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Effect of Pre Harvest Spray of Different Forms of Calcium on Post-Harvest Quality of Guava cv. Allahabad Safeda

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An experiment entitled "Effect pre harvest spray of different forms of calcium ($CaCl_2$, $Ca(NO_3)_2$, $CaSO_4$ each at 1 and 2%) on post-harvest quality of guava cv. Allahabad Safeda was conducted under randomized block design during the period of July, 2018 to January, 2019 at Fruit research station, Sangareddy, SKLTSHU, Telangana. The different levels of calcium had significant influence on the quality parameters. Various physical parameters like fruit length(cm), fruit diameter (cm), fruit weight (g), fruit firmness (kg/cm^2), shelf life (days), PLW(%), spoilage(%) and bio-chemical parameters like TSS (°Brix), ascorbic acid (mg/100g), titrable acidity (%), total sugars (%), reducing sugars (%), non- reducing sugars (%) and Brix: Acid ratio were recorded. Among different forms of pre-harvest sprays of calcium, $Ca(NO_3)_2$ @ 2% has recorded significantly the highest total soluble solids (11.39 °B), ascorbic acid (159.49mg/100g), total sugars (9.00%), reducing sugars (5.23%), non-reducing sugars (3.78%), TSS: Acid ratio (31.08), fruit firmness (10.03kg/cm^2), shelf life (8.51days) when compared to control. The same treatment recorded minimum acidity (0.37%), PLW (11.63%) and spoilage percentage (62.86%). $Ca(NO_3)_2$@ 2% emerged as best treatment to improve the quality attributes of guava cv. Allahabad Safeda.

Introduction

Guava (*Psidium guajava* L.) the apple of the tropics, is one of the most popular fruits grown in tropical, sub-tropical and some parts of arid regions of India. The fruit belongs to the family Myrtaceae. Due to hardy nature of plant it can withstand adverse climatic conditions and grows under a wide range of soil types from sandy loam to clay loam (Dhaliwal and Singla 2002). Guava is a prolific bearer and highly remunerative even without much care. Therefore, it is an ideal fruit crop in terms of yield, nutritional security as well as in economic boost. In India, guava position in production is fifth after Banana, Mango, Citrus and Papaya (Anonymous, 2017-18). Winter guava is mostly preferred in India which gives flowering in June-July and comes to harvest during Nov - Dec.

Guava has gained the considerable prominence due to its excellent flavor, nutritive value and pectin content and used in processing industry for preparing many kinds of excellent products like jelly, jam, canned fruit products, fruit butter, toffee, and cheese and guava nectar. It is a rich and cheap source of vitamin C and pectin (Agnihotri *et al.*, 1962). It is also a good source of vitamin A, phosphorous, calcium and iron as well as thiamin and niacin. Further, guava fruit has effective antioxidant properties due to presence of vitamin C and phytonutrients such as carotenoids, isoflavonoids and polyphenols. In some countries, the leaves are used for dyeing and tanning. It has a great demand as table fruit, as raw material for the processing industries and also earns good foreign exchange (Purseglove, 1974).Leaves of guava also have some medicinal properties. The guava leaf juice provides relief from cold, cough, diarrhoea and the leaf extract is used for the treatment of epilepsy, cholera and besides its usage as dying and tanning in industries.

Pre-harvest calcium spray is one of the most important practices of new strategies applied in the integrated fruit production systems, improving fruit characteristics and minimizing fungicides sprays towards the end of the harvest period, since they improve fruit resistance to brown rot (Conway *et al.*, 1994). Calcium, as a constituent of the cell wall, plays an important role in forming cross-bridges, which influence cell wall strength and regarded as the last barrier before cell separation. It also protects membranes from disorganization and maintains protein synthesizing cells. Calcium compounds extend the shelf-life of several fruits by maintaining firmness minimizing the rate of respiration, protein breakdown and disease incidence (Conway and Sams, 1985).

Quality as well as storability of guava fruits depend much on pre-harvest treatments rather than post-harvest treatments because fruits are perishable and its post-harvest handling becomes difficult. Foliar application of nutrients has gained much importance than soil application which becomes unavailable due to complex reactions in soil and leaching losses. However, the experimental effect of calcium sprays was not studied systematically and research is meagre in guava.

Post-harvest losses are due to poor post-harvest management. Post-harvest dipping will not be feasible as post-harvest handling of guava becomes difficult. Many works have been carried out with different forms of calcium in guava but not been able to standardize the best form of calcium spray in guava. So the present investigation was formulated.

