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EFFECT OF POST-HARVEST APPLICATION OF GROWTH REGULATORS ON ENHANCING PHYSICAL PARAMETERS AND SHELF LIFE OF BANANA CV. GRAND NAINE

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ABSTRACT

This experiment was carried out at fruit science Laboratory, department of fruit science and horticulture technology, Bhubaneswar, Odisha during year 2022-23 on banana cv. Grand Naine. The experiment was laid out in a completely randomized design (CRD) with three replications and ten treatments including control to study the effect of post-harvest application of growth regulators on enhancing physical parameters and shelf life of banana. Observations were taken in each three days till spoilage of fruits and recorded. Banana fruits treated with gibberellic acid @ 150 ppm recorded lowest Physiological loss in weight (7.95%), pulp to peel ratio (2.68), highest peel thickness (2.51 mm) and highest shelf life of 19 days compared to other treatments over control.

***Keywords* :** Banana post-harvest treatment, gibberellic acid, physical parameters, shelf life.

Introduction

The banana (*Musa* spp.) belongs to the family Musaceae is one of the most widely consumed fruits globally due to its high calorific value, nutritional content and variety of use as food source. it is one of the most widely cultivated commercial fruit crops in tropical and subtropical regions. Cultivation of banana has a significant role in economy of countries. Considering the nutritive values of banana, it is believed to be the “Poor man's apple”. Banana is a rich source of vitamins and minerals like carbohydrate, potassium, phosphorus, calcium, magnesium and Vit-B. Fruits are free from fat with high calorific value. The low-fat and high sugar bananas are uses as dessert food and staple foods (Aurore *et al*., 2009). India is the largest producer of banana in the world with a production of 34.50 million ton during the year 2021-22 (FAOSTAT, 2023). A large number of banana cultivars are grown in India, out of these Grand Naine cultivar become popular and dominant one for domestic trade in India. Besides the increasing population, the production of banana has also increased for fulfilling the demand among consumers. Though introduction of high yielding varieties resulted in increase in production but the post-harvest storage of banana is at risk due to lack of proper post-harvest facilities. As a result, a huge amount of banana is spoiled every year. Banana is a climacteric fruit and its biochemical changes are a continuous process after harvest till senescence (Rao and Chundawat, 1984). Unlike many other fruits, banana is not a seasonal fruit and the availability of fruits in large quantities round the year. The benefits of increased production will not be realized unless it is duly accompanied by advanced storage, packaging and transport techniques. Effective fruit storage aims to reduce post-harvest losses by using appropriate post-harvest handling procedures and improving knowledge of the biochemical regulation of fruit ripening to extend the shelf life. Ripening of banana can be delayed by the use of chemical like GA_3, Kinetin, BA and ethylene absorbent (Prasad and Singh, 1993). Application of GA_3, kinetin and benzyl adenine found significantly lower physiological weight loss and pulp to peel ratio throughout the storage period (Patil and Hulamani, 1998).These treatments may arrest the growth and spread of microorganism by reducing the shrivelling which leads to an increased shelf life and maintain the marketability of the fruit for a certain period (Sudha *et al*., 2007). It is necessary to study and understand the shelf life and quality of banana under different chemical treatments. Hence, the experiment was carried out with objective to find out the effect of various post-harvest treatments with growth regulators on changes in physico-chemical parameters during the storage period.

