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Effect of Preharvest Spray on Shelf Life and Quality of Strawberry (*Fragaria ananassa*)

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ABSTRACT: Strawberry (*Fragaria ananassa*), belongs to the family Rosaceae has basic Chromosome no. (2n) = 56 is generally originated from France, in the 1750s. It is an important fruit crop of India and its commercial production is possible in temperate and sub-tropical areas of the country including the Terai region of West Bengal. An experiment was conducted to evaluate the effect of pre harvests spray on shelf life of fruit and to study the shelf life and quality of the fruit as influenced by pre-harvest spray. Total number of treatment was five and replication was also five and the experimental design was RBD. Parameters like length of fruit, breadth of fruit, fruit weight, fruit colour, penetration force, physiological loss in weight and biochemical parameters like Total soluble solid (ºBrix), Total sugar (%), Reducing sugar (%), Titratable acidity (%), Ascorbic acid content (mg/100g of pulp). The challenge of this study is not only increasing shelf life of fruits and but also discovering the treatment which maintain quality after harvest as well as increased shelf life. Here the T_5 $CaCl_2$ spray treatment performed best in terms of least physiological weight loss, most total soluble solid, lowering sugar, and total sugar. Fruits from T5 were also discovered to have texture retention after 3 days of storage and to have lower acidity.

Keywords: Shelf life, Pre harvest spray, Biochemical parameter, RBC design, Quality of fruit.

INTRODUCTION

One of the most delicious, scrumptious, and nutrient-dense fruits in the world is the modern grow strawberry (Fragaria × ananassa). It belongs to the Rosaceae family and is a hybrid of two Native American species, *Fragaria chiloensis* and *Fragaria virginiana*. It is a monoecious, short-day, succulent, low-growing perennial herb, and fruit plant that grows quickly. Etaerio of achens is a sort of fruit in botany. Inflorescence is dichotomic raceme, flowers are brone in small cluster and white in color. Fruit is small, red, sweet and fruit contains citric acid. Strawberry fruit is a whole fruit with 98% of its edible portion being the succulent thalamus. These plants act as a small perennial herb with a shallow root system in temperate temperature conditions, but as annuals in sub-tropical conditions (Finn and Strike 2008). Strawberries are unique with a distinct and pleasant aroma, delicate flavor, and excellent source of vitamins, potassium, fiber and sugars and suitable for kitchen garden. It contains a variety of crucial dietary ingredients and is a good source of vitamin C (Riyaphan *et al.,* 2005). Strawberries are a good source of dietary glutathionone, metabolites, carotenoids, vitamins, phenols, flavonoids, and natural antioxidants (Wang *et al.,* 1996; Heinonen *et al.,* 1998; Larson, 1988). It is eaten both raw and processed, including in jam, ice cream, biscuits, fruit juice, pies, ice cream, milkshakes, chocolate, and other dishes. The demand for strawberries on both the domestic and international markets has been constantly rising. It has been commercially cultivated in Canada, USA, Japan, Spain, Germany, Korea, Italy, Poland, Thailand and so many other countries in the world (Biswas *et al.,* 2007). Strawberry is one of the nine fruit crops (Banana, Mango, Grapes, Litchi, Citrus, Sapota, Custard apple, Strawberry and Pomegranate) identified by the APEDA (Agricultural Produce Export Development Authority) for future growth of exports. Valle *et al*. (2005) worked on cactus-mucilage edible coating (*Opuntia ficus indica*) and its application to extend strawberry (*Fragaria* × *ananassa*) shelf-life and as a result he concluded that the use of mucilage coatings leads to increased strawberry shelf-life

Naphun *et al*. (1997) reported that effects of pre harvest calcium spray on the quality of strawberry var. 'Nyoho' treated. Result showed that calcium chloride which increased ascorbic acid and maintained fruit soundness by delaying decay caused by gray mold. Gayed *et al*. (2017) examined the effect of pre-harvest sprays of calcium chloride and chitosan, separately for quality attributes and storability of peach. Post-harvest treatment of fruits is the most perishable agricultural practices to check the decay and improve the storage life, marketability and colour development of fruits. Post-harvest losses are the quality and quantity losses of horticultural products from the time of harvest till consumption. However, pathogen-related losses are a genuine concern, and illnesses are the leading reason for strawberry losses. Following harvest, fungicides are not applied. *Botrytis cinerea* and the fungus *Rhyzopus*

