AUSTRALIAN AVOCADO SUPPLY CHAIN
Best Practice Guide

Hort Innovation

Contents

03. Introduction

04. Pre-harvest

08. Harvesting

12. Packhouse

20. Transport

22. Ripener/Wholesaler

26. Distribution centre

28. Links and references

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All photographs and diagrams by AHR unless otherwise indicated

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Avocados Australia

Queensland Government

01. Introduction

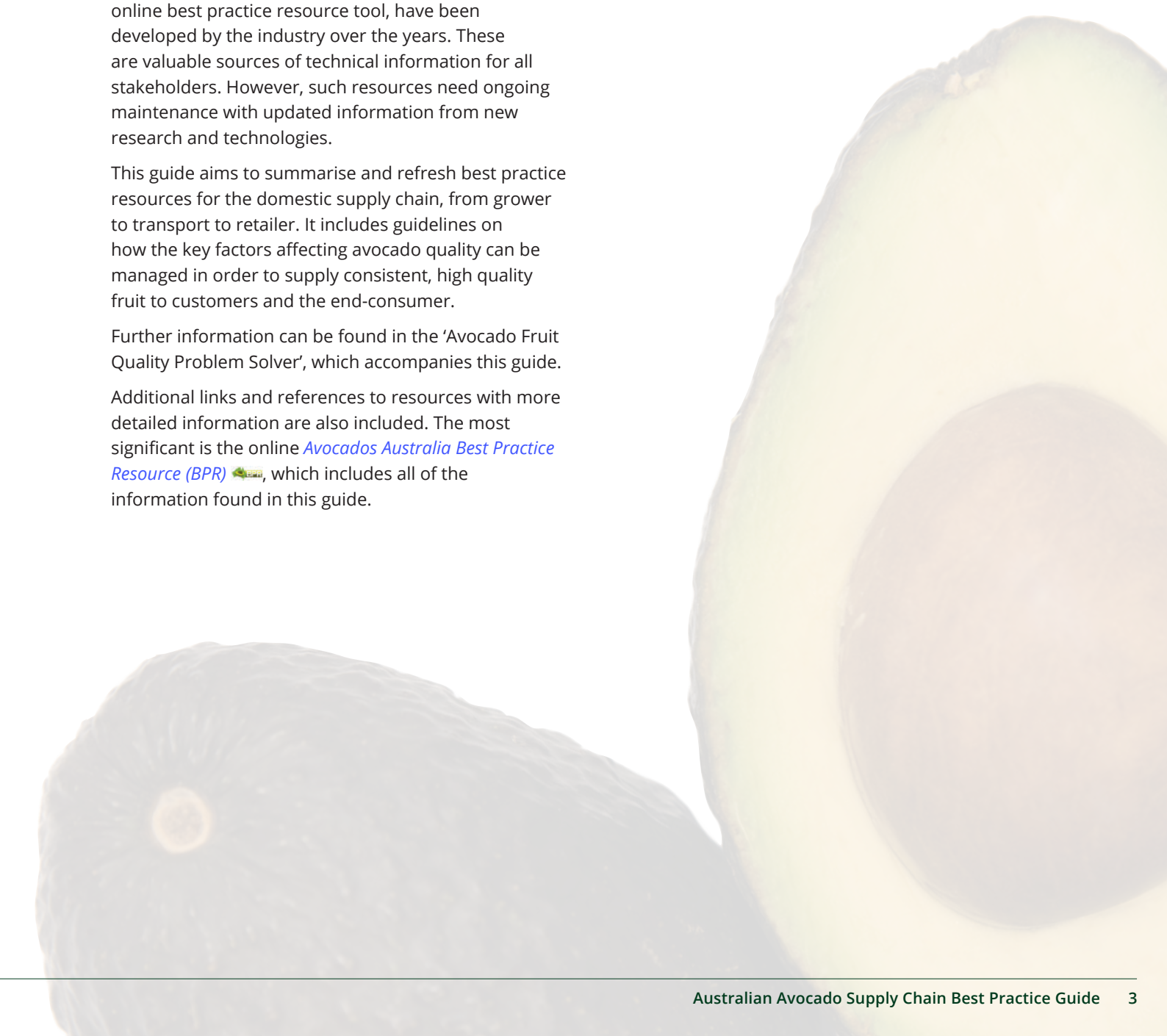
Consistent fruit quality at retail is vital to satisfy consumers and continue to increase consumption of fresh avocados. Maintaining avocado fruit quality through the supply chain depends on many factors, including effective orchard management, well managed harvesting and packing operations, postharvest treatments and control of fruit temperature.

Best practice resources, including printed documents, posters, stickers, and a comprehensive online best practice resource tool, have been developed by the industry over the years. These are valuable sources of technical information for all stakeholders. However, such resources need ongoing maintenance with updated information from new research and technologies.

This guide aims to summarise and refresh best practice resources for the domestic supply chain, from grower to transport to retailer. It includes guidelines on how the key factors affecting avocado quality can be managed in order to supply consistent, high quality fruit to customers and the end-consumer.

Further information can be found in the 'Avocado Fruit Quality Problem Solver', which accompanies this guide.

Additional links and references to resources with more detailed information are also included. The most significant is the online *Avocados Australia Best Practice Resource (BPR)*, which includes all of the information found in this guide.



02. Pre-harvest

Postharvest operations can only deliver high quality fruit if it is grown well from the start. Best practice in the orchard depends on growing region, soil-type, season, tree age and many other factors. Detailed information on production practices is provided in the 'Growing' section of the online *Avocados Australia BPR*. This section is a summary of the key pre-harvest factors that **directly impact postharvest quality**.

BEST PRACTICE

- ✔ **Use a copper and strobilurin fungicide spray program to control disease**
- ✔ **Use leaf and soil testing to develop and monitor your nutrition program**
- ✔ **Aim for fruit calcium greater than 400mg/kg dry weight**
- ✔ **Measure soil moisture and keep it between the full point and refill point**
- ✔ **Maintain healthy trees through pruning and control of Phytophthora root rot**
- ✔ **Keep the orchard and cutting equipment clean**

2.1 NUTRITION

Ensuring adequate nutrients are supplied to the trees in a balanced program is critical in producing quality avocado fruit. Optimise crop nutrition by using professional advice to help develop a fertiliser program for your farm. The effectiveness of the program should be monitored using regular leaf analysis and soil testing.

For detailed information on managing the nutrition of your orchard consult the 'Growing' section of the online *Avocados Australia BPR*.

Calcium and nitrogen in the fruit

Adequate calcium levels in fruit are critical for good fruit quality. There is good evidence that high calcium concentrations suppress the development of diseases such as anthracnose, reduce the potential for chilling injury and increase potential shelf-life.

Low calcium may be associated with high nitrogen. While nitrogen is essential for good yield, high levels can increase fruit susceptibility to rots and chilling damage. This is because shoot growth is boosted at the expense of fruit development.

Fruit from young trees (first 1-2 years of cropping) are often high in nitrogen due to generous use of fertiliser during orchard establishment. These fruit can be more susceptible to rots and disorders, so should be marketed carefully.

How to increase fruit calcium: It is most important to get adequate calcium into the fruit during early fruit development:

- In high cation exchange capacity (CEC) soils apply 200 to 1,000 kg/ha gypsum well before flowering.
- In low CEC soils apply gypsum just before or at flowering, then repeat applications fortnightly for 8–10 weeks from fruit set.
- Lime or dolomite are alternate sources of calcium to gypsum; particularly if soil pH is low.
- Increase soil organic matter with mulch or compost to help retain calcium in the soil.
- Do not apply excessive nitrogen or potassium (light applications often are best), as these tend to reduce calcium levels in the fruit.
- Avoid excessive irrigation in sandy soils as this can leach calcium out of the root zone.

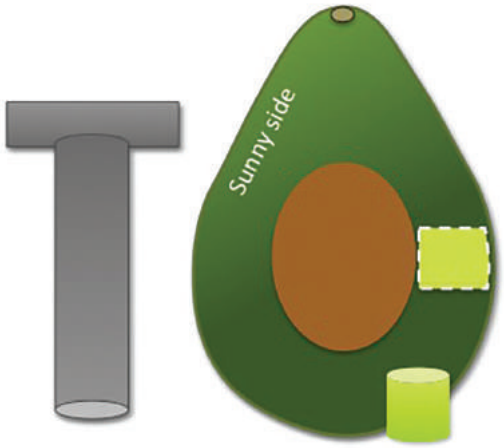
Note: Foliar application of calcium is not effective at increasing calcium levels in the fruit.

It is not possible to increase calcium in the fruit once it has developed. However, it is still useful to measure calcium in mature fruit as this can help predict which blocks are most likely to be suitable for longer storage, particularly if exporting. Such measurements can also help prioritise calcium applications for the subsequent season.

How to measure calcium and nitrogen in the fruit:
In the weeks leading up to harvest, take a sample of 10 mature fruit randomly selected from across a uniform block. Remove a section of skin and, using a corer, take a small sample of flesh from each fruit, avoiding the side that was facing directly outwards on the tree. Combine samples and dry in a conventional or microwave oven, then send to a NATA or ASPAC accredited lab for dry tissue analysis.

Optimal calcium and nitrogen levels in the fruit flesh:

- **Calcium:** Aim for greater than 400mg Ca/kg dry weight in mature fruit
- **Nitrogen:** Less than 1% dry weight in the weeks leading up to harvest



Use a corer to take samples of fruit flesh for testing.

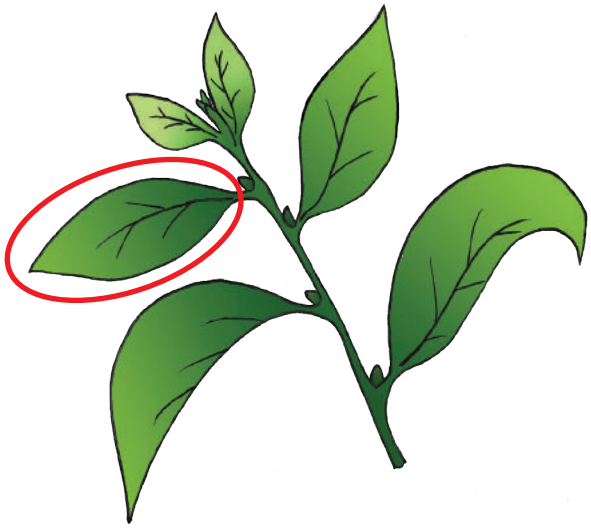
Leaf analysis

While leaf analysis can provide information on overall nutrition, calcium levels in leaves do not necessarily indicate calcium levels in fruit. It is fruit calcium that is most important for postharvest quality.

