# Sweet cherry fruit cracking: mechanism and countermeasures

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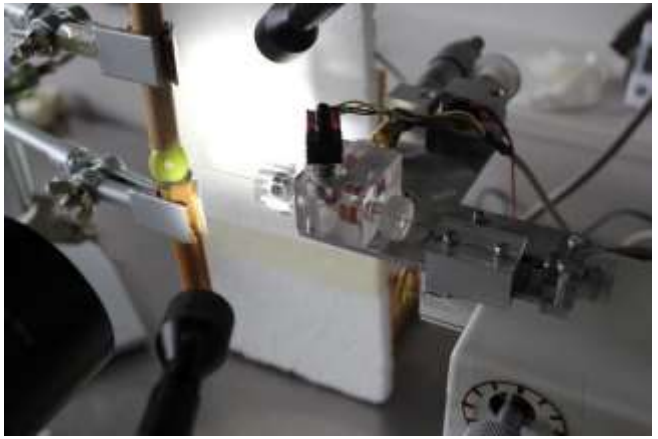
# Program

- Why do cherries crack?
- Countermeasures
  - Rain covers
  - Ca salts
  - Magic stuff

# Traditional view

-Π= -30 bar  vs  P = 0.3 bar



No excessive pressure in rain

cracking!

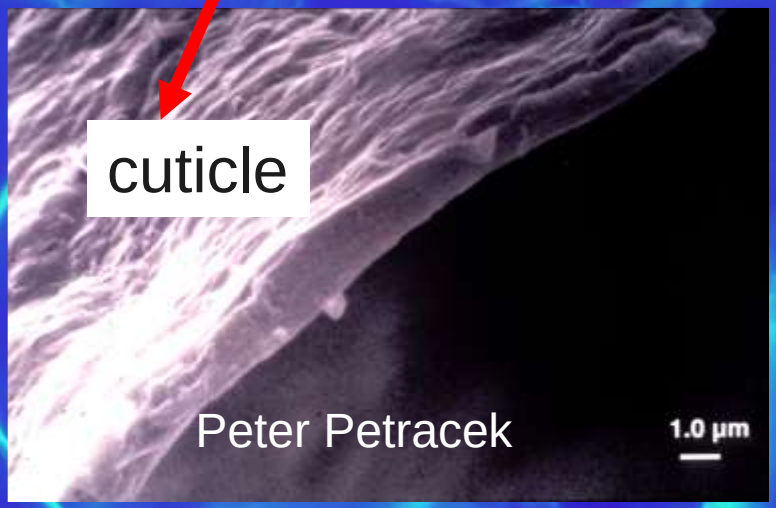
Proper terminology is

strain-cracking!

# The fruit skin

Skin cells

Flesh cells




Cuticle: barrier in water transport

invasion with pathogens

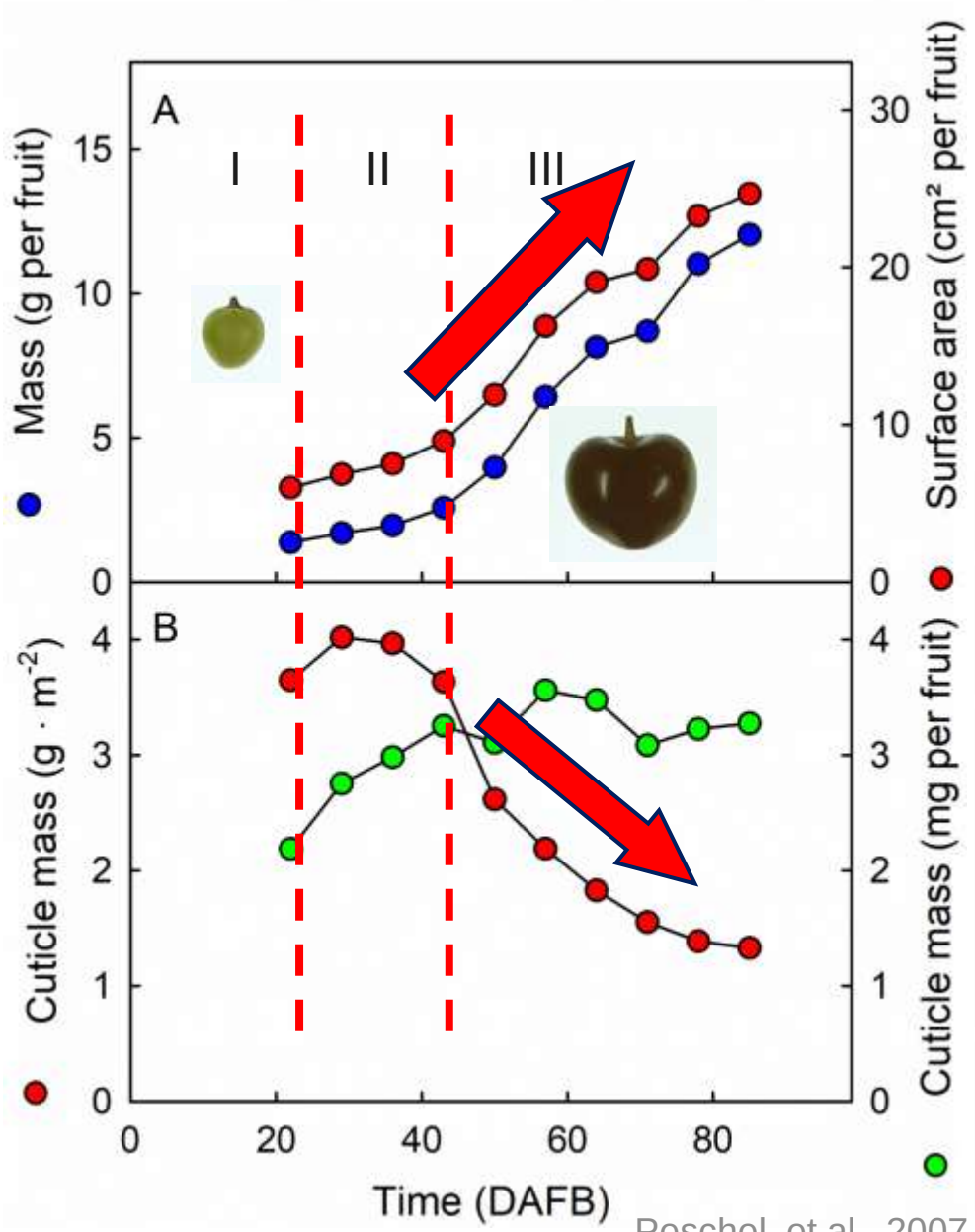
Skin cells and cell walls:

structural strength

Flesh cells: Storage

Martin Brüggenwirth

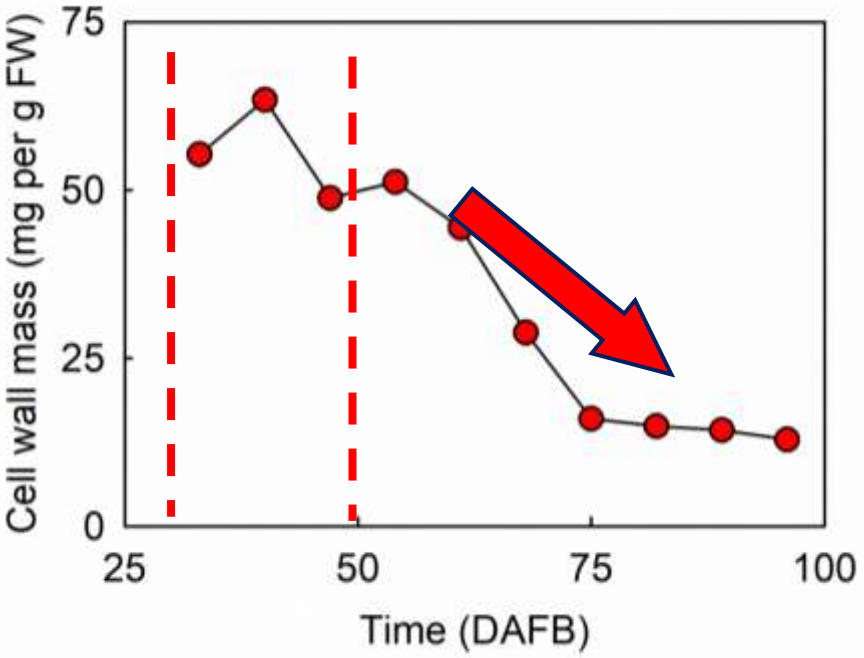
# The skin during fruit development



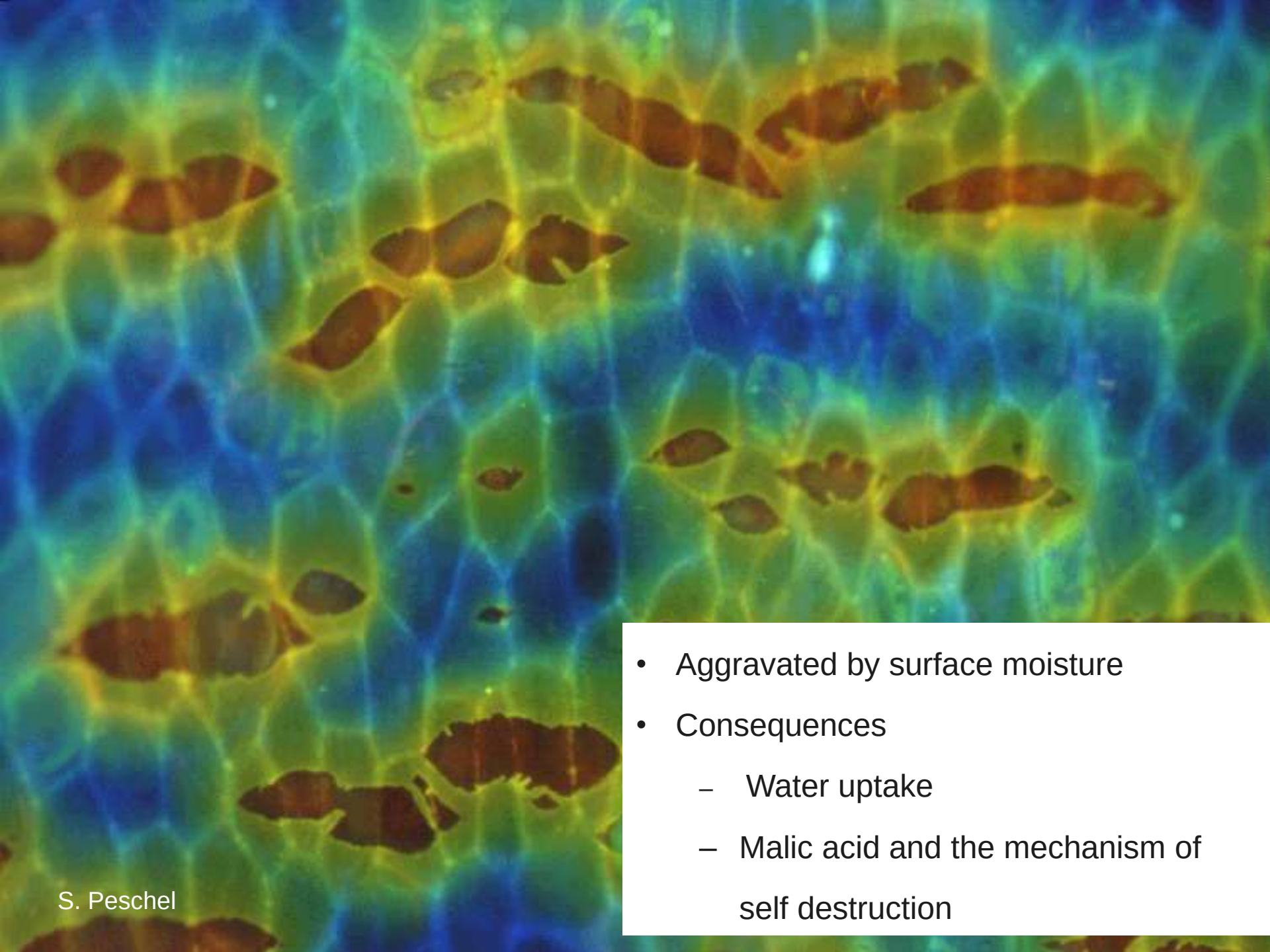

