Chemical Regulation of Crop Load in Apples: Present Options and Future Possibilities

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Critical Components of the Thinning Process

- Orchard design
- Spraying technology
- Chemistry
- Management Decision Tools

Currently Available Thinning Chemicals

- ~~Sevin~~ Banned in EU
- NAA and NAAm
- ~~Ethrel~~ ?????????
- 6-BA

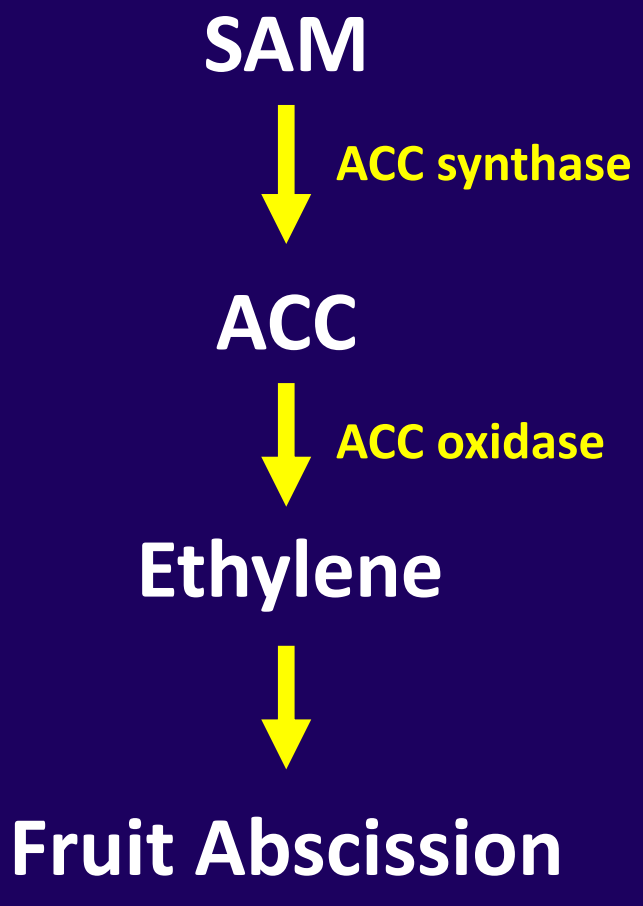
Potential New Thinning Chemicals

- ACC
- Metamitron
- Abscisic acid

Pictures taken <u>3 days</u> after application of 400 mg/L ACC To Cameo at 19 mm

Pictures taken <u>3 days</u> after application of 400 mg/L ACC
To Cameo at 19 mm

So what exactly is ACC?



- **ACC is naturally occurring in <u>all</u> plants**
- **ACC is the precursor of ethylene**
- **ACC is <u>not</u> Ethrel**

  Ethylene is derived from ACC by a biochemical reaction vs. a physico-chemical response for Ethrel

- **Could ACC be an organic thinner?**

NAA ± ACC (Goldrush, 2009, 2010)

Treatments

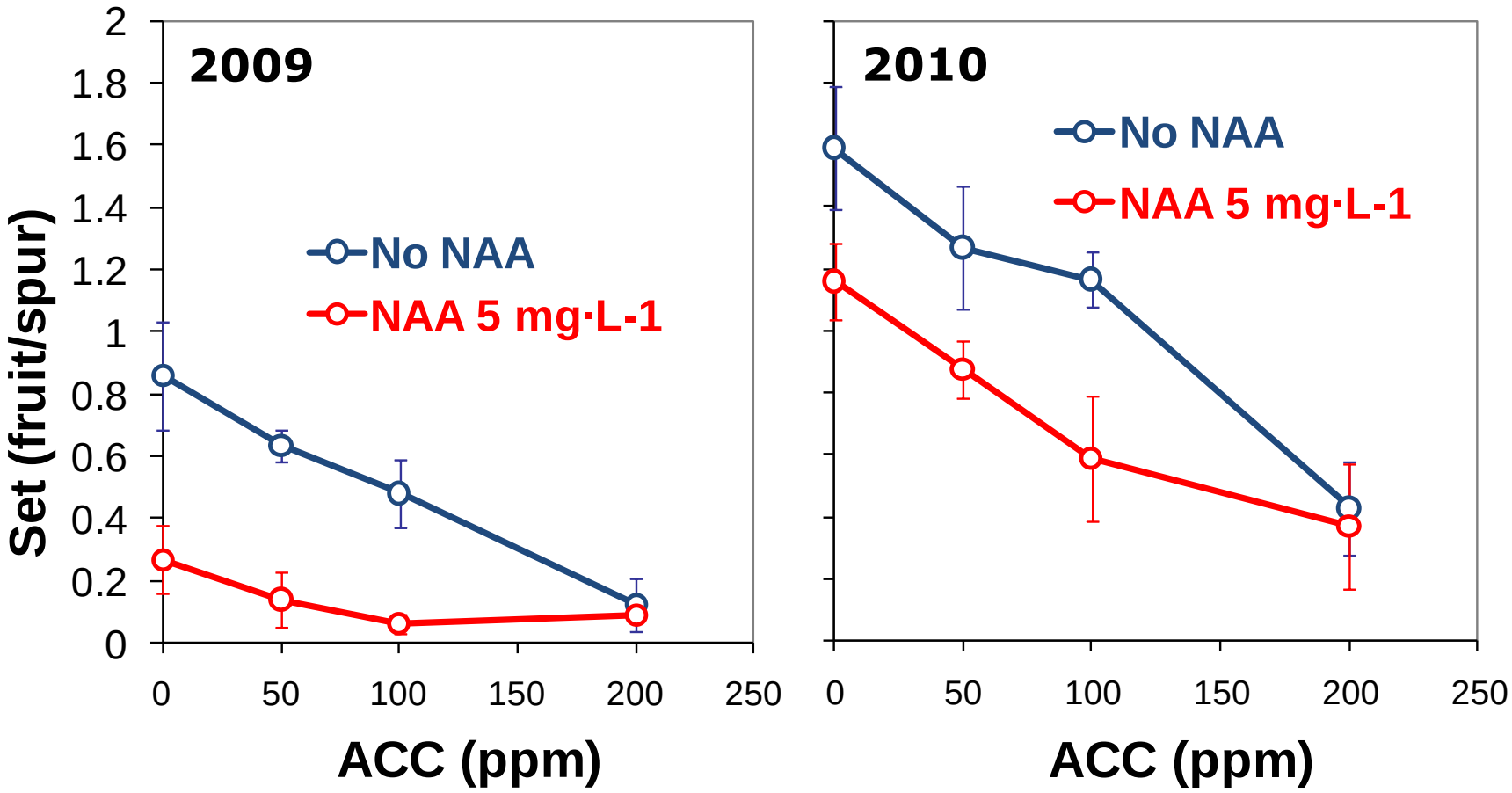
- Whole tree sprays of 5 ppm NAA with an airblast sprayer
- Individual spurs sprayed with 0, 50, 100, 200 ppm ACC
- Split-plot design experiment with NAA as the main plot

