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EFFECT OF GROWTH REGULATORS ON PHYSICAL CHANGES AND SHELF LIFE OF BANANA DURING STORAGE

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ABSTRACT

Sultana MS, Islam MZ, Shamim AHM, Mondal MF (2012) Effect of growth regulators on physical changes and shelf life of banana during storage. *Int. J. Sustain. Crop Prod.* 7(3), 31-35.

The experiment was conducted to evaluate the effect of growth regulators on physical changes and on shelf life of banana during storage. There were five growth regulators *viz*; control, gibberallic acid (GA_3), naphthalene acetic acid (NAA), benzyl adenine (BA) and kinetin with two varieties of banana *viz* Amritasagar (V_1) and Sabri (V_2). Results showed the striking changes between the varieties Amritasagar and Sabri fruits characteristics. Total weight loss (21.78%) was the highest in Amritasagar under control treatment, whereas GA_3 treated Sabri the lowest (10.10%). The pulp to peel ratio were found significant except at 9^{th} and12^{th} days of storage. At 6^{th} days of storage the maximum and minimum moisture content (67.58% and 63.49%) were observed in Amritasagar with control (V_1T_0) and Sabri with GA_3 which followed by V_1T_1 (V_1: Amritasagar T_1: Gibberellic acid) treatment combination. The effect of growth regulator treatments and variety were not significant in relation to percent dry matter content at all days of storage. The growth regulators treatments showed highly significant variation in respect of shelf life among the treated and untreated bananas. GA_3, BA and Kinetin treatments exhibited better storage performances. The variety Sabri treated with GA_3 showed the longest shelf life (14.46 days) followed by BA treatment (12.30 days). The study revealed that GA_3 treatment found minimum weight loss, pulp to peel ratio, percent moisture content and percent dry mater content.

Key words: *post harvest, growth regulator, total weight loss, pulp to peel ratio, moisture content, shelf life*

INTRODUCTION

Banana (*Musa* spp.) belongs to the family Musaceae. Banana is a very popular fruit in Bangladesh in respect of total production; it ranks top position among the major fruits grown in Bangladesh (BBS 2006) and comprises about 42% of the total fruit production (Haque 1988). It is a nutritious fruit rich in carbohydrates and a good source of vitamins. It is highly perishable and rated very poor for process ability and it is mainly used for table purpose. Amritasagar is the best banana of Bangladesh and is considered to be the leading commercial cultivar in this country. After ripening, it has soft pulp with fine textures and good aroma and is completely seedless. On the other hand, Sabri is one of the most important commercial varieties in Bangladesh and is considered even better than Amritasagar by many consumers. Pulp of the ripe fruit is soft with mild to distinct aroma.

Banana in Bangladesh, a considerable quantity of Banana is being spoiled every year due to prevailing high temperature and high humidity through loss of weight of banana due to respiration and transpiration, softening of flesh and loss of resistance to microbial attack.

Such losses occur either during transpiration and or in market. Hence, it is necessary to check such post harvest losses. Prolongation of shelf life of banana may be done by some techniques like using packaging materials, hot water, fungicides, ethylene absorbents and growth regulators. These techniques may arrest the growth and spread of micro organism by reducing the shriveling which ultimately leads to an increased shelf life and maintain the marketability of the fruit for a longer period (Sudha *et al.* 2007). Growth regulator is usually described as a natural or synthetic substance that modifies biochemical or physiological processes of banana. Delay or hasten banana ripening by using growth regulators like auxins, gibbrellins cytokinin and growth retatdent, both natural and synthetic would be great value in developing anew technology to regulate the self life. It had been reported that ripening of banana can be delayed by the use of chemical like GA_3, Kinetin, BA, Benlate and ethylene absorbent (Vendrell 1971; Weaver 1972; Kapor and Turner, 1976; Rao and Chundawat, 1984; and Prasad and Singh, 1993). Patil and Hulamani (1998) had also carried out an experiment with GA_3 and found that in significantly lower physiological weight loss, decay loss, percent fruit ripening and pulp to peel ratio throughout the storage period.

