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Short communication

Effect of maturity and storage temperature on shelf-life and quality of banana cv. Grand Naine

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ABSTRACT

A study was undertaken at Regional Horticulture Research Station, NAU, Navsari, during 2008-2009 to assess the effect of maturity stage and storage temperature on shelf-life and quality of banana cv. Grand Naine. The experiment was evaluated in Completely Randomized Ddesign based on the factorial concept, and comprised of three maturity stages (75, 90 and 100% maturity) and four storage temperatures (12°C, 14°C, 16°C & ambient temperature). Fruits harvested at 75% maturity and stored at 12°C recorded maximum green-life and better overall shelf-life, whereas, yellow-life was highest when fruits at 75% maturity were stored at 14°C. Best colour and texture was seen in fruits harvested at 100% maturity and stored at 16°C.

Key words: Banana, maturity, shelf life, quality

Banana (*Musa* spp.) is the fourth most important food crop in the world in terms of gross value, exceeded only by paddy, wheat and milk products. Banana is a rich source of carbohydrates and minerals, particularly, potassium. India is the largest producer of banana in the world, contributing over 25% to the total global production. Among fruit crops, banana ranks first in production and productivity at the national level. Gujarat is the third largest producer of banana in the country next only to Tamil Nadu and Maharashtra producing about 40,47,767 metric tonnes of banana from an area of 65,029 hectares. Of this, South Gujarat alone accounts for about 56% of total production and 54% of total area under banana in the state (Anonymous, 2013). Basrai was until now the leading banana variety in South Gujarat. Of late, banana growers have turned to Grand Naine owing to its earliness, synchronous maturity, superior quality and export potential.

Banana from Gujarat is marketed all over the country. Maturity is an important factor affecting banana marketability. The stage at which fruits need to be harvested is often dictated by distance to the destined market. Duration required for attaining maturity varies depending on soil and climatic conditions. Though the duration for maturity has been worked out at different locations in India, information on Grand Naine pertaining to Gujarat is not available. Therefore, there is a need to generate information regarding the effect of different maturity grades on shelf-life and quality of 'Grand Naine' banana under Gujarat conditions. Secondly, post harvest losses in banana are as high as 30-40% (Patil and Hulmani, 1998). These losses are mainly due to improper handling practices and lack of storage facilities. To reduce these losses, information on critical storage temperature is essential. With an objective of curtailing post-harvest losses in banana and extending availability of the fruit, it was decided to study the effect of different maturity stages and storage temperatures on shelf-life and organoleptic quality in banana cv. Grand Naine.

The experiment was carried out at Regional Horticultural Research Station and Post Harvest Technology Centre, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during 2008–2009. Thirty six healthy inflorescences were selected randomly just after their emergence. Stage of harvest was determined on the basis of number of days taken to maturity after inflorescence emergence. Based on the above criteria, in the cv. Grand Naine, 100 days from shooting (flowering) to harvest was determined as the time required for full maturity and the value was fixed as 100% maturity. Accordingly, 90 and 75 days after shooting were considered as the duration required to attained 90% and 75% maturity stage. The hands were separated and kept in cold storage (12°, 14° and 16°C temperature and 90% RH) and under ambient conditions

(34°C temperature and 70% RH.) Days taken to colour break (from green to yellow stage) was considered as the green-life of the fruit. The period of development of yellow colour to the stage at which fruits showed signs of senescence was considered as yellow-life of the fruits. A total of the green-life and yellow-life was considered as overall shelf-life of the fruits.

Organoleptic evaluation for assessing flavour, taste, colour of skin, colour of pulp, texture and overall acceptability was made on fruit ripening by a panel of five judges, using a 10 point scale. Pulp:peel ratio was calculated by dividing pulp weight by the respective peel weight for each finger. Data was analyzed in this Completely Randomized Design, based on the factorial concept.

Significant differences were observed in green-life (Table 1), yellow-life (Table 2) and overall shelf-life (Table 3) of banana fruits owing to varying maturity levels and storage at different temperatures. Fruits harvested at 75% maturity recorded highest green-life (23.25 days), yellow-life (8.25 days) and overall shelf-life (31.5 days); whereas fully mature (100%) 'Grand Naine' fruits had 16.92 days of green-life, 5.83 days of yellow-life and 22.75 days of overall shelf life. This difference may be due to the fact that fruits harvested at 100% maturity exhibit rapid change in colour (chlorophyll breakdown) compared to those harvested at 75% maturity. It could also be due to higher tannin content in the fruits harvested early. This is in close conformity with findings of Narayana and Mustaffa (2007).

