THE ASIAN JOURNAL OF HORTICULTURE
Volume **8** | Issue 2 | December, 2013 | 581-587

Research Paper

***Article history* :**
Received : 11.07.2013
Revised : 25.09.2013
Accepted : 09.10.2013

Effect of pre harvest spray and post harvest dipping of fruit on shelf life and quality of papaya

LOKESH YADAV[1] AND **D.K. VARU**

Members of the Research Forum

Associated Authors:
[1]Department of Horticulture, College of Agriculture, Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA

Author for correspondence :
D.K. VARU
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA
Email : dkvaru@jau.in

ABSTRACT : An experiment was conducted to study the pre harvest spray and post harvest dipping of fruit on shelf life and quality of papaya (*Carica papaya* L.) cv. Madhubindu was carried out at Fruit Research Station, Lalbaug and P.G. Research Laboratory, Department of Horticulture, Junagadh Agricultural University, Junagadh during 2013. The experiment was laid out in Completely Randomized Design (Factorial) in two factors with three replications. There were two factors comprised of pre harvest spray *i.e.* water spray (S_1), GA_3 15 ppm (S_2), alar 500 ppm (S_3), GA_3 15 ppm + caobendazim 0.05% (S_4) and alar 500 ppm + caobendazim 0.05% (S_5) along with post harvestdipping *i.e.* water (D_1), $CaCl_2$ 1% (D_2) and $Ca(NO_3)_2$ (D_3).The pre harvest spray of GA_3 15 ppm + carbendazim 0.05% and post harvest dip in $CaCl_2$ 1% individually as well as their combination (S_4D_2) were found to be more effective in reducing physiological loss in weight, highest percentage of marketable fruit, lowest percentage of ripened fruit, lowest days to start ripening and highest shelf life. Similarly for biochemical parameters and organoleptic score, highest TSS, lowest acidity, highest ascorbic acid, total sugar, vitamin A and fungus intensity as well as organoleptic parameters like color, texture, taste, flavor and overall acceptability were also found better in GA_3 @ 15 ppm + carbendazim 0.05% as pre harvest spray and $CaCl_2$ 1% (D_1) as post harvest dip. The interaction effect was also found significant and better performance was observed in treatment combination S_4D_2.

KEY WORDS : Papaya, Pre harvest, Post harvest, Shelf life, Quality

HOW TO CITE THIS ARTICLE : Yadav, Lokesh and Varu, D.K. (2013). Effect of pre harvest spray and post harvest dipping of fruit on shelf life and quality of papaya. *Asian J. Hort.*, **8**(2) : 581-587.

Papaya (*Carica papaya* L.)is cultivated in the tropical and sub-tropical regions of the world. It is a native of tropical America and was introduced in India in the 16th century. It is now grown in all the tropical and subtropical countries of world. The total cultivated area and production are 1.22 lakh ha and 47.42 lakh MT, respectively (Anonymous, 2012). Papaya provides cheap source of vitamins and minerals in the daily diet of the people. It is an abundant source of carotene (2020 IU/100g, precursor of vitamin A). Papaya fruits are used for the treatment of piles, dyspepsia of spleen and liver, digestive disorders, diphtheria and skin blemishes. The fruits of excellent quality are produced under mild-subtropical climates where a dry warm sunny climate tends to add the sweetness of the fruit. It is suitable for growing in kitchen garden, monoculture and most suitable to grow an intercrop in mango orchard.

Pre and post harvest application of different growth regulators and chemicals which improves the post harvest quality of fruit. There is great role of gibberallic acid and growth retardant like alar to hasten not only shelf life of fruit but also improves the post harvest quality of fruits. Calcium is also known to play an important role in the quality retention of fruit in maintaining the firmness, reducing respiration rate and ethylene evolution and decreasing rot. Papaya is climacteric types of fruits ripened after harvesting. However, due perishable nature of fruit, the shelf life and post harvest quality of fruit is very poor. Hence, the study was conducted to investigate the pre harvest spray and post harvest dipping treatments on shelf life and quality of papaya.

