



# **AVOCADO**

## **RIPENING MANUAL**

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The International Avocado Quality Manual published by Plant & Food Research, New Zealand was used as a reference for descriptions and causes of common quality problems

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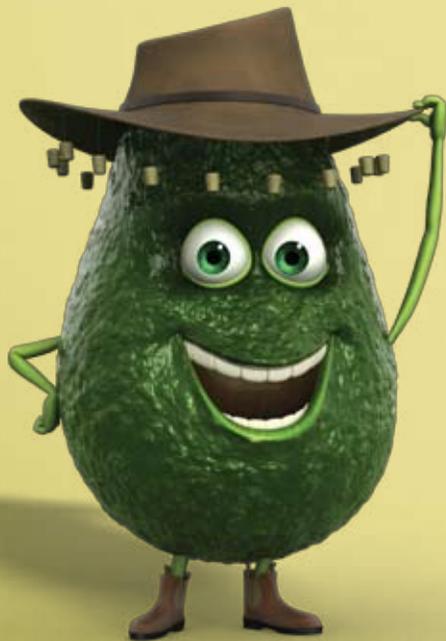
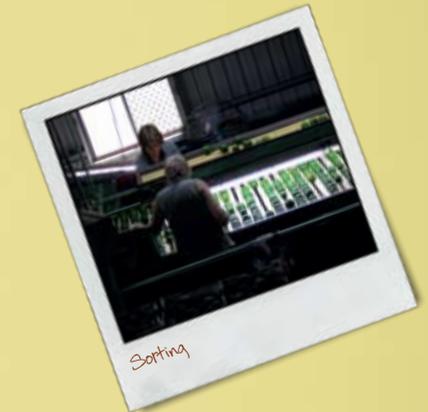
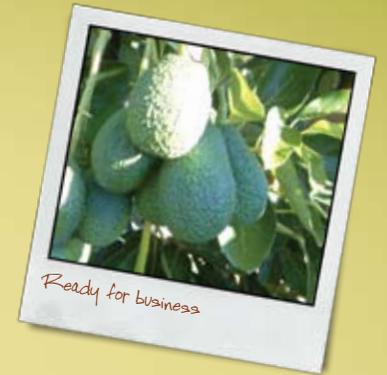
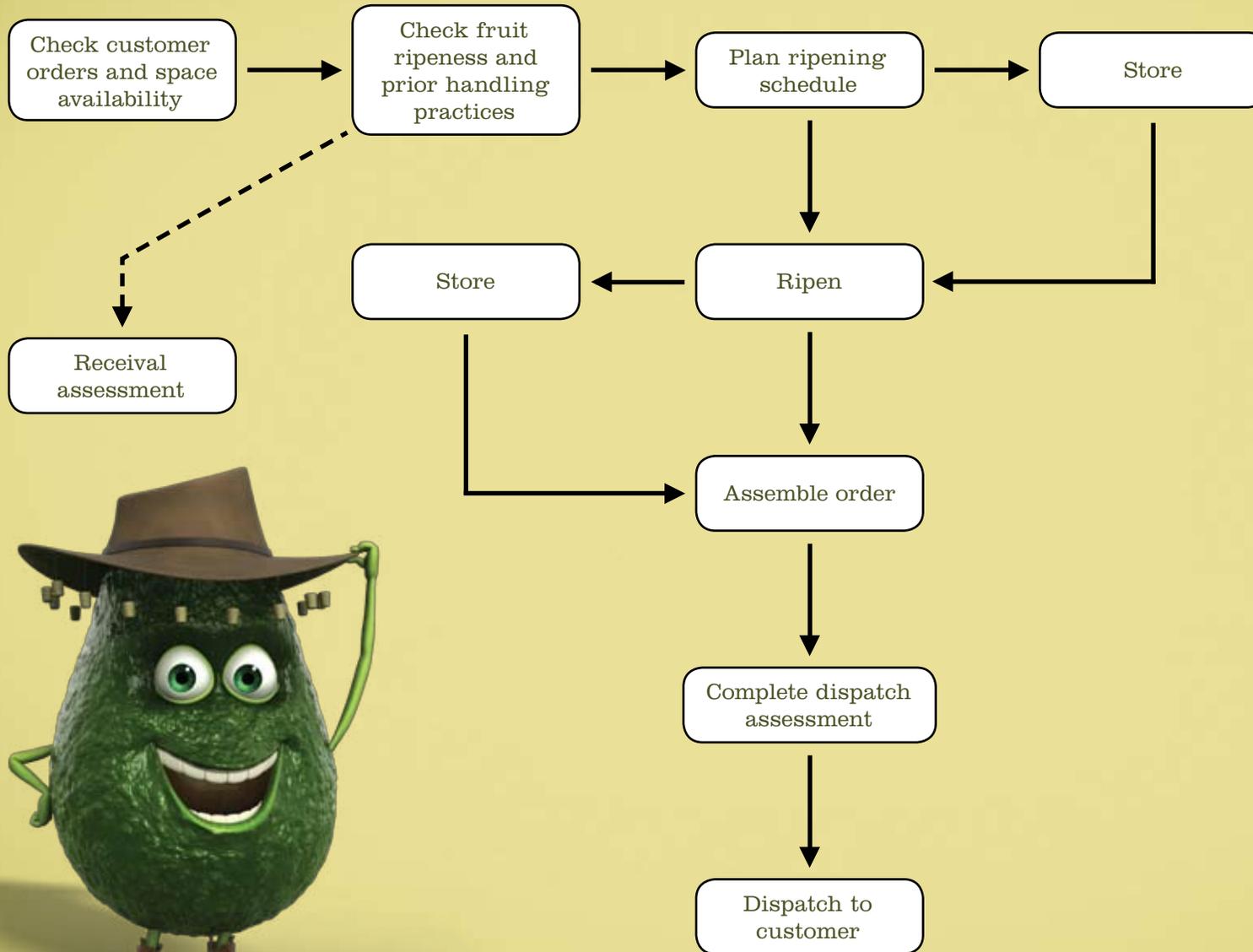
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# 1. Ripening

## Steps in ripening avocados



# Receival assessment

## Purpose

- To check that the product complies with the specification and to plan the ripening schedule.

## Sampling

- Select 3 packages or at least 50 fruit from across the size range for each grower and pack date.
- Select the packages from different pallets and avoid the top 3 layers.
- Record delivery details on record form – brand, variety, delivery date, type and no. of packages.
- Record label details – packer, grower, pack date, pallet number, product ID, count/fruit size

## Check prior handling practices

- Check pulp temperature of a fruit from the middle of each package and record the temperature.
- Calculate the number of days from packing to delivery.
- Note the stage (early, mid or late) in the season for the variety and district.

## Check packing, fruit quality and ripeness

- Weigh the package and record the net fruit weight.
- Observe the presentation and record if improvement is needed (eg loose pack, mixed sizing, missing stickers).
- Photograph the pack before removing any fruit for assessment.
- Assess each fruit for firmness and skin colour (Hass) and record if any fruit are softening or colouring.
- Assess each fruit for external appearance and record the number of fruit out of grade according to defect type.
- Calculate the percentage of out-of-grade fruit according to major and minor defects and determine whether the product meets specification.

## Provide feedback to grower/ packer

- Send electronic copy of receival assessment record and photographs to grower/ packer after completion of assessment.
- Request extra information about prior handling if fruit ripening is detected or if there is uncertainty about storage potential.