Peschel et al., 2007

No variation among 30 genotypes

Shut down genetically controlled



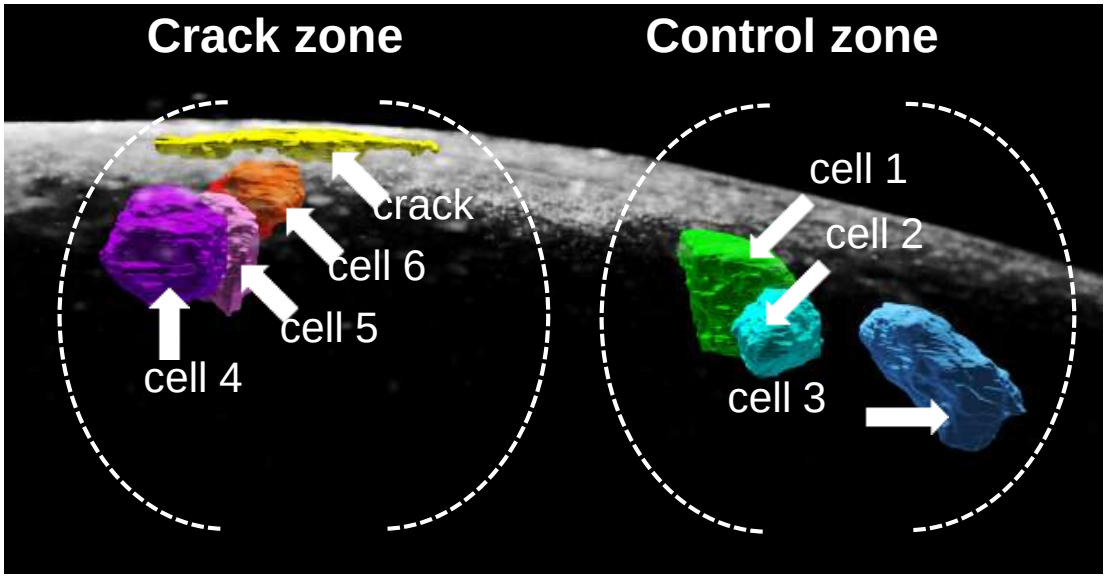

Schumann et al., 2020

