Plant Archives Vol. 15 No. 1, 2015 pp. 75-80 *ISSN 0972-5210*

POST HARVEST QUALITY ENHANCEMENT OF PLANTAIN *cv.* NENDRAN BY USING DIFFERENT GROWTH REGULATORS AND CHEMICALS

M. Jagadeesha*, K. Soorianathasundaram, V. Hari Kumar[1], P. Harikanth and C. Deepika

Department of Fruit Crops, Horticulture College and Research Institute,
Tamil Nadu Agriculture University, Coimbatore - 641 003 (Tamil Nadu), India.
[1]Department of Pomology and Floriculture, Kerala Agricultural University, Thrissur - 680 656 (Kerala), India.

Abstract

An experiment was conducted at H.C. & R.I., T.N.A.U., Coimbatore to find out the effect of different chemicals and growth regulators in combination with Thiabendazole (Fungicide) on post-harvest quality and shelf life of plantain *cv.* Nendran (French Plantain *Musa* AAB). Various concentration of, GA_3, BA, $CaCl_2$ and hot water treatment either alone or in combination with Thiabendazole was applied to fruits after harvest to study their impact on post-harvest quality and shelf life. Exogenous application of chemicals, growth regulators in combination with Thiabendazole significantly decreased post-harvest disease incidence leading to increase in post- harvest fruit quality and shelf life. Among the treatments, post harvest dipping of fruits in 150 ppm GA_3 + 200 ppm Thiabendazole significantly increased firmness (3.70 kg/cm^2) and titrable acidity (0.09%). While the parameters like PLW (13.53%), TSS (25.45^{o}B), total sugars (18.88%), reducing sugars (17.11%) and percent disease incidence (5.55) was observed minimum in the same treatment after 12th day of storage. The shelf life of fruits treated with 150 ppm GA_3 + 200 ppm Thiabendazole could be extended successfully for about 18 days of storage.

Key words : Growth regulators, chemicals, quality, Nendran, Plantain, postharvest treatments.

Introduction

Banana (*Musa* spp) is one of the major commercial fruit crops grown in tropics, subtropics and plays a key role in the economy of developing countries. Among the banana varieties grown in India, the French Plantain cultivar 'Nendran' belonging to the 'Plantain' group (*Musa* AAB) is the most popular variety among growers and consumers, particularly in Tamil Nadu and Kerala for domestic and export markets. Unfortunately, 25 to 30% of the harvested fresh produce deteriorates due to spoilage after the harvest in each year, with losses being higher in the tropical regions (Magdaline *et al*., 1998). Post harvest deterioration of fruits can be caused by many factors including high respiration rates, biochemical changes associated with respiratory metabolism, ethylene biosynthesis, compositional changes, anatomical changes associated with growth and development, physical injuries, water loss and pathological breakdown (Khader, 1996). Since, banana is a climacteric and highly perishable fruit, application of chemicals and growth regulators as pre harvest and post-harvest sprays become necessary to extend the shelf-life with better quality and minimal post-harvest losses. Apart from pre harvest sprays, handling of fruits after harvest assumes importance to achieve better shelf life. Post harvest dipping of fruits in various chemicals and growth regulators with or without fungicides has been used to delay the ripening to reduce losses and to improve and maintain the colour and quality by slowing down the metabolic activities of the produce which results in increased shelf life and marketability of the fruits for a longer time (Rao *et al*., 1986).

Thiabendazole is a systemic benzimidazole fungicide, used to control the fruit and vegetable diseases such as mould, anthrachnose and blight. It is also effective against storage diseases by inhibition of mitochondrial helminth-specific enzyme, fumaratereductase, with possible interaction with endogenous quinine (Smilanick *et al*., 2008). With this background, the present investigation was carried out with an objective to improve the shelf life and quality attributes of Nendran bananas by post-harvest application of certain chemicals and growth regulators.

***Author for correspondence:** e-mail-pmjaggu610@gmail.com

Materials and Methods

The preharvest treatments were conducted at two different locations and the best pre harvest treatment (2% Sulphate of Potash + 2 ppm Brassionosteroid) fruits were selected based on the bunch weight, finger size, total fruit yield and were subjected to post-harvest treatments and quality parameters were evaluated along with control. The experiment was carried out in FCRD by keeping the two locations as main factors with three replications. The fully matured bunches from the best treatment were dehanded and subjected to post harvest treatments and the observations on quality parameters were periodically recorded on 3rd, 7th and 12th day of storage. Fruits were analyzed for physiological loss in weight (PLW), firmness, total soluble solids, total sugars, reducing sugars, carotene content, ascorbic acid and acidity. Fruit firmness (kg/cm^2) was measured with a penetrometer (LT Luron model FG 5000 USA).

