits the deposition of cellulose and promotes the formation of non-cellulosic polysaccharides like lignin **(Picchioni et al., 1996).**

Potassium is one of the macronutrients, along with phosphorus and nitrogen (Fageria, 2016). Potassium is necessary for a number of physiological and biochemical processes that affect the growth and production of plants. Potassium has a role in enzyme activation, glucose metabolism, and protein synthesis **(Wang et al., 2013).** In the plant tissue, potassium levels varied from 2% to 5% of the plant's weight **(Lester et al., 2005).**

Plants have silicon in quantities similar to those of essential macronutrients like calcium, magnesium, and phosphorus **(Epstein, 1999).** The function of silicon in higher plant metabolism has recently drawn more attention especially under biotic or abiotic stress **(Kaya et al., 2006).** Silicon is participated in stimulating growth and increases plant strength and stress resistance **(Xiao et al., 2022).** According to previous report **(Pavlovic et al., 2021)**, Si regulates the absorption of phosphor and micronutrients and increases the efficiency with which nitrogen is used. Additionally, silicon played a role in the control of stomata and the antioxidant enzyme system, which reduced damage by halting the creation of lipid peroxide and hydrogen peroxide **(Xiao et al., 2022)**. The application of silicon under unstressed condition and its associations with plant growth, production, and postharvest behavior, however, have not been thoroughly investigated including strawberry.

Based on above information, in this study, we tested the pre-harvest applications with calcium and potassium to enhance the growth, production, and shelf-life of strawberry. Also, to best of our knowledge, the effect of pre-harvest fertilizer with calcium chloride and potassium silicate on the growth, production, and shelf-life of strawberry was not fully studied before.

2-MATERIALS AND METHODS:

Plant materials, experiment setup, and treatments

The current experiment was carried out in a plastic greenhouse at Faculty. of Agricture, Cairo University, Giza, in 2019/2020 and 2020/2021. Strawberry transplants of Festival cultivar were planted on 4 rows/bed with 25 cm between plants and between rows. Each plot was 6 m^2 (1.2 m width x 5 m length) with 24 transplants. Beds were covered with silver soil mulching. The fertigation method was applied to irrigate and fertilize the plants. Each bed was provided with two polyethylene lateral. Foliar treatments began 10 and 20 days after full flowering with different calcium chloride at rates i.e., 0.5, 1, and 2 %, while potassium silicate was used at rates of 0.40, 0.60, and 0.80 %. Untreated samples were sprayed with distilled water (control plants). The experimental design was randomized complete block design (RCBD) with three replicates.

Plant growth characteristics

Three months after transplanting, five plants were chosen randomly to measure leaves number, crown diameter, leaf area per plant, plant fresh weight, and plant dry matter. The four central plants in each plot were used to measure leaf greenness (as an indicator of chlorophyll content) by a SPAD-502 Chlorophyll Meter (Konica-Minolta, Osaka, Japan).

Yield and fruits characteristics

The total yield/m^2 and marketable yield/m^2 (free from defects, physiological disorders, or any other misshape) were evaluated. Average fruit weight, length, and diameter were also determined at harvest time from the average of 15 randomly selected fruits from every plot.

Shelf-life Experiment

On the same day of harvest, the shelf-life experiment was carried out. Within an hour, strawberries were picked and immediately transferred to the postharvest lab. Fruits that were almost the same in size and shape, free from damage, and without any defects were chosen. For a period of 7 days, the chosen fruits from each application were kept at 10° C and 95% relative humidity in vented clamshell containers weighing around 250 g. After being stored for seven days, the weight loss was calculated. The following chemical compositions were measured at harvest time and after 7 days of shelf-life.

Firmness, total soluble solids (TSS), vitamin C, and titratable acidity

To measure firmness, a fruit pressure tester (FT011, Wagner Instruments, Milan, Italy), was used twice at two points on opposing sides of the fruit's center. The mean value was then calculated. TSS was measured by digital refractometer (PR101, Palette, Co., Ltd., Tokyo, Japan). To measure the TSS percentage, a few drops of the juice were applied to the lens, and the results were then recorded. For calibration, deionized water was utilized. Between each sample, the lens was rinse by deionized water. Using a titrimetric method with the dye 2-6, dichlorophenol indophenol, the vitamin C content of strawberries was calculated and expressed as mg per 100 g of fresh weight. Ten grams of fresh fruit were mashed and mixed with 100 mL of distilled water to measure titratable acidity. The percentage of titratable acidity was then calculated from the titter as the proportion of citric acid in the juice by titrating 10 mL of the aliquot in triplicates with 0.1 N NaOH as mentioned in A.O.A.C. (2000).

Total sugars and total phenols

Total sugars and total phenols were evaluated in dry matter. To obtain dry matter for chemical determination, 100 g of fresh fruit were dried until weight constant at 70°C. Ethanol extract of dry material was used for estimation determination of total sugar using phosphomolibdic acid method. Total phenols were determined according to the method of Swain and Hillis (Swain and Hillis, 1959) by using the folin-ciocalteau colorimetric method.

Total anthocyanin

The method of Pirie and Mullins (Pirie and Mullins, 1976) was followed to determine the content of total anthocyanin in strawberry fruits. In brief, in 2 mL of 1% (v/v) HCl-ethanol, 0.5 g of leaf tissue was extracted before being centrifuged at 13,000 rpm for 20 min at 4°C. The liquid supernatant was then acidified with 0.1 N HCl to a pH of about 1.0, and the absorbance was gauged at 530 nm.

Polyphenol oxidase and Peroxidase activities

A weight of 1 g of fruit tissue was extracted with 2 ml of cold Na acetate buffer (pH 6.0) and then centrifuged at 15000 × g, the supernatant is plant tissue enzyme extract. Procedure: to a clean cuvette of a spectrophotometer add 3.0 ml buffered catechol solution (0.01M catechol, freshly prepared in 0.1 M phosphate buffer, PH 6.0) set the spectrophotometer to read absorbance at 495nm. Insert the cuvette in cuvette chamber of spectrophotometer and adjust absorbance to zero. Add 1 ml enzyme extract to cuvette, mix immediately, place the cuvette in the spectrophotometer and record absorbance after 2 minutes. The enzyme activity was expressed as units per g fresh weight (Chance and Maehly, 1955). Peroxidase can be assayed quite easily due to its high activity and stability and the activity of large number of hydrogen donors which can be used for assaying its activity. The reaction was measured as follows at absorbance 430 nm. Extraction of 1 g of fruit tissue with 2 ml of cold Na acetate buffer (pH 6.0) and centrifuge the extract at 15000 × g, the supernatant is plant tissue homogenate. Procedure: To a clean dry colorimeter cuvette with a 1 cm light path add phosphate buffer, pH 6.5, 0.1M 3.50 ml Plant tissue homogenate 0.20ml O-dianisidine solution (1 mg/ml in methanol) 0.10ml. Bring the mixture to 28-30oC in a constant temperature bath and then transfer the cuvette to spectrophotometer set at 430nm.Then add to cuvette 0.2ml hydrogen peroxide (0.2M). Simultaneously, start a stopwatch. Read after 60sec. The enzyme activity was expressed as units per g fresh weight (U/g.FW) (Reuveni *et al.*, 1992).

Statistical analysis

Results from each experiment were offered as the mean standard deviation (SD), with 3 replicates in each experiment. Least significant difference test (LSD, 5 % of probability) was used to evaluate differences between the means using SPSS software.

3-RESULTS AND DISCUSSION:

Effect of calcium chloride and potassium silicate on plant growth, chlorophyll reading, and dry matter

Our results in Figure 1 show that calcium chloride at a rate of 2 % significantly improved the leaves number in both years compared to the control, but the lower rates (1 % and 0.5 %) did not. Also, potassium silicate significantly increased the number of leaves in both years at a rate of 0.6 % and 0.8 %. All treatments did not affect the crown diameter in the two years of study compared to the control (Figure 2). Calcium chloride at a rate of 2 % and all rates of potassium silicate significantly enhanced fresh weight of plants only in the first year, while only potassium silicate at a rate of 0.8 % significantly increased the plant fresh weight in the second year compared to the control (Figure 3). Plant leaf area was significantly increased by all potassium silicate rates in the first year compared to the control, while in the second year, calcium chloride application at the high rates (1 % and 2 %) and all potassium silicate rates significantly increased the plant leaf area compared to the control (Figure 4). Our results in Figure 5 indicated that calcium chloride application (at rates of 0.5 % and 1 %) and potassium silicate (at rates of 0.6 % and 0.8 %) significantly increased dry matter of strawberry plants compared to the control in the first year.

One of the important nutrients for plant growth is calcium. It is required for the formation and stability of cell walls, proper root growth, and the stimulation of enzymes related to various metabolic processes **(Thor, 2019).** Calcium deficiency can lead to stunted growth, poor fruit quality, and increased susceptibility to diseases **(Hocking et al., 2016b).** The role of calcium in enhancing plant growth might be due to its function in conserving cell wall and membrane stability when calcium is applied exogenously **(Song et al., 2020).** Additionally, calcium speeds up the transfer of carbohydrates produced during photosynthesis to sinks **(Navazio et al., 2020).**

In agreement with our results, previous studies found that foliar calcium application enhanced the plant growth of tomatoes and cucumbers **(Zhang et al., 2014; Zhang et al., 2012)**. The second important nutrient for plant growth is potassium. It is required for various physiological processes, including the regulation of water balance, the enzymes activation, and the creation of proteins and carbohydrates **(Hasanuzzaman et al., 2018; Wang et al., 2013).** The enhancement of plant growth parameters such as number of leaves, plant fresh weight, dry matter and leaf area by potassium application could be due to its role in a variety of key processes, including the usage of nitrogen, protein biosynthesis, cell development, and cell expansion **(Coskun et al., 2017; Rani et al., 2021).** In agreement with our results, previous study found that high rates of potassium fertilizers improved plant growth (height, fresh weight, and dry weight) of wheat **(El-Mageed et al., 2023)** and chlorophyll content of strawberry leaves **(Nakro et al., 2023).** Recent work has demonstrated that silicon has a variety of effects on plants' morphology and physiology **(Bao-shan et al., 2004)**, including enhancing plant growth and yield of some plants such as maize and tomatoes **(Siddiqui and Al-Whaibi, 2014; Suriyaprabha et al., 2014).** In agreement with the outcomes of this study, Suriyaprabha et al. **(Suriyaprabha et al., 2012)** found that silicon application in the form of nano increased plant fresh weight of maize plants. Also, silicon fertilizer increased the plant growth of rice **(Pati et al., 2016)**, leaf area and dry matter of wheat (**Gong et al., 2003)**, leaf area of sorghum **(Ahmed et al., 2011)**