stolonifer are responsible for the two main kinds of strawberry rot. The main blight impacting strawberries is *Botrytis cinerea*. It results in significant post-harvest losses. Over 0°C, this fungus continued to develop, albeit at a very slow rate. The tissues lose their juice that drips from the packages when the second form of fungus, *Rhyzopus stolonifer*, creates a soft rot. At temperatures below 5°C, this fungus typically does not flourish. It is commonly established that calcium chloride pre-harvest treatments enhance both the quality and storage/shelf life of crops. The advantages of calcium for preserving fruit quality (Bakshi *et al.,* 2005). Commercial pre-harvest Ca applications are used in many fruits and vegetables to improve quality, postpone senescence, reduce post-harvest deterioration, and manage physiological disorders (Poovaviah, 1986; Conway *et al.,* 1994). The primary goals of the current study, titled The Impact of Preharvest Spray on Fruit Shelf Life and Quality, are to assess how preharvest spray affects fruit quality and shelf life.

MATERIALS AND METHOD

The current experiment was conducted from 2016 to 2018 at the instructional field and laboratory of the Faculty of Horticulture, Department of Pomology, at the Uttar Banga Krishi Viswsvidyalaya in Pundibari, Cooch Behar, West Bengal. The experimental site is located at 26°23'86" N latitude and 89°25'53" E longitude in West Bengal's plains of Terai agroclimatic zone. The location was 43 metres above mean sea level. The experimental site belongs to the sub-tropical humid climate, being situated just north of the tropic of cancer. Five replications of each of the Strawberry (Camarosa) variety plantings were made using a randomised block design. For better crop development, the suggested fertilizer and other cultural measures were implemented. Five plants from each replication were used to obtain the average value for each observation. The experimental field was thoroughly ploughed and harrowed by a power tiller to obtain a leveled land with good tilth. Vigorous and healthy runners with large light color root systems were planted in experimental plots (size 2 × 1.5 m). Per plot 15 runners were accommodated at a spacing of 25 cm (plant to plant) and 30 cm (row to row) on raised beds. For nutrient management, 3 bags cowdung, 50-60 kg vermicompost were mixed together and applied uniformly before the time of planting in each bed and mixed with soil properly and left for one day. Carbofuron 3G (2g/plant) was applied directly in the soil to protect from insects at the time of planting. Mancozeb+Metalaxyl(TATA Master)+Sticker(@0.5ml) was applied on fruits and leaves by making a solution of 2g/lit to prevent grey mould and leaf spot diseases. Colored ribbon was used during the time of fruiting to protect the fruits from bird damage. For mulching wheat straw were used which is treated with Bavistin (@2g/lit)+Sticker(0.5 ml) in 1 lit of water. Current study was five distinct treatments T_1 (control), T_2 (Calcium Chloride 0.5% in water), T_3 (Calcium Chloride 1.0% in water), T_4 (Calcium Chloride 1.5% in water), T_5 (Calcium Chloride 2.0% in water), Strawberry cv. Camarosa (*Fragaria ananasa)* was choosen for this experiment.

Design of Experiment: Randomized Block Design (R.B.D). The treatment were done according to the method first spray were done just after fruit set, second spray were done at 10 days just after first spray and third spray were done at 10 days of interval just after second spray respectively and harvesting were done just after 20-25 days just after third spray. Observations were recorded after first day of flowering up to harvesting. After flowering ten random plants are tagged from each replication of each treatment. From each replication five fruits were selected from those tagged plants and their length and breadth of those selected fruits were also measured by using vernier caliper scale and recorded. Fruit weights were recorded with digital balance in gram. The colors of the fruit were recorded with the help of Royal Horticulture society mini color chart. Penetration pressure of individual strawberry fruit was measured at different storage interval using texture analyzer (TA-XT Plus, Stable Microsystems Inc.). 2 mm cylindrical probe was used and the test speed was set at 2 mm/s, while post test speed was kept at 10mm/s. The trigger force was 5g. The maximum force (g) to penetrate the fruit to a depth of 5 mm was recorded. Five fruits from each replication were tested and the mean values were converted to kPa for the purpose of reporting. Initial weights of the fruit in each treatment were recorded at the day of storage as per treatment (0 day) and final weights were recorded every 3 days of interval weight. Next percentages of weight loss were calculated. Quality parameters like total soluble solid, total sugar, reducing sugar, ascorbic acid were observed and the changes of these parameters during storage period.

