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IMPACT OF PREHARVEST CHEMICAL APPLICATION ON PLUM (*PRUNUS SALICINA* L.) CV. SANTA ROSA QUALITY DURING STORAGE

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ABSTRACT
An experiment was conducted to studythe influenceof preharvest application of some chemicals on various chemical parameters of plum (*Prunus salicina*L.) cv. Santa Rosa under ambient storage conditions, involving pre harvest spraying with$CaCl_2$(0.1, 0.3 and 0.5%), GA_3(20, 40 and 60 ppm) and NAA(20, 40 and 60ppm)applied 20 and 10 days before the expected date of harvest. TSS (12.63%) and total sugars (8.80%) at the harvest time were reported to be maximum in response to GA_3 (60 ppm) while as 0.5% $CaCl_2$ resulted in highest ascorbic acid (7.18 mg/100g) and juice content (62.94%) which decreased during storage under all treatments. $CaCl_2$at higher concentration of 0.5%proved to be the most effective treatment in retaining the fruit quality during the entire storage period recording highest means values fortotal sugars (9.05%), reducing sugars (8.04%), non-reducing sugars (1.47%), TSS (12.80%), titrable acidity (1.411), ascorbic acid (6.69 mg/100gm) and juice content (55.07%). Thus, it can be inferred from the study that $CaCl_2$ (0.5%) was rated as most acceptable and superior, over all the other treatments in term of quality parameters observed during ambient storage.

INTRODUCTION

Plum (*Prunus salicina* L.)is prized for its exquisite fresh flavour, aroma, attractiveness and in fruit preservation industry. It is fairly good source of citric acid, sugars and vitamin-A (Westwood, 1993). Area under plum orchards in Jammu and Kashmir,is 4761 hectares with an annual production of 10777 metric tonnes (Anonymous, 2013). Plum cv. Santa Rosa known for its fair quality, aromaand characteristic flavour is an important export variety of the region. Plums cannot endure long storage periods after harvest as they are highly perishable at ambient temperatures. Thus, pre-harvest treatment of the fruits with theplant growth regulators like auxins, gibberellins, calcium chloride and growth retardants like cycocel which would retard the rate of deterioration in quality after harvest, can effectively be used to increase thestorage life of fresh fruits and thus spoilage can be reduced to some extentand thereby increasing the shelf life of the fruits. Plums treated with calcium containing compounds extend shelf-life of fruits byshowing increased conjugated forms of putrescine (conjugated soluble and cell-wall-bound), thereby, resulting in higher firmness values and minimizing the rate of respiration and thus preventing the disintegration of fruit tissues (Valero, *et al.,* 2002).The effectiveness of various preharvest chemicals sprayed, varies with the variety, environmental conditions and the stage of fruit development at which it is applied. Plum fruits treated with 4% $CaCl_2$maintained higher values of TSS, total sugars, reducing sugars and acidity during entire storage period under ambient conditions(Shazia *et al.,* 2013). In view of these perspectivesand with an increasing demand of plum fruit for fresh consumption in domestic markets, the present investigationwas conductedwithan objective to find out the suitable pre-harvest treatment application and at suitable concentration among $CaCl_2$, GA_3 and NAA which could maintain the quality of Santa Rosa plum under ambient storage conditions over a considerable period of time.

MATERIALS AND METHODS

Experimental Location

The present investigation was conducted in the Research Farm of Division of fruit Science and Laboratory of Division Of Fruit Sciences, SKUAST-Kashmir, Shalimar, Srinagar, (J & K) during the year 2010-2011, located at an altitude of 1390 meters above mean sea level and between 34º75' North latitude and 74º50' East longitude. The climate in the state is in general of typical temperate type.

Experimental Material

In the present investigation, 24 year old trees of plum cv. 'Santa Rosa',uniform in size and vigour which had received uniform cultural practices were selected as the experimental material to find out the effect of preharvest spraying of $CaCl_2$, GA_3 and NAA on storage quality of Santa Rosa plum.

