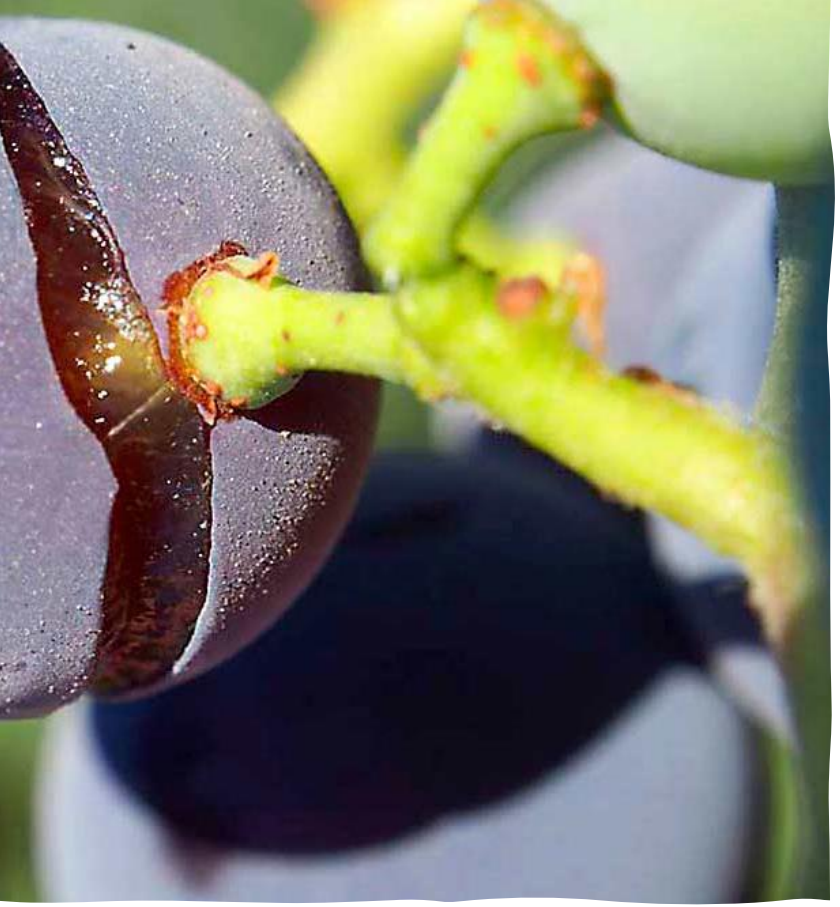
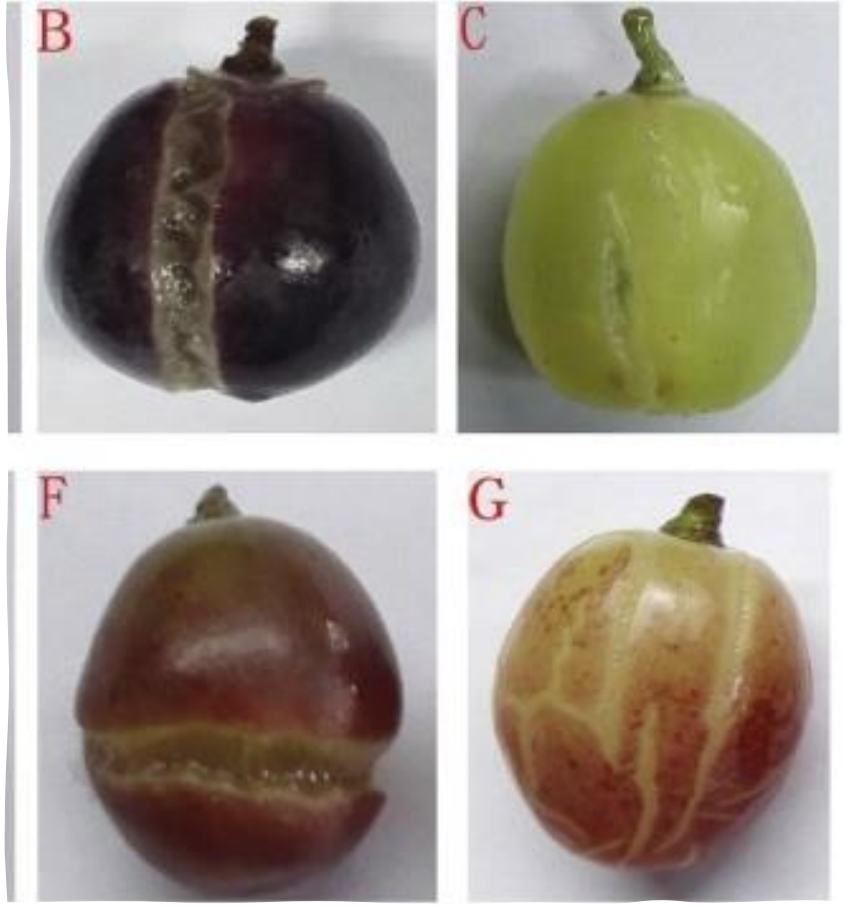
Mitigating Grape Berry Cracking through Modulation of Berry Skin Elasticity

