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Response of Pre-Harvest Spraying Treatments of Chemicals and Plant Growth Regulators on Post-Harvest Losses and Quality Attributes of Sapota [*Manilkara achras* (Mill.) Forsberg] Fruits cv. Kalipatti

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A B S T R A C T

Investigation was conducted to study the "Response of pre-harvest spraying treatments of chemicals and plant growth regulators on post-harvest losses and quality attributes of sapota fruit cv. Kalipatti". 15 years old sapota trees were sprayed one month before harvest with different chemicals (Calcium chloride @ 2%, Calcium nitrate @ 2%, Calcium sulphate @ 2% and Potassium chloride @ 2%) and different level of plant growth regulators (GA_3 @ 50 and 100 mg / l, NAA @ 50 and 100 mg / l) along with control (Water spray and Absolute). Harvested fruitswere stored in laboratory at room temperature. Pre harvest spray of $CaCl_2$ @ 2 % recorded minimum physiological loss in weight, spoilage percentage with maximum TSS, total sugar, reducing sugar, non-reducing sugar and ascorbic acid during 12 days storage period of the sapota fruit.

Introduction

Sapota (chiku) is native to tropical America, belongs to family Sapotaceae. Sapota rank fifth both in production and consumption next to mango, banana, citrus and grapes. South Gujarat is a horticulture belt where Kalipatti variety is grown on large area. Sapotais highly perishable and rated very poor for process ability and it is mainly used for table purpose. Being a climacteric nature during ripening fruit passes through a series of change in colour, texture and flavor indication that composition change are taking place. Sapota fruit ripens within 3 to 4 days after harvest and soon after full ripened stage, raped bio-chemical changes reduced the shelf life. To increase the shelf life through pre-harvest treatments is considered one of the major attempts in Sapota cultivation. Various chemicals have been used to hasten or delay ripening, to reduce losses and to improve and maintain colour and quality by slowing down the metabolic activities of fruit. These chemicals arrest the growth and spread of microorganism by reducing the shriveling which ultimately leads to an increased shelf life and maintain the marketability of the fruit

for a longer period. Therefore the present investigation was carried out to assess the response of pre-harvest spraying treatments of chemicals and plant growth regulators on post-harvest losses and quality attributes of sapota [*Manilkara achras* (Mill.) Forsberg] fruit cv. Kalipatti.

Materials and Methods

The present investigation was carried out during the year 2015 at Horticulture Research Farm and P.G. Laboratory, Department of Horticulture, Anand Agricultural University, Anand. Thirty uniform trees of sapota cv. Kalipatti were marked and one month before harvest sprayed with different chemicals (Calcium chloride @ 2 %, Calcium nitrate @ 2 %, Calcium sulphate @ 2 % and Potassium chloride @ 2 %) and different level of plant growth regulators (GA_3 @ 50 and 100 mg / l, NAA @ 50 and 100 mg / l) along with control (Water spray and Absolute). There were three replication comprising three plants per treatment. Fruits were harvested at optimum maturity stage from the representative tree.

Two kg fruits from each replication of each treatment were stored at room temperature in laboratory. The fruits were assessed at 6^{th}, $9^{th}$and 12^{th}day of storage for physiological loss in weight, spoilage percentage, TSS, acidity, total sugar, reducing sugar, non-reducing sugar and ascorbic acid.

The physiological loss in weight of stored fruits was calculated by subtracting final weight from the initial weight of the fruits and expressed in percent.

Spoilage percentage of fruit was calculated as the number of decayed fruit divided by intial number of all fruit multiplied by hundred. Total soluble solids of sapota fruit was recorded by using a Hand Refractometer (0-32 ° Brix). The titrametric method of Lane and Eynon described by Ranganna (1979) was adopted for the estimation of acidity, total sugar, reducing sugar and ascorbic acid. The experimental data was analyzed in completely randomized design with three repetitions.

Results and Discussion

Data presented in table 1 showed significantly minimum physiological loss in weight (4.61, 6.38 and 10.11 %) at 6^{th}, 9^{th} and 12^{th} day of storage period, respectively in treatment T_1 ($CaCl_2$ @ 2 %) which was at par with treatment T_2 [$Ca(NO_3)_2$ @ 2 %] i.e. 4.91, 6.97 and 10.28 %.

The reduction in weight loss might be due to the maintenance of firmness of fruits by calcium which decreased the enzyme activity responsible for disintegration of cellular structure and decreases the gaseous exchange.