Measure the level of nutrients in the leaves to monitor the nutrient status of the crop.

In autumn, select the youngest fully expanded leaves from the summer flush. These leaves will be about eight weeks old. Collect four leaves per tree from 10 representative trees across the block to make a sample of 40 leaves.

Note: This sampling and the reference information below refers to leaf analysis (dry ash) and not to sap testing. Sap testing can also be used to monitor nutrition but is more affected by environmental conditions and water stress.



Test the youngest, fully expanded leaf.

Optimum leaf nutrient levels, using the youngest fully expanded leaves from the summer flush.

	NUTRIENT		OPTIMUM RANGE
MACRONUTRIENTS	**N**	**Nitrogen**	**Hass, Shepard and other varieties: 2.2 – 2.6% Fuerte/Sharwill: 1.6 – 2.0%**
	P	Phosphorus	0.08 – 0.25%
	K	Potassium	0.75 – 2.0%
	S	Sulphur	0.2 – 0.6%
	Ca	**Calcium**	**1.6 – 3.0%**
	Mg	Magnesium	0.25 – 0.8%
MICRONUTRIENTS	**B**	**Boron**	**40 – 60 mg/kg**
	Cu	Copper	5 – 15 mg/kg
	Fe	Iron	50 – 200 mg/kg
	Mn	Manganese	30 – 500 mg/kg
	Zn	Zinc	40 – 80 mg/kg
	Cl	Chloride	< 0.25 mg/kg
	Na	Sodium	< 0.25 mg/kg

MOST CRITICAL FOR FRUIT QUALITY

Note: These values should ony be used as a guide – seek professional advice for your orchard.

Soil Testing

Take soil samples from under the tree canopy, within the wetted area of the sprinklers, and at least 30cm from the tree trunk. Avoid trees at ends of rows. Collect 15–20 subsamples across the block, mix together and take one 500g composite subsample per block. Send the sample/s for analysis to an ASPAC- or NATA-accredited laboratory.

Optimum soil analysis values, soil sampled from 10 to 15cm depth.

SOIL PROPERTY	METHOD	OPTIMUM SOIL LEVELS
pH	1:5 water	5.0 – 5.5 or 6.5 if manganese is ≥40
	1:5 $CaCl_2$	4.2 – 4.7 or 5.6 if manganese is ≥40
Organic carbon	Walkley-Black	> 2%
Nitrate-N (NO_3-N)	**1:5 aqueous extract**	**> 10 mg/kg**
Phosphorus	Colwell/bicarbonate	30 – 60 mg/kg
Potassium	exchangeable	0.75 – 1 meq/100 g, 5% cations
Calcium	**exchangeable**	**5 – 15 meq/100 g, 65 – 80% cations**
Magnesium	exchangeable	1.6 – 3 meq/100 g, 10 - 15% cations
Sulphur	Phosphate extraction	> 20 mg/kg
Calcium:magnesium ratio		**3:1 to 5:1**
Sodium	exchangeable	< 5 meq/100 g and <5% cations
Chloride	1:5 aqueous extract	< 200 mg/kg
Conductivity	1:5 aqueous extract	< 0.15 dS/m
Copper	DTPA	0.3 – 10.0 mg/kg
Zinc	DTPA	5 – 10 mg/kg
Manganese	DTPA	6 – 40 mg/kg
Iron	DTPA	4 – 20 mg/kg
Boron (mg/kg)	**hot calcium chloride**	**Clay loam: 2 – 8, Loam: 0.75 – 3, Sandy soils: 0.25 – 1**

MOST CRITICAL FOR FRUIT QUALITY

Note: These values should only be used as a guide, as they may vary by soil type – seek professional advice for your orchard. It is also important to regularly analyse the irrigation water as pH, salt and nutrient content can all affect soil chemistry and tree nutrition.

Use a soil auger to collect soil samples

2.2 IRRIGATION

Avocados have a shallow root system, with most of the roots in the top 20–30cm of the soil. This limits the water available to the trees, especially in sandy soils.

Best practice is to irrigate to bring the soil moisture in the root zone back to the **full point** and then let the trees extract water down to the **refill point**.

The most critical time to avoid water stress is the first three months of fruit development. This is important because avocado trees take up **calcium** in the water stream. Avoiding water stress helps the tree to transport calcium efficiently from the soil to the fruit.

If fruit are harvested very turgid they are more susceptible to lenticel damage. If possible, irrigation should be reduced prior to harvest, allowing some dry-down of the fruit.

When to water and how much to apply?

Monitor soil moisture: It is important to measure soil moisture. Tools such as the **WildEye®** (TDR) or **EnviroScan®** (capacitance) can be used to monitor soil moisture in the root zone and provide information on your soil moisture via a website. These tools allow you to set soil refill and full points, and monitor crop water stress. These tools can replace tensiometers, but may be less accurate in sands.

Scheduling irrigation: Measure your readily available soil water (RAW) and use reference evapotranspiration (ETo) plus a crop factor to calculate when to irrigate and how much water to apply, to avoid water stress.

The **IrriSat®** system can help you develop an irrigation schedule for your orchard and will measure ETo, rainfall and crop factor for your orchard.

Details on how to develop an effective irrigation system for your orchard can be found in the 'Growing' section of the online *Avocados Australia BPR*.

2.3 DISEASE MANAGEMENT

Fungicides

Although rots usually develop only as fruit ripen, the initial stages of infection can occur at any time. The pathogen that causes anthracnose can directly penetrate the fruit skin while avocados are developing on the tree. In contrast, the organisms that cause stem-end rots either infect fruit through the wound created at harvest or transfer directly from the stem tissue, where they can be present without causing disease. In both cases, infections often remain dormant in the fruit until after ripening.

A comprehensive spray program from fruit set (or earlier) through to harvest is essential to reduce postharvest development of anthracnose and stem-end rots.

Copper sprays: A copper-based fungicide should be applied as a foliar spray every two weeks in wet weather or every four weeks in dry weather from fruit set (pea size) to harvest. Copper acts as a barrier against fungal infection, so ensure fruit are well covered, especially if rain is expected. There are a number of copper based fungicides registered for use on avocado, the properties of which vary. For example, cuprous oxide has been found to have better adhesion than copper hydroxide during wet weather. Do not spray copper fungicides during flowering as they can be phytotoxic.

Strobilurin fungicides: To optimise disease control, also apply a strobilurin fungicide (e.g. azoxystrobin) a maximum of three times during the season, according to the label schedule, e.g.

- At early fruit set
- One month before harvest
- More than 7 days before harvest

Strobilurin fungicides are partially mobile in the plant, passing through the surface of the leaf or fruit and penetrating the underlying tissue. This means they can (potentially) control disease after infection has occurred. Strobilurins may be applied after a wet period to reduce the risk of later disease development.

Fungicide program: To reduce resistance to strobilurin fungicides:

- Start the season with a copper based fungicide.
- Alternate applications of strobilurins with a protectant fungicide. These include copper based products and Thiram, which is also registered for this purpose.
- Use strobilurins for no more than 1 of every 3 fungicide applications with a maximum of 3 applications per season.

Orchard hygiene and management

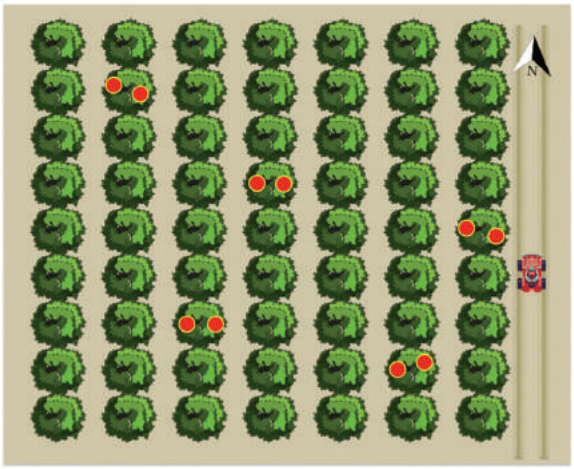
Keeping the orchard well managed and the equipment clean is another way to reduce disease pressure on fruit.

- Prune to remove dead wood and mummified fruit before flowering.
- In wet areas skirt trees to 0.5m to increase air movement through the canopy.
- Regularly disinfect cutting tools with an appropriate disinfectant such as bleach (100ppm chlorine) or methylated spirits (70%).
- Control insects, especially pests such as fruit-spotting bug, as damage provides entry points for rots.
- Trees with high yield also tend to produce more robust fruit. Practices that increase yield are likely to also increase disease resistance.

03. Harvesting

3.1 ASSESSING FRUIT MATURITY FOR HARVEST

Fruit must reach minimum maturity to ripen properly and eat well. Dry matter relates closely to oil content and is a good indicator of fruit maturity. Dry matter content varies within and between fruit, even those harvested from the same tree at the same time. The percentage dry matter content also varies from year to year, across and within blocks and with different rootstocks. Correct sampling is very important to ensure you get a reliable dry matter value.



When sampling fruit for DM, select pairs of medium sized fruit from midway up on opposite sides of each tree, choosing at least five trees randomly around the block. Red dots indicate sampling points.

Sampling fruit for testing

Test dry matter before picking by sampling at least **10 fruit per block** from a **minimum of five trees**. Select equal numbers of fruit from each side of the canopy (e.g. east:west).

Note that fruit at the top of the canopy and large fruit on the northern and eastern sides of the tree are likely to mature first. Choose fruit to sample that are typical of those that are to be harvested first e.g. medium to large size from the outer canopy.

Do not start harvesting until fruit meets minimum dry matter content:

- **Hass ≥23%**
- **Shepard, Reed, Fuerte ≥21%**

How to measure dry matter

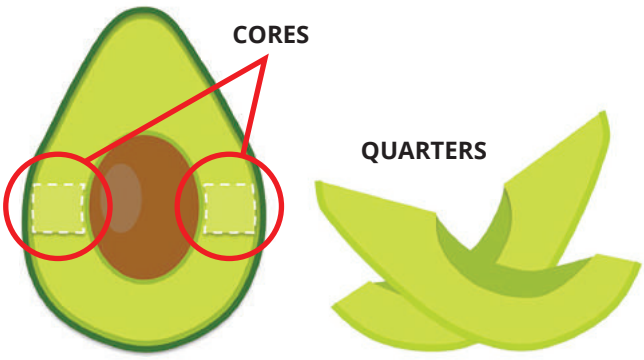
There are two short videos on how to measure dry matter using either the coring method (Hofshi) or the grated flesh method.

To view the videos, visit the 'Packhouse' section of the online *Avocados Australia BPR*.

