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ORIGINAL ARTICLE

Study of Pre and Post Harvest Treatment on Post Harvest Quality of Papaya

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ABSTRACT

An experiment was conducted to study the pre and post harvest treatment on quality of papaya was carried out at Laboratory as well as field of Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh during 2013. The experiment was laid out in Completely Randomized Design (Factorial) consisting two factors with three replications. There were two factors comprised pre-harvest spray i.e. 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) along with post harvest treatment i.e. water (D_1), $CaCl_2$ 1% (D_2) and $Ca(NO_3)_2$ (D_3). The pre-harvest spray and post-harvest dip individually as well as their combinations were found to be more effective and significant for biochemical parameters and organoleptic score. Highest TSS, lowest acidity, highest ascorbic acid, total sugar and vitamin A were recorded in pre-harvest spray of GA_3 @ 15 ppm + carbendazim 0.05% (S_4) as well as post harvest dip in $CaCl_2$ 1% (D_2) during all days of storage. The similar trend was also noted for organoleptic score and significantly highest score of color, flavour, texture, taste and overall acceptability were registered in pre-harvest treatment S_4 and post harvest treatment D_2.

Keywords: *Papaya, pre harvest, post harvest and shelf life.*

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INTRODUCTION

Papaya (*Carica papaya* L.) is cultivated in tropical and sub-tropical regions of the world. It is a native of tropical America and was introduced in India in the 16th century. The total cultivated area and production was 1.22 lakh ha and 47.42 lakh MT, respectively (1). 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). Papaya fruits are used for the treatment of piles, dyspepsia of spleen and liver, digestive disorders, diphtheria and skin blemishes. Pre and post harvest application of different growth regulators and chemicals 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 (6). It is climacteric fruit ripened after harvesting. However, due to perishable nature of fruit, the shelf life and post harvest quality is very poor. Hence, the study is conducted to investigate the pre harvest spray and post harvest dipping treatments on shelf life and quality of papaya.

MATERIAL AND METHODS

The present investigation was conducted by applying pre harvest spray and post harvest dipping on post harvest quality of papaya (*Carica papaya* L.) cv. Madhubindu was carried out at Laboratory as well as field of Fruit Research Station, 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 factor like pre harvest spray & post harvest dipping treatment. The treatments for 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 pre treatment. The sprayer was washed thoroughly with distilled water after application of every treatment. The spray of respective treatments were applied before 15 day of harvesting at the morning hours with the help of "Knapsack sprayer " till both leaves and fruit completely wet. Mature fruits 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, dipped for 30 seconds and dried with muslin cloth. Later fruits were dipped for five minutes in different dipping solution as per treatments. After dipping treatment, fruits were air dried at ambient temperature for 30 minutes 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 chemical parameter were recorded at 2, 4, 6 and 8 days of storage. The sensory evaluation was done on 2, 4, 6 and 8 days after storage and data generated undergone suitable analysis procedure.

RESULTS AND DISCUSSION

Total soluble solids (B^0)

The variation in total soluble solids (TSS) was found significant and recorded highest in GA_3 @ 15 ppm + carbendazim 0.05% (S_4) followed by treatment alar @ 500 ppm+carbendazim 0.05% (S_5) during 2, 4, 6 and 8 days of storage, respectively. While, minimum TSS was obtained in control (S_1). It might be due to quick metabolic transformation in soluble compounds and delay in ripining and senescence. These results was in conformity with the report of (7) in papaya. Similarly for post harvest treatment, highest TSS was obtained in $CaCl_2$ 1% (D_2) during 2, 4, 6 and 8 day 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 TSS was noted in D_1. This may be due to quick metabolic transformation in soluble compounds and more conservation of organic acids in to sugars by calcium. Similar trends were found by [9] in papaya as well as [10] in mango (Table 1).