RESEARCH METHODS

The present investigation was conducted by applying effect of pre harvest spary and post harvest dipping of fruit on shelf life and quality of papaya (*Carica papaya* L.) cv. Madhubindu was carried out at the Lalbaug, Fruit Research Station and P. G. Research Laboratory, Department of

Horticulture, Junagadh Agricultural University, Junagadh during 2013. The experiment was laid out in Completely Randomized Design (Factorial) with three replications. The treatment comprised with two factors like pre harvest spray and post harvest dipping treatment. The treatments of pre harvest spray were water spray (S_1), GA_3 @ 15 ppm (S_2), Alar @ 500 ppm (S_3), GA_3 @ 15 ppm + carbendazim 0.05% (S_4) and Alar @ 500 ppm + carbendazim 0.05% (S_5) whereas, for post harvest, water dip (D_1), $CaCl_2$ 1% (D_2) and $Ca(NO_3)_2$ 2% (D_3). The GA_3, alar and combination of carbendazim were sprayed as per treatment. The sprays of respective treatments were applied before 15 day of harvesting. The fruit which reaches to maturity showing slight streaks of yellowish color were harvested. Fruits with uniform size, shape, color and maturity were harvested and selected for post harvest dipping. For post harvest treatment the fruits were washed with clean water and dried with muslin cloth. Then the fruits were dipped for five minutes in different dipping solution as per treatment.After dipping treatment, the fruits were air dried at ambient temperature for 30 minutes in an attempt to reduce possible chemical injury and stored under ambient condition. The control fruits were dipped for five minutes in the distilled water without using the chemical solution. The observations on different physical and chemical parameter including sensory evaluation were recorded at 2, 4, 6 and 8 days of storage.

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Physiological loss in weight (%) :

The variation in physiological loss in weight was observed significant due to different treatment. Significantly lowest physiological loss in weight (7.22, 7.46, 7.89 and 8.52%) was noted in treatment GA_3 15 ppm + carbendazim 0.05% (S_4) during 2, 4, 6 and 8 days of storage, respectively. However, it was found at par with treatment GA_3 @ 15 ppm (S_2) during all days of storage. The reduction in weight loss may be due to reduced loss in moisture through transpiration. Similar results have also been reported by Yadav *et al.* (2006) in Nagpur mandarin and orange and Singh *et al.* (2008) in papaya.

In case of post harvest dipping, lowest physiological loss in weight (7.11, 7.43, 7.72 and 8.19%) was registered in $CaCl_2$ 1% (D_2) during all days of storage, respectively. But was found at par with $Ca(NO_3)_2$ 2% (D_3) during 2, 4 and 8 days of storage. Calcium treatments have been found to be effective in terms of membrane functionality and integrity which may be resulted for the lower weight loss found in calcium treated fruits. Similar results have also been reported by Singh *et al.* (2012) and Rajkumar *et al.* (2005) in papaya. For interaction effect, the result was found non significant during all days of storage except 8 days and lowest physiological loss in weight (7.17%) was noted with treatment combination S_4D_2 (Table 1 and 2).

Marketable fruits (%) :

The similar trend of PLW was observed for marketable fruit and significantly highest percentage of marketable fruit was recorded in treatment S_4 followed by S_5. Likewise, minimum marketable fruit was noted in control (S_1).

Table 1 : Effect of pre and post-harvest treatment on PLW%, Marketable fruit %, Ripened fruit %, spoiled fruit%, days to start ripening and shelf life during all days of storage

Treatments Days	PLW %				Marketable fruit %		Ripened fruit %				Spoiled fruit (%)			Days to start ripening	Shelf life
	2	4	6	8	4	6	2	4	6	8	4	6	8	Days	Days
Pre harvest treatment															
S_1	8.39	8.81	9.17	10.08	28.78	23.00	41.33	86.00	99.11	0.00	27.89	65.33	85.00	2.25	5.42
S_2	7.48	7.83	8.09	8.78	33.22	30.00	3.32	52.67	63.00	99.22	18.17	59.33	79.67	2.49	5.93
S_3	7.66	7.94	8.29	9.02	33.56	33.33	4.56	51.33	65.00	98.23	17.03	66.00	83.78	2.73	6.23
S_4	7.22	7.46	7.89	8.52	43.33	38.67	0.00	33.33	39.67	67.44	14.39	43.56	71.33	3.52	8.02
S_5	7.79	8.04	8.37	8.70	40.11	36.11	1.30	45.44	45.44	94.11	17.67	49.78	77.44	2.89	7.19
S.E.±	0.16	0.15	0.16	0.14	0.44	0.49	0.16	0.37	0.34	0.29	0.20	0.22	0.24	0.04	0.09
C.D. (P=0.05)	0.46	0.43	0.46	0.41	1.26	1.41	0.45	1.06	0.98	0.84	0.59	0.65	0.70	0.10	0.25
Post-harvest treatment															
D_1	8.57	8.89	9.26	10.27	13.13	9.87	13.67	66.07	70.27	74.93	27.19	63.27	91.67	2.66	5.79
D_2	7.11	7.43	7.72	8.19	52.20	45.47	8.20	44.03	55.63	70.00	14.80	51.57	72.67	2.87	7.51
D_3	7.43	7.73	8.10	8.61	42.07	41.33	8.38	55.17	61.43	70.47	15.10	55.57	74.00	2.80	6.39
S.E.±	0.12	0.12	0.12	0.11	0.34	0.38	0.12	0.29	0.26	0.23	0.16	0.17	0.19	0.03	0.07
C.D. (P=0.05)	0.36	0.33	0.36	0.32	0.98	1.09	0.35	0.82	0.76	0.65	0.46	0.50	0.54	0.08	0.19
CV %	6.18	5.58	5.76	4.73	3.65	4.56	4.68	2.06	1.64	1.22	3.22	1.19	0.92	3.82	3.96

