IICA. Miscellaneous Publication No: A2/TT-87-003 ISSN-0253-4746

POSTHARVEST HANDLING OF TROPICAL PRODUCE

A Training Guide

Photo: Harold Jiminez

Printed by Superservice

Prepared by

Agro-Industrial Products Programme
CARIRI

CARIRI Caribbean Industrial Research Institute

IICA

NOTE TO USERS

The material presented in these training guides provides a basic introduction to postharvest technology and to some of the methods and techniques which can be used to maintain quality and minimize postharvest losses in harvested tropical produce.

Postharvest technology is a relatively new field and great scope exists for the development of produce handling techniques that are appropriate to tropical production/marketing systems. The user is therefore encouraged to supplement and expand the information presented.

F O R E W O R D

Following the Caribbean Industrial Research Institute's (CARIRI) Postharvest Technology Seminar on "The Key to Profits After Harvest" which was held in early 1986, our Institute held discussions with CARIRI in order to identify areas of need within the context of national efforts to reduce postharvest losses. It became obvious from the discussions held that the lack of suitable local training materials on postharvest losses was a constraint in the effective delivery of postharvest technology information to farmers and other interest groups.

Our Institute and CARIRI therefore signed a cooperation agreement for the development of local training materials in postharvest technology. These slide sets and accompanying text represent the culmination of this agreement.

I am particularly pleased at the high level of competence demonstrated by CARIRI's professionals in the performance of this exercise and hope that these slide sets will prove to be a valuable foundation on which to build a national training course in Postharvest Technology which will assist in reducing postharvest losses in our crops. Our Institute is proud to be associated with this endeavour.

Dr C W D Brathwaite
Director
IICA Office in Trinidad & Tobago

ACKNOWLEDGEMENTS

CARIRI gratefully acknowledges the following persons, without whom the production of this material would not have been possible.

Mr Glen Ramjag, National Foodcrop Farmers Association - For organizing field visits and providing materials.

Ms Cynthra Persad, Plant Pathologist, Ministry of Food Production, Marine Exploitation, Forestry and the Environment - for providing photographic slides.

Mr Lennox Andrews, Fruit Agronomist, Ministry of Food Production, Marine Exploitation, Forestry and the Environment - for providing photographic slides.

Mr Michael Bharath, Produce Operations Manager, Hi-Lo Food Stores - for arranging a visit to Hi-Lo's facility.

Mr P Sutton - for visit to Sutton Farms.

Mrs M Manchouck, Acting Director, National Insititute for Higher Education, Research (Science and Technology) (NIHERST) - for assistance in the selection of graphic artists.

Dr R Basset, Acting Director, and Mr B Copeland, AV Technician, Caribbean Epidemiology Centre (CAREC) - for assistance with preparational processing of photographic slides.

Mr Deen Saidwan, Director, Wyatt and Co Ltd - for donation of chemicals.

Dr Stephen New, Postharvest Technologist, CATCO, Barbados - for provision of photographs.

Mr Vassel Stewart, Project Officer, CATCO, Caribbean Food Corporation (CFC) - for provision of packaging materials.

Mr B Cull, Extension Agronomist, Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia - for loan of photographic slides on mango.

Mr K Hosten, Project Officer, The Food & Agriculture Corporation of Trinidad & Tobago (FAC) - for visit to the Freeport Packing Facility.

POSTHARVEST HANDLING OF TROPICAL PRODUCE

III - COOLING, STORAGE AND POSTHARVEST TREATMENTS

1. TITLE SLIDE:

2. This slide set deals with the use of proper temperature management, storage and postharvest treatments in reducing postharvest losses.

3. The factors which cause deterioration can all be interrelated and are all influenced by temperature. High ambient temperatures result in high levels of field heat.

4. - and respiration heat. Especially for a commodity like pigeon peas that is often retailed in a deep pile, exposed to hot sun.

High temperatures cause increases in respiration rate and ethylene production which can lead to accelerated ripening and senescence.

6. High temperatures increase the rate of moisture loss and its effects.

7. Cooling and effective temperature management are the <u>most important tools</u> in controlling postharvest deterioration.

8. An understanding of basic principles of cooling is necessary in order to determine correct cooling requirements for different commodities. Heat may be transferred from a harvested product by conduction, convection, evaporation and/or radiation.

9. Convection involves the exchange of heat between the surface of a warm product and a cooling medium. In this drawing, the heat from the warm inner tissue of the melon is conducted to the fruit's surface where it is removed by convection.

10. The heat removed from this basket of sweet peppers may be transferred to a cooling medium such as refrigerated coils or ice.