The interaction effect was significant and registered highest TSS in treatment combination (S_4D_2) during 2, 4, 6 and 8 days of storage, respectively. However, it was at par with S_4D_3 and S_5D_2 during 2 days of storage. It was also found that TSS was increased with increased storage period up to 6 days, but reduced at 8 days of storage. While minimum TSS found in control (S_1D_1). (Table 2).

Acidity (%)

In case of acidity, similar trend was observed and lowest acidity was noted in treatment S_4 whereas, maximum acidity was obtained in control (S_1). 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 observations also been reported by (11) and (2) in mango. In case of post-harvest treatment, acidity was decreased gradually in all the treatment. Significantly lowest acidity was recorded in $CaCl_2$ 1% (D_2) and highest in control (D_1) during 2, 4, 6 and 8 days of storage, respectively. Whereas, the acidity decreased due to fermentation or break up of acids to sugars in fruits during respiration (12). The decrease in total acidity in papaya during respiration is probably due to reduced citric acid. The interaction effect was found significant and lowest acidity was observed in treatment combination (S_4D_2). This may be due to utilization of acid in the respiratory process or conversion of acid in to sugar. Similarly was also found by (13) in custard apple (Table 1 and 2).

Ascorbic acid (mg/100g)

Maximum ascorbic acid was registered in GA_3 @15 ppm+carbendazim 0.05% (S_4) followed by S_5 during 2, 4, 6 and 8 days of storage. 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 decrease in ascorbic acid content of the fruits. This result are in confirmity with (9) in aonla and (5) in custard apple. For post harvest treatment, variation in ascorbic acid due to different treatment was noticed significant and maximum ascorbic acid was recorded in $CaCl_2$ 1% (D_2) followed by treatment D_3 during 2, 4, 6 and 8 days of storage, respectively. Whereas, lowest ascorbic acid content was noted in control (D_1) during all days of storage, respectively. These result shows that $CaCl_2$ treatment had a significant effect on retaining ascorbic acid content in papaya fruits. Similar result 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 1 and 2).

Table 1: Effect of pre and post harvest dipping on TSS, acidity, ascorbic acid during all days of storage

S.N.	Treatment details	TSS %				Acidity (%)				Ascorbic acid (mg/100g)			
		2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days
A. Pre-harvest spray													
S_1	Water spray	6.67	6.83	8.27	7.36	0.47	0.39	0.25	0.15	25.45	26.22	39.48	33.74
S_2	GA_3 @ 15 ppm	6.89	7.21	9.06	7.61	0.46	0.36	0.19	0.15	24.15	28.35	42.20	33.16
S_3	Alar @ 500 ppm	7.10	7.43	9.10	7.83	0.46	0.37	0.20	0.14	25.82	27.99	41.61	34.17
S_4	GA_3 @ 15 ppm + Carbendazim 0.05%	8.04	8.26	10.44	9.78	0.44	0.34	0.18	0.12	27.33	31.22	44.37	36.64
S_5	Alar @ 500 ppm + Carbendazim 0.05%	7.37	7.49	9.78	8.11	0.45	0.37	0.18	0.13	23.56	29.09	42.61	34.40
S.Em.±		0.14	0.15	0.17	0.11	0.005	0.004	0.003	0.003	0.21	0.17	0.262	0.264
C.D. at 5%		0.39	0.42	0.50	0.31	0.014	0.011	0.008	0.008	0.61	0.49	0.75	0.76
B. Post harvest Treatment													
D_1	Water	6.73	6.97	8.90	7.88	0.46	0.38	0.21	0.15	25.09	28.00	41.69	32.62
D_2	$CaCl_2$ 1%	7.47	7.75	9.85	8.53	0.44	0.36	0.19	0.13	26.72	29.58	42.72	35.89
D_3	$Ca(NO_3)_2$ 2%	7.44	7.62	9.23	8.00	0.46	0.37	0.20	0.14	25.80	28.14	41.75	34.76
S.Em.±		0.10	0.11	0.13	0.08	0.004	0.003	0.002	0.002	0.16	0.13	0.20	0.20
C.D. at 5%		0.30	0.33	0.38	0.24	0.011	0.008	0.006	0.006	0.47	0.38	0.59	0.59
C.V. %		5.63	5.87	5.53	3.97	3.24	3.05	4.39	6.00	2.44	1.77	1.87	2.30
Interaction		SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	NS	SIG.	SIG.	SIG.	SIG.	SIG.