Follow these steps to measure dry matter:

1. Peel sections of skin off the 10 fruit.
2. Coring method: Take core plugs (minimum 16mm diameter), remove any seed coat (refer to diagram).
3. Grated flesh method: Cut quarter sections of flesh from either side of the fruit and remove any seed coat. Shred the quarter sections by hand or using a food processor.
4. Record the exact fresh weight of approx. 100g of shredded flesh or the 20 core sections using an electronic kitchen balance.
5. Dry the sample using a food dehydrator (60-65°C, 24h), oven (100-110°C, 5h), or microwave set on low power. If using a microwave, check the sample regularly to make sure it does not burn.
   - Re-weigh
   - Continue drying
   - Repeat until there is negligible weight change
6. Calculate dry matter = (final weight/start weight) x 100.

Note: steps 4–6 can be automated using a moisture determination balance.



Dry matter can be measured using either fruit cores or grated quarter sections.

Hass separate fairly easily from the stem, so can be plucked (left), whereas other varieties must be clipped (centre). If green skin varieties are plucked their thin skins can easily tear (right), and rots are likely.

3.2 PICKING METHOD

Watch the video in the 'Harvesting' section of the online *Avocados Australia BPR*. Develop a harvest schedule based on maturity zones or blocks and provide clear instructions to pickers and supervisors.

Hass can be **plucked**, other varieties must be **clipped**.

Avoid picking fruit wet or when fully turgid as this increases the risk of postharvest rots, sensitivity to mechanical abrasion and lenticel damage.

- Delay harvest for 48 hours after heavy rain (>20mm in 12 hours).
- Delay harvest for 24 hours after drizzle.

The risk of rots also increases if trees are stressed or it is late in the harvest season.

If the risk of rots is high and/or fruit has to be picked while wet, then it is safer to clip than pluck Hass avocados.

Apply a postharvest fungicide as soon as possible (within 24 hours) after harvest.

Harvesting during hot weather increases fruit moisture loss and the likelihood of sunburn. Harvest exposed fruit first if daytime temperatures are likely to exceed 30°C.

BEST PRACTICE

- ✔ **Harvest fruit once it reaches minimum dry matter content (Hass ≥ 23%, Other varieties ≥ 21%)**
- ✔ **Harvest fruit when dry**
- ✔ **Minimise all fruit drops**
- ✔ **Transport picking bins with care to reduce fruit bouncing**
- ✔ **Cover fruit in bins to keep cool and reduce sunburn**

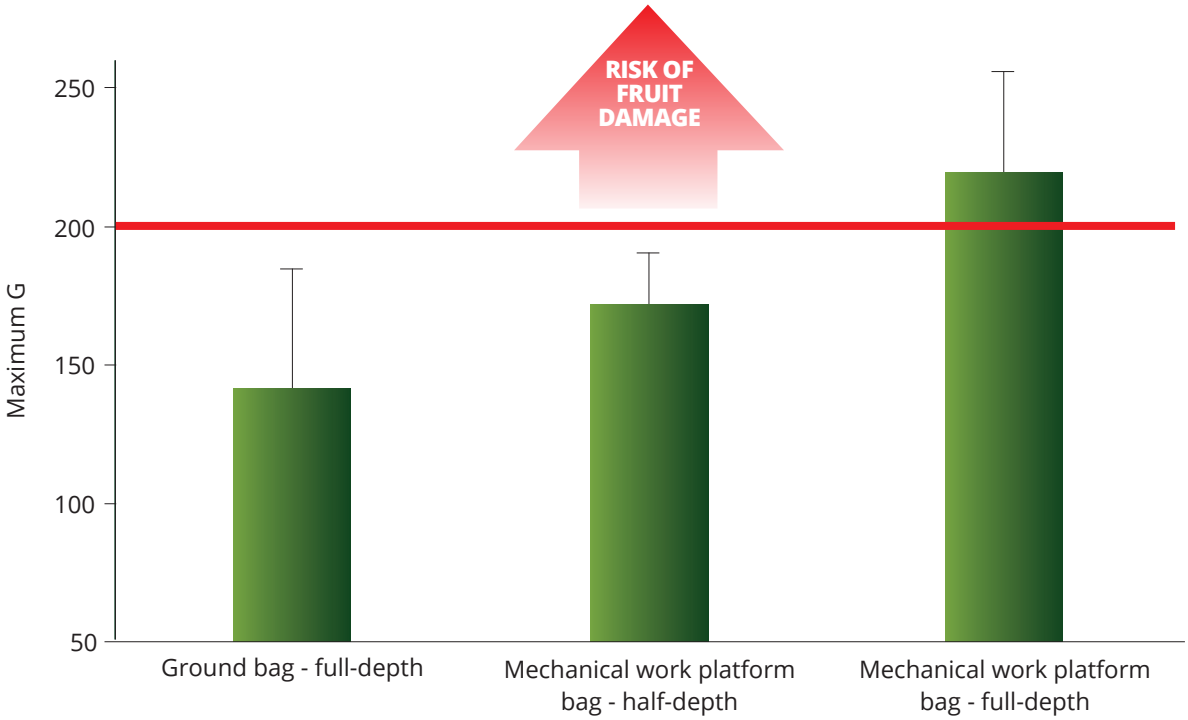
3.3 AVOIDING DAMAGE

Careful handling will reduce all forms of fruit physical injury, including lenticel damage, bruising and cracking, and reduce the chance of disease developing. Fruit harvested using mechanical work platforms (cherry pickers) are most at risk. Minimise all fruit drops; drops over 15cm can potentially cause skin damage, as well as increase the risk of rots and bruising.

- Train pickers and monitor them to ensure they are handling fruit carefully.
- Use rope extenders in picking bags attached to mechanical work platforms.
- Picking bags should be lowered into bins before releasing, so that fruit roll out gently.
- Raise mechanical work platforms slowly when emptying fruit.
- Minimise walking distance between bins and pickers.
- Check equipment for sharp edges or damage.

Fruit with lenticel damage.

Avoid fruit damage during harvest by mechanical work platforms by using the rope extenders to let the picking bag expand gradually.



Impacts over 200G have the potential to damage fruit, with injury most likely once impacts exceed 250G. Fruit harvested into empty, full-depth mechanical work platform bags (1m drop) often result in impacts >200G. Halving the height of the bag using rope extenders, or harvesting into ground picking bags, reduces impacts to safe levels. (AHR data)

Train harvesting crews to handle avocados carefully, especially if they are using mechanical work platforms. Photos by AHR and N. Delroy.

3.4 **BIN HANDLING**

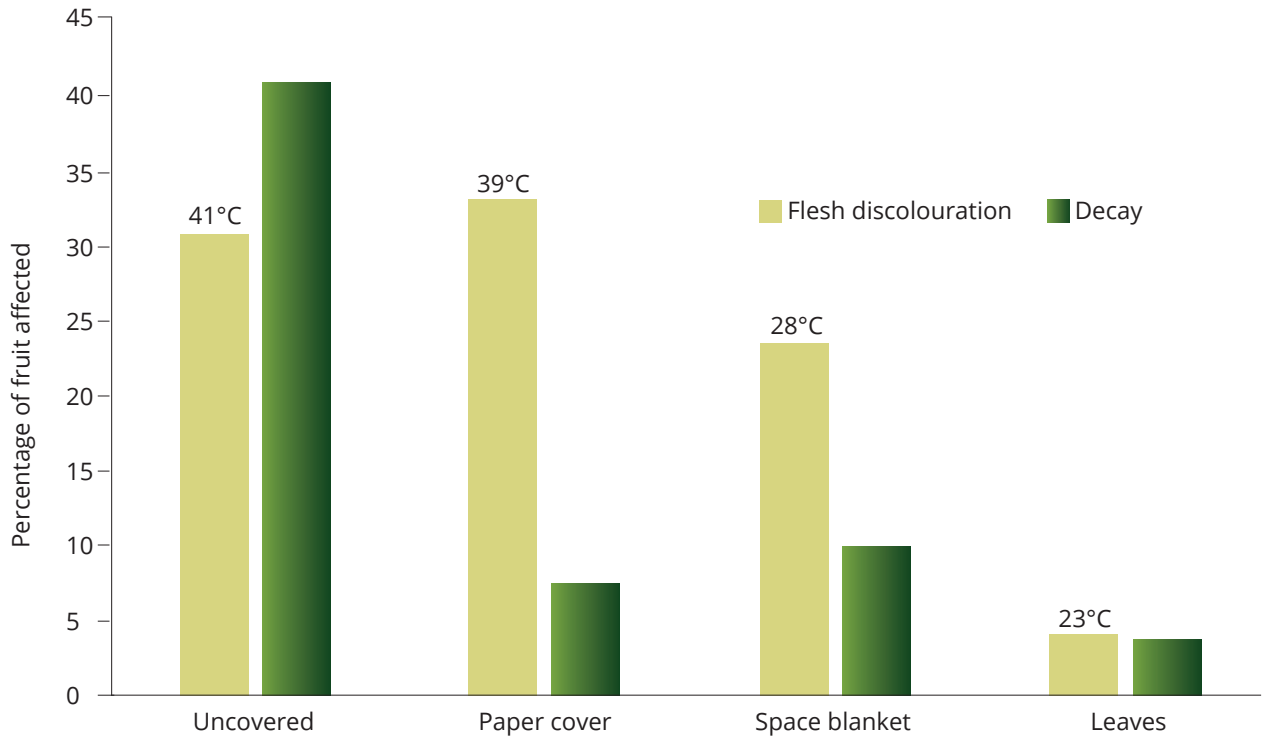
Keep harvested fruit shaded.

- Bins on mobile trolleys should be equipped with covers.
- If bins are placed on the ground, ensure they are under trees.

Bins need to be transferred from the field as soon as possible once full, preferably within 30 minutes. However, if there is no holding facility nearby, it is better to leave bins in a cool, shaded area such as under the trees, than a hot loading area.

Ensure that access roads are kept in good condition and that drivers travel at appropriate speeds (maximum 20km/h) to reduce fruit bouncing in bins. Placing foam-lined boards on top of bins can also help to reduce damage during bin transfer.

Bins should be kept shaded, whether by placing covers over them or placing in the shade. Photos by AHR and N. Delroy.



Covering picking bins reduces fruit pulp temperature and incidence of decay and internal discolouration. Sampled fruit were left in the top of harvest bins for approximately 5 hours after harvest. During this time they were exposed to direct sunshine (uncovered) or covered with paper, a space blanket, or leaves. Maximum pulp temperatures reached are provided above each column. Derived from Arpaia et al.,1992.