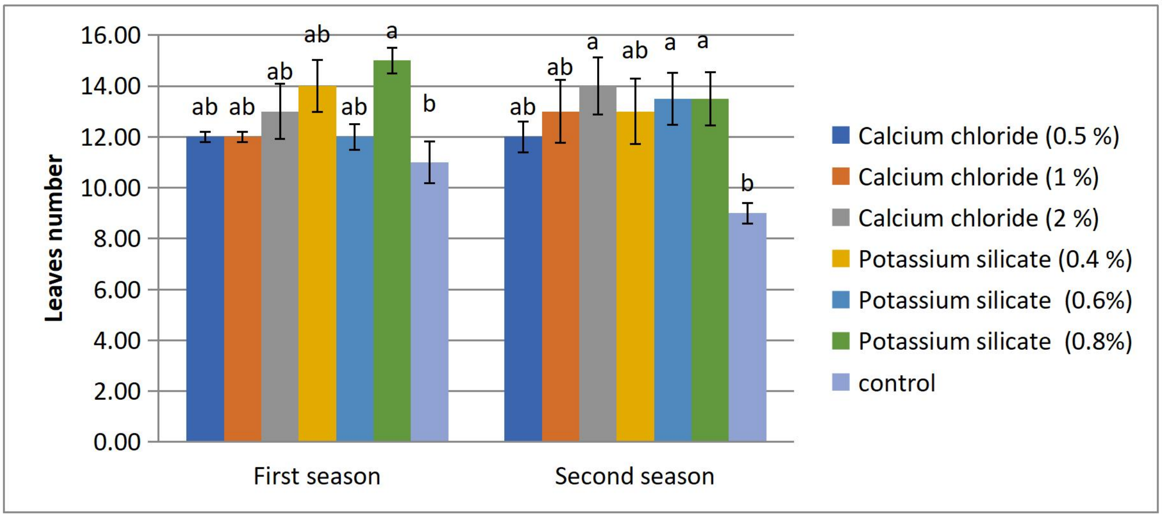


Figure 1: Effect of calcium chloride and potassium silicate on the number of leaves in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

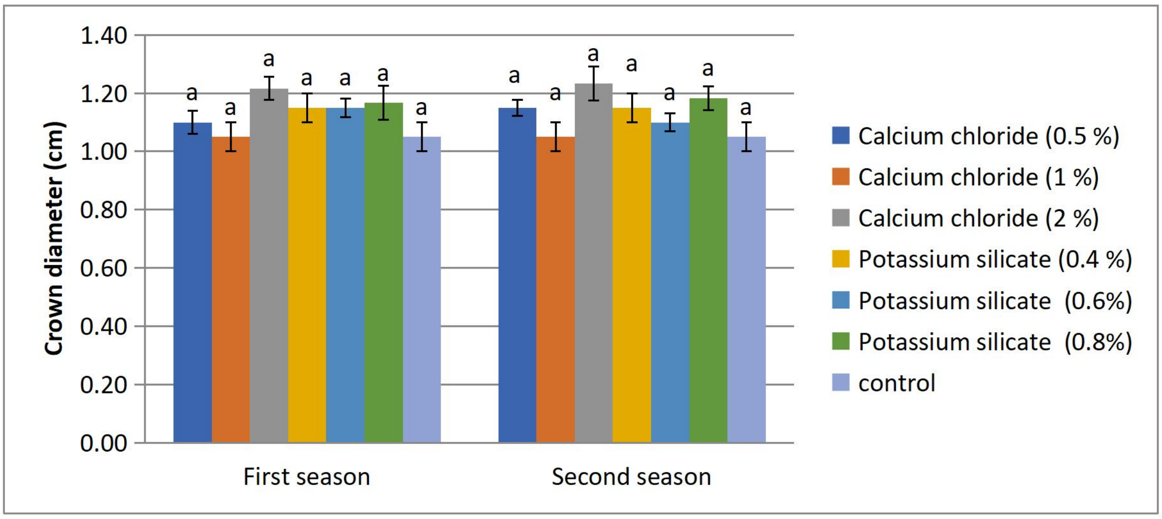


Figure 2: Effect of calcium chloride and potassium silicate on the crown diameter of strawberry plant leaves in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is

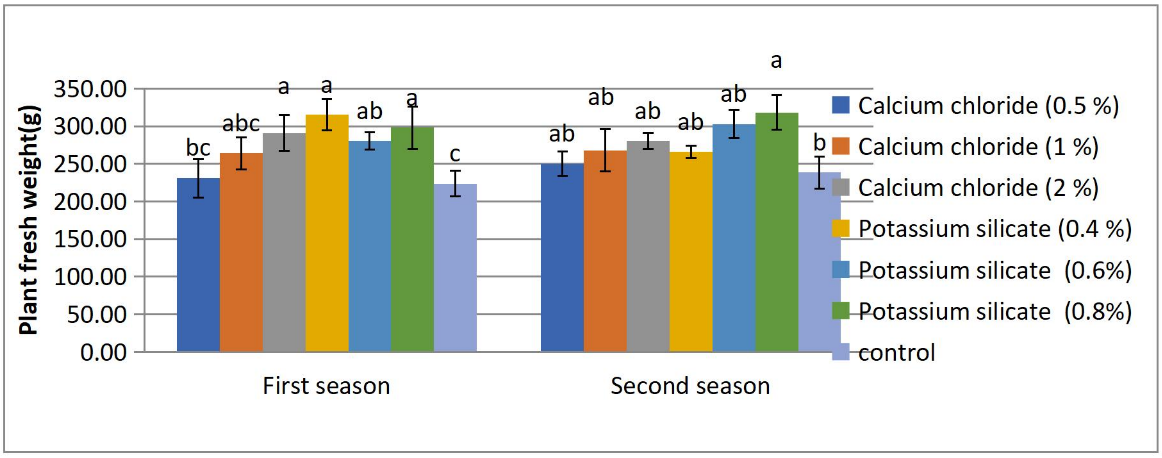


Figure 3: Effect of calcium chloride and potassium silicate on the plant fresh weight in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

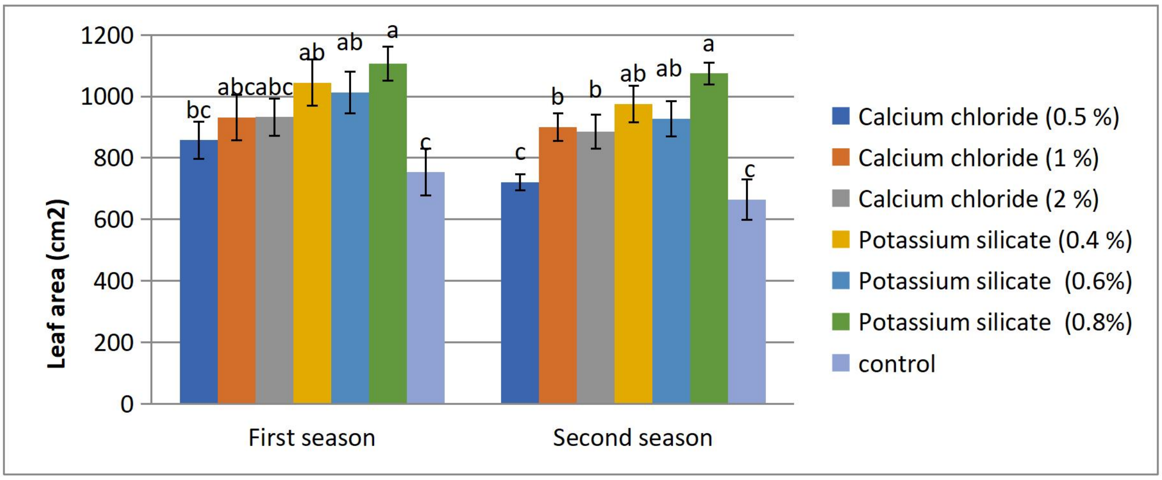


Figure 4: Effect of calcium chloride and potassium silicate on the leaf area of strawberry plant leaves in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

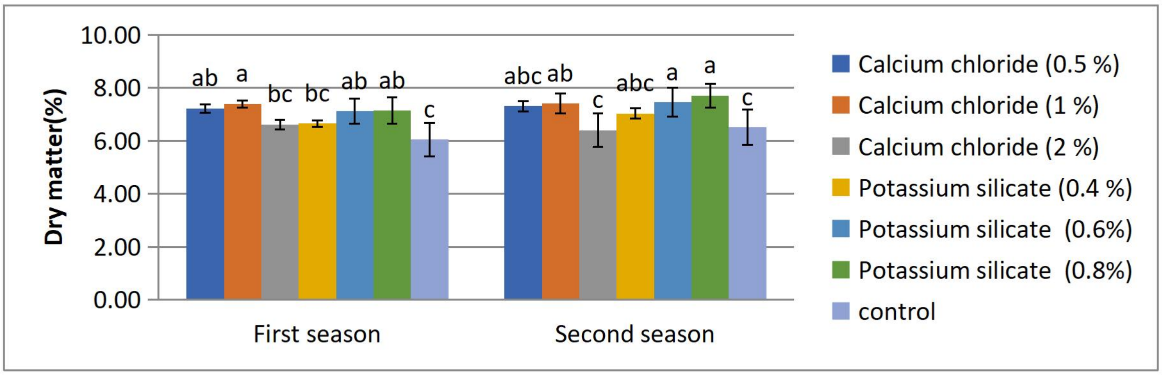


Figure 5: Effect of calcium chloride and potassium silicate on the dry matter of strawberry plant leaves in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Only the application of potassium silicate at a rate of 0.8 % significantly enhanced chlorophyll percentage in the strawberry leaves compared to the other treatments or the control in the first year of study (Figure 6). However, in the second year, both 1% calcium chloride and 0.6 % potassium silicate applications significantly enhanced chlorophyll percentage in the strawberry leaves compared to the other treatments or the control potassium application enhances the efficiency of chlorophyll, which is the primary component of chloroplasts, leading to an increase in photosynthesis **(Rani et al., 2021).**

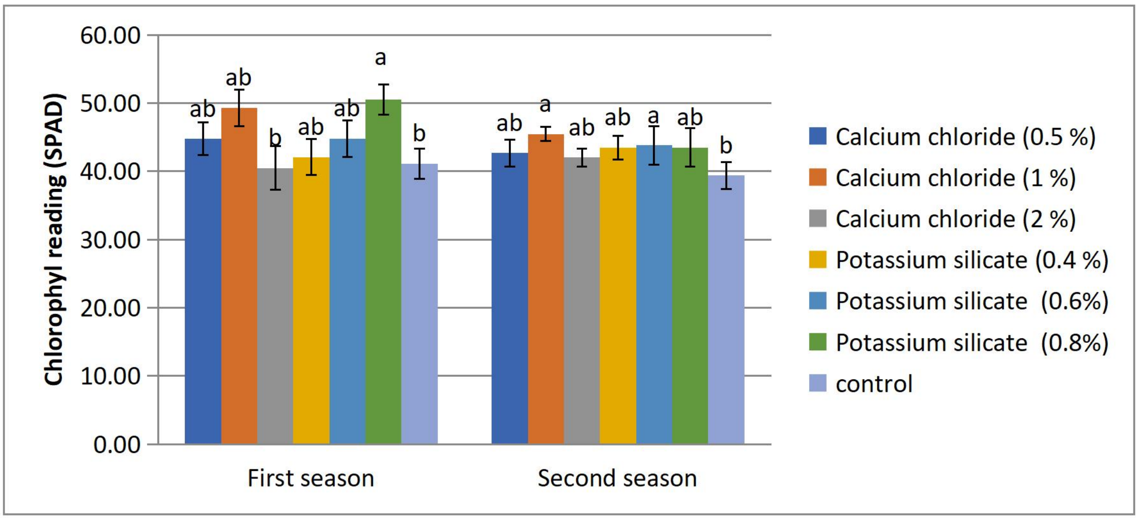


Figure 6: Effect of calcium chloride and potassium silicate on the chlorophyll reading of strawberry plant leaves in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Effect of calcium chloride and potassium silicate on fruit characteristics and yield

Fruits diameter of strawberry plants treated with either 1% calcium chloride or 0.6 % potassium silicate was higher than that of the control plants in the first season of study (Figure 7). In the second year, our results indicated that only 1% calcium chloride treatment significantly increased fruits diameter compared with the control samples. Fruit length was significantly increased by all treatments in both years except the application with 2 % calcium chloride in the second year (Figure 8). The most effective treatments for increasing fruit length were 1% calcium chloride followed by 0.8 potassium silicate in both years. The results in Figure 9 showed that fruit weight that obtained from plants that were treated with either 1 % calcium chloride or 0.6 % and 0.8 % potassium silicate were higher than those obtained from control plants in both years. Based on the data in Figure 10 and 11, it appears that the application of either calcium chloride or potassium silicate at different concentrations resulted in higher total yield and marketable yield compared with the control in the two years of the study. Additionally, the highest total and marketable yield were observed in the 0.8 % potassium silicate treatment compared with other treatments and the control.