Material and Methods

The present investigation was carried out at fruit science laboratory, Department of Fruit Science and Horticulture Technology, Bhubaneswar during 2022-23. Fruits of Grand Naine cultivar were collected from Biotechnology cum Tissue Culture Centre (BTCC), OUAT, Bhubaneswar farm when fruits attained 75 % physiological maturity stage. Selected fruits were then sorted and graded by size, colour and weight. The selected fruits were divided in lots and kept ready for post-harvest treatments with chemical and storage. The chemical solution of GA_3@ 50 ppm, GA_3@ 100 ppm, GA_3@ 150 ppm, BA@ 30 ppm, BA@ 50 ppm, BA@ 80 ppm, Kinetin@ 5 ppm, Kinetin@ 10 ppm and Kinetin@ 15 ppm were prepared as per treatments and fruits were dipped in solution for 2 minutes. After treatment, fruits were allowed to dry and finally these fruits were kept as per treatments in ambient condition. Storage temperature and relative humidity were recorded daily. The experiment was laid out in a completely randomized design (CRD) with three replications and ten treatments including control. The treatment details were T_1- GA_3 @ 50ppm, T_2- GA_3 @ 100ppm, T_3- GA_3 @ 150ppm, T_4- Benzyl adenine @ 20ppm, T_5- Benzyl adenine @ 50ppm, T_6- Benzyl adenine @ 80ppm, T_7- Kinetin @ 5 ppm, T_8- Kinetin @ 10 ppm, T_9- Kinetin @ 15 ppm and T_{10}- Control (no chemical spray). Data were recorded on physiological loss on weight (PWL) %, pulp to peel ratio, pulp weight (g), peel weight (g), peel thickness (mm), dry matter content (DMC) (%) and shelf life (days) of the fruits. Data were analysed statistically by following Gomez and Gomez (1984).

Results and Discussion

Physiological loss on Weight (%)

The result obtained on effect of chemical treatments on physiological loss on weight (%) are presented in Table 1. Weight losses increased significantly in all the treatments with increase in storage period. However, the increase had been at a reduced rate in all the treated fruits as compared to control. On 3rd day of storage, the minimum physiological loss in weight was observed in T_3 (2.13%) followed by T_2 (2.56%) and T_1 (2.79%). The maximum physiological loss in weight was observed in T_{10} (5.52%). T_3 was found significantly superior to other treatments and significant variation was observed among the treatments. Similar trend was observed on day 6th and 9th. On 12th day, the lowest physiological loss in weight was observed in T_3 (5.78%) followed by T_2 (6.67%), whereas the highest was observed in T_9 (13.54%). On 15th day, the lowest physiological loss in weight was observed in T_3 (7.95%) followed by T_2 (9.04%) whereas the highest was observed in T_7 (13.01%). In all the treatments, the physiological loss in weight increased gradually with increase in storage periods. Maximum rate of increase in physiological loss in weight (%) was recorded in T_{10} (Control) followed by T_9 (Kinetin @ 15 ppm) and T_8 (Kinetin @ 10 ppm). Whereas, the minimum rate of physiological loss in weight (%) was found in T3 (Gibberellic acid @ 150 ppm) followed by T_2 (Gibberellic acid @ 100 ppm) and T_1 (Gibberellic acid @ 50 ppm). Treatment T6 (Benzyl adenine @ 80 ppm) and T_7 (Kinetin @ 5 ppm) was also found significant in reducing the rate of physiological loss in weight as compared to T_{10} (Control), T_9 (Kinetin @ 15 ppm), T_8 (Kinetin @10 ppm), T_5 (Benzyl adenine @ 50 ppm) and T_4 (Benzyl adenine @ 30 ppm). It may be due to application of gibberellic acid slows down the rate of respiration, which in turn slows down the physiological weight loss. Gibberellic acid also delays the appearance of the climacteric peak in a concentration-dependent manner, which slows down the ripening of banana fruits. This result corroborated with Bhalerao *et al*. (2010) in banana and Madhavi *et al*. (2005) in sapota.

Pulp to peel ratio

The data regarding pulp to peel ratio as influenced by growth regulators treatment is presented in Table 1. From the Table, it was observed that the pulp to peel ratio gradually increases with increase in storage period. On 3rd day, maximum pulp to peel ratio was recorded in T_{10} (1.80) and minimum was recorded in T_3 (1.36) followed by T_2 (1.42) and T_3 (1.47) which was found to be at par. On 6th day, maximum pulp to peel ratio was recorded in T_{10} (2.41) and minimum was recorded in T_3 (1.43) followed by T_2 (1.51). similar trend was observed on 9th day. On 12th day, maximum pulp to peel ratio was recorded in T_9 (3.11) and minimum was recorded in T3 (2.23) followed by T_2 (2.36). On 15th day, maximum pulp to peel ratio was recorded in T_7 (3.08) and minimum was recorded in T_3 (2.68) followed by T_2 (2.77). For 18th day, T_3 was found statistically superior to all other treatments. Fruits treated with gibberellic acid have a decreased pulp to peel ratio. In the presence of gibberellic acid, the pulp to peel ratio indicated a delay in the ripening of banana fruit. The increased sugar concentration of the pulp in comparison to the peel causes a rise in the pulp to peel ratio, which is caused by the displacement of water from the peel towards the pulp during the ripening process because of the osmotic pressure gradient (Cerqueira *et al*., 2002).