Justin Lashbrooke
Stellenbosch University

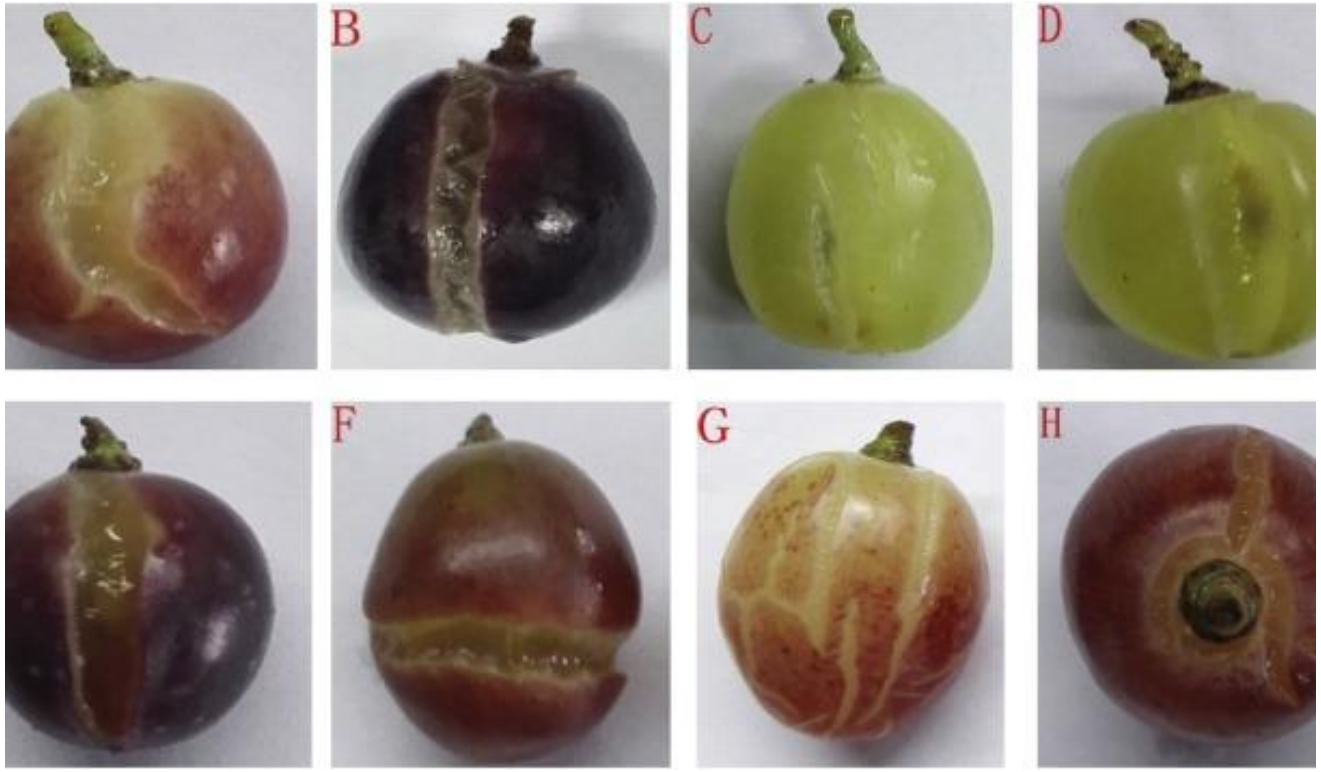




What is berry cracking?

- Berry cracking is a major problem for grape growers worldwide,
- For an export dominated industry, like that of South Africa, the problem is further amplified

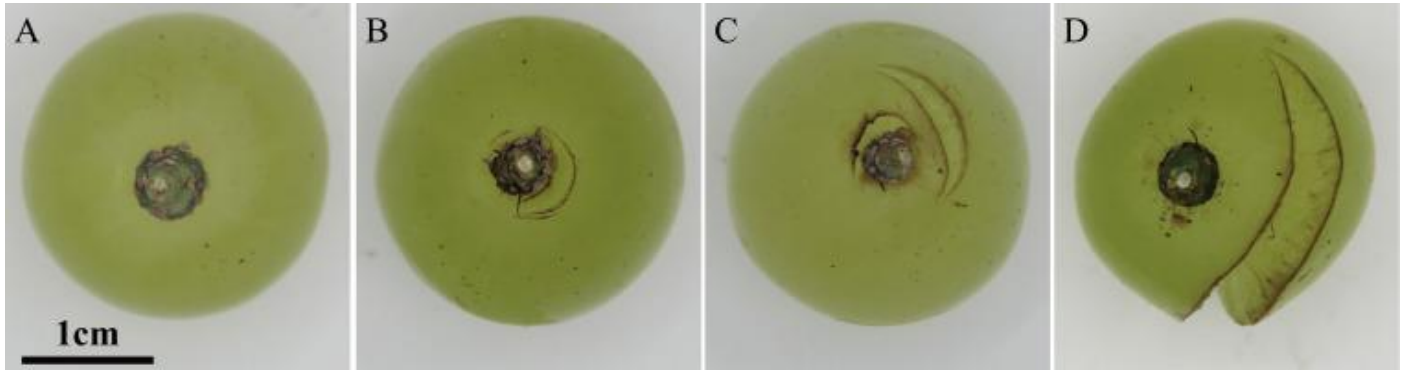
Berry cracking

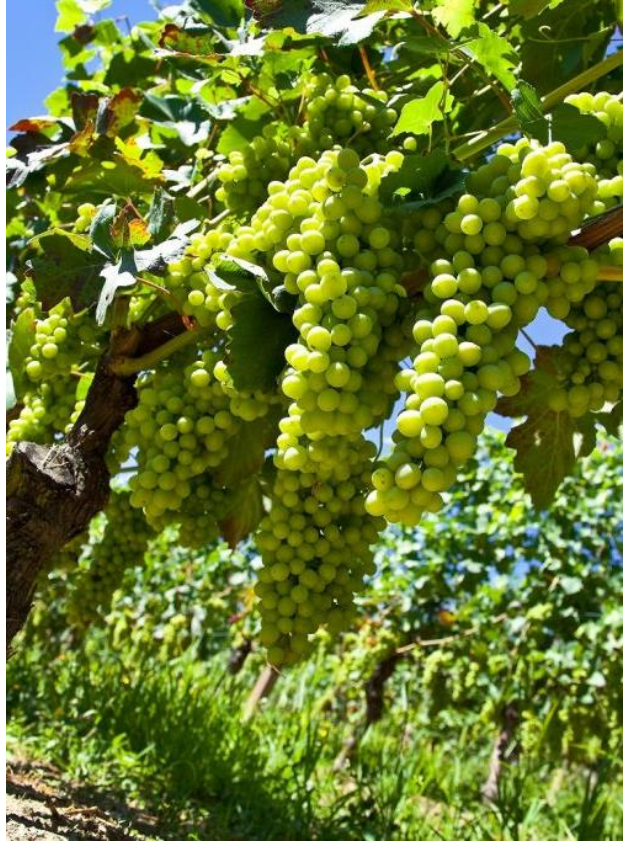


- In certain years, table grape growers will report berry cracking
  - **Environmental connection**
- Specific cultivars more susceptible to cracking
  - **Genetic link**
- Berry cracking jeopardizes profitability by increasing harvest costs and decreasing yield.
- Fruit quality and storage life both on the vine and in cold storage are also reduced
  - Significant concern for exports

Causes

- Environmental conditions
  - Specific timing of rains
  - Rain before harvest
- Genetic factors
  - Some cultivars extremely resistant to cracking
  - Others susceptible