Measurements

- Fruit set (fruit per spur)
- Ethylene evolution 1 d and 4 d after treatment
- Spur leaf number at harvest (in 2009 only)

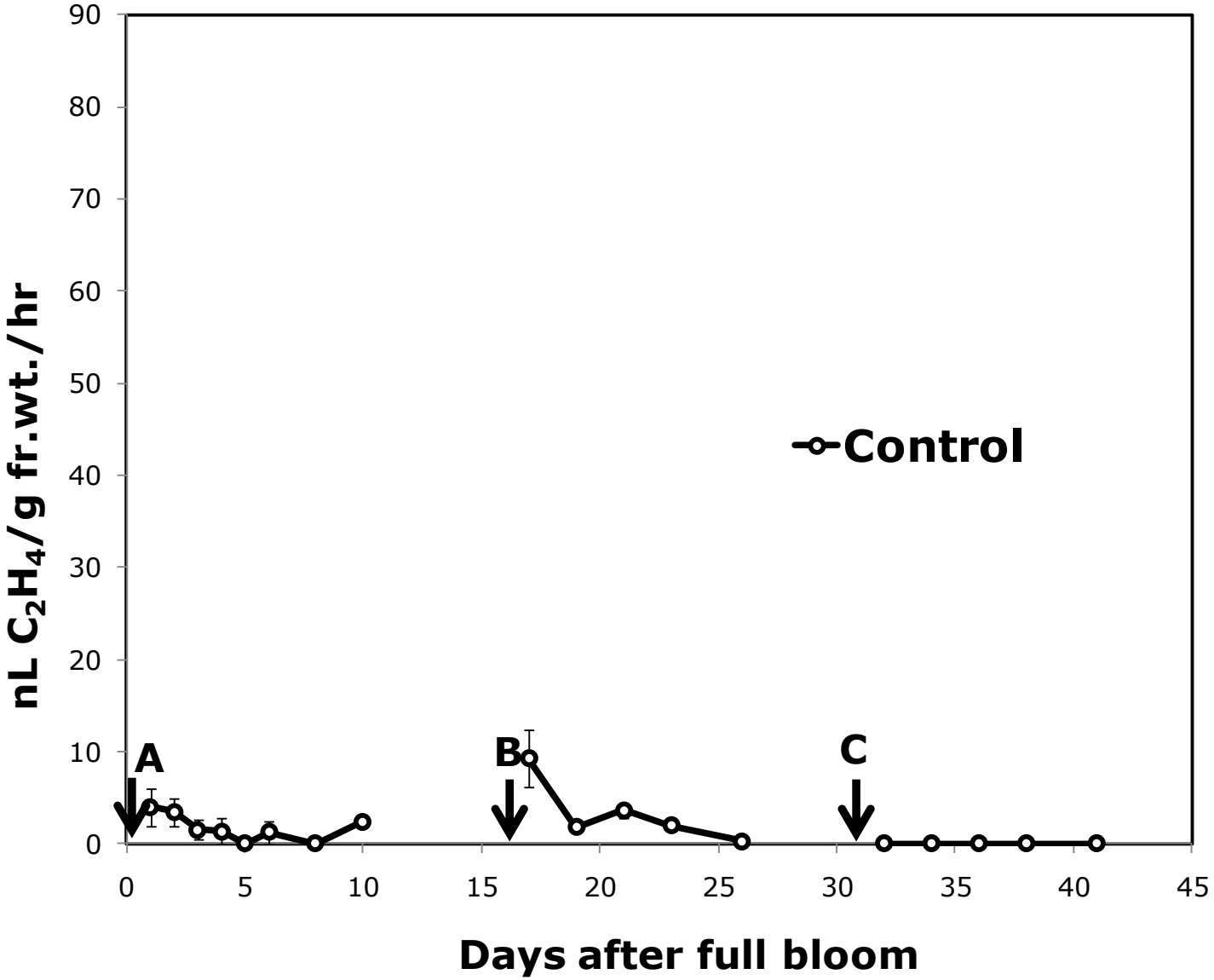
The ACC Response is Concentration Dependent

(GoldRush, 2009 and 2010)



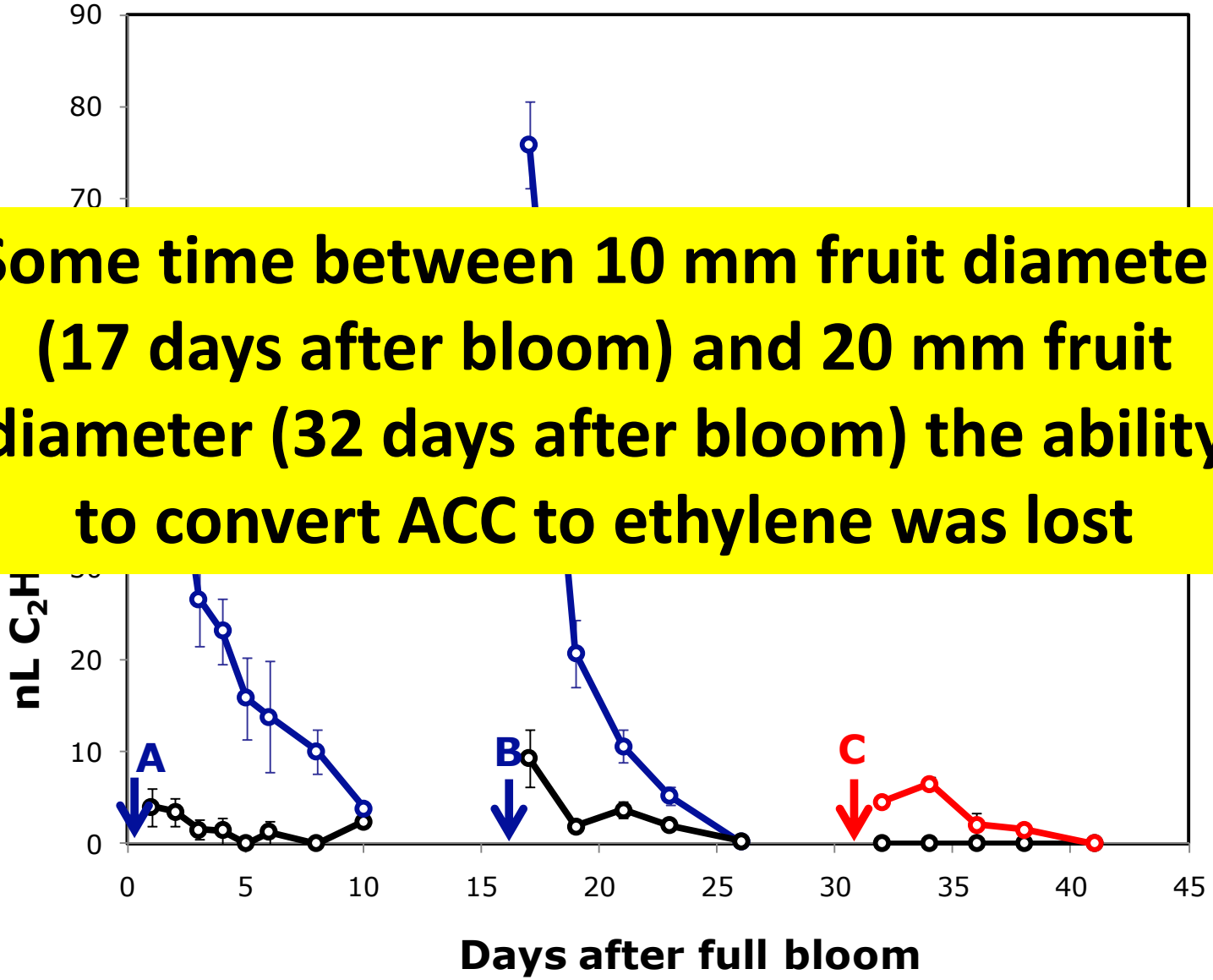
Ethylene evolution following application of ACC to Pink Lady