The present investigation is in conformity with the results reported by Rajkumar *et al.*, (2006) in papaya, Singh *et al.*, (2013) in ber and Tsomu and Patel (2014) in sapota.The perusal of analysis showed (Table 1) significantly, the lowest spoilageloss (5.00, 38.33 and 65.00 %) in treatment T_1 ($CaCl_2$ @ 2 %) at 6^{th}, 9^{th} and 12^{th} day of storage period, respectively followed by treatment T_2 ($Ca(NO_3)_2$ @ 2 %) i.e. 6.66, 41.67 and 68.33 %.

Calcium treated fruits showed significantly lesser extent of rotting which might be due to the higher fruit flesh and calcium content in peel, which resulted stronger intracellular organization and rigidified cell wall.

The finding are agreement with the results reported of Lal *et al.*, (2011) in apricot, Kirmani *et al.*, (2013) in plum and Tsomu and Patel (2014) in sapota.

At 9th and 12th day of storage period, the maximum TSS (22.22 and 20.37 ^{0} Brix, respectively) was observed in treatment T_1 ($CaCl_2$ @ 2 %) which was at par with treatment T_2 [$Ca(NO_3)_2$ @ 2 %] i.e 21.48 and 19.26 ^{0} Brixat 9th and 12th day of storage period. The increase in TSS during storage period might be due to hydrolysis of starch into sugar as on complete hydrolysis of starch no further increase occurs and subsequently decline in TSS is predictable.

Similar findings have been reported by Bhalerao *et al.,* (2010) in sapota and Karemera and Habimana (2014) in mango.

Data presented in table 2 showed non-significant difference for acidity content among all the treatments during storage period. It was observed from the data (Table 2) that total sugar increase up to 9th day of storage period and then after it started declining. The maximum total sugar (20.00, 22.61 and 18.34 %) was recorded with treatment T_1 ($CaCl_2$ @ 2 %) at 6th, 9th and 12th day of storage period, respectively which, was at par with treatment T_2 [$Ca(NO_3)_2$ @ 2 %] i.e 21.92 and 17.36 % at 9th and 12th day of storage period, respectively.

The increase in total sugar during initial storage period might be due to hydrolysis of starch into sugar as on complete hydrolysis of starch no further increase occurs and subsequently a decline in total sugar is predictable.

The present investigation is in conformity with the results reported by Bhalerao *et al.*, (2010) in sapota, Bisen *et al.,* (2014) in guava and Karemera and Habimana (2014) in mango. The maximum reducing sugar (10.31, 11.98 and 9.98 %) was observed with treatment T_1 ($CaCl_2$ @ 2 %) at 6th, 9th and 12th day of storage period, respectively which was at par with treatment T_2 [$Ca(NO_3)_2$ @ 2 %] i.e. 10.10, 11.80 and 9.39 %.

The increase of reducing sugar content by calcium application might be due to the less utilization of sugar in respiration and conversion of starch in to sugar, while the subsequent decline was perhaps due to consumption of sugar for respiration during storage. The present investigation is in conformity with the results reported by Bhalerao *et al.,* (2010) in sapota and Bisen *et al.,* (2014) in guava.

The maximum non-reducing sugar (9.71, 10.63 and 8.36 %) was recorded in treatment T_1 ($CaCl_2$ @ 2 %) at 6th, 9th and 12th day of storage period, respectively followed by treatment T_2 [$Ca(NO_3)_2$ @ 2 %] i.e. 9.20, 10.12 and 7.97 %. The increase in non-reducing sugar during storage was due to the conversion of starch into sugar, while, the subsequent decrease in sugar was might be due to consumption of sugar for respiration during storage period. These results are in accordance with the findings of Bhalerao *et al.,* (2010) in sapota, Bisen *et al.,* (2014) in guava and Karemera and Habimana (2014) in mango.

Examination of data (Table 2) on ascorbic acid revealed that at 6th, 9th and 12th day of storage period the highest ascorbic acid content (21.23, 16.16 and 13.49 mg/100 g pulp, respectively) was recorded by treatment T_1 ($CaCl_2$ @ 2 %) followed by treatment T_3 ($CuSO_4$ @ 2 %) i.e. 20.27 and 15.32 mg/100 g pulp at 6th and 9th day of storage period, respectively.

