

## MANDARIN Post- harvest Management



### **Postharvest Management of mandarins**

Postharvest losses of mandarins (*Citrus reticulata* Blanco) can be minimized by adopting the proper harvesting and handling practices and storage conditions.

### **Harvest Maturity Indices**

Mandarins are harvested at the fully mature stage. Very early harvesting renders to chilling injury and very late harvesting causes deformation and puffing of fruits during storage in humid condition. The most commonly used index of mandarin harvest maturity is peel colour. Fruit are considered mature and ready for harvest if they have a yellow-orange colour on 75% or more of the fruit surface. Internal quality signs of harvest maturity include total soluble solids content (TSS), acidity and TSS/acid ratio of the juice. The juice should have a TSS of 8.5% or higher which can be determined by a hand-held refractometer. The juice should have acidity 0.3-0.4 % with TSS: Acid ratio of 6.5 or higher.

### **Harvesting Methods**

Mandarins are very susceptible to damage during harvesting and proper harvesting techniques minimizes bruises and mechanical injuries. Mandarins should be best harvested by using a shear, knife or clippers.

For traditional method, fruit should be carefully twisted, jerked and pulled upward with a rotating movement of the wrist so that petiole may remain attached to the fruit. Branches left on the fruit should be cut off because they can puncture other fruit, rendering postharvest decay and fruit spoilage.

Shaking of the tree should be avoided because fruit that fall to the ground are likely to be bruised and subject to postharvest decay. The harvested fruit should be collected either into burlap padded collecting baskets or lined ventilated plastic field crates. Collecting baskets are either tied around the waist or put over the shoulder and made with a quick opening bottom. When collecting basket is filled, it should be lowered with a rope to the ground and fruits should be emptied into a larger field container carefully not tossed.

Mandarins should be harvested later in the day during 9.00 AM-3.00PM because this reduces the incidence of rind discolouration. Harvesting should be done during dry weather and transfer harvested fruits immediately to the shaded and cool place.

## **Preparation for Market**

### ***Cleaning***

Fruit should be cleaned to remove dirt and extraneous materials in order to meet the consumer's demand for clean produce and better price for growers. Cleaning can be done manually by hand rubbing individual fruit soaked for a few minutes in a tank filled with sodium hypochlorite or chlorine @ 150 ppm active chlorine. Then these fruits should be rinsed in another tank filled with normal water. Fruits can also be cleaned mechanically by passing the mandarins through roller conveyor fitted with a series of roller brushes and spray nozzles. Fruits should be allowed to stay in water only for a short time as possible. Fungicides can be used as high- pressure sprays or applied as emulsion wax in wash water like Imazalil (1000 ppm) fruits if to be kept for long storage.

## **Packing**

Mandarins should be packed in strong well-ventilated containers that can be stacked without collapsing. The commonly used containers for domestic market are large sacks usually containing 30 kg fruit. However, they do not provide enough protection against bruise damage and causing injury while stacked. Wooden crates provide much better protection to the fruit. The preferred containers for export marketing are full-telescope fiberboard cartons or Flip-on plastic crates that hold 20 kg of fruit. Modern technology of packing for mandarins is seal pack or shrink wrap of individual fruit with heat shrinkable HDPE (0.01mm) which replace the refrigeration process during storage.



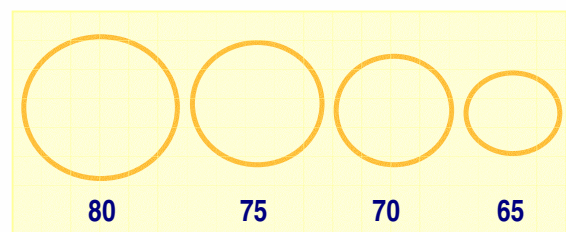
## **Peel De-Greening**

Mandarins can be treated with ethylene to de-green the skin to improve external peel colour which is important for the export market. Ethylene treatment does not alter the flavour of the fruit. The de-greening process involves exposing green-skinned fruit to low levels of ethylene (usually between 1 ppm to 10 ppm) at 20°C to 25°C, 90% RH for few days. Good internal air movement is needed so that the air circulates every 2 to 3 minutes. The CO<sub>2</sub> levels inside the treatment chamber should not rise above 2000 ppm. Fruits should not be washed before de-greening. Ethephon, a liquid ethylene-releasing compound, is applied @

or Thiabendazole (1000 ppm) or Benomyl (500 ppm) for the effective control of diseases which are the largest single cause of postharvest loss. Fruit collection boxes or containers should be treated with 6-8% Borax to clean and prevent the spread of diseases. Excess water adhered over the fruit should be eliminated by keeping fruits for drying in high velocity air or wipe gently with towel paper or soft cloth.