However, the percentage of marketable fruit was decreased with increasing the storage period. It is true that as storage period increased which leads to reduce the quality of fruit and hence, marketable fruit is reduced. Similar results have also been reported by Golhani *et al.* (2013) and Kumar *et al.* (2004) in custard apple. The marketable fruit was also highest during dipping the fruit in $CaCl_2$ 1% (D_2). Untreated fruit (D_1) retained less marketable fruit. The interaction was also found significant and highest marketable fruits were noted in treatment combination S_4D_2 (Table 1 and 2).

Spoilage fruits (%) :

The variation in spoiled fruit was also observed significant (Table 1 and 2) and lowest spoiled fruit was recorded in treatment $S_4$for pre harvest spray and $CaCl_2$ 1% (D_2) for post harvest dipping treatment.Highest spoiled fruit was recorded in control. This may be due to treatment effect with retarded ripening and reduced weight loss through controlled transpiration and respiration rates and delayed the disintegration of ripening. The similar findings were reported by Yadav *et al.* (2006) in mandarin and Patel *et al.* (2011) in

Table 2 : Interaction effect of PLW, marketable, spoiled, ripened fruit, days to start ripening, and shelf life during all days of storage

Treat. (S×D)	PLW %	Mart. fruit %		Ripened fruit (%)				Days to ripening	Shelf life	Spoiled fruit %		
	8	4	6	2	4	6	8	(Days)	(days)	4	6	8
S_1D_1	12.00	16.00	9.00	45.00	99.00	100	0.00	2.13	5.27	30.33	81.33	100
S_1D_2	9.17	30.00	20.00	40.00	80.00	99.00	0.00	2.20	5.67	24.33	50.33	79.67
S_1D_3	9.07	40.33	40.00	39.00	79.00	98.33	0.00	2.42	5.33	29.00	64.33	75.33
S_2D_1	9.40	10.00	10.00	9.67	40.00	60.00	100.00	2.50	5.33	30.00	72.67	93.00
S_2D_2	8.50	40.33	40.00	0.00	39.00	50.00	99.33	2.52	6.17	12.83	54.67	75.67
S_2D_3	8.43	49.33	40.00	0.00	79.00	79.00	98.33	2.47	6.10	11.67	50.67	70.33
S_3D_1	10.00	10.00	10.00	10.33	90.00	90.00	99.67	2.72	5.27	24.50	60.00	88.67
S_3D_2	8.10	50.00	50.00	1.00	20.00	49.00	97.33	2.89	7.17	15.17	77.50	82.33
S_3D_3	8.97	40.33	40.00	2.33	44.00	56.00	97.70	2.58	6.27	11.41	60.50	80.33
S_4D_1	10.33	9.67	10.33	0.00	40.17	40.17	78.33	3.10	7.13	21.00	50.00	92.00
S_4D_2	7.17	80.00	66.33	0.00	20.00	39.00	60.00	3.83	9.50	10.17	39.67	51.00
S_4D_3	8.07	40.33	39.93	0.00	39.83	39.83	64.00	3.61	7.43	12.00	41.00	71.00
S_5D_1	9.60	20.00	10.00	3.33	61.17	61.17	96.67	2.86	5.73	30.10	52.33	84.67
S_5D_2	8.00	60.33	51.00	0.00	41.17	41.17	93.33	2.90	9.03	11.50	35.67	74.67
S_5D_3	8.50	40.00	47.33	0.57	34.00	34.00	92.33	2.92	6.80	11.40	61.33	73.00
S.E..±	0.25	0.76	0.85	0.27	0.64	0.59	0.50	0.06	0.15	0.35	0.39	0.42
C.D. (P=0.05)	0.71	2.18	2.45	0.79	1.84	1.10	1.46	0.18	0.43	1.02	1.13	1.22
C.V. %	4.73	3.65	4.56	4.68	2.06	1.64	1.22	3.82	3.96	3.22	1.19	0.92

