

# 11 Postharvest handling



## Fruit maturity at harvest Time of day for harvest

In tropical and subtropical countries, the development of the fruit is affected by the temperature. Maturity of the rind and maturity of the flesh of the fruit are not synchronized. The fruit is edible even when the rind still remains green (Fig. 11-1).

Mature fruit vary in size, even those on the same tree (Fig. 11-2). With sweet oranges such as Valencia or Liucheng, harvesting should begin with the smaller fruit which mature first.

With mandarins such as Ponkan, it is the end of the fruit furthest from the stem which turns yellow first. Harvesting should begin with the large fruit. Smaller fruit, or those which are slow to turn color, should be harvested later on in the season.

It is best to harvest citrus on a clear, sunny day with low humidity. The fruit should be harvested as soon as the dew has evaporated. On a cloudy day, the fruit should be harvested in the afternoon. Fruit should not be harvested at all on a rainy day.

## Harvesting method

To prevent physical damage to the fruit, the worker should trim his/her fingernails, wear gloves, and use special harvesting scissors with rounded ends to cut the fruit. To harvest the fruit, it should be held in one hand, and the other hand used to cut the fruit stem together with a few leaves. Then the fruit is brought close to the chest and the rest of the stem is cut off smoothly, close to the fruit (Fig. 11-3).



Fig. 11-1. Ripe Ponkan mandarins with different amount of color.



Fig. 11-2. Ripe fruit ready for harvest

## Containers used for harvesting

The container used for newly harvested fruit should be solid, with good ventilation (Fig. 11-4). Fruit in flexible containers tend to crush each other, causing bruises. The bottom of wood or bamboo containers should be lined with newspapers, a paper bag or a fertilizer sack. It is important to move containers as little as possible, and not to leave them standing in the sun (Fig. 11-5).

## Grading and storability

Citrus are graded by size. This can be done by hand or by machine. If the grower is grading

citrus manually, it is best not to judge the size only by eye, but to use some kind of measuring device. A simple way to check fruit size is to cut a series of round holes in a thin wooden board or a piece of thick cardboard, according to standard market sizes for that variety (Fig. 11-6). A revolving drum type machine is often used by farmers in Taiwan (Fig. 11-7 and Fig. 11-8). Other low-cost grading machines are also available (Fig. 11-9).

Fruit of different sizes should not be mixed together, or the market price the grower gets may be only that of the smallest fruit (Fig. 11-10).

The optimum size for fruit varies from one variety to another. Generally, large fruit

fetch the highest price. However, in the case of mandarins such as Ponkan, large fruit (8.5 cm in diameter) and extra large fruit (9.0 cm in diameter) have a low level of total soluble solids and low acid content. They have a thick peel and little juice, and do not store well. They should be consumed soon after harvest.

Medium sized (8.0 cm in diameter) and small-sized (7.5 cm in diameter) Ponkan fruit have a higher level of total soluble solids and a higher acid content, so that the flavor improves after short-term storage.

In the case of oranges such as Valencia and Liucheng, the total soluble solids and acid content fall as fruit become larger. Small fruit (6.0 - 6.5 cm in diameter) have a thin rind and high total soluble sugars and acid, but also are more likely to rot in storage. They should be consumed fresh. Medium sized fruit (7.0 - 7.5 cm in diameter) have a low incidence of fruit rot after storage.

Tests have shown they still have a good flavor after two months of storage. Large fruit (more than 7.5 cm in diameter) have a low incidence of fruit rot but a poor flavor after storage, because of their low level of total soluble sugars and their low acid content.

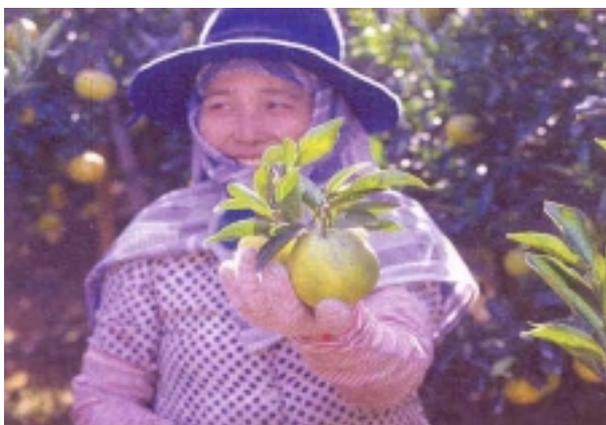


Fig. 11-3. First cut the fruit stem together with a few leaves. Then hold the fruit close to the chest and cut off the rest of the stem, making a smooth cut close to the fruit.