04. Packhouse

BEST PRACTICE

- ✔ Always aim to pick, pack and cool fruit within 24 hours
- ✔ Dry bin tippers should be designed and used so as to feed fruit out gradually
- ✔ Water used in wet dumps must contain a sanitiser
- ✔ Use baffles and padding to soften impacts
- ✔ Avoid crowding fruit on the line, as fruit rolling against each other can cause lenticel damage
- ✔ Over-brushing fruit (>1minute) can increase lenticel damage, especially if fruit are wet before packing
- ✔ Fungicides are most effective if applied within 24 hours of harvest; this is especially important if fruit is picked wet
- ✔ Reject bin analysis and library trays can help identify problem areas
- ✔ Use sturdy packaging to protect fruit during cooling and transport
- ✔ Cartons should have vents totalling 5-10% surface area
- ✔ Cool and store Hass at 5°C and green skin varieties at 7°C

4.1 IF THERE IS NO PACKING FACILITY ON THE FARM

If there is no packing facility at the farm, accumulated bins of harvested fruit need to be transported in batches. Harvested fruit must be kept as cool as possible. This may mean leaving bins in the orchard or transferring them to a cool, shaded holding facility.

Time at the farm should be minimised, with a view to enabling packing (and cooling) within 24 hours of harvest. If the weather is hot (>25°C) and bins are to be transported on an open truck, it is better to delay transport until temperatures drop and the sun is not intense. Overnight transfer from farm to packing facility can provide some cooling effect if temperatures are low.

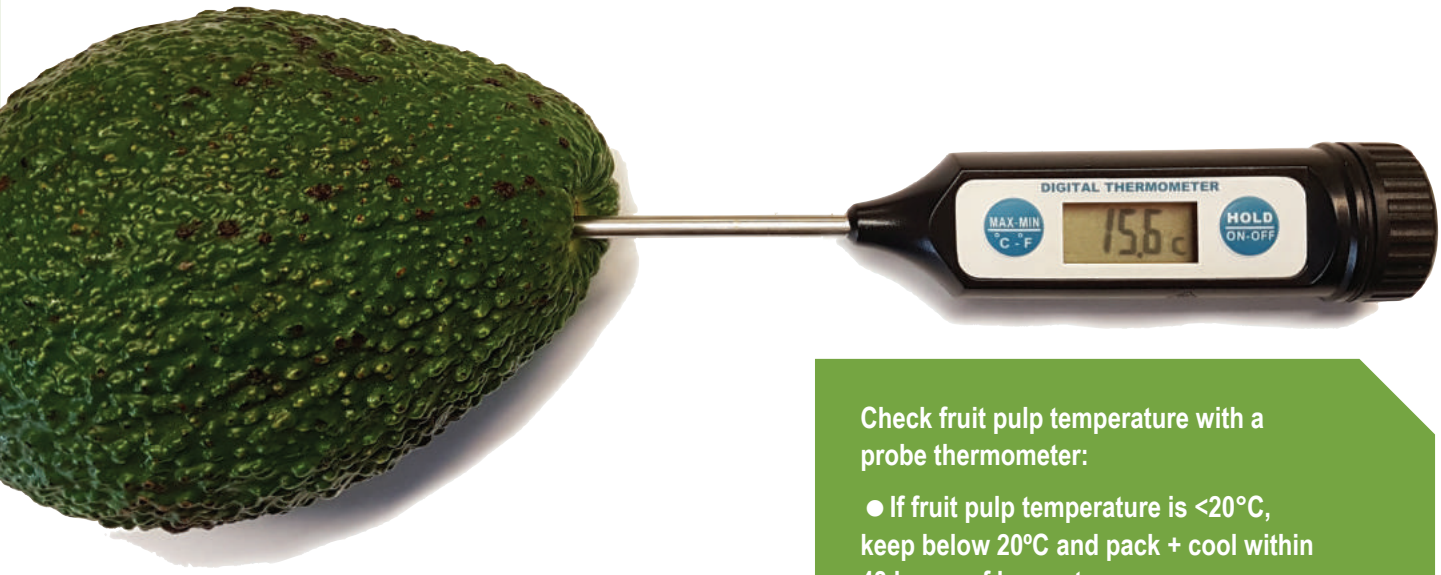
Vibration and bouncing can cause significant damage to the fruit skin. Ensure the truck has good suspension and is not driven fast over rough roads.

4.2 PACKHOUSE RECEIVAL

Always aim to pack + cool within 24 hours of harvest – *particularly if fruit is destined for export or expected to remain in the supply chain for more than 2 weeks*.

If picking, packing and cooling within 24 hours is **not possible**, immediate actions depend on fruit temperature. Removing field heat is most important if fruit are hot when harvested. In this case, pre-cooling below 16°C will slow degradation of the 'tree factor' compounds that prevent avocados from ripening. Cooling also slows the germination and growth of any fungi that have infected fruit during harvest.

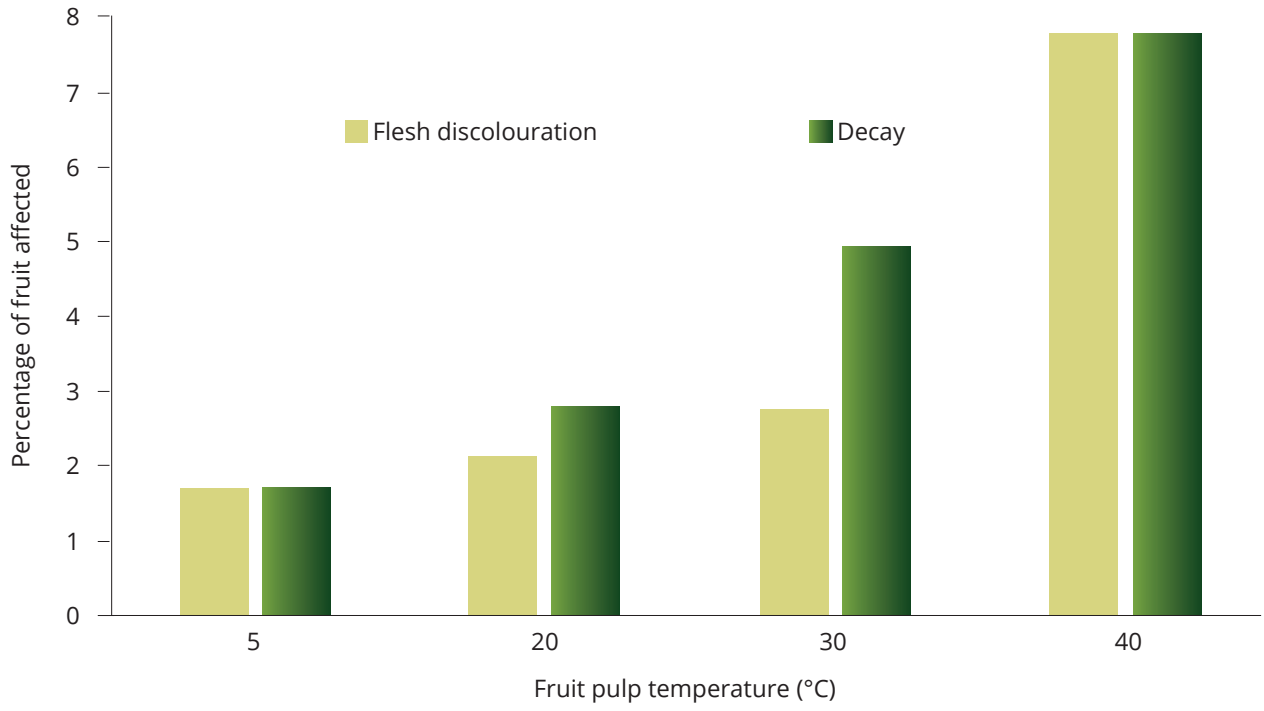
Delaying cooling shortens avocado storage life. Fruit that has remained warm for more than 24 hours after harvest should only be sent to local markets.



Always check the temperature of a representative sample of fruit (e.g. fruit from the centre and the top of different bins) with a probe thermometer.

Check fruit pulp temperature with a probe thermometer:

- **If fruit pulp temperature is <20°C, keep below 20ºC and pack + cool within 48 hours of harvest**
- **If fruit pulp temperature is 20–30°C either pack within 24 hours of harvest or cool to ≤16°C within 6 hours and pack within 3 days of harvest**
- **If fruit pulp temperature is >30°C cool to ≤16°C within 6 hours (e.g. using a forced-air system) and pack within 3 days of harvest.**



Leaving fruit warm between harvest and packing is likely to increase the incidence of flesh discolouration and rots. Fruit were left at 5, 20, 30 or 40°C for 24hrs between harvest and cooling, then ripened before assessment. Data from Arpaia et al., 1992.

Cooling fruit before packing

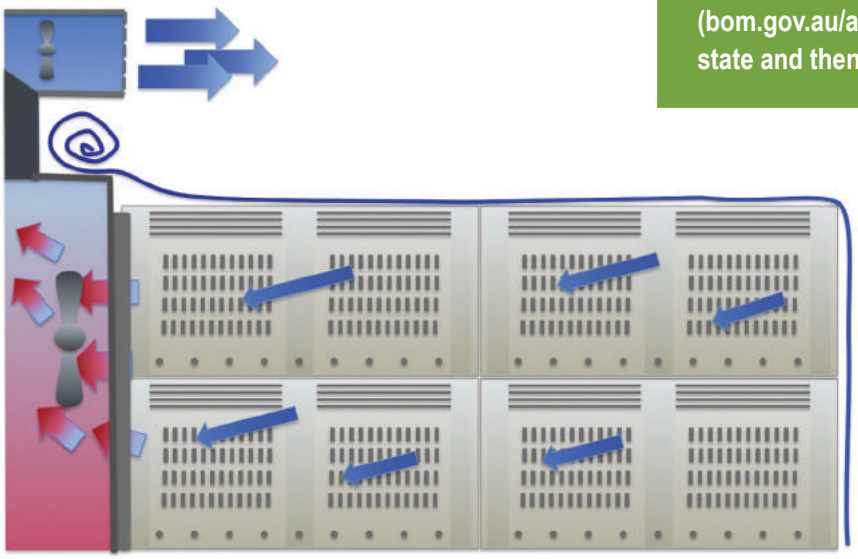
Forced-air cooling is strongly recommended if warm fruit needs to be cooled before packing. Forced-air cooling systems can remove heat up to 10 times faster than room-cooling. These systems also avoid condensation forming on the fruit, which can occur due to temperature gradients inside bins during room-cooling.

Condensation will form on avocados when they are removed from storage ***if*** they have been cooled below the ambient temperature dew point e.g. if ambient conditions are 32°C and 62% RH, the dew point will occur at approximately 24°C.