Table 3: Effect of pre and post-harvest dipping on TSS, acidity, ascorbic acid, total sugar and reducing sugar during all days of storage

	4	6	8	4	6	8	4	6	8	4	6	8	4	6	8
S_1	6.83	8.27	7.36	0.39	0.25	0.15	26.22	39.48	33.74	16.67	17.68	11.79	1.49	2.34	1.17
S_2	7.21	9.06	7.61	0.36	0.19	0.15	28.35	42.20	33.16	18.93	20.15	11.08	1.44	2.21	1.28
S_3	7.43	9.10	7.83	0.37	0.20	0.14	27.99	41.61	34.17	19.82	21.93	11.24	1.34	2.31	1.36
S_4	8.26	10.44	9.78	0.34	0.18	0.12	31.22	44.37	36.64	20.70	22.25	19.44	1.56	3.12	1.72
S_5	7.49	9.78	8.11	0.37	0.18	0.13	29.09	42.61	34.40	18.25	21.34	16.67	1.61	2.62	1.63
S.E..±	0.15	0.17	0.11	0.004	0.003	0.003	0.17	0.262	0.264	0.43	0.26	0.18	0.01	0.03	0.01
C.D.(P=0.05)	0.42	0.50	0.31	0.011	0.008	0.008	0.49	0.75	0.76	1.25	0.74	0.53	0.03	0.08	0.03
B. P															
D_1	6.97	8.90	7.88	0.38	0.21	0.15	28.00	41.69	32.62	17.08	19.02	12.60	1.28	2.30	1.16
D_2	7.75	9.85	8.53	0.36	0.19	0.13	29.58	42.72	35.89	22.10	23.23	15.11	1.66	2.65	1.73
D_3	7.62	9.23	8.00	0.37	0.20	0.14	28.14	41.75	34.76	17.44	19.76	14.43	1.53	2.60	1.40
S.E..±	0.11	0.13	0.08	0.003	0.002	0.002	0.13	0.20	0.20	0.34	0.20	0.14	0.01	0.02	0.01
C.D.(P=0.05)	0.33	0.38	0.24	0.008	0.006	0.006	0.38	0.59	0.59	0.97	0.57	0.41	0.02	0.06	0.02
C.V. %	5.87	5.53	3.97	3.05	4.39	6.00	1.77	1.87	2.30	6.89	3.72	3.91	1.83	3.39	1.85

custard apple. The similar trend of pre and post harvest treatment was observed in interaction effect and minimum spoiled fruit was noted in treatment combination S_4D_2 during all days of storage.

Ripened fruit (%) :

Ripening is physiological process which insists the conversion of starch to sugar. Hence, ripening is increased with increasing storage period. Significantly, lowest per cent of ripen fruits was noted in GA_3 15 ppm + Carbendazim 0.0 5% (S_4) as well as post harvest dipping in $CaCl_2$ 1% (D_2) during 4, 6 and 8 days of storage. Delay in ripening by use of GA_3 as pre harvest spray and $CaCl_2$ as post harvest dipping inhibited the enzyme activities during ripening and it had antagonistic effects on the biogenesis of endogenous ethylene. The result is in confirmation with those of Sudhavani and Ravisankar (2002) in mango and Rajput (2008) in papaya (Table 1).

The interaction for ripened fruit was also found significant and lowest ripened fruit was noted in S_4D_2 (Table 2).

Days to start ripening and shelf life (days) :

Highest day to start ripening and shelf life of fruit (3.52 and 8.02 days) were recorded in treatment S_4 followed by S_5, respectively. GA_3 is the growth promoter which suppresses the concentration of ethylene and the ripening is delayed. For post harvest dipping, maximum days to start ripening and shelf life (2.87 and 7.51 Days) was observed in $CaCl_2$ 1% (D_2), which was at par with D_3. Calcium also enhances shelf life of fruit resulted in delay ripening. For interaction effect, the result was found significant and better results were noted in treatment combinationS_4D_2. Similar trending were reported by Rajput *et al.* (2008) and Ramakrishna *et al.* (2001) in papaya. The interaction effect was also found significant and maximum days to ripening and shelf life were noted in treatment combinations.

