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POST-HARVEST TREATMENT FOR IMPROVEMENT OF SHELF LIFE IN GUAVA (*PISIDIUM GUAJAVA* L.) CULTIVAR 'ALLAHABAD SAFEDA' UNDER COLD STORAGE CONDITIONS

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Abstract

Fruits are particularly exposed to the risk of spoilage due to high moisture content and in order to increase the shelf life and retain the nutritional characteristics, it is important to curtail the loss of moisture and reduce the rate of respiration in the fruits. Chemically treated guava fruits stored under stored under cold conditions at (8-10 ^{0}C) temperature. $CaNO_3$ (2%) was effective to maintain, maximum firmness and ascorbic acid. Minimum decay was noted in Salicylic acid (200 ppm) treated fruits under cold storage conditions. In cold storage conditions, $CaNO_3$ (2%) showed minimum physiological loss in weight (1.74/ 1.08) during (2017-18) and (1.76/1.05) in year (2018-19). Quality parameter was also affected by the treatment and storage conditions. Naphthalene acetic acid (200ppm) was desirable to maintain higher total soluble solids and total sugars. Minimum acidity was noted in Naphthalene acetic acid (100ppm) in both the year. There was non-significant effect noted in cold stored fruits for fruit size (length and breadth).

Key words : Calcium nitrate, post harvest management, perishable.

Introduction

The fourth most important fruit crop of India is guava (*Psidium guajava* L.) which belongs to family Myrtaceae. Post-harvest handling of guava is more important because of climacteric nature of the fruit and shorter shelf life. High respiration rate results in high spoilage during storage. Due to improper post-harvest handling of guava crop, fruits lose their quality, appearance and market value. Post-harvest treatments have potential to preserve the quality during storage of guava fruits. The main purpose of chemical treatment is to decrease the losses of fruit quality and extension of the shelf life. Different methods are preferred to extend shelf life and biochemical properties of guava fruits. "Low temperature storage is a tried and tested method to extend the shelf life" (Reyes and Paull, 1995). Cold storage combined with chemical treatment can further enhance the storage time and retention of nutritional characteristics of the fruits. Many chemicals along with fungicides can delay ripening, senescence and extend the storage life of fruits. Ethylene scavengers are commonly used to regulate the ethylene under the threshold level. Other than chemicals, plant growth regulators are also effective to extend the post-harvest life of guava. "Calcium is thought to be the most important mineral element in determining fruit quality" (Conway *et al.,* 2002). Salicylic acid is responsible for various metabolic and physiological activities of the plants which affect growth and development of plant. Salicylic acid is widely used as pre-harvest or post-harvest application. Post-harvest application of salicylic acid affects physicochemical properties of fruits and vegetable (Supapvanich and Promyou, 2013).

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Materials and Methods

Studies were carried out in Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara during the year 2017-18 and 2018-19. Medium sized guava fruits at mature green stage were harvested during 3rd week of December from guava orchard of Punjab Agriculture University and collected

in plastic crates. After cleaning and sorting, pre cooling treatment was given to harvested fruits before application of chemical treatments. The fruits were exposed to dip treatment with calcium chloride, calcium nitrate, salicylic acid, naphthalene acetic acid for 3 minutes. This experiment was arranged as completely randomized design with 3 replications per treatment. Treated fruits were packed in CFB (corrugated fibre box) and kept under cold storage conditions (8-10^{0}C, 90-95 % RH) for recording of physico-chemical parameters. Observations were recorded at 7th, 14th and 21st days interval after storage. There were nine treatments *viz.,* T_1 (Calcium Chloride 1%), T_2 (Calcium Chloride 2%), T_3 (Calcium nitrate 1%), T_4 (Calcium nitrate 2%), T_5 (Naphthalene acetic acid 100ppm), T_6 (Naphthalene acetic acid 200ppm), T_7 (Salicylic acid 100ppm), T_8 (Salicylic acid 200ppm) and T_9 (Control). PLW was recorded from initial and final fruit weight. Fruit weight was recorded using electronic weighing balance. Fruit firmness was noted with the help of Penetrometer. Total soluble solids, acidity and ascorbic acid content were estimated as per A.O.A.C. (1990). Total and reducing sugars were estimated by the Lane and Eynon method, as explained by Ranganna (1986).

