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RESEARCH

EFFECT OF FOLIAR APPLICATION OF NUTRIENTS, GROWTH REGULATORS AND COLD STORAGE ON PHYSIOLOGICAL PARAMETERS OF SAPOTA

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Abstract: A field experiment was conducted to study the effect of foliar application of nutrients and growth regulators on physiological parameters of sapota, at Department of Fruit Science, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences Shivamogga during the year 2017-18. The experiment was laid out with fifteen treatments replicated three times in randomized complete block design. In the present investigation, application of calcium chloride ($CaCl_2$) at 1 per cent resulted minimum weight loss (10.00 %), fruit decay (19.40 %) with maximum days to ripen (25.17 days), shelf life (26.67 days) and fruit firmness (1.00 kg/cm^2) under low temperature (12˚C) storage.

Keywords: $CaCl_2$, Pre-harvest, Shelf life, Growth regulators

INTRODUCTION

Sapota [*Manilkara achras* (Mill.)] is a tropical fruit, belongs to the family sapotaceae. It is native to Mexico and Tropical America. India ranks fifth in both production and consumption of sapota next to mango, banana, citrus, and grape. In India, the major sapota growing states are Maharashtra, Gujarat, Karnataka, Tamil Nadu, Andra Pradesh, West Bengal, Uttar Pradesh, Punjab and Haryana. Among all states, Karnataka is leading sapota producing state and contributes about 26.5 per cent of the total production in the country. Sapota is highly perishable fruit suffer from heavy post-harvest losses to the extent of 9.73 per cent in India (NHB, 2016-17). Sapota is a climacteric fruit, ripens within 4 to 7 days after harvest and soon after the full ripened stage rapid biochemical and physiological changes which reduces the shelf life. Calcium salts frequently have been used in food preservation by food industry as pre-harvest applications in order to prolong the storage life of fruits (Gupta et al., 2011) and the low temperature storage can extend the shelf life of fruits by reducing the oxidative metabolism and ethylene production. The main objective of the present study was to evaluate the potential application of nutrients and growth regulators at various concentrations on storage life and physiological changes in fresh sapota fruits at low temperature storage.

MATERIALS AND METHODS

The present investigation was carried out at sapota orchard, College of Horticulture Mudigere, Chikamagalur during 2017-18. The experiment was laid out in randomized complete block design with three replications and fifteen treatments. The uniform sized sapota trees were marked and sprayed with different nutrients and plant growth regulators *viz*., T_1- control, T_2-GA_3 200ppm, T_3-GA_3 300ppm, T_4- Kinetin 50ppm, T_5- Kinetin 100ppm, T_6- 2,4-D 10ppm, T_7- 2,4-D 20ppm, T_8- Boron 0.2%, T_9- Boron 0.4%, T_{10}- $CaCl_2$ 1%, T_{11}- $CaCl_2$ 1.5%, T_{12}- $Ca(NO_3)_2$1%, T_{13}- $Ca(NO_3)_2$1.5%, T_{14}- KCl_2 0.5% and T_{15}- KCl_2 1% at two intervals i.e 40 days before harvest and 20 days after 1st spray. The fruits were harvested when colour of the fruit turned to light brown i.e potato colour. The harvested fruits were brought to the laboratory and two kilograms of sapota fruits for each treatment were kept for observation at 12˚C temperature under cold storage. The observations include physiological weight loss, days taken to ripening, shelf life, per cent fruit decay and fruit firmness of sapota were recorded in three days intervals up to twenty seven days of cold storage.

RESULTS AND DISCUSSION

Physiological loss in weight

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Under cold storage condition the data presented in Table-1 showed, the minimum physiological loss in weight from 3rd day to 27th day of storage was observed in treatment T_{10} ($CaCl_2$ @ 1%) i.e. 0.66 to 10.00% and the maximum physiological loss in weight (1.41 to 16.34% at 3rd and 18th day respectively) was noted in treatment T_1 (control) and 21st day onwards control fruits showed shrivelling and loss of appearance hence fruits were discarded. The reduction in weight loss might be due to the maintenance of firmness of fruits by calcium and low temperature which decreased the enzyme activity such as cellulases and pectinases responsible for disintegration of cellular structure and decreases the gaseous exchange. The present investigation is in conformity with the results reported by Saran *et al.* (2004), Rajkumar *et al.* (2006) in papaya, Yadav *et al.*(2009) in ber, Lal *et al.* (2011) in apricot, Singh *et al.* (2013) in ber and Tsomu and Patel (2014) in sapota.