Total soluble solids (B^0):

The variation in TSS was found significant and highest total soluble solids (8.04, 8.26, 10.44 and 9.78 ^{0}Brix) was recorded in GA_3 @ 15 ppm + carbendazim 0.05% (S_4) followed by treatment S_5. While, minimum total soluble solids was recorded in control (S_1). This might be due to quick metabolic transformation in soluble compounds and delay in repining and senescence. These results confirm the report of Rajkumar *et al.* (2005) in papaya .Similarly for post harvest treatment, highest total soluble solids (7.47, 7.75, 9.85 and 8.53 ^{0}Brix) was recorded in $CaCl_2$ 1% (D_2) during 2, 4, 6 and 8 days of storage, respectively. However, it was found at par with $Ca(NO_3)_2$ 2 % (D_3) during 2 and 4 days of storage. Minimum total soluble solid was noted in D_1. The result was also noted by Rajput *et al.* (2008) in papaya and Singh *et al.* (1998) in mango (Table 3). The interaction effect was also found significant and highest total soluble solid was registered in treatment combination (S_4D_2)

Table 4: Interaction effect of pre and post-harvest dipping on TSS, acidity, Ascorbic acid, total sugar and reducing sugar during all days of storage

Treatments (S×D)	TSS (^{0}Brix)			Acidity (%)			Ascorbic acid (mg/100g)			Total sugar (%)			Reducing sugar (%)		
	4	6	8	4	6	8	4	6	8	4	6	8	4	6	8
S_1D_1	6.50	7.87	6.73	0.41	0.28	0.16	26.00	38.10	32.25	17.67	18.00	9.97	1.11	2.04	0.88
S_1D_2	6.83	8.93	7.83	0.39	0.24	0.14	26.00	40.33	35.16	16.33	17.00	13.53	1.56	2.54	1.42
S_1D_3	7.17	8.00	7.50	0.36	0.25	0.15	26.67	40.00	33.80	16.00	18.03	11.87	1.81	2.43	1.22
S_2D_1	6.67	8.50	7.33	0.38	0.21	0.15	28.35	42.83	30.76	15.10	15.36	10.50	1.41	2.00	1.02
S_2D_2	7.67	9.17	7.67	0.33	0.187	0.15	28.82	42.76	35.49	23.07	24.77	11.89	1.31	2.31	1.32
S_2D_3	7.30	9.50	7.83	0.37	0.190	0.15	27.87	41.02	33.22	18.61	20.33	10.87	1.60	2.32	1.51
S_3D_1	7.33	8.97	8.17	0.36	0.197	0.15	27.00	41.00	31.57	20.33	22.80	10.20	1.50	2.21	1.54
S_3D_2	7.10	9.50	8.00	0.38	0.193	0.14	28.00	42.32	34.89	22.30	23.00	11.45	1.31	2.31	1.32
S_3D_3	7.87	8.83	7.33	0.38	0.20	0.14	28.98	41.50	36.06	16.82	20.00	12.08	1.21	2.41	1.21
S_4D_1	7.83	9.50	9.00	0.36	0.19	0.14	30.00	44.83	35.67	17.24	18.94	16.00	1.16	3.00	1.16
S_4D_2	9.00	12.00	11.00	0.32	0.16	0.10	35.33	45.00	38.00	25.10	27.37	22.00	2.09	3.10	2.50
S_4D_3	7.93	9.83	9.33	0.34	0.18	0.11	28.33	43.27	36.27	19.76	20.43	20.33	1.42	3.25	1.51
S_5D_1	6.50	9.67	8.17	0.36	0.20	0.13	28.67	41.67	32.83	15.04	20.00	16.33	1.21	2.26	1.22
S_5D_2	8.13	9.67	8.17	0.37	0.19	0.12	29.74	43.17	35.93	23.70	24.03	16.67	2.02	3.00	2.11
S_5D_3	7.83	10.00	8.00	0.37	0.187	0.14	28.86	42.98	34.43	16.00	20.00	17.00	1.59	2.61	1.57
S.E..±	0.25	0.30	0.19	0.006	0.005	0.005	0.29	0.45	0.47	0.75	0.44	0.32	0.02	0.05	0.02
C.D. (P=0.05)	0.73	0.86	0.54	0.019	NS	0.014	0.84	1.31	1.35	2.17	1.28	0.92	0.05	0.14	0.04
C.V. %	5.87	5.53	3.97	3.05	4.23	6.00	1.77	1.87	2.35	6.89	3.72	3.91	1.83	3.39	1.85

during 2, 4, 6 and 8 days of storage, respectively (Table 4).

