

Preventing Fruit Rots and Spray-associated Lenticel Issues in Apples

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Empire EXPO, Syracuse

17 Jan 2018

Outline

- Preventing fruit rots
 - Black rot
 - White rot
 - Bitter rot
 - Management
- Spray lenticel issues
 - Lenticel look & function
 - Known spray causes
 - Unknown
 - Distinguish
 - What can you do?



Preventing fruit rots

- Fungi -

- Black rot (*Botryosphaeria obtusa*)
- White rot (*Botryosphaeria dothidea*)
- Bitter rot (*Colletotrichum spp.*)
- Gray mold (*Botrytis cinerea*) –will not cover today

- All these fungi can later become storage-decays



Black Rot - *B. obtusa* -

Red Delicious



Cortland - Frogeye leaf spot



Gala



Photo by D.
Rosenberger

Black Rot

- *B. obtusa* -

- Overwinters in cankers, mummy fruitlets, dead bark, brush, trunk cankers (internal fungi decay), multiple hosts
- Infects fruit at warm rains (Spring: perithecia, Summer: pycnidia)
- Infects from petal fall - Harvest
- Forms dormant infections
- Fruit ripening activates the fungus
- It is a firm rot, mostly drier
- It inhabits fruitlet mummies after thinning
 - Lenticel infections occur on semi-mature fruit during summer
 - These infections are visible as lenticel spots
 - Later it can activate and continue to cause decay in storage
- Lenticel spots caused by white rot, black rot, and bitter rot possible if spray residue was lost before harvest.



Photo by D. Rosenberger

White rot

- *B. dothidea* -



White rot

- *B. dothidea* -

- Overwintering same as black rot
- Causes infections in hot summer days
- Soft rot (soggy, drippy fruit)
- Has irregular margins
- White rot on fruit in fall is firm similar to black rot
- It causes shallow bark cankers (trunk, branches)
- Typical sign is flaky bark on the trunk
- Drought stress helps trunk and branch infections (Schoeneweiss 1981)
- Do herbicides that hit trunk drought-stress the tree?



Black & White rot - Management -

- Good orchard sanitation:
- Prune, remove, burn, cankers & mummies
 - Brush should not be left flail mowed
 - Avoid pruning stubs
 - Prevent fruit bruising
- Fungicides
 - QoI (FRAC 11)
 - Thiophanates (FRAC 1)
 - Phthalimides (FRAC M4 – multi-site contact activity)