## Plan ripening schedule

- Check customer orders, ripening space available and storage potential using the decision tree on page 6.



## Ripening conditions

### Ripen mature fruit

- Fruit must be mature to ripen properly - minimum of 23% dry matter (Hass) and 21% (Shepard)
- The more mature the fruit, the quicker the ripening time and the darker the skin colour of ripe Hass

### Room temperature – 16 to 20°C

- Use a forced-air system to precool or warm fruit and maintain pulp temperatures during ripening
- Ripen at 18-20°C for less mature fruit (less than 26% dry matter)
- Ripen at 16-18°C for more mature fruit (26% and higher dry matter)
- Hold fruit at the required temperature until it reaches a ripeness level ready for dispatch
- High temperatures increase the risk of rots and fruit may ripen too quickly
- Low temperatures will reduce skin colour development in Hass
- Fruit pulp temperatures are typically 1-2°C above room temperature

### Ethylene duration and concentration

- Precool or warm fruit to ripening temperature before injecting ethylene
- Duration: first 2-3 days for less mature, early season fruit  
first 1-2 days for more mature, mid to late season fruit
- Concentration: trickle system: 10ppm continuous ethylene  
Shot system: 100ppm ethylene every 6 to 8 hours

### Maintain room humidity

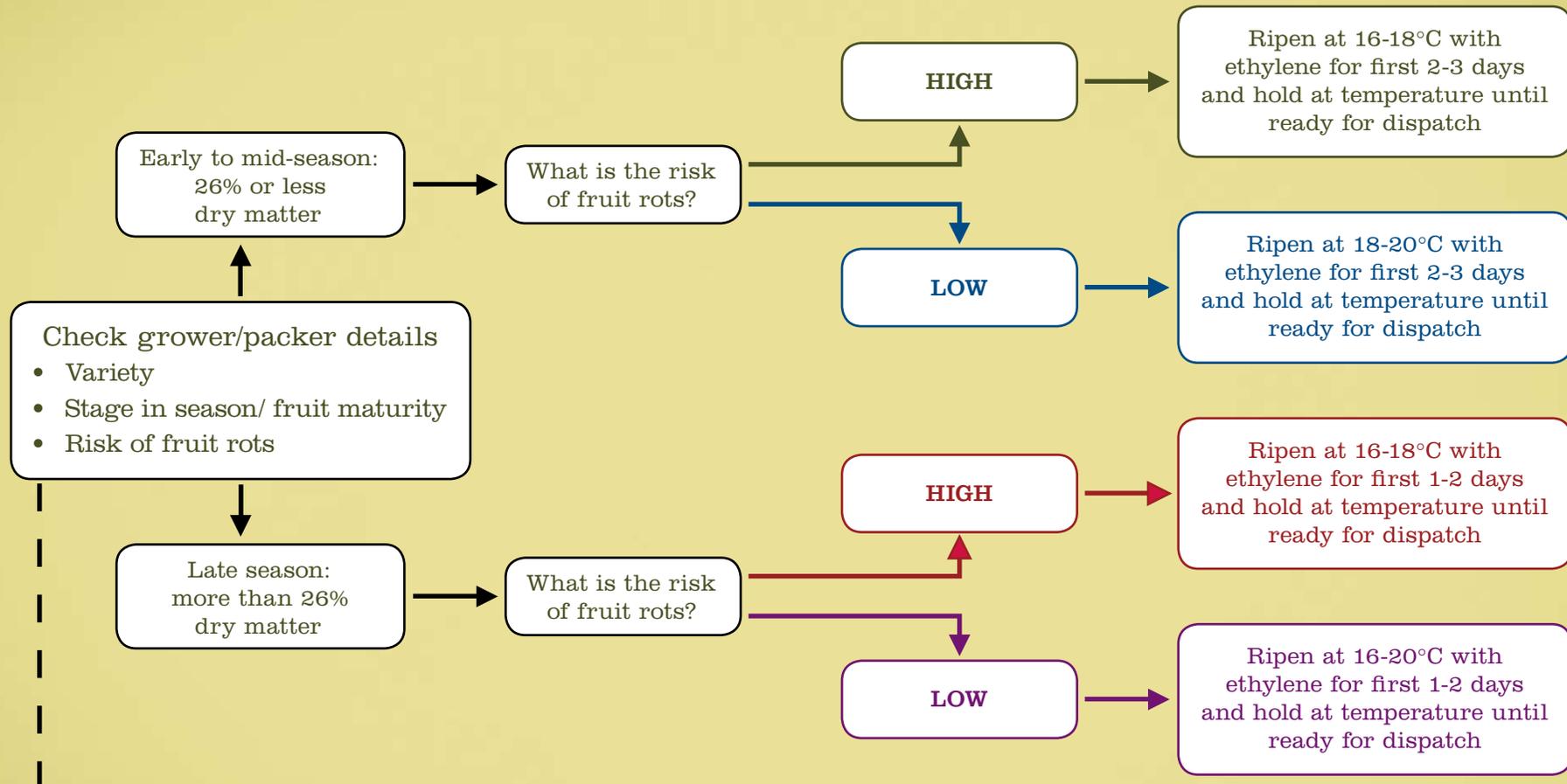
- Maintain at least 85% relative humidity

### Room venting

- Vent rooms to maintain carbon dioxide level below 1%
- Trickle system: vent rooms continuously to allow at least one room volume change every hour
- Shot system: vent rooms by opening doors for at least 10-15 minutes every 6-8 hours



# What ripening conditions do I use?



- The skin of early season Hass (dry matter less than 26%) may not be fully dark when ripe.
- The skin of Hass will darken more when ripened at 18-20°C than at 16-17°C
- The higher the ripening temperature, the faster the growth of rots.
- The risk of rots development depends on variety, growing conditions, orchard management and postharvest fungicide treatment. Wet weather favours infection in the orchard.

## Time to reach required ripeness stage

VARIETY	Ripening temperature	Ripening time (days from start of ethylene treatment)		
		Hard to rubbery	Rubbery to softening	Softening to firm ripe
Hass	16°C	6-7	3-4	2-3
	18°C	4-5	2-3	1-2
	20°C	3-4	2-3	1
Shepard	16°C	5-6	2-3	2
	18°C	3-4	1-2	1
	20°C	2-3	1	1

### Assumption:

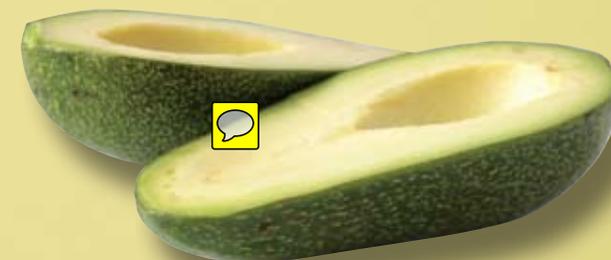
Ripening time assumes fruit were harvested mid season and have been exposed to ethylene

Ripeness stage	Description
Hard	No give with strong thumb pressure
Rubbery	Slight give with strong thumb pressure
Softening	Fruit deforms 2-3mm with moderate thumb pressure
Firm ripe	Fruit deforms 2-3mm with slight thumb pressure



### Factors affecting the time to ripen:

- Fruit maturity
- Temperature management and fruit age
- Ripening temperature
- Exposure time to ethylene
- Farm location
- Block location on farm
- Production practices



# How long can I store avocados before ripening?

Storage potential before ripening depends on ripeness, the pulp temperature on arrival at ripening facility and fruit age.