at full bloom (A), 10 mm fruit diam. (B) or 20 mm fruit diam. (C)



Ethylene evolution following application of ACC to Pink Lady (2010)

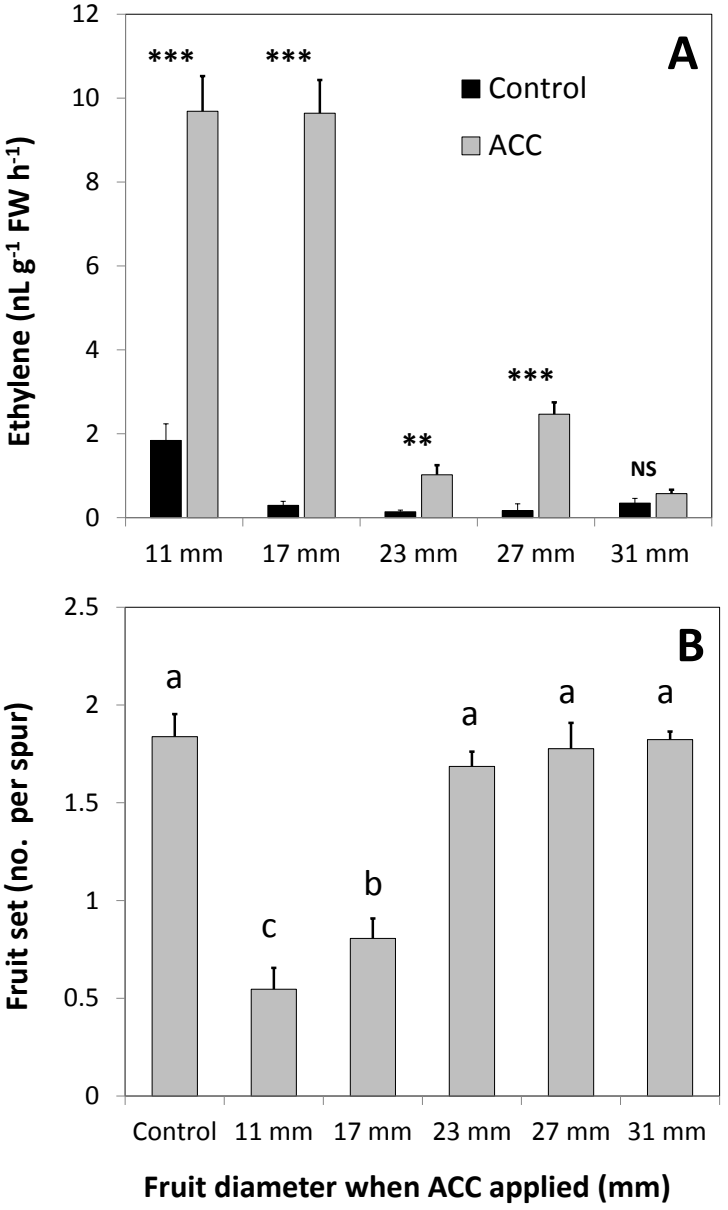
at full bloom (A), 10 mm fruit diam. (B) or 20 mm fruit diam. (C)



Some time between 10 mm fruit diameter (17 days after bloom) and 20 mm fruit diameter (32 days after bloom) the ability to convert ACC to ethylene was lost

ACC responses are reduced over time
(GoldRush, 2011)