There is hardly any information pertaining to the use of growth regulating chemicals for the control of ripening of banana available in Bangladesh. Hence, the study was undertaken with the following objectives: to find out the physiological changes of banana due to use growth regulators and to identify the suitable growth regulator in extending the shelf life.

MATERIALS AND METHODS

An experiment was conducted at the laboratories of Horticulture and Biochemistry Department of the Bangladesh Agricultural University, Mymensingh during the periods from 2003. The study was conducted in completely randomized design with three replications. There were two factor experiments with two banana cultivars *viz.*, Amritasagar and Sabri, while five treatments were control, gibberellic acid (GA_3)-150 ppm, naphthalene acetic acid (NAA)-600 ppm, benzyl adenine (BA)-20 ppm and Kinetin-15 ppm. All of the growth regulators were used in this study from synthetic origin.

Mature banana fruits, physically similar fruits approximately more or less uniform in size, shape and color were selected from both the varieties for conducting the experiment. The post harvest treatments used in the present study were randomly assigned to the selected banana fruits. After the application of treatments the fruits were kept on a brown paper previously placed on laboratory floor at room temperature. Fruits were used in the experiment were monitored carefully in every day. Data on change in different physical characters total weight loss, pulp to peel ratio, percent moisture content, percent dry matter and self life of banana were recorded. Shelf life of banana was calculated by counting the day require to ripe fully as to retaining optimum marketing and eating quality.

The collected data were statistically analyzed to find out the variation resulting from experimental treatments following F variance test. The significance of difference between the pair of means was compared by LSD test at 1% and 5% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The result of the present study on the post harvest attributes of banana namely physical changes like total weight loss, pulp to peel ratio, percent moisture content, percent dry matter and shelf life of banana as influenced by different growth regulators.

Total weight loss

Result showed statistically significant variation in respect of total weight loss of banana among two varieties except at 12 days of storage. It was found higher in Amritasagar than that of Sabri (Fig. 1). In respect of growth regulator treatments total weight loss was highly significant at all days of storage. At 6th, 9th and 12th days of storage control treatment showed maximum (9.19%, 14.69% and 20.66%) total weight loss and minimum (6.12%, 8.37% and 10.34%) were found in gibberellic acid (GA_3) treated fruit (Fig. 2). This result agreed with Rao and Chundawat (1984). Patil and Hulamani (1998) had also reported that GA_3 treated banana reduced physiological weight losses.

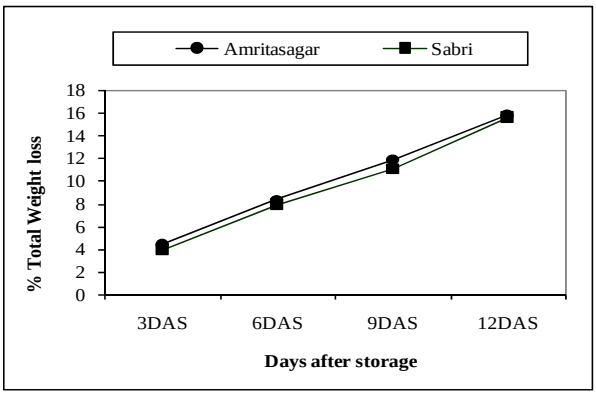
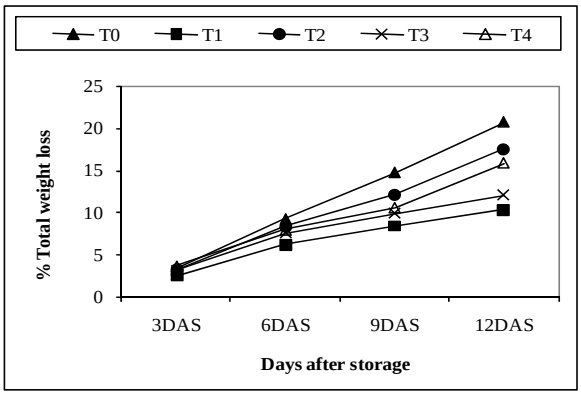


Fig. 1. Main effect of varieties on percent total weight loss of banana at different days after storage



T_0: Control, T_1: Gibberellic acid, T_2: Naphthalene acetic acid, T_3: Benzyl adenine, T_4: Kinetin