Days taken to ripening

The data presented in the Table 2, revealed that the combination of both foliar application of nutrients and growth regulators and low temperature exerted their significant effects on days taken to ripening under cold storage condition. Treatment T_{10}-$CaCl_2$(1%) observed the maximum number of days (25.17days) taken to ripening at cold storage. While, the minimum days (16.12days) taken to ripening was recorded in treatment T_1- control. The delay of ripening by$CaCl_2$ might be due to higher fruit calcium levels slowed down the process of ripening by retarding the pre-climacteric respiration rate and ethylene production. The present investigation is in conformity with the results obtained in different varieties of sapota by Gautam and Chundawat (1989), Attri and Singh (1996), Damodaran *et al.*(2001), Sudha *et al.* (2007), Tsomu and Patel (2014) and Karemera and Habimana (2014) in mango.

Shelf life

The shelf life of fruits was significantly influenced due to nutrients and plant growth regulator treatments in cold storage condition. The maximum shelf life (26.67 days) was reported in T_{10} ($CaCl_2$@ 1%). Whereas, the minimum shelf life (19.33 days) was recorded in T_1-control (Fig 1). Low temperature and Calcium treatments have better shelf life because it helps in reducing the moisture loss and maintain turgidity, structural integrity of both the cell wall and plasma membrane which delaying ripening by delayed ethylene production and extending storage life. Similar result were also found by Rajkumar *et al.* (2006) in papaya, Sudha *et al.* (2007), Rajput *et al.* (2008) in guava and Tsomu and Patel (2014) in sapota.

Fruit decay percentage

The spoilage percentage of sapota fruits was increased as the storage period advanced irrespective of any treatment in cold storage condition. The lowest spoilage of fruit (19.40%) was observed in treatment T_{10} -$CaCl_2$ at 1%. While the highest decaying percentage of fruit (42.67%) was noted in treatment T_1–Control.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. Similar finding are in agreement with the results of Lal *et al.* (2011) in apricot, Tsomu and Patel (2014) in sapota, Kirmani *et al.* (2013) in Plum.

Fruit firmness

Data presented in Table 3 showed significant differences in average fruit firmness at cold storage condition. The treatment T_{10} ($CaCl_2$ @ 1 %) recorded significantly highest fruit firmness at cold storage (27 days). Whereas lowest fruit firmness was noted in treatment T_1 (control).Decrease in fruit firmness during storage is due to changes in cell wall polysaccharides and decrease in cell wall uronic acids. The calcium helped to maintain cell wall integrity as a consequence of the influx of calcium that could help in thickening of calcium pectate in the cell wall and thus assist in prolonged shelf life and firmness of fruit (Rajkumar *et al.* 2006). The similar result also observed by Saran *et al.* (2004) in ber, Kirmani *et al.* (2013) in plum, Tsomu and Patel (2014) in sapota, Bisen *et al.* (2014) in guava and Singh and Gupta (2015) in apple.

Table 1. Effect of foliar application of nutrients and plant growth regulators on physiological loss in weight of sapota under cold storage at different days after harvest

Treatments	Physiological loss in weight (%)								
	3rd day	6th day	9th day	12th day	15th day	18th day	21st day	24th day	27th day
T_1- Control	1.41	3.82	4.69	5.11	5.97	16.34	--	--	--
T_2- GA_3 at 200 ppm	0.91	1.37	2.25	2.82	3.46	06.05	07.07	15.70	--
T_3- GA_3 at 300 ppm	0.82	1.50	2.38	3.08	3.52	06.11	09.10	16.66	--
T_4- Kinetin at 50 ppm	0.83	1.53	2.46	3.11	3.64	06.92	10.88	17.55	--
T_5- Kinetin at 100 ppm	0.92	1.58	2.50	3.26	3.79	07.02	12.09	20.89	--
T_6- 2,4-D at 10 ppm	1.12	1.59	2.61	3.33	3.82	11.08	12.43	21.63	--
T_7- 2,4-D at 20 ppm	1.00	1.67	2.63	3.36	3.88	11.94	12.90	23.83	--
T_8- Boron at 0.2%	1.00	1.77	2.73	3.50	3.95	12.01	13.91	24.05	--