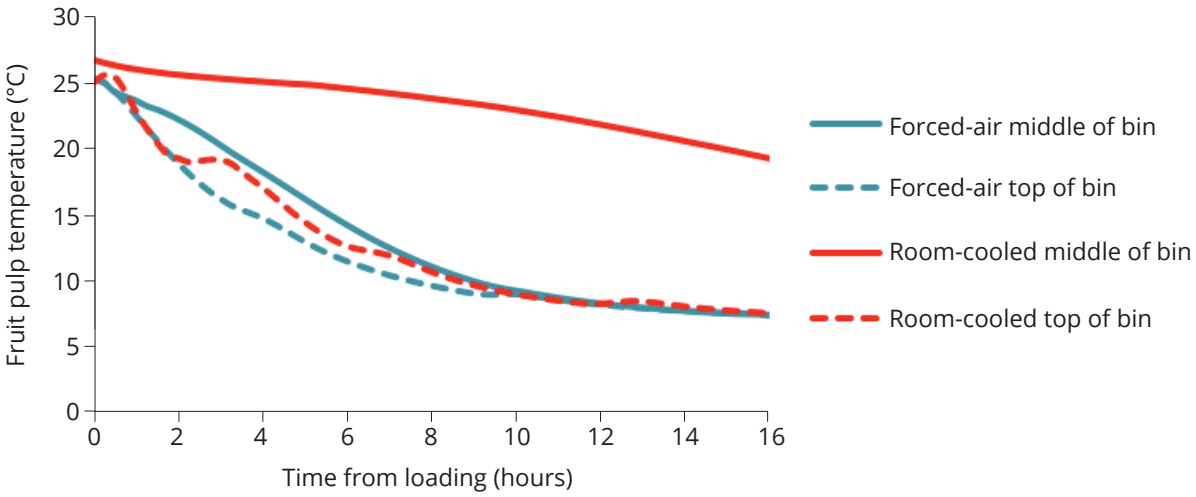
In this case:

- Only remove fruit from storage just before packing.
- Use an in-line dryer to ensure fruit are dry before applying stickers.
- If the in-line dryer is not adequate, consider warming stored fruit to just above the dewpoint using a forced-air system. For example, if it is 28°C and 60% RH, warming stored fruit to 20°C will prevent condensation during packing.
- Return fruit to the cool room **immediately** once packed and palletised.

Current dew point readings can be found on the Bureau of Meteorology website (bom.gov.au/australia/) by selecting your state and then 'latest observations'.



Forced-air system for cooling bins. Air is pulled rapidly through the vents on the plastic bins. Suction should be sufficiently strong to hold a piece of paper against a vent.



Pulp temperature of avocados in the middle (solid line) or top (broken line) of picking bins forced-air or room-cooled within the same storage room. A large temperature gradient developed between the middle and outside of the room-cooled bin. In contrast, fruit in the forced-air system cooled quickly and evenly (AHR data).

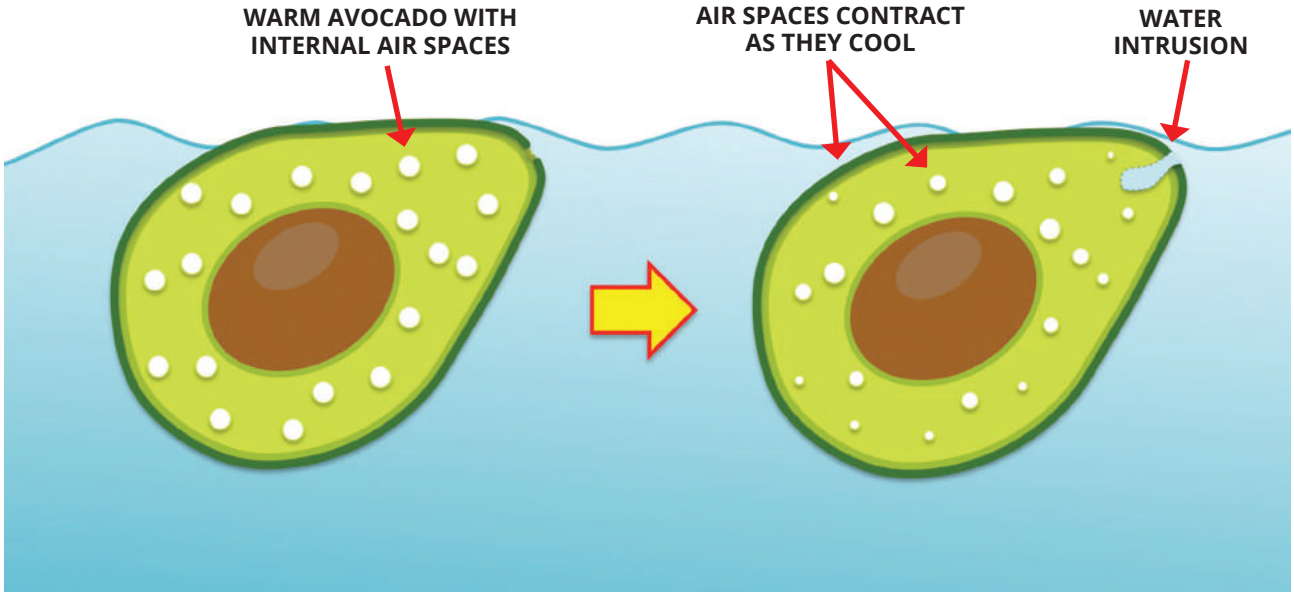
Dry bin tippers should include a cover, so that fruit is fed out gradually. Wet bin tips avoid impact damage, but the water must contain a sanitiser

4.3 **BIN TIPPERS**

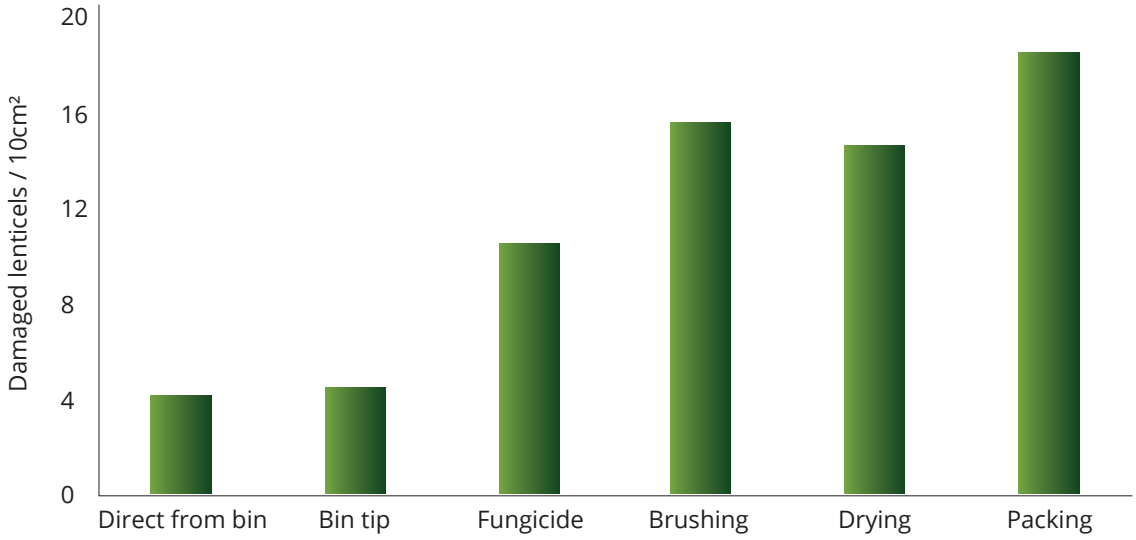
Significant impacts can occur if fruit free-falls out of bins during tipping. Impacts close to 200G, enough to damage fruit skins, have been recorded. Use covered, soft bin tippers that feed fruit gradually onto the conveyer.

Alternatively, fruit can be tipped into a water dump. This minimises damage and can help clean fruit. However, it is essential to include an effective sanitiser in the water to avoid spreading disease. **This is most important if packing plucked fruit that are warmer than the dump water** since fruit can "suck" infected dump water into the pulp through the stem scar as it cools. This is most important if fruit has been picked wet, as bacteria and fungi are more likely to be present on the fruit skin.

- For chlorine sanitisers, use test strips to confirm water contains 50–100ppm free chlorine.
- Chlorine is ineffective against microbes at pH>7.5. Check with a digital pH meter and adjust using an acidifier (e.g. hydrochloric acid) if pH is high.
- Chlorine is de-activated in dirty water. Change the water if it becomes visibly dirty.
- Sanitisers containing peroxyacetic acid (Tsunami®), chlorine dioxide or bromo-chlorodimethyl hydantoin (Nylate®), are less affected by pH and dirty water than standard chlorine solutions.



As hot avocados cool in a water bath, tiny air spaces inside the fruit contract. This pulls water from the bath through the stem scar and into the flesh. Disease can spread easily if fungal spores are present and no sanitiser is used.



Lenticel damage on avocados removed at different points during packing. The combination of fruit rubbing against each other and brushing caused most of the observed lenticel damage (AHR data).

4.4 BRUSHING AND CLEANING

Fruit may need to be cleaned to remove dirt and pre-harvest spray residues. However, over-brushing can cause skin damage, especially if fruit have soft skins due to being wet before packing commences. Avoid over-brushing, or allowing fruit to roll against each other due to crowding on the rollers. Lines that rely on fruit behind bumping into the fruit in front to move them through to the next set of rollers are most at risk of causing damage.

- Use soft brushes to avoid damaging lenticels.
- Adjust line speed and loading so fruit do not rub against each other moving on the line.
- Ensure brushes are replaced when worn, stiff, or difficult to clean.
- Adding a fruit removal bar to the brushing section will ensure all fruit move through evenly.
- Brushes that move along the line while rotating can limit fruit bumping.

Overcrowding of avocados during brushing can increase lenticel damage.

4.5 FUNGICIDES

Apply a registered postharvest fungicide (e.g. Graduate A$^{+®}$, prochloraz products) as a non-recirculated spray over fruit on rollers or brushes. Ensure the fruit is thoroughly covered, remaining under the spray for at least 30 seconds or as per label recommendations.

Treat fruit **within 24 hours after picking**. Applying fungicide soon after harvest is most important if fruit have been picked wet. Mix fresh fungicide solution for each batch.

Fungicides are less effective if the water is alkaline. It is important to test the pH of the solution, adding an acidifier (e.g. hydrochloric or citric acid) to reduce pH below 7 if necessary.

Packing lines should have baffles and padding to minimise drops (circled in red). Speed should be adjusted so that fruit do not accumulate and knock against each other.

