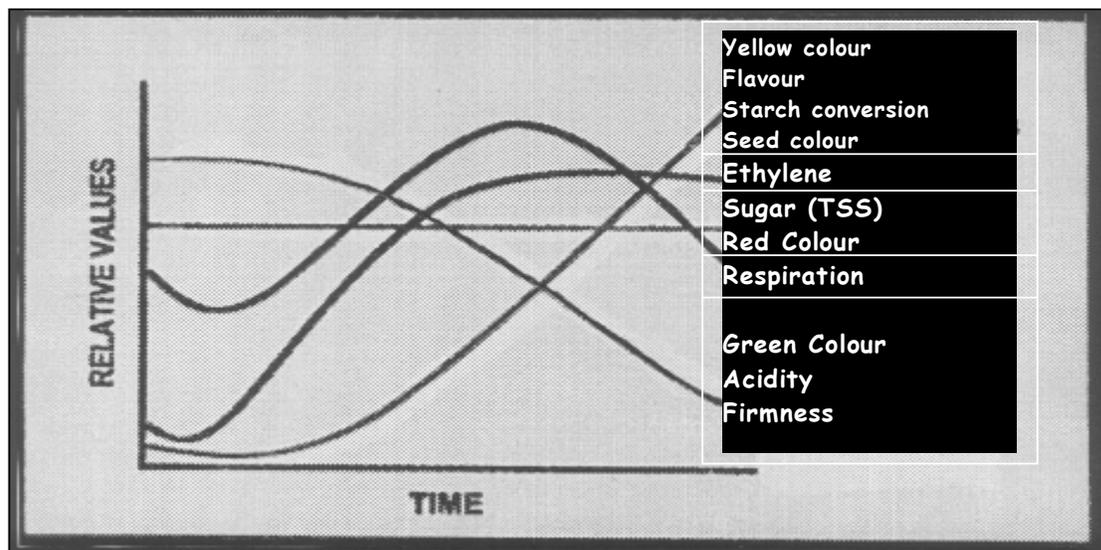


4. Harvest

Characteristics of fruit ripening

To understand why fruit must be handled strictly according to the protocol one needs to understand the physiology of the fruit. Pome fruit are climacteric fruit, which means that they produce the ripening hormone ethylene autocatalytically – once ethylene is produced, its tempo of production increases exponentially. Changes that take place during development and maturation (Figure 2) may include losses in chlorophyll (loss of green colour), development of anthocyanins (red cultivars) and changes in carbohydrates (starch to sugar conversion). Flavour volatiles are produced and are associated with the ripening of the fruit and are important to the eating quality of the fruit.



The proposed picking and handling protocol is aimed to provide producers with information to manage the fruit according to these characteristics.

Figure 2: Changes (relative values) during the ripening of Pome fruit

Fruit, during its lifetime goes through a pre-climacteric, climacteric and post climacteric phase, which includes senescence. When the onset, duration and termination of these phases are known, fruit can be handled accordingly. These changes in fruit physiology are referred to as changes in maturity.

Cooling after harvest and cold storage is aimed at maintaining the quality of the fruit. Therefore knowledge of the maturity or age of the fruit is necessary.

5. Fruit maturity and its role in fruit quality.

Fruit must be harvested at the optimum stage of maturity in order to be utilised according to its potential. Various picking and storage parameters (see Table 1) exist to accomplish this. The data was obtained from Hortec's (and its forerunners) maturity indexing programme, run from 1983 to 2001. The programme consisted of representative samples being taken in all the major production areas on a weekly basis, 5 - 6 weeks before anticipated harvest until after final harvest (average 10 weeks), of all the major cultivars. The maturity indices were monitored to establish trends.

Duplicate samples were taken, starting before harvest and continuing until after harvest, for storage under regular atmosphere. The fruit was evaluated after a simulated storage period for export. Maturity tests were once again conducted and the fruit was subjected to an organoleptic evaluation by a trained in-house taste panel. This served to verify in-season predictions and the building of a database of start and end of harvest maturity indices, and ultimately the setting of quality standards.

The release date (start of harvest) is defined as the fruit reaching physiological maturity i.e. it would ripen to good eating quality after a period of storage. It is thus the absolute minimum maturity for harvest, and the fruit should not be presented for immediate marketing from a consumers' eating quality point of view. Fruit, which is picked soon after the harvest release date will ripen normally, but will only develop an acceptable taste after storage and ripening. This fruit should thus be destined for long-term storage. The optimum stage of harvesting, to obtain the best balance of red or blushed colour (where applicable), fruit size and internal quality, usually occurs 10 – 14 days after the release date, depending on the cultivar.