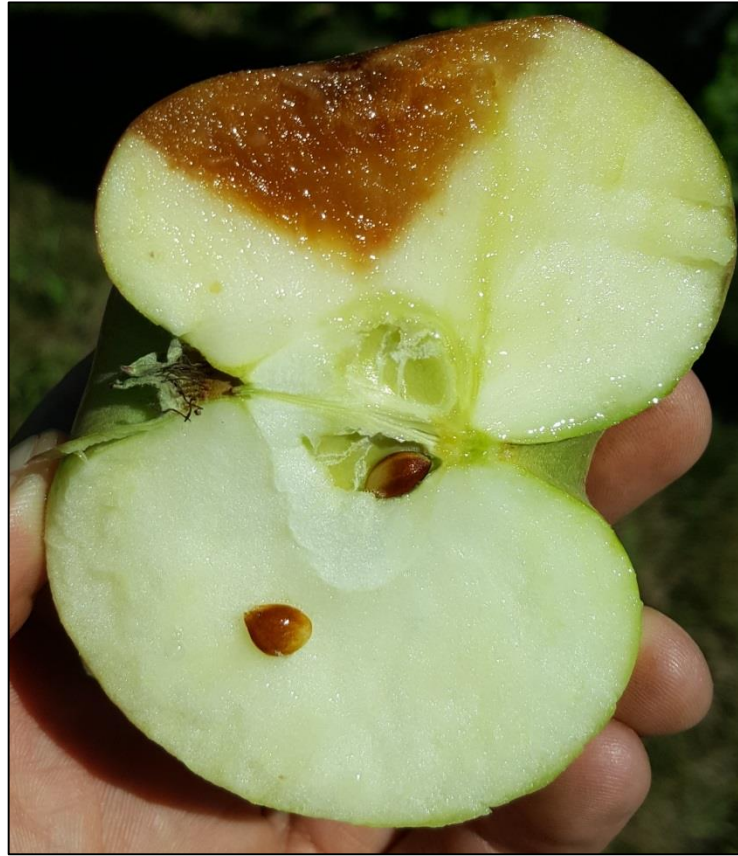


Top choice products

- Topsin-M/ Thiophanate Methyl + Captan (8 - 16 oz + 2.5 lb)
- **Topsin alone no bitter rot control**
- Flint + Captan (1.5 - 2.5 oz + 2.5 lb, also SBFS, bitter rot)
- Luna Sensation 4 - 5.8 oz (also SBFS, bitter rot)
- Merivon 4 - 5.5 oz (also SBFS, bitter rot)
- Sovran (3.2 - 6.4 oz + 2.5 lb, also SBFS, bitter rot)
- Pristine 14.5 - 18.5 oz (also SBFS, bitter rot)
- **Do not miss 10-15 July (based on lower Hudson Valley weather conditions)**
- **You must re-cover after >2 inch rain**
- **Make sure the residue is maintained on the fruit until harvest**
- Problem in organic orchards: liquid-lime sulfur for SBFS, oil (~1%), damage fruit skin
- Therefore fruit surface injury worsens rots in organic orchards

Bitter rot

- *Colletotrichum* spp. -



More Bitter Rot?

- Why? -

- Rare before mancozeb 77 PHI
- Hot, humid summers
- Susceptible cultivars
- Late-maturing cultivars
- More sprays Sep - Oct
- Less problems in North NY
- Worse on drought-stressed trees
- Fruit injury
- Spread rapidly if no fungicides
- Small bitter rot lesions near harvest
- Storage incidence West NY
- Dorman infection?
- Heat fruit injury?
- Sunny side infections?
- Different species – biology?
- Different management?
- Overwintering in NY?
- Relative importance of infection sources?
- Irrigate ahead of heat waves?
- Fruit cooling - overhead nets?

Bitter Rot Species on Apples in the US

- We do not know which species of fungi we have in NY -

Colletotrichum acutatum complex:

- *C. fioriniae* (Clade 2)
- *C. nymphaeae* (Clade 3)
- *C. acutatum* (Clade 4)
- *C. parananse*, *C. melonis*, *C. acerbum*, *C. godetiae*,
C. pyricola, *C. rhombiforme*, *C. salicis*, *C. piri*

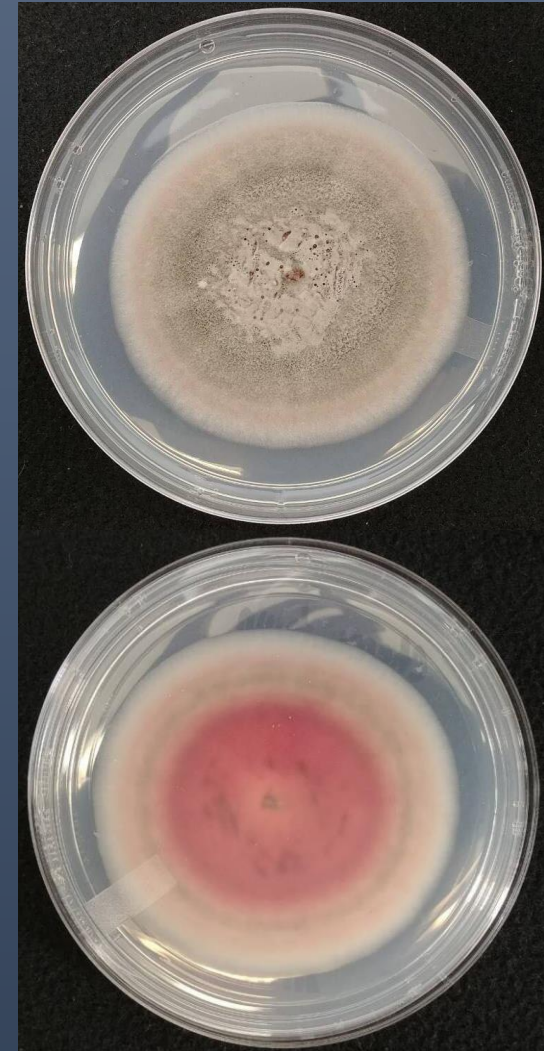
C. gloeosporioides complex (*Glomerella cingulata*)

- *C. gloeosporioides*
- *C. siamense*
- *C. theobromicola*
- *C. fructicola*
- *C. alienum*
- *C. aenigma*

C. boninense complex

- *C. karstii*

*Yellow ones are reported in literature to infect apple fruit



Do we have *C. gelosporoides*?