Results and Discussion

Loss of weight increased with progress of storage period (Table 1). During 2017-18 minimum physiological loss of weight (1.08%) was recorded in Calcium Nitrate (2%) treated fruits followed by (1.31%) Calcium Nitrate (1%) treatment. During 2nd year 2018-19, the minimum physiological loss of weight (1.05%) was observed in the Calcium Nitrate (2%). Highest physiological loss of weight was showed by control (5.53%). Because of low temperature ripening process was slow down. Calcium salts interfere with ethylene biosynthesis pathway and delay ripening and senescence (Kumar *et al.*, 2012). Pear fruits variety Nijisseiki treated with calcium nitrate (2%) results lower physiological loss of weight (Kaur *et. al.*, 2017). Same results were found with calcium nitrate in mango by Periyathambi *et al.,* (2013).

Fruit breadth and fruit breadth (Table 2a and table 2b, respectively) displayed non-significant results between treatment and storage interval in guava during (2017-18) and (2018-19) year. The use of chemicals did not affect the size of fruits significantly as reported by Kumar *et al.,* (2014). Reduction of fruit size, length and diameter may be due to the moisture loss of fruit (Singh *et.al.* 2017).

Guava fruit firmness reduced as the storage period progressed (Table 3). During 2017-18, Calcium Nitrate (2%) treated fruits showed mean firmness value of 16.43 kg/cm^2. This treatment was followed by Calcium Nitrate (1%) recording a mean fruit firmness of 16.20 kg/cm^2. Due to higher loss of firmness lowest mean (14.44 kg/cm^2) was found in control. During year 2018-19 also, firmness showed declining trend in all the treatments.

Table 1: Effect of post-harvest treatments on physiological loss in weight (%) of guava cv. Allahabad Safeda during cold storage conditions.

Physiological loss in weight (%)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	0.64	1.34	2.18	1.39	0.60	1.35	2.15	1.37	1.38
T_2	Calcium chloride (2%)	0.56	1.32	2.13	1.34	0.52	1.30	2.11	1.31	1.33
T_3	Calcium nitrate (1%)	0.44	1.18	2.30	1.31	0.40	1.09	2.35	1.28	1.30
T_4	Calcium nitrate (2%)	0.32	1.04	1.89	1.08	0.31	0.99	1.85	1.05	1.07
T_5	Naphthalene acetic acid (100 ppm)	0.69	1.47	2.35	1.50	0.60	1.48	2.30	1.46	1.48
T_6	Naphthalene acetic acid (200 ppm)	0.54	1.30	2.52	1.45	0.54	1.29	2.49	1.44	1.45
T_7	Salicylic acid (100 ppm)	0.62	1.40	2.28	1.43	0.62	1.40	2.22	1.41	1.42
T_8	Salicylic acid (200 ppm)	0.46	1.41	2.43	1.43	0.48	1.06	2.65	1.40	1.42
T_9	Control	2.11	4.56	11.62	6.10	2.06	4.43	10.11	5.53	5.82
Mean		0.71	1.67	3.30	1.89	0.68	1.60	3.14	1.81	1.85
		0 day = 0				0 day = 0				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.071		Treatment (t)		0.119		

Table 2(a): Effect of post-harvest treatments on fruit breadth (cm) of guava cv. Allahabad Safeda during cold storage conditions.