TABLE 1 Maturity Criteria

| Apples | | | | | Overmature Standard | |
|---------------------|---------------|------|------------------|--------|---------------------|--------|
| | Firmness (kg) | %TSS | Starch (% white) | Acid % | Firmness (kg) | Acid % |
| Royal Gala | 8.4 | 11.0 | 15 | 0.40 | 7.0 | 0.35 |
| Golden Delicious | 7.8 | 12.0 | 15 | 0.50 | 7.0 | 0.40 |
| Red Delicious types | 8.0 | 11.0 | 10 | 0.30 | 7.3 | 0.25 |
| Braeburn | 8.6 | 11.5 | 20 | 0.60 | 8.0 | 0.40 |
| Granny Smith | 7.8 | 11.0 | 20 | 0.75 | 6.8 | 0.55 |
| Fuji | 8.5 | 13.5 | 20 | 0.45 | 7.0 | 0.35 |
| Cripps' Pink | 8.7 | 12.5 | 10 | 0.75 | 7.5 | 0.55 |
| Cripps' Red | 9.1 | 12.5 | 15 | 0.75 | 8.5 | 0.60 |

| Pears | | | | Overmature Standard | |
|-------------------|---------------|------|--------|---------------------|--------|
| | Firmness (kg) | %TSS | Acid % | Firmness (kg) | Acid % |
| Williams BC | 10.5 | 11 | 0.35 | 7.2 | 0.30 |
| Beurre Hardy | 6.4 | 11 | 0.45 | 4.1 | 0.35 |
| Beurre Bosc | 8.1 | 12.5 | 0.30 | 4.5 | 0.20 |
| Doyenne du Comice | 6.8 | 12.0 | 0.35 | 3.6 | 0.25 |
| Packham's Triumph | 8.0 | 11.5 | 0.30 | 5.0 | 0.20 |
| Forelle | 6.8 | 13.5 | 0.30 | 4.5 | 0.20 |

Fruit, which is picked immature, will not ripen normally or develop a good taste during storage, as a result of an incomplete maturation process. There is a high risk of maturity related defects, for instance, bitter pit, wilting, superficial scald and failure to ripen after storage.

Fruit which is picked in the middle of the harvest window, will already have developed a good taste and can be stored for medium to long-term periods. The maturity related defect risks are minimised as the fruit has matured fully, although cold storage protocols still have to be applied strictly. Optimum maturity parameters for the major economic cultivars exist and producers are urged to have their fruit tested at a fruit maturity laboratory e.g. a Hortec laboratory.

Fruit that is harvested at the post-optimum stage is eating ripe and has the best flavour. This fruit is best stored for short to medium-term periods. This fruit has faster respiration rates than the previously mentioned groups and adherence to cold storage protocols is therefore of utmost importance. Potential maturity related defects are yellowing, bruising, development of mealiness and greasiness during shelf life.

6. Maturity and Harvesting

In the Western Cape where winters are mostly mild, the cold requirement of the fruit trees is not always met. This leads to delayed foliation and protracted bloom periods, which results in fruit of different physiological age on the same tree. The effect here of is mixed fruit maturities during harvest. Careful thinning methods and or selective picking can manage this problem.

Maturation of fruit differs from season to season. Several maturity indicators, such as firmness, seed colour, fruit colour, total soluble solids, acid and starch conversion, are used on a seasonal basis to determine fruit ripening and release dates. The role of the various maturity indices in determining harvest maturity

also varies from year to year, and the change in the rate of change of indices is regarded as an important indicator.

The physiological stage at which the fruit is harvested is very important. Fruit can be harvested during a certain window of opportunity, whereafter the fruit will be overripe and not be suitable for storage or exporting. This is referred to as the harvesting window. Each cultivar has its own pattern of ripening and therefore the length and timing of the harvest window may differ from year to year. Timing of the harvest window is influenced by seasonal climatic effects, and not by calendar date. The length of the harvest window is defined by maturity standards and rate of ripening.

The purpose of maturity indexing is to quantify these effects and determine the variation on the tree. Also the maturity of the fruit is determined in order to harvest all fruit optimally or at least minimise the effect of mixed maturity. When to harvest the fruit is a fine balance between optimal fruit size, external quality indicators for instance red colour and internal maturity. A common mistake is to wait for increase in fruit size, which then does not occur due to a number of possible reasons. The end result is that fruit is harvested at a post-optimum or over mature. This fruit then has very little storage potential and one is then forced to market the fruit in a most probably overstocked market.

Producers should use a maturity-indexing programme, involving regular maturity analyses to determine fruit maturity for:

- picking windows
- orchard ranking
- storage and export potential.

There are different methods of harvesting:

- Strip pick method: All the fruit is harvested at once. It is assumed that all the fruit is of the same maturity. This method of harvesting is not recommended although used frequently. Negative aspects are variation in maturity (internal factors i.e. starch breakdown) and quality (external factors i.e. red colour)
- Selective or multiple picking method: This is a better and recommended method of harvesting. Fruit is selectively picked according to size, green colour or red colouring. Fruit that is selectively picked normally is of similar maturity, although variation can be found, especially on cultivars such as Fuji and Royal Gala.

Picking windows: When a picking window is set the window can be divided in 3 periods i.e. pre-optimum, optimum and post-optimum.