Treatments	Treatment details
T_1	Dipping fruits in GA_3 @ 150 ppm
T_2	Dipping fruits in BA @ 50 ppm
T_3	Dipping fruits in $CaCl_2$ @ 1000 ppm
T_4	Dipping fruits in Thiabendazole @ 200 ppm
T_5	Dipping fruits in GA_3 @ 150 ppm + Thiabendazole @ 200 ppm
T_6	Dipping fruits in BA@50 ppm+Thiabendazole @ 200 ppm
T_7	Dipping fruits in $CaCl_2$ @ 1000 ppm + Thiabendazole @ 200 ppm
T_8	Dipping fruits in hot water @ 52^{0}C
T_9	Control (Dipping fruits in normal water)

The shelf life of fruits was noted by keeping the fruits at room temperature and the days taken from harvesting to optimum eating stage. The biochemical parameters include total soluble solids which has determined by using Carl-Zeiss hand refractrometer and expressed in degree brix. Total sugars and reducing sugars were estimated as per the method suggested by Somogyi (1952). Titrable acidity was expressed by A.O.A.C method (1960) using 0.1% NaOH and expressed in percentage. The ascorbic acid content was determined using 2, 6-dichlorophenol indophenol dye after extraction with four per cent oxalic acid and expressed as milligrams of ascorbic acid per 100 gram of fruit pulp (Freed, 1966). The carotene content was determined as per the method suggested by Ranganna (1979). Per cent Disease Incidence (PDI) was calculated based on the infection caused by the organisms was identified based on their symptoms and indexed as follows (Simmons, 1997) and expressed in percentage.

$$PDI\ (\%) = \frac{\text{Sum of all the individual ratings}}{\text{Total number of fruits observed} \times \text{maximum disease rate}} \times 100$$

Results and Discussion

Data presented in table 1 revealed that there was a significant difference in the physiological loss in weight (PLW) of fruits under different treatments and storage intervals. PLW, indicate the total moisture lost during storage and ripening, which results in desiccation and a shrivelled appearance of the fruit. The PLW of fruits gradually increased from 3rd day to 12th day of storage may be due to moisture loss through transpiration and respiration process of fruit. Among the locations, the least PLW of 4.55, 7.17 and 15.17 on 3rd, 7th and 12th day after storage was observed in location I, while it was significantly different from location II (table 1). Among the treatments, the lowest PLW of 2.26, 5.41 and 13.53 per cent were observed in T_5 (150 ppm GA_3 + 200 ppm Thiabendazole) on 3rd, 7th and 12th days of storage. This might be due to slowed down the process of ripening by retarding the pre climacteric respiration rate and subsequently on ethylene production and Thiabendazole preventing pathogenic infection by antifungal activity. Reduction in PLW by pre and post harvest GA_3 treatment was also observed in mango and in sapota (Sudha *et al*., 2007). The highest PLW recorded in control (T_9) of 7.34, 9.42 and 21.26 per cent on 3rd, 7th and 12th days of storage respectively. Interaction effect of location and treatments were significant. The least physiological loss in weight of 2.21, 5.34 and 13.51 per cent was observed in L_1T_5 combination (150 ppm GA_3 + 200 ppm Thiabendazole of location I) on 3rd, 7th and 12th DOS respectively and on par with treatment L_1T_7. The PLW was maximum in L_2T_9 (7.42, 9.48 and 21.64 per cent on 3rd, 7th and 12th days after storage, respectively).