Pulp weight (g)

The data for pulp weight under present investigation is presented in Table 2. From the Table, it is observed that pulp weight increased with increase in storage period. However, the rate of increase was slower in gibberellic acid treated fruits compared to other treatments. In treatment T_{10} , no fruits were left for 12th and 15th day of storage and in T_9, T_8, T_5 and T_4 complete loss of fruits was observed. On 18th day, no fruits were left for observation in all the treatments except for T_3. Although, the rate of increase was slower in T_3 but on 18th day, maximum pulp weight was recorded in T_3 treated fruits *i.e.,* 102.56 g followed by T_1 and T_2 which reached a peak pulp weight of 102.49 g and 101.85 g on 15th day of storage. Among all the treatments, T_3 was found statistically superior as minimum rate in increase in pulp weight was recorded, followed by T_2, whereas the maximum rate in increase was recorded in T_{10} followed by T_9. Gibberellic acid is a plant growth regulator that has been shown to increase the pulp weight of banana fruits during storage. This is likely due to a few different mechanisms like GA_3 promotes cell division and enlargement which leads to an increase in the number and size of cells in the banana pulp, resulting in a heavier fruit, reduction of ethylene production by GA_3 and it increases the production of enzymes that break down carbohydrates into sugars which lead to an increase in the sugar content of the banana pulp, which can also contribute to increased weight. This finding was well supported with result of Sarkar *et al*. (2016) in banana.

Peel weight (g)

The analyzed data regarding peel weight under present investigation is presented in Table 2. It was revealed from the Table that significant difference was recorded with respect to peel weight under storage period. It was observed that peel weight decreased with increasing storage period in all the treatments. In treatment T_{10} 100% fruit loss was observed in 12th day of storage and on 15th day complete loss of fruit was observed in treatment T_9, T_8, T_5 and T_4. On 18th day no fruits were left for all the treatments except for T_3. Among all the treatments, T_3 was found statistically superior as minimum rate of decrease in peel weight was recorded, followed by T_2, whereas the maximum rate of increase was recorded in T_{10} followed by T_9. The retention of dry matter content of fruits over storage period can show the stage of ripening. GA_3 treated fruits showed higher peel weight as compared to other treatments because GA_3 increase the cell size and number in peel, increase the production of cell wall components such as cellulose and pectin and delay the ripening process which can give the peel more time to grow. Same result was observed by Sarkar *et al*. (2016) in banana.

Peel thickness (mm)

The data regarding peel thickness is analyzed and presented in Table 3. Peel thickness was measured on 3rd, 5th, 9th, 12th, 15th and 18th day of storage. The maximum peel thickness was recorded in T_3 (3.86 mm, 3.68 mm, 3.35 mm, 3.04 mm, 2.51 mm and 2.26 mm) during 18 days of storage, followed by T_2 (3.72 mm, 3.51 mm, 3.28 mm, 2.84 mm and 2.32 mm) during 15 says of storage. It was observed on 6th day of storage that, T_{10} recorded peel thickness of 2.21 mm. The rate of reduction in peel thickness was much faster in T_{10} compared to all the other treatments which were found to have a delayed ripening. On 12th day of storage, T_9 and T_8 which are statistically at par were found to have reached their minimum peel thickness of 2.11 mm and 2.02 mm respectively, followed by T_5 (2.14 mm). On 15th day of storage, the peel thickness of T_2 reached a minimum of 2.84 mm followed by T_1 (2.71 mm) which is also *at par* with T_2. On 18th day of storage T_3 attained its minimum peel thickness *i.e.,* 2.26 mm. T_3 was found statistically superior compared to all other treatments as it retained maximum peel thickness during storage period. In comparison to other chemical treatments, the GA_3 treated fruits had the thickest peels, which may be due to their metabolisms were slower and their hydrolytic enzyme concentration was lower than with other treatments. The finding was well supported with results of Sarkar *et al.* (2016) in banana.