4.6 GRADING AND PACKING

Packing lines should be short and flat to avoid unnecessary bumps and drops. Padding and baffles can be used to reduce fruit speed at drops or directional change points. Running an impact recorder along the line can help identify any problem areas. Packing lines should be cleaned regularly to avoid build-up of dirt or sap.

Avocados are usually graded as Premium, Class 1 and Class 2. Workers need to be trained to ensure that fruit are graded correctly and that customer specifications are met. Examples include the percentage of fruit affected by minor defects such as healed scratches, slight sunburn or rubs. Specifications also include more serious defects such as bruises, rots, or physical damage.

4.7 IDENTIFYING ISSUES

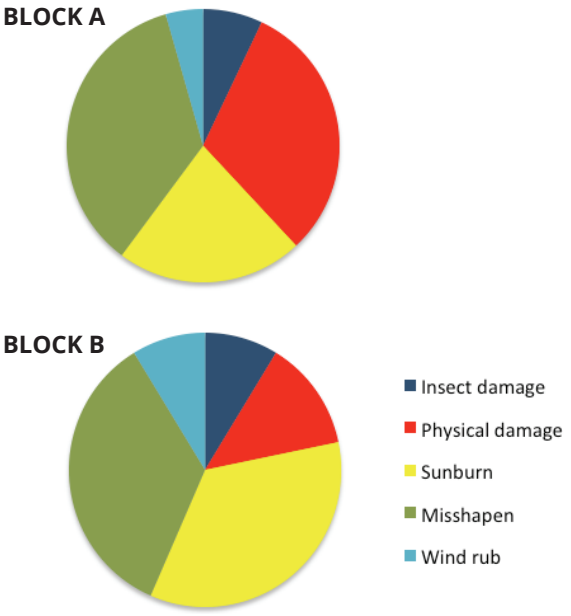
A **Reject Bin Analysis** can help identify problems in the orchard or during harvest, as well as verify that grading staff and equipment are not rejecting fruit unnecessarily.

- Record the date, block and variety.
- Randomly select 50 fruit, going down through the bin from top to bottom.
- Assess each fruit for the cause of rejection, particularly differentiating pre-harvest issues (sunburn, wind rub, insect damage etc.) from harvest and postharvest issues such as mechanical damage, lenticel damage and torn stems.
- Graphing the data makes it easy to see differences between blocks or by harvest team.

The Avocado Problem Solver Field Guide can help to identify specific issues.

Visit the *Avocados Australia BPR* to view a video on how to do a Reject Bin Analysis and download record forms.

Library Trays (reference trays) are another way to check fruit quality. Retaining a few trays from each packout provides a valuable record if issues occur in the supply chain. As with reject bin analysis, record block, harvest date, and pack date. Library trays can be cool stored at 5 to 7°C for up to four weeks, then ripened at 16 to 20°C and assessed as needed.



Example of reject analysis for two blocks. A greater proportion of fruit have been rejected because of physical damage from block A compared to block B, suggesting that this harvest team may not be handling fruit correctly.

Forced-air systems are the best way to pull down the temperature of packed fruit. Pallets are lined up in front of a plenum (left), then a tarpaulin is deployed over the double row and a fan turned on (right), pulling cold air through the pallets.

4.8 PACKAGING

Avocados are usually packed into single layer trays lined with a plastic insert (plix) containing 12 to 28 plastic cups. Smaller or lower grade fruit may be bulk packed in larger cartons.

Trays and cartons: Trays and cartons unitise and protect fruit. Humidity and condensation weaken cardboard, especially if low-grade materials are used. Packaging needs to be strong enough to protect fruit during cooling and marketing.

Air movement: Fruit cannot be cooled efficiently unless there is good air movement through the packaging. Vents or cut-outs need to cover approximately 5–10% of the package surface area (exposed). Ensure they line up on the pallet to permit cross flow.

Workers need to be trained to ensure that:

- All required labels, **including packed on dates**, are added to trays. These help the wholesaler and ripener determine which fruit need to be sold first, and how quickly they will ripen.
- Cartons are placed correctly on the pallet, and secured using locking sheets and strapping.

Hass should be cooled to 5°C and green skin varieties cooled to 7°C.

4.9 COOLING AND STORAGE

Avocados need to be cooled as soon and as quickly as possible after picking and packing. Cooling to the correct temperature is essential to preserve postharvest quality.

Forced-air systems are the most efficient way to reduce temperature quickly.

Typical air flow rates recommended for forced-air cooling are 20–60 L/kg/min. However, **air flow rates over 24 L/kg/min may provide only a small increase in cooling** while significantly increasing energy costs. For forced-air cooling:

- Place pallets tightly against the plenum and along the row to minimise gaps and prevent air by-passing the cartons.
- Stack pallets so that heights are even between the rows.
- Ensure the tarpaulin fits tightly where it covers the tunnel so as to force air through the packed trays and cartons.
- Monitor pulp temperature at the centre of a pallet and switch the fan off once cooled to within 2–3°C of the required storage temperature. This will avoid excessive water loss and energy consumption.

Avocados should be thoroughly cooled to the target temperature **before** transport; trucks do not cool fruit, at best they can maintain existing temperatures.

05. Transport

BEST PRACTICE

- ✔ **Cool packed avocados to 5°C (Hass) or 7°C (green skins) before transport; trucks can maintain product temperature, but don't cool fruit**
- ✔ **Limit fruit exposure to ambient temperatures when loading/unloading – ideally for less than 30 minutes**
- ✔ **Set truck thermostats at 5°C (Hass) or 7°C (green skins) with the sensor placed in the delivery air (not return air)**
- ✔ **Put temperature loggers in every load to verify the truck cooling system is operating correctly during transport**

5.1 LOADING

Cooling is value adding with electricity. Allowing fruit to warm up during transfer to the truck is not only money wasted but can cause condensation, which weakens packaging and increases disease. If possible, load avocados directly from the cool room into a pre-cooled truck trailer using an air lock system.

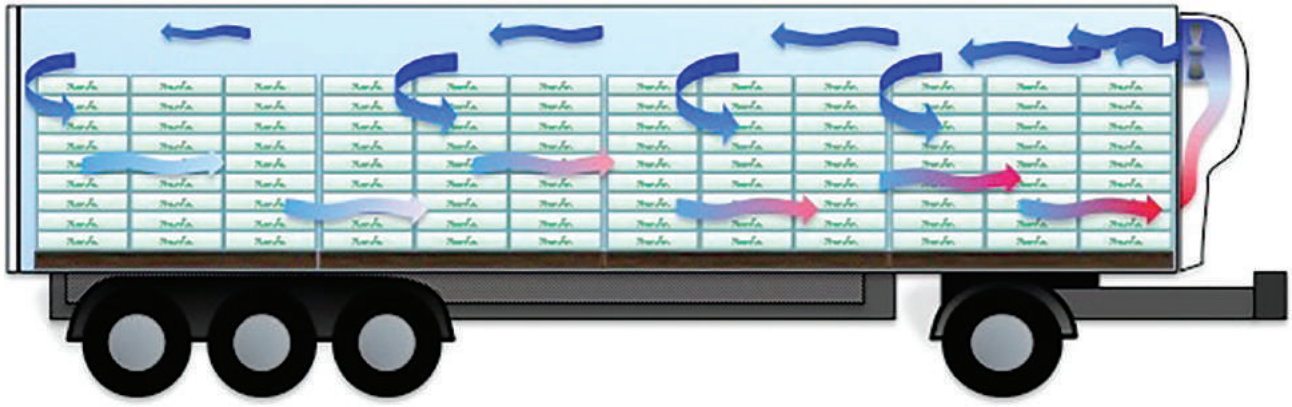
Loading pallets is a compromise between ensuring the load is stable, and allowing good air circulation through the packed fruit. When loading a truck trailer:

- Place the first pallet **hard against the front** of the trailer to prevent delivery air short-circuiting directly to the return air vent.
- **Use foam spacers** to stabilise pallets while still allowing air gaps down the sides and centre between pallets.
- **Position stabilising bars** at intervals between the rows of pallets. If using stabilising sheets ensure they do not block airflow through the load.
- **Ensure the trailer is fully loaded** for long distance transport, as a large space at the back will disrupt airflow.
- Avoid using Tautliner trucks as they generally have reduced airflow and are not well insulated.
- Do not load hard green avocados with ethylene producing fruit, as this will cause the avocados to ripen.

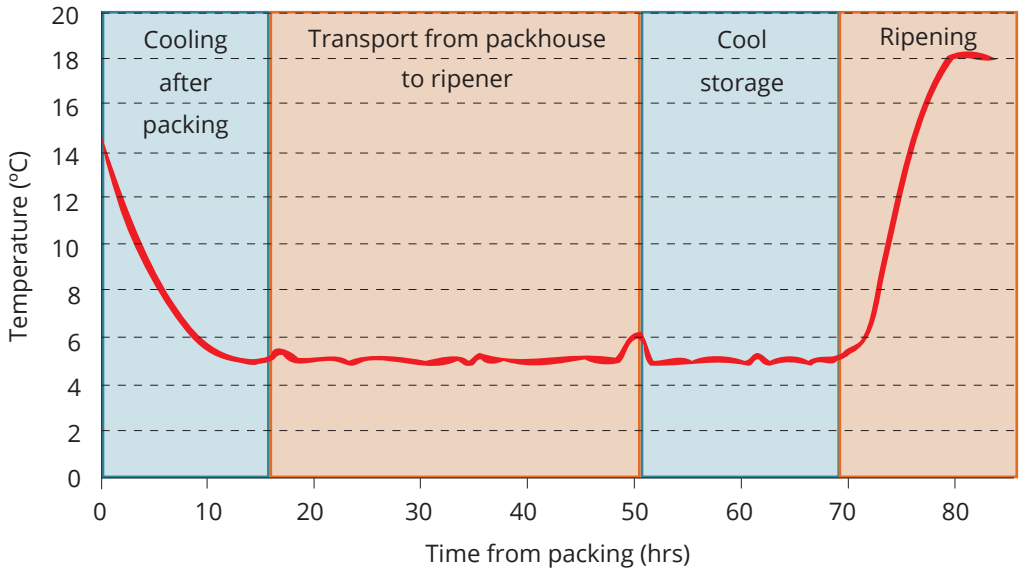
5.2 TEMPERATURE MANAGEMENT

Check fruit temperature with a temperature probe before loading. Truck cooling systems can prevent fruit from warming during transport but they cannot cool hot fruit. **Fruit should not be loaded if it is ≥7°C pulp temperature** unless transport distance is short (e.g. less than 6 hours) and fruit is to be ripened on arrival.