The firmness content (table 1) of fruit was gradually declined with proceeding of storage period from 3rd day to 12th day may be due to breakdown of pectic substances and cell wall softening. Among the locations, the highest firmness of 5.4, 3.8 and 1.8 kg cm^{-2} was observed on 3rd, 7th and 12th DAS respectively at location I while it was lowest at location II. Among the treatments the highest firmness of 6.65, 4.40 and 3.70 kg cm^{-2} were observed in T_5 (150 ppm GA_3+ 200 ppm Thiabendazole) on 3rd, 7th and 12th DOS respectively followed by T_7 (2 % $CaCl_2$ + 200 ppm Thiabendazole. The lowest firmness of 4.2, 3.5 and 2.2 kg cm$^-$ on different stages was observed in T_9 (control). In case of interaction effect due to location and treatments, the highest firmness of 6.7, 4.7 and 3.7

Table 1 : Effect of post harvest treatments on physiological loss in weight (%) and firmness in fruits of banana *cv.* Nendran (AAB).

Treatments	Physiological Loss in weight (%)									Firmness (kg cm-2)								
	3rd day			7th day			12th day			3rd day			7th day			12th day		
	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean
T_1	5.71	5.78	5.75	7.94	8.42	8.18	14.63	14.67	14.65	5.70	5.00	5.70	3.80	3.90	3.70	1.80	2.90	2.35
T_2	5.89	5.98	5.94	8.12	8.50	8.31	14.84	15.04	14.94	5.10	5.40	5.30	3.40	3.50	3.50	1.60	2.50	2.05
T_3	5.97	6.10	6.04	8.20	8.64	8.42	15.47	15.38	15.43	4.80	5.10	5.00	3.60	3.70	3.50	1.70	2.70	2.20
T_4	6.15	6.21	6.18	8.54	8.62	8.58	15.88	15.98	15.94	4.60	4.70	4.70	3.30	3.30	4.00	1.40	2.30	1.85
T_5	**2.21**	2.31	2.26	5.34	5.47	5.41	13.51	13.55	13.53	6.60	6.70	6.65	4.60	4.70	4.40	2.30	3.70	3.00
T_6	2.48	2.63	2.56	5.77	6.02	5.09	14.45	14.56	14.51	5.70	6.00	5.90	4.10	4.20	4.20	1.90	3.20	2.55
T_7	2.32	2.40	2.36	5.46	5.64	5.55	12.36	16.13	14.25	5.80	6.50	6.20	4.30	4.40	3.80	2.10	3.40	2.75
T_8	6.52	6.62	6.56	8.86	8.94	8.90	16.13	16.20	16.16	4.30	4.40	4.40	3.20	3.30	3.20	1.50	2.30	1.90
T_9	7.25	7.42	7.34	9.35	9.48	9.42	20.87	21.64	21.26	4.25	4.20	4.20	3.10	3.20	3.50	1.20	2.20	1.70
Mean	4.55	4.66	4.60	7.17	7.45	7.31	15.17	15.85	15.51	5.20	5.40	5.30	3.70	3.80	3.80	1.70	1.80	1.75
CD (0.05)	0.01	0.019	0.027	0.004	0.007	0.010	0.014	0.027	0.038	0.06	0.04	0.021	0.053	0.0371	0.0490	0.0589	0.0468	0.0196

Table 2 : Effect of post harvest treatments on TSS (^{0}brix) and ascorbic acid (mg /100 g) in fruits of banana cv. Nendran (AAB).

Treatments	Total soluble solids (%)									Ascorbic acid (mg /100 g)								
	3rd day			7th day			12th day			3rd day			7th day			12th day		
	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean
T_1	17.86	17.42	17.64	23.08	21.86	21.86	26.95	26.55	26.75	14.88	15.02	14.95	11.02	11.21	11.11	8.11	8.26	8.18
T_2	18.13	17.62	17.88	22.85	22.01	22.43	27.39	27.12	27.25	14.42	14.6	14.51	10.86	10.98	10.92	7.96	8.05	8.00
T_3	17.88	17.96	17.92	23.50	23.68	23.59	27.03	27.35	27.19	14.65	14.82	14.73	10.68	10.85	10.76	7.75	7.88	7.81
T_4	18.20	17.76	17.98	22.72	21.87	22.30	27.73	27.43	27.58	14.26	14.42	14.34	10.46	10.62	10.54	7.50	7.65	7.57
T_5	17.48	17.20	17.34	21.48	20.08	20.78	25.68	25.42	25.55	15.52	15.70	15.61	11.52	11.70	11.61	8.66	8.95	8.80
T_6	17.72	17.31	17.52	23.12	22.10	22.61	26.85	26.58	26.71	15.05	15.18	15.11	11.18	11.32	11.25	8.24	8.38	8.31
T_7	17.65	17.15	17.40	23.41	22.60	23.01	26.25	26.15	26.20	15.28	15.45	15.36	11.35	11.52	11.43	8.48	8.56	8.52
T_8	18.16	18.32	18.24	23.42	22.10	23.76	27.83	27.64	27.73	14.10	14.26	14.18	10.24	10.42	10.33	7.32	7.46	7.39
T_9	18.34	17.90	18.22	23.75	22.42	23.09	28.51	28.26	28.38	13.95	14.08	14.01	10.02	10.18	10.10	7.15	7.24	7.19
Mean	17.93	17.62	17.79	23.03	22.08	22.60	27.13	28.26	27.04	14.67	14.83	14.75	10.81	10.97	10.89	7.90	8.04	7.97
CD (0.05)	0.016	0.031	0.044	0.033	0.061	0.087	2.86	2.022	NS	NS	NS	NS	NS	0.76	NS	NS	0.562	NS