Fig. 2. Main effects of growth regulators on percent total weight loss of banana at different days after storage

Table 1. Combined effects of varieties and growth regulators treatment on percent total weight loss of banana during storage

Variety × Growth regulators	% Total weight loss			
	3DAS[#]	6DAS	9DAS	12DAS
V_1T_0	4.37	9.23	15.71	21.78
V_1T_1	3.39	6.85	8.93	10.57
V_1T_2	4.43	8.95	12.23	18.12
V_1T_3	4.12	8.10	10.27	13.79
V_1T_4	4.28	8.45	11.05	14.56
V_2T_0	4.12	9.16	13.67	19.53
V_2T_1	3.04	5.39	7.81	10.10
V_2T_2	3.64	8.97	12.01	17.68
V_2T_3	4.00	7.79	10.07	12.90
V_2T_4	4.10	8.39	11.59	17.83
LSD (0.05)	0.305	0.431	0.930	0.993
LSD (0.01)	0.416	0.588	1.268	1.355

[#]DAS = Days after storage, T_0: Control, T_1: Gibberellic acid, T_2: Naphthalene acetic acid, T_3: Benzyl adenine, T_4: Kinetin, V_1: Amritasagar, V_2: Sabri

The highest total weight loss (21.78%) was found in Amritasagar with control (V_1T_0) treatment combination and the lowest total weight loss (10.10%) was observed in Sabri with GA_3 growth regulator (V_2T_1) treatment combination at the 12 days of storage (Table 1).

Pulp to peel ratio

Pulp to peel ratio between the varieties were found significant at 3rd and 6th days of storage. The lowest (2.74 and the highest (3.25) pulp to peel ratio in Amritasagar were showed similar trends. Variation among the treatments in relation to pulp to peel ratio were statistically significant at different days of storage. At 6th day storage the highest (2.96) was recorded from kinetin (T_4) treatment and at 6th days the highest (3.53) was noticed from control treatment where as, the lowest (2.57 and 2.93) was observed in GA_3 (T_1) treatment at 6th and 9th days of storage (Table 2). The interaction effects between different growth regulator treatment and variety in relation to pulp to peel ratio were significant during storage except at 9th and 12th day of storage. At 6th days of storage the highest (3.03) pulp to peel ratio was found in (V_2T_2) treatment combinations which followed by kinetin with Sabri treatment (V_2T_4) and the lowest (2.51) in Amritasagar with (GA_3) treatment combination. Again at 9th day of storage, the highest (3.57) pulp to peel ratio was recorded in V_1T_0 (Amritasagar with control) where as the lowest pulp to peel ratio (2.87) was observed V_1T_1 (Amritasagar with GA_3) treatment combination (Table 3). Higher rate of transpiration from the peel than pulp and also accumulation of moisture in pulp which is derived from carbohydrate break down and the osmotic transfer of water may increase pulp to peel ratio. The findings were in agreement with that of Simmonds (1960).

Moisture content in banana pulp

Moisture content in the pulp of banana of all treatment increased during the storage period. Significant Variation was found in moisture content between the variety at 9th and 12th days of storage. Higher moisture content (65.82% and 70.75) was found in Amritasagar in comparison with Sabri at 6th and 9th days of storage. After the 9th days, the moisture content was decline gradually (Table 2). Various growth regulator treatments adopted in the present study showed significant at 9th and 12th days of storage (Table 2). Interaction effects between the growth regulator variety and treatment were found non significant at different days of storage. At 6th days of storage the maximum and minimum moisture content (67.58% and63.49%) were observed in Amritasagar with control (V_1T_0) and Sabri with GA_3 which followed by V_1T_1 treatment combination. At 9th days of storage, the highest (71.68%) and the lowest (65.61%) moisture content were also recorded from Sabri with control and Sabri with GA_3 treatment combination (Table 3). The increase in moisture percent was probably due to (i) Osmotic withdrawl of water from peel to pulp and (ii) complete break down of starch to CO_2 and water.