## Option 1 Storage before ripening – 14 days storage potential

Check fruit condition and age on arrival at warehouse



Variety	Storage temperature
Hass	5°C
Shepard	7°C
Other green skins	7°C

### CAUTION

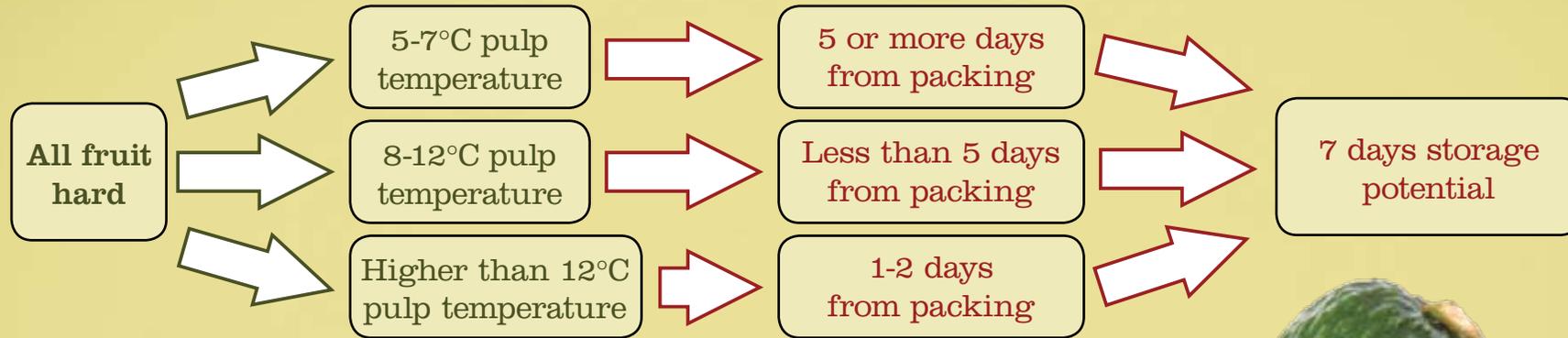
- Flesh greying/ browning can occur if fruit starts to ripen during storage.
- Fruit must be precooled effectively to 5-7°C within 36 hours of harvest and transported at 5-7°C.
- If the fruit age is more than 5 days from packing, reduce the storage period before ripening.
- Place the fruit into the storage room within 4 hours of receipt at the ripening facility.
- Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.
- Do not store late season fruit for more than 5 days.



Ripening Stage One:  
Hard

## Option 2 Storage before ripening – 7 days storage potential

Check fruit condition and age on arrival at warehouse



Variety	Storage temperature
Hass	5°C
Shepard	7°C
Other green skins	7°C

### CAUTION

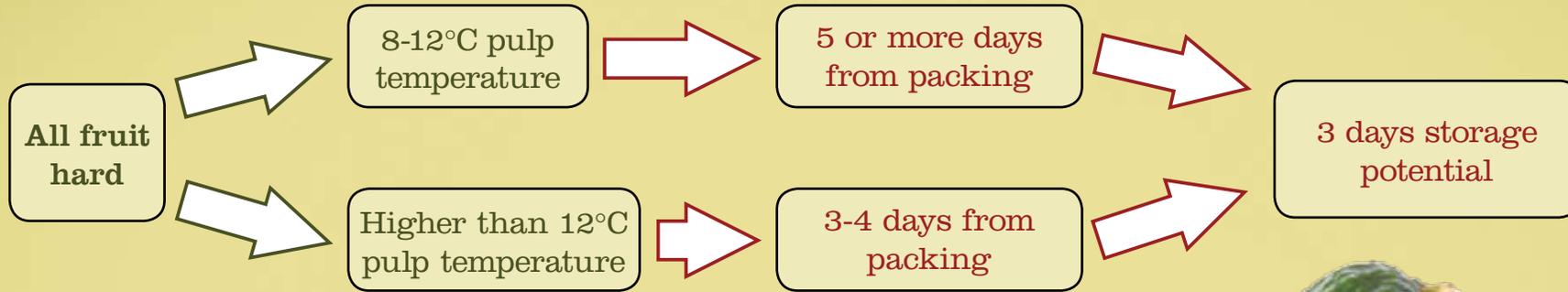
- Flesh greying/ browning can occur if fruit starts to ripen during storage.
- High temperatures on arrival increase the risk of fruit starting to ripen in storage. Precool warm fruit (higher than 12°C) to 5°C within 12 hours of arrival.
- Place cold fruit (less than 12°C) into the storage room within 4 hours of receipt at the ripening facility.
- Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.



Ripening Stage One:  
Hard

### Option 3 Storage before ripening – 3 days storage potential

Check fruit condition and age on arrival at warehouse



Variety	Storage temperature
Hass	5°C
Shepard	7°C
Other green skins	7°C

### CAUTION

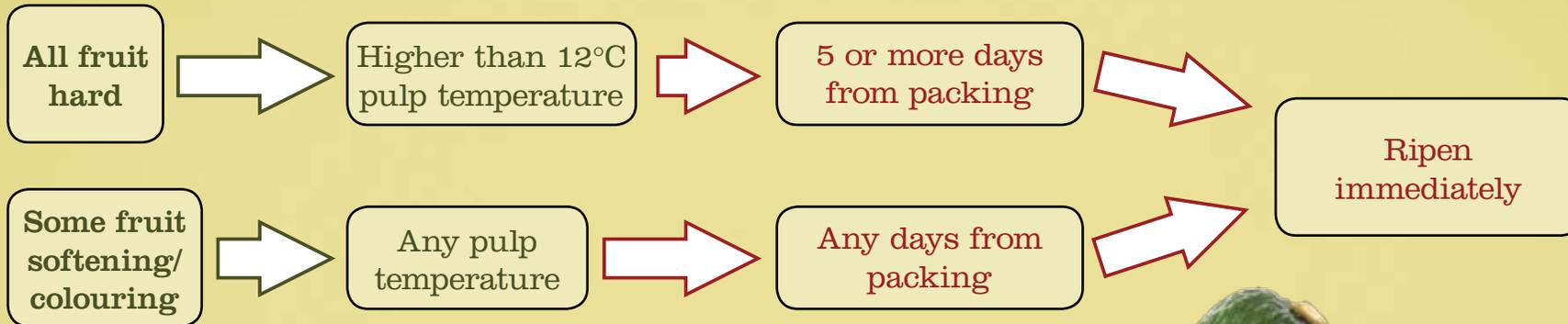
- Flesh greying/ browning can occur if fruit starts to ripen during storage.
- High temperatures on arrival increase the risk of fruit starting to ripen in storage. Precool warm fruit (higher than 12°C) to 5°C within 12 hours of arrival.
- Place cold fruit (less than 12°C) into the storage room within 4 hours of receipt at the ripening facility.
- Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.