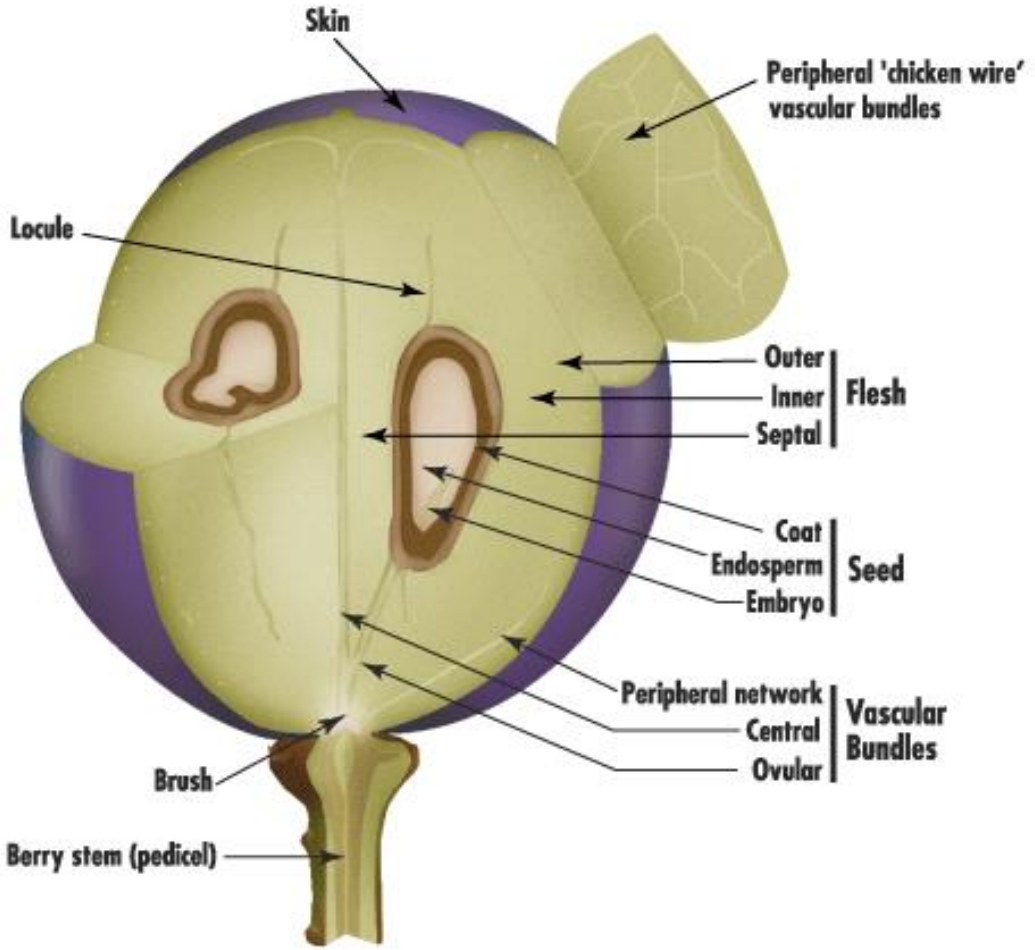



Mitigating berry cracking

- Application of different biological growth agents is performed
  - Cytokinins
  - Gibberellins
- Sporadic success

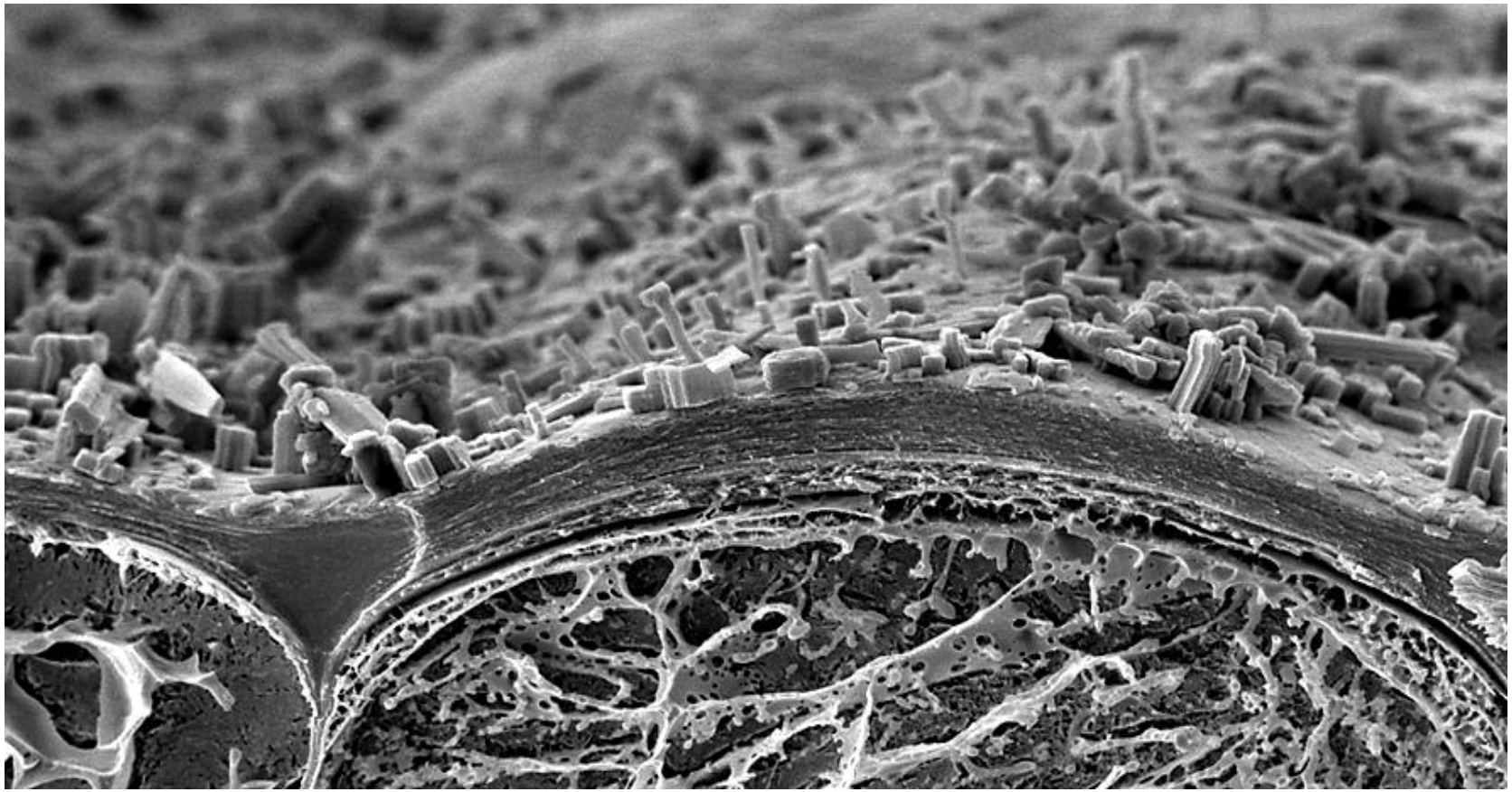
What are the molecular physiologies involved?