Acidity (%) :

In case of acidity, the similar trend was observed and lowest acidity was noted in treatment S_4 for pre harvest spray and D_2 for post harvest dipping. Whereas, maximum acidity was recorded in control. The reduction in acidity during storage might be associated with the conversion of organic acids into sugar and their derivatives or their utilization in respiration. Similar results have also been reported by Singh

Table 5 : Effects of pre and post-harvest dipping on vitamin 'A' during all days of storage

Sr. No.	vitamin 'A' (IU/100g)				Treatments (S×D)	vitamin 'A' (IU/100g)			
	2 days	4 days	6 days	8 days		2 days	4 days	6 days	8 days
Pre harvest treatments					S_1D_1	713.33	858.67	1045.00	930.00
S_1	685.56	859.92	1047.67	928.11	S_1D_2	700.00	871.10	1015.00	863.33
S_2	800.00	1005.56	1213.78	1115.00	S_1D_3	643.33	850.00	1083.00	991.00
S_3	788.00	922.00	1100.00	1040.00	S_2D_1	833.33	960.00	1193.33	1030.00
S_4	846.62	1284.44	1475.89	1224.78	S_2D_2	790.00	1030.00	1231.33	1090.00
S_5	817.78	1060.00	1376.29	1109.11	S_2D_3	776.67	1026.67	1216.67	1225.00
S.E.±	7.93	14.12	13.44	13.72	S_3D_1	823.33	885.00	1083.33	1200.00
C. D. (P=0.05)	22.89	40.77	38.81	39.61	S_3D_2	764.00	916.67	1216.67	1030.00
Post harvest treatments					S_3D_3	776.67	964.33	1000.00	890.00
D_1	763.77	980.07	1189.00	1040.20	S_4D_1	672.20	1183.33	1400.00	946.67
D_2	812.13	1078.22	1311.74	1135.47	S_4D_2	956.67	1483.33	1594.33	1494.33
D_3	788.67	1020.87	1227.71	1074.53	S_4D_3	920.00	1186.67	1433.33	1233.33
S.E.±	6.14	10.93	10.41	10.62	S_5D_1	776.67	1013.33	1223.33	1094.33
C.D. (P=0.05)	17.73	31.58	30.06	30.68	S_5D_2	850.00	1090.00	1500.00	1199.67
CV%	3.02	4.13	3.24	3.80	S_5D_3	826.67	1076.67	1405.53	1033.33
					S.E±	13.73	24.45	23.27	23.76
					C.D. (P=0.05)	39.65	70.61	67.22	68.61
					C.V. %	3.02	4.13	3.24	3.80

Table 6 : Effect of pre-harvest spray and post harvest dipping on organolaptic taste of papaya cv. MADHUBINDU

Sr. No.	Treatment Details	Organoleptic Taste					Treatment (S×D)	Organoleptic Taste	
		Color	Flavour	Texture	Taste	Overall acceptability		Taste	Overall acceptability
Pre-harvest spray							S_1D_1	2.00	2.33
S_1	Water spray	3.28	2.23	3.11	2.73	3.21	S_1D_2	3.12	3.20
S_2	GA_3 @ 15 ppm	3.88	2.74	3.84	3.49	4.04	S_1D_3	3.07	4.10
S_3	Alar @ 500 ppm	5.00	3.99	4.40	5.39	4.31	S_2D_1	3.13	4.30
S_4	GA_3 @ 15 ppm + Carbendazim 0.05%	6.31	4.37	5.38	6.33	6.29	S_2D_2	4.33	4.80
S_5	Alar @ 500 ppm + Carbendazim 0.05%	5.54	4.11	4.86	6.12	5.54	S_2D_3	3.00	3.03
S.E..±		0.17	0.13	0.09	0.07	0.12	S_3D_1	5.97	4.57
C.D. (P=0.05)		0.50	0.37	0.26	0.20	0.35	S_3D_2	4.60	3.27
Post harvest Treatment							S_3D_3	5.60	5.08
D_1	Water	4.47	3.27	3.99	4.21	4.37	S_4D_1	5.00	5.67
D_2	$CaCl_2$ 1%	5.25	3.95	4.55	5.41	4.91	S_4D_2	8.00	7.03
D_3	$Ca(NO_3)_2$ 2%	4.70	3.25	4.41	4.81	4.75	S_4D_3	6.00	6.17
S.E.±		0.13	0.10	0.07	0.05	0.10	S_5D_1	4.97	5.00
C.D. (P=0.05)		0.39	0.28	0.20	0.15	0.27	S_5D_2	7.00	6.27
C.V. %		7.50	8.00	6.19	4.28	7.86	S_5D_3	6.40	5.37
Interaction		NS	NS	NS	SIG.	SIG.	S.E.±	0.12	0.21
							C.D. (P=0.05)	0.34	0.61
							C.V. %	4.28	7.86

NS=Non-significant

et al. (2008) and Hoda *et al.* (2000) in mango.The interaction effect was also found significant and lowest acidity was observed in treatment combination (S_4D_2). Similar result was also found by Sudha *et al.* (2007) in custard apple (Table 3 and 4).

