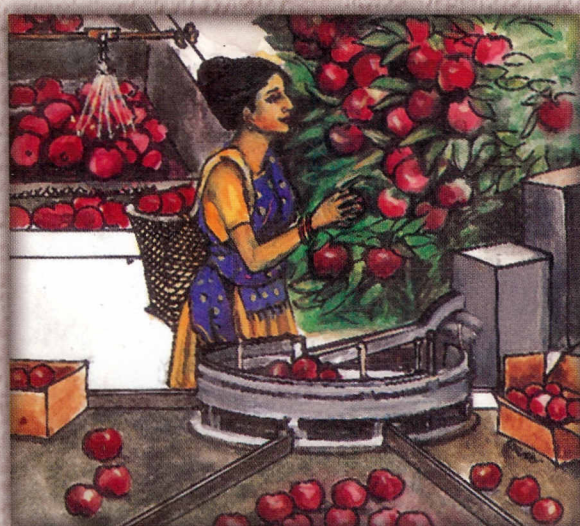




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# Postharvest Management in Agriculture

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# **Postharvest Management in Agriculture** **SAARC Bibliographical Database**

*A S Chandel and R M Kamal*



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**SAARC Agricultural Information Centre (SAIC)**

SAARC Agricultural Information Centre (SAIC)  
BARC Complex, Farmgate, Dhaka 1215, Bangladesh

**Published : 1995**

**Cover design : Mafruha Begum**

**Price :** US\$ 5.00 for SAARC countries  
US\$ 8.00 for other countries

Chandel, A S and Kamal, R M

Postharvest Management in Agriculture: SAARC bibliographical database.

Dhaka: SAARC Agricultural Information Centre, 1995.

ii, 231, xxxv p.

1. Postharvest technology, bibliography. 2. SAARC Agricultural Information Centre. i. Jt. Author.  
ii. Title.

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**Published by :** Director, SAARC Agricultural Information Centre (SAIC)

**Printed at :** Panir Printers, 9 Nilkhet, Dhaka 1205

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*Term Index*

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*Pachadraksha grapes* stored at 8-10°C and wrapped in a polythene sheet (100 gauge), had min. wt yield losses (10.52%) after 50 d and no disease was recorded. It is concluded that shelf-life of grapes could be extended to up to 50 d by using cold storage.

## BANANAS

### Ripening

**923** KUMAR, S; SINHA, SK. 1992. **Alternative respiration and heat production in ripening banana fruits (*Musa paradisiaca* var. *mysore kadali*).** *Journal of Experimental Botany*, 43: 257, 1639-1642.

The involvement of alternative respiration in thermogenesis during the ripening of banana (*Musa paradisiaca* var. *Mysore Kadali*) fruits, attached to a bunch, has been examined. The temperature of the youngest (unripened) banana fruit increased from  $27.0 \pm 0.2^\circ\text{C}$  to  $30.8 \pm 0.1^\circ\text{C}$  and the total respiration (in nmol oxygen  $\text{min}^{-1} \text{g}^{-1}$  dry wt.) increased from  $139.6 \pm 5.5$  to  $167.3 \pm 7.0$  at the fully ripened stage. Although the capacity for alternative respiration showed little change, the actual operation of this pathway increased from 38 to 73% ( $\rho = 0.38$  to  $0.73$ ) during ripening. Similar results were obtained in fruits along the central axis at different stages of ripening. It is suggested that alternative respiration may contribute to the temperature rise observed in ripening banana fruit.

**924** WASKAR, DP; ROY, SK. 1992. **Post-harvest ripening changes in banana.** *Agricultural Reviews (India)*, 13: 1, 36-42.

### Postharvest handling

**925** INIBAP, MONTFERRIER-SUR-LEZ, FRANCE. 1990. **Banana and plantain R & D in Asia and the Pacific.** *ASPNET Book Series*/edited by RV Valmayor. No. 2, 189 p.

This publication is the proceedings of a regional consultation on banana and plantain R & D networking, held at Manila and Davao, Philippines, 20-24 Nov. 1989. The Workshop was the second step in the establishment of a regional network for Asia and the Pacific. The contributions at the Workshop comprised an overview of INIBAP and its global banana and plantain networks, a discussion of the rationale of the Asia-Pacific Banana and Plantain R & D Network, and country reports on banana and plantain research and production from Australia, China, Indonesia, Malaysia, Philippines and

Thailand. The country reports cover the following aspects: production, cultivars, germplasm collections, cropping systems, domestic and export markets, postharvest handling technology, processing and utilization, pests and diseases, and adverse environmental factors; they also list research institutions and current research and development programmes. A country paper report from India, and a banana mission report compiled by Dr. R. V. Valmayor describing the present status of banana and plantain in different countries in Asia, are included in the appendices.