RESULT AND DISCUSSION

Length of fruits were highest in treatment T_1 with a pooled value of (5.67 cm) both the year (2016-17 and 2017-18) followed by T_4 (5.39 cm) and T_5 (5.37 cm) and the lowest value of fruits length was recorded in T_3 (5.07 cm) with 1.0 *per cent* $CaCl_2$ spray. Observation during storage period revealed that fruit breadth has showed maximum value in T_5 with a mean value of 4.00 cm for both year, whereas the minimum value of fruit breadth were recorded in T_2 with 0.5 *per cent* $CaCl_2$ spray with a pooled value of 3.27 cm. According to (Kumer *et al*., 2006) these result have showed that cv. After being sprayed with 1.50% $CaCl_2$ 30 days prior to harvest, Mallika's fruit length (13.33 cm) and breadth (8.63 cm) were much higher. The increase in fruit quality brought about by calcium chloride application to trees may be attributed to its effects on promoting the synthesis and transformation of carbohydrates and carbohydrates enzymes. Other possible explanations include the reduction of abscission and the effects of calcium chloride pre-harvest sprays on post-harvest behaviour in mango fruits. Calcium plays a crucial role in maintaining the middle lamella of cells. The table was shown that the heaviest fruit weight were harvested from treatment T_1 (control) with pooled value 25.86 g