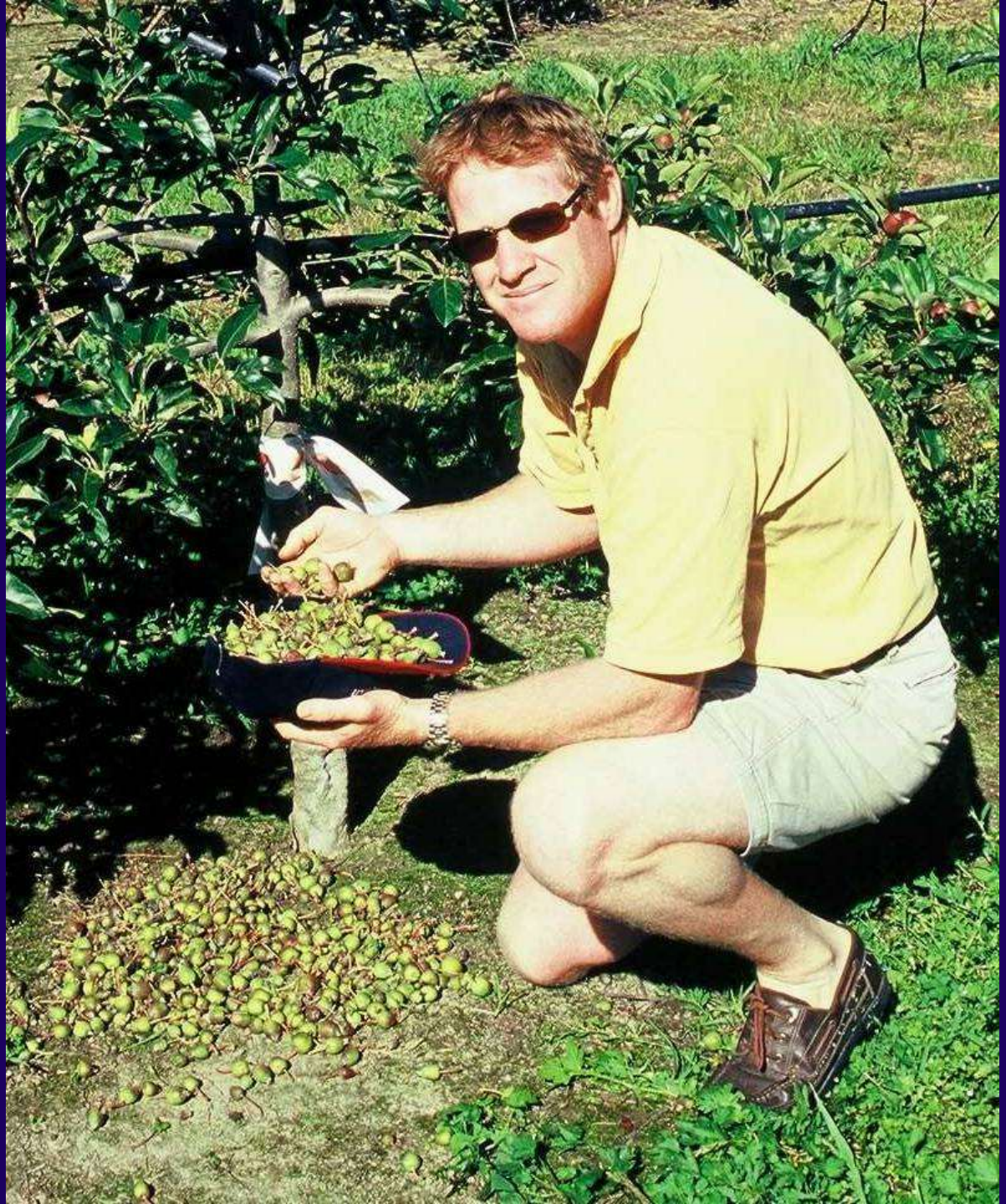
Effects of fruit diameter at time of ACC (200 mg·L^{-1}) application on ethylene evolution from detached fruit (A) and final fruit set (B) of 'GoldRush' apples in 2011. Ethylene evolution was measured 1 d after each time of ACC application.



Perhaps the inability to thin fruit >20 mm in size is related to the loss of ACC oxidase activity?

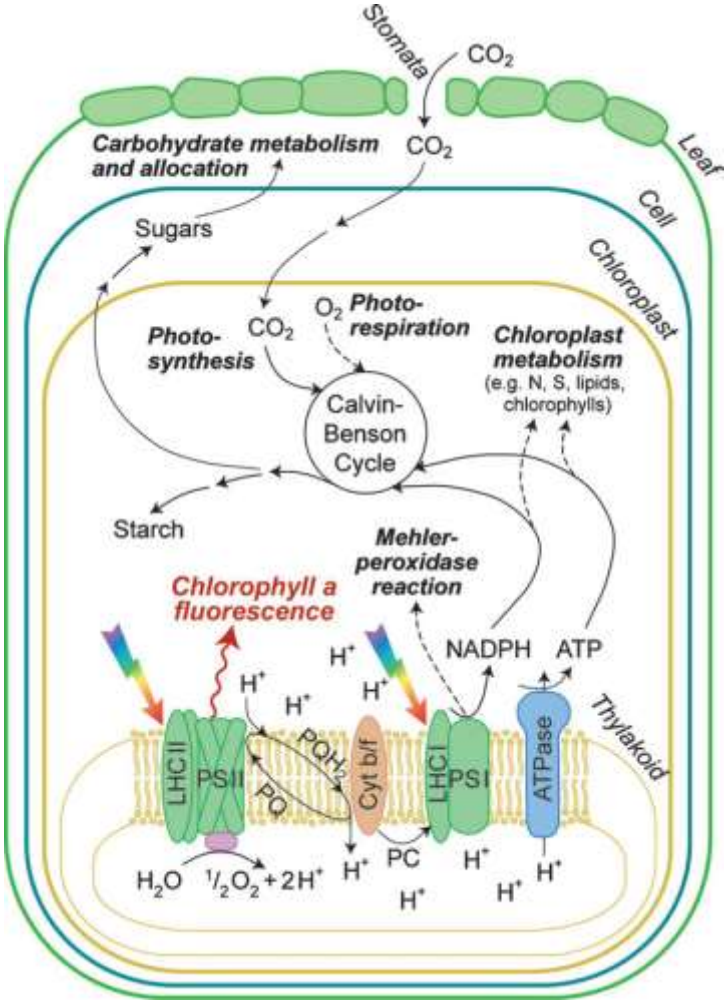
Why do apple fruit become more difficult to thin with time …

- **there is an increasing carbohydrate surplus in the tree, or…**
- **the fruit lose the ability to convert ACC to ethylene, or…**
- **both of the above**



Metamitron is a photosynthetic inhibitor

Binds to the Q_B-binding site in PSII,
Interrupting photosynthetic electron transport