Experimental details

Thirty trees of plum cv. Santa Rosa, spaced at 4 x 4m, were selected and tagged for experimental workat the time of final bloom. The investigation consisted of 10 treatments viz.,(T_1) Calcium chloride @ 0.1%, (T_2) Calcium chloride @ 0.3%, (T_3) Calcium chloride @ 0.5%, (T_4) GA_3 @ 20 ppm, (T_5) GA_3 @ 40

ppm, (T_6) GA_3 @ 60 ppm, (T_7) NAA @ 20 ppm, (T_8) NAA @ 40 ppm, (T_9) NAA @ 60 ppm and (T_{10}) Control ; and were replicated thrice in a randomized block design. Application of chemicals $CaCl_2$ (0.1, 0.3 and 0.5%), GA_3 (20, 40 and 60 ppm) and NAA (20, 40 and 60 ppm) was done twice, 20 and 10 days before expected harvest date. The sprays were carried out in the morning hours using foot sprayer.The fruits from each treatment were harvested at optimum maturity (8th July, 2010) and immersed in running water to remove field heat and then air dried in shade.The fruits were then stored in the laboratory of Division of Fruit Science at an ambient temperature (26 ± 2^oC to 15 ± 2^oC) and relative humidity (60 to 70 %) during entire investigating period in standard wooden boxes. The chemical attributes of the fruit were recorded at harvest and throughout at an interval of 5 days during storage period of 15 days. Titrableacidity, total sugars, reducing sugar, non-reducing sugar and juice content were calculated as per the standard methods describedin AOAC (1984).Total soluble solids (TSS) measured in % was determined with the helpof an Erma Hand Refractometer as per the method described by Dong *et al.* (2001). Ascorbic acid was estimated by standard titration method using 2, 6-dichloro indophenol as dye as given by Ranganna (1986).The data generated from the present investigations were put to statistical analysis by using R-software. Treatment means were separated and compared using least significant differences (LSD) at Pless or equal to 0.05 as per the procedures described by Cochran and Cox (1963).