for both the year and it was found statistically at per with T_4 (25.17 g) and T_5 (23 g) and T_2 (22.24). The treatment T_3 (19.57 g) with 1.0% $CaCl_2$ spray revealed the lowest weight of fruits. According to (Kazemi *et al*., 2011), mango trees treated with 1.5% $CaCl_2$ 30 days before to harvest showed the greatest weight value among all trees when compared to control trees. Fruit weight loss in the control treatment was at its highest, whereas trees sprayed with 1.5% $CaCl_2$ experienced the lowest loss. Applications of calcium are known to be important for maintaining and functioning membranes. It might be the cause of the reduced weight loss observed in fruits with calcium spray. $CaCl_2$ 2.0% in treatment T_5 resulted in the lowest percentage of physiological weight loss (10.44%) and the highest percentage was obtained in T_3 (14.23 per cent). According to Kumar *et al*. (2012), apricot cv. Harcot fruits that were kept at room temperature during the growing seasons of 2008 and 2009 saw a percent weight loss. $CaCl_2$ treatment resulted in a minimum percentage of physiological weight loss (5.76%) when compared to control (8.11 per cent). These findings concur with those of Tomala *et al.* (1998); Tabatabaie and Malakouti (1998), who found that apple fruits treated with varying doses of calcium chloride. The maximum physiological loss in weight (14.92 *per cent*) was found after 8 days of storage in all the treatments as compared to 0 day of storage. The increase in loss percentage of fruit weight with the increase in storage period was also reported by Abd El-Motty *et al.* (2007) "Canino" apricot. Fruit firmness is an important criterion for quality and market value of strawberry. On the first day of storage highest penetration value (63.21 kPa) was obtained in T_2 with 0.5 *per cent* calcium chloride spray in both year, whereas the lowest penetration value was recorded in T_1 (control) without calcium chloride spray with a pooled value of 43.63 kPa penetration force. After 3 day of storage it has observed the similar trend of penetration force in all treatment. The pooled values were indicated a marginal decline in penetration force values. The highest decline of 7.31 *per cent* from 54.19 kPa to 50.24 kPa of penetration value was recorded in T_4 with 1.5 *per cent* calcium chloride spray after 3 day of storage. In T_4 with 1.5% calcium chloride spray, the minimum fall was 1%, from 54.54 kPa to 53.99 kPa. According to (DeEll *et al.,* 2001), fruit firmness is a crucial criterion for the market value and edible quality of apples, and losing fruit firmness is a severe issue that lowers quality (Kov *et al.,* 2005). Fruit became softer and more mealy as the storage period went on as a result of the primary cell wall and middle lamella structures degrading (Cosgrove *et al.,* 1997). At the time of harvesting the fruit colour of strawberry was bright deep red. On second day the colour of fruit was changed slightly, from bright deep red to dull deep red and on the 3rd day of storage the appearance of strawberry was totally changed and some black patches were appeared on the skin of strawberry. On the first day the best TSS was noticed in T_5 with a mean value of 8.74 ºB for the year 2016-17 and 9.03 ºB for the year 2017-18, the lowest TSS values were recorded in T_2 with 0.5 *per cent* $CaCl_2$ spray with a pooled value of 7.22ºB. TSS value on 1st day was not statistically different from control and from all treatment except T_2. Similar trend in TSS after third day of storage was observed in all treatments. The pooled values indicated a marginal decline in TSS values. The highest decline of TSS value (9.78ºB from 8.52ºB to 8.19ºB) was noticed for control sample after 3 day of storage. The decline was minimum (8.42ºB to 8.13ºB with a pooled value 3.48ºB) in T_4. These findings are consistent with those of Badshah *et al.* (1994); Hussain *et al.* (2001), which showed that TSS percentage gradually increased with increasing storage-interval. The highest T.S.S. (17.61° B) was seen after 8 days of storage as opposed to just one day (6.07° B). This upward trend in T.S.S. in response to extended storage was most likely brought on by the polysaccharide breakdown and the concentrated juice produced by dehydration. These findings are consistent with those made on apple fruits by Farooqi *et al.* (1973); Wills *et al*. (1980), who indicated that T.S.S. of apple fruits increased during storage. During storage of period it was observed that highest acidity were recorded in treatment T_1 (0.68 *per cent*) with control for both year (2016-17 and 2017-18) and the lowest acid content was noticed in T_3 with 1.0 *per cent* $CaCl_2$ spray with a pooled value of 0.64 *per cent*. After 3 day of storage highest acid content was seen in treatment T_5 (0.63 *per cent*) with 2.0 *per cent* $CaCl_2$ for the year 2016-17 and 0.62 *per cent* for the year 2017-18 whereas lowest acid were recorded in T_3 with 1.0 *per cent* $CaCl_2$ spray with a pooled value of 0.60 *per cent*. At the end of storage maximum decline in T_1 (11.91 *per cent* from 0.69 *per cent* to 0.60 *per cent*) with TA value and minimum value was in T_5 (3.07 *per cent* from 0.65 *per cent* to 0.63 *per cent*) with 2.0 *per cent* $CaCl_2$ spray. According to Drake and Spayed, 1983 demonstrated that $CaCl_2$ 1.5% offered the highest value (1.24%), while the control showed the lowest value (1.11%). Lower oxidation may be the cause of this. They discovered that "Golden Delicious" apples have more titratable acidity after being treated with $CaCl_2$ than untreated apples (Kumar *et al.,* 2006). Acids were less likely to degrade when calcium was present, keeping the cells' integrity intact. These findings concur with those of Hussain *et al.* (2001); Wojcik (2001). All treatments exhibited an increase in acidity during the storage interval. On 0 day of storage, titrable acidity was 1.30 *per cent*, which decreased to 1.00 *per cent* at 8 days of storage. .Observation during storage period revealed that reducing sugar was increases in T_5 with 1.67 *per cent* for the year 2016-17 and 1.57 *per cent* for the year 2017-18 with 2.0 *per cent* $CaCl_2$ spray after that it was decreased in T_1 1.51 *per cent* for control sample. Similar trend in reducing sugar after third day of storage was observed in all treatments. Lowest marginal decline of T_5 (1.24 *per cent*) from 1.62 *per cent* to 1.59 *per cent* treated with 2.0 *per cent* $CaCl_2$ spray, whereas highest reducing sugar was seen in T_1 (12.19 *per cent*) from 1.51 *per cent* to 1.37 *per cent* for control sample at the end of storage. These conclusions