- We do not know which fungi cause bitter rot in New York -

- We found *Glomerella* leaf spot in Warwick, NY
- It is a exual stage of *C. gloeosporioides*
- Found on Fuji, Jonagold
- It caused low crown defoliation
- *C. acutatum* is reported to predominated in cooler regions vs. *C. gloeosporioides* that is predominant in warmer regions



Management

- Why sp. matters? -

- *Colletotrichum* species vary in fungicide sensitivity
- *C. gloeosporioides* complex are susceptible to benzimidazoles vs. *C. acutatum* complex (Topsin M)
- The same is for: Rally, Flint, Captan
 - **Topsin M does not control bitter rot**
- Also susceptibility to DMI-s (triazoles) varies as well depending on species
- Vary in resistance to QoI, SDHI-s: Fontelis good on *Ca*, not *Cg*
- There are location-related differences in which bitter rot species are present
- If fruit is stored below 41°F, and sold before senescence, bitter rot might not be an issue
- *C. acutatum* complex species grow below 41°F

Management

- Options -

- Sources of infection: Many wild hosts hedgerows, woods
- Remove dead wood, brush
- Remove floor decayed fruit
- Maintain grass strip below trees – it helps decay rotten fruit on the ground
- Thinned fruit left hanging in the canopy give inoculum for ripening fruit on the tree
- Fungicides
 - Use full rates of Captan if used alone
 - Ziram
 - Qol-s + captan
 - Flint, Merivon, Luna Sensation, Sovran, Pristine
 - *C. acutatum* clade more tolerant to Topsin, Rally, trifloxystrobin, captan



Management

- What if -

- Spray from 10-15 July until harvest (based on lower Hudson Valley weather conditions and disease pressures)
- Where bitter rot shows on a valuable cultivar spray full rate of Captan + 18.5 oz /A of Pristine or 5.5 oz/A Merivon, or Luna Sensation 5.8 oz/A, add LI-700 to enhance fruit coverage
- Repeat as 10-14 day intervals
- Maintain fungicide coverage up until harvest (Honeycrisp)
- October sprays are a must for late maturing cultivars
- If more than 2 inches of rain occur you have to respray
- **Cut fire blight strikes out**
- Storage incidence happened in fall 2016 in West NY: stem and calyx infections established in Fall 2016
- Cool fruit below 40°F immediately
- Postharvest use of Scholar (fludioxonil) an option only for freshly initiated infections
- It will not kill the fungus once it has penetrated in the fruit

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Spray-related Lenticel Issues