T_9- Boron at 0.4%	0.87	1.93	2.98	3.73	4.38	12.34	13.98	--	--
T_{10}- $CaCl_2$ at 1%	0.66	1.10	1.27	1.92	2.73	03.89	05.43	06.54	10.00
T_{11}- $CaCl_2$ at 1.5%	0.75	1.21	2.00	2.33	3.04	04.69	05.88	09.48	12.66
T_{12}- $CaNO_3$ at 1%	0.78	1.28	2.05	2.77	3.31	04.86	05.99	12.27	15.05
T_{13}- $CaNO_3$ at 1.5%	0.77	1.33	2.10	2.80	3.47	05.46	06.55	14.85	15.17
T_{14}- KCl_2 at 0.5%	1.10	2.09	3.49	3.79	4.46	13.91	14.72	--	--
T_{15}- KCl_2 at 1%	1.24	3.81	3.87	4.99	4.70	15.93	16.32	--	--
S.Em ±	0.10	0.20	0.31	0.33	0.42	0.98	1.04	1.74	1.12
C.D at 1%	0.39	0.77	1.22	1.29	1.63	3.83	4.08	6.80	4.39

Note: -- Termination of shelf life

Table 2. Effect of foliar application of nutrients and plant growth regulators on days taken to ripening, shelf life and fruit decay percentage under cold storage condition

Treatments	Days taken to ripening	Shelf life (days)	Fruit decay (%)
T_1- Control	16.12	19.33	42.67
T_2- GA_3 at 200 ppm	23.20	24.67	24.57
T_3- GA_3 at 300 ppm	22.33	24.33	24.67
T_4- Kinetin at 50 ppm	22.00	24.00	27.33
T_5- Kinetin at 100 ppm	21.67	23.93	28.00
T_6- 2,4-D at 10 ppm	21.33	23.67	29.33
T_7- 2,4-D at 20 ppm	21.00	23.33	30.00
T_8- Boron at 0.2%	20.92	23.00	30.01
T_9- Boron at 0.4%	20.33	22.67	33.00
T_{10}- $CaCl_2$ at 1%	25.17	26.67	19.40
T_{11}- $CaCl_2$ at 1.5%	25.00	26.33	21.13
T_{12}- $CaNO_3$ at 1%	24.37	26.00	22.00
T_{13}- $CaNO_3$ at 1.5%	23.67	25.33	22.10
T_{14}- KCl_2 at 0.5%	19.33	22.33	38.00
T_{15}- KCl_2 at 1%	19.00	21.67	40.00
S.Em ±	0.77	0.69	2.10
C.D at 1%	2.99	2.69	8.19

Note: -- Termination of shelf life

Table 3. Effect of foliar application of nutrients and plant growth regulators on firmness of the sapota fruit under cold storage at different days after harvest

Treatments	Fruit firmness (kg/cm^2)								
	3rd day	6th day	9th day	12th day	15th day	18th day	21st day	24th day	27th day
T_1- Control	2.18	1.85	1.53	1.19	1.02	0.97	--	--	--
T_2- GA_3 at 200 ppm	3.78	3.08	2.36	1.68	1.69	1.24	1.17	1.04	--
T_3- GA_3 at 300 ppm	3.69	3.07	2.24	1.67	1.47	1.24	1.13	1.03	--
T_4- Kinetin at 50 ppm	3.60	2.72	2.08	1.56	1.36	1.23	1.11	1.01	--
T_5- Kinetin at 100 ppm	3.53	2.71	1.96	1.55	1.32	1.22	1.09	1.00	--
T_6- 2,4-D at 10 ppm	3.52	2.70	1.93	1.50	1.25	1.21	1.08	0.97	--
T_7- 2,4-D at 20 ppm	3.28	2.45	1.79	1.49	1.24	1.20	1.07	0.96	--
T_8- Boron at 0.2%	3.19	2.41	1.72	1.43	1.23	1.17	1.05	0.95	--
T_9- Boron at 0.4%	2.98	2.40	1.65	1.36	1.22	1.13	1.05	--	--
T_{10}- $CaCl_2$ at 1%	4.93	4.16	2.98	2.30	1.96	1.45	1.23	1.18	1.00
T_{11}- $CaCl_2$ at 1.5%	4.53	3.71	2.55	1.94	1.84	1.37	1.21	1.17	0.97
T_{12}- $CaNO_3$ at 1%	4.22	3.32	2.50	1.79	1.80	1.25	1.20	1.13	0.95
T_{13}- $CaNO_3$ at 1.5%	3.91	3.17	2.49	1.78	1.76	1.24	1.20	1.10	0.96
T_{14}- KCl_2 at 0.5%	2.89	2.10	1.64	1.33	1.16	1.13	1.03	--	--
T_{15}- KCl_2 at 1%	2.55	2.03	1.61	1.26	1.11	0.98	0.93	--	--
S.Em ±	0.38	0.27	0.21	0.17	0.15	0.06	0.06	0.03	0.02
C.D at 1%	1.49	1.07	0.83	0.67	0.60	0.22	0.22	0.11	0.09