Ripening Stage One:  
Hard

## Option 4 Ripen immediately – do not store before ripening

Check fruit condition and age on arrival at warehouse



Variety	Storage temperature
Hass	5°C
Shepard	7°C
Other green skins	7°C



Ripening Stage One:  
Hard



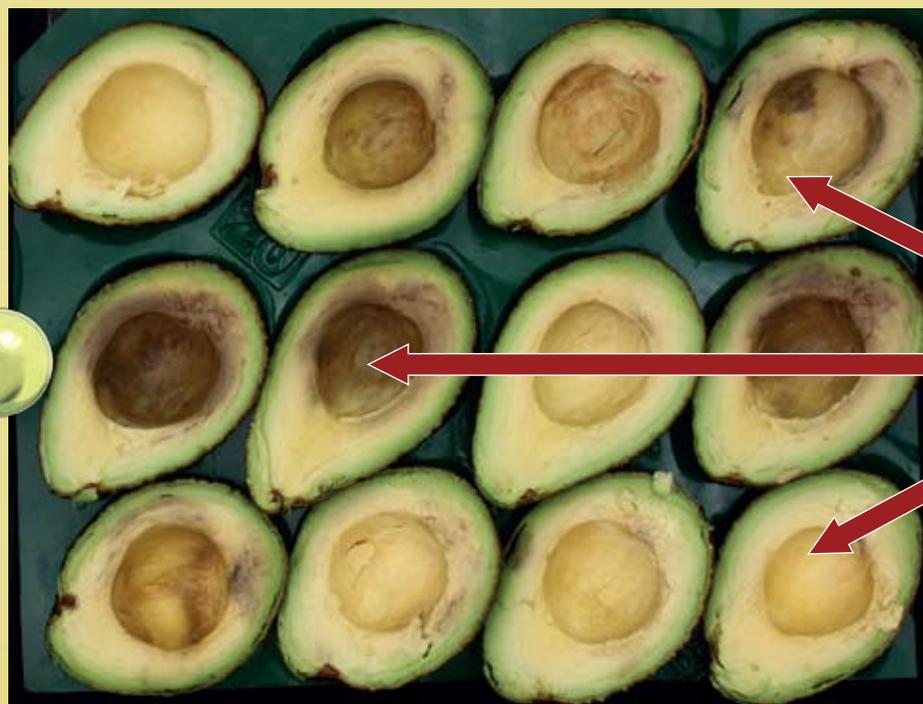
Ripening Stage Three:  
Softening

### CAUTION

- Flesh greying/ browning may occur if ripening fruit is placed into storage.
- Loads that arrive with mixed ripeness can be sorted by pack dates and ripeness.
- Select the oldest pack dates and ripening fruit immediately. Store hard green fruit for a maximum of 3 days.

## Storage after ripening

Variety	Storage temperature	Storage time (days)		
		Rubbery	Softening	Firm ripe
Hass	5-7°C	7 day max	5 day max	3 day max
Shepard	6-8°C	5 day max	3 day max	3 day max
Other green skins	6-8°C	5 day max	3 day max	3 day max



The risk of grey/ brown flesh or vascular browning occurring increases with storage time after ripening and as storage temperature decreases

# Ethylene injection

## Systems

- **Shot injection** – one volume of ethylene injected every 6-8 hours to achieve 100ppm in ripening room
- **Trickle injection** – continuous measured flow of ethylene to achieve 10ppm in ripening room
- **Catalytic generation** – one volume of gas generated every 6-8 hours to achieve 100ppm in ripening room
- **Controlled monitoring** – ethylene level in ripening room is monitored and ethylene is injected when concentration drops below set point of 10ppm – carbon dioxide level is also monitored and vents are opened when concentration reaches set point of 1%



Shot system



Trickle system



Catalytic generation



Controlled monitoring

Ethylene is available in cylinders as pure ethylene or Ripegas™, which contains 4-5% by weight of ethylene and 7% by volume. If pure ethylene is used, special safety precautions are required to prevent explosions.

In a typical shot system, the required volume of gas is first flushed into a secondary cylinder before injecting this volume into the room.

With catalytic generators, ethanol is poured into the generator and catalysed into ethylene. The amount of ethanol required is calculated to match the room volume.

## Venting rooms

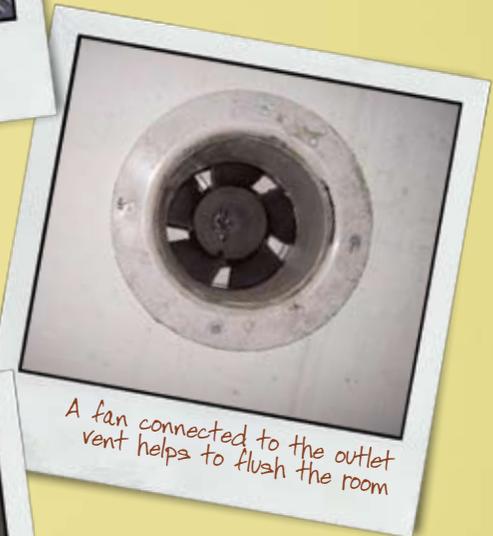
A system for positively venting the ripening room is required to remove carbon dioxide (CO<sub>2</sub>). Carbon dioxide is produced by the ripening fruit and will build up if the room is not regularly flushed. Carbon dioxide levels above 1% inhibit fruit ripening and are a health hazard to operators. Concentrations of 3-5% cause increased respiration and headaches and 8-15% cause headache, nausea and vomiting and may lead to unconsciousness. Concentrations as high as 12% have been measured in fruit ripening rooms.

### Venting systems

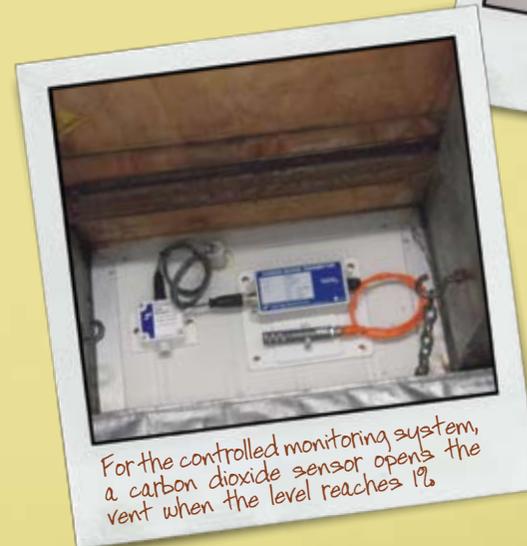
- **Shot systems and catalytic generators** – room is manually vented by opening the doors for 10-15 minutes every 6-8 hours. Run the room fans to flush the room.
- **Trickle system** – room is continuously vented with inlet and outlet vents. The inlet vent is typically behind the cooling coils to suck in fresh air. Carbon dioxide is heavier than air so the outlet vent is best placed on a wall near the floor. The vents need to be large enough to allow at least one room volume change every hour.
- **Controlled monitoring** – A sensor is placed inside the room and monitors the level of carbon dioxide. Inlet and outlet vents are placed in the same positions as for the trickle system. When the carbon dioxide level reaches 1%, the outlet vent is opened, a fan is started and the room is flushed. Once the room is flushed the outlet vent is closed.



Outlet vent is placed near the floor and can be closed when not flushing the room



A fan connected to the outlet vent helps to flush the room



For the controlled monitoring system, a carbon dioxide sensor opens the vent when the level reaches 1%

# Monitoring fruit and handling conditions

## Temperature

- Check set temperatures daily for ripening and storage rooms. Calibrate the room temperature gauges with a temperature logger at least monthly to ensure the gauges are accurate.
- Spot check pulp temperatures at least monthly to ensure that fruit temperatures are uniform within pallets and between pallets. Probe fruit through the stem end and check packages in different layers and on opposite sides of the pallet. Do not check fruit in the top three layers as the temperature may not be representative of other fruit in the pallet.