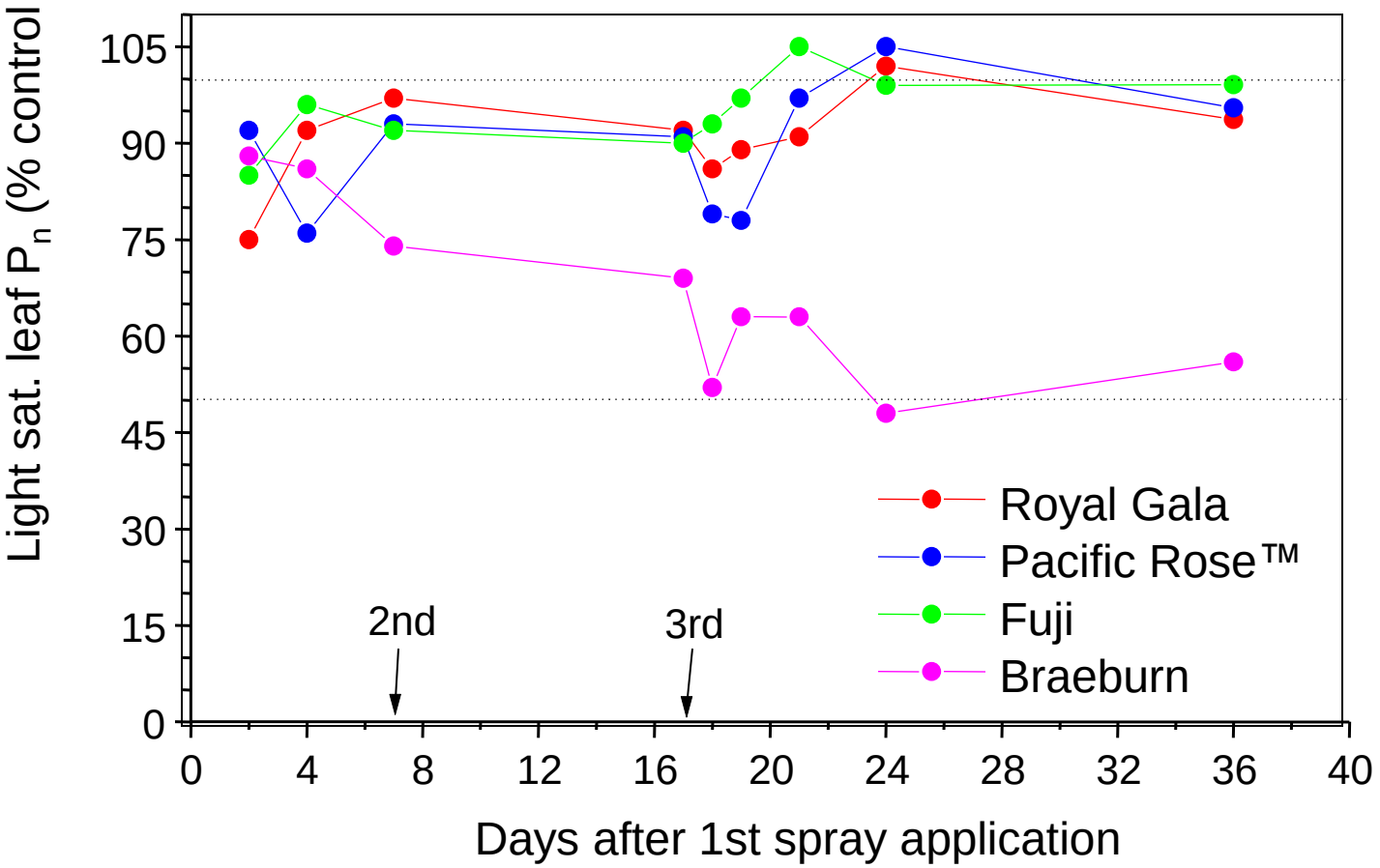


Control

Metamitron 300 mg·L^{-1}

Braeburn is more sensitive to Lime Sulfur than other cultivars

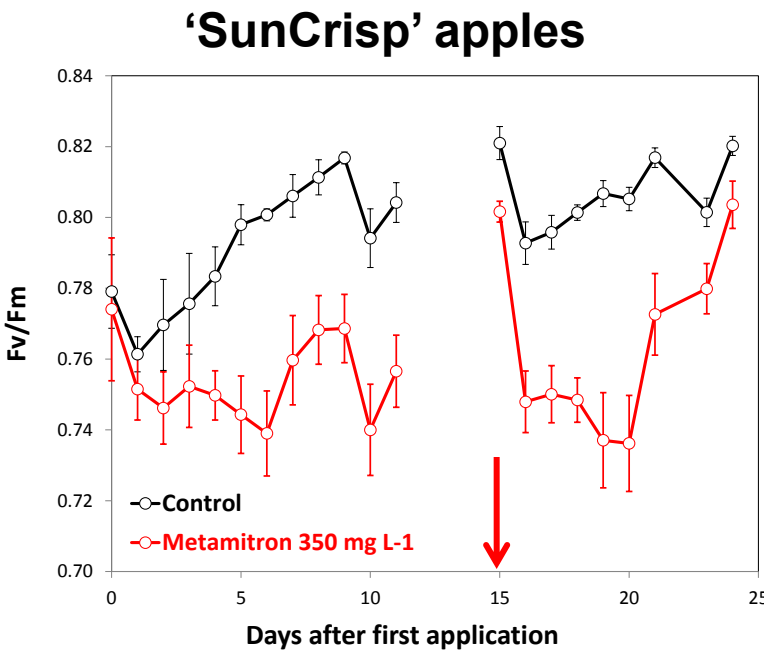
What if apple cultivars responded differently to Metamitron?

