International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 3091-3095

Received: 20-01-2018
Accepted: 21-02-2018

Lipsa Prit Bhusan
PhD Scholar, Department of Fruit Science and Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

AK Das
Ex-Prof. and Head, Department of Vegetable Science, OUAT, Bhubaneswar, Odisha, India

DK Dash
Prof. and Head, Department of Fruit Science and Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

SN Dash
Prof. Department of Fruit Science and Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

S Swain
Asst. Prof. Horticulture, OIC, AICRP on Banana, Bhubaneswar, Odisha, India

B Pradhan
Prof. and Head, Department of Plant Breeding and Genetics, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Correspondence
Lipsa Prit Bhusan
PhD Scholar, Department of Fruit Science and Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

Influence of Gibberellic acid and calcium on quality of banana (*Musa spp*.) cv. Grand Naine

Lipsa Prit Bhusan, AK Das, DK Dash, SN Dash, S Swain and B Pradhan

Abstract
The present study was undertaken at Post Harvest Laboratory, Department of Fruit Science and Horticulture Technology, OUAT, BBSR during 2015-16 and 2016-17 to envisage the effect of different post harvest treatments on quality of banana *cv.* Grand Naine, where fruits were subjected to ten treatments with different concentration of GA_3, $CaCl_2$, their combination and Control (without any treatment) and replicated thrice. Fruits were treated in different concentration of chemicals/growth regulator. Among the treatments, post-harvest dipping of fruits in 150 ppm GA_3 significantly increased titrable acidity, ascorbic acid content and storage life of fruits (22.04 days in plant crop & 22.06 days in ratoon crop). While the parameters like TSS (20.12^0Brix in plant crop and 20.16^0Brix in ratoon crop), total sugars (17.42% in plant crop, 17.96% in ratoon crop), were observed minimum in the same treatment after 21st day of storage.

Keywords: Gibberllic acid, calcium, quality, banana

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 farmers. It cultivated over 130 countries in the tropical and subtropical regions. India ranks 2nd in terms of area (880.0THa), first in production (30008.0Tton) and productivity is 34.1ton/ha. In the state of Odisha area under banana is (24.73Tha) with annual production of (467.73Tton) (NHB 2015) [1].
Among various groups of banana AAA group (Cavendish group) is commercially and widely grown in tropics. Banana cultivar Grand Naine is commercially cultivated in large areas with high productivity and acceptability. Since banana is a climacteric and highly perishable fruit, application of chemicals and growth regulators as pre harvest and post-harvest sprays becomes necessary to extend the shelf-life with quality and minimal post-harvest losses. Apart from pre harvest sprays, handling of fruits after harvest assumes importance to achieve better keeping quality. 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. 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 keeping quality and marketability of the fruits for a longer time (Rao and Chundawat, 1986) [10]. With this background, the present investigation was carried out with an objective to improve the keeping quality of Grand Naine bananas by post harvest treatments.

Materials and methods
The present experiment on the Influence of Gibberellic acid and Calcium on quality of Banana (*Musa spp*.) cv. Grand Naine was carried out during 2015-16 and 2016-17. Mature banana fruits were collected from experimental field located at Horticulture research station, Department of Fruit Science and Horticulture Technology, OUAT, Bhubaneswar. Effective control of major pests and diseases were followed during fruit development and maturation until the fruits harvested. Selected fruits were then washed with clean water and dried under shade. The fingers were randomly divided into different treatment groups. The experiment was designed in completely randomized design (CRD) at Post Harvest laboratory, Department of Fruit Science and Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar with following ten treatments T_1:$CaCl_2$ @2%, T_2: $CaCl_2$ @3%, T_3: $CaCl_2$ @4%,T_4: GA_3 @50ppm,

T_5: GA_3 @100ppm, T_6: GA_3 @150ppm, T_7: GA_3 @50ppm + $CaCl_2$ @2%, T_8: GA_3 @100ppm + $CaCl_2$ @3%, T9: GA_3 @150ppm + $CaCl_2$ @4% and T_{10}: Control [with out any treatment)] replicated thrice. Solutions were prepared and fruits were dipped for 30 minutes and stored in room temperature.