Table 2: Interaction effect of pre and post harvest dipping on TSS, acidity, Ascorbic acid during all days of storage

Treatment (S×D)	TSS (^{0}Brix)				Acidity (%)				Ascorbic Acid (mg/100g)			
	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days
S_1D_1	6.33	6.50	7.87	6.73	0.49	0.41	0.28	0.16	25.27	26.00	38.10	32.25
S_1D_2	6.33	6.83	8.93	7.83	0.43	0.39	0.24	0.14	25.48	26.00	40.33	35.16
S_1D_3	7.33	7.17	8.00	7.50	0.48	0.36	0.25	0.15	25.60	26.67	40.00	33.80
S_2D_1	6.00	6.67	8.50	7.33	0.46	0.38	0.21	0.15	22.67	28.35	42.83	30.76
S_2D_2	7.50	7.67	9.17	7.67	0.47	0.33	0.187	0.15	26.11	28.82	42.76	35.49
S_2D_3	7.17	7.30	9.50	7.83	0.45	0.37	0.190	0.15	23.67	27.87	41.02	33.22
S_3D_1	7.30	7.33	8.97	8.17	0.46	0.36	0.197	0.15	25.16	27.00	41.00	31.57
S_3D_2	7.00	7.10	9.50	8.00	0.44	0.38	0.193	0.14	26.15	28.00	42.32	34.89
S_3D_3	7.00	7.87	8.83	7.33	0.48	0.38	0.20	0.14	26.16	28.98	41.50	36.06
S_4D_1	7.67	7.83	9.50	9.00	0.44	0.36	0.19	0.14	26.00	30.00	44.83	35.67
S_4D_2	8.43	9.00	12.00	11.00	0.42	0.32	0.16	0.10	29.00	35.33	45.00	38.00
S_4D_3	8.03	7.93	9.83	9.33	0.45	0.34	0.18	0.11	27.00	28.33	43.27	36.27
S_5D_1	6.33	6.50	9.67	8.17	0.47	0.36	0.20	0.13	26.35	28.67	41.67	32.83
S_5D_2	8.10	8.13	9.67	8.17	0.44	0.37	0.19	0.12	26.84	29.74	43.17	35.93
S_5D_3	7.67	7.83	10.00	8.00	0.43	0.37	0.187	0.14	26.59	28.86	42.98	34.43
S.Em.±	0.23	0.25	0.30	0.19	0.008	0.006	0.005	0.005	0.36	0.29	0.45	0.47
C.D. at 5%	0.68	0.73	0.86	0.54	0.024	0.019	NS	0.014	1.05	0.84	1.31	1.35
C.V. %	5.63	5.87	5.53	3.97	3.24	3.05	4.23	6.00	2.44	1.77	1.87	2.35

Total sugars (%)

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 confirmity with those of (5) in custard apple and (16) in mango (Table 3 and 4).

Vitamin 'A' (IU/100g)

Similar for sugars, variation in vitamin 'A' was found significant. Maximum vitamin 'A' (846.62, 1284.44, 1475.89 and 1224.78 IU/100 g) was recorded in treatment (S_4) followed by treatment S_5 during 2, 4, 6 and 8 days of storage, respectively. Whereas, lowest vitamin 'A' was noted in control (S_1) during 2, 4, 6 and 8 days of storage. The value of total carotenoids in unripe papaya is raw because papaya is very low in fat and these are fat soluble pigments. The carotenoid content in ripe papaya was higher than over-ripe papaya. The finding was also given by (14) in papaya and (12) in mango (Table 3).