Potassium is crucial for the development of yield and the improvement of quality for crops **(Oosterhuis et al., 2014)** that could be due to the role of potassium in cell division and elongation, which is a crucial step in the growth and yield production of crops **(Hepler et al., 2001; Hu et al., 2016).** In this study, calcium application increased the marketable yield. In accordance with previous result, it has been found that calcium application before harvest reduced the misshape of tomato fruits, which led to a higher marketable yield **(Navarro *et al.*, 2005)**. Previous study recorded the positive effect of silicon fertilizer in increase the yield and production of maize **(Kaya et al., 2006).** The role of silicon application in enhance yield might be due to its role for increasing photosynthetic rates, photochemical efficiency, and nutrients uptake and balance **(Chen et al., 2011; Wang et al., 2021).**

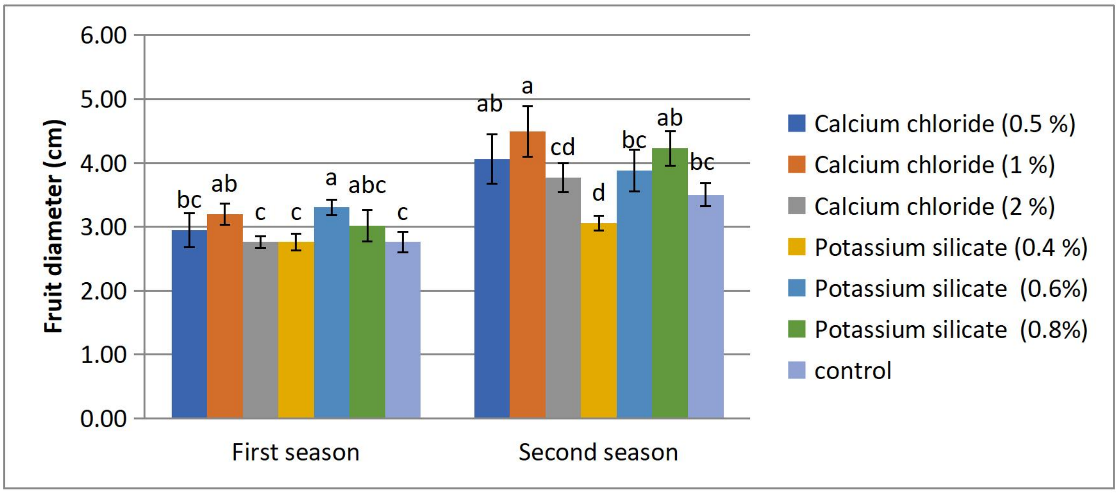


Figure 7: Effect of calcium chloride and potassium silicate on the fruit diameter in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

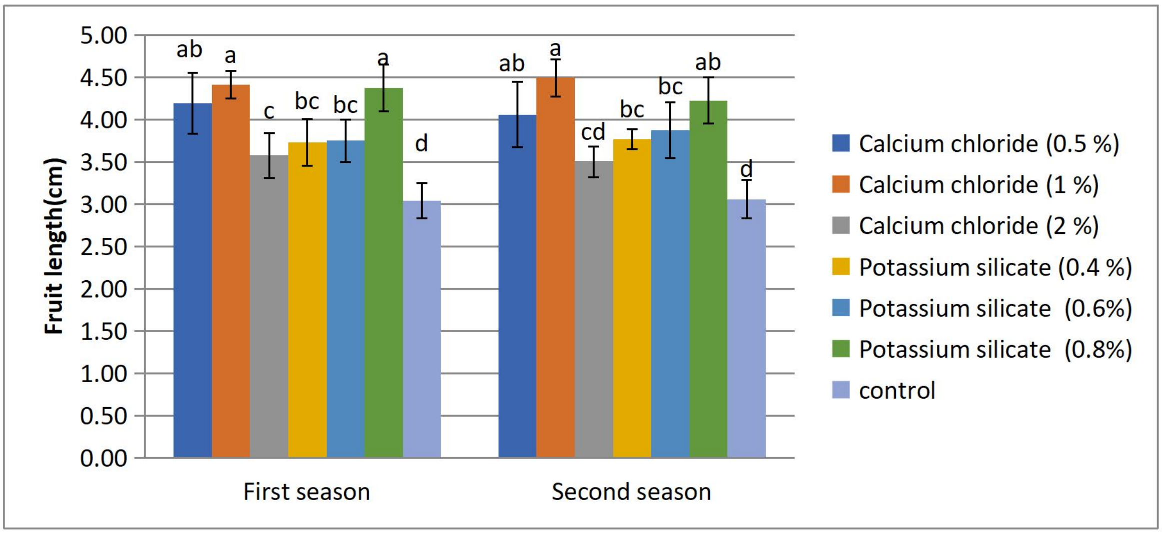


Figure 8: Effect of calcium chloride and potassium silicate on the fruit length in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

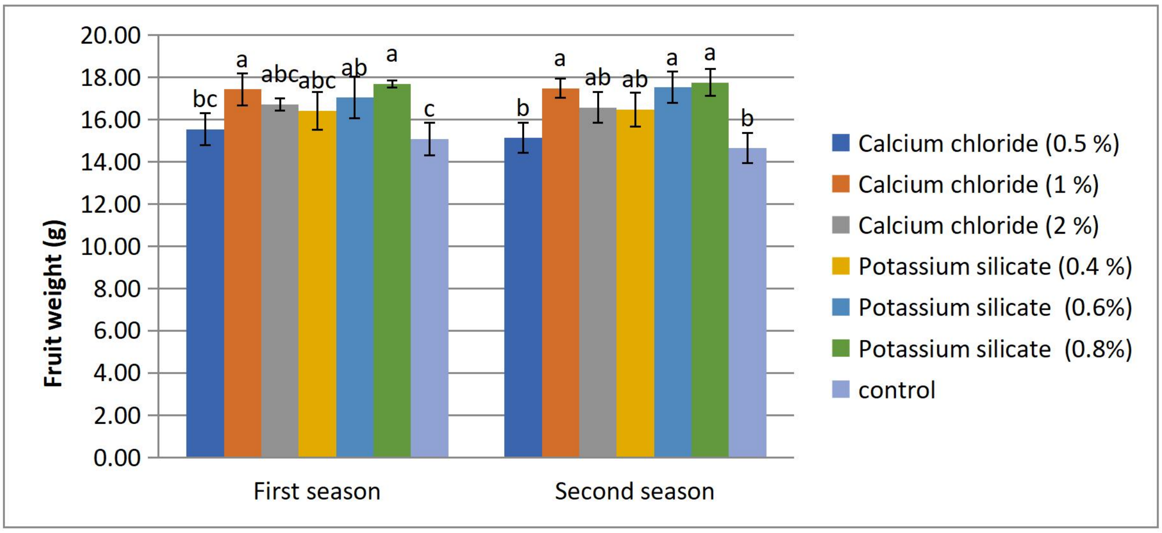


Figure 9: Effect of calcium chloride and potassium silicate on the fruit weight in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

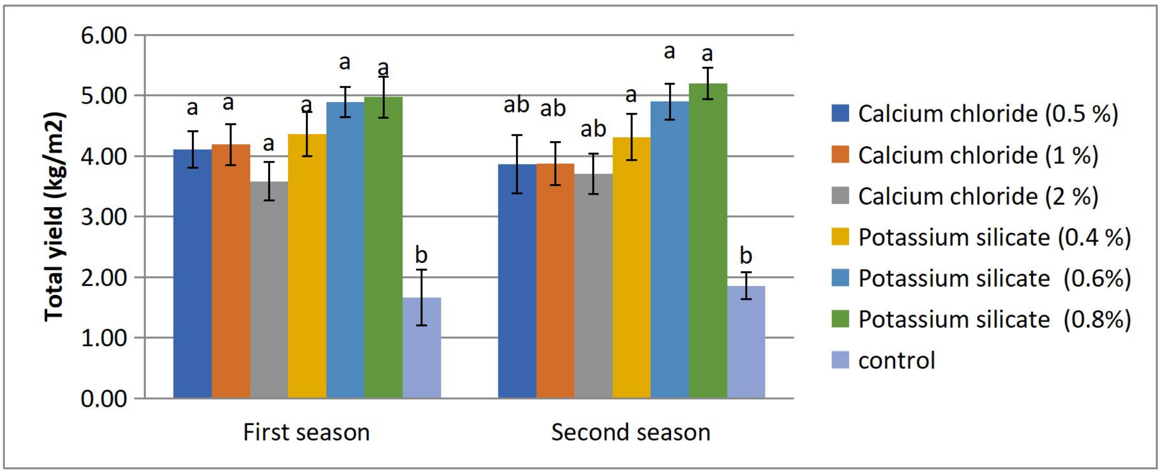


Figure 10: Effect of calcium chloride and potassium silicate on total yield in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