Then observations were periodically recorded on 3rd, 6th, 9th, 12th, 15th, 18th and 21st day of storage. Days taken by the fruits to lose their edible quality by over softening and decay is taken for calculating shelf life of fruits and expressed in number of days. The biochemical parameters include total soluble solids which has determined by using Carl-Zeiss hand refractrometer and expressed in degree brix. Total sugars, reducing sugars and Non reducing sugars were estimated as per the method suggested by (Somogyi, 1952) [11]. Titrable acidity was determined by taking 5ml of juice against 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.

Result and Discussion

Table 1: Effect of GA and Ca on TSS ^{0}Brix of Plant crop and Ratoon crop

Treatment	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC
T1	7.19	7.20	11.97	12.00	19.11	19.14	22.19	22.19	21.86	21.88	20.42	20.40	0.00	0.00
T2	6.93	6.95	10.11	10.15	18.25	18.25	22.24	22.28	22.91	22.93	21.06	21.06	0.00	0.00
T3	6.82	6.84	9.91	9.93	17.91	17.93	22.07	22.11	22.87	22.89	20.98	20.96	0.00	0.00
T4	6.71	6.74	9.82	9.82	18.17	18.20	20.98	21.06	22.86	22.90	21.44	21.46	21.02	21.01
T5	6.62	6.62	9.76	9.78	17.29	17.28	20.82	20.84	22.14	22.33	21.07	21.09	20.83	20.92
T6	6.53	6.51	9.13	9.16	17.07	17.09	20.76	20.78	21.98	22.03	20.74	20.77	20.12	20.16
T7	11.67	11.68	19.02	19.05	21.98	21.98	22.93	22.96	21.07	21.12	0.00	0.00	0.00	0.00
T8	11.13	11.16	18.27	18.26	21.31	21.34	22.87	22.87	20.41	20.42	0.00	0.00	0.00	0.00
T9	10.97	11.01	17.13	17.15	20.21	20.28	22.82	22.84	20.91	20.95	20.09	20.08	0.00	0.00
T10	12.76	12.79	19.89	19.88	22.91	22.97	20.21	20.22	0.00	0.00	0.00	0.00	0.00	0.00
SE(m)±	0.02	0.03	0.03	0.05	0.19	0.19	0.03	0.05	0.03	0.09	0.05	0.05	0.01	0.02
CD at 5%	0.05	0.10	0.10	0.14	0.55	0.56	0.09	0.14	0.07	0.25	0.13	0.15	0.04	0.05
CV	0.35	0.68	0.41	0.59	1.66	1.68	0.25	0.37	0.22	0.76	0.54	0.59	0.40	0.44
F –test	**	**	**	**	**	**	**	**	**	**	**	**	**	**

NS= Non Significant, *= Significant at 1%, **=Significant at 5%

The influence of different treatments on total soluble solids of banana var. Grand Naine fruit of plant and ratoon crop is presented in Table (1).There was a gradual increment of TSS throughout the storage period was recorded but the rate of increment was higher in fruits stored with no treatment (control) than other treated fruits. Post harvest treatments with different concentrations of GA_3 are significantly affected the TSS (total soluble soilds) content of banana fruits. Control fruits showed a faster increment in their TSS content, increasing from 12.76 ºBrix on day 3rd to 22.91 ºBrix on day 9th and declined to 20.21 ºBrix on day 12th 1st, after which all fruits in this group were discarded in plant crop. Similar trend also found in ratoon crop.TSS of the fruits under control was significantly higher than all the treatment fruits throughout its storage period and it reached its peak (22.91°Brix and 22.97 °Brix in plant crop and ratoon crop respectively) faster on 9th day of storage. On this day when all fruits under control had ripened. On the other hand, fruits treated with GA3 were the slowest to reach their TSS peak. Banana fruits treated with 150, 100 and 50 ppm GA_3 reached their peak (21.98°Brix, 22.14°Brix and 22.86ºBrix, respectively in plant crop) and (22.03°Brix, 22.33°Brix, 22.90 ºBrix respectively in ratoon crop) on day 15th followed by calcium treated fruits. However higher concentration of GA found significantly superior among all other treatments.