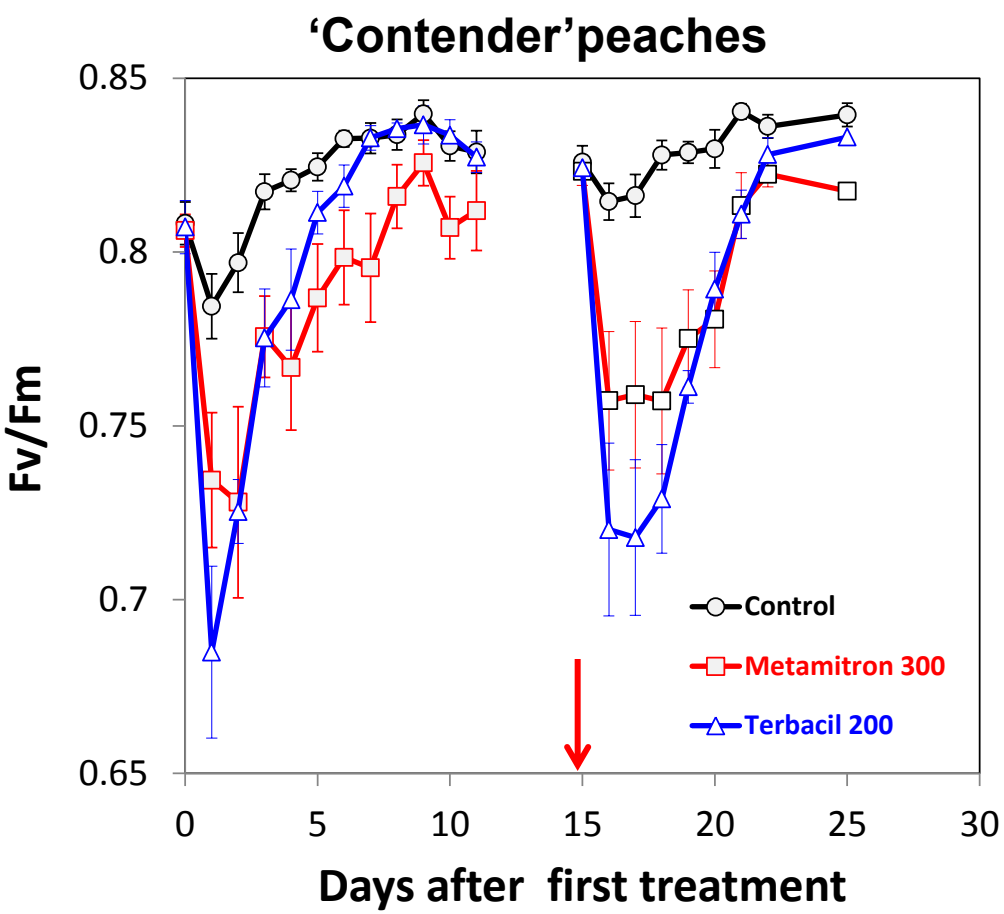


Data from Jens Wünsche

Metamitron

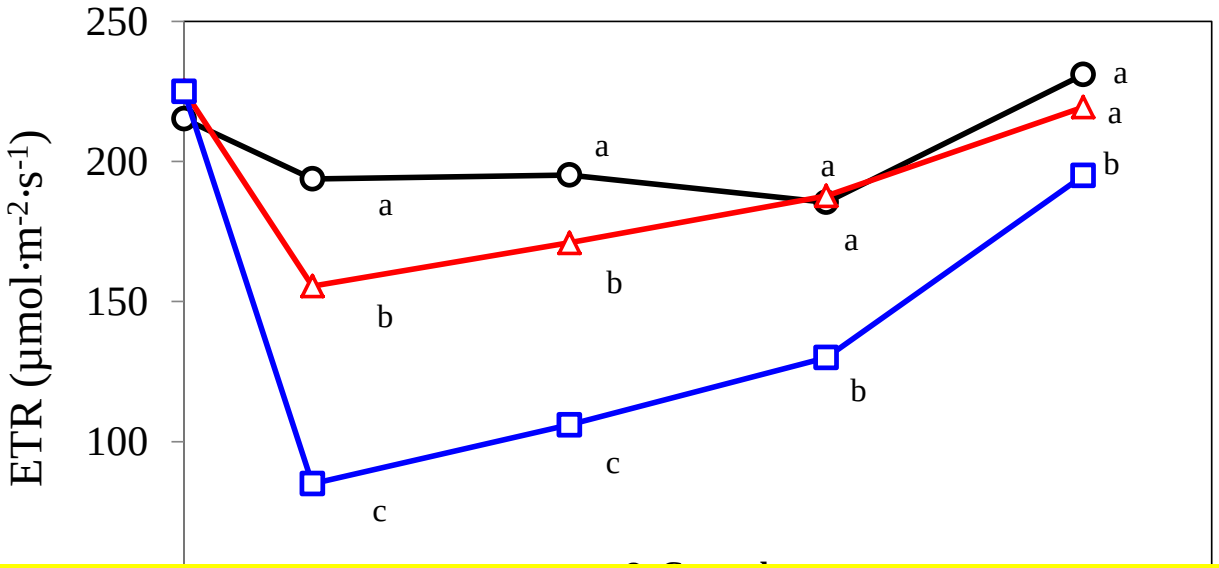
Creates a transient carbohydrate stress, as measured by chlorophyll fluorescence,





Metamitron

Activity can be greatly increased by adding a surfactant



Addition of a surfactant (Silwet L-77) greatly increased the effects of metamitron on chlorophyll fluorescence in ‘Cameo’

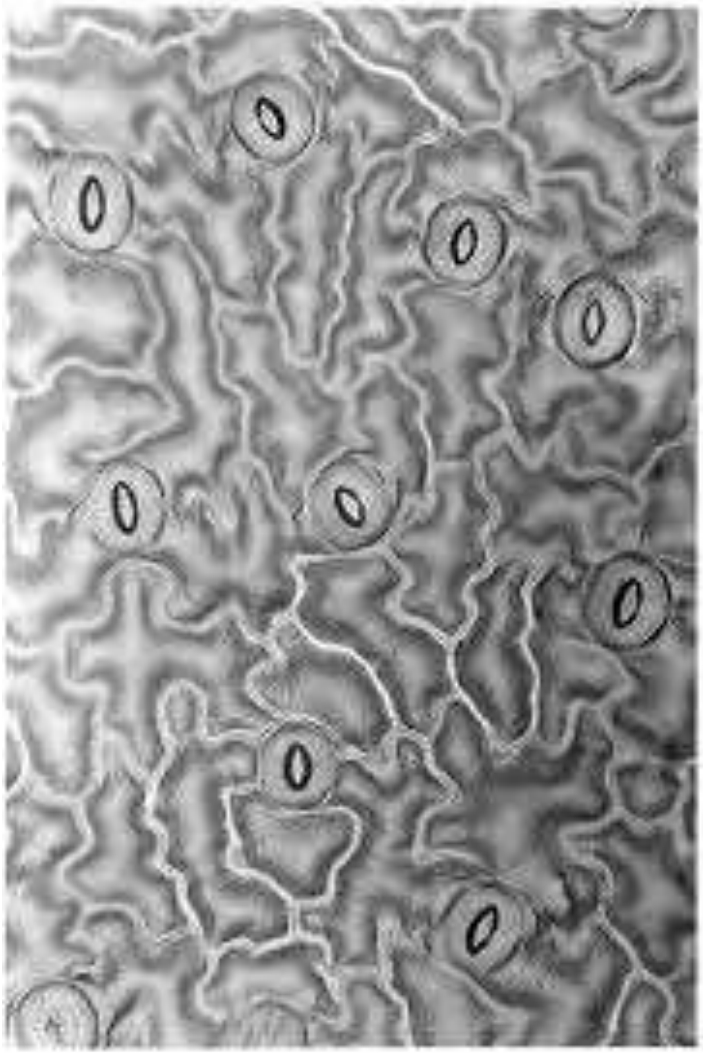
Use of Combinations of ACC and Metamitron for Re-thinning

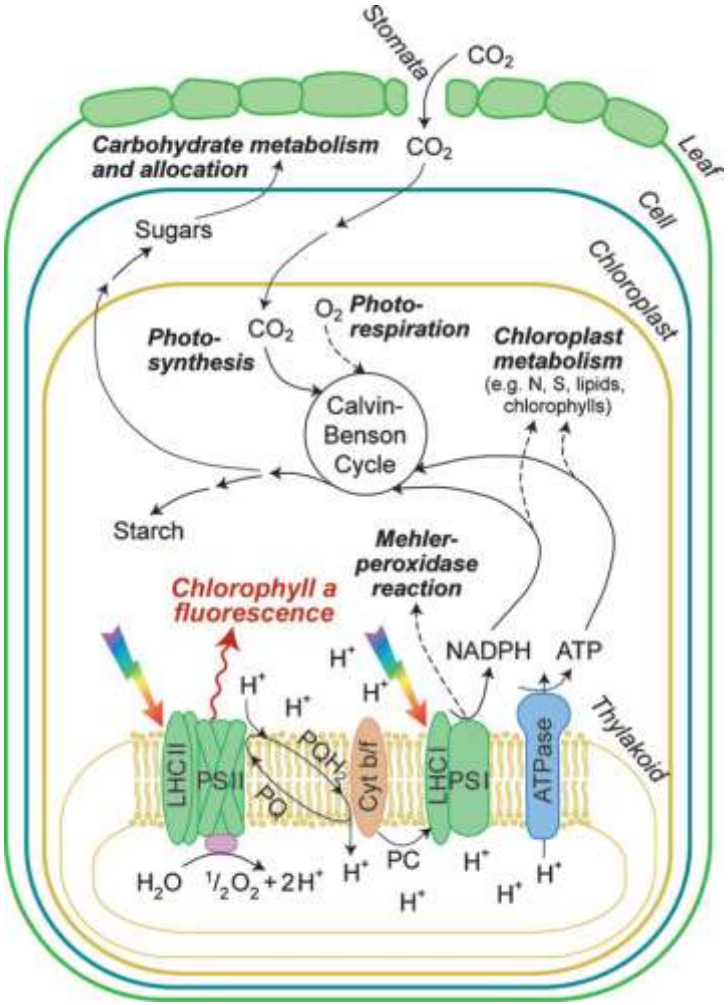
Abscisic Acid (ABA)

