

'Cripps' Pink' Best Practice

1. Correct harvest maturity (for long term storage)

- Starch breakdown: optimum 20-30% and < 40%. Can be released at 15%, depending on other parameters.
- Firmness: > 7.8 kg (11.1 mm tip) as they have to arrive in UK at 6.8 kg.
- Total soluble solids (TSS): advisable to be above 12.5% (13% at receipt)
- Titratable acidity: 0.75 – 0.55%

NOTE: Maturity is the biggest factor in diffuse browning development after storage. Post-optimum harvested fruit should never be stored long-term.

2. Reduce variability

- Orchards ranked 4 weeks before harvest on maturity and then pre-delivery samples to determine ripening rate and storability.
- Market fruit from orchards with faster ripening rates first and do not store in CA.
- Inside and outside canopy fruit maturity differences need to be determined.
- The outside, well-coloured fruit will be harvested first due to block colour standard of 40% (some markets 60%).
- The inside pale fruit will be left for last in order to potentially colour up. Consider leaf-stripping after first pick when sunburn risk has diminished. Rather consider reflective mulching should sunburn be a risk.
- These inside canopy fruit may be riper (even at the first pick) and should not be stored in CA / longer than 12 weeks.
- Depending on the size of the first pick, the second pick may be put into CA / long term storage depending on the starch breakdown.
- Avoid extended periods between picks / long picking window.
- Do not harvest after 50% starch breakdown for CA storage purposes longer than 12 weeks. May be fine for RA and RA + 1-MCP and short-term CA storage,

3. Long term storage - orchard history ranking

- Age of trees - do not store fruit from young trees longer than 12 weeks.
- Light crop load fruit may be more susceptible to disorders / earlier ripening.
- Irrigation status (under or over irrigation may result in faster ripening rates and poor storability).
- Soil types (sandy soil orchard fruit tend to ripen faster).
- Mineral nutrition (important in storage quality / ripening rate).
- History of progressive defects and ripening rates pre-harvest of each orchard.
- Grafted trees may also have a higher internal browning risk due to increased stress.
- Fruit that received any type of stress during the season should be sold within 6 weeks.

4. After harvest and storage handling

- Harvested bins should not remain in the sun and should be accumulated in a shaded area before transport to the packhouse as soon as possible.
- At the packhouse fruit should be loaded into the cold room as quickly as possible.
- Fruit should not be accumulated outside the packhouse in the shade / overnight to facilitate initial cooling.
- Be aware of cold room temperature (3 °C - 4 °C) while adding warm fruit. This may lead to excessive temperature fluctuations / cooling maintenance or poor removal of field heat.
Separated areas with curtains in the cold room to split warm and cooled fruit may help to avoid this.
Make sure the cooling capacity of cold store can remove the heat from the volume of warm fruit. This will have to be closely monitored.
Load two or three rooms simultaneously to get even cooling rates.
- Attain pulp temperature of 4 °C after 48 hours.
- CO₂ should be monitored when warm fruit are closed in a cold room.
- CO₂ levels should never reach levels higher than 1%.
- Use additional lime / new generation scrubbers to reduce CO₂ to 0.5%.
- Fruit should further be cooled stepwise.
- Fruit will benefit from ethylene inhibitors (1-MCP) (to reduce the ripening rate, greasiness, superficial scald and internal browning) and should be treated within 7 days of harvest especially if stored for extended periods in RA (3 months) or CA (> 3 months).
- The current treatment protocol has performed the best in terms of diffuse browning and maturity over two seasons for long term storage CA (>7 months).
- *SmartFreshSM within 7 days + 7 days at 4 °C, 14 days at 3 °C, 21 days at 2 °C, remaining days at 1 °C.*

5. CA O₂ and CO₂ gas regimes - Industry Guidelines (ARC/HORTGRO)

Nitrogen Flushing: attain gas regime of 3% O₂ + 1.5 % CO₂ within 48 hours of sealing the room.

Table 1: Regimes (Appendix 2 Industry Guidelines Apples (ARC/ Hortgro):

Gas regime:	O₂ (%)	CO₂ (%)
<i>Optimum</i>	1.5	0.5
<i>Maximum</i>	2.0	1.0
<i>Minimum</i>	1.0	0.0

6. DCA guidelines

DCA- RQ / ACR system (Van Amerongen) (PACKHOUSE EXPERIENCE / VA)

- Room filling (5-7 days); keep CO₂ <1%
- Room full (3 days) fruit on temperature; keep CO₂ <1%
- Pull down O₂ to max 6% (2 days); keep CO₂ <1%
- O₂ reduction to 1.2% (7 days); keep CO₂ <1%
- O₂ 1.2% (14 days); CO₂ <1% (total 28 days).
- ACR mode > 28 days onwards: O₂ > 0.6% ; CO₂ <1%
- Keep O₂ between 0.5 - 0.7% depending on the season.
- Always keep CO₂ as close to 0.5% as possible.
- It is a good idea to monitor the fruit from DCA for ethanol levels.
- *PLEASE CONTACT SERVICE PROVIDER FOR THEIR SPECIFIC GUIDELINES*

DCA-CF system (Isolcel / Gas at Site) (ARC GUIDELINE)

- Load the room and cool to core temperature within 48 hours of harvest.
- Allow 5 days for loading the room.
- Then seal and pull down to 3% O₂ + 1.5% CO₂ over 2 days.
- For the next 2 days pull down to 1.5% O₂ + 1% CO₂.
- Pull down to LOL O₂, less than 1% CO₂ within the next 2 days.
- Therefore, the total time from harvest to LOL is 11 days.
- After spiking, adjust to 0.2% O₂ above spiking (LOL) and keep CO₂ less than 1% during storage. Monitor for spiking during storage period.
- *PLEASE CONTACT SERVICE PROVIDER FOR THEIR SPECIFIC GUIDELINES*

7. Internal browning considerations

- Fruit maturity (starch breakdown) is linked to diffuse browning development after storage and ripening.
Starch breakdown 15-40%: lower risk of diffuse browning (3 months storage).
Starch breakdown 15-40%: risk of diffuse browning depends on other factors (>3 months storage).
Starch breakdown 40%-50%: higher risk of diffuse browning (>3 months storage).
Starch breakdown 40%-50%: medium risk of diffuse browning (3 months).
Starch breakdown >50%: high risk of diffuse browning (3 months).
- Low storage temperature is linked to diffuse browning development. Storage temperatures of -0.5 °C up to 1 °C have previously been linked to diffuse browning after only 3 months of storage.
- Pre-harvest factors that affect maturity (i.e. younger trees with lighter crops loads and fruit grown on sandy soils) have been linked to diffuse browning.
- Radial browning also occurs after extended storage periods, but seems to be linked to pre-harvest temperatures. Be mindful that in seasons with lower than usual maximum and minimum temperatures as well as GDD_{10C} after 0-50 DAFB (cell division) and 50-100 DAFB (cell enlargement), the risk of

radial browning occurrence may be higher. When long term storage period is determined and fruit allocated for this purpose, the risk of radial browning in each season should be taken into account. *These results need to be confirmed and further researched.*

- Irrigation and rootstock trials seem to show differences in maturity and links with diffuse browning.
Radial browning seems higher where drought stress was applied.
These results need to be confirmed and the trial repeated.
- ‘Cripps’ Pink’ is CO₂ sensitive and readily shows CO₂ browning in cases where CO₂ increased above 1%.
- Non-perforated bags could lead to the build-up of CO₂, especially with fluctuating temperatures during shipping and distribution.
- Consider shipping container vents 5% open due to CO₂ sensitivity and risk of temperature fluctuations during the voyage.