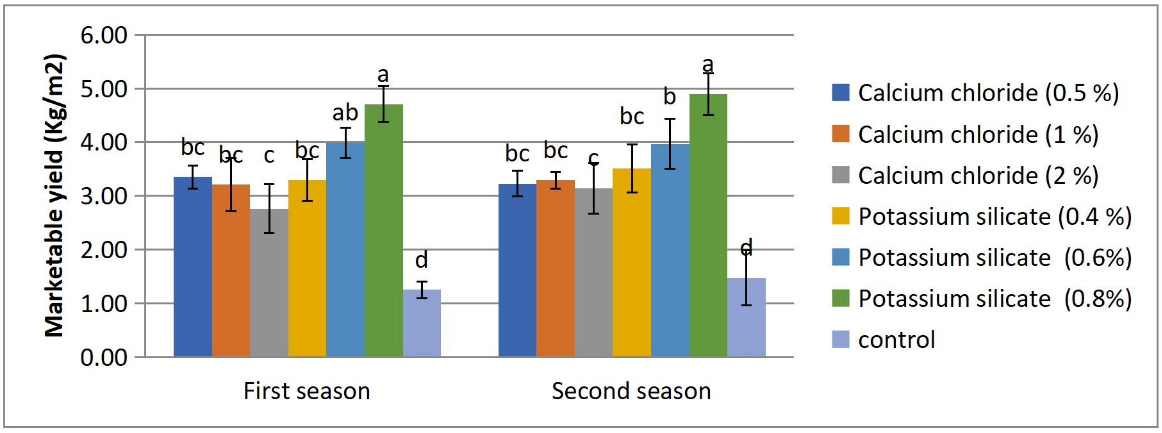


Figure 11: Effect of calcium chloride and potassium silicate on the marketable yield in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Effect of calcium chloride and potassium silicate on fruits weight loss, TSS, and firmness during shelf-life

According to Figure 12, the highest weight loss percentage in both years was observed in the control (7.17%), while the lowest weight loss percentage was observed in the 1% calcium chloride treatment (2.62%). Total soluble solids were not significantly influenced by all treatments compared to the control in both seasons (Figure 13). However, after 7 days of cold storage, the 1% calcium chloride treatment showed the highest TSS values in the first season of study, while in the season of study, the 1% and 2% calcium chloride and 0.8% potassium silicate treatments showed the highest TSS values. Figure 14 show that the 1% calcium chloride treatment recorder firmer fruits than all other treatments while the control recorded the lowest values in both years of study. After 7 days of storage, 0,6 % and 0.8% potassium silicate treatments showed higher hardness than the control.

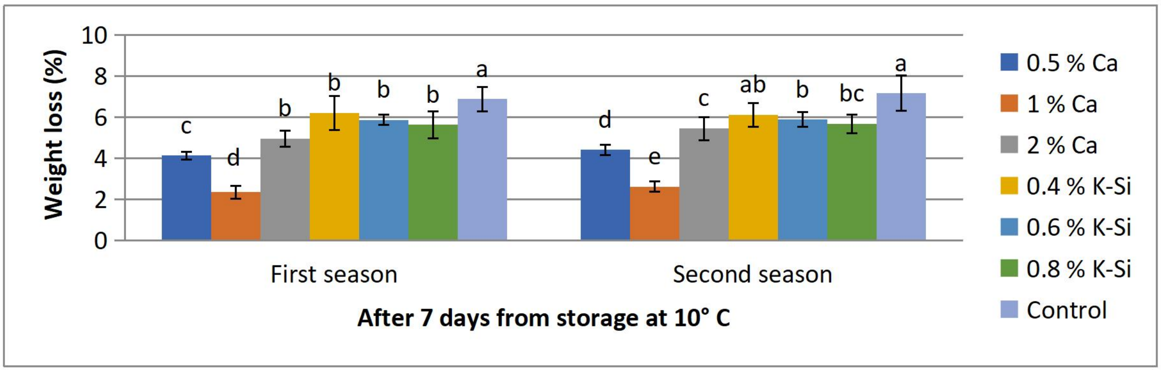


Figure 12: Effect of calcium chloride and potassium silicate on weight loss of fruits in both seasons of the study. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

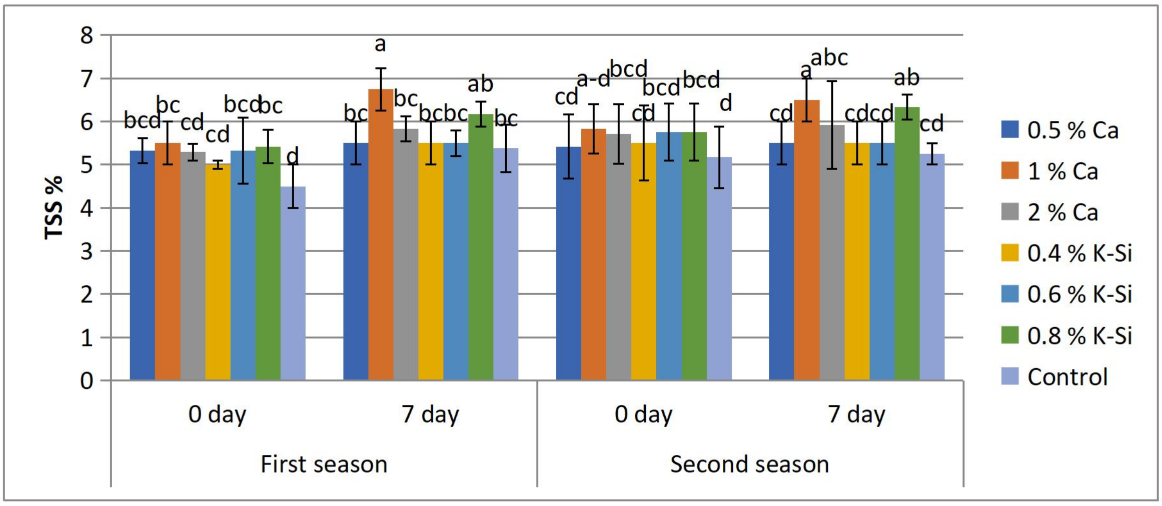


Figure 13: Effect of calcium chloride and potassium silicate on the fruit TSS in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Both respiration and transpiration cause weight loss of horticultural crops **(Shafiee et al., 2010)**. In our study, calcium fertilizer reduced weight loss after 7 days from storage. Previous works reported that membrane fruit's functionality and integrity are maintained by calcium application resulted in lower weight loss **(Moradinezhad and Dorostkar, 2021)**. In agreement of our results, previous works found that pre-harvest calcium application reserved the firmness and TSS of strawberry fruits compared to non-fertilized plants **(Cvelbar Weber et al., 2021; Wójcik and Lewandowski, 2003)**. It has been recorded that calcium is a vital divalent cation plant nutrient needed for cellular membrane and cell wall construction **(Nguyen *et al.*, 2020).** It has been reported that plants received calcium had higher firmer fruits than non-received plants **(Naradisorn et al., 2006)**. This result might be due to the fact that calcium plays an imperative role in the formation of the middle lamella and controls the stability of pectin–protein complexes **(Wójcik and Lewandowski, 2003).** Additionally, it has been found that calcium application increased the shelf-life of strawberry fruits **(Chéour et al., 1990; Tomala, 1997; Wójcik and Lewandowski, 2003)**.

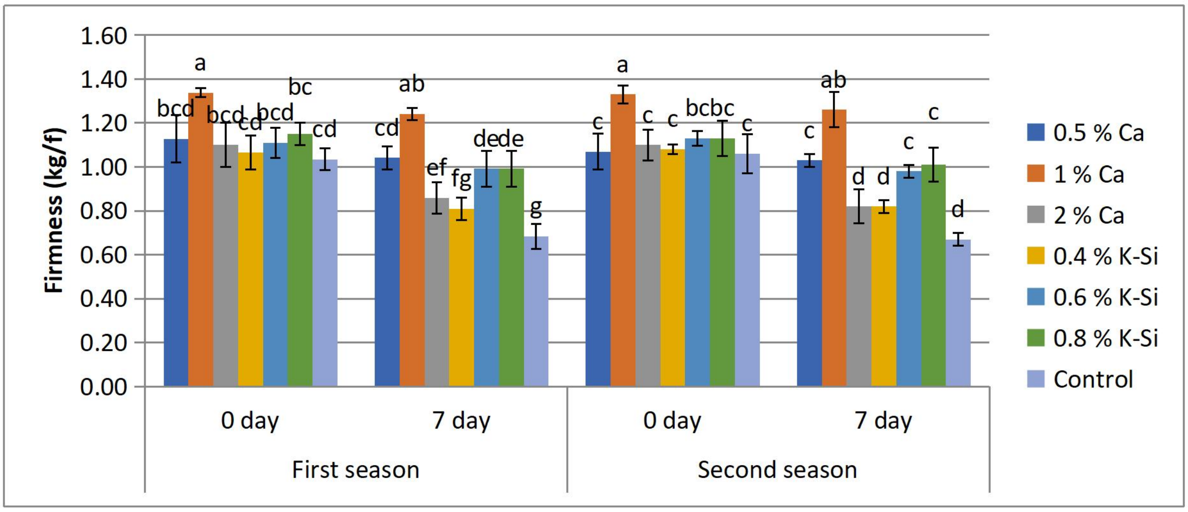


Figure 14: Effect of calcium chloride and potassium silicate on the fruit firmness in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Effect of calcium chloride and potassium silicate on vitamin C, titratable acidity, total sugar, and phenolic compounds

Data in Figure 15 indicates that the highest vit. C contents were achieved by the 0.6% potassium silicate treatment at harvest time in both years, while the control treatment recorded the lowest values. After 7 days of storage, all applications presented higher vit. C contents than the control treatment in the first year, while the variances were not significant in the second year. The acidity content in strawberry fruits decreased by increasing the storage period (Figure 16). At harvest time in both years, the control treatment showed the lowest acidity values, but the difference between treatments was not significant. Both 1 and 2 % of calcium chloride treatments increased acidity compared with the control at harvest time. After 7 days of storage, there was no significant difference between treatments in the first year. In the second year, the highest acidity content was recorded in fruits that were treated with 0.6 % potassium silicate, while the control showed the lowest acidity content. Our results in Figure 17 show that the total sugar increased after 7 days of storage compared to harvest time. At harvest time, all treatments significantly increased total sugar compared with the control in both years. After 7 days of storage, 2 % calcium chloride and 0.6 % potassium silicate treatments showed the highest content of total sugar compared with the control in both seasons. The influence of calcium chloride and potassium silicate applications on total phenols is presented in Figure 18. The results indicate that all treatments didn't affect the total phenol content in strawberry fruits in both years, either at harvest time or after 7 days of storage.