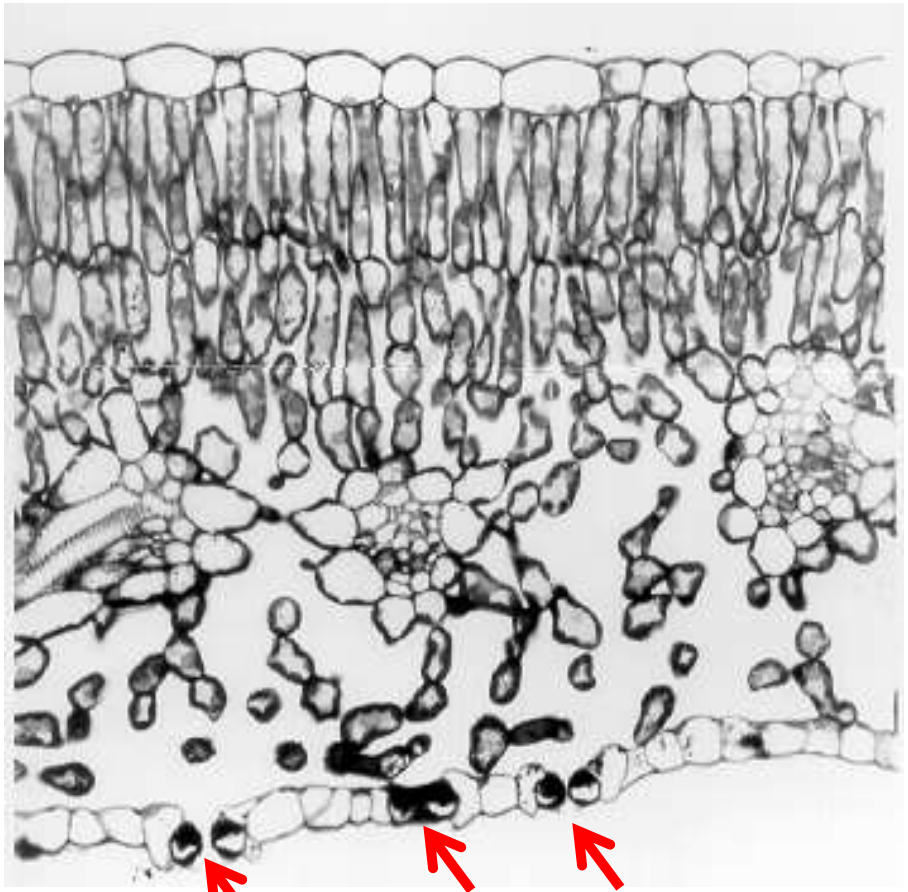
Control

S-ABA [Protone]

Abscisic Acid (ABA)