### ***Grading/Sorting***

Mandarins should be graded according to size, colour of the peel, amount of scarring, damage and decay. Accordingly fruits can be designated as Choice, regular, Plain and processing. Grading and sorting can be done by hand in small operations where the different size categories can be checked by using hand-held rings of different diameters. It can be done mechanically in larger volume packinghouses where the fruit is loaded on a slow moving conveyor type mandarin sizer. Only fruit of like sizes should be packed in the same container.



### ***Waxing***

During washing most of the natural wax on the peel surface is removed. Waxing the fruit will retard transpiration, shrivelling, moisture loss, add

gloss to the surface, seal injuries on the surface and extend market life. Wax can be applied manually by foam waxing method which has advantage of even coating, or by dipping method especially used for water emulsions or by spraying method where fine fog of wax dissolved in volatile solvent is sprayed or it can be applied by brushing method. Waxing should not be too thick or too thin and let the wax to dry on fruit surface thoroughly and immediately. Carnauba wax, polyethylene emulsions and sucrose ester coatings can be used for waxing of mandarins @ 140 mg/Kg of 500 ppm by dipping the fruit for 1 minute in a tank filled with sanitized water at room temperature.

### **Temperature Management**

The best postharvest temperature to store mandarins is between 2°C to 3°C. Market life at this temperature range is up to 4 months depending on maturity stage at harvest. For short-term storage of several weeks and during transit, 10°C is adequate. Storage at ambient temperature will result in rapid moisture loss, flavour deterioration, and decay. Mandarins may lose up to 10% of the moisture in the peel after 3 weeks at ambient temperature and relative humidity. Mandarins should be stored at their optimum relative humidity of 85-90%. At a low RH, the peel becomes thin, dry, and shrivelled.

### **Principal Postharvest Diseases**

Postharvest decay can be reduced by the use of appropriate pre-harvest and postharvest fungicides, good sanitation of the wash water, and appropriate storage temperature and RH conditions.

#### ***Green Mould***

Green mould is generally the most awful postharvest disease of mandarins. The initial symptom appears as a soft, watery, slightly discoloured spot on the rind. After the spot enlarges to a diameter of about 2.5 cm, olive-green spores are produced inside a zone of white fungal growth and softened rind tissue.

### ***Blue Mould***

Blue mould decay and symptoms are similar to green mould, except the fungal spores are bluer in colour. Blue mould grows better than green mould below 10°C. Unlike green mould, blue mould spreads in packed containers.

### ***Stem-end Rot***

Stem-end rot is caused by several different fungal species with varying symptoms. Decay begins as water-soaked spots at the stem end of the fruit that turn brown and continue to spread down the rind. The infected tissue shrinks and a clear line of separation is formed between the diseased and healthy rind. The decay proceeds either down the rind or unevenly producing finger-like projections of brown tissue. Stem-end rot can be retarded by postharvest applications of 2,4-D @ 500 ppm.

## **Postharvest Disorders**

### ***Oleocellosis (Oil Spotting)***

Oil spotting results from damage to the peel that ruptures the oil glands. The extruded oil kills the rind cells, causing them to turn brown and form spots on the fruit surface. Harvesting in the early morning or while dew is on the fruit should be avoided. Oil spotting can be prevented or reduced by picking fruit when the surface is completely dry, waiting to pick 2 or 3 days after a rain, using foam-lined or padded field containers, and having pickers wear cotton gloves.

### ***Stem-end Rind Breakdown (SERB)***

Stem-end rind breakdown is a collapse and subsequent darkening of the rind around the stem-end of mandarins. A narrow band of rind around the stem usually remains undamaged. The collapse of tissue is due to excessive moisture loss from the rind. The incidence of SERB is reduced by irrigating prior to harvest during dry weather and waxing the fruit.

### ***Chilling Injury (CI)***

Mandarins are sensitive to chilling injury. This disorder is developed during storage at low temperature and/or transit. Symptoms of chilling injury are pitting, discoloured patches, superficial brown straining of the rind and watery breakdown. Incidence of chilling injury can be overcome by pre-storage conditioning, waxing, film packaging and/or treatment with ethylene and CO<sub>2</sub>

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Source: Suresh Tiwari,(2006), Mandarin: Post Harvest Management Guide, Extension Bulletin, Published under the Technology Mission on Integrated Development of Horticulture in NE states including Sikkim, College of Horticulture and Forestry, Pasighat.