are supported by a study of Lal *et al.* (2011) on custard apples, who found that the sugar content of the fruit gradually increased while the acidity gradually decreased. According to scientists, calcium chloride pre-harvest spray on 'Le Conte' pear fruits caused larger levels of reducing sugars to accumulate during storage than in Control. The breakdown of starch and sugar results in an increase in lowering sugar. However (Klimczac and Stropek 1988), who reported that strawberries grown at higher altitude had higher sugar content, comes in the support of the above finding. Observation during storage period revealed that total sugar was increased in T_5 with 2.63 *per cent* for the year 2016-17 and 2.73 *per cent* for the year 2017-18 with 2.0 *per cent* $CaCl_2$ spray after that it was decreased in T_3 (2.42 *per cent*) with 1.0 *per cent* $CaCl_2$ spray. Similar trend in total sugar after third day of storage was observed in all treatments. Highest in total sugar marginal decline was observed in T_3 (12.79 *per cent* from 2.42 to 2.11 *per cent*) with 1.0 *per cent* $CaCl_2$, whereas lowest decline in T_1 (1.09 *per cent* from 2.72 to 2.69 *per cent*) for control sample was seen at the end of storage. The increase in sugar content during the time of storage was due to break down of starch (Beaudry *et al*., 1989) into sugar (Crouch, 2003) and after that started to decrease. As the storage period progressed, microbial growth also increased in fruits and for the consumption of sugar content by microbes is the reason of decreasing sugar content. Storage-interval, on the other hand, implies a constant rise in total sugars from 0 to 8 days of storage (Haratian *et al.,* 2015). This progressive rise in the amount of total sugar may have been brought about by fruits becoming more dehydrated, which produced more concentrated juice. Both Badshah *et al.* (1994) and observed that the sugar content of apples and mangoes increased with storage, which lends validity to these findings. Observation during storage period revealed that the ascorbic acid content increases in T_3 with 1.0 *per cent* $CaCl_2$ spray with a pooled value 57.98 mg/100g after that it was decreased in T_1 for control sample with pooled value 57.20 mg/100g. After 3 day of storage highest ascorbic acid content in treatment T_3 with 2.0 *per cent* $CaCl_2$ spray with a pooled value 56.97 mg/100g, whereas lowest ascorbic acid content were recorded in T_4 with 1.0 *per cent* $CaCl_2$ spray with a pooled value of 57.04 mg/100g. At the end of storage maximum decline in T_3 (1.75 mg/100g from 57.98 mg/100g to 56.97 mg/100g) with 1.0 *per cent* $CaCl_2$ spray after 3 days of storage and minimum in T_5 (0.24 mg/100g from 57.47 mg/100g to 57.34 mg/100g) with 2.0 *per cent* $CaCl_2$ spray (Sadeghi *et al.,* 2015). A bioactive substance with antioxidant capabilities is ascorbic acid. Results, however, indicated that the highest ascorbic acid level (60.88 mg/100 g) was found in plants treated with 0.6% zinc sulphate (Le *et al.,* 2018) which was equivalent to 0.2% calcium chloride. Only 58.26 mg of ascorbic acid per 100 grammes was found in the control group. Different calcium, iron, and zinc concentrations were also accompanied by a rise in the ascorbic acid content. These findings support those of Kumar *et al.* (2010), who also noted an increase in ascorbic acid production with the administration of iron and zinc.

Table 1: Effect of pre-harvest sprays on weight (g), breadth(g), length(cm) and physiological loss in weight (%) of strawberry fruit cv. Camarosa.

Treatment	Length	Breadth	Fruit weight	Physiological loss in weight (%)
T-1	5.616	3.504	25.860	12.404
T-2	5.300	3.276	22.240	12.616
T-3	5.070	3.374	19.506	14.234
T-4	5.382	3.432	25.174	11.782
T-5	5.378	4.004	23.000	10.442
SE(m)±	0.101	0.289	0.892	0.942
C.D. at 5%	0.307	N/S	2.699	1.645

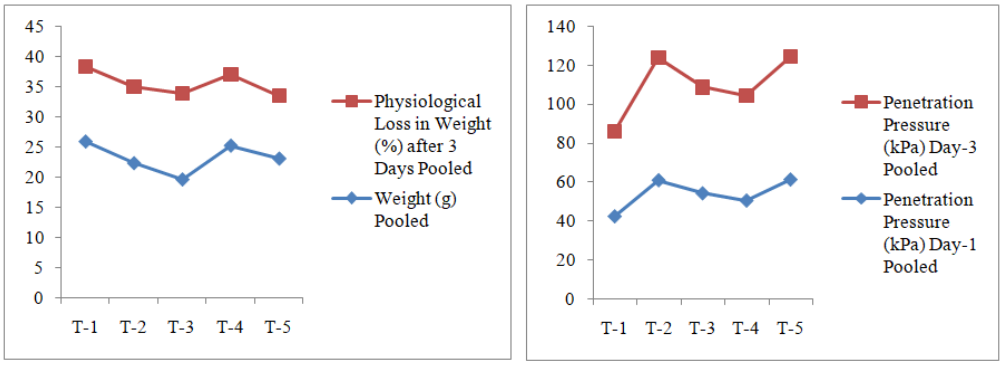

Fig. 1. Effect of pre-harvest sprays on weight (g) and physiological loss in weight (%) of strawberry fruit content and changes of penetration force cv. Camarosa.