Ascorbic acid (mg/100g) :

The maximum ascorbic acid was registered in GA_3 @ 15ppm + carbesndazim 0.05% (S_4) followed by S_5 during 2, 4, 6 and 8 days of storage. Likewise, lowest ascorbic acid content was recorded in control (S_1). The result may be due to different levels of oxidation in different treatment. During storage, oxidation enzymes like ascorbic acid oxidase, peraoxidase, catalase and polyphenol oxidase might be causing decreased in ascorbic acid content of the fruits. The result is also in confirmation with those of Singh *et al.* (2008) in aonla and Patel *et al.* (2011) in custard apple. For post harvest treatment, the variation in ascorbic acid due to deferent treatment was noted significant and maximum ascorbic acid was recorded in $CaCl_2$ 1% (D_2) followed by treatment D_3. These result show that $CaCl_2$ treatment had a significant effect on retaining ascorbic acid content in papaya fruits. Similar result was found by Singh *et al.* (2012) in papaya. The interaction effect was also found significant and highest ascorbic acid was registered in treatment combination S_4D_2. Similarly, lowest ascorbic acid content was observed in S_2D_1 during 2 days, S_1D_1 during 4 and 6 days, and S_2D_1 during 8 days of storage, respectively (Table 3 and 4).

Total sugars and reducing sugar (%) :

The significant variation was also recorded for reducing sugar and total sugar. Highest reducing sugar and total sugar was noted in pre harvest spray of GA_3 @ 15 ppm + carbendazim 0.05% (S_4) followed by S_3. Similar for post harvest dipping, highest reducing and total sugar were registered in treatment D_2 followed by D_3. It was also found that sugars were increased with increasing the storage period up to 6 days of storage, but at 8 days of storage it reduced drastically. It may be due to breakdown of physiological process. The results are also in confirmation with those of Patel *et al.* (2011) in custard apple and Yuvraj *et al.* (1999) in mango (Table 3 and 4).

Vitamin 'A' (IU/100g) :

Variation in vitamin 'A' was found significant and maximum vitamin 'A' was recorded in treatment (S_4) followed by treatment S_5 during 2, 4, 6 and 8 days of storage.Whereas, lowest vitamin 'A' was noted in control (S_1). The carotenoid content in ripe papaya was higher than over-ripe papaya. Similar findings were also given by Umoh (1995) in papaya and Singh *et al.* (2012) in mango. Similar to pre harvest spray, highest vitamin 'A' was noted in $CaCl_2$ 1% (D_2) followed by D_3. Likewise, lowest vitamin 'A' was registered in control (D_1). The vitamin 'A' increased with increasing of storage period in all treatments, but reduced at 8 days. Similar result was reported by Ramakrishna and Haribabau (2007) in papaya (Table 5).

For interaction effect, the result was found significant during all days of storage and maximum vitamin 'A' was noted in treatment combination (S_4D_2). However, was found at par with combination S_4D_3 at 2 day of storage. Likewise, lowest vitamin 'A' was found in S_1D_3 during 2 and 4 days of storage (Table 5).

Organoleptic rating (mark) :

The significant variation in organoleptic score was also found and the maximum score was recorded in GA_3 15 ppm + carbendazim 0.05% (S_4) for colour, flavour, texture, taste and overall acceptability during storage. But was found at par with treatment S_5 in flavouronly. While minimum organoleptic score of papaya fruits was recorded in control for all parameters. Similar result was also noted by Kumar (2004) in custard apple. In case of post harvest dipping, the maximum organoleptic score was recorded in treatment $CaCl_2$ 1% (D_2) for colour, flavour, texture, taste and overall acceptability. While, minimum organoleptic score of papaya fruits was recorded in control (S_1). The retention of firmness in calcium treated fruits might be due to its accumulation in the cell wall leading to facilitation in the cross linking of the pectin polymers which increases stenth and cell chohesion. Similar result was also supported by Singh *et al.* (2012) in mango and White and Broadly 2003) in papaya. For interaction effect, the result was found significant for taste and overall acceptability but color, flavour and texture were found non significant. Maximum organoleptic score of papaya fruits (8.00 and 7.03) was found in pre harvest treatment GA_3 15@ ppm + carbendazim 0.05% along with post harvest dip in $CaCl_2$ 1% (S_4D_2) on taste and overall acceptability, respectively. Whereas, lowest organoleptic score of papaya fruits was noted in treatment S_1D_3 (Table 6).