Fruit breadth (cm)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	6.40	6.40	6.38	6.39	6.35	6.34	6.32	6.34	6.37
T_2	Calcium chloride (2%)	6.42	6.40	6.39	6.40	6.37	6.35	6.33	6.35	6.38
T_3	Calcium nitrate (1%)	6.39	6.37	6.36	6.37	6.42	6.41	6.36	6.40	6.39
T_4	Calcium nitrate (2%)	6.40	6.39	6.38	6.39	6.44	6.42	6.41	6.42	6.41
T_5	Naphthalene acetic acid (100 ppm)	6.39	6.38	6.37	6.38	6.35	6.34	6.32	6.34	6.36
T_6	Naphthalene acetic acid (200 ppm)	6.46	6.45	6.44	6.45	6.39	6.37	6.36	6.37	6.41
T_7	Salicylic acid (100 ppm)	6.41	6.41	6.40	6.41	6.40	6.39	6.37	6.39	6.40
T_8	Salicylic acid (200 ppm)	6.36	6.35	6.33	6.35	6.34	6.33	6.30	6.32	6.34
T_9	Control	6.38	6.36	6.34	6.36	6.22	6.19	6.16	6.19	6.28
Mean		6.40	6.39	6.38	6.39	6.36	6.35	6.33	6.35	6.37
		0 day = 6.49				0 day = 6.46				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		N/A		Treatment (t)		N/A		

Table 2(b): Effect of post-harvest treatments on fruit length (cm) of guava cv. Allahabad Safeda during cold storage conditions.

Fruit length (cm)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	6.12	6.12	6.11	6.12	6.09	6.08	6.07	6.08	6.10
T_2	Calcium chloride (2%)	6.10	6.09	6.08	6.09	6.12	6.11	6.09	6.11	6.10
T_3	Calcium nitrate (1%)	6.12	6.11	6.10	6.11	6.14	6.12	6.11	6.12	6.12
T_4	Calcium nitrate (2%)	6.17	6.16	6.15	6.16	6.12	6.12	6.11	6.12	6.14
T_5	Naphthalene acetic acid (100 ppm)	6.14	6.14	6.13	6.14	6.14	6.13	6.11	6.13	6.14
T_6	Naphthalene acetic acid (200 ppm)	6.09	6.08	6.07	6.08	6.11	6.09	6.08	6.09	6.09
T_7	Salicylic acid (100 ppm)	6.15	6.14	6.14	6.14	6.10	6.08	6.07	6.08	6.11
T_8	Salicylic acid (200 ppm)	6.07	6.06	6.06	6.06	6.14	6.13	6.12	6.13	6.10
T_9	Control	6.06	6.04	6.02	6.04	6.13	6.01	5.98	6.04	6.04
Mean		6.11	6.10	6.10	6.10	6.12	6.10	6.08	6.10	6.10
		0 day = 6.15				0 day = 6.17				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		N/A		Treatment (t)		N/A		

Highest firmness (16.46 kg/cm^2) was maintained by Calcium Nitrate (2%) followed by 16.24 kg/cm^2 obtained under Calcium Nitrate (1%) treated fruits. Minimum mean value of firmness was reported in control (14.46 kg/cm^2. Fruit firmness is related to the pectin content and during storage; there is a gradual breakdown of pectin content by some enzymes. Calcium salts are useful to maintain firmness by slowing down the breakdown process of pectin in guava fruits (Kumar *et al.,* 2012).

Spoilage increased with advancement of the storage period (Table 4). During 2017-18, minimum spoilage (6.68%) was observed in salicylic (200ppm) treated fruits followed by calcium nitrate (2%) with an average spoilage value of 8.07%. Maximum spoilage mean was observed

Table 3: Effect of post-harvest treatments on firmness (kg/cm^2) of guava cv. Allahabad Safeda during cold storage conditions.