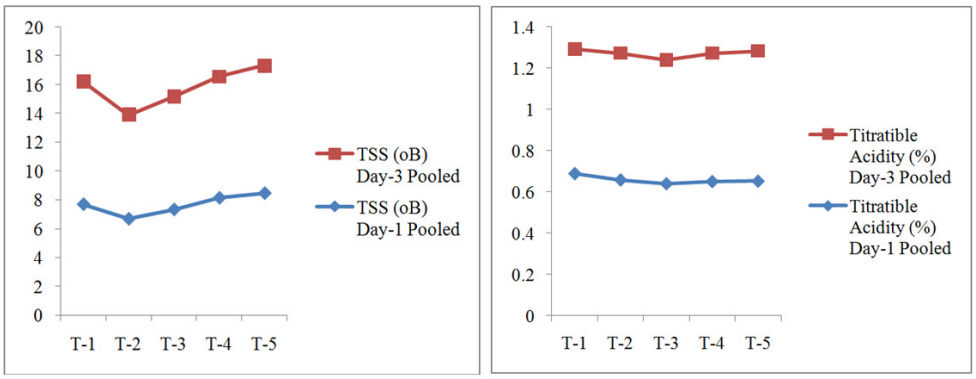

Fig. 2. Effect of pre-harvest sprays on TSS (ºB) and tritatable acidity of strawberry fruit content cv. Camarosa**.**

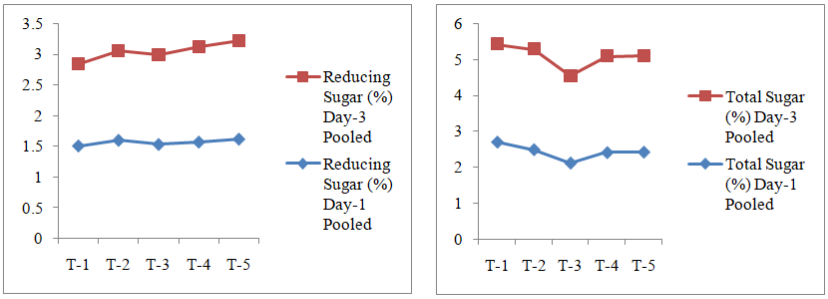

Fig. 3. Effect of pre-harvest sprays on reducing sugar (%) and total sugar (%) of strawberry fruit content cv. Camarosa.

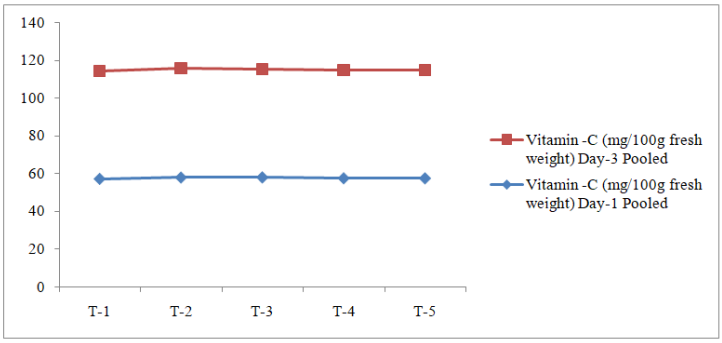

Fig. 4. Effect of pre-harvest sprays on ascorbic acid content (mg/100g of pulp) of strawberry fruit content cv. Camarosa.

CONCLUSIONS

From this experiment we can conclude that treatment T_5 $CaCl_2$ spray showed the best result with respect to minimum loss in physiological weight, maximum total soluble solid, reducing sugar and total sugar. Fruits from T_5 also found to retain its texture after 3 days of storage and the fruit were less acidity. Vit-C content in T_5 was marginally less than other $CaCl_2$ treated fruits. Considering all parameters under study it is further concluded that T_2 was second best treatment with respect to less physiological loss in weight, better texture analyzer (60.768 kPa), total sugar as well as highest Vit-C content (57.9864).

FUTURE SCOPE

The best result showed from this experiment it was found that pre-harvest calcium chloride spray at treatment T_5 2.0 percent for three time of spray were first spray after fruit set, second at 10 days after fruit set and third at 10 days after fruit set then harvested the fruit 20-25 days just after third spray where it produced fruit with better quality and shelf life. However, further experiment is needed to. Find any plant based chemicals as pre-harvest spray. To standardize frequency of pre-harvest calcium chloride spray and find out effect of calcium chloride on surface microbes.

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Conflict of Interest. None.

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