Temperature data logger

## Ethylene

- Ethylene is monitored using a gas aspirating pump (eg Kitagawa) and detector tubes.
- Spot check ripening rooms weekly to ensure correct concentration is being injected during ripening.
- Spot check storage rooms weekly to ensure that ethylene is not present in room.

## Carbon dioxide

- Carbon dioxide is monitored using a gas aspirating pump (eg Kitagawa) and detector tubes.
- Spot check ripening rooms weekly to ensure that levels don't exceed 1%.

## Ripeness

- Check fruit daily in ripening rooms to monitor the ripening rate.
- Check fruit daily in storage rooms and remove at first sign of ripening.
- Check packages in different layers and on opposite sides of the pallet.
- Do not check fruit in the top three layers as ripeness may not be representative of other fruit.

## Shelf life (library samples)

- Sample fruit at dispatch and hold in an air conditioned room (20-23°C) to assess shelf life.



Gas pump and detector tube

- Select fruit weekly for each variety from each grower/ packer to monitor for seasonal effects.
- Assess the fruit when ripe for skin colour (Hass), external appearance and flesh quality.

## Monitoring records

- Monitoring records help to identify problems and areas for improvement and provide feedback to growers/ packers.
- A handling log records room conditions (temperature, ethylene, carbon dioxide) and tracks fruit movement from receipt to dispatch.
- A shelf life assessment record together with photographs provides feedback to grower/ packers on fruit quality.

## Operating a forced-air ripening system

Forced-air coolers enable effective control of fruit temperature during ripening, provided the containers are suitable and the pallets and room are stacked to optimise air movement across the fruit. If uneven amounts of air flow through different layers or pallets, ripening will be uneven within and between pallets. Air will always take the path of least resistance and flow through gaps around containers and pallets rather than through the containers.

### Checklist for forced-air ripening systems:

- Are the containers stacked so that the side with the most ventilation area is aligned to allow maximum air flow through the pallet?
- Are the containers stacked in columns to ensure even air flow through all layers on the pallet?
- Are the pallets placed tightly against the plenum and along the row to minimize gaps between the pallets?
- Are large gaps between pallets covered to prevent air bypassing through the containers on the pallets?
- When ripening pallets with different types of containers, are the pallets with containers having the least amount of ventilation placed at the front of each row (near the plenum) and pallets with containers having the most ventilation placed at the back of the row?
- Are the heights of the pallet stacks even between the two rows so that the tarp fits tightly without any gaps underneath?
- For open top containers, does the tarp cover the full width of the 2 rows of pallets or the tops of pallets are covered to prevent air leaking under the tarp?

Stack pallets to same height along the 2 rows to ensure tarp fits tightly without gaps underneath

Cover the top row of open top trays.



Place pallets with least ventilation at front of row near fan

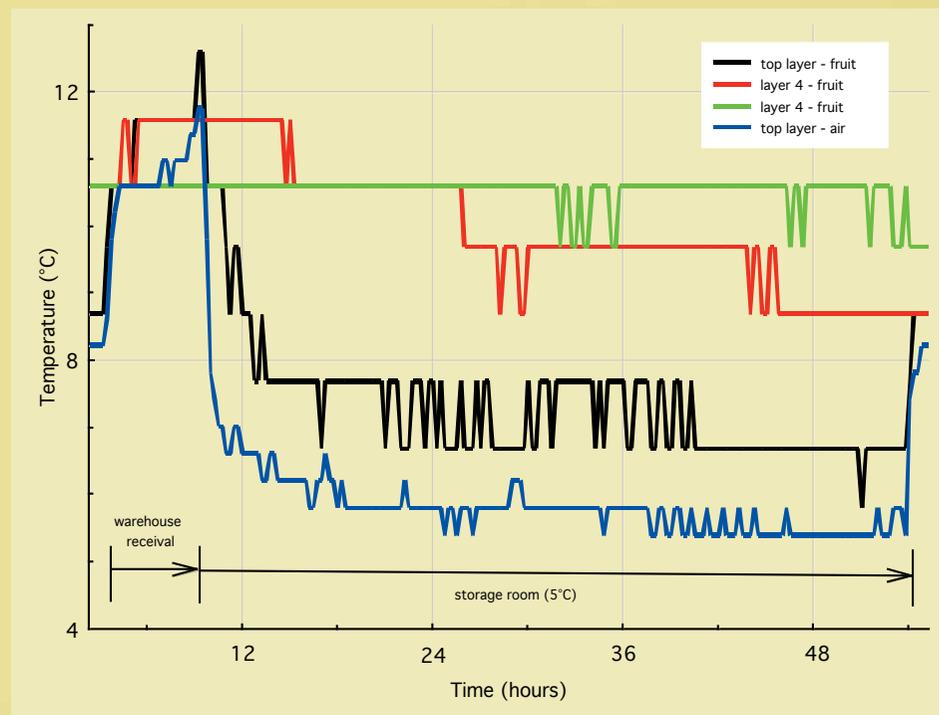
## Operating a storage room

Ensure a space of at least 10cm is left around all sides of pallets during storage to allow effective air circulation to maintain fruit temperatures.



Allow a space of at least 10cm around pallets to ensure effective air movement

Pulp temperature variation between layers on the pallet due to insufficient air circulation during storage at 5°C. Fruit on opposite sides of pallet in the 4th layer were 3°C higher than fruit in the top layer.



## Fruit ripens too slowly

### What is it?

- Fruit takes more than 7 days to reach softening stage.

### What causes it?

- Immature fruit ripen slowly even if ethylene is used.
- Low fruit temperature – the lower the temperature, the slower the ripening.
- High carbon dioxide – levels above 1% can inhibit ripening.
- Faulty ethylene injection – empty gas bottle or leakage/ blockage in injection system.

### How can it be minimised or prevented?

- Check fruit maturity – dry matter should be above 23% (Hass) and 21% (Shepard).
- Check the room temperature setting and calibrate the room temperature gauge to ensure it is accurate.
- Check carbon dioxide levels and venting.
- Shot system – Manual flushing of room may not be frequent enough. Open the doors to vent the room every 6-8 hours.
- Trickle system – The size of inlet and outlet vents may not be large enough or the length of the outlet pipe may be too long or the outlet vent may not be located correctly (near floor). At least one room air change per hour is required.
- Check ethylene level and treatment duration. Inject ethylene into ripening room for first 2-3 days for early season fruit and for first 1-2 days for mid-late season fruit.