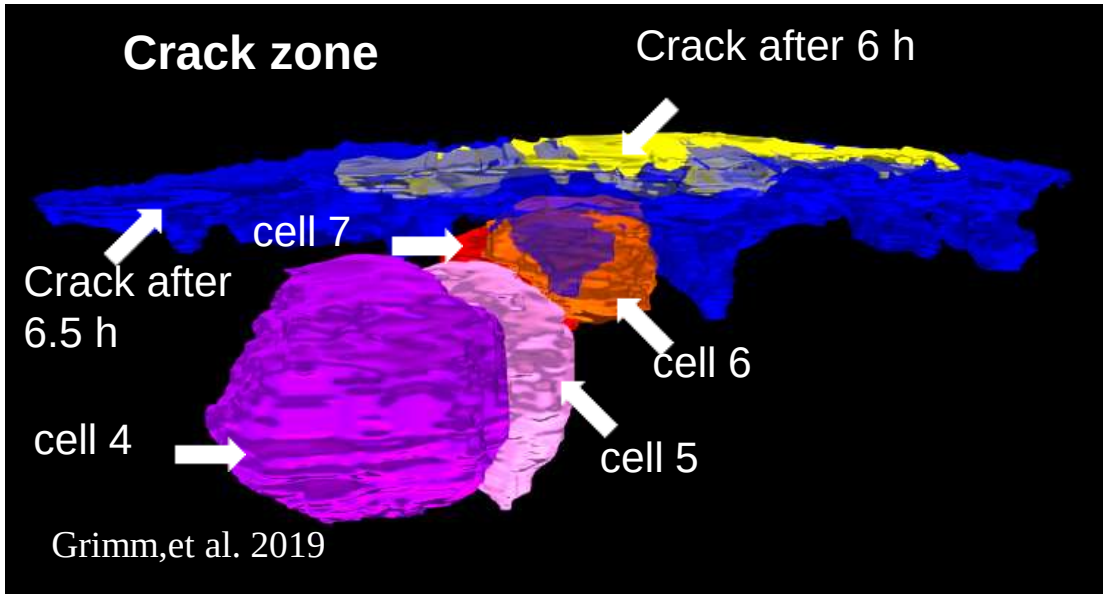


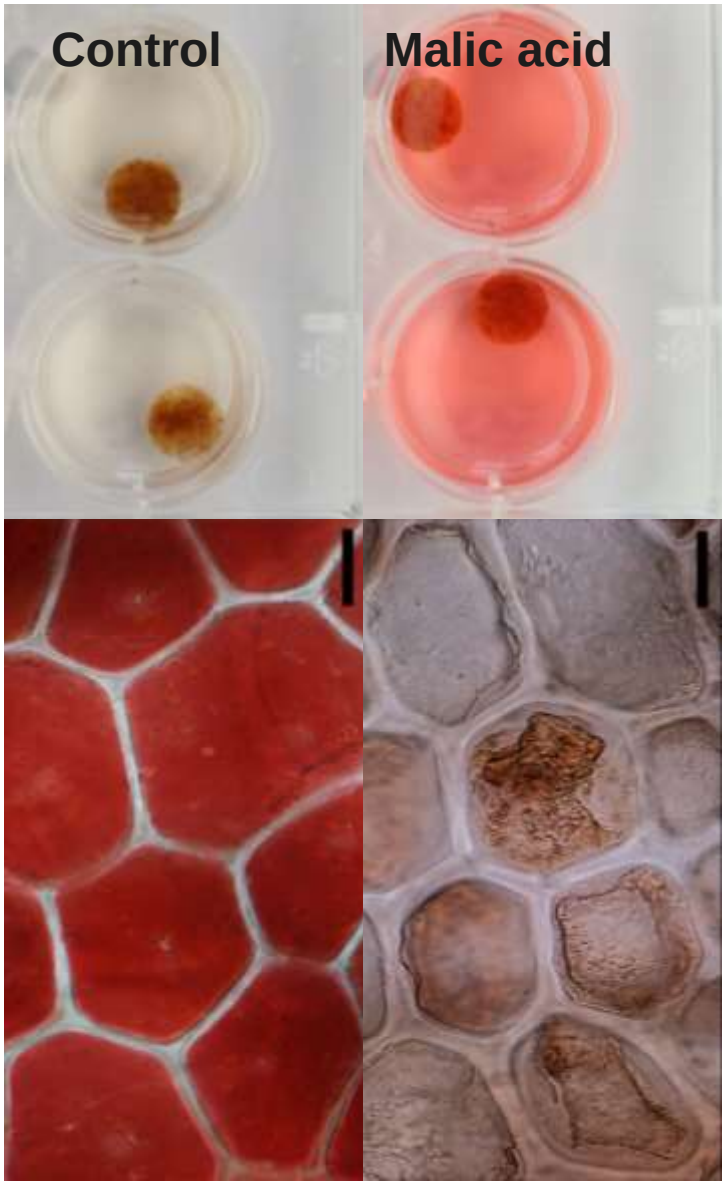
- Aggravated by surface moisture
- Consequences
  - Water uptake
  - Malic acid and the mechanism of self destruction