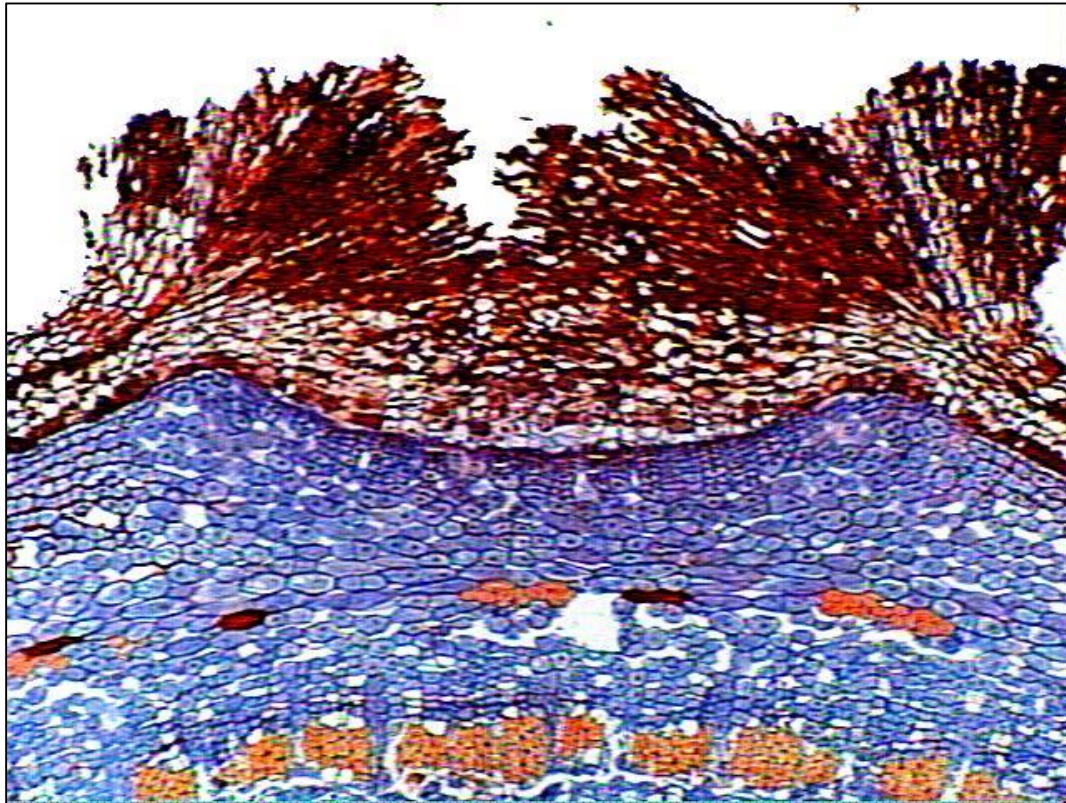
- Causes -

- Extremely difficult to diagnose in storage (when we get questions about it)
- Slightly easier to diagnose in orchard
- Lenticel damage is also caused by environmental factors
- Later change of symptoms can happen due to secondary fungi, further complicating the diagnosis

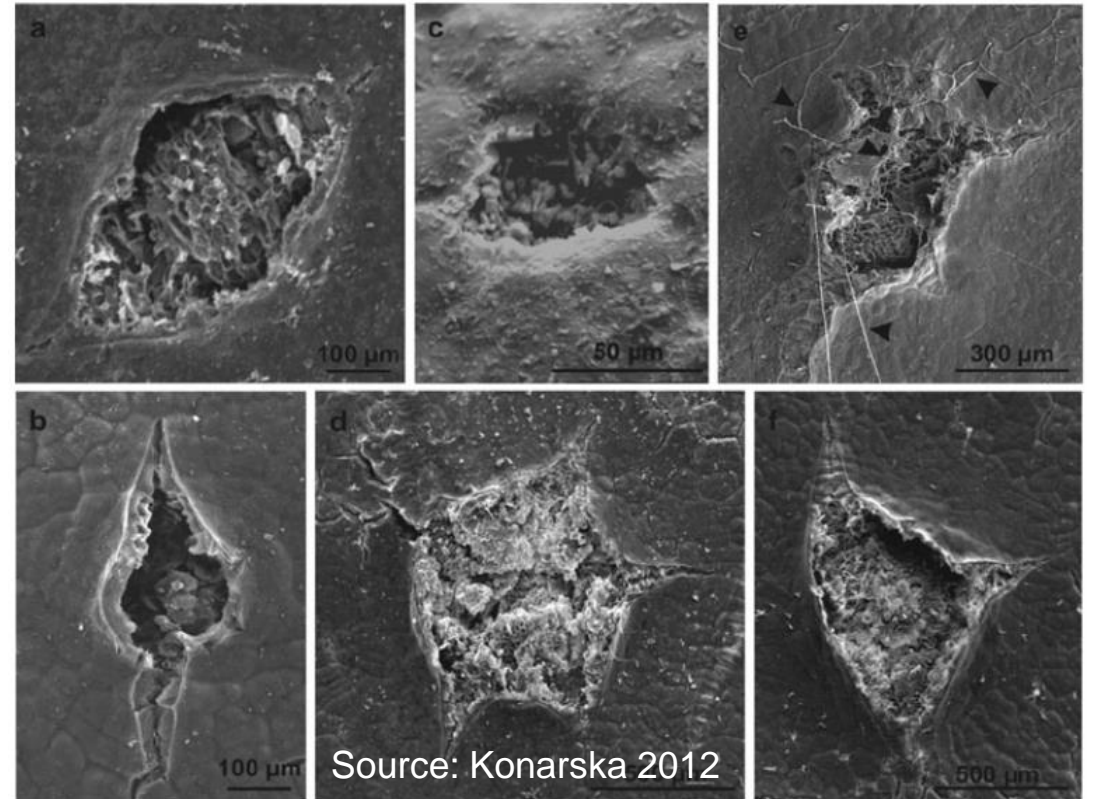
- **Lenticel** is a porous tissue of cells with large intercellular spaces in the periderm of the secondarily thickened organs
- **Functions** as a pore, i.e. pathway for the direct exchange of gases between the inside tissues and atmosphere