RESULTS AND DISCUSSION

In the present study, at harvest, maximum total sugar (8.80%) was recorded with 60 ppm GA_3 (T_6) and it was found to be at par with 60 ppm NAA (8.60%) and 40 ppm GA_3 (8.50%). Similarly, reducing sugar (7.79%), non reducing sugar (1.41%) and TSS (12.63%) wasalso found to be significantly higher in fruits treated with GA_3 60 ppm (T6).However, titrable acidity (1.614%), ascorbic acid (7.18mg/100g) and juice content (62.94) were found to be significantly higher in response to 0.5% $CaCl_2$(T_3) at the harvest time.In response to preharvest treatments, TSS, total sugars, reducing sugar and non-reducing sugar content increased with an advancement of storage period at room temperature during the initial 10 days but subsequently a decline was observed in these constituents during the remaining storage period. Application of preharvest treatments retained higher total sugars, reducing sugars, non-reducing sugar content and TSS over the control during storage.During storage, highest mean total sugar content were recorded in response to 0.5% $CaCl_2$ (T_3) (9.06%) followed by T_6 (8.94%), T_2 (8.90%) and T_1 (8.82%). Lowest mean total sugar content was recorded in control (7.99%). Interactions between treatments and storage interval were found to be significant. Similarly, maximum mean reducing sugar content (8.04%) was recorded in fruits treated with 0.5 per cent $CaCl_2$ (T_3) and it was found to be at par with T_2, T_1 and T_6 which recorded 7.94%, 7.89% and 7.88%, respectively. Interactions between treatments and storage intervals were found to be significant. Maximum mean non-reducing sugar (1.50%) was recorded with GA_3 60 ppm (T_6) and it was found to be at par with T_3, T_2 and T_5 (1.47%, 1.41% and1.41% respectively). Interactions between treatments and storage intervals were found to be non-significant. Preharvest treatments with different substances significantly increased the total soluble solids to varying extent as compared to control in which lowest TSS content (10.80%) was recorded. The highest mean TSS content (12.80%) was recorded in response to 0.5 per cent $CaCl_2$ and it was found to be at par with T_6 (12.61%) and T_2 (12.44%) and minimum in control (10.80%).Titrable acidity decreased continuously with the advancement of storage. The treatments 0.5% $CaCl_2$ (T_3) and GA_3 60 ppm (T_6) had retained maximum acidity at the end of storage as compared to the control which recorded the lowest value.**S**imilar changes have been reported by Monica *et. al.,* (2013) in litchi cv. Dehradun dipped in calcium nitrate, in which,the storage studies revealed that over a period of 10 days at (32 + 3°C), a continuous and significant decline in acidity and ascorbic acid was recorded, whereas, a gradual increase in TSS, total sugar and reducing sugarwas observed upto first 6 days of storage and then a gradual decline upto 10th storage day was observed. Mahajan *et al.* (2011) also observed that $CaCl_2$increased the TSS and total sugars in guava upto 3 weeks of storage and thereafter it declined gradually. Sharad *et. al.,* (2014) also observed that when Calcium nitrate and GA_3 combination was applied at different concentrationsat pre harvest stage to guava fruits, there was a gradual increase in total sugar, reducing sugar and non reducing sugar upto 2 days of storage period followed by a decline thereafter.The increase and the subsequent decrease in these biochemical attributes may possibly be attributed to the numerous catabolic processes taking place in the fruits preparing for senescence. Hulme (1958) states that in apple, starch, hemicellulose and other polysaccharides acting as a source of sugars get hydrolysed into mono and disaccharides during ripeningwhich in turn lead to an increase in TSS and sugars during storage. Treated fruits owing to the slow substrate utilization of primary sugars due to decline in respiration rates may have reflected in the increased TSS and sugar contents noted towards the end of storage as calcium, along with other growth substances are known to delay numerous senescence processes (Sharples and Johnson, 1977).The gradual decline in titrable acidity during storage period can be attributed to an increase in malate decarboxylating system during the ripening period (Rhodes *et al.*, 1968) and the ability of fruit cells to use organic acids as a respiratory substrate during storage (Ulrich, 1974) and hence the decline during ripening and storage. The effect of calcium in slowing down the decline of titrable acids may be attributed to the reduced decarboxylation of malic acid brought about by calcium (Shear and Faust, 1971) while as GA_3 induced reduction in acidity, may be linked with hormonal stimulation of assimilates translocation. The present investigation exhibit a continuous decline in ascorbic acid content of fruit with the increased storage duration. 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 (Das and Dash, 1967). The highest mean ascorbic acid content (6.69 mg/100 g) was recorded in fruits treated with 0.5% $CaCl_2$ and the lowest (5.72 mg/100 g) in control. The results have been found to be in confirmity with that of Rani and Brahmachari (2003) who observed that prehavest sprays of calcium compounds on mango fruits significantly

Table 1: Effect of pre-harvest sprays of various chemicals on Total sugars content (%), Reducing sugar content (%) , Non- reducing sugar content (%) and total soluble solids (%) during ambient storage in plum cv. Santa Rosa (Prunus salicina L.)