Materials and Methods

An experiment was carried out during July, 2018 to January, 2019 (Hasta bahar crop) at Fruit Research Station (FRS), Sangareddy, SKLTSHU, Telangana. This experiment was laid out in randomized block design with 3 replications and 7 treatments.

Experiment was conducted on the Effect of pre harvest spray of different forms of calcium on post-harvest quality of guava (*Psidium guajava* L.) cv. Allahabad Safeda. Allahabad safeda was chosen for calcium sprays as its shelf life is lesser than Lucknow-49. Four and half years old, well grown, uniform statured trees of guava cv. Allahabad Safeda were selected for experiment. The trees were spaced at 2.5m on either side.

Treatmental trees were selected by random numbers and the experiment was laid out in randomised block design with different treatments (Oliver, 1965).

To prepare 1% and 2% Calcium chloride, Calcium nitrate and Calcium sulphate solutions, 20 gm and 40 gm of each chemical was dissolved in 2 litres of water. Pre harvest sprays of different forms of calcium taken one and half month before harvesting (September) by using hand sprayer.

Random selection of trees per plots for recording the post-harvest quality characters like TSS (°Brix), ascorbic acid (mg/100g), titrable acidity (%), total sugars (%), reducing sugars (%), non- reducing sugars (%) and Brix: Acid ratio, fruit firmness (kg/cm^2), shelf life (days), PLW(%), spoilage(%) were recorded. Data recorded on growth, yield and quality parameter was subjected to analysis of variance (ANOVA, $p \leq 0.05$) and means comparisons were done at $P \leq 0.05$.

Results and Discussion

Total sugars

The per cent total sugars in fruit pulp of guava cv. Allahabad Safeda as influenced by different forms of calcium were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on per cent total sugars. The maximum total sugars (9.00) were noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% which was statistically on par with $Ca(NO_3)_2$ @ 1% (8.87), followed by $CaCl_2$@ 2% (8.25) which was statistically on par with $CaCl_2$@ 1% (8.01). However, the fruits harvested from plant sprayed with water (control) recorded the lowest per cent total sugars (7.16).

The present results were found similar with the findings of Alila and Achumi (2012), Kaul *et al.*, (2009) and Haq *et al.*, (2013) in litchi, Bhat *et al.*, (1997) in cherry. In guava, similar results were found by Singh and Chauhan (1982), Farag and Kassem (2000), Chandra (2004), Brahmachari *et al.*, (1997) and Jayachandran *et al.*, (2005).

In the present investigation, calcium treated fruits maintained significantly higher level of total sugars in guava fruits. The increase in total sugars during storage might be attributed to physiological loss in weight of fruits and partly to hydrolysis of cell wall polysaccharides (Hulme, 1970). The increased conversion of starch into sugars due to activation of hydrolytic enzymes by calcium could be responsible for increase in sugar content (Saha *et al.*, 1993). The application of different forms of calcium may have favorably influenced the metabolic activities possibly due to their increased endogenous level following external application. These may have enhanced the process of synthesis, translocation and accumulation of quality constituents like total soluble solids, sugars, TSS: acid ratio ascorbic acid following strong source sink relationship.

Reducing sugars

The per cent reducing sugars in fruit pulp of guava cv. Allahabad Safeda as influenced by different forms of calcium were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on per cent reducing sugars. The maximum reducing sugars (5.23) were noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% followed by $Ca(NO_3)_2$ @ 1% (5.19), $CaSO_4$@ 2% (4.85), $CaCl_2$@ 2% (4.77) respectively.

However, the fruits harvested from plant sprayed with water (control) recorded the lowest reducing sugars (4.25).

The present results were found similar with the findings of Alila and Achumi (2012), Kaul *et al.,* (2009) and Haq *et al.,* (2013) in litchi, Bhat *et al.,* (1997) in cherry. In guava, similar results were found by Singh and Chauhan (1982), Farag and Kassem (2000), Chandra (2004), Brahmachari *et al.,* (1997) and Jayachandran *et al.,* (2005).

In the present investigation, the increase in reducing sugars during storage might be attributed to physiological loss in weight of fruits and partly to hydrolysis of cell wall polysaccharides (Hulme, 1970). The increased conversion of starch into sugars due to activation of hydrolytic enzymes by calcium could be responsible for increase in sugar content (Saha *et al.,* 1993).