In this study and previous studies, found that silicon fertilizer enhanced the quality and postharvest behavior of horticultural crops. For example, previous work found that increasing silicon fertilizer doses increased TSS and vitamin C contents in tomato fruits **(Marodin et al., 2016).** Increasing TSS with silicon fertilizer might be related to increasing the rate of photosynthetic efficiency, which increases the accumulation of TSS in fruits **(Al-aghabary et al., 2005).** Increasing fruits firmness by silicon application was also reported previously in tomatoes **(Marodin et al., 2016; Stamatakis et al., 2003).** The role of silicon fertilizer in increase fruits firmness might be due to the deposition of silicon in the cell wall resulted in thicker cell walls **(Almeida et al., 2009)**

It has been well known that higher yields, fruit size, TSS content, vitamin C, shelf life, and quality parameters have all been linked to adequate potassium nutrition in some crops such as cantaloupe and tomatoes (Kanai *et al.*, 2007; Lester *et al.*, 2005). In accordance with our results, a previous study found that potassium fertilizer increases muskmelon firmness (Jifon and Lester, 2009). It could be that potassium application increases fruit firmness due to the increased integrity of the cell wall and enhances the movement of calcium into fruits **(Jifon and Lester, 2009).**

In agreement with our results, previous works recorded that calcium application before harvest increased the acidity, TSS, ascorbic acid of strawberry fruits **(Singh *et al.*, 2007; Wójcik and Lewandowski, 2003).** This could be as a result of the ability of calcium to slow down fruit ripening and senescence **(Sharma et al., 2006).** Additionally, it has been found that calcium treatment preserved total sugar in strawberry fruits during cold storage **(Amiri et al., 2022).**

In agreement with our results, previous work found that potassium fertilizer increased the chemical compounds of muskmelon fruits, including vitamin C, which might be due to the enhancement of enzyme activation of the formation of vitamin C **(Jifon and Lester, 2009).** This study found that potassium silicate fertilizer enhanced sugar content in strawberry fruits. This finding may be connected to potassium's effects on enhanced the photosynthesis process and sugar accumulation, enhanced transport of sugar from leaves to fruits, enhanced enzyme activity, and improved the relations between fruit and water **(Beringer et al., 1986; Terry and Ulrich, 1973).**

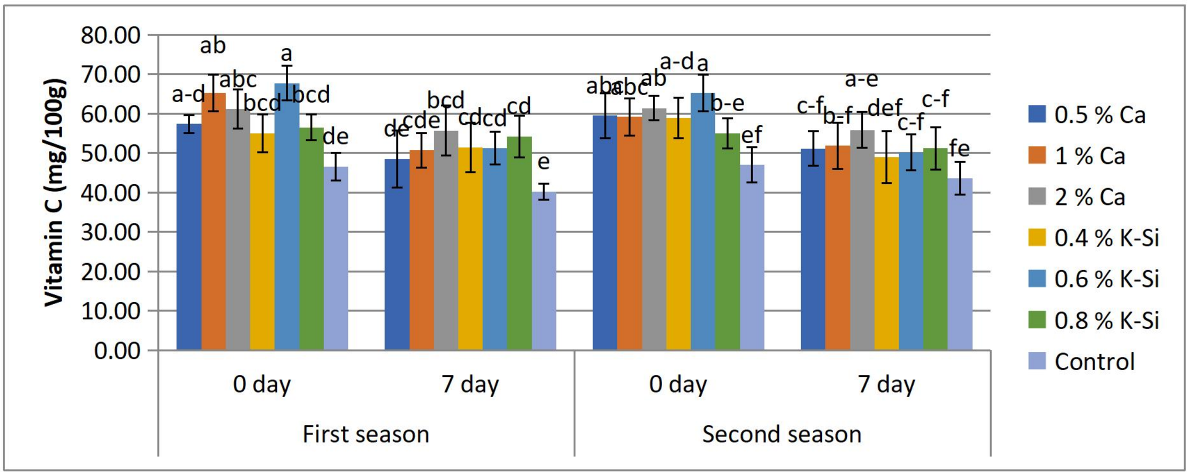


Figure 15: Effect of calcium chloride and potassium silicate on the fruit vitamin C in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

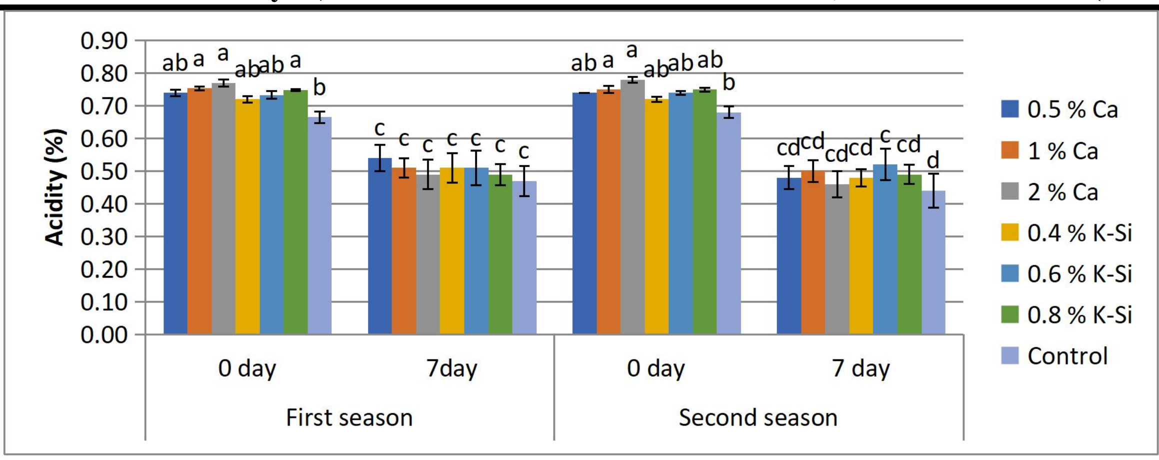


Figure 16: Effect of calcium chloride and potassium silicate on the fruit treatable acidity in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

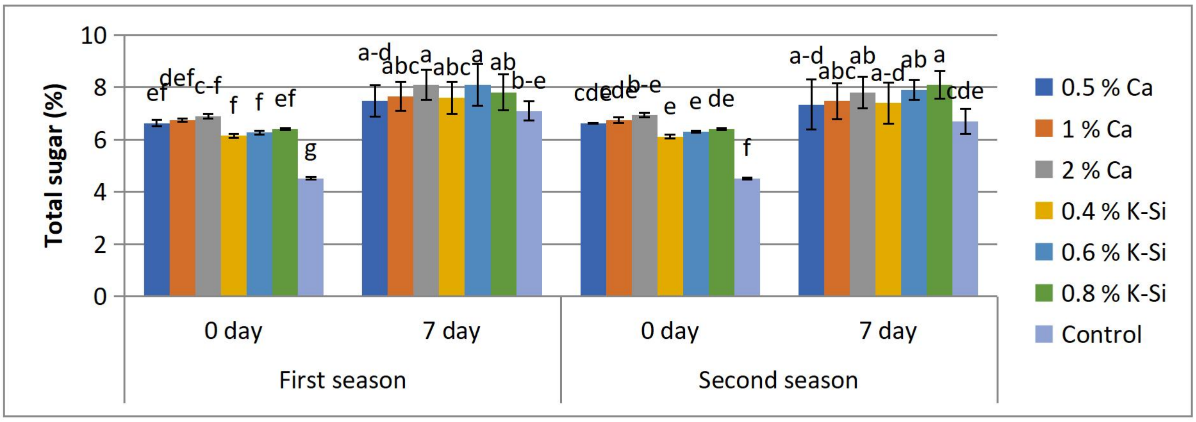


Figure 17: Effect of calcium chloride and potassium silicate on the fruit total sugar in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

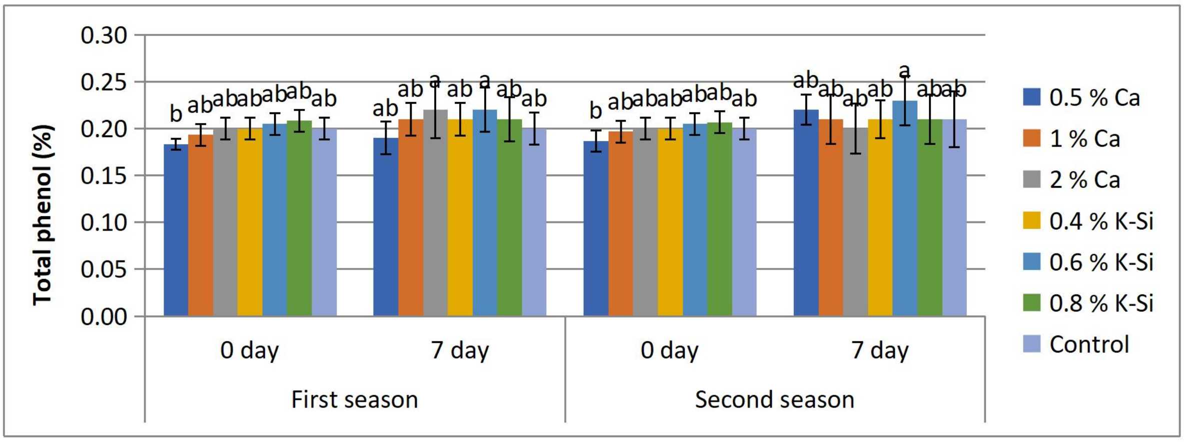


Figure 18: Effect of calcium chloride and potassium silicate on the fruit total phenols in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

Effect of calcium chloride and potassium silicate on total anthocyanin, total antioxidants, poly phenol oxidase activity, and peroxidase activity

The total anthocyanin in strawberry fruits increased after 7 days of storage compared with the harvest time (Figure 19). At harvest time in both years, all calcium chloride concentrations significantly increased the total anthocyanin content compared to the control, while there was no significant difference between all the potassium silicate treatments and the control. After 7 days of storage, there was no significant difference between all treatments in both years. Previous study stated that the strawberry samples treated with calcium had the greatest concentrations of anthocyanins, which indicated higher redness, which is consistent with our finding **(Amiri et al., 2022)**

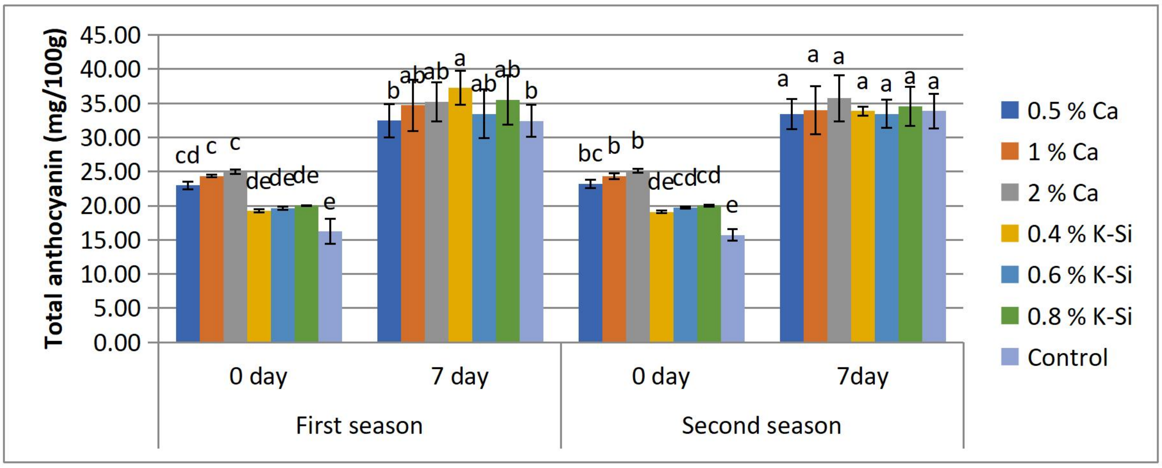


Figure 19: Effect of calcium chloride and potassium silicate on the fruit total anthocyanin in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