Treatments (T)	Total sugars content (%) Storage intervals in days (I)					Reducing sugar content (%) Storage intervals in days (I)				
	0	5	10	15	Mean	0	5	10	15	Mean
T_1 $CaCl_2$ 0.1%	8.3	8.8	9.4	8.8	8.82	7.5	7.87	8.29	7.92	7.89
	-2.88	-2.97	-3.06	-2.97	-2.97	-2.74	-2.8	-2.88	-2.81	-2.81
T_2 $CaCl_2$ 0.3%	8.35	8.9	9.5	8.85	8.9	7.53	7.88	8.35	7.99	7.94
	-2.89	-2.98	-3.08	-2.97	-2.98	-2.74	-2.81	-2.89	-2.83	-2.82
T_3 $CaCl_2$ 0.5%	8.4	9.2	9.6	9.05	9.06	7.6	8.05	8.41	8.1	8.04
	-2.9	-3.03	-3.09	-3.01	-3.01	-2.76	-2.84	-2.9	-2.85	-2.83
T_4 GA_3 20 ppm	8.35	8.5	8.75	8.55	8.54	7.56	7.65	7.77	7.68	7.67
	-2.89	-2.91	-2.96	-2.92	-2.92	-2.75	-2.76	-2.79	-2.77	-2.77
T_5 GA_3 40 ppm	8.5	8.8	9.03	8.4	8.67	7.66	7.8	7.88	7.51	7.71
	-2.91	-2.97	-3	-2.9	-2.94	-2.77	-2.79	-2.81	-2.74	-2.78
T_6 GA_3 60 ppm	8.8	9	9.3	8.68	8.94	7.79	7.91	8.01	7.8	7.88
	-2.97	-3	-3.05	-2.95	-2.99	-2.79	-2.81	-2.83	-2.79	-2.81
T_7 NAA 20 ppm	8.25	8.37	8.8	7.94	8.35	7.42	7.49	7.72	7.21	7.46
	-2.87	-2.89	-2.96	-2.82	-2.9	-2.72	-2.74	-2.78	-2.68	-2.73
T_8 NAA 40 ppm	8.4	8.5	8.7	7.81	8.35	7.53	7.59	7.68	7.12	7.48
	-2.9	-2.91	-2.95	-2.79	-2.9	-2.74	-2.75	-2.77	-2.67	-2.73
T_9 NAA 60 ppm	8.6	8.72	8.82	7.8	8.48	7.69	7.74	7.79	7.05	7.57
	-2.93	-2.95	-2.97	-2.79	-2.91	-2.77	-2.78	-2.79	-2.65	-2.75
T_{10} Control	8.1	8.22	8.25	7.4	7.99	7.4	7.48	7.56	6.95	7.35
	-2.85	-2.87	-2.87	-2.72	-2.83	-2.72	-2.73	-2.75	-2.64	-2.08
Mean	8.41	8.71	9.03	8.35		7.56	7.75	7.95	7.53	
	-2.9	-2.95	-3	-2.89		-2.74	-2.78	-2.82	-2.74	
sLsd (Pd"0.05)	Treatment (T) 0.06 Intervals (I) 0.03 T X I 0.07					Treatment (T) 0.04 Intervals (I) 0.03 T X I 0.07				

Treatments (T)	Non- reducing sugar content (%) Storage intervals in days (I)					Total soluble solids (%) Storage intervals in days (I)				
	0	5	10	15	Mean	0	5	10	15	Mean
T_1 $CaCl_2$ 0.1%	1.26	1.38	1.55	1.34	1.38	11.9	12.3	12.4	12	12.02
	-1.12	-1.17	-1.24	-1.16	-1.17	-3.45	-3.51	-3.52	-3	-3.47
T_2 $CaCl_2$ 0.3%	1.28	1.47	1.59	1.32	1.41	12.1	12.6	13	12	12.44
	-1.13	-1.21	-1.26	-1.15	-1.19	-3.47	-3.55	-3.6	-3	-3.53
T_3 $CaCl_2$ 0.5%	1.26	1.58	1.63	1.4	1.47	12.2	13	13.4	13	12.8
	-1.12	-1.26	-1.28	-1.18	-1.21	-3.49	-3.6	-3.66	-4	-3.58
T_4 GA_3 20 ppm	1.25	1.31	1.43	1.33	1.33	12	12.4	12.8	12	12.3
	-1.12	-1.14	-1.19	-1.15	-1.15	-3.46	-3.52	-3.58	-3	-3.51
T_5 GA_3 40 ppm	1.29	1.45	1.58	1.34	1.41	12.3	12.6	12.9	12	12.4
	-1.13	-1.2	-1.26	-1.16	-1.19	-3.51	-3.55	-3.59	-3	-3.52
T_6 GA_3 60 ppm	1.41	1.53	1.72	1.34	1.5	12.6	12.8	13	12	12.61
	-1.19	-1.24	-1.31	-1.16	-1.22	-3.55	-3.58	-3.6	-3	-3.55
T_7 NAA 20 ppm	1.28	1.34	1.53	1.19	1.33	12	12.1	12.2	10	11.6
	-1.13	-1.16	-1.24	-1.09	-1.15	-3.46	-3.47	-3.49	-3	-3.41
T_8 NAA 40 ppm	1.33	1.36	1.47	1.15	1.33	12.1	12.3	12.5	10	11.73
	-1.15	-1.17	-1.21	-1.07	-1.15	-3.48	-3.5	-3.53	-3	-3.42
T_9 NAA 60 ppm	1.36	1.43	1.48	1.21	1.37	12.5	12.6	12.8	10	11.97
	-1.17	-1.19	-1.22	-1.1	-1.17	-3.53	-3.55	-3.58	-3	-3.46
T_{10} Control	1.26	1.3	1.35	1.12	1.26	11	11.4	11	10	10.8
	-1.12	-1.14	-1.16	-1.06	-1.12	-3.32	-3.35	-3.32	-3	-3.29
Mean	1.3	1.41	1.53	1.27		12.1	12.4	12.6	11	
	-1.14	-1.19	-1.24	-1.13		-3.47	-3.52	-3.56	-3	
sLsd (Pd"0.05)	Treatment (T) 0.04 Intervals (I) 0.02 T X I NS					Treatment (T) 0.05 Intervals (I) 0.03 T X I 0.09				

