Frost damage in citrus fruit
23-29 June CITTgroup 2006, Sunraysia

Update : 29 June 06

Steven Falivene (NSW DPI) &

Tony Filippi (MVCB)

Purpose of the Session

- To gain a better understanding on the degree of damage caused by frost
- Identify early potential damage
- Difficulty of classifying areas of damage
- Reason is to avoid collapsed fruit reaching any of our markets
- Instill confidence to our marketing agents that we have procedures in place.

How do fruit become frosted?

- Frost damage is a time and temperature relationship
  - Fruit need time to decrease in temperature to reach freezing point
  - Length of time at this threshold damage is likely
  - From the outside in??
- Ripe citrus pulp freezes at about -1.9^{o}C to – 3.9^{o}C

  Riversun : (temperature logger good tool)
  - -2^{o}C for 4 hours = alert, need check
  - -4^{o}C for 5 hours = suspension 14 days
    - Can continue harvesting if fruit is cut on same morning (ice in fruit) or temperature loggers in orchard

What can affect freezing of fruit

- Mature fruit are less susceptible than younger greener fruit
  - Sugar in juice acts as an antifreeze
  - Varietal differences WNO, Lates, Valencias (still unclear of extent), rootstocks??? (mandarins & lemons more susceptible)
- Size of fruit
  - Smaller fruit will freeze quicker than larger fruit. Less store of heat energy in smaller fruit
- Starting temperature of fruit in evening
  - Depends on temperature during the day

Factors affecting orchard temperature

- Open sick trees are more exposed
  - Tree canopy can provide some protection
  - Small trees more exposure
- Compared to dry ground with a high sod:
  - moist bare soil; 2^{o}C increase
  - sparse mown sod dry soil; 1^{o}C increase
  - drip irrigated soils are a problem.
- Movement of cold dense air overnight can cause damage to unexpected parts of the block
- In a radiation frost (still night, clear sky), fruit damage may only occur to lower parts of the canopy.

What can affect localised temperature

- Beside native vegetation – vegetated dry land; devoid of soil moisture.
  - Wheat paddocks, bushland etc.
- Topography – cold air is heavy
  - Low lying areas of the block can have lower temperatures
  - Check for differences between both side of the row regardless of block layout

What can affect localised temperature

- Trapped air mass can create unusually low temp where it is not expected

How does frost affect fruit

- External damage
  - Oleo & water-soak damage
  - *Can see it in the tree; obvious*
- Internal damage
  - Ruptured juice sacs = dry segments.
  - *Can't see it, especially in the early stages of breakdown*
- *Can have internal without external damage*
- Weaken rinds can have no obvious signs.

External damage

- Water soaked rind – reported to appear within a day

External damage

- Oleo type – oil glands rupture
  - Estimate it may take 3 to 14 day to fully express

External damage

- Possibly may take 3 to 14 day to fully express
- Severe damage

Internal Damage

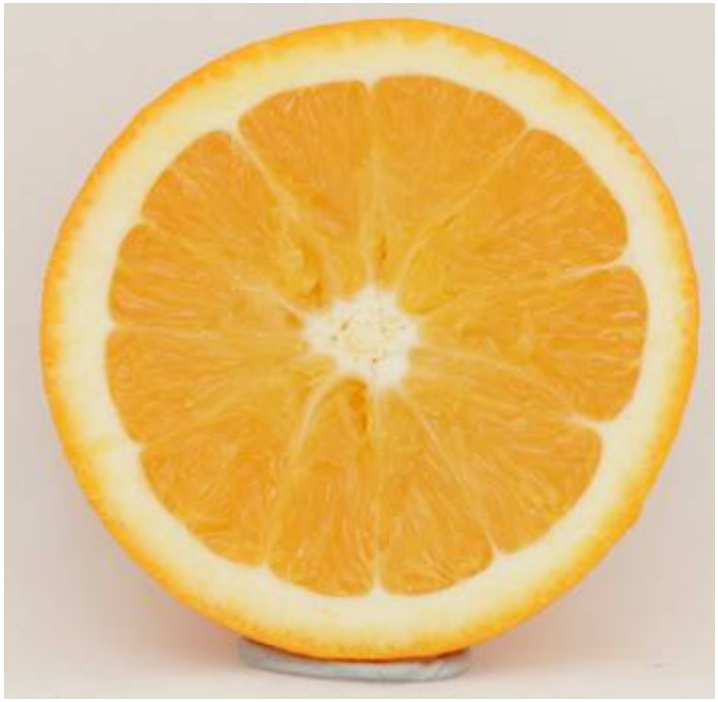
- As juice forms ice it expands in volume and breaks juice sacks
- Juice is liberated within the segment
- Juice eventually moves to the rind and evaporates through the rind
- Best to wait 2 weeks for confident assessment
- Portions of the fruit dry out
  - Most damage seen in centres of fruit
    - less sugar in the centre
  - Dry fruit will be seen at the market
    - Could develop into a rot
    - Reported bitter/off taste