Firmness (kg/cm^2)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	17.39	16.18	13.54	15.70	17.42	16.2	13.56	15.73	15.72
T_2	Calcium chloride (2%)	17.52	16.48	13.92	15.97	17.5	16.45	13.99	15.98	15.98
T_3	Calcium nitrate (1%)	17.70	16.82	14.09	16.2	17.78	16.84	14.1	16.24	16.22
T_4	Calcium nitrate (2%)	17.28	16.49	15.52	16.43	17.3	16.52	15.55	16.46	16.45
T_5	Naphthalene acetic acid (100 ppm)	16.4	15.17	13.92	15.16	16.42	15.25	13.94	15.20	15.18
T_6	Naphthalene acetic acid (200 ppm)	16.41	15.24	13.98	15.21	16.48	15.28	13.99	15.25	15.23
T_7	Salicylic acid (100 ppm)	16.53	15.43	14.14	15.37	16.5	15.5	14.22	15.41	15.39
T_8	Salicylic acid (200 ppm)	17.00	16.12	13.15	15.42	17.10	16.15	13.2	15.48	15.45
T_9	Control	16.00	14.65	12.66	14.44	15.94	14.56	12.87	14.46	14.45
Mean		16.91	15.84	13.88	15.55	16.94	15.86	13.94	15.58	15.52
		0 day = 17.97				0 day = 17.85				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.126		Treatment (t)		0.447		

Table 4: Effect of post-harvest treatments on spoilage (%) of guava cv. Allahabad Safeda during cold storage conditions.

Spoilage (%)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	0.00	9.42	19.82	9.75	0.00	10.44	21.18	10.54	10.15
T_2	Calcium chloride (2%)	0.00	6.58	22.00	9.53	0.00	15.68	29.66	15.11	12.32
T_3	Calcium nitrate (1%)	0.00	7.83	18.00	8.61	0.00	8.28	20.11	9.46	9.04
T_4	Calcium nitrate (2%)	0.00	6.34	17.86	8.07	0.00	7.44	18.80	8.75	8.41
T_5	Naphthalene acetic acid (100 ppm)	0.00	14.00	28.21	14.07	0.00	7.50	23.17	10.22	12.15
T_6	Naphthalene acetic acid (200 ppm)	0.00	10.00	20.01	10.00	0.00	18.00	22.22	13.41	11.71
T_7	Salicylic acid (100 ppm)	0.00	14.01	25.99	13.33	0.00	15.87	27.00	14.29	13.81
T_8	Salicylic acid (200 ppm)	0.00	5.98	14.06	6.68	0.00	6.18	15.42	7.20	6.94
T_9	Control	0.00	18.64	24.31	14.32	0.00	22.11	31.26	17.79	16.06
Mean		0.00	10.31	21.14	10.48	0.00	12.39	23.20	11.86	11.17
		0 day = 0				0 day = 0				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.599		Treatment (t)		0.537		

in control (14.32%). During 2018-19, minimum spoilage (7.20%) was observed in salicylic (200ppm). Highest mean spoilage was showed in control (17.79%). Salicylic acid affects the post-harvest disease resistance, decay, oxidative stress, ethylene biosynthesis and action, fruit ripening, respiration and also discussed about their nutritional quality (Asghari and Aghdam, 2010). Salicylic acid was found effective against spoilage (Kaur, 2016).

Table 5 represent the data of total soluble solids of treated guava fruits with different chemicals at different storage intervals. During both the years of study, Naphthalene Acetic Acid 200ppm was responsible for highest mean total soluble solids value of 11.19^{0}brix and 11.26^{0}brix, respectively. Minimum total soluble solids mean (9.98^{0}brix) and (9.94^{0}brix) was noted in control during (2017-18) and (2018-19). Effect of Naphthalene acetic

Table 5: Effect of post-harvest treatments on total soluble solids (^{0}Brix) of guava cv. Allahabad Safeda during cold storage conditions.