retained more ascorbic acid in mature green fruits and during storage. Similar findings were also reported in ber (Yadav *et al.*, 2003). Fruits treated with 60 ppm NAA (T_9) recorded the highest TSS/acid ratio of 8.01 at harvest while as on the 15th day of storage fruits treated with 20 ppm GA_3 (T_4) retained highest TSS/acid ratio of 9.72. Highest mean TSS/acid ratio (9.03) obtained in fruits treated with 40 ppm GA_3 (T_5) and was found to be at par with T_4. Minimum mean TSS/acid ratio

Table 2: Effect of pre-harvest sprays of various chemicals on Acidity (%),TSS/acidity ratio, ascorbic acid content (mg/100 g) and juice content (%) during ambient storage in plum cv. Santa Rosa (Prunus salicina L.)

	Acidity (%) Storage intervals in days (I)					TSS/acidity ratio Storage intervals in days (I)				
	0	5	10	15	Mean	0	5	10	15	Mean
T_1 $CaCl_2$ 0.1 %	1.590(1.261)	1.378(1.174)	1.315(1.138)	1.244(1.152)	1.397(1.181)	7.48	8.92	9.43	9.24	8.77
T_2 $CaCl_2$ 0.3 %	1.596(1.263)	1.416(1.190)	1.338(1.156)	1.288(1.135)	1.409(1.184)	7.57	8.90	9.72	9.39	8.89
T_3 $CaCl_2$ 0.5 %	1.614(1.270)	1.437(1.199)	1.379(1.174)	1.327(1.103)	1.411(1.186)	7.56	9.05	9.72	9.49	8.95
T_4 GA_3 20 ppm	1.584(1.259)	1.387(1.177)	1.303(1.141)	1.233(1.110)	1.377(1.172)	7.57	8.94	9.82	9.72	9.01
T_5 GA_3 40 ppm	1.587(1.260)	1.385(1.177)	1.315(1.147)	1.245(1.116)	1.383(1.175)	7.75	9.10	9.79	9.48	9.03
T_6 GA_3 60 ppm	1.602(1.265)	1.392(1.184)	1.355(1.168)	1.300(1.145)	1.410(1.185)	7.88	9.19	9.59	9.23	8.97
T_7 NAA 20 ppm	1.567(1.251)	1.349(1.161)	1.254(1.119)	1.196(1.094)	1.341(1.157)	7.63	8.93	9.73	8.53	8.70
T_8 NAA 40 ppm	1.573(1.254)	1.346(1.160)	1.298(1.139)	1.217(1.103)	1.358(1.164)	7.68	9.10	9.63	8.30	8.68
T_9 NAA 60 ppm	1.554(1.248)	1.358(1.165)	1.307(1.143)	1.217(1.103)	1.359(1.165)	8.01	9.28	9.80	8.22	8.83
T_{10} Control	1.551(1.247)	1.318(1.148)	1.186(1.089)	1.156(1.075)	1.303(1.141)	7.09	8.65	9.27	8.48	8.37
Mean	1.581(1.258)	1.376(1.174)	1.305(1.142)	1.242(1.114)		7.62	9.01	9.65	9.01	
Lsd (Pd"0.05)	Treatment (T) 0.004 Intervals(I)0.003 T X I 0.008					Treatment (T) 0.60 Intervals (I) 0.40 T X I NS				