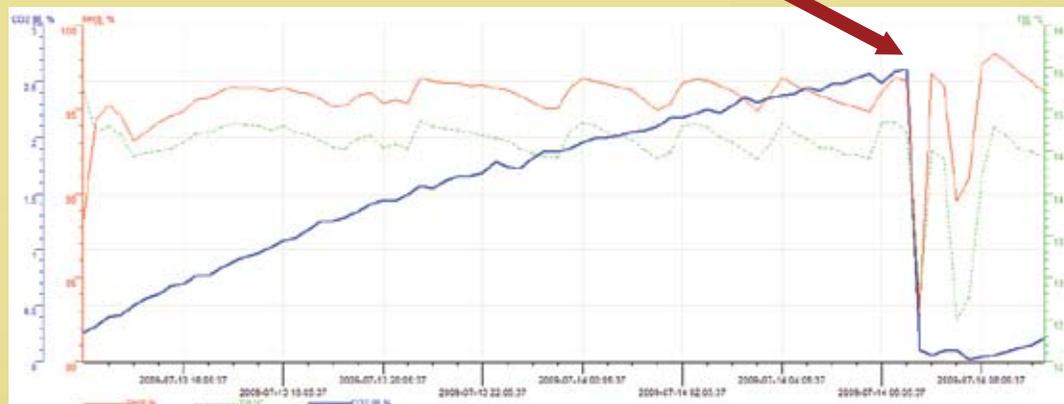
### Slow ripening

More than 6 days from start of the ethylene treatment



Ripening Stage One: Hard → Ripening Stage Three: Softening

Carbon dioxide level in shot ripening room rose to 2.5% in 18 hours until door was opened to vent room



# Uneven ripening

## What is it?

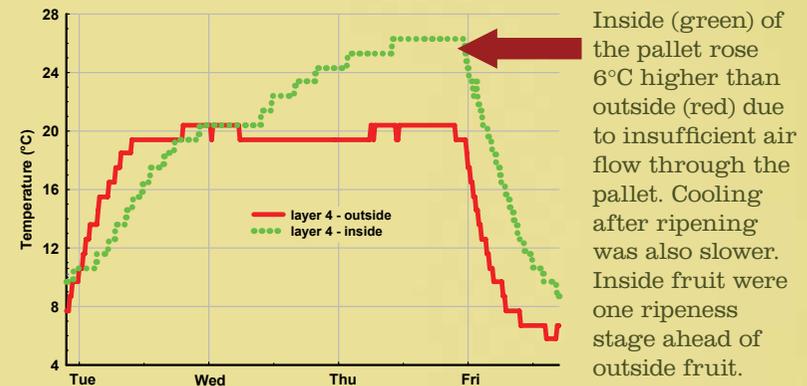
- Fruit ripening is uneven within trays, between trays in pallets or between trays on different pallets in the ripening room.

## What causes it?

- Variable fruit maturity. Fruit maturity varies within trays and ripening rate will vary if fruit are ripened without ethylene.
- Variable fruit age. If the pallets are stacked with packages from different growers/ packers or different pack dates, ripening rate is likely to vary.
- Variable fruit temperature. The higher the temperature, the faster the ripening rate. Avocados generate heat during ripening and if not removed, temperature will rise and fruit will ripen quicker. This can occur if package ventilation is insufficient or if pallets are cross stacked or if pallets with different packages are placed in the ripening room.

## How can it be minimised or prevented?

- Check ethylene level and treatment duration.
- Check the grower/ packer details and pack dates. If the pallets are stacked with different growers/ packers or different pack dates, ripening rate is likely to vary. Restack pallets with the same grower or similar pack dates.
- Check the package design. Is the ventilation suitable to allow enough air to flow across the pallet? At least 4% of the side of the package must be vented.
- Check the stacking of pallets. Stack pallets with packages that have similar ventilation area on all sides or column stack the packages.
- Check pallet and tarp placement. Look for gaps between the pallets and under the tarp. Air will always take the path of least resistance.
- If there is a mixture of pallets on the forced air cooler, place pallets having the least amount of ventilation at the front near the fan. For example, stack pallets with cartons at the front and pallets with plastic returnable crates at the back.



## Poor skin colour of Hass

### What is it?

- The fruit softens but the skin fails to darken evenly as the fruit ripens.
- Skin appears mottled with areas of brown, purple and green.

### What causes it?

- Fruit maturity – early season fruit with low dry matter content do not colour well.
- Low ripening temperature – the lower the ripening temperature, the less the fruit colours.

### How can it be minimised or prevented?

- Select ripening temperature based on maturity/ season.
- Ripen early season fruit at 18-20°C.
- Late season fruit can be ripened at 16-18°C to produce acceptable skin colour.



Temperature too low  
(less than 18°C) for  
early season fruit



Ripen early season fruit  
at 18-20°C for good  
colour development



## Dark patches on skin

### What is it?

- Irregular black or brown patches on the skin. The dark patches vary in size from small patches to large solid areas.
- Symptoms only occur on the skin and do not penetrate into the flesh, which distinguishes the injury from fruit rots.
- Becomes less obvious in Hass as the skin colours.

### What causes it?

- Chilling injury during storage and transport can cause irregular dark patches on the skin (usually more than 3 mm diameter).
- Injury may occur if unripe fruit is stored or transported below 5°C for more than 7 days.
- Growing region may influence the temperature threshold for damage.
- Symptoms increase after the fruit is removed from storage or transport.

### How can it be minimised or prevented?

- Do not store or transport unripe fruit below 5°C for longer than 7 days.
- Calibrate the room temperature gauges with a temperature logger at least monthly to ensure the gauges are accurate.

Irregular dark patches on the skin caused by storing unripe fruit below 5°C for longer than 7 days



## Flesh bruising

### What is it?

- Dark areas in the flesh usually brown or brown/black in colour and with relatively distinct margins.
- Cracking and air cavities can be associated with this discolouration.

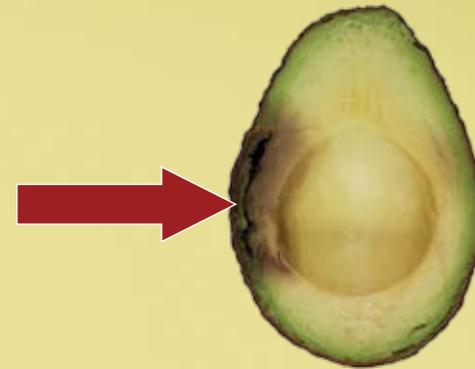
### What causes it?

- Impact damage from dropping of packages, bumps to pallets during fork lift operation, and knocks/ shocks during transport (road, air, sea).
- Severity increases with fruit ripeness and impact level (eg drop height).

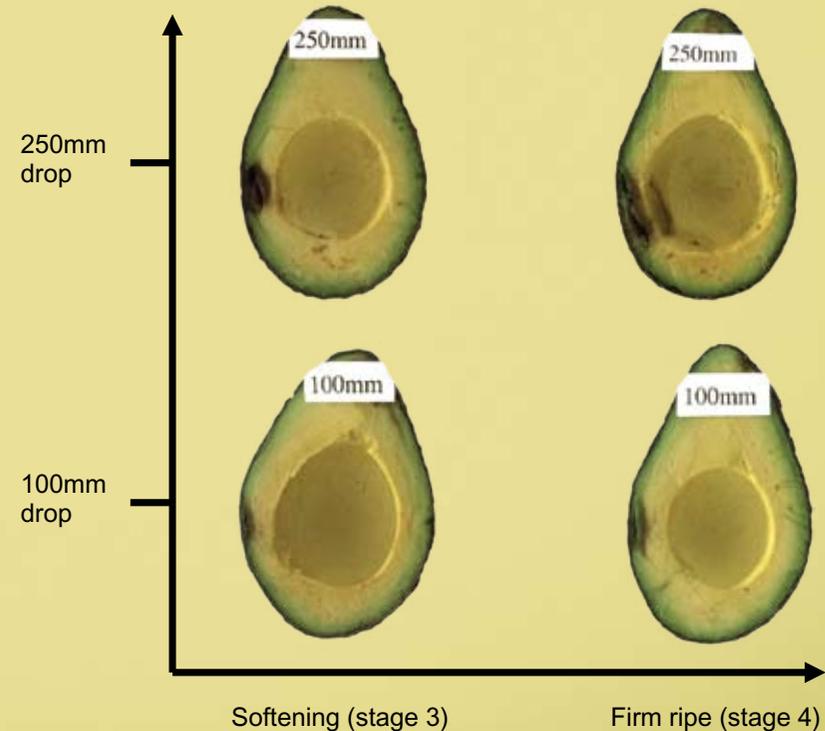
### How can it be minimised or prevented?