**926** RAO, VNM. 1984. **Banana.** Indian Council of Agricultural Research, New Delhi, India. 61 p.

This booklet deals with the origin, distribution, uses, food value, area and production, botany, morphology, nomenclature, classification, important clones of India, climate, soil, propagation, planting, manuring, irrigation, cultivation, packing, transport, preservation, pests, diseases and breeding of bananas.

**927** ROY, SK. 1992. **Post-harvest handling, marketing and export of banana.** *Golden Jubilee Symposium on optimisation of productivity and Utilisation of Banana.* (Pune: 1992: 22-23 Sept.) Hort. Soc. India & MPKV.

**928** THOMAS, P; JANAVE, MT. 1992. **Effect of temperature on chlorophyllase activity, chlorophyll degradation and carotenoids of Cavendish bananas during ripening.** *Int. Journal of Food Science and Technology*, 27: 1, 57-63; 26 ref.

Changes in chlorophyllase activity, and chlorophyll and carotenoid content of Giant Cavendish banana fruit peel were measured during ripening at tropical temperatures (30-34°C) and at 20° to relate them to the greenish and yellow colours of fruits ripened at these temperatures. At 30-34° fruits remained green on ripening due to incomplete chlorophyll degradation while at 20° complete degreening occurred and fruits turned yellow. Peel total carotenoid content remained constant during ripening and did not change with temperature. Free xanthophylls decreased while xanthophyll esters increased on ripening at 20° and at 30-34°. Chlorophyllase activity increased during ripening and paralleled the respiratory climacteric, although activity was not consistently related to the differential degradation of chlorophyll at these temperatures. Exogenous application of ethylene and Ethrel accelerated ripening, but had no effect on chlorophyllase levels, chlorophyll degradation or carotenoid content of fruits ripened at either 30-34° or at 20°.

929 WASKAR, DP; ROY, SK. 1993. Studies on harvesting, handling, transportation and marketing of banana. *Indian Food Pack.*, 47: 4, 29-34.

### Storage and storage decay

930 ARYA, ARUN; BIHARI LAL; AGARWAL, R; SRIVASTAVA, RC. 1986. Some new fruit rot diseases-II: symptomatology and host range. *Indian Journal of Mycology and Plant Pathology*, 16: 3, 265-269; 16 ref.

A further 9 fungal records are reported on pawpaw, banana, *Aegle marmelos*, plum and orange fruits collected from orchards and markets in Allahabad. Symptoms and host ranges are described.

931 BHARGAVA, SN; PANDEY, RS; DWIVEDI, DK; SHUKLA, DN. 1983. Chemical control of *Botryodiplodia* rot of banana. *Biological Bulletin of India*, 5: 1, 52-53; 4 ref.

When healthy cv. Bombay Green banana fruits were dipped in fungicides 24 h before or 24 h after prick inoculation with *B. theobromae*, Saprol [triforine] gave complete and 90% control respectively and Delan [dithianon] dips 80 and 70%.

932 CHANDRAMONTI, HD; HUDDAR, AG; NACHEGOWDA, V. 1991. Effect of post-harvest application of calcium on ripening of bananas cv. *Robusta*. *Haryana Journal of Horticultural Sciences*, 20: 1-2, 60-64; 12 ref.

Fully mature bananas, harvested green from commercial orchards, were dipped in calcium chloride solutions (0-6%), then stored at room temperature for 14 days, when samples from each of the 7 treatments and the untreated controls were examined. The treatment enhanced ripening by 2-5 days, compared with untreated control fruits. This enhancement of ripening was shown by increases in the rate of softening, pulp:peel ratio, total soluble solids, acidity and sugar content. The increases in most of these parameters were correlated with the concentration of the calcium chloride solution. The calcium content of the treated fruits (both peel and pulp) was higher than that of controls, although most calcium was retained in the peel.

933 DATAR, VV; GHULE, KK. 1988. Investigations on some aspects of control of fruit rot of banana (*Musa cavendishii* L.). *Indian Journal of Plant Pathology*, 6: 2, 133-138; 21 ref.