Similar of pre harvest spray, highest vitamin 'A' (812.13, 1078.22, 1311.74 and 1135.47 IU/100 g) was noted in $CaCl_2$ 1% (D_2) followed by D_3 and 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. The rate of increase in total carotenoid content in papaya fruits treated with post harvest dip in $CaCl_2$ 1% was also slower as compared to the fruits in control indicating their ability in showering down the process of conversion of chlorophyll to orange coloured pigments. The result was supported by (8) in papaya (Table No. 3).

Table 3: Effect of pre and post harvest dipping on total sugar, reducing sugar and vitamin A during all days of storage

S. N.	Treatment details	Total sugar (%)				Reducing sugar (%)				vitamin 'A' (IU/100g)			
		2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days
A. Pre-harvest spray													
S_1	Water spray	11.11	16.67	17.68	11.79	1.04	1.49	2.34	1.17	685.56	859.92	1047.67	928.11
S_2	GA_3 @ 15 ppm	11.39	18.93	20.15	11.08	1.16	1.44	2.21	1.28	800.00	1005.56	1213.78	1115.00
S_3	Alar @ 500 ppm	12.00	19.82	21.93	11.24	1.17	1.34	2.31	1.36	788.00	922.00	1100.00	1040.00
S_4	GA_3 @ 15 ppm + Carbendazim 0.05%	13.06	20.70	22.25	19.44	1.29	1.56	3.12	1.72	846.62	1284.44	1475.89	1224.78
S_5	Alar @ 500 ppm + Carbendazim 0.05%	12.32	18.25	21.34	16.67	1.18	1.61	2.62	1.63	817.78	1060.00	1376.29	1109.11
S.Em.±		0.15	0.43	0.26	0.18	0.01	0.01	0.03	0.01	7.93	14.12	13.44	13.72
C.D. at 5%		0.43	1.25	0.74	0.53	0.02	0.03	0.08	0.03	22.89	40.77	38.81	39.61
B. Post harvest Treatment													
D_1	Water	11.73	17.08	19.02	12.60	1.10	1.28	2.30	1.16	763.77	980.07	1189.00	1040.20
D_2	$CaCl_2$ 1%	12.43	22.10	23.23	15.11	1.27	1.66	2.65	1.73	812.13	1078.22	1311.74	1135.47
D_3	$Ca(NO_3)_2$ 2%	11.77	17.44	19.76	14.43	1.13	1.53	2.60	1.40	788.67	1020.87	1227.71	1074.53
S.Em.±		0.11	0.34	0.20	0.14	0.01	0.01	0.02	0.01	6.14	10.93	10.41	10.62
C.D. at 5%		0.33	0.97	0.57	0.41	0.02	0.02	0.06	0.02	17.73	31.58	30.06	30.68
C.V. %		3.71	6.89	3.72	3.91	1.74	1.83	3.39	1.85	3.02	4.13	3.24	3.80
Interaction		SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.	SIG.

Table 4: Interaction effect of pre and post harvest dipping on total sugar, reducing sugar and vitamin A during all days of storage