- Check workers for rough handling of fruit, packages, and pallets, particularly after fruit has been ripened.
- Re-train workers if rough handling is detected.
- Use suitable vehicles for transporting ripened avocados (eg correct suspension).

Flesh bruising appears as dark areas with relatively distinct margins and often with cracking or air cavities



Susceptibility to bruising increases as fruit ripens and with drop height



## Grey/ brown flesh

### What is it?

- Dark areas in the flesh usually grey to grey/ brown in colour and with poorly defined margins.
- Usually starts at the bottom and near the seed and spreads upwards and outwards.
- Vascular browning may be associated with grey/ brown flesh.

### What causes it?

- Storing or transporting fruit for too long prior to ripening or at too low a temperature after ripening.

### How can it be minimised or prevented?

#### *Before ripening*

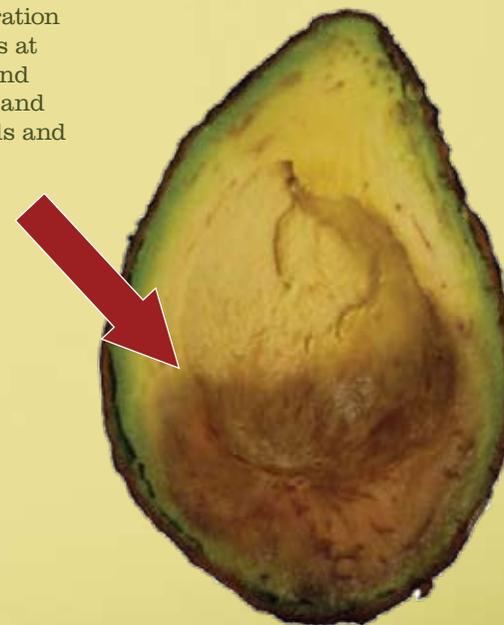
- Do not store early-mid season fruit before ripening for longer than 14 days and late season fruit for longer than 5 days.
- Poor temperature management following packing and during transport will shorten storage time prior to ripening.
- Ethylene present during storage may trigger ripening and cause early onset of symptoms.
- Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.

#### *After ripening*

- After ripening, do not store Hass for longer than 7 days or Shepard for longer than 5 days. See Section 3 - for further information.
- Check internal quality of ripened fruit held in storage every day and remove at first sign of flesh discolouration.



Flesh discolouration usually starts at the bottom and near the seed and spreads upwards and outwards.



## Vascular browning

### What is it?

- Browning of the vascular bundles (strands) which run longitudinally through the flesh and carry fluids from the stem to the base of the fruit.

### What causes it?

- Storage of fruit for too long before ripening.
- May be associated with stem end rot.

### How can it be minimised or prevented?

- Do not store early-mid season fruit before ripening for longer than 14 days and late season fruit for longer than 5 days.
- Poor temperature management following packing and during transport will shorten storage time prior to ripening.
- High ethylene levels during storage or transport may trigger ripening and cause early onset of symptoms.
- Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.



Browning of the vascular bundles may be caused by stem end rot or storage of fruit before ripening for too long.

## Fruit rots

### What is it?

#### *Body rot*

- Discrete brown or black discoloured areas on the skin – may also show light brown/ pink spores in severe cases. Infection may not be obvious on the skin of coloured, ripe Hass.
- Spreads from the skin into the flesh and appears as brown semi-circular areas. Brown patches under the skin can indicate the presence of rots.

#### *Stem end rot*

- Discoloured area on the skin and in the flesh, spreading from the stem end and often associated with vascular browning. Infection may not be obvious on the skin of coloured, ripe Hass.
- The discoloured area is usually softer than the surrounding flesh.

### What causes it?

- Poor field hygiene. Infection of fruit occurs on the tree and the organisms remain dormant until the fruit starts to ripen.
- Incorrect or poor application of fungicide treatments in the pack shed.
- Fruit ripening at high temperatures above 22°C.
- Fruit overripe – holding ripened fruit for too long.

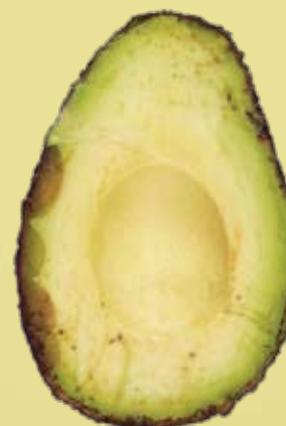
### How can it be minimised or prevented?

- Check the grower/ packer details. Infection levels vary between growers and the effectiveness of the postharvest fungicide.
- Check the ripening room temperature.
- Ripen fruit, suspected to be infected with body or stem rots, at 16-18°C.
- Do not hold firm ripe fruit at room temperature for longer than 3 days.

External body rot



Body rot in flesh



Stem end rot



## Frequently asked questions

### What do I do if the fruit arrives hot?

- Check the fruit history – stage of season and pack dates. See Section 2. Storage before ripening – for more information.
- Ripen fruit immediately if the temperature is above 12°C and fruit age is 5 or more days from packing or if the fruit is late season.
- If the fruit are early-mid season, the temperature is above 12°C and the time from packing is less than 5 days, the fruit may be stored before ripening for up to 3 days. Precool fruit to 5°C within 4 hours of arrival. Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen. High temperatures on arrival increase the risk of flesh discolouration developing during storage.

### What do I do if fruit arrives already softening or colouring?

- Ripen the fruit immediately. Do not store the fruit at low temperature as the risk of flesh discolouration occurring is high.

### What temperature do I use for ripening avocados?

- Ripen early season fruit at 18-20°C and mid-late season fruit between 16-20°C depending on how quickly you need to ripen the fruit. The higher the ripening temperature, the better the skin colouring of Hass, but the risk of fruit rots increases. See Section 1. Ripening – for more information.

### How much ethylene do I add to the ripening room and for how long?

- There are 4 methods for injecting ethylene into the ripening room – shot, catalytic generator, trickle, and controlled monitoring. Use 100ppm ethylene for the shot and catalytic generator methods and 10ppm for the trickle and controlled monitoring methods. The duration of the ethylene treatment is 2-3 days for early season fruit and 1-2 days for mid-late season fruit. Spot check ripening rooms weekly to ensure correct concentration is being injected during ripening. Refer to Section 3. Room operation – for more information.

### What temperature and for how long can I store avocados before and after ripening?

- Store Hass at 5°C and other green skin varieties at 7°C, before and after ripening
- Before ripening, fruit may be stored for up to 14 days depending on the arrival temperature, and the fruit maturity and age. See Section 3. Storage before ripening – for more information.
- After ripening, Hass can be stored for up to 7 days and Shepard for 5 days. Refer to Section 4. Storage after ripening – for more information.