	ascorbic acid content (mg/100 g) Storage intervals in days (I)					juice content (%) Storage intervals in days (I)				
	0	5	10	15	Mean	0	5	10	15	Mean
T_1 $CaCl_2$ 0.1 %	7.00	6.85	6.30	5.90	6.51	62.33	58.25	50.63	43.80	53.75
T_2 $CaCl_2$ 0.3 %	7.10	7.00	6.41	5.99	6.62	62.76	59.60	49.50	45.95	54.45
T_3 $CaCl_2$ 0.5 %	7.18	7.11	6.45	6.00	6.69	62.94	60.00	51.00	46.35	55.07
T_4 GA_3 20 ppm	6.80	6.60	6.21	5.84	6.36	58.00	51.00	43.51	38.35	47.71
T_5 GA_3 40 ppm	6.90	6.71	6.25	5.92	6.44	58.33	52.45	44.22	39.01	48.50
T_6 GA_3 60 ppm	6.84	6.72	6.35	5.97	6.47	60.16	54.66	44.75	39.41	49.74
T_7 NAA 20 ppm	6.46	6.20	5.80	5.30	5.94	57.00	49.00	42.00	35.00	45.75
T_8 NAA 40 ppm	6.50	6.29	5.83	5.35	5.99	56.54	49.95	43.21	36.11	46.22
T_9 NAA 60 ppm	6.50	6.31	5.82	5.31	5.99	56.30	49.32	43.00	35.58	46.06
T_{10} Control	6.40	6.00	5.43	5.03	5.72	54.95	48.95	40.00	35.00	44.72
Mean	6.77	6.58	6.09	5.66		58.93	53.32	45.18	39.46	
Lsd (Pd"0.05)	Treatment (T) 0.05 Intervals (I) 0.03 T X I 0.08					Treatment (T) 2.30 Intervals (I) 2.41 T X I 4.80				

(8.37) was recorded in control (T_{10}). The maximum juice content (62.94%) at harvest were recorded in T_3 (0.5% $CaCl_2$) and it was found to be at par with 0.3 % $CaCl_2$ (62.76%) and 0.1 % $CaCl_2$(62.33%). Juice content in all the treatments showed a gradual decline at various storage intervals while as fruits treated with 0.5 % $CaCl_2$retained maximum juice content at all storage intervals. Highest mean juice content during storage (55.07%) was recorded in fruits treated with 0.5 % $CaCl_2$ (T_3) and it was to be found at par with T_2(54.45%) and T_1(53.75%), respectively. Minimum mean juice content (44.72%) was recorded with control. Interaction between treatments and storage intervals was found to be significant. From the studies, if may be concluded that preharvest application of $CaCl_2$ at 0.5% proved most beneficial in enhancement of quality in terms of improving TSS and sugar as well as prolonged shelf-life under ambient storage conditions. Hence, it represents the best preharvest treatment for getting better quality plum 'Santa Rosa' to the orchardist for better remuneration.

REFERENCES

A.O.A.C. 1984. Official Methods of Analysis. Association of the Analytical Chemists 10th edition. *Benjamin Franklin Station, Washington, D.C.* **20(40):** 271-273.