Total soluble solids (^{0}Brix)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	9.24	10.78	10.58	10.20	9.66	10.84	10.26	10.25	10.23
T_2	Calcium chloride (2%)	9.34	11.00	10.73	10.36	9.79	11.04	10.53	10.45	10.41
T_3	Calcium nitrate (1%)	9.12	10.62	10.41	10.05	9.02	10.58	10.50	10.03	10.04
T_4	Calcium nitrate (2%)	9.20	10.79	10.52	10.17	9.09	10.81	10.70	10.20	10.19
T_5	Naphthalene acetic acid (100 ppm)	11.22	12.04	9.86	11.04	11.28	12.09	9.83	11.07	11.06
T_6	Naphthalene acetic acid (200 ppm)	11.51	12.12	9.95	11.19	11.68	12.10	10.00	11.26	11.23
T_7	Salicylic acid (100 ppm)	10.76	11.18	9.98	10.64	10.75	11.11	10.00	10.62	10.63
T_8	Salicylic acid (200 ppm)	10.92	11.30	10.12	10.78	10.90	11.23	10.16	10.76	10.77
T_9	Control	10.34	11.18	8.42	9.98	10.28	11.13	8.42	9.94	9.96
Mean		10.18	11.22	10.06	10.49	10.27	11.21	10.04	10.51	10.50
		0 day= 9.01				0 day= 8.94				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.152		Treatment (t)		0.112		

Table 6: Effect of post-harvest treatments on acidity (%)of guava cv. Allahabad Safeda during cold storage conditions.

Acidity (%)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	0.63	0.61	0.54	0.59	0.66	0.62	0.55	0.61	0.60
T_2	Calcium chloride (2%)	0.63	0.62	0.56	0.60	0.65	0.61	0.59	0.62	0.61
T_3	Calcium nitrate (1%)	0.65	0.61	0.56	0.61	0.70	0.62	0.59	0.64	0.63
T_4	Calcium nitrate (2%)	0.66	0.64	0.56	0.62	0.72	0.64	0.60	0.65	0.64
T_5	Naphthalene acetic acid (100 ppm)	0.60	0.52	0.50	0.54	0.61	0.58	0.45	0.55	0.55
T_6	Naphthalene acetic acid (200 ppm)	0.62	0.55	0.52	0.56	0.61	0.59	0.47	0.56	0.56
T_7	Salicylic acid (100 ppm)	0.61	0.59	0.52	0.57	0.62	0.61	0.49	0.57	0.57
T_8	Salicylic acid (200 ppm)	0.61	0.59	0.54	0.58	0.62	0.57	0.54	0.58	0.58
T_9	Control	0.59	0.52	0.41	0.51	0.57	0.52	0.40	0.50	0.51
Mean		0.62	0.58	0.52	0.58	0.64	0.60	0.52	0.59	0.59
		0 day= 0.77				0 day= 0.71				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.065		Treatment (t)		0.043		

acid treatment in increasing the TSS in fruits has been demonstrated by Selvan and Bal (2005) and Singh *et al.,* (2017). Acidity was decreased as the storage period progressed (Table 6). Lowest acidity (average) was found in control (0.51%) whereas maximum acidity (average) of 0.62% and 0.65% was recorded under fruits treated with calcium nitrate (2%) during (2017-18) and (2018-19). Ascorbic acid depicted reducing trend with the progress of storage period (Table 7). Calcium Nitrate (2%) treated fruits had highest mean ascorbic acid content of 217.38 mg/100ml and 217.52mg/100ml respectively during both the years of study. Minimum ascorbic content mean (140.04mg/100ml and 135.53mg/100ml) was recorded in control. During the storage calcium application

Table 7: Effect of post-harvest treatments on Ascorbic acid (mg/100ml) of guava cv. Allahabad Safeda during cold storage conditions.