Fig. 11-4. Solid crate with good ventilation to hold harvested fruit

## Treatment after harvest

Only fruit which have not been damaged in harvest are used for storage, although it is difficult to harvest fruit without some minor damage. Sometimes a chemical treatment is applied to the fruit before storage, to reduce the incidence of postharvest diseases.

Citrus fruit age during storage. The stem becomes first yellow, then brown. Finally, it drops off, leaving a vulnerable place on the fruit which may be infected by fungus diseases. A treatment of 10 to 40 ppm 2,4-D can prevent the fruit stem from drying up and dropping off.

The chemical thiabendazole (40% diluted at 500X) can be sprayed onto fruit one or two weeks before harvest. Alternatively, fruit can be soaked for three minutes immediately after harvest. The treatment reduces the incidence of fruit rot during storage. Iminoctodine 25%, (diluted at 2000X) can be used as a spray four days before harvest, or used to soak the fruit before they are packed. It also reduces the incidence of fruit rot.



Fig. 11-5. Picked fruit should be moved as gently as possible



Fig. 11-6. Board with holes to check diameter of fruit for grading.

## Other treatments before storage

After harvest or chemical treatment, fruit should be kept in the shade for a few days before they are put into a PE plastic bag. The bag should be 0.02 - 0.03 mm thick. Keeping the fruit in the shade in this way is a curing treatment, to reduce the water content of the peel. This reduces cell activity in the peel, which otherwise might soften the fruit.

The time needed for water loss or evaporation depends on the temperature, the length of time the fruit is to be stored, and the thickness of the peel. If

temperatures are high, citrus fruit need a longer period of curing. They also need a longer period of curing if they are to be stored for a long time, or if they have a thick peel.

On average, it takes from three to seven days to reduce the fruit weight by about 3%. A higher water content than this causes to condense inside the plastic bag, leading to stem rot. Water loss may cure minor wounds on the peel and reduce the incidence of rot during storage.

Fruit which are to be stored for a long period are wrapped in plastic, to reduce water loss. Sometimes only one fruit is kept in each bag. This is the case with mandarins such as Ponkan (Fig. 11-11). However with other varieties such as Valencia or Tonkan, several layers of fruit can be stored in each bag.

If the fruit are to be stored for more than two months, PE film is used, wrapped around stacked crates of fruit to form a pillar.



Fig. 11-7. (left) and Fig. 11-8. Mechanized grading of fruit by size, using different types of revolving drum



11-9. Mechanized grading of fruit by size, using slats



Fig. 11-10. Fruit graded by size

## Storage

Plastic crates or boxes are used for storing fruit (Fig. 11-12). Mandarins such as Ponkan should be stored with only one or two layers per box. Sweet oranges such as Valencia or Liucheng should be stored with three or four layers per box. Too many layers in one box may cause bruising of the fruit.

Boxes should be stacked inside the storage room in a way that maintains good ventilation. For the first few weeks of storage, ventilation windows should be left open. Throughout the storage period, the windows should be left open at night or in cold weather, in order to cool the fruit.

When temperatures are

high in the day time, the ventilation windows should be closed. Sunlight should not be able to penetrate inside the storage room. Any rotting fruit that are found should be removed.

Storage rooms should be constructed in places where cold air can flow into the room at night. The storage room should have a high roof, to allow better circulation of cold air at night. Ventilation windows should be small but there should be a large number of them, to allow better air circulation (Fig. 11-13). It is recommended to that some ventilation pipes should be buried under ground, to bring in cool air through the floor of the room.

The roof and walls should

have good heat insulation, to keep temperatures as cool as possible. The storage room should be insect-proof and rat-proof. A good storage room is the key for extending the shelf life while maintaining fruit quality. The room should be kept clean, and all rotting fruits should be removed. Before storage, the room should be sanitized by washing the walls and floor with 5% formalin.

Another way of storing fruit is to leave them on the tree. In California, Valencia oranges can be left on the tree for five months, from May to October. In Taiwan, this has been tried for the very similar Liucheng orange. However, the harvest can only be delayed for one month and then the fruit drop to the ground.



Fig. 11-11. Ponkan mandarin packed one fruit per bag, ready for storage. Left: traditional wooden box; Right: modern plastic crate.



Fig. 11-12. Sweet oranges for fresh consumption. Since they are to be eaten within a few weeks, they are not wrapped in plastic.



Fig. 11-13. Packing house with many small windows, and ventilators in roof.