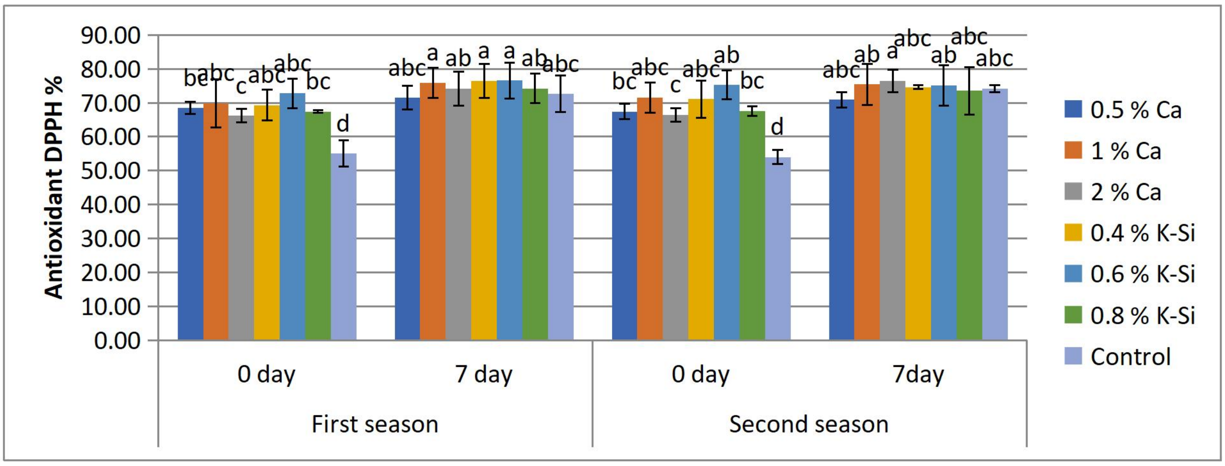


Figure 20: Effect of calcium chloride and potassium silicate on the fruit total antioxidant in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

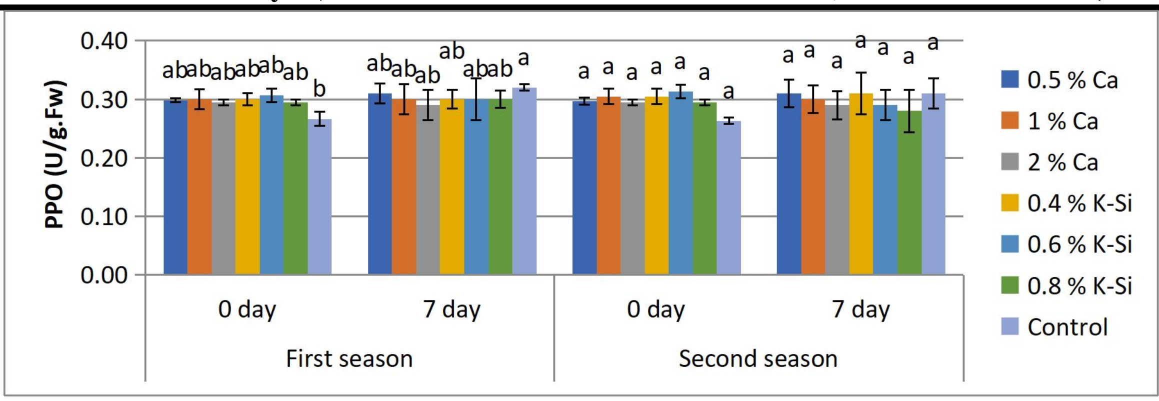


Figure 21: Effect of calcium chloride and potassium silicate on the activity of poly phenol oxidase (PPO) in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications(LSD test at $p < 0.05$). A standard deviation is presented as vertical bars.

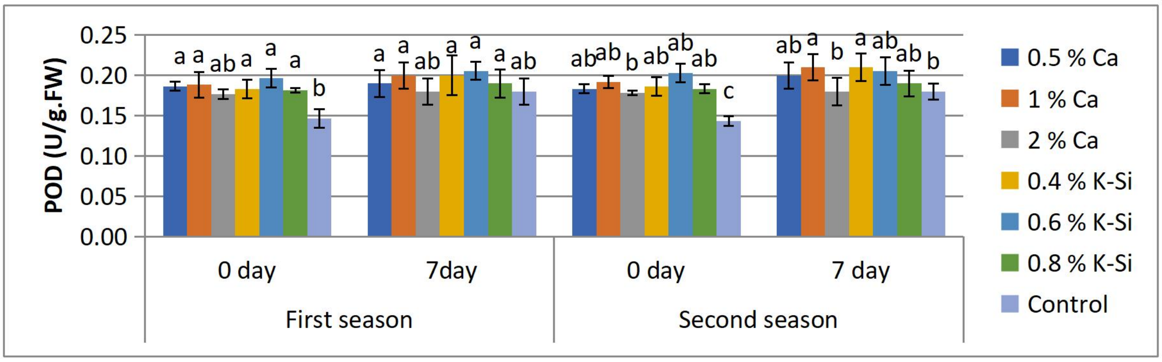


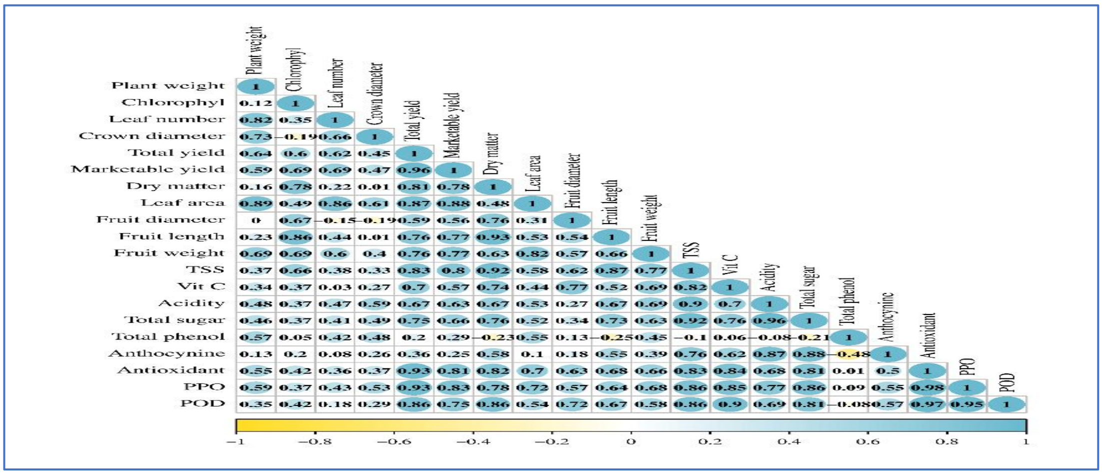
Figure 22: Effect of calcium chloride and potassium silicate on the activity of the peroxidase enzyme (POD) in both seasons of the study kept at 10°C for 7 days. Different letters above the columns showed the variances between applications (Duncan test at $p < 0.05$). A standard error is presented as vertical bars.

The results in Figure 20 show that all treatments significantly increased antioxidant capacity at harvest time in both years compared to the control treatment. However, after 7 days of storage, there was no significant difference between all treatments in both years. The PPO activity was not significantly affected by any treatments at harvest time in both years (Figure 21). At harvest time in both years, all treatments showed higher POD activity than the control (Figure 22). However, the difference was not significant after 7 days of cold storage.

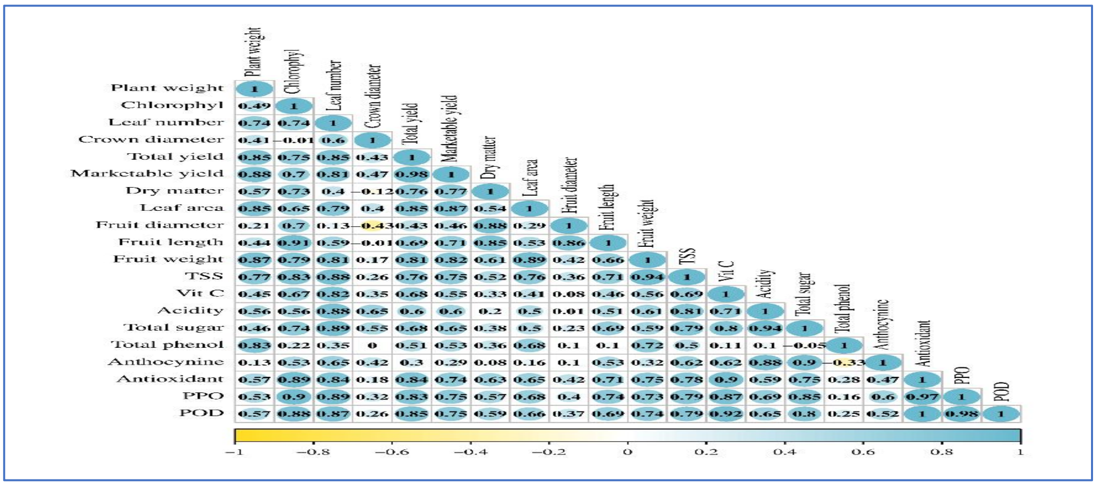
In agreement with our results, it has been found that pre-harvest calcium application increased antioxidant capacity in fruits compared to the control **(Ranjbar et al., 2018).** Enhancing the content of antioxidant capacity by calcium application could be due to the role of calcium in reduces respiration rate and ethylene production resulted in less antioxidant capacity loss **(Lester and Grusak, 1999).** The increase of POD activity by calcium treatment was recorded in our study. In agreement with this result, it has been found that pre-harvest calcium application increased POD activity in broccoli microgreens **(Kou et al., 2014).**

Correlation study

The correlation study was performed to show the relation and correlation between the tested parameters in two seasons (Figure 23A, B). The results indicated that both seasons had the same trend of the results. In the first season (Figure 23A), for example, there was a strong positive correlation between plant weight and other parameters including leaf number, crown diameter, and leaf area. In the second year (Figure 23B), plant weight was positively correlated with leaf number, total yield, marketable yield, leaf area, fruit weight, TSS, and total phenols. The most important parameter is the total yield which was positively correlated with dry matter, leaf area, TSS, total sugar, total antioxidant, PPO, and POD in the first season, while in the second season, total yield was correlated positively with dry matter, leaf area, fruit weight, TSS, total antioxidant, PPO, and POD.



A



B

Figure 23. Correlation (Person test) between the tested parameters in the first season (A) and the second season (B).

CONCLUSION:

In the current study, we have evaluated the impact of pre-harvest calcium chloride and potassium silicate treatments on strawberry's yield and postharvest quality. Our findings show that calcium chloride and potassium silicate applications considerably increased growth, yield, and fruit quality. In comparison to control that were sprayed with water, calcium-treated plants produced firmer fruits and decrease the weight loss during shelf-life. Potassium silicate application increased total sugar, total anthocyanin, and vitamin C. The results of this study show the value of calcium and potassium in enhancing strawberry yield as well as postharvest quality and shelf life. Additionally, on the applied scale, the results of this study can be useful in increasing the calcium and potassium content in fruits through pre-harvest treatment, which increases the storage ability of strawberry fruits during the transport process globally.

Acknowledgements

All authors extend their gratitude to Vegetable department, Faculty of Agriculture, Cairo University and Fruit Crops Handling Research Department, Horticulture Research Institute (HRI), Agricultural Research Center for providing some facilities and equipment to finalize this research work.