Non-reducing sugars

The per cent non-reducing sugars in fruit pulp of guava cv. Allahabad Safeda as influenced by different forms of calcium were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on per cent non-reducing sugars. The maximum non-reducing sugars (3.78) were noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% which was statistically on par with $Ca(NO_3)_2$ @ 1% (3.68) and also with $CaCl_2$@ 1% (3.54) followed by $CaCl_2$@ 2% (3.48). However, the fruits harvested from plants sprayed with water (control) recorded the lowest per cent non-reducing sugars (2.92). The present results were found similar with the findings of Alila and Achumi (2012), Kaul *et al.,* (2009) and Haq *et al.,* (2013) in litchi, Bhat *et al.,* (1997) in cherry. In guava, similar results were found by Singh and Chauhan (1982), Farag and Kassem (2000), Chandra (2004), Brahmachari *et al.,* (1997) and Jayachandran *et al.,* (2005).

In the present investigation, the increase in non-reducing sugars during storage might be attributed to physiological loss in weight of fruits and partly to hydrolysis of cell wall polysaccharides (Hulme, 1970). The increased conversion of starch into sugars due to activation of hydrolytic enzymes by calcium could be responsible for increase in sugar content (Saha *et al.,* 1993).

TSS (° Brix)

The data revealed that there was significant difference among different forms of calcium with respect to TSS, were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on TSS. The maximum TSS (11.39) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% followed by $Ca(NO_3)_2$ @ 1% (11.23), $CaCl_2$@ 2% (10.55), $CaCl_2$@ 1% (10.14) respectively. However, the fruits harvested from plant sprayed with water (control) recorded the lowest TSS (8.09).

The present results were found similar with the findings of Alila and Achumi (2012), Kaul *et al.,* (2009) and Haq *et al.,* (2013) in litchi, Bhat *et al.,* (1997) in cherry. In guava, similar results were found by Chandra *et al.,* (1994), Singh and Chauhan (1982), Farag and Kassem (2000), Chandra (2004), Brahmachari *et al.,* (1997) and Jayachandran *et al.,* (2005).

In the present investigation, the increase of TSS during storage might be due to the breakdown of complex polymer into simple substances by hydrolytic enzymes and also due to rapid mobilization of sugars and other soluble solids to developing fruits. Higher T.S.S. induced by calcium treatments may be due to lesser utilization of sugars in metabolic processes as a result of reduced respiration (Gupta *et al.,* 1980).

Titrable acidity (%)

The data revealed that there was significant difference among different forms of calcium with respect to acidity, were calculated and the data are presented in Table-1.

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on acidity.

The minimum acidity (0.37) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (0.43), $CaCl_2$@ 2% (0.44), $CaCl_2$@ 1% (0.54). However, the fruits harvested from plant sprayed with water (control) recorded the maximum acidity (0.63).

The present results obtained in the present study are in conformity with those reported earlier by Haq *et al.*, (2013) in litchi, Bhat *et al.*, (1997) in cherry, Singh and Chauhan (1982) and Farag and Kassem (2000) in guava.

In the present investigation, the decrease in acidity could be explained on the grounds that organic acids might be utilized rapidly in respiration from pre-climacteric to post-climacteric stage. It may be also due to marked increase in malic enzyme and pyruvate decarboxylation reaction during the climacteric period commensurate with an increase in the rate of respiration and other biodegradable metabolic reactions (Kliewer, 1971). Neutralization of organic acids in fruit tissues could also resulted in a reduction of titrable acidity.

Brix acid ratio

The data revealed that there was significant difference among different forms of calcium with respect to brix acid ratio, were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on Brix acid ratio. The maximum Brix acid ratio (31.08) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% followed by $Ca(NO_3)_2$ @ 1% (25.91), $CaCl_2$@ 2% (23.81) respectively. However, the fruits harvested from plant sprayed with water (control) recorded the lowest Brix acid ratio (12.86).

The present results obtained in the present study are in conformity with those reported earlier by Haq *et al.*, (2013) in litchi, Bhat *et al.*, (1997) in cherry, Agrawal (2012), Kaul *et al.*, (2009) and Aly and Ismail (2000) in guava.

In the present investigation, increase in Brix acid ratio might be due to increase in total soluble content of fruits with decreased acidity ultimately by pre harvest spray of calcium compounds leads to higher ratio of brix : acid.