Dry matter content (%)

The dry matter content (%) was recorded at every 3 days interval. The data regarding dry matter content was analyzed and tabulated in Table 3. From the Table, it was observed that the dry matter content reduced gradually for all the treatments over the period of ripening. On 3rd day, minimum dry matter content of 32.95 % was observed in T_{10}. Whereas, the maximum dry matter content of 36% was found in T_3 followed by T_2 (35.43) and T_1 (35.31). Similar trend was observed till 9th day of storage. On 12th day, minimum dry matter content of 27.92 % was found in T_8 and the maximum dry matter content of 31.07 % was found in T_3. On 15th day, minimum dry matter content was recorded in T_7 (27.76%) and the maximum dry matter content was recorded in T_3 (29.33 %) followed by T_2 (28.87%). On 18th day, fruits from T_3 were recorded a dry matter content of 28.97%. The starch present in the banana is converted to simple sugars over ripening and dry matter comprises of about 72% of starch. Hence more dry matter shows more scope of ripening and prolonged shelf life. The dry matter content directly depends on the moisture content of the fruit. As the ripening of the fruit advances moisture accumulation within banana fruits increases, hence the dry matter content decreases. The result was in conformity with the findings of Sultana *et al.* (2012) in banana.

Shelf life (days)

The data regarding shelf life of banana cv. Grand Naine is presented in Table 4. The minimum shelf life of 10 days in banana fruits was recorded in T_{10} followed by 13 days for both T_8 and T_9. It was recorded 16 and 15 days for T_6 and T_7 respectively. For T_4 and T_5 shelf life of 14 days was recorded. Maximum shelf life recorded was 19 days in T_3 followed by 17 days in both T_2 and T_1. From the data, it was observed that the shelf life of banana fruits was significantly influenced by all the treatments over T_{10} (Control). T_3 (Gibberellic acid @ 150 ppm) was observed increase in maximum shelf life of banana fruits. Enzymatic activity and the generation of ethylene may have been regulated by gibberellic acid. It is possible that decreased respiration and transpiration activities slowed the ripening process. The GA_3 treatment may have contributed to the longer shelf life of fruits by preventing the climacteric increase in respiration. Similar results were observed by Regmi *et al.* (2024), Zomo *et al.* (2014) and Gangwar *et al.* (2008) in banana, Sanches and Feitosa (2024) in guava.

Conclusion

From the above experiment it may be concluded that post-harvest treatment of banana with gibberellic acid significantly influenced physiological loss of weight, peel weight, maximum pulp weight, pulp to peel ratio, dry matter content and longer shelf life in banana cv. Grand Naine under Odisha condition.

Table 1 : Effect of post-harvest application of growth regulators on physiological loss in weight and pulp to peel ratio on banana cv. Grand Naine

Treatment	Physiological loss in weight (%)						Pulp to peel ratio					
	3rd day	6th day	9th day	12th day	15th day	18th day	3rd day	6th day	9th day	12th day	15th day	18th day
T_1	2.79	4.62	5.62	6.94	9.43	-	1.47	1.58	2.14	2.45	2.83	-
T_2	2.56	4.23	5.43	6.67	9.04	-	1.42	1.51	2.09	2.36	2.77	-
T_3	2.13	3.95	4.83	5.78	7.95	9.21	1.36	1.43	2.04	2.23	2.68	2.97
T_4	4.23	5.41	8.56	12.87	-	-	1.59	1.85	2.32	2.97	-	-
T_5	4.19	5.38	8.31	12.82	-	-	1.57	1.83	2.31	2.92	-	-
T_6	3.19	4.93	7.14	8.57	12.95	-	1.53	1.74	2.21	2.51	3.12	-
T_7	3.21	4.97	7.52	9.41	13.01	-	1.54	1.79	2.25	2.56	3.08	-
T_8	4.31	6.49	9.54	13.27	-	-	1.62	1.98	2.37	3.03	-	-
T_9	4.35	6.52	9.61	13.54	-	-	1.67	2.01	2.41	3.11	-	-
T_{10}	5.52	8.27	14.45	-	-	-	1.8	2.41	3.24	-	-	-
SE(m)±	0.01	0.02	0.05	0.05	-	-	0.02	0.02	0.01	0.03	-	-
CD (P=0.05 %)	0.04	0.06	0.15	0.13	-	-	0.07	0.05	0.03	0.09	-	-