4-REFERENCES:

Ahmed, M, Hassen, F, Qadeer, U and Aslam, M. A. 2011. Silicon application and drought tolerance mechanism of sorghum. African Journal of Agricultural Research 6, 594-607. DOI: 10.5897/AJAR10.626.

Al-aghabary, K., Zhu, Z. and Shi, Q. 2005. Influence of Silicon Supply on Chlorophyll Content, Chlorophyll Fluorescence, and Antioxidative Enzyme Activities in Tomato Plants Under Salt Stress. Journal of Plant Nutrition 27, 2101-2115. https://doi.org/10.1081/PLN-200034641.

Al-Kuraieef, A.N., Alshawi, A.H. and Alsuhaibani, A.M.A. 2019. Effect of the combined action of potassium sorbate and irradiation on the quality-maintenance of strawberries. Journal of Food Science and Technology 56, 3374-3379. https://doi.org/10.1007/s13197-019-03821-7.

Alharaty, G. and Ramaswamy, H. S. 2020. The Effect of Sodium Alginate-Calcium Chloride Coating on the Quality Parameters and Shelf Life of Strawberry Cut Fruits, Journal of Composites Science. Journal of Composites Science 4(3):123. https://doi.org/10.3390/jcs4030123.

Almeida, G.D., Pratissoli, D., Zanuncio, J.C., Vicentini, V. B., Holtz, A. M. and Serrão, J. E. 2009. Calcium silicate and organic mineral fertilizer increase the resistance of tomato plants to Frankliniella schultzei. Phytoparasitica. 37(3):225-230. doi:10.1007/s12600-009-0034-7.

Amiri, S., Rezazad, Bari L., Malekzadeh, S., Amiri, S., Mostashari, P. and Ahmadi, Gheshlagh, P. 2022. Effect of Aloe vera gel-based active coating incorporated with catechin nanoemulsion and calcium chloride on postharvest quality of fresh strawberry fruit. Journal of Food Processing and Preservation 46(10):e15960. https://doi.org/10.1111/jfpp.15960

A.O.A.C. (2000). Official Methods of Analysis, 17th ed.; The Association of Official Analytical Chemists: Gaithersburg, MD, USA.

Bao-shan, L., shao-qi, D., Chun-hui, L., Li-jun, F., Shu-chun, Q. and Min, Y. (2004). Effect of TMS (nanostructured silicon dioxide) on growth of Changbai larch seedlings. Journal of Forestry Research 15, 138-140. doi:10.1007/BF02856749.

Beringer, H., Koch, K. and Lindhauer, M. G. (1986). Sucrose accumulation and osmotic potentials in sugar beet at increasing levels of potassium nutrition. Journal of the Science of Food and Agriculture 37, 211-218. https://doi.org/10.1002/jsfa.2740370303.

Chance, B. and Maehly, A. C. 1955. Assay of catalases and peroxidases, Methods in Enzymology. Academic Press, pp. 764-775.

Chen, W., Yao, X., Cai, K. and Chen, J. 2011. Silicon Alleviates Drought Stress of Rice Plants by Improving Plant Water Status, Photosynthesis and Mineral Nutrient Absorption. Biological Trace Element Research 142, 67-76.doi:10.1007/s12011-010-8742-x.

Chéour, F., Willemot, C., Arul, J., Desjardins, Y., Makhlouf, J., Charest, P. M. and Gosselin, A. 1990. Foliar Application of Calcium Chloride Delays Postharvest Ripening of Strawberry. Journal of the American Society for Horticultural Science jashs 115, 789-792. doi:10.21273/JASHS.115.5.789

Coskun, D., Britto, D. T. and Kronzucker, H. J. 2017. The nitrogen–potassium intersection: membranes, metabolism, and mechanism. Plant, Cell & Environment 40, 2029-2041. https://doi.org/10.1111/pce.12671.

Cvelbar, Weber N., Koron, D., Jakopič, J., Veberič, R., Hudina, M. and Baša Česnik, H. 2021. Influence of Nitrogen, Calcium and Nano-Fertilizer on Strawberry (*Fragaria × ananassa* Duch.) Fruit Inner and Outer Quality, Agronomy. doi:10.3390/agronomy11050997.

Danner, M. A., Citadin, I., Sasso, S. A. Z., Zarth, N. A. and Mazaro, S. M. 2009. Fontes de cálcio aplicadas no solo e sua relação com a qualidade da uva 'Vênus'. Revista Brasileira de Fruticultura 31.

Eklund, L. and Eliasson, L. 1990. Effects of Calcium Ion Concentration on Cel Wall Synthesis. Journal of Experimental Botany 41, 863-867. doi:10.1093/jxb/41.7.863.

El-Mageed, T. A. A., Semida, W. M. , Abdou, N. M. and El-Mageed, S. A. A. 2023.. Coupling Effects of Potassium Fertilization Rate and Application Time on Growth and Grain Yield of Wheat (Triticum aestivum L.) Plants Grown Under Cd-Contaminated Saline Soil. Journal of Soil Science and Plant Nutrition 23, 1070-1084. doi:10.1007/s42729-022-01104-3.

Epstein, E. 1999. SILICON. Annual review of plant physiology and plant molecular biology 50, 641-664.

Fageria, N. K. 2016. The use of nutrients in crop plants. CRC press.

Gong, H. J., Chen, K. M., Chen, G.C., Wang, S. M. and Zhang, C.L. 2003. Effects of Silicon on Growth of Wheat Under Drought. Journal of Plant Nutrition 26, 1055-1063. doi:10.1081/PLN-120020075.

Hasanuzzaman, M., Bhuyan, M. H. M. B., Nahar, K., Hossain, M. S., Mahmud, J. A., Hossen, M. S. , Masud, A. A. and Moumita Fujita, M. 2018. Potassium: A Vital Regulator of Plant Responses and Tolerance to Abiotic Stresses, Agronomy. doi:10.3390/agronomy8030031

Hepler, P. K., Vidali, L. and Cheung, A. Y. 2001. Polarized Cell Growth in Higher Plants. Annual Review of Cell and Developmental Biology 17, 159-187. doi:10.1146/annurev.cellbio.17.1.159.

Hocking, B., Tyerman, S. D, Burton, R. A. and Gilliham, M. 2016a. Fruit Calcium: Transport and Physiology. Frontiers in Plant Science 7.

Hocking, B, Tyerman, S. D., Burton, R. A. and Gilliham, M. 2016b. Fruit Calcium: Transport and Physiology. Front Plant Sci 7, 569.

Hu, W., Jiang, N., Yang, J., Meng, Y., Wang, Y., Chen, B., Zhao, W., Oosterhuis, D. M. and Zhou, Z. 2016. Potassium (K) supply affects K accumulation and photosynthetic physiology in two cotton (Gossypium hirsutum L.) cultivars with different K sensitivities. Field Crops Research 196, 51-63. https://doi.org/10.1016/j.fcr.2016.06.005.

Jifon, J. L. and Lester, G. E. 2009. Foliar potassium fertilization improves fruit quality of field-grown muskmelon on calcareous soils in south Texas. Journal of the Science of Food and Agriculture 89, 2452-2460. https://doi.org/10.1002/jsfa.3745.

Kanai, S., Ohkura, K., Adu-Gyamfi, J. J., Mohapatra, P. K., Nguyen, N.T., Saneoka, H. and Fujita K. 2007. Depression of sink activity precedes the inhibition of biomass production in tomato plants subjected to potassium deficiency stress. Journal of Experimental Botany 58, 2917-2928. doi:10.1093/jxb/erm149

Kaya, C., Tuna, L. and Higgs, D. 2006. Effect of Silicon on Plant Growth and Mineral Nutrition of Maize Grown Under Water-Stress Conditions. Journal of Plant Nutrition 29, 1469-1480. doi:10.1080/01904160600837238.

Kou, L., Yang, T., Luo, Y., Liu, X., Huang, L. and Codling, E. 2014. Pre-harvest calcium application increases biomass and delays senescence of broccoli microgreens. Postharvest Biology and Technology 87, 70-78. https://doi.org/10.1016/j.postharvbio.2013.08.004.

Lester, G.E. and Grusak, M. A. 1999. Postharvest Application of Calcium and Magnesium to Honeydew and Netted Muskmelons: Effects on Tissue Ion Concentrations, Quality, and Senescence. Journal of the American Society for Horticultural Science jashs 124, 545-552. doi:10.21273/JASHS.124.5.545.

Lester, G .E., Jifon, J. L. and Rogers, G. 2005. Supplemental Foliar Potassium Applications during Muskmelon Fruit Development Can Improve Fruit Quality, Ascorbic Acid, and Beta-carotene Contents. Journal of the American Society for Horticultural Science jashs 130, 649-653. doi:10.21273/JASHS.130.4.649.

Liu, M., Wang, R., Sun, W., Han, W., Li G., Zong, W. and Fu, J. 2023. Effects of postharvest calcium treatmenttreatment on the firmness of persimmon (Diospyros kaki) fruit based on a decline in WSP. Scientia Horticulturae 307, 111490. https://doi.org/10.1016/j.scienta.2022.111490.

Marodin, J. C., Resende, J. T. V., Morales, R. G. F., Faria, M. V., Trevisam, A. R., Figueiredo, A. S. T. and Dias D. M. (2016). Tomato post-harvest durability and physicochemical quality depending on silicon sources and doses. Horticultura Brasileira 34. https://doi.org/10.1590/S0102-05362016003009.

Moradinezhad, F. and Dorostkar, M. 2021. Pre-harvest Foliar Application of Calcium Chloride and Potassium Nitrate Influences Growth and Quality of Apricot (Prunus armeniaca L.) Fruit cv. 'Shahroudi'. Journal of Soil Science and Plant Nutrition 21, 1642-1652. doi:10.1007/s42729-021-00468-2

Nakro A., Bamouh, A., Bouslama, H., San Bautista, A. and Ghaouti, L. (2023). The Effect of Potassium–Nitrogen Balance on the Yield and Quality of Strawberries Grown under Soilless Conditions, Horticulturae 9(3). doi:10.3390/horticulturae9030304

Naradisorn, M., Klieber, A., Sedgley, M., Scott, E. and Able A. J. 2006. Effect of preharvest calcium application on grey mould development and postharvest quality in strawberries, 708 ed.

International Society for Horticultural Science (ISHS), Leuven, Belgium, pp. 147-150.

Navarro, J. M., Flores, P., Carvajal, M. and Martinez, V. 2005. Changes in quality and yield of tomato fruit with ammonium, bicarbonate and calcium fertilisation under saline conditions. The Journal of Horticultural Science and Biotechnology 80, 351-357. doi:10.1080/14620316.2005.11511943.

Navazio, L., Formentin, E., Cendron, L. and Szabò, I. 2020. Chloroplast Calcium Signaling in the Spotlight. Front Plant Sci 11, 186. doi:10.3389/fpls.2020.00186.