*Cylindrocarpon tokinensis*, *Penicillium funiculosum*,

*Fusarium solani*, *Fusarium sp.* and *Colletotrichum sp.* were associated with rotting of banana fruits in the market and were pathogenic on inoculation. Fruit rots caused by *C. tokinensis* and *P. funiculosum* were new host records for India. Rotting by all the fungi was completely arrested at 0 and 5°C, slow at 10 and 15° and most rapid at 20-30°. Dipping fruits in indole-3-butyric acid (IBA) at 200 p.p.m. for 2 h reduced rotting by most of the pathogens. Other growth regulators in descending order of efficacy were gibberellic acid (GA), naphthyllic acid (NAA) and indole-3-acetic acid (IAA). Fruit rots caused by all the pathogens were effectively controlled by dipping the fruits in carbendazim (1000 p.p.m.) for 10 min.

934 DESAI, BB; SHUKLA, DV; CHOUGULE, BA. 1989. Biochemical changes during storage of chemical treated banana fruits. *Jrl. of Maharashtra Agricultural Univ.*, 14: 1, 44-47.

Ten treatments were applied (including water treatment as a control). Whole mature green fruits were dipped for 5 minutes, dried, placed in perforated polyethylene bags and held at room temperature for up to 18 days. The best results with regard to shelf life were obtained with fruits treated with (1) Tal-Prolong (sucrose esters of fatty acids) at 0.5%, (2) 2% wax emulsion + Topsin M (thiophanate-methyl) at 0.5%, or (3) 2% wax emulsion + 0.5% benomyl. Data on the effects of the various treatments on TSS, alcohol insoluble contents, contents of reducing sugars, non-reducing sugars and starch, and titratable acidity, at 6, 12 and 18 days after treatment, are tabulated.

935 GRAHAM, D. 1990. Chilling injury in plants and fruits: some possible causes with means of amelioration by manipulation of postharvest storage conditions. *Proceedings of the International Congress of Plant physiology*. V. 2. (New Delhi: 1988: 15-20 February)/edited by SK Sinha; PV Sane; SC Bhargava; PK Agrawal. New Delhi: Society for Plant Physiology and Biochemistry, p. 1373-1384; 39 ref.

Chilling sensitivity in plants of tropical and subtropical origin is defined and the major symptoms of chilling injury are briefly described. An outline is given of 2 likely causes of chilling sensitivity which lead to chilling injury. The first involves physical changes in certain membrane lipids, particularly phosphatidylglycerols, which result in changes in membrane properties and eventual disorganization of cellular compartmentation. The second cause is due to the impairment of the catalytic function of certain key enzymes of metabolism, of which phosphoenol pyruvate carboxylase is an

example. Some effects of low non-freezing temperatures on kinetic properties of this enzyme are described. Some ways to avoid or minimize chilling injury during storage of fruits are described. In particular, conditions for long term (6-8 weeks) storage of bananas at ambient temperatures under controlled atmospheres with ethylene absorption are described which avoid chilling injury. Banana is unique in its ability to store under such conditions. Manipulation of storage conditions of mango fruits at temperatures as low as 1°C, including the use of polyethylene bags to create a modified atmosphere, stepwise reduction of storage temperature or intermittent warming during storage, enabled extension of postharvest life for up to 5 weeks with minimal losses. The interaction of temperature, ripening and postharvest pathology in extending postharvest life is briefly discussed.

**936** HUDDAR, AG; CHANDRAMOULI, HD; CHIKKASUBBANNA, V. 1989. **Effect of various modes of application of calcium chloride on ripening of banana cv. *Robusta*.** *Crop Research Hisar*, 2: 2, 175-179; 15 ref.

In an experiment carried out during the summer season of 1985-86, mature green fruits of banana cv. *Robusta* were treated with a 3% CaCl<sub>2</sub> solution by spraying, quick dipping or dipping for 2 or 5 min. After 14 days of storage at RT, fruits treated with CaCl<sub>2</sub> showed reduced firmness and increases in pulp:peel ratio, TSS, titratable acidity, reducing sugars and total sugars compared with the control. The lowest firmness (1.968 kg/cm<sup>2</sup>, compared with 2.618 kg/cm<sup>2</sup> for the control) was obtained with dipping for 5 min. CaCl<sub>2</sub> treatments also reduced the shelf-life of bananas, the 2-min treatment resulting in a shelf-life of 10.57 days compared with 14.42 in the control. Calcium appears to enhance ripening of bananas, ruling out the use of CaCl<sub>2</sub> for extending their shelf-life.