Lenticel

- Dynamic Tissue -



Source: <http://www.bio.miami.edu/dana/dox/stem.html>



1. Captan + surfactant lenticel injury

- Penetrating adjuvants -

- Injury can happen due to uptake of captan into fruit flesh through lenticels if:
 - Captan applied before or after an oil (within a 2-week period)
 - Damage to sensitive varieties: Marshall McIntosh (West NY)
 - Captan + liquid calcium (contains adjuvants to allow Ca uptake and captan as well)
 - Captan + oil, Captan + surfactant: pesticide, thinner, nutrient (Ca)
- All these allow captan (toxicant) to penetrate into lenticels
- When heavy rain after drought occurs, and inconsistent water supply is provided, fruit rapidly expand, lenticels crack thus allowing uptake of captan
- Spray mix penetrates via damaged lenticels
- Especially damaging when wax cracks occur on fruit, switching from hot to rainy conditions

July 2010, McIntosh - Champlain Valley -



Photos by D.
Rosenberger

Oct 2016 Marshall McIntosh - Champlain Valley -



Photos by Anna Wallis

2. Lenticel injury - Copper Sprays - Liberty -

- Summer copper sprays in dilute sprays and/or at high rates can cause the injury
- Common in organic orchards
- Occurs in conventional orchards when low-rate copper sprays are used for shoot blight sprays
- Copper spray from bloom and 4th cover (~July 4 in NY) causes blackening at the lenticels.



Photo by D.
Rosenberger

3. Lenticel injury - Calcium Spray - Calcium burn -

Calcium Burn

Lesions are superficial and localized. Affected lenticels are dark brown to black. Often visible at harvest.



Photos by Curry et al

Photos by Meheriuk et al 1994



15



16

Fig. 15 Calcium chloride injury (Spartan)

Fig. 16 Calcium chloride injury (Golden Delicious)

Spray Considerations – What Promotes Lenticel Injury?

- Diagnosis in orchard -

- Time of day when sprayed - slow drying more uptake
- Shaded sides of fruit have very thin cuticle, slower drying after sprays, or are residues are redistributed by rainfall
- Lower crown = higher dose, slow drying, more injury on fruit
- Products applied at too high temperatures
- Crown position and side of fruit closer to sprayer before harvest?
- High-velocity airblast sprayers might infuse spray materials into lenticel?

- Distinguish: stink bug damage mostly on stem end half of the fruit (clustered on a shoulder due to feeding under a leaf)

4. Lenticel injury - Unknown Causes -



Photos by D. Rosenberger (Rome)



Empire (spray during the latter half of the season)

4. Lenticel injury - Unknown Causes-



4. Lenticel injury - Unknown Causes-



Photos by D. Rosenberger (Rome)

Observations by Dr. Rosenberger

- If spots are on calyx half of the fruit, good chance that the problem is related to low calcium in fruit, even if fruit do not show traditional bitter pit
- If 1-MCP (Harvista, SmartFresh) is applied to low calcium fruit, then MCP-induced lenticel blotch can occur
- These look like dime-size blotches of dry necrosis of the skin layer, with little or no necrosis of the flesh
- Past several years, reported to us mostly on Red Delicious in West NY

Case: Sep 2017, Koru

- Lenticel cracking, West NY -

- Lenticel cracks in drought years
- In the past Benlate damaged fruit increased lenticel damage
- Drought could cause low Ca intake
- Ca/Mg ratio bad; hence low Ca
- 1-MCP (Harvista) increases problem in low Ca fruit
- Diagnosis gets more complicated after saprophytic fungi move in