Nguyen, V. T. B., Nguyen, D. H. H. and Nguyen, H. V. H. 2020. Combination effects of calcium chloride and nano-chitosan on the postharvest quality of strawberry (*Fragaria x ananassa* Duch.). Postharvest Biology and Technology 162, 111103. https://doi.org/10.1016/j.postharvbio.2019.111103.

Niazi A-R., Ghanbari, F. and Erfani-Moghadam, J. 2021. Simultaneous effects of hot water treatment with calcium and salicylic acid on shelf life and qualitative characteristics of strawberry during refrigerated storage. Journal of Food Processing and Preservation 45, e15005. https://doi.org/10.1111/jfpp.15005.

Oosterhuis, D. M., Loka, D. A., Kawakami, E. M. and Pettigrew, W. T. 2014. Chapter Three - The Physiology of Potassium in Crop Production, In: Sparks, D.L. (Ed.), Advances in Agronomy. Academic Press, pp. 203-233.

Pati, S., Pal, B., Badole, S., Hazra, G. C., Mandal, B. 2016. Effect of Silicon Fertilization on Growth, Yield, and Nutrient Uptake of Rice. Communications in Soil Science and Plant Analysis 47, 284-290. doi:10.1080/00103624.2015.1122797.

Pavlovic, J., Kostic, L., Bosnic, P., Kirkby, E. A. and Nikolic, M. 2021. Interactions of Silicon With Essential and Beneficial Elements in Plants. Front Plant Sci 12, 697592. doi:10.3389/fpls.2021.697592.

Picchioni, G. A., Watada. A. E., Whitaker, B. D. and Reyes, A. 1996. Calcium delays senescence-related membrane lipid changes and increases net synthesis of membrane lipid components in shredded carrots. Postharvest Biology and Technology 9, 235-245. https://doi.org/10.1016/S0925-5214(96)00051-8.

Pirie, A. and Mullins, M. G. 1976. Changes in anthocyanin and phenolics content of grapevine leaf and fruit tissues treated with sucrose, nitrate, and abscisic Acid. Plant physiology 58, 468-472. doi:10.1104/pp.58.4.468.

Rani, P., Saini, I., Singh, N., Kaushik, P., Wijaya, L., Al-Barty, A., Darwish, H. and Noureldeen, A. (2021). Effect of potassium fertilizer on the growth, physiological parameters, and water status of Brassica juncea cultivars under different irrigation regimes. PloS one 16, e0257023. doi:10.1371/journal.pone.0257023.

Ranjbar, S., Rahemi, M. and Ramezanian, A. 2018. Comparison of nano-calcium and calcium chloride spray on postharvest quality and cell wall enzymes activity in apple cv. Red Delicious. Scientia Horticulturae 240, 57-64. https://doi.org/10.1016/j.scienta.2018.05.035.

Reuveni, R., Shimoni, M., Karchi, Z. and Kuc J. J. P. 1992. Peroxidase activity as a biochemical marker for resistance of muskmelon(Cucumis melo) to Pseudoperonospora cubensis. 82, 749-753.

Serrano M, Martínez-Romero D, Castillo S, Guillén F, Valero D (2004). Effect of preharvest sprays containing calcium, magnesium and titanium on the quality of peaches and nectarines at harvest and during postharvest storage. Journal of the Science of Food and Agriculture 84, 1270-1276. https://doi.org/10.1002/jsfa.1753.

Shafiee M, Taghavi TS, Babalar M (2010). Addition of salicylic acid to nutrient solution combined with postharvest treatments (hot water, salicylic acid, and calcium dipping) improved postharvest fruit quality of strawberry. Scientia Horticulturae 124, 40-45. https://doi.org/10.1016/j.scienta.2009.12.004.

Sharma, R. R., Krishna, H., Patel, V. B., Dahuja, A. and Singh, R. 2006. Fruit calcium content and lipoxygenase activity in relation to albinism disorder in strawberry. Scientia Horticulturae 107, 150-154. https://doi.org/10.1016/j.scienta.2005.06.008.

Siddiqui, M. H. and Al-Whaibi, M. H. 2014. Role of nano-SiO2 in germination of tomato (*Lycopersicum esculentum* seeds Mill.). Saudi journal of biological sciences 21, 13-17. *doi:10.1016/j.sjbs.2013.04.005.*

Singh, R., Sharma, R. R. and Tyagi, S. K. 2007. Pre-harvest foliar application of calcium and boron influences physiological disorders, fruit yield and quality of strawberry (*Fragaria×ananassa* Duch.). Scientia Horticulturae 112, 215-220. https://doi.org/10.1016/j.scienta.2006.12.019.

Song, Q., Liu, Y., Pang, J., Yong, J. W. H., Chen, Y., Bai, C., Gille, C., Shi, Q., Wu, D., Han, X., Li, T., Siddique, K. H. M., Lambers, H. 2020. Supplementary Calcium Restores Peanut (*Arachis hypogaea*) Growth and Photosynthetic Capacity Under Low Nocturnal Temperature. Frontiers in Plant Science 10.

Stamatakis, A., Papadantonakis, N., Savvas, D., Lydakis-Simantiris, N. and Kefalas, P. 2003. Effects of silicon and salinity on fruit yield and quality of tomato grown hydroponically, 609 ed. International Society for Horticultural Science (ISHS), Leuven, Belgium, pp. 141-147.

Suriyaprabha, R., Karunakaran, G., Yuvakkumar, R., Prabu, P., Rajendran, V. and Kannan, N. 2012. Growth and physiological responses of maize (*Zea mays* L.) to porous silica nanoparticles in soil. Journal of Nanoparticle Research 14, 1294. doi:10.1007/s11051-012-1294-6.

Suriyaprabha, R., Karunakaran, G., Yuvakkumar, R., Rajendran, V. and Kannan, N. 2014. Foliar Application of Silica Nanoparticles on the Phytochemical Responses of Maize (Zea mays L.) and Its Toxicological Behavior. Synthesis and Reactivity in Inorganic, Metal-Organic, and Nano-Metal Chemistry 44, 1128-1131. *doi:10.1080/15533174.2013.799197.*

Swain T. and Hillis, W. E. 1959. The phenolic constituents of Prunus domestica. I.—The quantitative analysis of phenolic constituents. Journal of the Science of Food and Agriculture 10, 63-68. https://doi.org/10.1002/jsfa.2740100110.

Terry N. and Ulrich, A. 1973. Effects of potassium deficiency on the photosynthesis and respiration of leaves of sugar beet. Plant physiology 51, 783-786. doi:10.1104/pp.51.4.783.

Thor, K. 2019. Calcium—Nutrient and Messenger. Frontiers in Plant Science 10.

Tomala, K. 1997. Orchard factors affecting nutrient content and fruit quality, 448 ed. International Society for Horticultural Science (ISHS), Leuven, Belgium, pp. 257-264.

Wang, M., Wang, R., Mur, L. A. J., Ruan, J., Shen, Q. and Guo, S. 2021. Functions of silicon in plant drought stress responses.

Horticulture Research 8, 254. doi:10.1038/s41438-021-00681-1.

Wang, M., Zheng, Q., Shen, Q. and Guo, S. 2013. The Critical Role of Potassium in Plant Stress Response, International Journal of Molecular Sciences, pp. 7370-7390. doi:10.3390/ijms14047370.

Wójcik, P. and Lewandowski, M. 2003. Effect of Calcium and Boron Sprays on Yield and Quality of “Elsanta” Strawberry. Journal of Plant Nutrition 26, 671-682. doi:10.1081/PLN-120017674.

Xiao J., Li, Y. and Jeong, B. R. 2022. Foliar Silicon Spray to Strawberry Plants During Summer Cutting Propagation Enhances Resistance of Transplants to High Temperature Stresses. Frontiers in Sustainable Food Systems 6.

Zhang, G., Liu, Y., Ni, Y., Meng, Z., Lu, T., Li, T. 2014. Exogenous calcium alleviates low night temperature stress on the photosynthetic apparatus of tomato leaves. PloS one 9, e97322. doi:10.1371/journal.pone.0097322.

Zhang, Z. S., Yang, C., Gao, H. Y., Wang, W. W., Sun, X. J., Meng, X. L. and Meng, Q. W. (2012). [Effects of cucumber leaf's PS II activity and electron transfer on its PS I activity in recovery process after chilling-induced photoinhibition]. Ying yong sheng tai xue bao = The journal of applied ecology 23, 1049-1054.

الملخص العربي

سيليكات البوتاسيوم وكلوريد الكالسيوم لتحسين إنتاج الفراولة ومدة صلاحيتها للتداول

شيرين سيد فتحى السيد[1] ، محمدمحمد زكى الموجى[1] ، جيهان أحمد محمود[2]
قسم محاصيل الخضر، كلية الزراعة، جامعة القاهرة، الجيزة، 12613، مصر [1]؛
قسم بحوث تداول الفاكهة، معهد بحوث البساتين ، مركز البحوث الزراعية، الجيزة، مصر[2]

يمثل العمر الافتراضي القصير لثمار الفراولة التحدي الرئيسي للنقلها لمسافات طويلة أثناء التصدير والاستيراد حول العالم، قد تؤدي إضافة معاملات ما بعد الحصاد إلى زيادة تعفن الثمار أثناء النقل. وبالتالي فإن الغرض من هذه الدراسة هو تقييم تأثير تطبيقات ما قبل الحصاد بمعدلات مختلفة من كلوريد الكالسيوم (0,5، 1، 2%) وسيليكات البوتاسيوم (0,4، 0,6، 0,8%) على النمو والمحصول وخصائص الثمار. ومدة الصلاحية (7 أيام عند 10 درجة مئوية)، والمحتوى من المركبات النشطة بيولوجيا، ونشاط الإنزيمات في الفراولة ، وقد أشارت النتائج إلى أن كلوريد الكالسيوم وسيليكات البوتاسيوم أدى إلى زيادة معنوية في عدد الأوراق والوزن الطازج للنبات ونسبة الكلوروفيل والمساحة الورقية للنبات والمادة الجافة مقارنة بالكنترول. بالإضافة إلى ذلك، أدى كلوريد الكالسيوم وسيليكات البوتاسيوم إلى زيادة كبيرة في المحصول الكلى ، والمحصول القابل للتسويق، وطول الثمرة، ووزن الثمرة، وقطر الثمرة. كان كلوريد الكالسيوم هو العلاج الأكثر فعالية لتقليل فقدان الوزن وزيادة صلابة الثمار والأنثوسيانين الكلي مقارنة بالمعاملات الأخرى. علاوة على ذلك، كان سيليكات البوتاسيوم هو المعاملة الأكثر فعالية لتحسين فيتامين C. وقد أدى كلا المركبين إلى زيادة كبيرة في السكريات الكلية والمواد المضادة للأكسدة ونشاط البيروكسيديز (POD)، توفر نتائجنا بيانات مهمة للمنتجين التجاريين لزيادة الإنتاج، وتحسين جودة ما بعد الحصاد، وإطالة العمر الافتراضي، مما يسمح بنطاق أوسع من تسويق الفراولة بالتجزئة.

الكلمات المفتاحية: التخزين، الجودة، الأنثوسيانين، المركبات فينوليه؛ البولي فينول أوكسيديز ، البيروكسيديز