**937** HUSSAIN, M; NAZLI, M; SHAH, SSH. 1991. **Post harvest diseases of fruits in Peshawar market. Rot of banana fruit.** *Sarhad Journal of Agriculture*, 7: 2, 39-41; 9 ref.

A survey was conducted during Nov. 1989 in Peshawar, Pakistan, to determine the causes of market rot of banana (samples were taken of fresh bananas immediately prior to storage, after 5-d storage at 4°C, RH 85%, from the retail stalls and after 24 h with the retailer). *Fusarium* sp. was isolated from all non-sterilized samples, and *Alternaria* sp. and *Mucor* sp. from non-sterilized fruits after storage. After surface sterilization, only *Fusarium* was isolated, and it is suggested that this

fungus is the cause of the rot. Infection occurred during storage and frequency increased thereafter (to 70% in bananas obtained 24 h after purchase by the retailer).

**938** KRISHNAIAH, J; SATYAPRASAD, C; SINGH, TG; THIRUPATHAIAH, V; DAVE, B. 1985. **Protection of banana fruits using food-grade fruit coatings.** *Indian Journal of Horticulture*, 42: 1/2, 136-138; 6 ref.

Three commercial Decco food-grade fruit coatings, namely, WT-12, WT-22 and WT-23, each containing the fungicide orthophenylphenol at 1.8, 2.5 and 2.5%, respectively, were effective in controlling *Rhizopus oryzae* and *Aspergillus niger* and to a lesser extent *Gloeosporium musarum* [*Colletotrichum musae*]. WT-23 gave better control of *C. musae* than the other 2 formulations.

**939** KRISHNAMURTHY, S; KUSHALAPPA, CG. 1985. **Studies on the shelf life and quality of *Robusta* bananas as affected by post-harvest treatments.** *Journal of Horticultural Science*, 60: 4, 549-556; 19 ref.

The effects of skin coating with Waxol (6%) or Tal Prolong (1.0% and 2.0%) combined with packing in polyethylene bags and the use of the ethylene absorbent Purafil, on the physiochemical changes and ripening were compared at ambient storage conditions (21-28°C; 70-90° RH). There were no differences in ripening between untreated and Waxol treated fruits but 1% and 2% Tal Prolong delayed ripening by 4 to 5 days. Waxol-and Tal Prolong-treated fruits kept in ventilated polyethylene packs showed delayed ripening by 6 days, and untreated fruits kept in sealed Purafil packs also showed a 7-day delay in ripening. This delayed ripening was correlated with reduced rates of softening, and the development of yellow surface colour and with increases in moisture, the pulp:peel ratio, acidity, tannin, total sugar, starch and alcohol-insoluble residue contents in the pulp of the fruit. Weight loss during storage was considerably less in fruits kept in polyethylene bags than in unpacked fruits. Untreated fruits packed in polyethylene bags ripened to a higher quality than untreated, unpacked fruits. Waxol did not extend the shelf life except when used on packaged fruits. Tal Prolong was effective in delaying ripening both with and without packaging but the fruits were yellowish-green, softer and slightly inferior in quality to untreated fruits. Purafil provided maximum delay in ripening and the best quality.

**940** KRISHNAMURTHY, S. 1989. **Storage life and quality of *Robusta* banana in relation to their stage of maturity and storage temperature.** *Journal of Food*

*Science and Technology Mysore*, 26: 2, 87-89; 9 ref.

Green unripe fruits at 2 stages of maturity (100 and 115 days from fruit set) were held at room temperature (control) or at 15 and 20°C for 1-4 weeks, followed by ripening in ambient conditions. The fruits remained green, firm and unripe for 2-3 weeks at all temperatures. The delay in ripening was related to reduced rates of softening and peel colour development, to increased pulp to peel ratios, and to the levels of tannins, total sugars and alcohol-insoluble residue in the fruit pulp. Weight loss was less in fruits held at 15 and 20° compared with room temperature. Quality of the fruits after 1-4 weeks of holding at 20° was best; quality was next best in fruits held for 3 weeks at 15°. By harvesting the fruits early (at 100 days) the shelf life in ambient conditions could be extended from 16 to 21 days.

**941** MANOHARACHARY, C; RAO, PR. 1989. **Survey and patho-physiological studies of fruit rot diseases.** *Perspectives in phytopathology*/edited by VP Agrihotri; N Singh; HS Chaube; US Singh; TS Dwivedi. New Delhi: Today and Tomorrow's Printers & Publishers, p. 141-154; 110 ref.