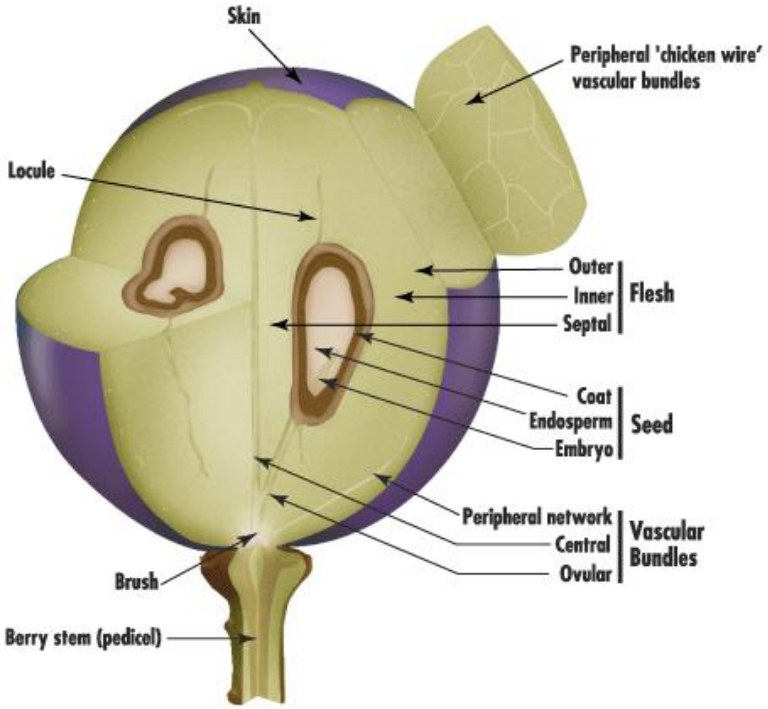
- Berry surface
  - Cuticular layer

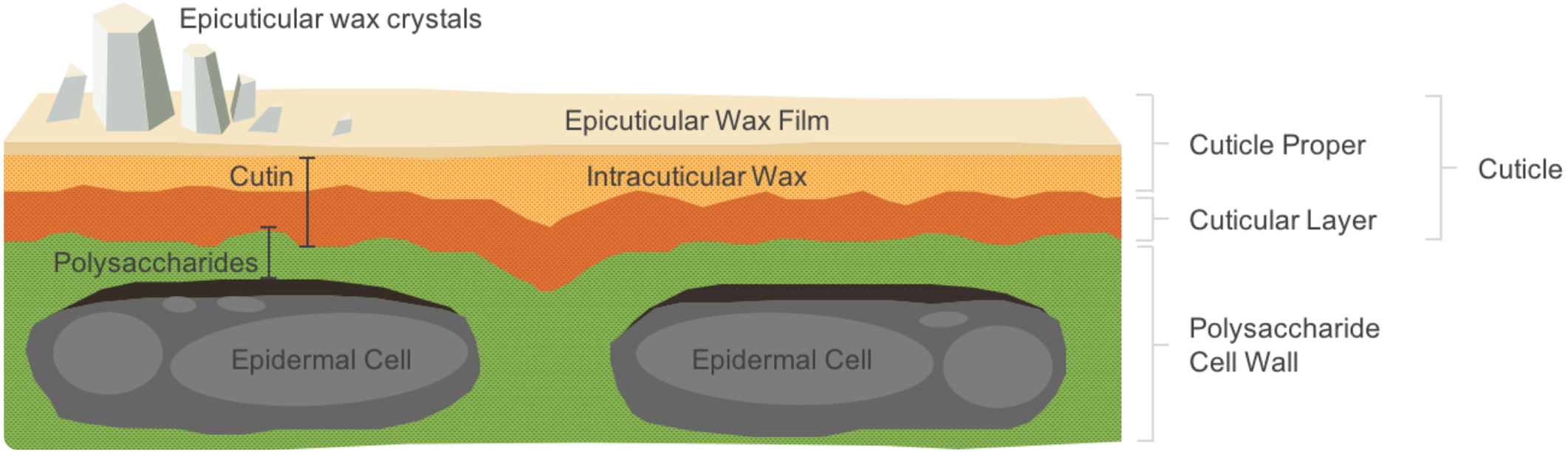


The Plant Cuticle

Outermost layer covering all aerial plant surfaces







Role of the cuticle

- Waterproof barrier: mediating the permeation of solutes, gases and water
- Defence - biotic & abiotic
- Mechanical and structural support to plant organs

What are the molecular physiologies involved?

- Fruit cuticles are specifically adapted to undergo rapid expansion during fruit ripening
- Cracking occurs do to the elasticity of the fruit surface being unable to cope with the expansion

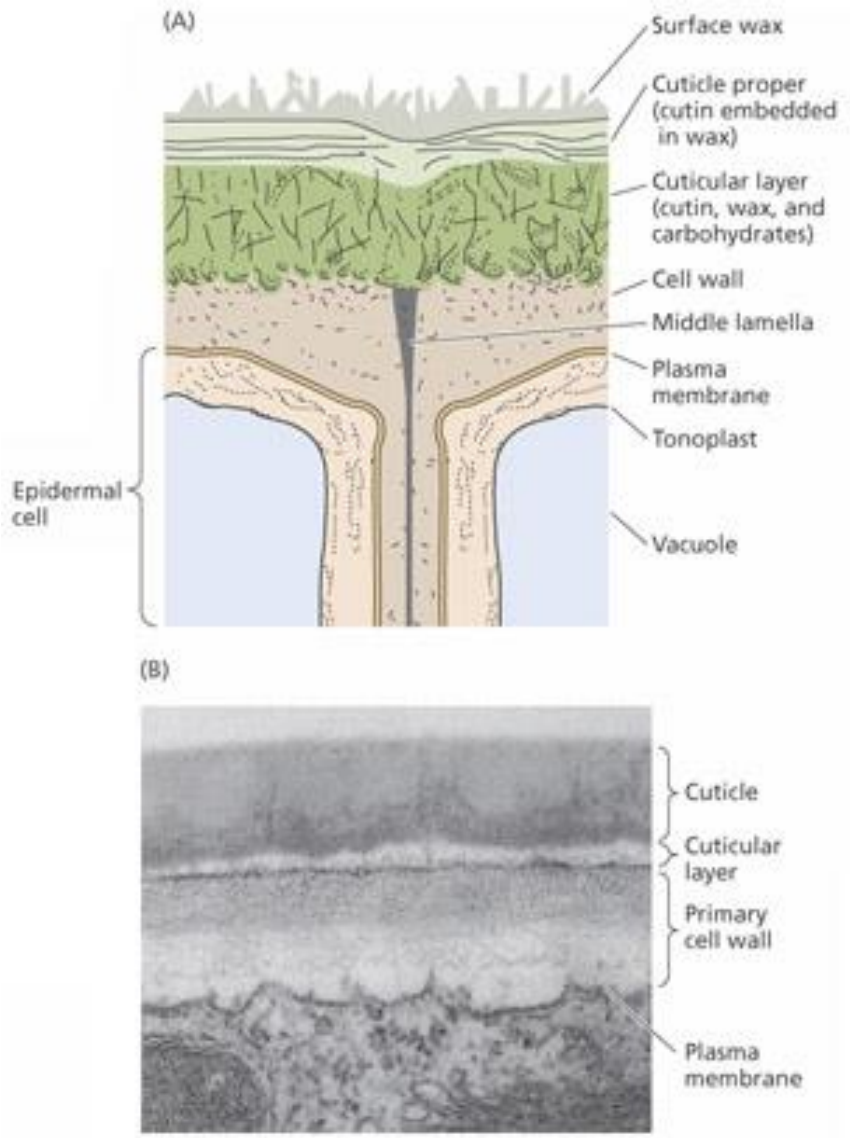


Lessons from other crops

- Tomato, apple, cherry
  - Definite genetic link
  - Environment has a massive impact