S. Peschel

# Water uptake, cell bursting and release of malic acid

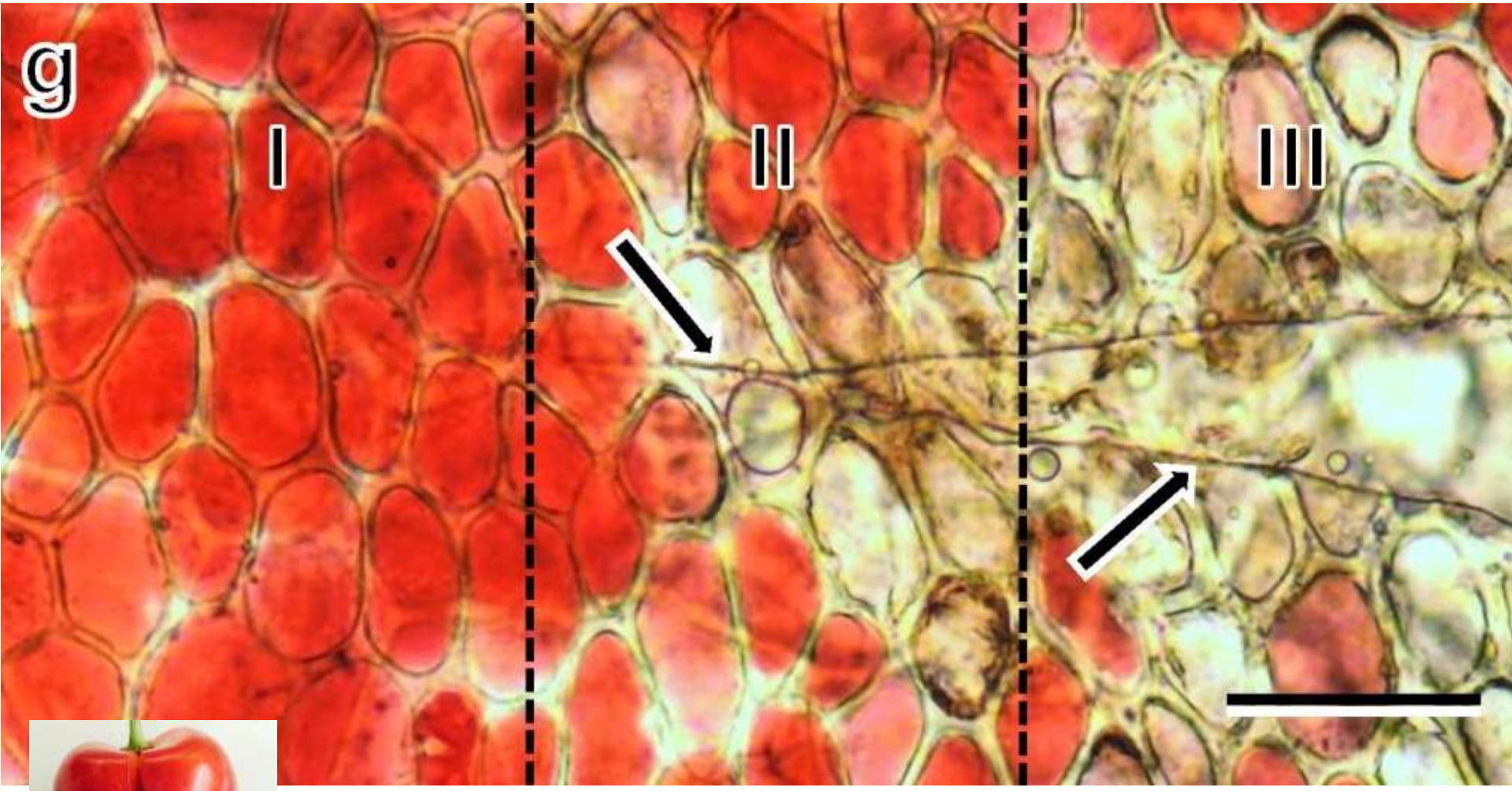


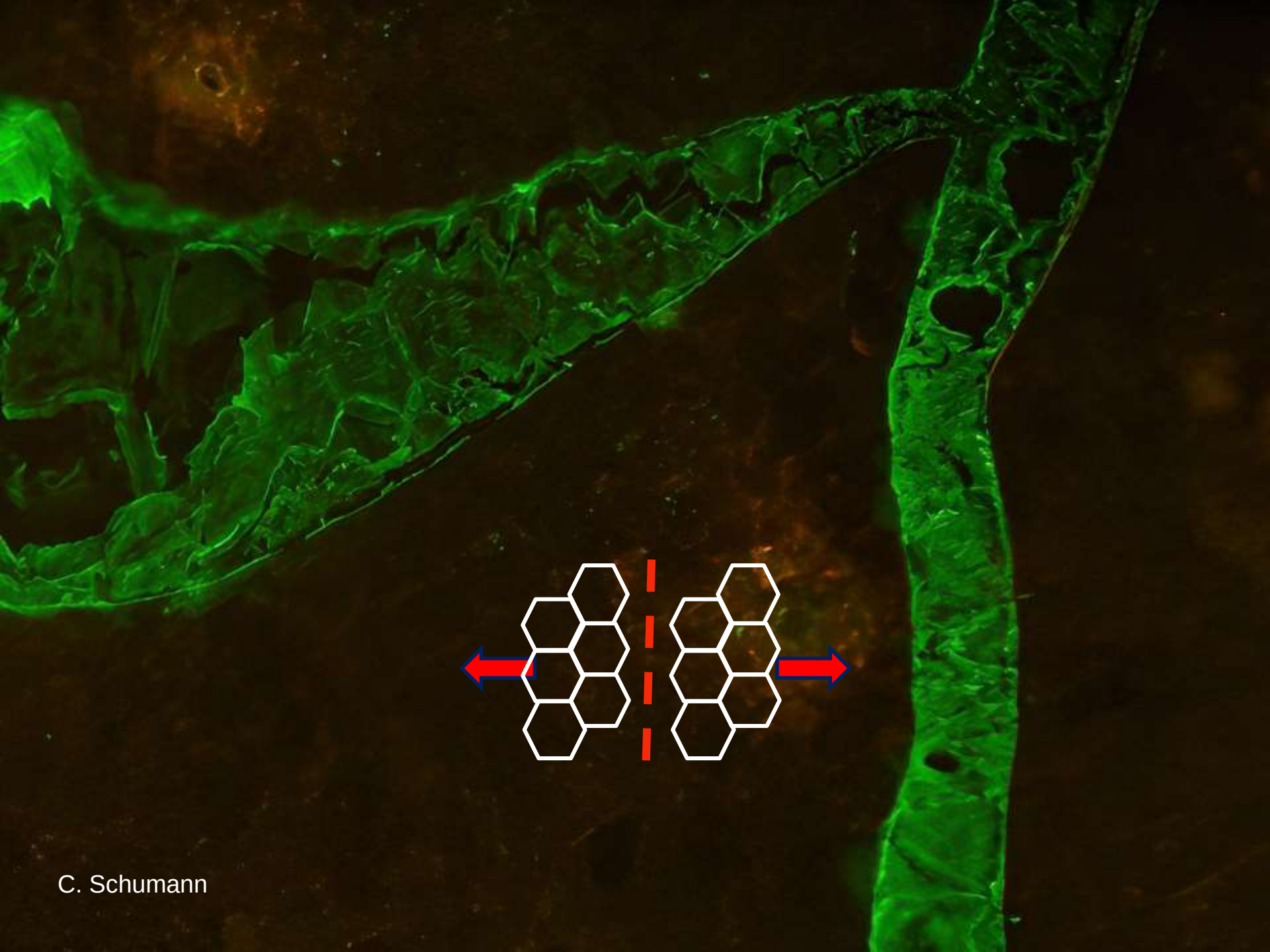




Water uptake is localized!

# The crack begins to run – from microcrack to macrocrack

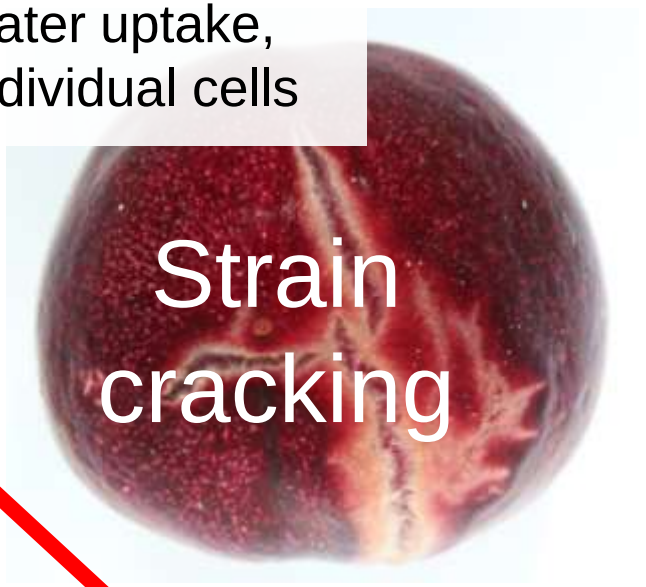




C. Schumann

# The zipper model

Increase in area, no cuticle deposition → Strain of skin and cuticle, microcracking → Surface moisture aggravates microcracking

Localized water uptake, bursting of individual cells




Leakage of malic acid, leakage of membranes

Cell wall swelling → Decreased cell to cell adhesion → Decreasing fracture pressure

# Program

- Why do cherries crack?

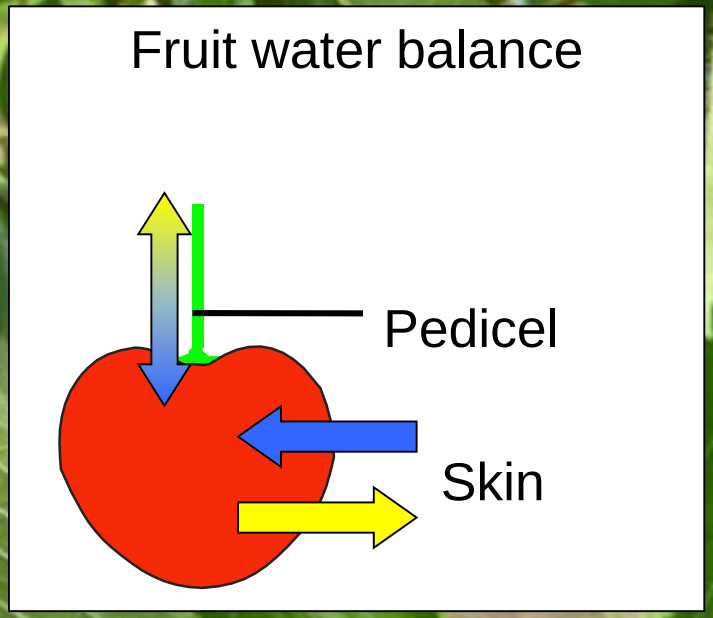
  …….or the myth of turgor

- Countermeasures
  - Rain covers
  - Ca salts
  - Magic stuff

Rain shelters are effective against cracking

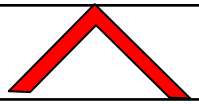
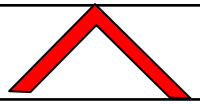
but:

devastating cracking may occasionally occur




Vignola 2019

# Water balance of fruit

| Parameter | Unit | | | | |
|---|---|---|---|---|---|
| | | |  | |  |
| | | Open field + sun | Shelter + sun | Open field + rain | Shelter + rain |
| VPD | kPa | 1.2 | 0.8 | 0 | 0 |
| Transpiration | mg $h^{-1}$ | -15.9 | -10.6 | 0 | 0 |
| Uptake skin | mg $h^{-1}$ | 0 | 0 | 19.4 | 0 |
| Phloem | mg $h^{-1}$ | 17.6 | 17.6 | 17.6 | 17.6 |
| Xylem | mg $h^{-1}$ | 5 | 5 | 5 | 5 |
| Total | mg $h^{-1}$ | 6.7 | 12.0 | 42.0 | 22.6 |

# Why do cherries crack under a rain shelter

**Reason:**

- **Lack of transpiration**
- Vascular inflow via phloem (and xylem - low)
- Uptake of water from the vapor phase (low)

**Measures**

- Open canopy and short grass
  mulch to maximize transpiration
- Question: Would removal of
  excess soil moisture from
  tractor alley work?