### **What causes uneven ripening of avocados within and between pallets?**

- Uneven ripening may be caused by ripening multiple growers or pack dates in the same room, insufficient ethylene concentration or duration, or uneven fruit temperatures.
- If there is fruit from different growers/ packers or different pack dates in the room, the ripening rate is likely to vary. Check the package labels at receipt for details of the grower and packer and the pack dates, and segregate batches that may ripen differently.
- The ripening rate of fruit within packages varies due to maturity differences. Gassing avocados with ethylene increases the uniformity of ripening. Check the ethylene level and treatment duration. Gas early season fruit for 2-3 days and mid-late season fruit for 1-2 days.
- Fruit temperature variations within ripening rooms may be caused by placing different packages in the room, variable stacking of the pallets and the location of the pallets. In a forced-air system, air will always take the path of least resistance. If the container ventilation space is too small or there are gaps between pallets or under the tarp, there may not be enough air flowing through the pallets. The temperature on the inside of the pallet will be higher and the fruit will be ripier than the outside of the pallet.
- Ideally it is best to have the same package on all pallets in the ripening room. Where this is not possible, position the pallets so that the less ventilated packages are placed at the front nearest to the forced-air fan and the packages with the most ventilation placed further away. Air flow should be as even as possible across all pallets.
- Refer to the description of “Uneven ripening” on page 18 for more information.

### **Why do I lose my breath when I walk into a ripening room?**

- This is a sure indication that the level of carbon dioxide has reached a high concentration (3-5%) and is affecting your breathing. As well as being a health hazard, carbon dioxide levels above 1% will inhibit ripening. Avocados generate carbon dioxide during ripening and the level will build up if the room is not vented effectively.
- Vent the room immediately by opening the door(s) for 10-15 minutes. Refer to section 4. Room operation for instructions on venting for the various types of ripening systems.

### **What temperature do I use if I only have one room available for storing Hass and Shepard?**

- During the Shepard season, set the temperature of the storage room at 7°C. Hass can be stored at this temperature but reduce the storage period to 10 days maximum. Check fruit condition and length of time in storage every day. Remove fruit if there is a risk of fruit starting to ripen.
- Once the Shepard season is complete, set the temperature of the storage room at 5°C.

## Assessing fruit ripeness

*How do you know when we're ripe?*

**AVOCADO COLOUR & RIPENESS CHART**

*where do we come from?*

**HASS**  
Look & Touch

**GREEN SKINS**  
Touch  
*(Illawarra, Marriwil, Warru, Bendi)*

*Try a little tenderness*

**1** Hard (Slight pressure 0kgf using 11mm tip)

**2** Rubbery (0kgf)

**3** Softening (0kgf)

**4** Firm Ripe (0kgf)

**5** Medium to Soft Ripe (0.60kgf)

**6** Soft to Over Ripe (0.40kgf)

**HASS Harvest Maps:**  
 - Apr-Jun (South Australia)  
 - Apr-Aug (New South Wales)  
 - Jun-Dec (Victoria)  
 - Jul-Nov (Queensland)  
 - Oct-Jan (Western Australia)  
 - Aug-Dec (Tasmania)

**GREEN SKINS Harvest Maps:**  
 - Feb-Jun (New South Wales)  
 - Mar-Dec (Victoria)  
 - Jan-Aug (Queensland)  
 - Jan-Jul (Western Australia)  
 - Aug-Sep (Tasmania)

### Firmness measurement

Firmness	Hand feel	Instron Newtons 10mm tip, 2mm skin	Densimeter	Firmometer 200g weight	Penetrometer 11mm tip, no skin
1. Hard	No give with strong thumb pressure	>25 N	92-96	<10	>5 kgf force
2. Rubbery	Slight give with strong thumb pressure	20-25 N	90-91	10-20	5-10 kgf force
3. Softening	Deforms 2-3mm with moderate thumb pressure	10-20 N	86-89	20-60	2-5 kgf force
4. Firm ripe	Deforms 2-3mm with slight thumb pressure	5-10 N	74-85	60-80	1-2 kgf force
5. Medium-soft ripe	Deforms with moderate hand pressure	<5 N	65-73	>80	<1 kgf force

## Harvesting periods for Shepard and Hass Avocados

GROWING AREAS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Atherton Tablelands		Shepard	Shepard	Shepard	Shepard	Hass						
Bundaberg – Childers			Shepard	Shepard	Hass	Hass	Hass	Hass				
Sunshine Coast				Hass	Hass	Hass	Hass	Hass	Hass	Hass		
Tamborine – Blackall Ranges									Hass	Hass	Hass	
Lockyer Valley						Hass						
Toowoomba						Hass						
Northern NSW							Hass	Hass	Hass	Hass	Hass	
Central NSW								Hass	Hass	Hass	Hass	Hass
Tristate	Hass										Hass	Hass
Perth									Hass	Hass	Hass	Hass
South West WA	Hass	Hass									Hass	Hass

Shepard
  Hass

## Contacts

### Ethylene gas

- BOC (pure Ethylene, Ripegas™ ([www.boc.com.au](http://www.boc.com.au)))
- Air Liquide (pure ethylene) ([www.airliquide.com.au](http://www.airliquide.com.au))

### Catalytic ethylene generators

- QA Supplies ([www.qasupplies.com](http://www.qasupplies.com))

### Temperature/ humidity monitoring equipment

- OneTemp (data loggers) ([www.onetemp.com.au](http://www.onetemp.com.au))
- Hastings Data Loggers ([www.hdl.com.au](http://www.hdl.com.au))
- ECEFast (data loggers, meters) ([www.ecefast.com.au](http://www.ecefast.com.au))
- RS Australia (thermometers) ([www.australia-rs-online.com](http://www.australia-rs-online.com))

### Gas monitoring equipment (ethylene, carbon dioxide)

- EE Muir (Kitagawa gas aspiration pump) ([www.eem.com.au](http://www.eem.com.au))
- Air-Met Scientific (detector tubes/pump) ([www.airmet.com.au](http://www.airmet.com.au))
- Vaisala (carbon dioxide data logger) ([www.vaisala.com](http://www.vaisala.com))

### Controlled monitoring equipment

- Controlled Ripening Systems Australia (GT Automatic Fruit Ripener) ([www.crsa.net.au](http://www.crsa.net.au))

### Technical advice

- Agrilink Manual
- DEEDI website ([www.dpi.qld.gov.au](http://www.dpi.qld.gov.au))
- Avocados Australia website ([www.avocado.org.au/industry](http://www.avocado.org.au/industry))



# References

- The International Avocado Quality Manual, Plant & Food Research, New Zealand ([www.plantandfood.com](http://www.plantandfood.com))
- Avocado Maturity Testing Guide
- Avocado handling posters
  - o Avocado colour and ripeness chart
  - o Avocado handling – packhouse
  - o Avocado handling – wholesale
  - o Avocado handling – retail
- Avocado handling guides
  - o Avocado ripening guide
  - o Avocado handling training guide
  - o Defect guide
  - o Harvesting season calendar
  - o Australian growing areas
- Avocado training modules
  - o Physiology of avocados
  - o Avocado quality loss
  - o Managing avocado ripening and storage
  - o Handling avocados in export destinations
- Avocado hazard analysis





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