11. Radiation is the heat energy given off by warm bodies to their surroundings.

12. Evaporation of moisture from the surface of produce such as bhagi, sweet pepper, carrot, cabbage and chive results in cooling. The produce releases heat (latent heat of evaporation) for evaporating moisture and is subsequently cooled.

13. There are several commercial cooling methods.

14. Produce may be cooled before or after it is packed, or during holding and/or shipment.

15. In the case of room cooling, cold air, discharged into the room near the ceiling moves horizontally across the ceiling and returns past the cooling produce on the floor. The air flow rate is usually 60-125 m/min.

16. The drying effect of the cold air may be minimized by installing misting systems to raise the relative humidity.

17. Room cooling tends to be slow, which is an advantage for chilling sensitive products but which favours desiccation and retards the flow of operations. Cooling rate can be increased by increasing air temperature or flow rate. This increases the cost of cooling, however.

18. Forced air or pressure cooling involves the creation of a pressure gradient to cause air to flow through rather than around the containers of produce, so resulting in rapid uniform cooling.

19. A tunnel is created between banks of produce. At one end an exhaust fan is placed, while the top and other end are closed with a flexible cover (such as tarpaulin). The air is pulled from the cold room through the containers and vented into a plenum before re-entry into the cold room. Forced air cooling is much faster than room cooling.

20. Stacking depth has a direct effect on the power requirement for adequate cooling. As the depth of stacking increases from one to three boxes across, the energy to move the air increases by a power of 3.

21. Hydrocooling, as the name implies, involves cooling with water. Water is very effective as a cooling medium because it can absorb a lot of heat (specific heat = 1). Products which can be hydrocooled must be able to tolerate wetting, water pressure damage and microbial infection from recirculating water.

22. Hydrocooling methods can range from manual sprinkling (using the produce itself) as shown for retail sale of watercress.

23. - or sprinkling of packaged produce such as melongene in this basket.

24. - to a commercial stationary (or mobile) spray hydrocooler, cooling produce packaged in moisture proof cartons. In such systems, cleaning of shower pan holes is important and sanitation is critical.

25. Products can also be hydrocooled by immersion in cold water. Immersion hydrocooling has disadvantages however. In vegetables such as pepper and tomato, cool water may be sucked into the warm fruit along a pressure gradient, resulting in rotting from inside out. The produce may also split.

26. A comparison of cooling speeds shows hydrocooling to be faster than forced-air and room cooling. In the Caribbean, both hydrocooling and forced-air cooling are appropriate methods in terms of cost and establishment. Evaporative cooling methods may be extremely simple.

27. The covering of bhagi (spinach) with a wet crocus bag cools the leaves by providing an evaporative surface.

28. In greenhouse systems, evaporative cooling is often incorporated using a wet pad/fan system. Water is pumped to the top of the pad and as it trickles down it evaporates into the greenhouse. Evaporative cooling has great potential for use in the drier Caribbean countries.

29. An open mesh pad provides a large surface area for trickling water to evaporate easily.

30. This type of pad (honeycomb) tends to become more easily contaminated than the previous type and is more costly in terms of maintenance and replacement.

31. Vegetables which have a high surface area : volume ratio, cool easily by vacuum cooling. Cooling is achieved by reducing the pressure in a strongly-constructed steel chamber. At lowered pressures, the water evaporates out of the product resulting in cooling. For each 6°C drop in temperature, a weight loss of 1% results. Vacuum cooling is very expensive relative to the previous methods. It is not recommended for Caribbean postharvest handling systems.

32. Cooling and good temperature management during transport can be easily achieved by covering loads with a light coloured tarpaulin and by transportation during the cool hours of the day.

33. The choice of a cooling method depends on the product perishability, packing method, handling method, product type and speed of marketing.

34. Cooling costs should be estimated on the basis of the fixed and operational costs associated with the use of space, refrigeration requirements and air circulation requirements. The cost should be reflected in the final price and profit gained when the product is sold.

35. Storage may be needed to extend marketing season, to accumulate a supply for holidays or festivals, to facilitate orderly marketing, to buffer the effects of seasonality on prices and demand, or to develop export markets. Refrigeration retards the rate of deterioration by retarding respiration and ripening, minimizing moisture loss, infection and the secondary effects of physical injury.

36. Chilling injury occurs in tropical perishables stored at temperatures less than 12-15°C and proper chill storage conditions must be followed.