Truck thermostats should be set at 5°C (Hass) or 7°C (green skins) with the sensor placed in the delivery air (not return air).



Truck trailers should be loaded so that airflow over the top of pallets is uninterrupted from front to rear.



An optimal supply chain temperature profile. Fruit is cooled rapidly and maintained close to 5°C until ripening.

Maintaining the cool chain during transport is vital to maintain quality and prevent ripening. Keeping avocados cold:

- Allows fruit to be stored before ripening, providing more flexibility to meet customer orders.
- Reduces the risk of chilling injury due to fruit starting to ripen during storage.
- Reduces the symptoms of bruising.

5.3 MONITORING TEMPERATURE

The temperature of fruit during transport is critical. Air temperature and relative humidity inside trucks need to be checked regularly to ensure cooling systems are operating correctly. Data loggers can be used to monitor fruit during transport in the following ways:

- **Air temperature data loggers** record **truck air temperatures** during transport.
- **Data loggers with probes** can **monitor fruit pulp temperature**. Some models include temperature displays and/or Bluetooth connectivity. These loggers are likely to require specific software, are relatively expensive and must be retrieved before sending to customers.
- **Single use air temperature loggers are very cheap and easy to use**. They can be plugged into any computer to download and email the data.
- **Single use GPS air temperature loggers** are increasingly affordable and provide real time information on both temperature and location. These do not need to be retrieved as they can be viewed and downloaded remotely. If a cool chain breach occurs they can send an alarm signal in real time, allowing corrective actions to occur.
- **Wireless temperature monitoring systems** download the data recorded by the logger as the pallet passes an internet connected base station. These stations may be located at the pack-house, wholesaler or DC. Data and alerts are sent automatically via email or phone.

Loggers should be placed inside trays 4 to 8 rows from the top of the pallet.

- If loggers are included in **two pallets**, these should be located 2nd from the front and 2nd from the rear of the truck trailer, with one each on the left and right hand sides.
- If only **one pallet** is monitored then locate it toward the centre of the load.

5.4 ON ARRIVAL

As with dispatch, pallets must be transferred directly from the truck to the cool room. Ideally, loading docks should connect directly with the cool room. Pallets of cold fruit must never be left on a warm loading dock. If the fruit has warmed during transport, it may be preferable to transfer the fruit directly to a ripening room.

For more information on transport, see the 'Transport' section of the online *Avocados Australia BPR*.

Examples of data loggers- probe types, single use air temperature and a GPS enabled air temperature.

06. Ripener/Wholesaler

BEST PRACTICE

- ✔ Store Hass at 5°C and green skin varieties at 7°C for a maximum of two weeks (from packing) before ripening
- ✔ Consider temperature management history and fruit maturity when determining cool storage potential
- ✔ Higher than recommended temperatures can reduce potential storage to only a few days
- ✔ Ripen fruit between 16-20°C
- ✔ Late season and long stored fruit should be ripened at 16–18°C, less mature fruit can be ripened at 18–20°C
- ✔ Fruit should be thoroughly warmed to temperature before ethylene is added
- ✔ Vent the ripening room to avoid build-up of >1% CO2
- ✔ Allow fruit to ripen to at least breaking (stage 3) before cooling
- ✔ Once fruit has reached the desired ripeness stage, forced-air cool to 5°C (Hass) or 7°C (green skins)
- ✔ Do not store ripe fruit for more than a few days but dispatch immediately

6.1 RECEIVAL

The length of time that fruit can be cold-stored before ripening depends on maturity at harvest, pulp temperature on arrival and fruit age. The longer fruit is stored, the more susceptible it is to rots after ripening, so fruit age is directly related to storage potential.

Download any data-loggers included with the load on arrival, as well as checking fruit pulp temperature using a probe thermometer:

- Probe fruit from several layers down on the pallet, not the top layer.
- Check fruit furthest from the airflow e.g. near the front of the pallet.
- Check different locations within the trailer.

Fruit temperature: If fruit arrives warm (≥12°C), check temperature records to determine how long it has been above ~7°C. Fruit that has been warm for <24 hours should be cooled to 5 – 7°C immediately, preferably using forced-air. If fruit has been warm for a longer period, or if no temperature record is available, then it should be placed directly into ripening.

Fruit firmness and colouring should also be checked, especially if fruit is more than five days old. Cup fruit in one hand and squeeze gently. If there is any 'give' the avocados have already started to ripen.

Fruit that has started to ripen **cannot be cool stored**, but must remain at warmer temperatures. Interrupting ripening immediately after fruit is triggered reduces quality and consistency of the ripened product and increases the risk of chilling injury.

For more information on ripening decisions at receival, see the 'Ripening' section of the online *Avocados Australia BPR*.

6.2 STORAGE

Temperature and humidity

Hass should be stored at 5°C and green skin varieties at 7°C. Mid-season Hass can be stored as low as 2°C for 2 weeks so long as harvest and packing procedures have been optimised.

Cool rooms should operate at 80-90% relative humidity. Lower relative humidity increases weight loss, while high relative humidity causes condensation on fruit and packaging.

Ethylene

Check accumulation of ethylene in storage rooms. If more than 1ppm ethylene is detected, vent the room using fresh air. Ethylene can also be removed using scrubbing systems. These usually pass the air across a potassium permanganate filter, which absorbs

ethylene. Filters must be changed once the potassium permanganate beads become oxidised, losing their bright purple colour.

Ozone generators can also be used to scrub ethylene. However ozone must be managed and monitored to ensure workers are never exposed to 0.1ppm or higher.

If possible, storage rooms should be located well away from ripening rooms.

Stock management

Examine fruit every 2–3 days for colouring or softening. Transfer to ripening immediately if changes are detected. Late season fruit, and fruit that has been stored for a long period, are the most likely to start ripening during cool storage. Storage of these fruit should be minimised and fruit condition checked daily.

Stock needs to be rotated based on **fruit age and condition**, rather than when it was delivered. Older fruit (days from harvest), or fruit suspected of having been poorly managed, should be ripened first.

Even if fruit handling has been optimal, **avocados should not be stored more than 2 weeks before ripening.** Longer storage times are likely to lead to increased disease, as well as the potential for internal defects like diffuse discolouration and vascular browning.

6.3 **RIPENING**

Avocados can't ripen immediately after harvest due to the presence of 'tree factor' compounds. This inhibition phase lasts for around 24 to 72 hours after harvest, after which fruit becomes responsive to ethylene.

Avocados ripen more quickly later in the season and with increasing storage time. Depending on maturity and temperature, fruit can be ripened from hard green to firm-ripe (stage 1 to 4) in 3 to 10 days. Shepard ripens more quickly than Hass, whereas Lamb Hass ripens comparatively slowly.

Ripening conditions

Each batch of fruit needs to be managed separately during ripening, with twice-daily checks on progress to ensure that fruit does not become over-ripe before cooling and despatch.

Ripening needs to be planned according to customer orders. Ripening fruit at warmer temperatures helps it to ripen faster but increases the risk of rot development. Low ripening temperatures may not allow Hass to fully change colour.

Optimum ripening temperature depends on fruit maturity;

- **Ripen early season fruit at 18–20°C (dry matter < 26%)**
- **Ripen late season fruit at 16–18°C (dry matter > 26%)**

Preparing fruit for ripening

Fruit needs to be warmed to the target temperature before ethylene is added to the room. Rapid, uniform warming using a forced-air system will provide a better result than simply allowing pallets of fruit to heat up. **Uncontrolled warming will result in uneven ripening**. Maintain good airflow around the fruit and maintain 85% relative humidity.

Managing ethylene and CO_2

Ripening fruit with added ethylene accelerates ripening as well as resulting in a more homogenous product at retail. Ethylene needs to be applied for 2–3 days to early season fruit, but only 1–2 days for mature fruit.

While it is important to retain ethylene inside the ripening room, rooms need to be ventilated enough to prevent build-up of CO_2. Concentrations above 1% CO_2 reduce the rate of ripening.

Ethylene concentration and venting will depend on the method used;

Trickle injection	Continuous flow of ethylene to achieve >10ppm in the room, room vented with inlet behind the cooling coils and outlet near the floor, one room air change per hour.
Shot system	Ethylene injected every 6–8 hours to achieve 100ppm, room vented manually by opening the door for 10–15 minutes every 6–8 hours with room fans running.
Full control	Gas concentrations controlled automatically with sensors. Ethylene is injected when concentration falls below 10ppm, outlet vent opens to flush room when CO_2 rises to 1%.

Stages of ripeness

The stages of ripeness that are widely accepted by the Australian avocado industry supply chain are shown in the table on p24.

Note that Hass avocados can remain green or partially green when ripe, particularly in less mature fruit early in the season. Later in the season, very mature fruit that has been exposed to the sun can develop colour while on the tree.

The common green skin varieties are: Shepard, Sharwill, Wurtz and Reed.

Avocado stages of ripeness

	DESCRIPTION	USE	FIRMNESS	
			PENETROMETER	DENSIMETER
STAGE 1 – HARD				
	Very firm with no give in flesh or neck, even with strong thumb pressure. Bright green colour. Not very susceptible to bruising.	Storage and transport.	>10 kgf	>91
STAGE 2 – PRE-CONDITIONED (RUBBERY)				
	Rubbery, slight give with strong thumb pressure, skin starting to darken slightly, susceptible to bruising from ≥10cm drops.	Transport and marketing. Ready to eat in approximately 3 days at room temperature. Do not coolstore, but continue to ripen at 16-20ºC.	5–10 kgf	90–91
STAGE 3 – BREAKING (SOFTENING)				
	Slightly soft, deforming 2–3mm with moderate thumb pressure. Skin mostly dark. Bruised by small drops, especially if fruit is warm.	Ready to eat in two days or less at room temperature.	2–5 kgf	86–89
STAGE 4 – FIRM-RIPE				
	Fruit deforms easily, moving 2–3mm with slight thumb pressure. Can be bruised by squeezing.	Ready for slicing into salads, onto toast, or other uses. Fully soft the next day at room temperature.	1–2 kgf	74–85
STAGE 5 – RIPE				
	Fruit deforms very easily under gentle hand pressure. Fruit is fragile and easily bruised by squeezing to check ripeness.	Can be sliced if handled gently, otherwise smashed / mashed for use in dips and spreads.	0.5–1 kgf	65–73

NB: The same stages apply for green skin varieties, however their skin colour does not change as they ripen

6.4 MEASURING FIRMNESS

There are two instruments that are commonly used to assess firmness in avocados: the penetrometer and the densimeter.

Penetrometer: This is a destructive test for firmness. It is widely used and regarded as reasonably accurate.