Note: -- Termination of shelf life

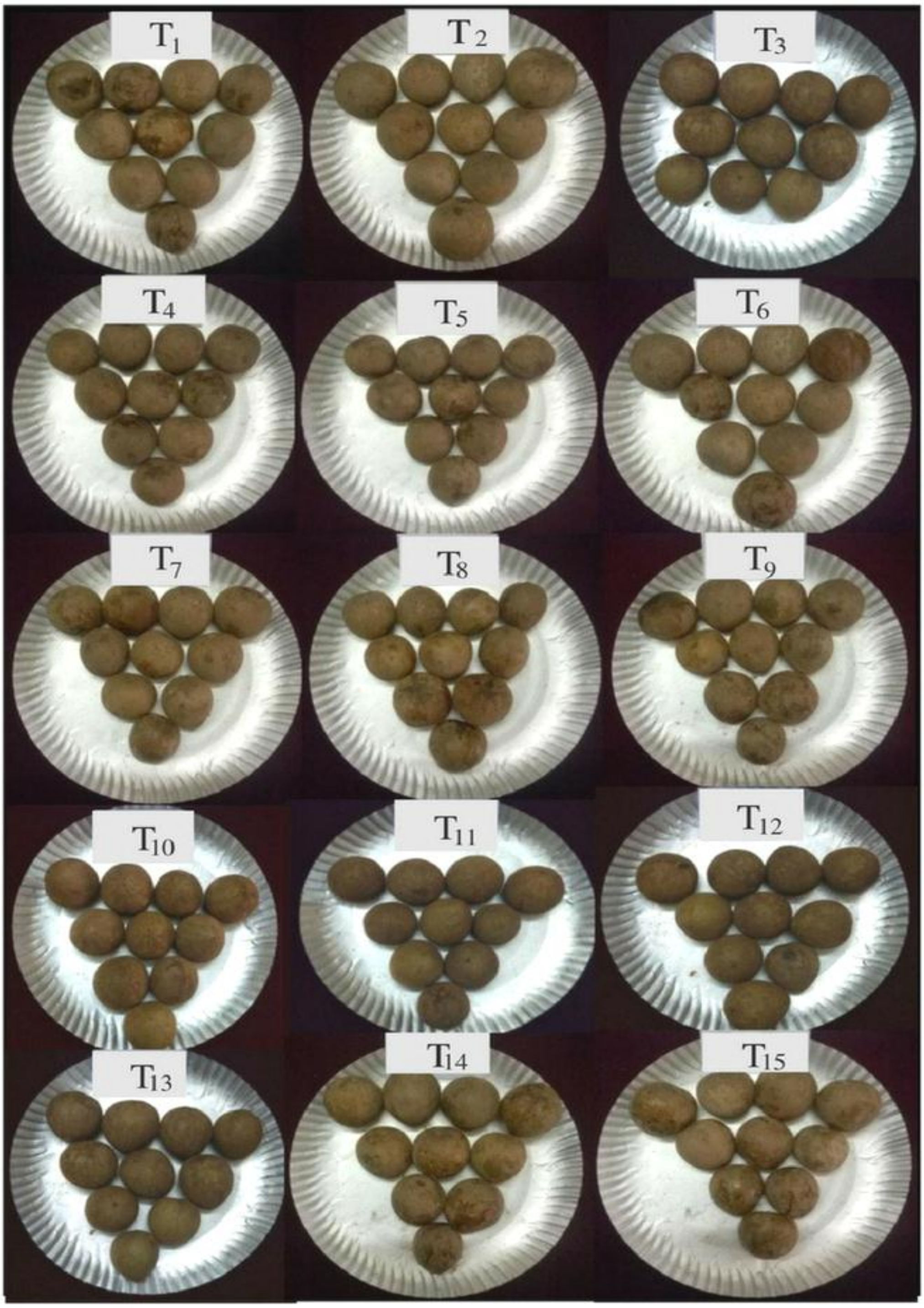

Fig. 1 Shelf life of sapota fruits at 25th day of cold storage

CONCLUSION

On the basis of finding of the investigation it can be concluded that pre-harvest spraying of $CaCl_2$ at 1% or $CaCl_2$ at 1.5% is effective and found promising for maintaining minimum physiological loss in weight and spoilage percentage with maximum shelf life, days taken for ripening and fruit firmness under low temperature storage.

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