REFERENCES

Anonymous (2012). Horticultural Database.National Horticulture Board, Ministry of Horticulture, New Delhi (INDIA).

Golhani, S., Pushpanjali, W. and Bisen, B.P. (2013). Studies on the effect of post harvest treatment to enhance the shelf life of custard apple. *Indian Hort. J.,* **3** (1-2): 19-22.

Hoda, M.N., Yadav, G.S., Singh, S. and Singh, J. (2000). Storage behaviour of mango hybrids. *Indian J. Agric. Sci.,* **71**: 469-472.

Kumar, S., Kumar, A., Baig, M.J. and Choubey, B.K. (2004). Effect of calcium on physico-chemical changes in aonla. *Indian J. Hort.* **62** (4) : 324-326.

Patel, N., Naik, A.G. and Shakti, S. (2011). Response of post harvest chemical treatments on shelf life and quality of custard apple cv. BALANAGAR. *Indian J. Hort.,* **68** (4): 547-550.

Rajkumar, M., Karuppaih, P. and Kandasamy, R. (2005). Effect of calcium and gibberellic acid on post harvest behavior of papaya cv. Co-2. *Indian J. Hort.,* **62** (4): 327-331.

Ramakrishna, M. and Haribabu, K. (2007). Effect of post harvest application of calcium chloride and wax emulsion on the storage life of papaya. *South Indian J. Hort.,* **50** (4-6): 323-328.

Ramakrishna, M., Haribabu, K., Reddy, Y.N. and Purushotham, K. (2001). Effect of Pre-harvest application of calcium on physio-chemical changes during ripening and storage of Papaya. *Indian J. Hort.,* **58** (1) : 228-231

Rajput, B.S., Lekhe, R., Sharma, G.K. and Singh, I. (2008). Effect of pre and post harvest treatments on shelf life and quality of papaya fruits. *Asian J. Hort.,* **3** (2): 368-371.

Singh, S., Brahmachari, V.S. and Jha, K.K. (1998). Effect of calcium and polythene wrapping on storage life of mango. *Indian J. Hort*., **55** (3): 235-239.

Singh, A.K., Joshi, H.K. and Apparao, V.V. (2008). Effect of various post harvest treatments on shelf life of aonla. *Orissa J. Hort.,* **36** (1): 8-15.

Singh, P., Kumar, S., Maji, S., Kunar, A. and Yadav, Y.D. (2012). Effect of calcium chloride on post harvestchanes in papaya fruits. *Asian J. Hort.,* **7** (1): 113-117.

Sudhavani, V. and Ravisankar, C. (2002). Effect of pre-harvest spray on the shelf life and quality of Baneshan mango fruits under cold storage. *South Indian J. Hort.,* **50** (1-3): 173-177.

Sudha, R., Amutha, R., Muthulahshmi, S., Baby Rani, W., Indira, K. and Mareeswari (2007). Influence of pre-and-post harvest chemical treatment on physical characteristics of sapota cv. PKM1. *Res. J. Agric. & Biol. Sci.,* **3** (5): 450-452.

Umoh, I.B. (1995). Chemical composition of very ripe, just ripe and unripe papaya fruits. *Hort. Tech.,* **14** : 29-38.

White, P.J. and Broadly, M.R. (2003). Calcium in plants.*Ann. Bot*., **92** : 487-511.

Yadav, M.K., Singh, P., Patel, N.L. and Bhardhan, K. (2006). Responsw of $GA_3Ca(NO_3)_2$bavistin and neem extract on the storage life of nagpur mandarin. *Indian J. Arid Hort.,* **1** (1): 80-82.

Yuvraj, K.M., Ughreja, P.P. and Jambukia, T.K. (1999). Effect of post harvest treatments on ripening changes and storage life of mango fruits.National Seminar on Food Processing, Nov., 25 & 26, G.A.U., Anand, pp 125-29.

8th Year
★★★★★ of Excellence ★★★★★