Green-life of fruits was maximum (29.89 days) at storage temperature of 12°C and minimum (8.11 days) at ambient temperature. Shelf-life in fruits is associated with rate of respiration. The rate of respiration is slow in fruits stored at lower temperatures than in those stored at ambient temperature (Gane, 1936). Similar results were obtained by Deka *et al* (2006). Yellow-life of fruits was observed to be maximum (9.78 days) at 14°C and minimum (3.56 days) at ambient temperature, whereas, this was intermediate (8.78 days) at 12°C. This can be attributed to a slow-down in physiological processes within the fruit at lower temperatures. Early senescence was observed in fruits stored at ambient temperature, for, the temperature was high and, therefore, rate of the physiological processes was probably fast. Desai and Deshpande (1975) reported similar results with various storage temperatures in banana.

Combination of the green and yellow life of fruits was considered as the overall shelf-life of fruits. Fruits stored at 12°C had a shelf-life of 38.67 days, while those stored at ambient temperature had a shelf-life of 11.67 days. These observations corroborate findings of Muthuswamy *et al* (1971) and Patil and Magar (1976). Interaction between maturity stage and storage temperature was found to be significant for green-life, yellow-life and overall shelf-life. Fruits harvested at 75% maturity and kept at 12°C had maximum green-life (35 days) and shelf-life (45 days), whereas, highest yellow-life (12 days) was observed in fruits harvested at 75% maturity and stored at 14°C. Lowest green-life (6.67 days), yellow-life (3.33 days) and overall shelf-life (10 days) was observed in fruits harvested at 100% maturity and stored under ambient conditions.

At different maturity levels, variation in colour, texture and taste were found to be non-significant, except flavour,

Table 1. Effect of maturity and storage temperature on green life of banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	35.00	27.67	21.00	9.33	23.25
M_2	28.67	24.33	16.00	8.33	19.33
M_3	26.00	21.00	14.00	6.67	16.92
Mean	29.89	24.33	17.00	8.11	
Source	M	T		M x T	
S. Em±	0.12	0.14		0.24	
CD (*P=0.05*)	0.34	0.40		0.69	
CV%	2.06				

Table 2. Effect of maturity and storage temperature on yellow-life of banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	10.00	12.00	7.00	4.00	8.25
M_2	8.33	10.33	6.00	3.33	7.00
M_3	8.00	7.00	5.00	3.33	5.83
Mean	8.78	9.78	6.00	3.56	
Source	M	T		M x T	
S. Em±	0.13	0.15		0.25	
CD *(P=0.05)*	0.37	0.43		0.74	
CV%	6.27				

Table 3. Effect of maturity and storage temperature on overall shelf life of banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	45.00	39.67	28.00	13.33	31.50
M_2	37.00	34.67	22.00	11.67	26.33
M_3	34.00	28.00	19.00	10.00	22.75
Mean	38.67	34.11	23.00	11.67	
Source	M	T		M x T	
S. Em±	0.13	0.15		0.25	
CD *(P=0.05)*	0.37	0.43		0.74	
CV%	1.64				

which was maximum (7.18) in fully mature fruits (Table 4). Flavor in banana is imparted by amyl esters and its frutiness is attributable to butyl esters (Mc Carthy *et al*, 1963). Concentration of these volatile compounds increases as ripening progresses and, therefore, better flavour is noticed in 100% mature fruits. As far as storage temperature is concerned, significantly high score for flavour (7.5), colour (7.85), texture (7.59) and taste (7.58) was recorded in fruits ripened at 16°C (Tables 4-7). In an earlier study, Peacock (1980) examined colour-quality and eating-quality in 'Cavendish' banana ripened at 13-33°C. He observed better colour and taste development when these were ripened between 13 to 24°C. Higher scores for sensory parameters in 'Grand Naine' banana can be attributed to uniform ripening at 16°C compared to that at lower temperatures or storage at ambient temperature. This is a varietal trait dictated by genetic composition of a particular genotype. Interaction effect between maturity stage and storage temperature was found to be significant for colour and texture. Higher scores for colour and texture were recorded when fruits of 100% maturity were stored at various low temperatures (M_3T_1, M_3T_2 and M_3T_3).