Table 3 : Effect of post harvest treatments on reducing and total sugars in fruits of banana cv. Nendran (AAB).

Treatments	Reducing sugars (%)									Total sugars (%)								
	3rd day			7th day			12th day			3rd day			7th day			12th day		
	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean
T_1	11.18	10.85	11.02	14.25	13.25	12.02	18.98	18.36	18.68	12.35	11.97	12.16	15.82	14.79	15.30	20.82	20.16	20.49
T_2	11.56	10.58	11.07	14.65	13.82	12.07	19.16	19.13	19.15	12.84	11.83	12.33	16.34	15.47	15.90	21.06	20.97	21.01
T_3	11.28	10.79	11.04	14.56	13.62	12.04	19.1	18.74	18.92	12.51	11.99	12.25	16.21	15.24	15.72	20.97	20.61	20.79
T_4	11.94	11.46	11.70	14.82	13.94	12.70	19.31	19.63	19.47	13.30	12.77	13.03	16.55	15.64	16.09	21.24	21.53	21.38
T_5	10.18	9.95	10.07	13.65	12.73	11.07	17.94	16.27	17.11	11.16	10.91	11.03	15.11	14.16	14.63	19.66	17.95	18.80
T_6	10.75	10.52	10.64	14.13	13.18	11.64	18.55	18.31	18.43	11.88	11.63	11.75	15.66	14.68	15.17	20.35	20.07	20.21
T_7	10.27	10.16	10.22	14.12	13.16	11.22	18.13	17.76	17.95	11.35	11.22	11.28	15.62	14.62	15.12	19.89	19.49	19.69
T_8	12.02	11.91	11.97	15.36	14.58	12.97	19.84	19.95	19.90	13.42	13.26	13.34	17.13	16.32	16.72	21.8	21.89	21.84
T_9	12.12	11.12	11.62	15.96	14.82	14.12	20.49	20.57	20.53	13.56	12.52	13.04	17.77	16.6	17.18	22.47	22.53	22.50
Mean	11.26	10.82	11.04	12.26	12.15	12.20	19.06	18.75	18.90	12.49	12.02	12.25	13.89	13.75	13.82	20.92	20.58	20.75
CD(0.05)	NS	0.777	NS	NS	0.99	NS	NS	1.33	NS	NS	0.86	NS	NS	1.11	NS	NS	1.46	NS

Table 4 : Effect of post harvest treatments on acidity and carotene content in fruits of banana cv. Nendran (AAB).