Anonymous, 2013. *Area and Production of Fruit plants*, Directorate of Horticulture, Govt. of Jammu and Kashmir, Srinagar.(http://hortikashmir.gov.in/AreaProd.html#)

Cochran, G. C. and Cox, G. M. 1963. Experimental Designs. *Asia Publishing Home, Bombay*. p. 611.

Das, R. C. and Dash, J. 1967. The effect of wax emulsion, 2, 4-D and 2, 4, 5-T on storage behaviour of Mausambi fruits (*Citrus sinensis* L.). *Proceedings International Symposium on Subtropical and Tropical Horticulture, New Delhi*, pp. 104-107.

Dong, Li., Zhou, H. W., Sonega, L., Lers, A. and Lurie, S. 2001. Ripening of "Red Rosa" plums:effect of ethylene and 1-methylcyclopropane. *Aust. J. Plant. Physiol.* **28:** 1039-1045.

Hulme, A. C. 1958. Some aspects of biochemistry of apple and pear fruits. *Advances in Food Research.* **8:** 297-395.

Mahajan, B. V. C., Ghuman, B. S and Harsimrat, K. B. 2011. Effect of post harvest treatments of calcium chloride and Gibberellic acid on storage behavior and quality of guava fruits. *J. Horticultural Science and Ornamental Plants.* **3(1):** 38-42.

Monica, R., Kaul, R. K., Bhat, A. and Sharma, S. K. 2013. Response of post harvest treatments on nutritionalcharacteristics and shelf life of litchi (cv. Dehradun). *The Bioscan.* **8(4):** 1219-1222.

Ranganna, S. 1986. Manual of analysis of fruits and vegetable products. *Tata McGraw Hill Publishing Co. Ltd., New Delhi.* p. 524.

Rani, R. and Brahmachari, V. S. 2003. Effect of foliar application of chemicals on quality characters of mango during storage. *Progressive Horticulture.* **35(2):** 216-218.

Rhodes, M. J. C., Wooltorten, L. S. C., Galliard, T. and Hulme, A. C. 1968. Metabolic changes in excised fruit tissue. I. Factors affecting the development of a melate decarboxylation system during the ageing of discs of preclimacteric apples. *Phytochemistry.* **7:** 459-462.

Sharad, B., Thakur, R. S. and Tembhare, D. 2014. Effect of calcium nitrate and gibberellic acidapplication on growth, fruit quality and post harvestbehaviour of guava fruit. *The Ecoscan.* **VI:** 55-62.

Sharples, R. O. and Johnson, D. S. 1977. The influence of calcium senescence changes in apple. *Annual Applied Biology.* **85:** 450-454.

Shazia, H, Mir, M. A, Singh, D. B, Hayat, N and Khan, F. U.

2013.Effect of post-harvest treatment and storage conditions on quality of plum cv. Santa Rosa. *Progressive Horticulture*. **45:** No. 1,

Shear, C. B. and Faust, M. 1971. Value of various tissue analysis indetermining the calcium status of the apple tree and fruit. [Ed. R.M. Samiah]. *Plant Annul. Fert. Probl. Res. Adv. Plant Nut.***1:** 75-98.

Ulrich, R. 1974. Organic acids. In : *Biochemsitry of Fruit and their Products* (Ed. A.C. Hulme). *Vol. I. Academic Press, London and New York*. pp. 189-218.

Valero, D., Perez, V. A., Martinez, R. D., Castillo, S., Guillen, G., Serrano, M. 2002. Plum storability improved after calciumand heat postharvest treatments: role of polyamines. *J. Food Science*. **67:** 2571-5.

Westwood, M. N. 1993. Temperate Zone Pomology. *W.H. Freeman and Company, San Francisco, California, USA*. p. 223.

Yadav, I. J., Sharma, R. K., Siddiqui, S. and Godara, R. K. 2003. Effect of pre harvest sprays of calcium on fruit physical characteristics, quality and peel pigmentation of ber (*Zizyphus mauritiana* Lamk.) cv. Umran. *Haryana J. Horticultural Science*. **32(1-2):** 75-76.