Internal damage

- Advanced (possibly 1- 2 weeks +, depends on severity)
  - Segments begin to dry, “off” flavours

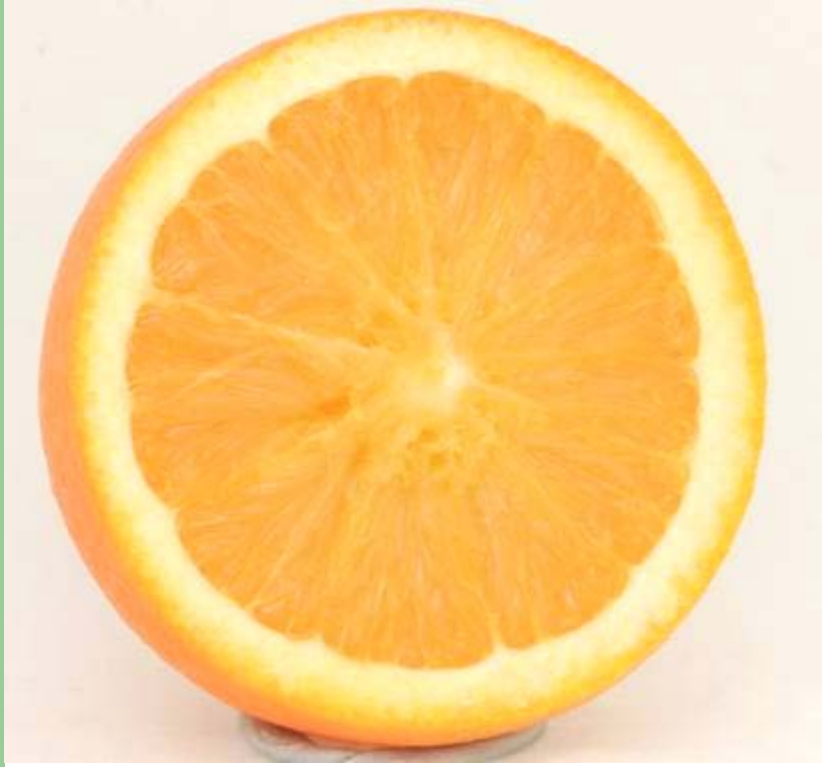
Internal damage

- Advanced (possibly 1- 2 weeks +, depends on severity)
  - Segments begin to dry