Drainage pipe

# Program

- Why do cherries crack?
- Myths, miracles and mysteries
  - Myth: Rain covers prevent cracking
  - The truth about Ca
  - Mysteries: Magic stuff

# Calcium – the magic element?

- Ca crosslinks cell wall constituents
- Ca prevents cell wall swelling
- Ca increases fracture force of fruit skin

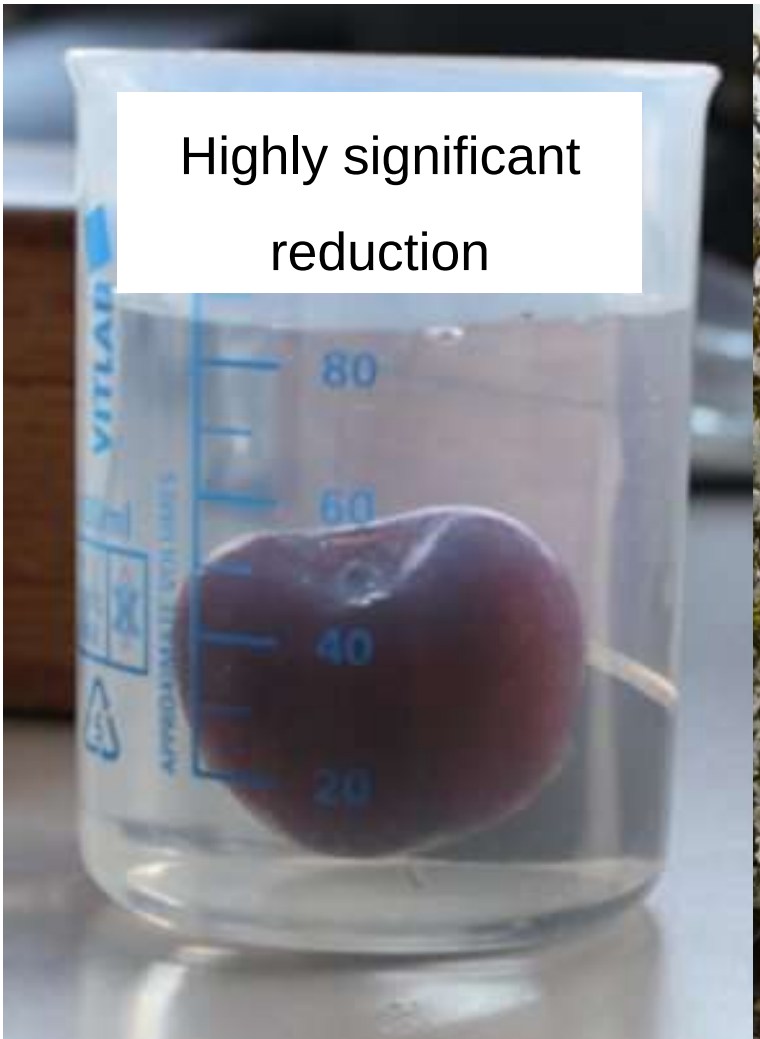
stage II stage III

But:

- Xylem breakdown prevents Ca import
- Ca import is limited to early fruit development
- Ca import related to transpiration of fruit

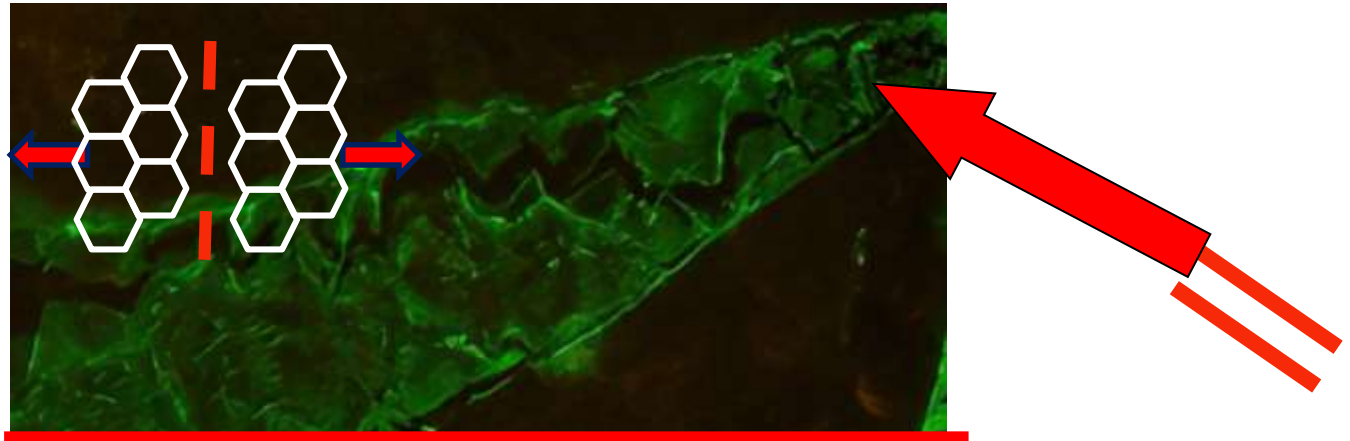
# Calcium – performance

Uptake similar, but effect on cracking very different




# Can Ca ‘jam‘ the Zipper?

- Multiple applications (6-9x) increase uptake up to 1.6-fold, but no or small (!) effect on cracking
- Decrease in cracking larger when sprayed on wet surface
- Ca must have access to ‚running‘ crack to jam the zipper, elsewise Ca concentration in cell wall too low!