- Fruit harvested during the pre-optimum period (typically the first 3 to 4 days after the release date) has good storage potential but acceptable taste will

only develop during and after storage. The risk of superficial scald and bitter pit development exists.

- Optimum harvested fruit (middle period of 7 to 10 days) is best suited for medium to long storage and has better taste.
- Post-optimum harvested fruit has short storage potential but superior taste. Fruit harvested over mature in this period has potential for over maturity defects i.e. greasiness, mealiness, internal breakdown and decay.

Also keep in mind the minimum residue levels (MRL's) and withholding periods of the pesticides or fungicides used in spray programmes. If fruit is harvested before the withholding period has expired, the pesticide or fungicide will not breakdown adequately and MRL's will be too high, which will result in rejection during inspection. Also fruit maturity will change during the withholding period and you should make sure that fruit maturity is still acceptable for your purposes after the withholding period.

Fruit has to comply with National export standards as set out by National Department of Agriculture (www.nda.agric.za) as well as standards set out by the supermarket or country the fruit is exported to.

Pears: The Summer pear cultivars are especially sensitive to picking maturity. If the summer pears are harvested when over-ripe, the storage potential and shelf-life is severely compromised.

Pears normally have a picking window of up to 15 days. The fruit that is picked first is normally suitable for long-term CA storage. Using selective picking methods is the best way to classify fruit according to its maturity and storability – especially for the summer pears. Pears that are harvested immature will not ripen after any length of storage and will wilt during storage.

Pears are especially prone to moisture loss and signs of shrivel will develop mostly around the stem area. Take all necessary precautions to prevent moisture loss during harvesting, transport to the cold store, time of transport and cooling method. Signs of shrivel do not show directly but develop during cold storage. The damage however might have occurred at any stage during harvesting or cold chain.

Bon Chretien pears are also sensitive to premature ripening. Premature ripening is induced when pears are exposed to up to 3 nights of continuous night time temperatures of 7,2°C and less, and day time temperatures of not higher than 21.1°C in the 6 to 9 week period before harvesting. In some cases the fruit can recover when subsequent temperatures are above the threshold levels.

Apples: Of all the apple varieties the Gala, Fuji types and Pink Lady® are the most difficult to make a harvest decision. For the Gala types maturity indicators might vary from season to season. Fuji apples harvested too early will not ripen after any length of storage. In the case of Cripps' Pink (Pink Lady®) there is a

trade-off between development of red colour versus increasing fruit maturity and post-storage development of defects such as greasiness and possible internal browning.

Apples have longer picking windows than pears (up to 20 days), and also benefit from selective picking, especially the Gala, Fuji and Braeburn types where intensity of colour and fruit size plays a major role. Red apples, Golden Delicious and Granny Smith are mostly strip-picked. In this case it is advised that orchard maturity ranking is done so that maturity of the fruit is optimally used in determining storage and marketing plans. If fruit is destined for storage after picking, make sure it is picked at the correct maturity stage for the required storage period.

Time of harvest plays an important role especially with cultivars such as Golden Delicious and Cripps' Pink (Pink Lady[®]) that have high bruise potential. It is better to start picking late morning in order for the fruit to lose some turgidity. Rather start with harvesting red apples in the early part of the day. Irrigation can be minimized in order to aid with the wilting process prior to harvesting, but this must be done in conjunction with your consultant and keeping all factors in mind.

In general a producer can follow many protocols to ensure fruit quality during and after picking.

7. Harvest guidelines

- 📖 Clean bins, using high pressure hot water/steam and sanitising agents (see post-harvest treatments), before picking. Bins are a perfect host for decay pathogens and over wintering place for insects.
- 📖 Use bin liners to minimise chafe marks and bruising where applicable. Susceptible cultivars are mostly the Summer pears of which Bon Chretien and Doyenne du Comice are most susceptible. Bin liners must be used correctly as they can restrict air movement during the cooling process – i.e. no bin liner in the bottom of the bin in the case of serpentine cooling, as air moves from the top to bottom in the bin.
- 📖 Do not pick during rain or directly after rain. Fruit turgidity is high and fruit will be more prone to bruising and infection.
- 📖 During harvest on hot days, keep the bins covered, for instance with a wet blanket. This will protect the fruit against a rise in temperature and sunburn.
- 📖 Fruit pickers should have short nails and not wear jewellery on their fingers, in order not to injure the fruit during picking.
- 📖 Pickers can empty their picking bags onto a thick (10 mm) sponge blanket or mat in order to minimise bruising in the bin.
- 📖 If fruit is picked during the cooler periods of the day, less pressure is placed on the cooling capacity and facilities.
- 📖 Coordinate delivery times at cold store depots or pack houses as to minimise the time fruit is spent waiting outside.

📖 Keep fruit under cover during transport or during waiting times at depots.

Some of these guidelines might not be the most practical to implement (mainly due to costs) but every precaution taken will have a positive effect on fruit quality.