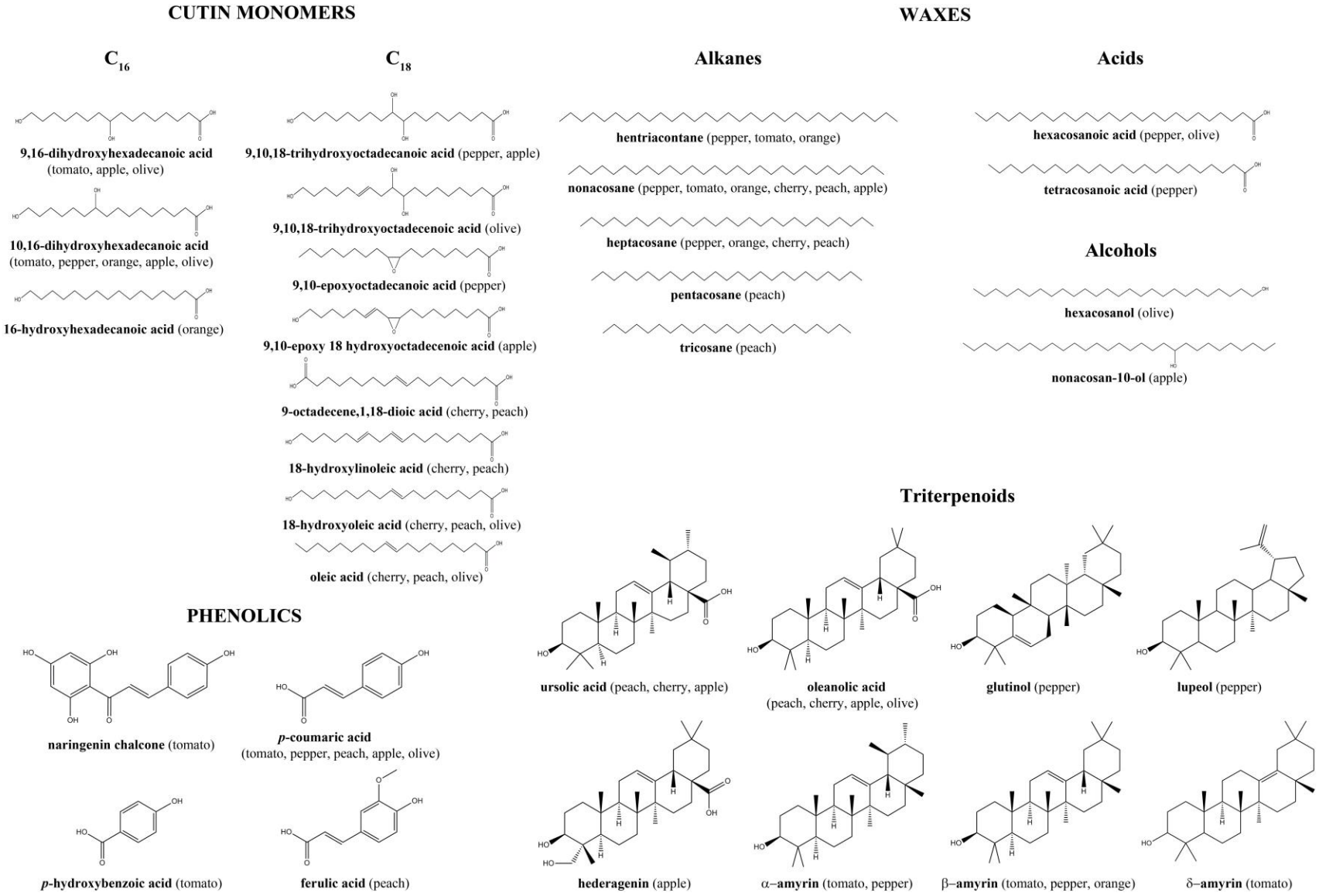
Cuticle composition

- Massive diversity between species and organs
  - E.g.: Fruit vs leaf
    Grape vs wheat
- Two major components of the cuticle:
  - Cutin matrix
  - Waxes



- Chemical analysis of grape berry cuticles shows over fifty specific compounds
  - Fatty acids, fatty alcohols, alkanes, aldehydes, phenolics, triterpenoids

Cuticle composition



Impact of cuticle composition on berry cracking?

- Hypothesis:
  - Cuticle properties such as ***strength***, ***elasticity*** and ***permeability*** are not determined by the total quantity of cuticle, but rather by the specific composition of the cuticle

Project plan: establish methods

1

Establish methods to quantify crack*ability*

- Can we reliably induce cracking in susceptible cultivars?

2

Establish methods to quantify tensile properties of grape berry skins

3

Establish methods to chemically analyse the monomer constituents of the cuticular layer

What I need from you

- **Suggestions** of cultivars you consider worth evaluating for their crack resistance/susceptibility
- **Survey** sent out: please list 3 cultivars you consider crack susceptible, and 3 you consider crack resistant
- We will consider both seeded and unseeded cultivars

Project plan: assay grape cultivars

1

Quantify crack*ability*

- How susceptible to cracking is a cultivar?
- Cracking index?

2

Quantify tensile properties of grape berry skins

3

Chemically analyse the monomer constituents of the cuticular layer

4

Determine relationship between cracking and cuticular constituents

Project plan: manipulate cuticular constituents

Treat selected cultivars with a variety of plant growth regulators

- Gibberellins, cytokinins, abscisic acid

Assay impact on cuticle constituents and tensile properties

- Chemical analysis, mechanical analysis

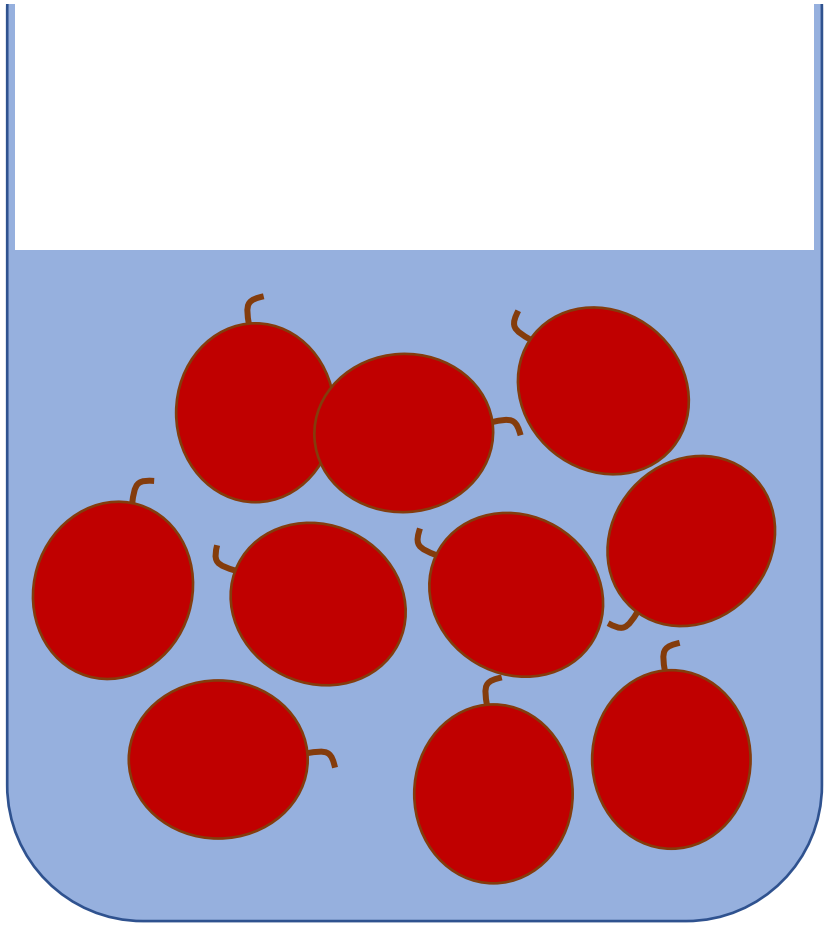
Leading to impact on susceptibility to cracking

- Quantify susceptibility to cracking

Can we modulate cuticular properties to prevent cracking?