Yes, but do not expect miracles!

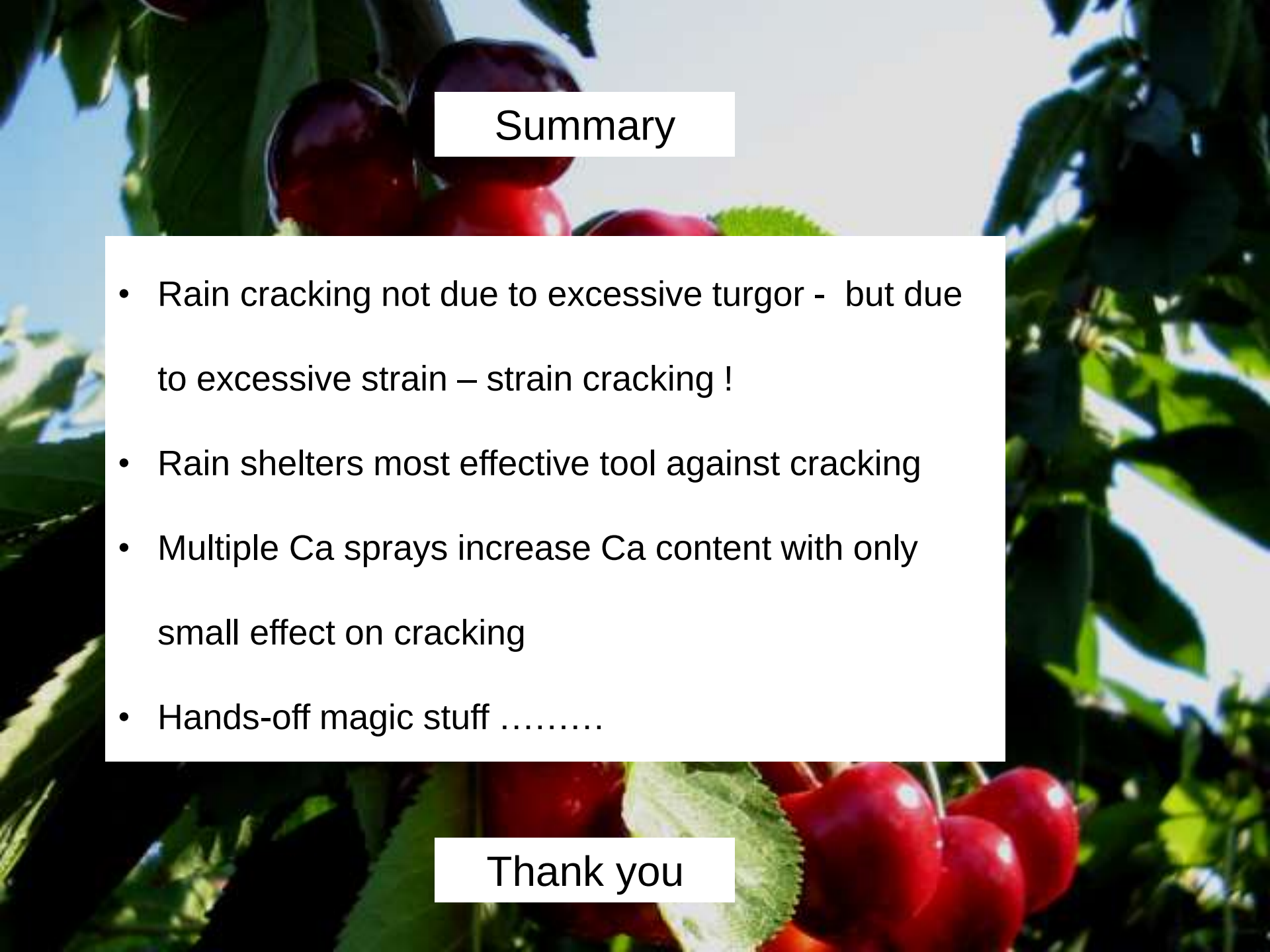
# Program

- Why do cherries crack?
- Myths, miracles and mysteries
  - Myth: Rain covers prevent cracking
  - Miracles: Postharvest cracking
  - The truth about Ca
  - Mysteries: Magic stuff

# Mysteries: Magic stuff

- Irrigation scheduling: xylem is non-functional, effect on phloem hard to predict
- Spray application of osmolytes
- Spray application of film forming agents
- Magic stuff: silver bullets, snake oils….. – this helps the wrong people!

….and the cracked cherry



# Summary

- Rain cracking not due to excessive turgor - but due to excessive strain – strain cracking !
- Rain shelters most effective tool against cracking
- Multiple Ca sprays increase Ca content with only small effect on cracking
- Hands-off magic stuff ……

Thank you