Ascorbic acid (mg/ 100g)

The data revealed that there was significant difference among different forms of calcium with respect to ascorbic acid, were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on ascorbic acid. The maximum ascorbic acid (159.49) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (157.39) which was statistically on par with $CaCl_2$@ 2% (154.73). However, the fruits harvested from plant sprayed with water (control) recorded the lowest ascorbic acid (135.38).

Results obtained regarding ascorbic acid content are in conformity with Aly and Ismail (2000) in guava, Bisen *et al.,* (2011) and Kumar *et al.,* (2005) in mango, Ali *et al.,* (2014) in guava, Asghar *et al.,* (2009) in pomegranate.

In the present investigation, increase in ascorbic acid was observed by pre- and post-harvest application of calcium. The application of different forms of calcium may have favorably influenced the metabolic activities possibly due to their increased endogenous level following external application. These may have enhanced the process of synthesis, translocation and accumulation of quality constituents like total soluble solids, sugars, TSS: acid ratio ascorbic acid following strong source sink relationship. This higher retention of Vitamin C during storage by application of calcium might be due to continued synthesis of its precursor like Glucose-6-phosphate during conversion as starch into various sugars and slow rate of oxidation as has been reported in guava (Singh *et al.,* 1981; Soppin *et al.,* 1997) and in peach (Gupta *et al.,* 1984).

Fruit firmness (kg/cm^2)

The data revealed that there was significant difference among different forms of calcium with respect to fruit firmness, were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on fruit firmness. The maximum fruit firmness (10.03) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% followed by $Ca(NO_3)_2$ @ 1% (9.83) which was statistically on par with $CaCl_2$@ 2% (9.75). However, the fruits harvested from plant sprayed with water (control) recorded the lowest fruit firmness (7.19).

Martinsson *et al.,* (2006) also observed that application of calcium nitrate in Elsanta Strawberry contributed to more firmness of the fruits. These findings are in line with those reported by Gupta *et al.,* 1980 in grapes, Sudha *et al.,* 2006 in sapota fruit, Goutam *et al.,* (2010) in guava, Barwal *et al.,* (2015) in apple, Raja *et al.,* (2015) in peach, Mahajan and Sharma (2000) in pear, Gamal (2012) in apricot, Saran *et al.,* (2004) in ber

In the present investigation, Calcium is essential for the firmness of cell membrane systems on which the fundamental integrity of the cell metabolism is dependent. The fruit firmness has direct relationship with pectin content which was primarily due to higher calcium content of fruits. Calcium having profound effect on the cell wall (Goutam *et al.,* 2010) reported that calcium compounds significantly thickened the middle lamella of fruit cells owing to increased deposition of calcium pectate and thereby maintained the cell wall. According to Faust and Shear (1972), calcium was effective in increasing the firmness of fruits by delaying senescence, preserving cellular organization and retarding respiration rate. Thus, calcium treated fruits recorded significantly higher firmness.

Shelf life (days)

The data revealed that there was significant difference among different forms of calcium with respect to shelf life, were calculated and the data are presented in Table-1

Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on shelf life.

The maximum shelf life (8.51) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (8.08) which was statistically on par with $CaCl_2$@ 2% (7.84). However, the fruits harvested from plant sprayed with water (control) recorded the lowest shelf life (7.19).

Calcium nitrate at 2 % has significantly influenced shelf life of guava cv. Allahabad Safeda. Similar results obtained by Goutam *et al.,* (2010), Singh *et al.,* (1981), Jayachandran *et al.,* (2005) in guava, Bharathi and Srihari (2004) in sapota and Mahajan *et al.*, (2008) in plum. Singh *et al.,* (2007) reported that spray of calcium nitrate at lower concentration i.e., 1.0% also showed beneficial effects in prolonging the storage life of guava fruits upto 10 days in cv. Allahabad Safeda. More shelf life about 10days was observed when guava fruits are sprayed with calcium nitrate at 1% (Ali *et al.*, 2014). Calcium proved beneficial in delaying the ripening related changes in guava fruits (Deepthi *et al.*, 2016). The present results are similar with the findings of Bhusan and Panda (2015) in Amrapali and Singh *et al.,* (2012) in Dashehari mango.