Table 2. Main effects of Growth regulators treatment on pulp to peel ratio and percent moisture content of banana during storage

Growth Regulators	Pulp to peel ratio				% Moisture content			
	3DAS#	6DAS	9DAS	12DAS	3DAS	6DAS	9DAS	12DAS
T_0	2.52	2.78	3.53	3.42	64.92	66.98	71.73	70.20
T_1	2.35	2.57	2.92	2.90	62.04	63.73	67.46	67.55
T_2	2.65	2.89	3.40	3.25	63.82	65.71	70.99	69.58
T_3	2.58	2.81	3.11	3.08	62.96	64.83	69.77	68.71
T_4	2.61	2.96	3.30	3.16	63.40	65.29	70.13	69.77
LSD (0.05)	0.126	0.076	0.205	0.120	-	-	1.523	1.741
LSD (0.01)	0.172	0.104	0.280	0.164	-	-	2.077	-

#DAS = Days after storage, T_0: Control, T_1: Gibberellic acid, T_2: Naphthalene acetic acid, T_3: Benzyl adenine, T_4: Kinetin

Dry matter content of banana pulp

Dry matter content of banana pulp was calculated from percent moisture content. Significant Variation was found in percent dry matter content between varieties at 9th and 12th days of storage. Dry matter contents were found higher (35.21% and 30.72%) in Sabri than in Amritasagar (34.18% and 29.25%) at 6th and 9th days of storage. Different growth regulators treatment on percent dry matter content was significant at 9th and 12th days of storage. At the 6th and 12th days of storage, the highest (36.28% and 32.55%) and lowest (33.03% and 28.27%) dry matter content were found in GA_3 growth regulator which is followed by benzyl adenine (BA) growth regulator treatment. The lowest (33.03% and 28.27%) dry matter content were observed in control treatment. The interaction effect between the varieties and different growth regulator treatments were non significant at all days of storage. However at 6th and 9th days of storage the highest (36.51% and 34.39%) and lowest (32.42% and 28.32%) dry matter contents were observed in V_2T_1 (Sabri with GA_3) and V_1T_0 (Amritasagar with control) treatment respectively (Table 4).

Table 3. Combined effect of varieties and growth regulators treatment on pulp to peel ratio and percent moisture content of banana during storage

Variety × Growth regulators	Pulp to peel ratio				% Moisture content			
	3DAS[#]	6DAS	9DAS	12DAS	3DAS	6DAS	9DAS	12DAS
V_1T_0	2.57	2.83	3.57	3.43	65.74	67.58	71.68	70.03
V_1T_1	2.37	2.51	2.87	2.90	62.91	63.96	69.30	69.48
V_1T_2	2.40	2.74	3.40	3.29	64.17	66.23	71.34	70.05
V_1T_3	2.39	2.67	3.10	3.00	63.33	65.41	70.56	69.41
V_1T_4	2.43	2.93	3.31	3.19	63.87	65.93	70.87	70.67
V_2T_0	2.47	2.73	3.49	3.40	64.10	66.37	71.78	70.36
V_2T_1	2.32	2.63	2.97	2.89	61.17	63.49	65.61	65.61
V_2T_2	2.89	3.03	3.39	3.21	63.46	65.19	70.64	69.10
V_2T_3	2.76	2.94	3.12	3.16	62.59	64.25	68.98	68.00
V_2T_4	2.79	2.99	3.29	3.14	62.93	64.64	69.39	68.87
LSD (0.05)	0.179	0.108	0.290	0.170	-	-	2.154	2.463
LSD (0.01)	0.244	0.147	0.396	0.232	-	-	2.938	-

[#]DAS = Days after storage, V_1: Amritasagar, V_2: Sabri, T_0: Control, T_1: Gibberellic acid, T_2: Naphthalene acetic acid, T_3: Benzyl adenine, T_4: Kinetin

Table 4. Combined effects of varieties and growth regulators treatment on percent dry matter content of banana during storage

Variety × Growth regulators	% Dry matter content			
	3DAS[#]	6DAS	9DAS	12DAS
V_1T_0	34.26	32.42	28.32	29.97
V_1T_1	37.09	36.04	30.70	30.52
V_1T_2	35.83	33.77	28.66	29.95
V_1T_3	36.67	34.59	29.44	30.59
V_1T_4	36.13	34.07	29.13	29.30
V_2T_0	35.90	33.63	28.22	29.64
V_2T_1	38.83	36.51	34.39	34.39
V_2T_2	36.54	34.81	29.36	30.90
V_2T_3	37.41	35.75	31.02	32.00
V_2T_4	37.04	35.36	30.61	31.13
LSD (0.05)	-	-	2.154	2.463
LSD (0.01)	-	-	2.938	-