The gradual reduction in ascorbic acid content during entire storage period might be due to its degradation through enzymatic oxidation of L-ascorbic acid to dehydro ascorbic acid during metabolic processes. Similar observations were recorded by Rajput *et al.*(2008) in guava, Ramezanian *et al.,* (2009) in pomegranate and Bisen *et al.,* (2014) in guava.

Table.1 Influence of pre-harvest spraying treatments of chemicals and plant growth regulators on post-harvest losses

Sr. No.	Parameters	Treatments	6th Day	9th Day	12th Day
1.	Physiological loss in weight (%)	T_1- $CaCl_2$ @ 2 %	4.61	6.38	10.11
		T_2- $Ca(NO_3)_2$ @ 2 %	4.91	6.97	10.28
		T_3- $CaSO_4$ @ 2 %	9.12	12.34	17.57
		T_4- KCl @ 2 %	9.84	13.57	18.52
		T_5- GA_3 @ 50 mg / l	7.29	11.11	16.41
		T_6- GA_3 @ 100 mg / l	6.40	9.78	13.75
		T_7- NAA @ 50 mg / l	8.50	11.34	15.77
		T_8- NAA @ 100 mg / l	7.90	10.91	15.17
		T_9- Control (Water spray)	10.56	14.97	19.99
		T_{10}- Control (Absolute)	13.11	17.11	23.35
		S.Em. ±	0.40	0.52	0.62
		C.D. (P = 0.05)	1.08	1.53	1.82
		C.V. %	7.71	7.84	6.65
2.	Spoilage loss (%)	T_1- $CaCl_2$ @ 2 %	5.00	38.33	65.00
		T_2- $Ca(NO_3)_2$ @ 2 %	6.66	41.67	68.33
		T_3- $CaSO_4$ @ 2 %	20.00	55.00	80.00
		T_4- KCl @ 2 %	18.33	56.67	81.67
		T_5- GA_3 @ 50 mg / l	11.66	50.00	75.00
		T_6- GA_3 @ 100 mg / l	10.00	48.33	73.33
		T_7- NAA @ 50 mg / l	16.66	53.33	78.33
		T_8- NAA @ 100 mg / l	15.00	51.67	76.67
		T_9- Control (Water spray)	23.33	61.66	83.33
		T_{10}- Control (Absolute)	25.00	63.33	85.00
		S.Em. ±	1.17	2.69	2.42
		C.D. (P = 0.05)	3.48	7.93	7.12

Table.2 Influence of pre-harvest spraying treatments of chemicals and plant growth regulators on quality attributes

Sr. No.	Parameters	Treatments	6th Day	9th Day	12th Day
1.	Total Soluble Solids (^{0}Brix)	T_1- $CaCl_2$ @ 2 %	20.62	22.22	20.37
		T_2- $Ca(NO_3)_2$ @ 2 %	19.78	21.48	19.26
		T_3- $CaSO_4$ @ 2 %	18.79	18.21	17.86
		T_4- KCl @ 2 %	18.29	18.16	17.66
		T_5- GA_3 @ 50 mg / l	18.37	19.15	17.92
		T_6- GA_3 @ 100 mg / l	18.61	19.45	18.06
		T_7- NAA @ 50 mg / l	18.74	19.58	18.09
		T_8- NAA @ 100 mg / l	18.76	19.75	18.13
		T_9- Control (Water spray)	18.24	18.10	17.63
		T_{10}- Control (Absolute)	17.90	17.21	15.94
		S.Em. ±	0.81	0.73	0.54
		C.D. (P = 0.05)	NS	2.16	1.59
		C.V. %	7.50	6.56	5.17
2.	Acidity (%)	T_1- $CaCl_2$ @ 2 %	0.21	0.19	0.15
		T_2- $Ca(NO_3)_2$ @ 2 %	0.21	0.19	0.14
		T_3- $CaSO_4$ @ 2 %	0.22	0.20	0.15
		T_4- KCl @ 2 %	0.22	0.21	0.15
		T_5- GA_3 @ 50 mg / l	0.23	0.22	0.16
		T_6- GA_3 @ 100 mg / l	0.23	0.22	0.16
		T_7- NAA @ 50 mg / l	0.22	0.21	0.16
		T_8- NAA @ 100 mg / l	0.22	0.21	0.15
		T_9- Control (Water spray)	0.23	0.22	0.17
		T_{10}- Control (Absolute)	0.24	0.23	0.18
		S.Em. ±	0.01	0.01	0.01
		C.D. (P = 0.05)	NS	NS	NS
		C.V. %	6.80	7.53	10.27
3.	Total sugar (%)	T_1- $CaCl_2$ @ 2 %	20.00	22.61	18.34
		T_2- $Ca(NO_3)_2$ @ 2 %	19.30	21.92	17.36
		T_3- $CaSO_4$ @ 2 %	16.32	15.04	13.08
		T_4- KCl @ 2 %	15.28	14.45	12.62
		T_5- GA_3 @ 50 mg / l	16.94	18.54	14.07
		T_6- GA_3 @ 100 mg / l	17.24	19.22	15.09
		T_7- NAA @ 50 mg / l	17.81	20.22	15.46
		T_8- NAA @ 100 mg / l	18.42	20.94	16.46
		T_9- Control (Water spray)	14.78	13.70	12.09
		T_{10}- Control (Absolute)	14.43	13.32	11.42
		S.Em. ±	0.18	0.26	0.33
		C.D. (P = 0.05)	0.52	0.77	0.99
		C.V. %	1.80	2.50	3.96