Physiological loss in weight (%)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	212.88	198.16	183.42	198.15	215.14	196.00	180.97	197.37	197.76
T_2	Calcium chloride (2%)	218.42	210.91	190.96	206.76	220.21	212.10	182.94	205.08	205.92
T_3	Calcium nitrate (1%)	225.64	218.12	197.00	213.59	226.36	220.61	195.97	214.31	213.95
T_4	Calcium nitrate (2%)	227.99	225.00	199.14	217.38	228.62	226.56	197.37	217.52	217.45
T_5	Naphthalene acetic acid (100 ppm)	180.46	158.91	135.20	158.19	181.19	159.33	138.21	159.58	158.89
T_6	Naphthalene acetic acid (200 ppm)	182.91	166.72	142.90	164.18	183.27	167.56	144.68	165.17	164.68
T_7	Salicylic acid (100 ppm)	204.00	188.29	168.31	186.87	209.00	187.20	170.74	188.98	187.93
T_8	Salicylic acid (200 ppm)	209.98	193.80	179.11	194.30	211.41	195.73	178.52	195.22	194.76
T_9	Control	167.41	137.19	115.51	140.04	171.42	130.87	104.31	135.53	137.99
Mean		203.3	188.57	167.95	186.61	205.18	188.44	165.97	186.53	186.57
		0 day = 229.46				0 day = 230.09				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		1.511		Treatment (t)		0.663		

Table 8: Effect of post-harvest treatments on total sugars (%) of guava cv. Allahabad Safeda during cold storage conditions.

Total sugars (%)										
Treatments		2017-18				2018-19				Pooled mean
		Storage intervals (Days)								
		7th	14th	21st	Mean	7th	14th	21st	Mean	
T_1	Calcium chloride (1%)	7.06	7.95	7.84	7.62	7.00	7.98	7.80	7.59	7.61
T_2	Calcium chloride (2%)	7.20	8.03	7.90	7.71	7.19	8.00	7.97	7.72	7.72
T_3	Calcium nitrate (1%)	6.09	7.85	7.65	7.20	6.04	7.80	7.67	7.17	7.19
T_4	Calcium nitrate (2%)	6.19	7.90	7.70	7.26	6.17	7.87	7.72	7.25	7.26
T_5	Naphthalene acetic acid (100 ppm)	8.21	8.46	7.68	8.12	8.23	8.40	7.65	8.09	8.11
T_6	Naphthalene acetic acid (200 ppm)	8.21	8.56	7.85	8.21	8.24	8.51	7.84	8.20	8.21
T_7	Salicylic acid (100 ppm)	7.92	8.09	7.33	7.78	7.92	8.03	7.31	7.75	7.77
T_8	Salicylic acid (200 ppm)	8.06	8.24	7.10	7.80	8.00	8.20	7.09	7.76	7.78
T_9	Control	7.20	7.36	5.77	6.78	7.14	7.22	5.16	6.51	6.65
Mean		7.35	8.05	7.42	7.61	7.33	8.00	7.36	7.56	7.59
		0 day = 5.96				0 day = 5.83				
		Factors C.D. ($p \geq 0.05$)				Factors C.D. ($p \geq 0.05$)				
		Factors		C.D.		Factors		C.D.		
		Treatment (t)		0.245		Treatment (t)		0.479		

in papaya results higher ascorbic acid by Rajkumar *et al.,* (2005) Similar findings were reported by Deepthi *et al.,* (2016) in guava with the use of calcium nitrate (2%) and Bhooriya *et al.,* (2018). Post-harvest use of calcium salt effectively sustains ascorbic acid in papaya (Ramesh *et al.,* 2014).

Data presented in table 8 reveals the significant variation in total sugar content among the different treatments. Highest mean total sugars content (8.21 % and 8.20% respectively) was recorded in fruits treated with Naphthalene Acetic Acid (200ppm) during both the years of study. Dhoot *et al.,* (1984) showed NAA

application results in maximum total sugars in guava fruits. Same kind of results were reported by Yadav *et al.,* (2001). Naphthalene acetic acid treated guava fruits exhibited highest total sugars as reported by Singh *et al.,* (2017).

Conclusion

Under cold storage conditions, calcium nitrate (2%) was found to be the best treatment among all the treatments evaluated that led to maximum firmness, ascorbic acid and minimum physiological loss in weight during both the year. Minimum spoilage was observed in salicylic acid (200 ppm) treated fruits under cold storage conditions during both years. Naphthalene acetic acid (200ppm) was effective in maintaining higher total soluble solids and total sugars. Minimum acidity was recorded in Naphthalene acetic acid (100ppm) during both the years of study.

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