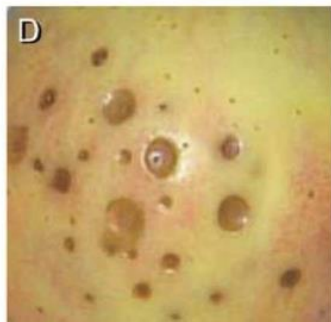
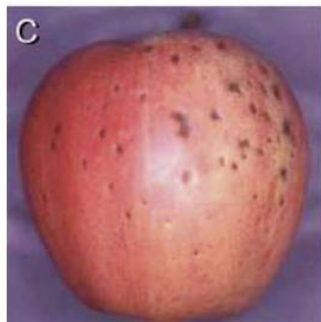
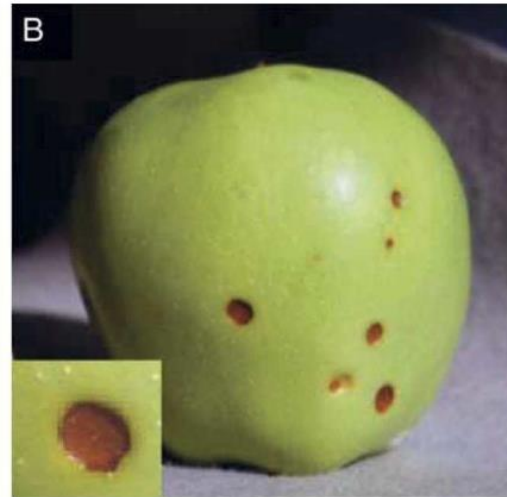
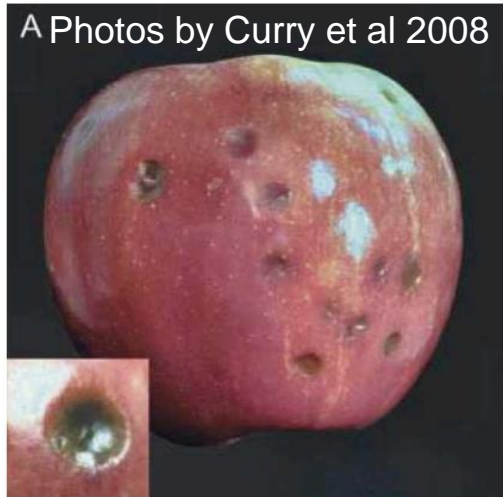


Photo by C. Khalke (Koru)

Physiological disorders

- Hard to differ from spray injury -

- **Lenticel breakdown** - physiological disorder: Gala, Honeycrisp, Fuji, Ambrosia



Mineral disbalance in fruit underlying factor besides the environmental factors

Lenticel Breakdown

- Curry et al. -



PROGRESSION



Distinguish Bitter Pit

- Bitter pit has sunken, irregular, mostly diffuse edges -



Photo: Poliana Francescato (Honeycrisp)

Change of lenticel injury symptoms

- Fungal saprophytes move in -

1. Lenticel damage?
2. Mixed symptoms!
3. Secondary invaders move in on the dead tissue: fungi or yeasts (*Aureobasidium spp.*)
4. If no fungi are isolated from these injuries, then the cell death is the one caused by infiltration of either preharvest or postharvest chemicals into the flesh via damaged lenticels



What can you do?

- Pay attention to when the High Risk of lenticel damage is: It is when fruit grow slowly due to drought stress in July-August, and then switch to rapid growth before harvest. That is significant precursor for lenticel and skin cracking allowing more lenticel injury
- Special care when spraying drought stressed trees (mid-July - harvest)
- Irrigate well BEFORE predicted drought to prevent drought stress in trees
- Avoid applying complicated spray mixes
- Avoid applying excessive surfactants
- Avoid tank mixes such as: Captan + calcium, oil, nutrients - surfactants for uptake
- Be cautious with weird spray mixes! Before you apply it – try it on 1-2 trees
- Especially for heavy rains after drought

- Distinguish: stink bug damage, late rots that move in if residue is washed off

Acknowledgements

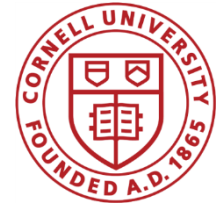
This work was supported by the NY Apple Research and Development Program

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Dr. David Rosenberger
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ACIMOVIC LAB

FRUIT TREE PATHOLOGY



Thank you for attention

Questions . . .