In the present investigation, shelf life increased with calcium sprays might be due to the fact that calcium, as a constituent of the cell wall, plays a important role in forming cross- bridges, which influence cell wall strength and regarded as the last barrier before cell separation. Calcium spray during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits. Calcium having profound effect on the cell wall (Goutam *et al.,* 2010) reported that calcium compounds significantly thickened the middle lamella of fruit cells owing to increased deposition of calcium pectate and thereby maintained the cell wall. Thus, calcium decreased the spoiling of fruit by reduction in process of respiration and increased the fruit firmness which lead to benefits like slower ripening and increased the shelf life (Karemera and Habimana, 2014).

Physiological loss in weight (%)

The data revealed that there was significant difference among different forms of calcium with respect to PLW, were calculated and the data are presented in Table-2. Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on PLW.

The lowest PLW @ 3days (3.87) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (4.06), $CaCl_2$@ 2% (4.30), $CaCl_2$@ 1% (4.77) respectively. However, the fruits harvested from plant sprayed with water (control) recorded the maximum PLW @ 3days (7.08).

The lowest PLW @ 6 days (7.36) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (7.48), $CaCl_2$@ 2% (7.72) respectively, and statistically on par with $CaCl_2$@ 1% (7.75). However, the fruits harvested from plant sprayed with water (control) recorded the maximum PLW @ 6days (11.11).

The lowest PLW @ 9days (11.63) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (11.94), $CaCl_2$@ 1% (12.83), $CaCl_2$@ 2% (13.26) respectively. However, the fruits harvested from plant sprayed with water (control) recorded the maximum PLW @ 9days (20.68). The role of calcium chloride in reducing physiological loss in weight has been reported by Singh and Chauhan (1982), Mishra *et al.,* (2003) and Jaychandran *et al.,* (2005) in guava are in conformity with the present results. Kirmani *et al.,* (2013) also reported the $CaCl_2$ is the most effective in 15 days storage of plum for minimizing physiological loss in weight. Similar results on reductions in weight loss by calcium treatment were also reported by Gupta *et al.,* (1987) and Saran *et al.,* (2004) in ber, Ghosh *et al.,* (2003) in litchi, Ramkrishna *et al.,* (2001) in papaya.

In the present investigation, the decrease in weight loss by application of calcium might be due to its role in the maintenance of the fruits firmness (Mika, 1983), retardation of respiratory rate (Jones *et al.,* 1967) and delayed senescence (Bangerth *et al.,* 1972).

The possible reason for reduced weight loss by chemicals may be due to some chemical changes within the fruits, resulting in retention of more water against the rate of evaporation. This may be due to the role of calcium on limiting respiration which was attributed to altered membrane permeability (Conway and sams, 1985).

Spoilage (%)

The data revealed that there was significant difference among different forms of calcium with respect to spoilage percentage, were calculated and the data are presented in Table-2. Irrespective of treatments, all the forms of calcium sprayed at various concentrations exerted a significant influence on spoilage percentage.

The lowest spoilage percentage @ 6 days (22.53) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2% which was on par with $Ca(NO_3)_2$ @ 1% (25.06), followed by $CaCl_2$@ 1% (30.43) which was on par with $CaCl_2$@ 2% (32.80). However, the fruits harvested from plant sprayed with water (control) recorded the maximum spoilage percentage @ 6days (44.73). The lowest spoilage percentage @ 9days (62.86) was noticed in fruits obtained from the plants sprayed with $Ca(NO_3)_2$ @ 2%, followed by $Ca(NO_3)_2$ @ 1% (67.49) which was on par with $CaCl_2$@ 2% (68.44), followed by $CaCl_2$@ 1% (71.44) respectively. However, the fruits harvested from plant sprayed with water (control) recorded the maximum spoilage percentage @ 9days (87.62).

Gupta *et al.,* (1984) reported that calcium compounds significantly thickened the middle lamella of fruit cells owing to increased deposition of calcium pectate and thereby maintained the cell wall, which inhibits the penetration and spread of pathogens in fruits ultimately reducing the spoilage percentage in peach fruits. Our results are in concordance with the findings of Hiwale and Singh (2003), Selvan and Bal (2005) and Goutam *et al.,* (2010) in guava fruits, Conway *et al.,* (1994), Mahajan and Sharma (2000) in pear, Mir *et al.,* (1996) in apple, Saran *et al.,* (2004) in ber.