Treatment (S×D)	Total sugar (%)				Reducing sugar (%)				vitamin 'A' (IU/100g)			
	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days	2 days	4 days	6 days	8 days
S_1D_1	11.17	17.67	18.00	9.97	0.98	1.11	2.04	0.88	713.33	858.67	1045.00	930.00
S_1D_2	11.50	16.33	17.00	13.53	1.12	1.56	2.54	1.42	700.00	871.10	1015.00	863.33
S_1D_3	10.67	16.00	18.03	11.87	1.02	1.81	2.43	1.22	643.33	850.00	1083.00	991.00
S_2D_1	11.50	15.10	15.36	10.50	1.19	1.41	2.00	1.02	833.33	960.00	1193.33	1030.00
S_2D_2	11.50	23.07	24.77	11.89	1.10	1.31	2.31	1.32	790.00	1030.00	1231.33	1090.00
S_2D_3	11.17	18.61	20.33	10.87	1.20	1.60	2.32	1.51	776.67	1026.67	1216.67	1225.00
S_3D_1	11.33	20.33	22.80	10.20	1.17	1.50	2.21	1.54	823.33	885.00	1083.33	1200.00
S_3D_2	12.33	22.30	23.00	11.45	1.21	1.31	2.31	1.32	764.00	916.67	1216.67	1030.00
S_3D_3	12.33	16.82	20.00	12.08	1.13	1.21	2.41	1.21	776.67	964.33	1000.00	890.00
S_4D_1	13.00	17.24	18.94	16.00	1.04	1.16	3.00	1.16	672.20	1183.33	1400.00	946.67
S_4D_2	14.00	25.10	27.37	22.00	1.61	2.09	3.10	2.50	956.67	1483.33	1594.33	1494.33
S_4D_3	12.17	19.76	20.43	20.33	1.21	1.42	3.25	1.51	920.00	1186.67	1433.33	1233.33
S_5D_1	11.67	15.04	20.00	16.33	1.13	1.21	2.26	1.22	776.67	1013.33	1223.33	1094.33
S_5D_2	12.81	23.70	24.03	16.67	1.30	2.02	3.00	2.11	850.00	1090.00	1500.00	1199.67
S_5D_3	12.50	16.00	20.00	17.00	1.11	1.59	2.61	1.57	826.67	1076.67	1405.53	1033.33
S.Em.±	0.26	0.75	0.44	0.32	0.01	0.02	0.05	0.02	13.73	24.45	23.27	23.76
C.D. at 5%	0.74	2.17	1.28	0.92	0.03	0.05	0.14	0.04	39.65	70.61	67.22	68.61
C.V. %	3.71	6.89	3.72	3.91	1.74	1.83	3.39	1.85	3.02	4.13	3.24	3.80

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. Whereas, S_1D_2 during 6 and 8 days of storage. The result may be due to combine effect of both GA_3 and calcium on fruits as improves the post harvest quality of fruits. The carotenoid content in ripe papaya was also higher than over-ripe papaya. It was also supported by the finding of (14) in papaya and (12) in mango (Table No.4).

Organoleptic rating (mark)

The significant variation in organoleptic score were found and the maximum organoleptic score was recorded in treatment GA_3 @ 15 ppm+Carbendazim 0.05% (S_4) on color, flavour, texture, taste and overall acceptability during storage, respectively. But was found at par with treatment S_5 in flavor only. While minimum organoleptic score of papaya fruits was recorded in control for all parameter. It might be due to slow degration of chemical composition of the fruits and prevention of pathogens. Similar result was also noted by (3) in custard apple. In case of post harvest dipping, the maximum organoleptic score was recorded in treatment $CaCl_2$ 1% (D_2) on color, flavour, texture, taste and overall acceptability during storage, respectively. 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 cross linking of the pectin polymers which increases strength and cell cohesion. The result was also supported by (12) in mango and (15) 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. It might be due to slow degration of the chemical composition of the fruits and prevention of pathogens (Table 5).

Table 5: Effect of pre-harvest spray and post harvest dipping on organoleptic 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
A. 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.Em.±	0.17	0.13	0.09	0.07	0.12	S_3D_1	5.97	4.57
	C.D. at 5%	0.50	0.37	0.26	0.20	0.35	S_3D_2	4.60	3.27
B. Post harvest Treatment							S_3D_3	5.60	5.08
D_1	Water spray	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.Em.±		0.13	0.10	0.07	0.05	0.10	S_5D_1	4.97	5.00
C.D. at 5%		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.Em.±	0.12	0.21
							C.D. at 5%	0.34	0.61
							C.V. %	4.28	7.86

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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