This indicates that in normal storage at ambient environment the ripening process was faster due to higher and accelerated production of ripening hormone and accelerated respiration which otherwise was slower due to GA and the peak TSS was recorded 6-8 days later the ripening of controlled fruits. The observed increment in TSS content during ripening of fruits and decrease after attaining peak levels followed natural fruit ripening and senescence processes that have also been exhibited in related traits including colour change and fruit marketability which are typical of postharvest change in climacteric fruit (Pinto *et al.*,2004) [9]. This result is in agreement with the report of Dharmasenal and Kumari (2005) [3] that showed increase in TSS contents of different banana varieties from 0 to 17th °Brix over a storage period of 16 days and Duguma *et al*., 2014 [4] . The slightly more amount of TSS at the peak of ripening in the present study could be due to effects of the treatments applied.

Table 2: Effect of GA and Ca on Acidity % of plant crop and ratoon crop

Treatment	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC
T1	1.06	1.06	0.79	0.79	0.59	0.58	0.41	0.41	0.35	0.36	0.32	0.33	0.00	0.00
T2	1.07	1.07	0.81	0.82	0.64	0.64	0.48	0.47	0.37	0.37	0.31	0.32	0.00	0.00
T3	1.07	1.07	0.82	0.80	0.69	0.69	0.57	0.55	0.39	0.38	0.33	0.33	0.00	0.00
T4	1.08	1.07	0.84	0.84	0.71	0.71	0.62	0.62	0.41	0.40	0.34	0.35	0.32	0.33
T5	1.06	1.06	0.89	0.91	0.72	0.72	0.62	0.62	0.49	0.50	0.39	0.37	0.33	0.34
T6	1.07	1.08	0.91	0.91	0.74	0.75	0.64	0.63	0.54	0.52	0.41	0.40	0.38	0.39
T7	1.07	1.07	0.67	0.68	0.43	0.45	0.39	0.39	0.31	0.30	0.00	0.00	0.00	0.00
T8	1.02	1.02	0.72	0.71	0.48	0.48	0.43	0.43	0.36	0.36	0.00	0.00	0.00	0.00
T9	1.02	0.99	0.76	0.77	0.51	0.51	0.49	0.51	0.37	0.37	0.35	0.36	0.00	0.00
T10	0.97	0.97	0.64	0.66	0.41	0.41	0.32	0.31	0.00	0.00	0.00	0.00	0.00	0.00

SE(m)±	0.02	0.03	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
CD at 5%	0.07	0.07	0.04	0.06	0.05	0.03	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01
CV	3.77	4.21	2.89	4.21	4.77	3.36	4.20	2.79	4.04	3.80	4.78	3.86	3.99	3.85
F –test	NS	NS	**	**	**	**	**	**	**	**	**	**	**	**

NS= Non Significant, *= Significant at 1%, **=Significant at 5%

The influence of different treatments on titrable acidity of banana fruits var. Grand Naine in both plant crop and ratoon crop is presented in Table (2). The acidity of stored fruit ranged from (0.97% to 1.08%) on 3rd day, (0.64%-0.91%) on 6th day, (0.41%-0.74%) on 9th day, (0.32%-0.64%) on 12th day, (0.31%-0.54%) on 15th day, (0.31%-0.41%) on 18th day and (0.32%0.38%) on 21st day of storage in plant crop and (0.97% to 1.08%) on 3rd day, (0.66%-0.91%) on 6th day, (0.41%-0.75%) on 9th day, (0.31%-0.63%) on 12th day, (0.30%-0.52%) on 15th day, (0.32%-0.40%) on 18th day and (0.33%-0.39%) on 21st day of storage in ratoon crop.

Acidity % was not influenced by treatments on 3rd day of storage in both plant crop and ratoon crop. Acidity decreased at a faster rate in the fruits under control than the other fruits which having an extended ripening period. The fruits under control had significantly lower acidity of 0.97%, 0.64%, 0.41% and 0.32% in plant crop and 0.97%, 0.66%, 0.41% and 0.31% in ratoon crop on 3rd, 6th, 9th and 12th day of storage throughout its ripening period as compared to the other fruits. Titratable acidity of banana decreased gradually from a maximum on day of storage to a minimum on completion of ripening in both plant crop and ratoon crop. It showed a constant decrease during the storage period. 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.