Treatments	Acidity (%)									Carotene content (mg /100g)								
	3rd day			7th day			12th day			3rd day			7th day			12th day		
	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean
T_1	0.33	0.33	0.33	0.142	0.14	0.14	0.08	0.07	0.08	20.73	19.56	20.15	21.45	20.26	20.86	22.1	20.1	21.10
T_2	0.33	0.34	0.34	0.15	0.16	0.16	0.10	0.08	0.09	21.28	20.33	20.81	22.00	21.03	21.52	22.65	21.65	22.15
T_3	0.33	0.33	0.33	0.15	0.15	0.15	0.10	0.07	0.08	20.95	20.00	20.48	21.67	20.70	21.19	22.32	21.32	21.82
T_4	0.33	0.34	0.34	0.16	0.16	0.16	0.10	0.09	0.09	21.68	20.73	21.21	22.4	21.43	21.92	23.05	22.05	22.55
T_5	0.31	0.32	0.32	0.18	0.19	0.18	0.12	0.08	0.10	19.93	18.78	19.36	20.65	19.48	20.07	21.3	20.30	20.80
T_6	0.32	0.33	0.33	0.13	0.13	0.13	0.09	0.06	0.08	20.51	19.30	19.91	21.23	20.00	20.62	21.88	20.88	21.38
T_7	0.32	0.32	0.32	0.12	0.13	0.12	0.08	0.06	0.07	20.25	18.98	19.62	20.97	19.68	20.33	21.62	20.62	21.12
T_8	0.33	0.35	0.34	0.11	0.13	0.12	0.07	0.10	0.09	22.23	21.28	21.76	22.95	21.98	22.47	23.60	22.60	23.10
T_9	0.35	0.35	0.35	0.12	0.17	0.14	0.07	0.11	0.09	22.93	21.98	22.46	23.65	22.68	23.17	24.30	23.30	23.80
Mean	0.33	0.33	0.33	0.15	0.15	0.15	0.09	0.08	0.09	21.17	20.10	20.64	21.89	20.80	21.35	22.54	21.42	21.98
CD(0.05)	NS	NS	NS	0.005	0.011	NS	0.684	1.452	NS	0.684	1.452	2.053	0.708	1.502	NS	0.729	1.546	NS

Table 5 : Effect of post harvest treatments on Percent of Disease Incidence (PDI) (%) and shelf life (days) of banana *cv.* Nendran (AAB).

Treatments	Percent of Disease Incidence (PDI)						Shelf life (days)		
	7th day			12th day			3rd day		
	L-I	L-II	Mean	L-I	L-II	Mean	L-I	L-II	Mean
T_1	0.00 (1.65)	0.00 (1.65)	0.00	8.38(9.45)	8.56(9.62)	7.47	15.33	15.66	15.49
T_2	0.5(2.55)	0.00(1.65)	0.25	8.81(9.35)	8.45(9.35)	6.83	14.50	15.00	14.75
T_3	0.5(2.25)	0.00(1.65)	0.25	8.41 (9.59)	8.25 (9.52)	6.63	15.00	15.33	15.16
T_4	00(1.65)	0.0(2.25)	0.00	7.56(8.59)	7.11(8.05)	7.38	14.00	14.33	14.16
T_5	0.00(1.65)	0.00(1.65)	**0.00**	**6.38(12.08)**	**5.55(12.08)**	**5.97**	**17.50**	**18.50**	**18.00**
T_6	0.00(1.65)	0.00(1.65)	0.00	6.55(6.85)	7.80(8.60)	7.18	15.67	16.00	15.83
T_7	0.00(1.65)	0.00(1.65)	0.00	6.45(13.56)	6.38(12.85)	6.42	16.00	18.33	17.16
T_8	6.38 (12.85)	5.55 (6.68)	5.95	14.55(22.35)	13.81(20.65)	14.18	13.50	14.00	13.75
T_9	7.80(8.60)	6.42 (7.08)	7.15	25.93(30.50)	22.93(27.35)	24.43	12.33	12.66	12.49
Mean	1.68	1.33	4.93	10.92	9.98	10.47	14.77	15.14	14.96
CD (0.05)	NS	NS	NS	NS	2.620	NS	NS	1.0550	NS

kg cm^{-2} was observed in L_1T_5 (150 ppm GA_3 + 200 ppm Thiabendazole at location I) on 3rd, 7th and 12th DAS respectively. L_2T_9 recorded lower fruit firmness all storage intervals. Post harvest dipping with GA_3 150 ppm might be reduced the activities of softening enzymes *i.e.* polygalactouronase and pectin methyl esterase (PME) by protecting stiff pectin macromolecules against demethylation (or) reduced depolymarization of olygalactouronase and thus, maintained the firmness of fruits. Similar findings reported in sapota (Sudha *et al*., 2007, Tsomu and Patel, 2014).