Data presented in Table 8 indicates significant effect of maturity level and storage temperature on pulp:peel ratio. Maximum pulp:peel ratio (3.39) was observed in fully mature fruits, and the minimum (2.37) in 75% mature fruits. With advancing maturity, percentage of pulp:peel ratio increased, with a concomitant decrease in peel weight. This could be due to migration of moisture from the peel to the pulp during the process of ripening. As the fruit ripens, water is lost from the peel to the pulp in response to changes in osmotic potential (Stratton and von Loesecke, 1931). These results are in accordance with reports of Desai and Deshpande (1975) and Tripathi *et al* (1981) at full maturity of the fruit. With regard to temperature, maximum pulp:peel ratio (3.02) was observed in fruits stored at ambient conditions compared to those placed in cold storage. Pulp:peel ratio increased with increase in temperature. Pulp:peel ratio is related to accumulation of moisture in the pulp derived from breakdown of carbohydrates, and osmotic transfer of water from the skin to the pulp (Charles and Tung, 1973). This is in line with findings of Saeed Ahmad *et al* (2006) in banana stored at different temperatures. Interaction between maturity stage and storage temperature was found to be non-significant for pulp:peel ratio during the course of our experimentation.

Bananas are harvested while green, and transported to markets where they are ripened. There is a need to

Table 4. Effect of maturity and storage temperature on flavour at ripening in banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	6.66	6.87	7.21	6.67	6.85
M_2	6.47	7.33	7.63	6.75	7.04
M_3	6.81	7.50	7.67	6.75	7.18
Mean	6.65	7.23	7.50	6.72	
Source	M		T	M x T	
S. Em±	0.06		0.07	0.13	
CD *(P=0.05)*	0.19		0.21	NS	
CV%	3.13				

NS = Non Significant

Table 5. Effect of maturity and storage temperature on colour at ripening in banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	6.76	6.47	7.50	6.80	6.88
M_2	6.52	7.40	7.88	5.96	6.94
M_3	7.04	7.40	8.17	5.79	7.10
Mean	6.77	7.09	7.85	6.18	
Source	M		T	M x T	
S. Em±	0.08		0.09	0.16	
CD *(P=0.05)*	NS		0.27	0.47	
CV%	3.96				

NS = Non Significant

Table 6. Effect of maturity and storage temperature on texture at ripening in banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	7.04	7.20	7.43	6.87	7.14
M_2	6.85	7.40	7.43	6.96	7.16
M_3	7.14	7.87	7.92	6.29	7.30
Mean	7.01	7.49	7.59	6.71	
Source	M		T	M x T	
S. Em±	0.07		0.08	0.13	
CD *(P=0.05)*	NS		0.22	0.39	
CV%	3.19				

NS = Non Significant

Table 7. Effect of maturity and storage temperature on taste at ripening in banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	7.15	7.53	7.54	6.93	7.29
M_2	7.14	7.60	7.58	7.08	7.35
M_3	7.09	7.47	7.62	7.32	7.37
Mean	7.13	7.53	7.58	7.11	
Source	M	T		M x T	
S. Em±	0.08	0.07		0.12	
CD *(P=0.05)*	NS	0.21		NS	
CV%	2.93				

NS = Non Significant

Table 8. Effect of maturity and storage temperature on pulp:peel ratio at ripening of banana cv. Grand Naine

Level of maturity	Storage temperature (T)				Mean
	T_1	T_2	T_3	T_4	
M_1	2.27	2.30	2.40	2.49	2.37
M_2	2.52	2.65	2.74	3.00	2.73
M_3	3.36	3.37	3.26	3.56	3.39
Mean	2.72	2.77	2.80	3.02	
Source	M		T	M x T	
S. Em±	0.03		0.03	0.06	
CD *(P=0.05)*	0.08		0.10	0.17	
CV%	3.52				

NS = Non Significant

transport the fruit in the green state. Based on the above investigation, it may be concluded that for distant markets, fruits of banana cv. Grand Naine banana should be harvested at 75% maturity and stored at 12°C. For nearby markets, fruits can be harvested at 90% maturity and stored at 14°C. For local markets, it is recommended to harvest fruits at 100% maturity, followed by their storage at 16°C.

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