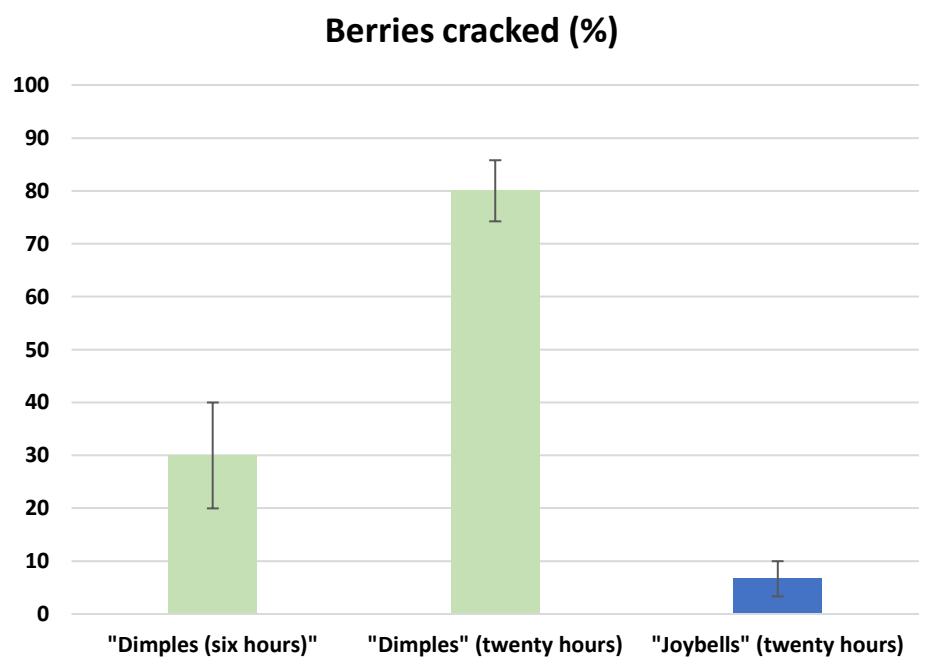
Project: establish methods

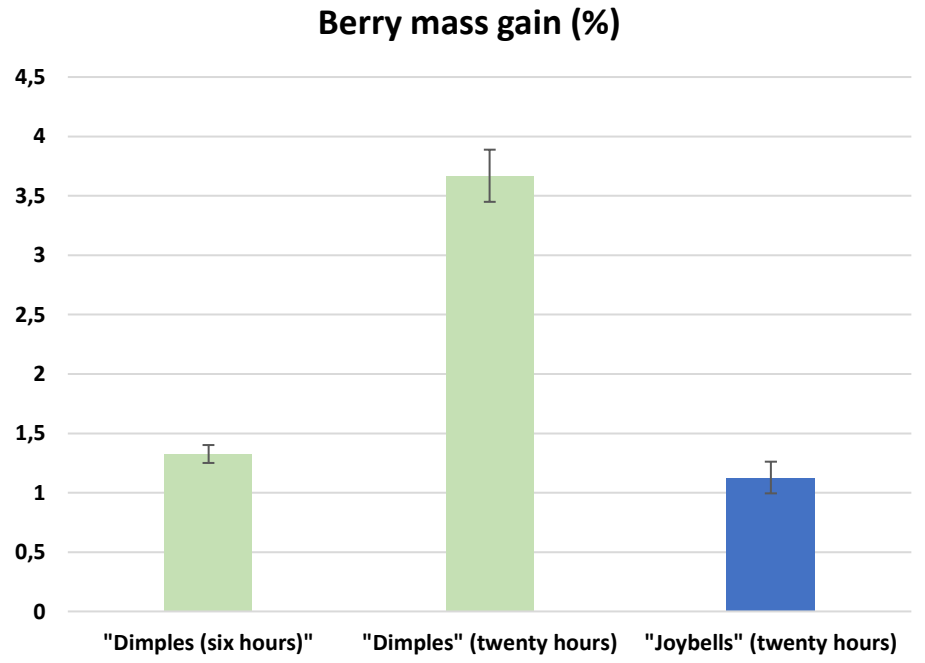
- Induce cracking
  - Submerge berries in distilled water containing a surfactant
- Cracking occurs within six hours in susceptible cultivars



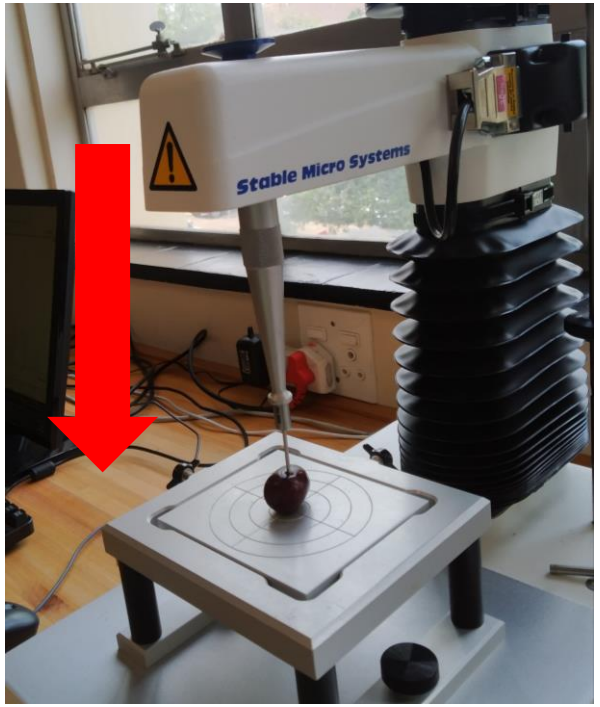
Quantifying cracking potential

- Selected two cultivars chosen for the anecdotal evidence suggesting one to be crack resistant (“Joybells”) and the other crack susceptible (“Dimples”)