TSS was found to be increased gradually as storage period progressed. This might be due to conversion of carbohydrate into simple sugars (Rub *et al*., 2010) The highest total soluble solids were observed in location I and it was low in location II. Among the treatments, the highest total soluble solids of 18.22, 23.09 and 28.38 °brix were observed in $\mathbf{T_9}$ (control) on 3rd, 7th and 12th DAS respectively followed by $\mathbf{T_8}$ (Hot water treatment). The lowest total soluble solids of 17.34, 20.78 and 25.55 °brix on different stages was observed in $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole). This may be due to effect of GA_3, delayed the conversion of starch to sugars, reduced peroxidase activity and ethylene production. Similar finding reported in sapota (Sudha *et al*., 2007). In case of interaction effect, the highest total soluble solids of 18.34, 23.75 and 28.51°brix was observed in L_1T_9 (control of location I) on 3rd, 7th and 12th DAS respectively. The total soluble solids was minimum in L_1T_5 (17.20, 20.08 and 25.42 °brix of location I) on 3rd, 7th and 12th DAS respectively.

Ascorbic acid of fruits (table 2) was gradually declined from 3rd day to 12th day of storage. The loss in ascorbic acid content on prolonged storage might be mainly due to rapid conversion of L-ascorbic acid into dehydroascorbic acid in the presence of enzyme ascorbinase (Mapson, 1970). There is no significant effect due to location and their interaction on ascorbic acid content of fruits on 3rd day of storage. On 7th and 12th day of storage, the treatment $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole) recorded the highest ascorbic acid content of 11.61 and 8.80 mg/100g and on par with $\mathbf{T_7}$ (11.43 and 8.52 mg/100g respectively). This may be due to reduced degradation of L-ascorbic acid resulting maximum ascorbic acid at the end of storage period. The lowest ascorbic acid content was observed in $\mathbf{T_9}$ (10.10 and 7.19 mg/100g) on 7th and 12th DAS, respectively. This may be due to rapid degradation of ascorbic acid. Similar findings reported in Grand naine (Harikumar and Dilipbabu, 2014). There is no significant difference due to interaction of location and post harvest treatments on ascorbic acid contents at all the three stages of observation.

There was a significant increase in reducing and total sugars (table 3) from 3rd day (11.04, 12.25) to 12th day (18.90, 20.75). This might be due to conversion of carbohydrate into simple sugars (Rub *et al*., 2010). Among the all treatments, the highest reducing and total sugars were observed in $\mathbf{T_9}$ (control) on all storage intervals, whereas, the lowest content was observed in $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole). GA_3 might be slow down the ripening process leads to extend the shelflife. Similar findings reported in Sapota (Sudha *et al*., 2007).

The data registered on the effect of post harvest treatments on acidity (%) of fruits were furnished in the table 4. Titrable acidity declined gradually from 3rd day to 12th day of storage. The decline in acidity may be

attributed to the utilization of acids in the process of ripening in the presence of reduced supply of sugar as a substrate of respiration which might be due to lower rate of starch degradation during the ripening. On 7th day of storage, among the treatments, $\mathbf{T_5}$ (150 ppm GA_3+ 200 ppm Thiabendazole) recorded the highest acidity content (0.18%) and significantly different from rest of the treatments. The lowest acidity content was observed in $\mathbf{T_8}$ (0.12%). Among the location, the location II registered the highest acidity content (0.15%) and highly significant from the location I (0.14%). Similarly on 12th day of storage, the $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole) recorded the highest acidity content (0.09%) may be due to less utilization of organic acids in respiration by antisenscent action of GA_3, which delays the ripening mechanism through reduced rate of starch degradation. This finding of the present study was in accordance with Sudha (2007) in sapota, Bhalerao (2011) and Macwan and Vihol (2012) in banana.

The data on the effect of post harvest treatments on carotene content (mg/100g) of fruits are furnished in the table 4. The carotene content of stored fruits gradually increased during storage period. The highest carotene content (mg/100g) of 21.17, 21.89 and 22.54 mg/100g on 3rd, 7th and 12th DOS respectively was observed in location I and it was lowest in location II. Among the treatments, the highest carotene content of 22.46, 23.17 and 23.80 mg/100g were observed in $\mathbf{T_9}$ (control) on 3rd, 7th and 12th DOS respectively followed by $\mathbf{T_7}$ (2 % $CaCl_2$ + 200 ppm Thiabendazole). The lowest carotene content of 19.36, 20.07 and 20.80 mg/100g on different storage intervals were observed in $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole). GA_3 treatment decreases the activity of chlorophyllase and Mg-dechelatase, which are responsible for breakdown of chlorophyll (Matile *et al*., 1999). Similar findings were also reported in papaya (Rajkumar *et al*., 2005) and banana (Patel and Padhiar, 2010).