In the present investigation, improved resistance to spoilage in calcium-treated fruit was associated with preservation of cell wall and middle lamella structure. This might be due to higher firmness of fruit which inhibits the penetration and spread of pathogens in fruits (Gupta *et al.,* 1987). Calcium maintains the structural rigidity of cell wall and thereby reduces the penetration of Rhizopus rot/soft rot causing organisms like fungi and bacteria, which transform parenchymatous tissue to watery mass. Calcium also imparts resistance against certain pathogenic invasion (Bangreth *et al.,* 1972) and has been associated with decreased incidences of physiological disorders, improved storage life and reduced severity of bacterial and fungal decay (Conway and Sams, 1985). The higher spoilage in untreated fruits was the result of lesser tissue strength and cellular disorganization of the cell organelle.

Table.1 Effect of pre harvest spray of different forms of calcium on total sugars, reducing and non-reducing sugars, TSS, acidity and Brix Acid ratio, ascorbic acid , fruit firmness and shelf life of guava cv. Allahabad Safeda

TREATMENTS	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	TSS (°Brix)	Titrable acidity (%)	Brix acid ratio	Ascorbic acid (mg/ 100g)	Fruit firmness (kg/cm^2)	Shelf life (days)
T_1 - $CaCl_2$ @1%	8.01^b	4.47^b	3.54^c	10.14^d	0.54^d	18.67^d	147.69^b	9.19^c	7.52^c
T_2 - $CaCl_2$ @ 2%	8.25^b	4.77^d	3.48^b	10.55^e	0.44^c	23.81^e	154.73^c	9.75^d	7.84^d
T_3 - $Ca(NO_3)_2$ @1%	8.87^c	5.19^f	3.68^c	11.23^f	0.43^b	25.91^f	157.39^c	9.83^d	8.08^d
T_4 - $Ca(NO_3)_2$ @2%	9.00^c	5.23^g	3.78^c	11.39^g	0.37^a	31.08^g	159.49^d	10.03^e	8.51^e
T_5 - $CaSO_4$ @1 %	7.85^a	4.74^c	3.11^a	9.95^c	0.55^e	17.99^c	141.86^b	8.43^b	6.54^a
T_6 - $CaSO_4$ @2 %	7.90^b	4.85^e	3.05^a	9.74^b	0.58^f	16.80^b	139.12^b	8.40^b	6.65^b
T_7 - Control	7.16^a	4.25^a	2.92^a	8.09^a	0.63^g	12.86^a	135.38^a	7.19^a	6.32^a
S.E m ±	0.22	0.006	0.09	0.07	0.002	0.098	1.14	0.04	0.09
CD (P= 0.05)	0.69	0.019	0.28	0.02	0.006	0.306	3.55	0.13	0.28

Table.2 Effect of pre harvest spray of different forms of calcium on Physiological loss in weight (%) Spoilage percentage (%) of guava cv. Allahabad Safeda

TREATMENTS	Physiological loss in weight (%)				Spoilage percentage (%)			
	0 days	3 days	6 days	9 days	0 days	3 days	6 days	9 days
T_1 - $CaCl_2$ @1%	0	4.77^d	7.72^c	12.83^c	0	0	30.43^b	71.44^c
T_2 - $CaCl_2$ @ 2%	0	4.30^c	7.75^c	13.26^d	0	0	32.80^b	68.44^b
T_3 - $Ca(NO_3)_2$ @1%	0	4.06^b	7.48^b	11.94^b	0	0	25.06^a	67.49^b
T_4 - $Ca(NO_3)_2$ @2%	0	3.87^a	7.36^a	11.63^a	0	0	22.53^a	62.86^a
T_5 - $CaSO_4$ @1 %	0	5.11^f	8.47^d	14.49^f	0	0	33.78^c	80.68^e
T_6 - $CaSO_4$ @2 %	0	4.86^e	9.18^e	13.44^e	0	0	41.11^d	73.49^d
T_7 - Control	0	7.08^g	11.11^f	20.68^g	0	0	44.73^e	87.62^f
S.E m ±	0	0.016	0.02	0.05	0	0	1.01	0.46
CD (P= 0.05)	0	0.051	0.06	0.15	0	0	3.14	1.43

Among different forms of pre-harvest sprays of calcium, $Ca(NO_3)_2$@ 2% has recorded significantly maximum total soluble solids, ascorbic acid total sugars, reducing sugars, non-reducing sugars, TSS: Acid ratio, fruit firmness, shelf life when compared to control. Same treatment recorded minimum acidity (%), PLW and spoilage percentage. From the results obtained in the present investigation, it can be concluded that $Ca(NO_3)_2$@ 2% emerged as best treatment to improve the quality attributes of guava cv. Allahabad Safeda.

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