The highest titrable acidity of 1.07%, 0.91%, 0.74%, 0.64%, 0.41%, 0.38% in plant crop and 1.08%, 0.91%,0.75%, 0.63%, 0.52%,0.40%, 0.39% in ratoon crop on 3rd, 6th, 9th, 12th, 15th, 18th and 21st day of storage respectively was observed with fruits treated with GA_3 (150 ppm)T_6 in both plant crop and ratoon crop. This 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 Tapas *et al*., (2016) [12] in grand naine banana, Duguma *et al*., (2014) [4], Zomo *et al*., (2014) [13], Mulagund *et al*., (2015) [6] in banana, Bhalerao and Parmar, (2011) [2] in banana.

Table 3: Effect of GA and Ca on Ascorbic acid(mg/100gm) of Plant crop and Ratoon crop

Treatment	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC
T1	14.39	14.37	13.22	13.21	12.29	12.32	11.22	11.23	8.59	8.56	6.72	6.74	0.00	0.00
T2	14.43	14.41	13.29	13.28	12.34	12.34	11.29	11.33	10.21	10.18	6.79	6.76	0.00	0.00
T3	14.59	14.58	13.58	13.55	12.42	12.43	11.38	11.40	10.92	10.93	6.94	6.91	0.00	0.00
T4	14.62	14.62	14.04	14.01	12.47	12.47	11.54	11.50	11.17	11.14	7.12	7.13	6.01	6.01
T5	14.67	14.65	14.26	14.29	12.51	12.51	11.68	11.69	11.24	11.24	7.45	7.43	6.36	6.38
T6	14.98	14.95	14.57	14.55	12.76	12.77	11.92	11.91	11.79	11.80	7.81	7.80	6.92	6.89
T7	14.12	14.09	12.51	12.50	11.92	11.88	10.54	10.54	8.19	8.20	0.00	0.00	0.00	0.00
T8	14.19	14.19	12.72	12.73	12.21	12.22	10.62	10.63	8.32	8.30	0.00	0.00	0.00	0.00
T9	14.30	14.34	12.76	12.76	12.41	12.41	10.71	10.69	8.37	8.31	6.92	6.90	0.00	0.00
T10	13.95	13.97	12.23	12.19	10.02	10.29	6.80	6.84	0.00	0.00	0.00	0.00	0.00	0.00
SE(m)±	0.15	0.14	0.04	0.06	0.03	0.10	0.06	0.06	0.05	0.05	0.02	0.03	0.02	0.02
CD at 5%	0.44	0.42	0.12	0.17	0.10	0.31	0.18	0.18	0.14	0.15	0.06	0.09	0.05	0.05
CV	1.80	1.71	0.55	0.74	0.48	1.49	0.96	0.98	0.92	1.01	0.70	1.05	1.43	1.51
F –test	**	**	**	**	**	**	**	**	**	**	**	**	**	**

NS= Non Significant, *= Significant at 1%, **=Significant at 5%

A significant difference was recorded in the ascorbic acid content of grand naine banana fruits receiving different post harvest treatments in both plant crop and ratoon crop as presented in table no (3).Control fruits T_{10} showed a rapid decrease in ascorbic acid content then fruits treated with GA and Ca. There were no fruits recorded on control T_{10} after 12th day. However in T_{10} ascorbic acid content of maximum 13.95mg/100gm was observed on 3rd day of storage then it gradually decreases to 12.23mg/100gm in 6th day, 10.02mg/100gm in 9th day and finally 6.80mg/100gm in 12th day of storage in plant crop of banana cv. Grand naine. Similar trend also recorded in ratoon crop. After control minimum ascorbic content was recorded in T_7 followed by T_8 and there were no fruits found on 15th, 18th day and 21st day of storage.