The data on the effect of post harvest treatments on percent disease incidence and shelf life of fruits are furnished in table 5. Disease incidence was not observed in any of the fruits until the third day of storage. There were significant differences due to treatments alone on 12th day of storage. On the 12th day of storage, the maximum percent of disease incidence of 24.43 was observed in control ($\mathbf{T_9}$). The lowest PDI of 5.97 was observed in $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole).

Shelf life of fruits significantly differed with treatments (table 5). The highest shelflife (18 days) was recorded in $\mathbf{T_5}$ (150 ppm GA_3 + 200 ppm Thiabendazole) was on par with $\mathbf{T_7}$ (17.16 days) whereas lowest observed in control (12.49).

References

Abdul, Kadar (1966). Effect of growth regulating substances on ripening and shelf life of mango. *Hort. Sci.,* **1** : 90-93.

Bhaleroa, P. P. and B. R. Parmar (2011). Effect of growth regulators on post harvest life of banana *cv.* Grand naine. *The Asian. J. of Hort.,* **6(2)** : 283-287.

Freed, M. (1966). Methods of Vitamin Assay. *ed*. The Association of Vitamin Chemists Inc. New York: Interscience Publishers.

HariKumar, V. and J. Dilipbabu (2014). Effect of modified atmosphere packing on ascorbic acid and organoleptic evaluation of banana *Cv.* Grand Naine at different storage conditions. *Green Farming*, **5(1)** : 133-135.

Magdaline, F. V., V. Sreenarayanan and S. Easwaran (1998). Modified atmosphere packaging in banana. *Agro India,* **Sep :** 26.

Mapson, L. W. (1970). Vitamins in fruits, stability of L-ascorbic acid. In: Biochemistry of fruits and their products Vol. **1** pp. 376-377 (ed) Hulme A C Acadamic press Landon.

Rajkumar, M. P. Karuppaiah and R. Kandasamy (2005). Effect of calcium and gibberllic acid on post harvest behaviour of papaya *cv.* Co2. *Indian Journal of Horticulture*, **62 (4)** : 327-331.

Matile, P., S. Hörtensteiner and H. Thomas (1999). Chlorophyll degradation. *Annu Rev Plant Physiol Plant Mol Biol.,* **50** : 67–95.

Patil, S. N. and N. C. Hulamani (1998). Effect of post harvest treatments on physical characters and shelf life of banana fruits. *Karnataka J. Agric. Sci*., **11(2)** : 535-537.

Ranganna, S. (1979). *Manual of analysis of fruit and vegetable products*, Tata McGrawHill publishing company limited, New Delhi, India.

Rao, D. V. R. and B. S. Chundawat (1986). Effect of certain chemical retardants on ripening changes of banana *cv.* Lacatan at ambient temperatures. *Prog. Hort*., **18 (3-4)** : 189-195.

Rub, A., S. Haq, S. A. Khalil and S. G. Ali (2010). Fruit quality and senescence related changes in sweet orange cultivar Blood red unipacked in different packing materials. Sarhad J. Agric., **26** : 221–227

Simmons, R. (1997). Indexing of banana diseases based on the symptoms. *Banana News*, **6**: 16-19.

Smilanick, J. L., M F. Mansour, F G. Galber and D. Sorenson (2008). Control of citrus post-harvest green mold and sour rot by thiabendazole combined with heat and potassium sorbate. *Post-harvest Biol. Technol*., **47** : 226-238.

Somogyi, N. (1952). Notes on sugar determination. *J. Biol. Chem*., **200** : 145-154.

Sudha, R., R. Amutha, S. Muthulaksmi, W. Baby Rani, K. Indira and P. Mareeswari (2007). Influence of Pre and Post Harvest Chemical Treatments on Physical Characteristics of Sapota (*Achras sapota* L.) var. PKM_1. *Research J. Agric. and Biological Sciences*, **3(5)** : 450-452.

Tsomu, T. and H. C. Patel (2014). Effect of Post-harvest Treatments of Chemical and Plant Growth Regulators on Physical Parameters of Sapota Fruit *cv.* Kalipatti. *J Food Process Technol.,* **5** : 347. doi: 10.4172/2157-7110.1000347