- Mount the penetrometer in a drill press and attach a 11mm diameter tip.
- Remove a section of skin on two opposing sides of the fruit, and place under the drill press.
- Press the unit into the flesh to the depth indicated on the plunger and read the force (kgf) required.
- Repeat on the other side.
- Record the average of the two readings.

Densimeter: This is a non-destructive method of measuring firmness. It should be noted that results from the densimeter are highly variable, being strongly affected by operator technique.

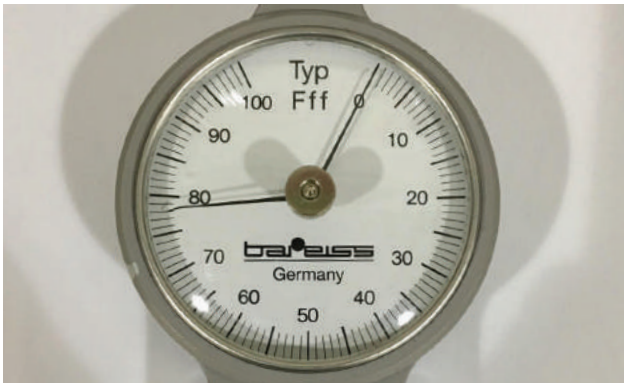
- Measure two opposing sides in the middle of the fruit by gently pushing the densimeter down onto the skin.
- The result is the maximum reading from 0-100.

6.5 HANDLING AND COOL STORAGE OF RIPE FRUIT

Fruit should be left in the ripening room until it reaches breaking (stage 3) rather than dispatched when pre-conditioned (stage 2).

Once fruit has reached the required stage of ripeness (minimum stage 3), forced-air cool to 5°C for Hass, and 7°C for green skin varieties. Breaking (stage 3) to ripe (stage 5) fruit need to be dispatched to retailers as soon as possible; this fruit **should not be stored for more than 3 days.**

Penetrometer

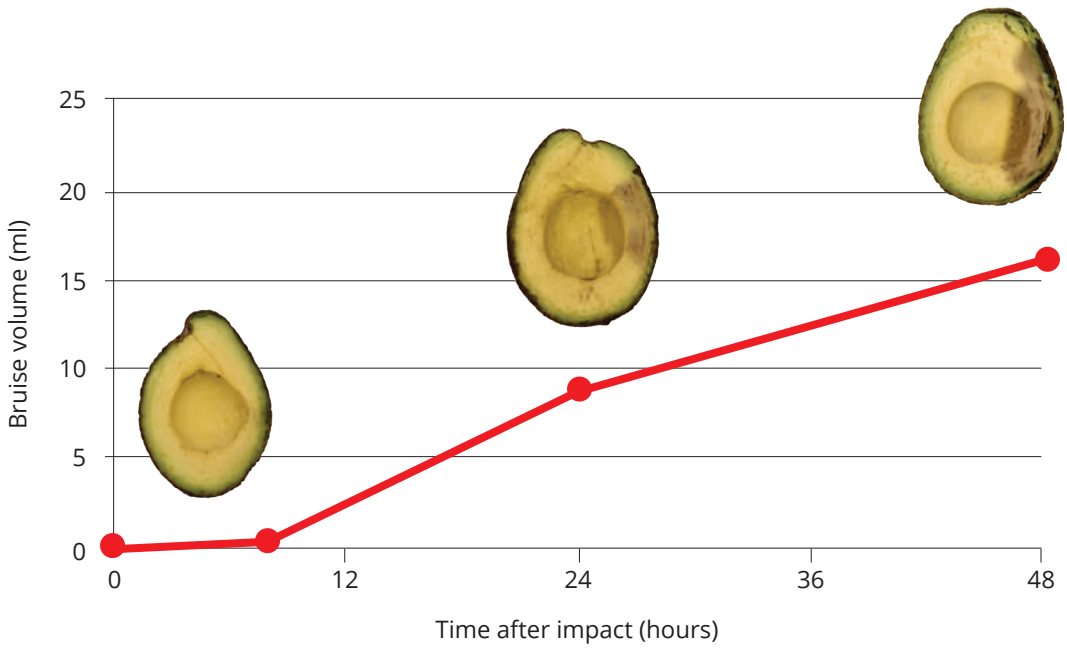


Densimeter

Chilling injury: Fruit is still susceptible to chilling injury after ripening. Risk is a function of time and temperature. Extended storage and **temperatures below 5°C** increase the likelihood of grey flesh and vascular browning.

Trays and individual fruit must never be dropped. Ripening fruit are very susceptible to bruising. Bruises are not always visible immediately but develop over time, continuing to enlarge and darken for up to a week.

For more information on ripening techniques refer to the 'Ripening Manual' in the online *Avocados Australia BPR*.



Dropping firm-ripe fruit 50cm results in bruising that continues to expand and darken over a number of days. (Data from Joyce et al., 2017)

07. Distribution Centre

BEST PRACTICE

- ✔ **Check pulp temperature is acceptable on arrival**
  - **4–20°C for hard fruit (stage 1)**
  - **10–20°C for pre-conditioned fruit (stage 2)**
  - **4–10°C for ripe fruit (stages 3 to 5)**
  - **but can vary between DC's**
- ✔ **Check firmness on arrival**
  - **Use a densimeter or penetrometer**
  - **Breaking and firm-ripe (stages 3 and 4) are ideal for ripe in-store programs**
- ✔ **Keep ripe avocados refrigerated at all times**
- ✔ **Prioritise dispatch of stock**
  - **Send softest fruit first, and then by order of receival to the DC**

7.1 ASSESSING QUALITY ON ARRIVAL

Sampling

Select a representative sample (at least 3 trays per consignment) of fruit that includes trays from:

- Top, middle and lower rows of the pallet
- Middle and corner columns of the pallet
- Different growers or pack dates

Temperature

Always check pulp temperature of a representative sample of fruit with a probe thermometer (Section 4.2). Probe thermometers are more accurate than infrared thermometers, which only measure the skin surface temperature. Suitable arrival pulp temperatures depend on the stage of ripeness:

- Hard fruit (stage 1): 4–20°C
- Pre-conditioned fruit (stage 2): 10–20°C
- Breaking to ripe fruit (stages 3 to 5): 4–10°C, but can vary between DCs. Note that ripe fruit that arrive >10°C will quickly become over-ripe.

Ripeness

Firmness of a representative sample of fruit should be measured with a densimeter or penetrometer (Section 6.4). Firmness levels should meet customer specifications. These are typically that fruit is sprung, but not soft, and yields to slight thumb pressure without permanently deforming.

- Breaking (stage 3) to firm-ripe (stage 4) is ideal for ripe in-store programs.
- Fruit that is fully-ripe (stage 5) is likely to become over-ripe before purchase, as well as developing rots, bruising and internal disorders.

Colour is a secondary indicator of ripeness of Hass avocados. At times, Hass avocado skin will already be brown while fruit are still firm, or remain green when ripe.

Defects

Minor defects, such as superficial skin markings, do not affect the internal quality of the product. There is an allowance for minor defects e.g. 10% of the consignment affected. However major defects such as cuts, bruises and rots DO affect the internal quality of the product, and can continue to worsen as fruit ripen. Consignments should contain very limited numbers of major defects e.g. 2%.

Acceptable levels of major and minor defects will be determined by customer specifications. However assessment should include:

- **External quality –** Check for major defects including the early signs of external rots and mechanical damage. Also record the frequency of minor defects such as lenticel damage, sunburn or healed marks.
- **Internal quality –** Cut fruit long-ways into quarters, remove the seed and peel skin back to expose the outer flesh. Examine for bruising, rots and internal disorders such as flesh discolouration or vascular browning.

Cut fruit into quarters, and peel the skin off to check for internal disorders, bruising or rots.

Use the Avocado Fruit Quality Problem Solver Guide or Avocado Problem Solver Field Guide to help identify postharvest avocado defects (Section 8.2).

Fruit age

Packaging should always include a **date the fruit was packed (**and, ideally, pick date as well). Customer specifications often include the maximum number of days from harvest/packing to arrival at the retail DC. However, as the time between harvest and ripening increases, so does the risk of rots and internal disorders in the ripened fruit. Risks increase markedly 3 weeks after harvest, even if fruit has been stored correctly.

7.2 MANAGING FRUIT AT THE DISTRIBUTION CENTRE

Handling

Ripe avocados remain saleable for only a few days, so should be dispatched from the DC to retail store as soon as possible, ideally within 48hrs. Prioritise dispatch of stock by:

- Firmness – **dispatch softest fruit first**, and then;
- Receival order - **dispatch stock in the order it arrived at the DC**

Softening avocados bruise easily, so handle pallets and cartons carefully. When restacking trays, carefully place them down on the new pallet, and ensure the trays are well secured on the pallet.

Temperature management

Ripe fruit (stages 3 to 5) must be kept refrigerated. Warm fruit will continue to soften, soon becoming difficult to manage and over-ripe in retail terms.

It requires less energy to keep avocados cool than to re-cool warm fruit. Pallets of avocados must never be left on a warm loading dock. Ideally, loading docks should connect directly to the cool room, maintaining the cold chain.

- Hard-green and pre-conditioned fruit (stages 1 and 2) that will be held at the DC for less than 24 hours can be stored at 15–20°C to allow them to start to ripen and soften.
- Ripe fruit are best stored at 5°C (Hass) or 7°C (green skins).
- Ripe Hass can be stored as low as 2°C for up to 3 days if 5°C cool rooms are unavailable.

Storage

Avoid storing avocados in a cool room with ethylene sensitive produce such as green leafy vegetables or carrots. Ripe avocados produce ethylene, which will accelerate senescence or production of off-flavours of those products.

08. Links/References

8.1 ONLINE RESOURCES

Best Practice Resource. Avocados Australia Limited (AAL): comprehensive best practice information for all sectors of the avocado supply chain. Includes a detailed library of R&D reports, educational materials, market data, event proceedings, videos and links to other resources. Users need to register with AAL for access.
avocado.org.au/best-practice-resource/

Avocado Source. Global online library of avocado reports. avocadosource.com

Talking Avocados. AAL. Industry magazine with many useful technical articles.
avocado.org.au/news-publications/talking-avocados/

8.2 OTHER KEY PUBLICATIONS

Australian Avocado Supply Chain Checklists. 2018. Horticulture Innovation Australia Limited. A companion to this guide, outlining the key actions needed to maintain the postharvest quality of avocados.

Avocado Fruit Quality Problem Solver. 2018. Horticulture Innovation Australia Limited. A companion to this guide, containing pictures and descriptions of key postharvest issues.

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