Post-harvest diseases of fruit (bananas, *Ziziphus mauritiana*, cherries, figs, grapes, guavas, *Artocarpus integrifolius*, *Syzygium cumini*, *Litchi chinensis*, mangoes, oranges, plums and *Achras sapota*) recorded in Andhra Pradesh during 1979-85 are tabulated giving host, pathogen and nature of infection. Biochemical and enzymatic changes in infected fruit, effects of temperature and relative humidity and nutrition of fruit rot pathogens are considered.

**942** RAM, V; VIR, D. 1983. **Evaluation of benzimidazole and other fungicides against post-harvest spoilage of banana fruits caused by *Colletotrichum musae* (Berkeley et Curtis) Von Arx.** *Pesticides*, 17: 5, 28-29; 14 ref.

Bavistin [carbendazim], Benlate [benomyl], thiabendazole and Panactin dip treatment effectively controlled *C. musae* post harvest decay. Propionic and salicylic acids were also effective but the latter caused skin discoloration.

**943** RAM, V; VIR, D. 1984. **Post-harvest chemical treatment for prevention of *Aspergillus flavus* and *A. fumigatus* on banana fruits.** *Pesticides*, 18: 1, 65-66; 9 ref.

Mycotoxins were detected in banana tissues decayed by the *A. spp.* Fruit dips in benzimidazole fungicides, propionic acid and sodium metabisulphite protected the fruits and extended their shelf life to 8 days.

**944** RAO, DVR; CHUNDAWAT, BS. 1984. **Chemical regulation of ripening in Basrai banana at ambient temperature.** *Progressive Horticulture*, 16: 1/2, 58-68; 18 ref.

To retard ripening and to minimize post-harvest wastage, kinetin, GA, hydroquinone, MH or IAA was tested alone or in combination with Waxol (6%) or Benlate [benomyl] as post-harvest dips. Ripening was rapid in untreated fruit as shown by marked weight loss and decreased marketability. The metabolic rate of the fruits was high as indicated by high sugar: acid ratio. Post-harvest treatments with GA at 150 p.p.m. + benomyl at 500 p.p.m. or with GA at 150 p.p.m. + Waxol significantly retarded ripening and extended the days to ripening by 4.63 and 4.47, respectively, over the control. These treatments also retained good fruit marketability and reduced physiological weight loss.

**945** RAO, DVR; CHUNDAWAT, BS. 1988. **Post harvest behaviour of banana bunches of cv. Basrai in response to certain chemical and packing treatment.** *Gujarat Agricultural University Research Journal*, 14: 1, 42-48; 10 ref.

The efficacy of 4 postharvest treatments of the bunches (GA at 150 p.p.m. + 6% Waxol, GA at 150 p.p.m. + Benlate [benomyl] at 500 p.p.m., use of an ethylene absorbent, or wrapping with polyethylene) was evaluated under ambient temperatures. The 3 treatments were found beneficial in retarding the ripening process and extending ripening by 2.97, 2.42 and 1.88 days, respectively. These treatments resulted in relatively high numbers of green fruits, good marketability over a long period, and reduced weight loss. The metabolic rate of the treated fruits was low, as evidenced by low catalase activity in pulp tissues. Wrapping the bunches in polyethylene film was ineffective in minimising the weight loss and bruising. In untreated bunches the ripening was rapid.

**946** SARANANDA, KH. 1989. **Response of embul banana (*Musa spp.*) to modified atmosphere storage.** *Tropical Agriculturist (Sri Lanka)*, 145: 113-119.

**947** SINGH, HNP; PRASAD, MM; ROY, AK. 1991. **Sugar and vitamin C level in chinia variety of banana under pathogenesis.** *National Academy Science Letters*, 14: 12, 459-461; 9 ref.

The content of total sugars, reducing and non-reducing sugars and ascorbic acid decreased faster in bananas inoculated with *Botryodiplodia theobromae*, *Fusarium oxysporum* or *Aspergillus niger* and stored for 10 d, than in healthy fruits, with a maximum decrease occurring in

fruit infected by *B. theobromae*.

**948** VED RAM; DHARAM VIR. 1986. Efficacy of fungicides XXXVI. Relative evaluation of various post-harvest chemical treatments against spoilage of banana fruits caused by *Curvularia lunata*. *Indian Phytopathology*, 39: 4, 594-595; 6 ref.