Maximum Ascorbic acid content 14.98mg/100gm to 6.92mg/100gm in plant crop and 14.95 to 6.89mg/100gm in ratoon crop was recorded in T_6 (GA_3@150ppm) followed by T_5 and T_4. On 12th day of storage the ascorbic acid content of banana fruits placed in control group decreased to 6.80mg/100gm in plant crop and 6.84mg/100gm in ratoon crop, while fruits treated with 150ppm GA_3 reduced to 11.92mg/100gm in plant crop and 11.91mg/100gm in ratoon crop and fruits treated with GA_3 100ppm reduced to 11.68mg/100gm in plant crop and 11.69mg/100gm in ratoon crop. Where as during end of storage there was no fruits recorded inT_{10}, T_7 and T_8 and Ascorbic acid content of 6.92mg/100gm in plant crop and 6.89mg/100gm in ratoon crop was recorded in T_6 on 21th day of storage. There was a progressive decrease in ascorbic acid content up to the end of shelf life. The decrease in ascorbic acid on prolonged storage might be mainly due to rapid conversion of L-ascorbic acid into dehydro ascorbic acid in the presence of enzyme ascorbinase (Duguma *et al*.,2014) [4]. The difference in the ascorbic acid levels among fruits in the different treatments could be due to the effects of respective treatments on ripening as described for other parameters in the earlier sections.

These results show that concentration of 150ppm GA_3 is the most effective in delaying ripening of banana fruits. With

regard to ascorbic acid content, the higher levels of ascorbic acid recorded in GA_3 treated fruits. This may be due reduced oxidization of ascorbic acid into dehydroascorbic acid in GA_3 treated fruits and also changes in the metabolism of carbohydrates and biosynthesis of glucose which is considered to be the precursor of Vit-C. Mulagund *et al*., 2015 [6]. The similar response may be the reason for higher acidity and ascorbic acid in GA_3 treatment in the present study. But it recorded when GA_3 combined with Ca no significant result recorded, it might be due to the antagonistic effect of Ca on GA.

Table 4: Effect of GA and Ca on total sugar % of plant crop and ratoon crop

Treatment	3rd day		6th day		9th day		12th day		15th day		18th day		21st day	
	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC	PC	RC
T1	3.45	4.08	6.62	7.74	11.60	13.11	15.15	17.21	19.96	21.25	19.80	20.86	0.00	0.00
T2	3.51	4.20	6.55	7.66	11.82	13.02	14.90	16.92	19.65	21.11	19.49	21.05	0.00	0.00
T3	3.51	4.17	6.44	7.64	11.39	12.81	14.73	16.55	19.47	20.91	19.31	20.85	0.00	0.00
T4	3.32	3.92	6.13	7.58	10.87	12.65	14.35	16.53	19.19	20.80	19.06	20.72	18.77	19.02
T5	3.33	3.89	6.04	7.10	10.78	12.44	14.33	16.25	19.00	20.42	18.93	20.32	18.53	18.78
T6	2.95	3.80	5.93	7.06	10.70	12.42	14.25	16.13	18.84	20.36	18.75	20.33	17.42	17.96
T7	3.32	4.18	6.94	7.95	12.59	14.10	16.83	18.91	16.61	18.83	0.00	0.00	0.00	0.00
T8	3.32	4.23	6.86	7.95	12.43	13.84	16.64	18.27	16.56	18.14	0.00	0.00	0.00	0.00
T9	3.33	4.30	6.68	7.77	12.26	13.68	15.96	18.14	15.77	21.44	15.66	21.31	0.00	0.00
T10	4.09	5.01	9.26	11.67	21.16	22.07	20.10	20.13	0.00	0.00	0.00	0.00	0.00	0.00
SE(m)±	0.04	0.07	0.04	0.04	0.12	0.05	0.07	0.05	0.04	0.04	0.03	0.11	0.07	0.03
CD at 5%	0.11	0.20	0.10	0.13	0.35	0.16	0.20	0.16	0.10	0.11	0.10	0.32	0.21	0.10
CV	1.86	2.77	0.91	0.93	1.65	0.67	0.75	0.53	0.37	0.37	0.46	1.30	2.21	1.08
F –test	**	**	**	**	**	**	**	**	**	**	**	**	**	**