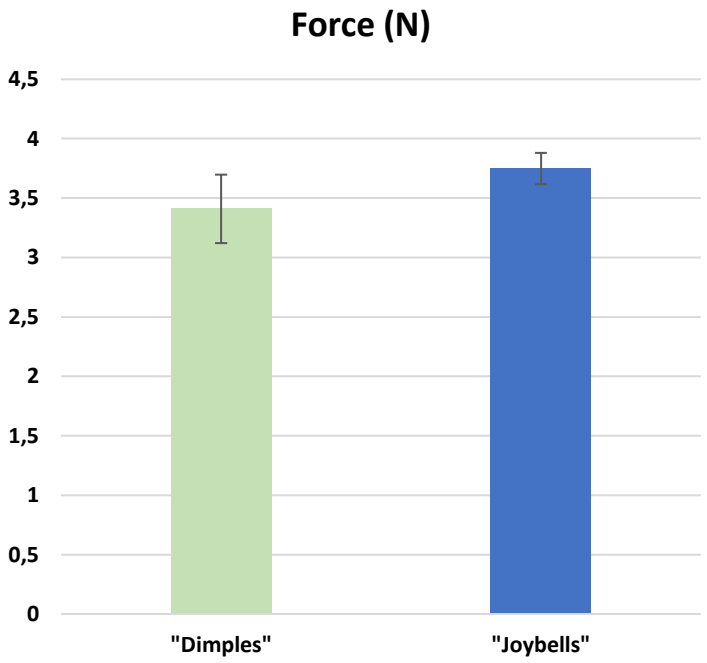




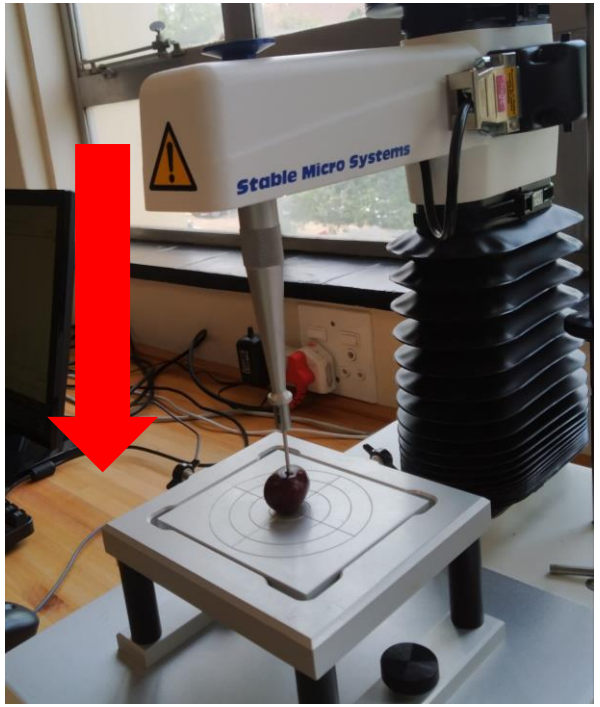
Measuring tensile properties



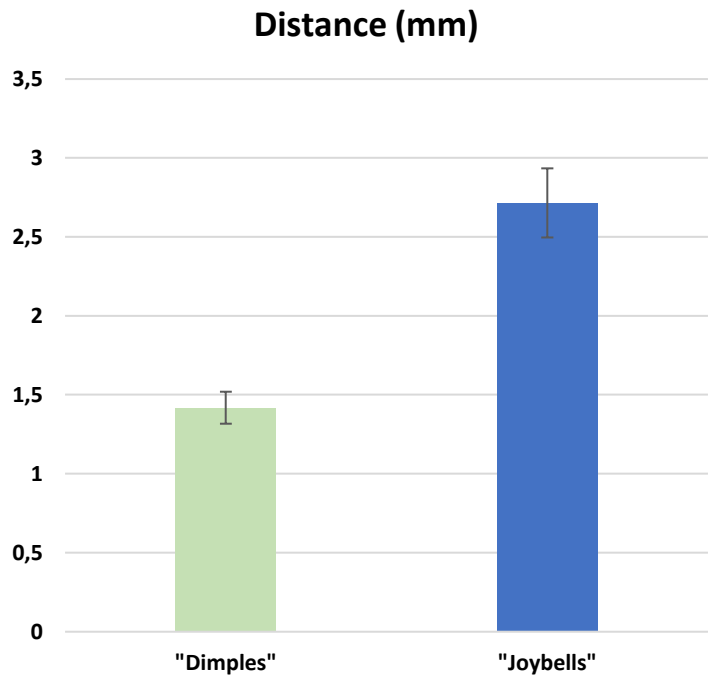
- Making use of a Texture Analyser TA/XT machine
  - **Force** require to puncture a berry was measured



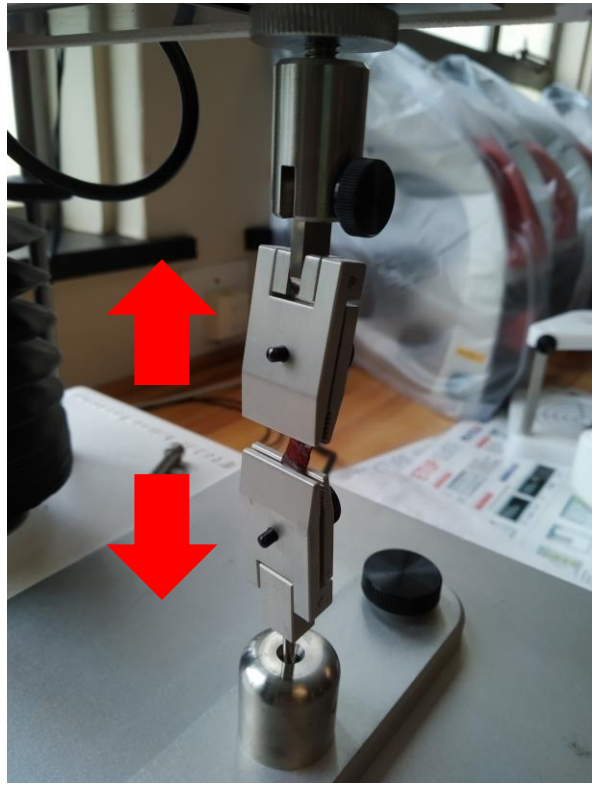
Measuring tensile properties



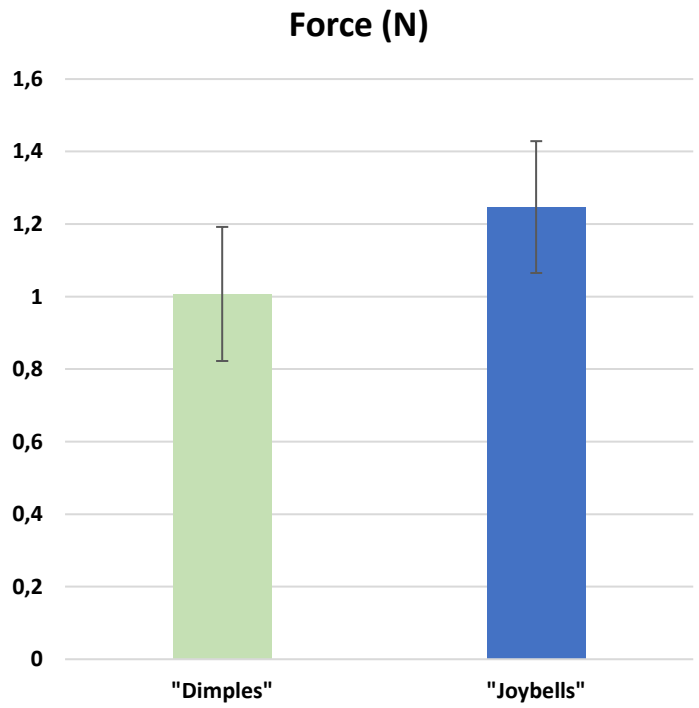
- Making use of a Texture Analyser TA/XT machine
  - **Distance** probe was able to move before skin failure occurred