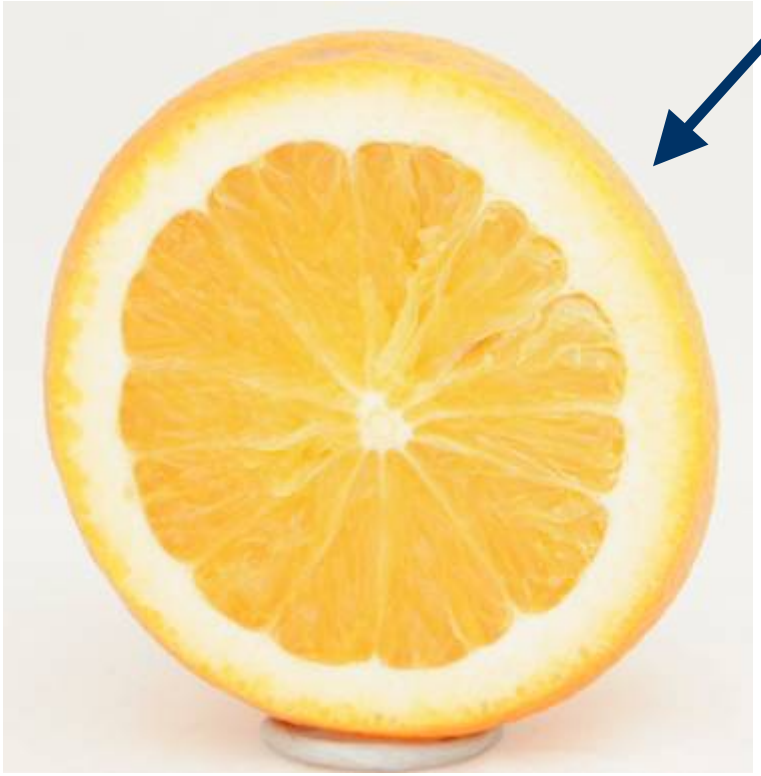
Internal damage

- Advanced (possibly 1- 2 weeks +, depends on severity)
- Segments begin to dry



Internal damage

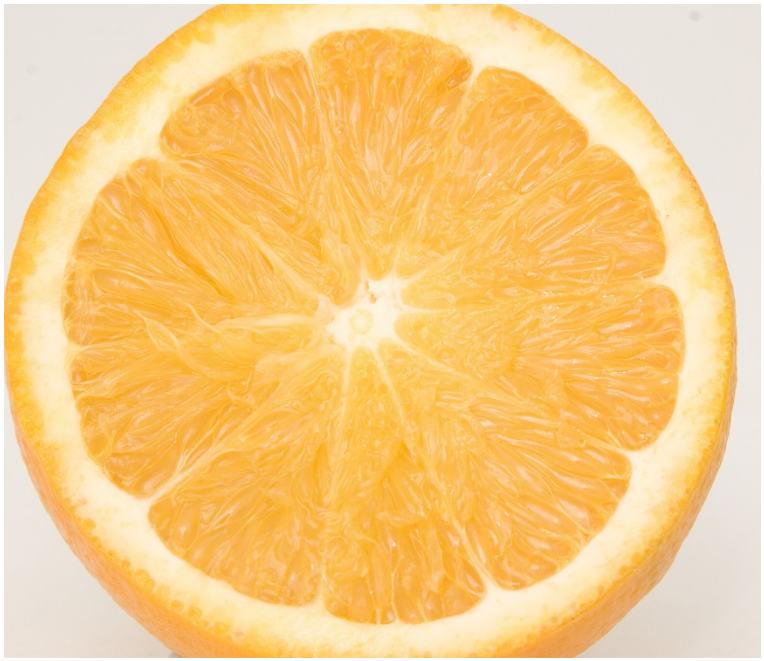
- Do not get confused with sunburn fruit or granulation causing similar damage, which still can not be marketed