NS= Non Significant, *= Significant at 1%, **=Significant at 5%

Perusal data in Table no (4) revealed that Total sugar of the fruits under control was significantly higher than the other treatment throughout its storage period and it reached its peak (21.16%) in plant crop and (22.07%) in ratoon crop in T_{10}, faster on 9th day of storage. On this day when all fruits under control had ripened, fruits treated with GA had estimated with total sugar of 10.70%(T_6), 10.78%(T_5), 0.87%(T_4) in plant crop and 12.42%(T_6),12.44%(T_5),12.65%(T_4) in ratoon crop. Which was significantly lower than the total sugar estimated in the treatment with Ca and also in combination.

Among the treatments maximum total sugars of 4.09% on 3rd day, 9.26% on 6th day, 21.16%on 9th day, 20.10% on 12th day in plant crop and 5.01% on 3rd day, 11.67% on 6th day, 22.07%on 9th day, 20.13% on 12th day in ratoon crop recorded in control T_{10}.Where as lowest total sugar of 2.95%, 5.93%, 10.70%,14.25%, 18.84%, 18.75%, 17.42% in plant crop and 3.80%, 7.06%, 12.42%, 16.13%, 20.36%, 20.33%, 17.96% in ratoon crop was recorded in T_6 (GA_3@150ppm) on 3rd,6th, 9th, 12th, 15th, 18th and 21st day of storage receptively.

The most striking chemical changes occurred during the postharvest ripening of banana fruits were hydrolysis of starch and accumulation of sugars (Patil and Magar, 1976) [8]. Considering the interaction effects of banana varieties and different postharvest treatments, significant variations where found on total sugar contents in fruit pulp (Zomo *et al.,* 2014) [13]. Postharvest treatments with different concentrations of GA_3 were significantly affected the total sugar content of banana fruits. Banana fruits treated with different concentrations of GA_3 showed slight increase in total sugar contents during storage period and decreased after reaching their peaks in concentration dependent manner while untreated fruits showed rapid increase to their peak and decrease thereafter. Which are in agreement with that reported by Duguma *et al*., (2014) [4], Mulagund *et al.,* (2015) [6], Tapas *et al*., (2016) [12].

Rapid increment in the total sugar contents of control fruit could be due to faster ripening process which converts starch in to sugar, while the slower rate in the rest of the treatments could be due to the effects of the treatments in delaying the ripening process (Golding *et al*., 2005) [5].

The fruits treated with GA_3 (150 ppm) recorded lowest total sugars at full ripe stage. This may be due to slow hydrolysis of starch to sugars by antagonistic effect on autocatalytic biosynthesis of ethylene and inhibit the activity of α amylase, β amylase and starch phosphorylase this maintaining the organic acid and acidity level which results in low sugar content and higher starch in fruits at ripening (Mulagund *et al*., 2015) [6].

Table 5: Effect of GA and Ca on shelf life in plant crop and ratoon crop

Treatment	Final shelf life (Days)	
	PC	RC
T1	17.60	17.70
T2	17.64	17.66
T3	17.74	17.82
T4	20.57	20.58
T5	21.28	21.72
T6	22.04	22.06
T7	15.02	15.01
T8	15.04	15.06
T9	17.58	17.59
T10	12.27	12.32
SE(m)±	0.14	0.24
CD at 5%	0.43	0.70
CV	1.42	2.33
F –test	**	**

NS= Non Significant, *= Significant at 1%, **=Significant at 5%

The tabulated data (7) shows highly significant variations were obtained for the shelf life of both plant crop and ratoon crop of banana. The shelf life of T_6 (22.04 days in plant crop and 22.06 days in ratoon crop) was higher than that all other treatments. The maximum shelf life was observed in T_6 whereas the minimum (12.27 days in plant crop and 12.32 days in ratoon crop) was in T_{10}. The treatment GA_3 causes the decrease in the tissue permeability and thereby reduced the rate of water loss leading to delayed fruit ripening (Nirupama *et al*., 2010) [7].