Sr. No.	Parameters	Treatments	6th Day	9th Day	12th Day
4.	Reducing sugar (%)	T_1- $CaCl_2$ @ 2 %	10.31	11.98	9.98
		T_2- $Ca(NO_3)_2$ @ 2 %	10.10	11.80	9.39
		T_3- $CaSO_4$ @ 2 %	8.66	7.92	6.97
		T_4- KCl @ 2 %	8.15	7.63	6.26
		T_5- GA_3 @ 50 mg / l	8.98	9.62	7.22
		T_6- GA_3 @ 100 mg / l	9.12	9.98	7.98
		T_7- NAA @ 50 mg / l	9.56	10.49	8.12
		T_8- NAA @ 100 mg / l	9.79	10.98	8.78
		T_9- Control (Water spray)	7.97	7.31	6.11
		T_{10}- Control (Absolute)	7.80	7.18	5.72
		S.Em. ±	0.13	0.14	0.19
		C.D. (P = 0.05)	0.38	0.42	0.57
		C.V. %	2.45	2.58	4.37
5.	Non-reducing sugar (%)	T_1- $CaCl_2$ @ 2 %	9.71	10.63	8.36
		T_2- $Ca(NO_3)_2$ @ 2 %	9.20	10.12	7.97
		T_3- $CaSO_4$ @ 2 %	7.66	7.12	6.11
		T_4- KCl @ 2 %	7.12	6.82	6.36
		T_5- GA_3 @ 50 mg / l	7.96	8.92	6.85
		T_6- GA_3 @ 100 mg / l	8.12	9.24	7.11
		T_7- NAA @ 50 mg / l	8.25	9.73	7.34
		T_8- NAA @ 100 mg / l	8.63	9.96	7.68
		T_9- Control (Water spray)	6.81	6.39	5.98
		T_{10}- Control (Absolute)	6.63	6.14	5.70
		S.Em. ±	0.21	0.21	0.15
		C.D. (P = 0.05)	0.61	0.63	0.45
		C.V. %	4.48	4.34	3.79
6.	Ascorbic acid (mg / 100 g pulp)	T_1- $CaCl_2$ @ 2 %	21.23	16.16	13.49
		T_2- $Ca(NO_3)_2$ @ 2 %	15.41	9.26	7.71
		T_3- $CaSO_4$ @ 2 %	20.27	15.32	11.29
		T_4- KCl @ 2 %	14.70	8.93	7.13
		T_5- GA_3 @ 50 mg / l	15.71	10.02	8.30
		T_6- GA_3 @ 100 mg / l	17.17	11.41	8.98
		T_7- NAA @ 50 mg / l	17.86	12.28	9.53
		T_8- NAA @ 100 mg / l	18.36	14.25	10.31
		T_9- Control (Water spray)	12.14	8.25	5.53
		T_{10}- Control (Absolute)	11.74	8.09	5.20
		S.Em. ±	0.85	0.57	0.40
		C.D. (P = 0.05)	2.49	1.69	1.19
		C.V. %	8.89	8.68	7.98

On the basis of finding of the investigation it can be concluded that pre-harvest (one month) spraying of $CaCl_2$ @ 2 % or $Ca(NO_3)_2$ @ 2 % is effective and found promising for maintaining quality attributes *viz.* TSS, total sugar, reducing sugar, non-reducing sugar, ascorbic acid with minimum physiological loss in weight and spoilage percentage.

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