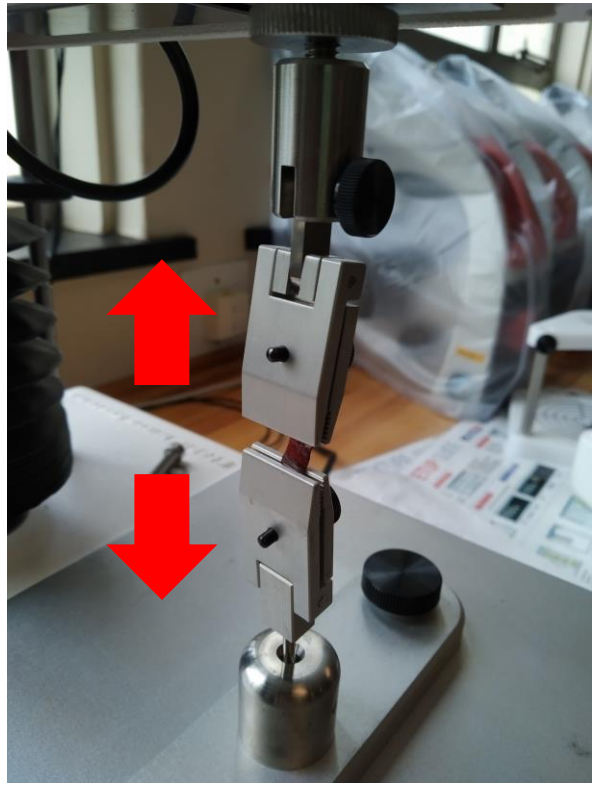
Measuring tensile properties



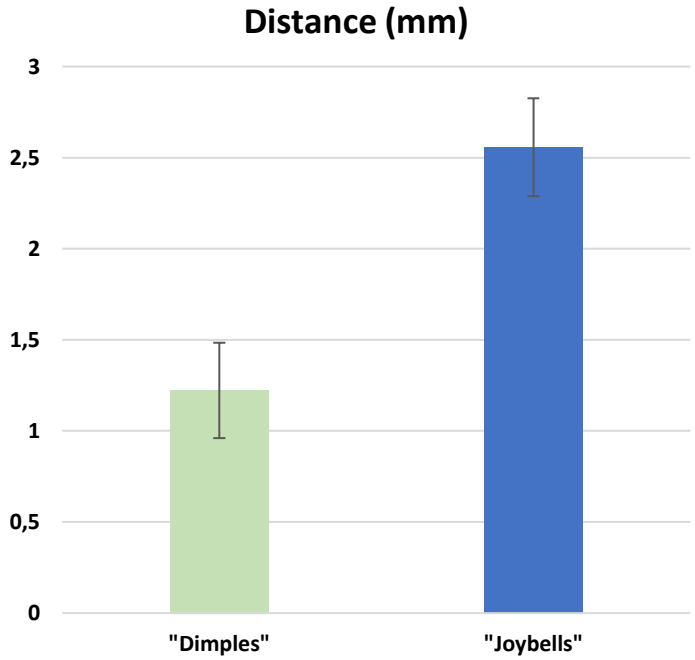
- Making use of a Texture Analyser TA/XT machine
  - **Force** require to tear apart a peel strip was measured



Measuring tensile properties

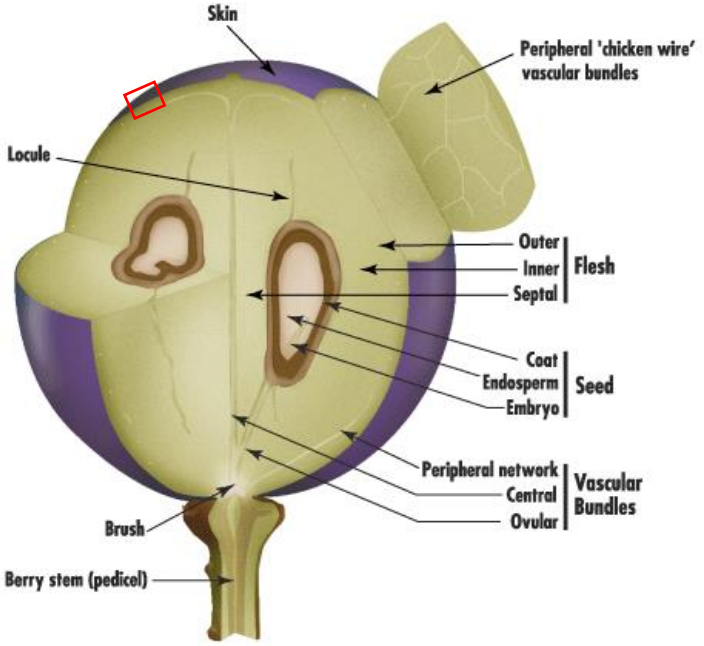


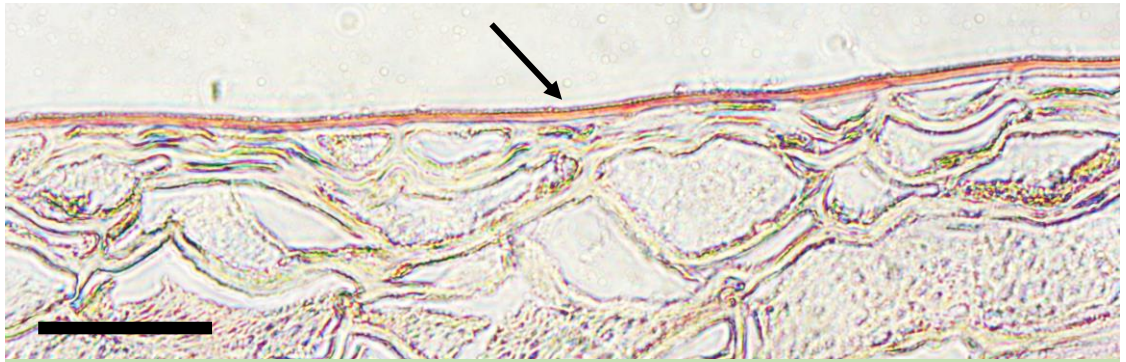
- Making use of a Texture Analyser TA/XT machine
  - **Distance** clamps were able was able to pull apart a berry peel strip before failure occurred



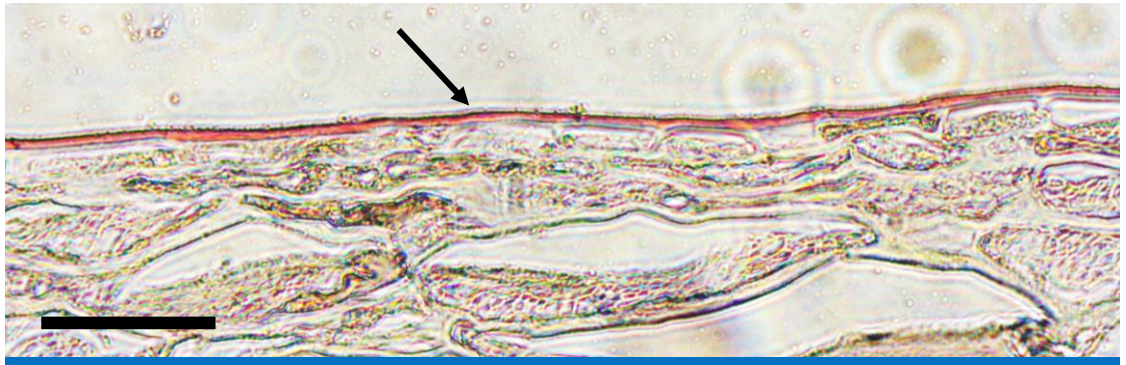
Light microscopy

Berry peel sections
Sudan IV staining for cuticular lipids





"Dimples"



"Joybells"

Final thoughts

Early results show we have reliable methods established for this project

Elasticity seems to play a bigger role than peel strength in crack resistance

Increasing sample size will prove crucial to determining the robustness of this relationship

Will we be able to identify key compounds of the cuticle that contribute to increased elasticity?

Remember to please fill out the survey to request your cultivar of choice

Thank you!

Time for some questions

Email: *jglash@sun.ac.za*