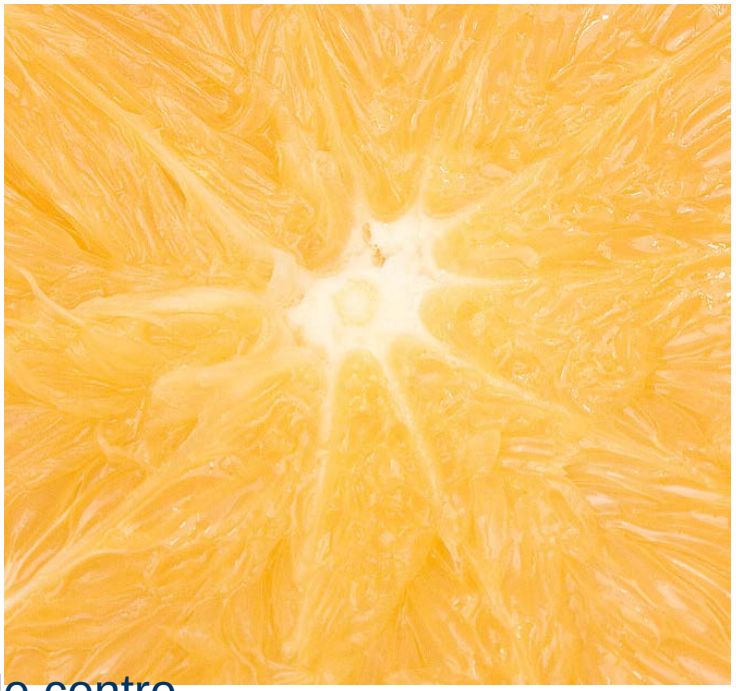


Flat side of sunburnt fruit

Internal damage

- Early symptoms – (possibly 5-7 days+, "suspicion only"
  - Look for signs of ruptured juice sacs, pale colour
  - Difficult to make definite I.D. – wait longer





Note: late varieties can naturally have a pale centre

Internal damage

- Early symptoms – “suspicion only”
  - Can leave cut fruit to dry out 24hrs to see dry areas better (fan heater quicker!)

Internal damage

- Early symptoms – “suspected only”
  - Compare against fruit not frosted


Suspected frosted


Not frosted

Internal damage

- Imperial mandarins :
  - “Off flavoured” fruit
  - Segment separating easily and spongy
  - Difficult detection by cutting

Internal damage

- Internal damage can occur **without** signs of external damage – must cut fruit

Damage assessment

- First target high risk areas of the block
  - low lying areas
  - look for burned new growth
  - desiccated leaves
  - rind damage

Severe Damage

- All summer growth burnt and wilting of branches/leaves – obvious fruit damage

Suspected Damage

- Young shoots/flush burnt, but no rind damage
- Suspect fruit detected, wait longer (2 weeks), for more definite symptoms to appear
- Difficult to assess early, damage can be;
  - confined to a section of the block
  - randomly scattered among trees
  - variation in extent & severity

Damage assessment

- **Must cut fruit**
  - Best to cut fruit on morning of frost (ice in fruit).
  - Otherwise cut fruit at regular short intervals for a period of at least 2 weeks.
  - Damage may be apparent after 1 week
    - Symptoms more visible as time progresses
    - Taste fruit for “off” flavours
  - Use a **sharp** knife and preferably with a blade longer than width of fruit
  - Must cut numerous fruit from the outer canopy in the lower and upper parts of the trees, and both sides.
  - **Calibrate** your focus, start with definite undamaged fruit

Damage assessment

- **Must cut fruit**
  - Assess whole patch randomly
  - Advised to cut at least 50 fruit per patch
  - Begin with cutting small fruit and include larger fruit
  - If only found in isolated area, continue sampling to define damaged section
    - Section off with flagging tape
  - Take note of numbers of damaged fruit (i.e. 2 in 100)
    - Record in diary for future reference (date & severity)
  - *Aim is to be confident no damage reaches market!*

Damage assessment

- Cut fruit in about 4 separate slices to assess whole of fruit (assess as cutting). Taste suspect fruit.

Fruit drop

- Do not depend on fruit drop
- Imperial mandarin fruit drop seen after 1 week of severe damage
- Oranges will eventually begin to drop, but not all damaged fruit will drop

Final messages

- Frosted areas, fruit possibly more susceptible to oleo or post harvest rindbreakdown
  - Treat fruit with more care; weaken rinds?????
  - Some damage maybe expressed when heated & waxed
  - Oleo problems can occur regardless of frost, do not blame poor harvesting practices on frost
- If suspected signs observed, suspend harvest and re-assess after more time
- Communicate with your packing house
- If damaged fruit is sent to market you could end up with a bill

Final wrap up

- Fruit with no obvious but suspicious damage don't harvest for 12 – 14 days.
- Constantly cut fruit to be ultra confident fruit it is OK
- Communicate with packer/agent
- Follow it through the packing shed
- Install data loggers – regional reference
- Let us know where the damage in the area is for regional reference.
- Presentation is available from ACG "Resources" web page (diseases & disorders)
- **Be vigilant - More frosts can still occur**

Thank you

- Lets go and cut some fruit