A new post-harvest disease of banana in Delhi markets is caused by *C. lunata* [*Cochliobolus lunatus*]. Propionic acid, salicylic acid and sodium metabisulphite kept inoculated fruits free from infection for up to 8 d but systemic fungicides had only very limited effects.

**949** VIR, D; SHARMA, RK. 1985. Efficacy of fungicides XXVI. Evaluation of triforine against post-harvest spoilage of banana fruits. *International Journal of Tropical Plant Diseases*, 3: 1, 89-90; 10 ref.

Dipping the fruit in triforine (2500 p.p.m.) for 5 min gave good protection against rot and deterioration caused by *Colletotrichum musae* and enhanced the shelf life.

## PINEAPPLES

### Postharvest handling

**950** AHMED, F; BORA, PC. 1989. Changes in quality of Kew pineapple fruit at different times. *Journal of Food Science and Technology Mysore*, 26: 1, 51-52; 6 ref.

Fruits harvested during different months of the year showed variation in the time taken to attain maturity, % juice content, TSS and acidity of the juice. Fruits harvested from July to Nov. matured early and were very juicy and sweet, while those harvested from Dec. to Feb. were sour, and those harvested from Jan. to May were late maturing and less juicy.

**951** DAMAYANTI, M; SHARMA, GJ; KUNDU, SC. 1990. Effect of gamma radiation on pineapple fruit rotting fungus, *Ceratocystis paradoxa*, at different temperatures. *Microbios Letters*, 45: 179-180, 145-150; 14 ref.

Gamma-rays reduce radial growth and conidial germination and decrease germ tube length of *C. paradoxa* in vitro. Irradiation also decreases the percentage of spore germination. The inactivation is directly correlated with the radiation doses applied. The synergistic effect of radiation and temp. was more pronounced at lower temp. ( $12 \pm 1^\circ\text{C}$ ) than at higher temp. ( $25 \pm 1^\circ$ ). At  $8^\circ$ , the non-irradiated and irradiated cultures were

unable to grow even after prolonged incubation (12 d).

**952** HEENKENDA, HMS; BANDARANAYAKE, M. 1990. Effect of postharvest wax treatment on weight loss and shelf-life of five tropical fruits. *Tropical Agriculturist (Sri Lanka)*, 146 p. 37-44.

**953** NANAYAKKARA, KPGA. 1990. A preliminary survey on pineapple cultivation and export from Sri Lanka. *Krusha (Sri Lanka)*, 12: 2,3,4, 35-41.

## ZIZIPHUS MAURITIANA (BER)

### Storage

**954** BANIK, D; HORE, JK; SEN, SK. 1988. Studies on storage life of ber (*Ziziphus mauritiana* Lamk). *Haryana Journal of Horticultural Sciences*, 17: 1-2, 49-55; 7 ref.

An experiment was conducted to assess the efficacy of wax emulsion coating, some growth regulators and low temperature storage in prolonging the storage life of ber. Fruits kept at  $10-12^\circ\text{C}$  and 85-90% RH, and fruits coated with paraffin wax and kept at  $10-12^\circ$  stored well for up to 18 days with minimum spoilage and physiological weight loss when 100% spoilage occurred in untreated fruits (held at  $28-32^\circ$  and 70-75% RH) on the 9th day of storage. Fruits coated with paraffin wax emulsion (2%) and fruits treated with NAA at 100 p.p.m. or ascorbic acid at 100 p.p.m. could be retained for up to 12 days at room temperature ( $28-30^\circ$ ) with minimum spoilage. Contents of TSS, total sugar, and reducing sugar increased as the period of storage increased. Titratable acidity and ascorbic acid content decreased with increasing length of storage.

**955** GUPTA, OP; SIDDIQUI, S; GUPTA, AK. 1989. Effect of preharvest sprays of various chemicals on the storage of ber fruit (*Ziziphus mauritiana* Lamk.). *Research and Development Reporter*, 6: 1, 35-40; 17 ref.

Preharvest spraying with captafol or thiabendazole (TBZ), each at 500 p.p.m. or with 1% calcium nitrate solution improved the shelf life of [*Ziziphus mauritiana*] cv. Kaithli fruits. On the 12th day of storage, the highest reduction in weight loss was observed with captafol; decay loss was reduced most by TBZ. The treated fruits retained high ascorbic acid with low acid contents during storage.

**956** GUPTA, OP; NEENA MEHTA. 1988. Effect of pre-harvest applications on the shelf life of ber