This finding is also in agreement with those of Zomo *et al*., (2014) [13], Mulagund *et al*., (2015) [6]. Post-harvest GA_3 dipping have shown to increase the shelf life in a range of banana cultivars as it inhibits the ethylene biosynthesis by its antisenescent action. Extension of shelf-life is also possible by suppression of pathogenic infections and increased synthesis of nucleic acids.

Apart from GA_3, the treatment with calcium chloride also showed promise in reducing disease incidence and extending shelf life. Calcium dip was effective in inhibiting spore germination, thus provided a good control of *Colletotrichum gloeosporiodes* infection on papaya.Similar effect of Ca was reported to inhibit the growth of *Botryosphaeria dothidea* on apple and *Monilinia fructicola* on peach. Calcium chloride application as postharvest treatment has been reported to markedly elevate Ca content in the fruit peel, fruit firmness and reduce post-harvest disease caused by anthracnose in apple, peach papaya and dragon fruit (Mulagund *et al*., 2015) [6]. Calcium chloride may serve as an effective postharvest treatment but present findings indicate that calcium Chloride does not show superiority over different concentrations of GA it might be due to post harvest dip it gets less time to be absorbed by the fruits.

Also it is recorded that when GA combines with Ca shelf life decreases. After control minimum shelf life of 15.02 days in plant crop and 15.01days in ratoon crop was recorded in T_7 (GA_3 @50ppm + $CaCl_2$ @ 2%)and 15.04 days in plant crop and 15.06days in ratoon crop was recorded in T_8 (GA_3 @100ppm + $CaCl_2$ @ 3%). This is due to the antagonist effect of Ca on GA.

The study conclude that post-harvest dipping of fruits with 150 ppm GA3 + 200 ppm may be followed by producers to attain maximum quality and post-harvest life.

References

1. Anonymous Database. Area, production, productivity of major fruit crops in India, 2015. www.nhb.gov.in
2. Bhaleroa PP, Parmar BR. Effect of growth regulators on post-harvest life of banana cv. Grand naine. The Asian J of Hort. 2011; 6:283-287.
3. Dharmasenal DA, Kumari AH. Suitability of charcoalcement passive evaporative cooler for banana ripening. Journal of Agricultural Science. 2005; 1:1-10.
4. Duguma T, Meseret CE, Muthuswamy M. The effects of gibberellic acid on quality and shelf life of banana (*musa* spp.). Int J Cur Res Rev. 2014; 6(23):63-69.
5. Golding JB, Ekman JH, Glasson M. Regulation of Fruit Ripening. Stewart Postharvest Review. Posthharvests Biology and Technology. 2005; 3:1-5.
6. Mulagund J, Porika H, Soorianathasundaram K, Deepika C. Influence of Growth Regulators Combined with Chemicals to Improve Postharvest Fruit Quality in Banana cv. Nendran (Musa AAB). J Food Process Technol. 2015; 6:3.
7. Nirupama P, Neeta BG, Rao TVR. Effect of post harvest treatments on physiochemical Characteristics and shelf life tomato fruits during storage. American-Eurasian Journal of Agriculture & Environmental Science. 2010; 9(5):470-479.
8. Patil DL, Magar NG. Physicochemical changes in banana fruit during ripening. Journal of Maharashtra Agricultural University. 1976; 1:95-99.
9. Pinto AC, Alues RE, Pereira EC. Efficiency of different heat treatment procedures in controlling disease of mango fruits. Acta Horticulture. 2004; 645:551- 553.
10. Rao DVR, Chundawat BS. Effect of certain chemical retardants on ripening changes of banana cv. Lacatan at ambient temperatures. Prog Hort. 1986; 18:189-195.
11. Somogyi M. Notes on sugar determination. J Biol Chem. 1952; 195:19-23.
12. Tapas S, Veena J, Tanmoy S, Sayan S. Effect of post harvest treatments on shelf life and quality of banana cv. Grand Naine. International Journal of Agriculture Sciences. 2016; 8(61):3505-3509.
13. Zomo SA, Ismail SM, Jahan MS, Kabir K, Kabir MH. Chemical Properties and Shelf Life of Banana (*Musa sapientum* L.) as Influenced by different Postharvest Treatments. A Scientific Journal of Krishi Foundation. 2014; 12(2):6-17.