[#]DAS = Days after storage, V_1: Amritasagar, V_2: Sabri; T_0: Control, T_1: Gibberellic acid, T_2: Naphthalene acetic acid, T_3: Benzyl adenine, T_4: Kinetin

Shelf life

In respect of self life of two varieties of banana were found significant. The shelf life of Sabri (12.01 days) was greater in comparison with Amritasagar was (8.49 days). The effect of different growth regulators treatment used in the present investigations was highly significant in respect of prolonging the shelf life of banana. The maximum shelf life (12.48 days) was observed in GA_3 treated fruits followed by (10.85 days) in BA treated fruits whereas minimum shelf life (7.82 days) was recorded in control. The GA_3 is also known to maintain chlorophyll and there after, would have maintained the green colour of bananas. Pinaki *et al.* (1997) had reported that mature and fully developed banana fruits of uniform size were dipped into GA_3 (150 ppm) was most effective treatments for prolonging the shelf life of banana. The interaction effect between different growth regulators treatment and varieties were highly significant in case of self life of banana. Considering the combined effect of variety and growth regulator treatments, the maximum self life (14.46 days) was found in Sabri when treated with GA_3 growth regulator followed by Sabri with BA treated banana. The minimum shelf life 6.33 days recorded in Amritasagar banana without growth regulators (Fig. 3). The increase of self life was probably due to the

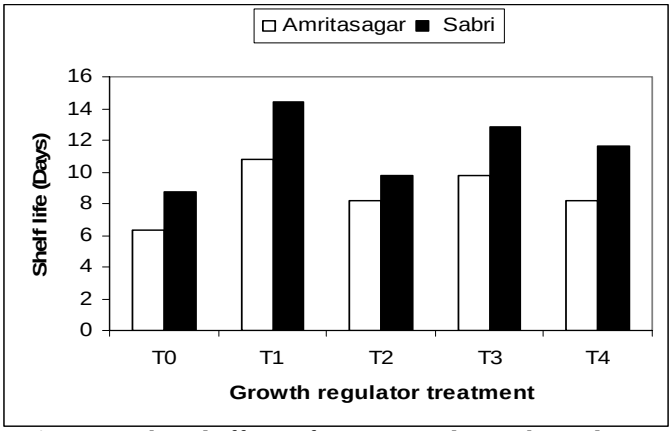


Fig. 3. Combined effects of varieties and growth regulators treatment on shelf life of Banana

reduction of various gases (O_2, CO_2) exchange from inner and outer atmosphere as well as slowing down the process leading to the ripening by different growth regulator treatments.

The maximum and minimum temperature experienced in the storage room was 32°C to 27°C and relative humidity ranges from 86% to 72% during the experimental period. Microbial decay (*Botryodiplodia theobromae*, *Colletotrichum musae*) was observed to the highest in untreated Amritsagar whereas, it was observed the lowest in GA_3 treated in Sabri. The highest temperatures also influence to produce ethylene (ripening natural hormone) which is responsible to enhance ripening of fruits whereas, low temperature counteract the ethylene production.

The experimental result shows the relationship between the relative humidity and temperature. Low humidity make the temperature low resulting the microbial decay on sample was minimum depending on storage duration. The GA_3/GR delayed ripening by counteracting of ethylene which is the ripening hormone. The growth regulators maintain chlorophyll so would keep up green colour of banana.

CONCLUSION

From the foregoing discussion, it can be concluded that gibberellic acid (GA_3) treatment found minimum weight loss, pulp to peel ratio, percent moisture content, and percent dry mater content. The results also revealed that among the growth regulator treatments GA_3 appeared to be more suitable for extending the self life as well as other quality attributes of banana fruits. However, further investigation and research is encouraged to find out the optimum concentration of growth regulators GA_3 for improving of this technology.

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