37. Typical symptoms of CI in banana fruits are the development of a smoky peel and failure to ripen properly.

38. Alternatives to refrigerated storage include storage in the ground until required.

39. Clamp storage of root crops such as cassava. Roots are interlayered with soil and grass in clamps in the field.

40. In Africa, a common storage structure for yams is the yam barn. Tubers are tied with string onto uprights and the entire frame is then shaded with palm leaves.

41. Supplements to refrigeration include a number of treatments applied to the commodity.

42. Curing of root crops and some vegetables (pumpkin, onion and garlic) at high temperatures either in the field or in environmentally controlled rooms, encourages sealing of wounds and cut surfaces with scar tissue.

43. Cleaning results in the removal of soil and surface organisms which could lead to decay and spoilage.

44. Waxing provides a protective waterproof barrier and also adds lustre and sheen (aesthetic) appeal to fruits and vegetables.

45. Fungicides such as these provide added protection against fungal infection.

46. Fungicides can be used together with hot water to control latent infections like anthracnose, in pawpaw and mango. In the laboratory, the temperature which is most effective for pawpaw is first determined.

47. Experimental fruits are then treated in the hot water/fungicide dip.

48. In the field situation, mangoes can be dipped in a large tank containing hot water and fungicide.

49. Pawpaw fruits are submerged after harvest for a few minutes in a cold water dip containing 0.5% Benlate.

50. They are then taken out and drained on unprinted newsprint.

51. Dry newsprint is then used to wrap the individual fruits before they are sent for sale.

52. Growth regulators and other chemicals are often used to control sprouting in root crops such as onions. Maleic hydrazide and giberellic acid are common chemmicals used.

53. Treatment of produce with ethylene results in faster and more uniform ripening in fruits; stimulation of abscission which facilitates harvesting; induction of sprouting in seed material.

54. Ripening can be initiated simply on a small scale by wrapping fruit in newspaper as is shown here for pawpaw, and holding at ambient conditions - clean rice straw or sawdust may also be used.

55. Ethylene comes in various forms. Liquid formulations include Florel and Ethrel.

56. Ethylene may be applied commercially using gas (shot system) or flowing systems. One application of a flowing system, used in batch operations is the catalytic ethylene generator.

57. The liquid produces ethylene when heated in the presence of catalysts which cause dehydration of the alcohol to ethylene. The generator combines a simple heating unit with a system for dispensing the liquid from a bottle. The generator delivers about 14L of C_2H_4/h and a 1L bottle of liquid generates 100 ppm ethylene for 16 h.

58. Banana fruits are placed in ventilated crates (or cardboard cartons) in the ripening room to be gassed.

59. The fruits ripening mechanism is triggered by the release ethylene. Characteristic changes in colour, texture and aroma result.

60. Ripened fruits are packed in cartons for delivery to supermarket outlets.

61. Ripening conditions must be carefully controlled. If humitity levels are not correctly adjusted, these effects can occur.

62. Ethylene in the environment can cause postharvest losses to occur in leafy vegetables and ornamentals. In some cases, it is therefore necessary to remove or "scrub" the gas from a storage room or holding area. This purple compound, potassium permanganate is the best "scrubber" for removing ethylene gas.

63. The chemical is often dispersed on a surface-active medium such as glass beads, perlite or diatomaceous earth and packaged in sachets, tubes or blankets for use in various locations. This stack of blankets is suspended in a fruit storage room.

64. Modification of the gaseous composition (O_2, CO_2) around a product is another supplement to refrigeration. When a surface treatment is applied to a fruit, a respiration equilibrium is set up resulting in an eventual build-up of CO_2 and depletion of O_2 around the product. This effectively retards the respiration and ripening process and results in longer shelf life.

65. A plastic coating may be sealed onto individual fruit as is shown here to achieve a greater effect in atmospheric modification and control of respiration and moisture loss. Such modification can be beneficial or harmful depending on the levels of O_2 and CO_2 attained.

66. Modified atmospheres can also be established around an entire pallet as shown here. The plastic shroud (4-5 mil gauge) is taped to the pallet base, a partial vacuum is established and CO_2 is introduced up to a concentration of 15-20% for strawberries.

67. In banana handling, the use of a plastic film liner (1.5 mil) is effective in retarding moisture loss, respiration and ripening of the fruit during ocean transport.

68. High CO_2 injury is seen here on tomatoes. Injury symptoms include poor ripening and infection near the stem scar.

69. The combined effects of high temperatures and reduced oxygen (less than 1%) result in symptoms of blackheart (due to anaerobic respiration) in these potatoes.

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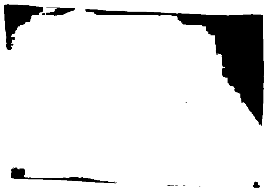


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