Table 2 : Effect of post-harvest application of growth regulators on pulp weight and peel weight of banana cv. Grand Naine

Treatment	Pulp weight (g)						Peel weight (g)					
	3rd day	6th day	9th day	12th day	15th day	18th day	3rd day	6th day	9th day	12th day	15th day	18th day
T_1	88.52	89.37	98.41	101.11	102.49	-	60.22	56.56	45.98	41.27	36.09	-
T_2	87.14	87.8	97.48	99.9	101.85	-	61.36	58.15	46.64	42.33	36.77	-
T_3	85.16	85.35	96.9	98.23	99.95	102.56	62.62	59.69	46.81	44.05	37.29	34.53
T_4	89.84	93.82	97.64	99.6	-	-	56.5	50.71	42.08	33.54	-	-
T_5	89.43	93.49	97.78	99.23	-	-	56.96	51.09	42.33	33.98	-	-
T_6	88.4	91.16	96.54	98.73	101.17	-	57.78	52.39	43.68	39.33	32.42	-
T_7	88.61	92.06	96.68	98.37	99.16	-	57.54	51.43	42.97	38.42	32.19	-
T_8	90.41	94.94	97.21	99.48	-	-	55.81	47.95	41.02	33.05	-	-
T_9	91.41	95.38	97.61	99.97	-	-	54.74	47.45	40.5	32.14	-	-
T_{10}	92.44	98.67	99.5	-	-	-	51.36	40.94	30.71	-	-	-
SE(m)±	0.11	0.08	0.07	0.14	-	-	0.13	0.11	0.10	0.09	-	-
CD (P=0.05 %)	0.34	0.25	0.21	0.42	-	-	0.37	0.31	0.28	0.25	-	-

Table 3 : Effect of post-harvest application of growth regulators on peel thickness and dry matter of banana cv. Grand Naine

Treatment	Peel thickness (g)						Dry matter (%)					
	3rd day	6th day	9th day	12th day	15th day	18th day	3rd day	6th day	9th day	12th day	15th day	18th day
T_1	3.61	3.45	3.17	2.71	2.28	-	35.31	33.72	30.52	30.09	28.61	-
T_2	3.72	3.51	3.28	2.84	2.32	-	35.43	33.84	30.46	30.06	28.87	-
T_3	3.86	3.68	3.35	3.04	2.51	2.26	36.23	34.65	31.37	31.07	29.33	28.97
T_4	3.41	3.18	2.59	2.14	-	-	34.93	32.54	28.53	28.26	-	-
T_5	3.46	3.23	2.68	2.29	-	-	34.94	32.55	28.61	28.37	-	-
T_6	3.58	3.37	3.14	2.57	2.14	-	34.89	32.34	29.63	29.18	27.92	-
T_7	3.52	3.34	3.11	2.52	2.04	-	34.89	32.33	29.51	29.91	27.76	-
T_8	3.35	3.12	2.79	2.11	-	-	34.76	32.2	28.27	28.14	-	-
T_9	3.28	3.07	2.72	2.02	-	-	34.62	32.19	28.19	27.92	-	-
T_{10}	3.78	2.76	2.21	-	-	-	32.95	30.34	27.7	-	-	-
SE(m)±	0.04	0.02	0.03	0.04	-	-	0.08	0.09	0.09	0.05	-	-
CD (P=0.05 %)	0.11	0.06	0.09	0.12	-	-	0.22	0.25	0.26	0.13	-	-

Table 4 : Effect of various post-harvest treatments with growth regulators on shelf life of banana cv. Grand Naine

Treatment	Days
T1	17
T2	17
T3	19
T4	14
T5	14
T6	16
T7	15
T8	13
T9	13
T10	10
SE(m)±	0.21
CD at 5%	0.62

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