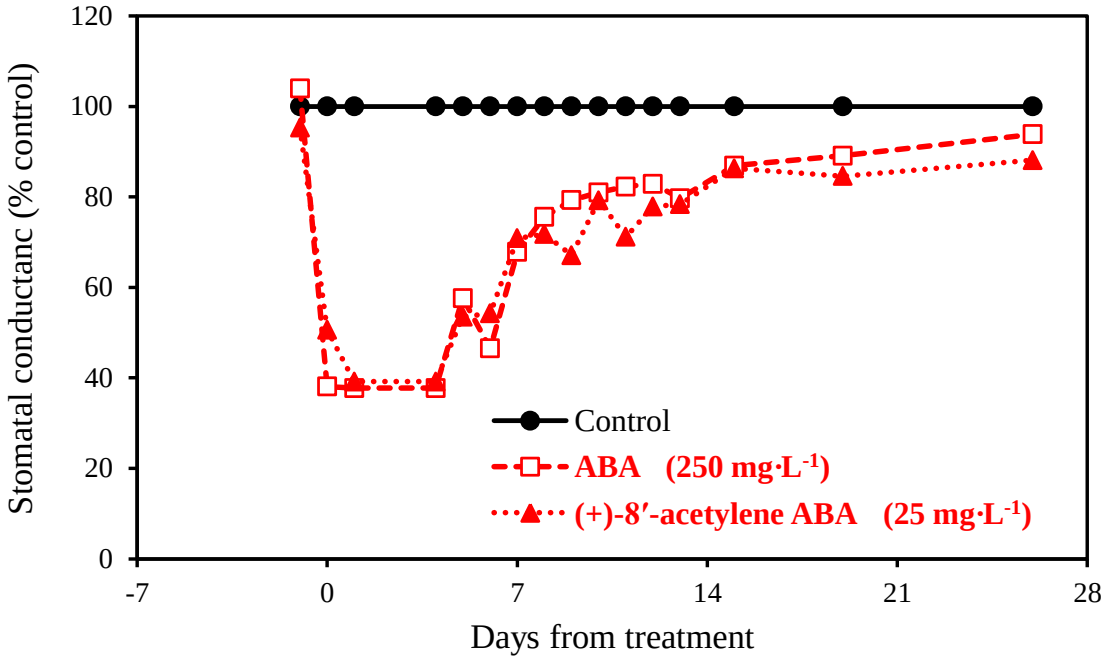


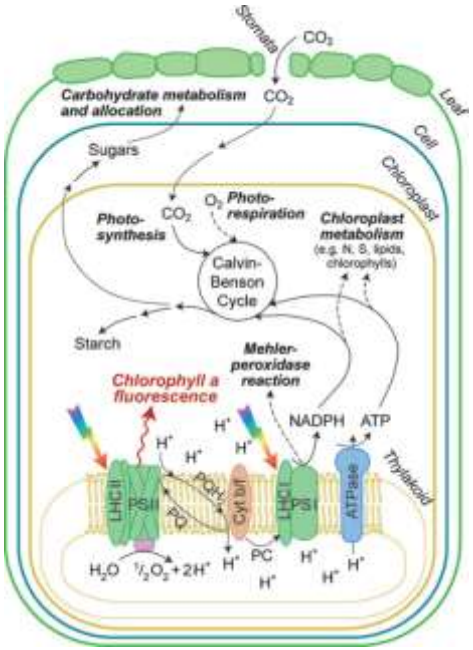


Cross-section through an apple leaf

300-500 stomata/mm^2

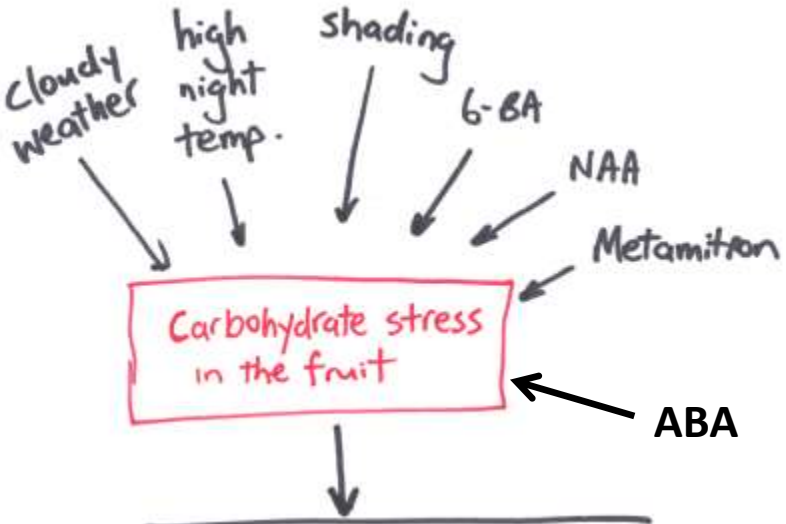
Is Abscisic Acid an Apple Thinner?





Phytotoxicity from Abscisic Acid (ABA)

Carbohydrate Stress in the Fruit Integrates the Effects of Environment and Chemical Thinners on Fruit Set



You can make a big apple small but you can't make a small apple big

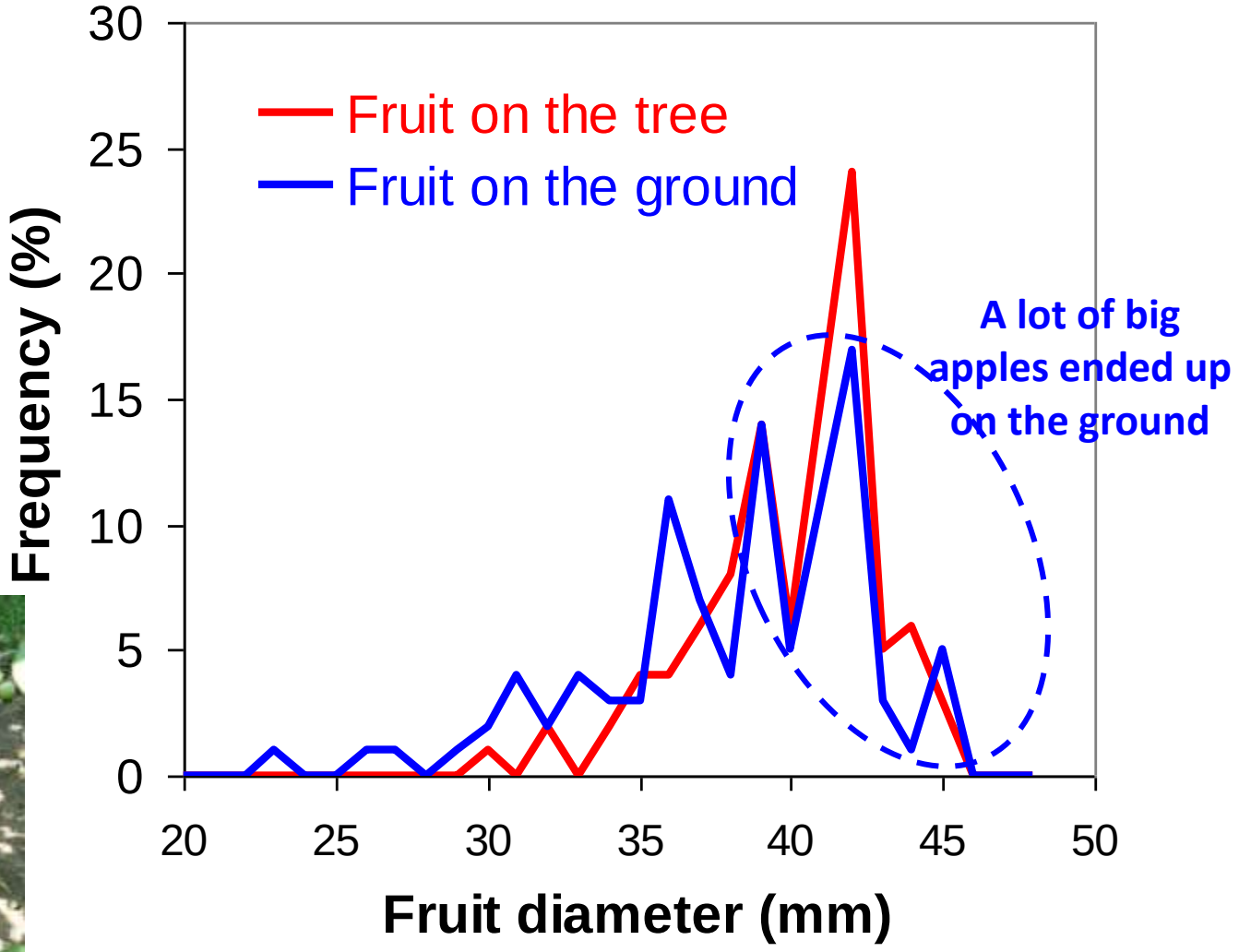
Typical Hand Thinning Instructions

1. Damaged or misshapen fruit removed first
2. Fruit number per spur reduced
3. Remaining fruit spaced 6-8 inches apart

Notice!

Fruit number per tree or fruit size were not considered during this process!

Traditional Hand Thinning Methods do <u>not</u> Consider Fruit Size



‘Size Thinning’ Method

The size thinning method uses fruit size (diameter) as the primary basis for deciding which fruit to remove

It places a lower priority on the number of fruit per spur and on spacing between *fruit*

‘Size Thinning’ Method

You will need to do three things…

1. Count how many fruit you have on each tree
2. Have an idea how many fruit you want to have (TARGET CROP LOAD)
3. Measure the diameter of 100 random fruit in mm and sort in order from smallest to largest

‘Size Thinning’ Method

Example…

1. Actual crop load = 450 fruit per tree

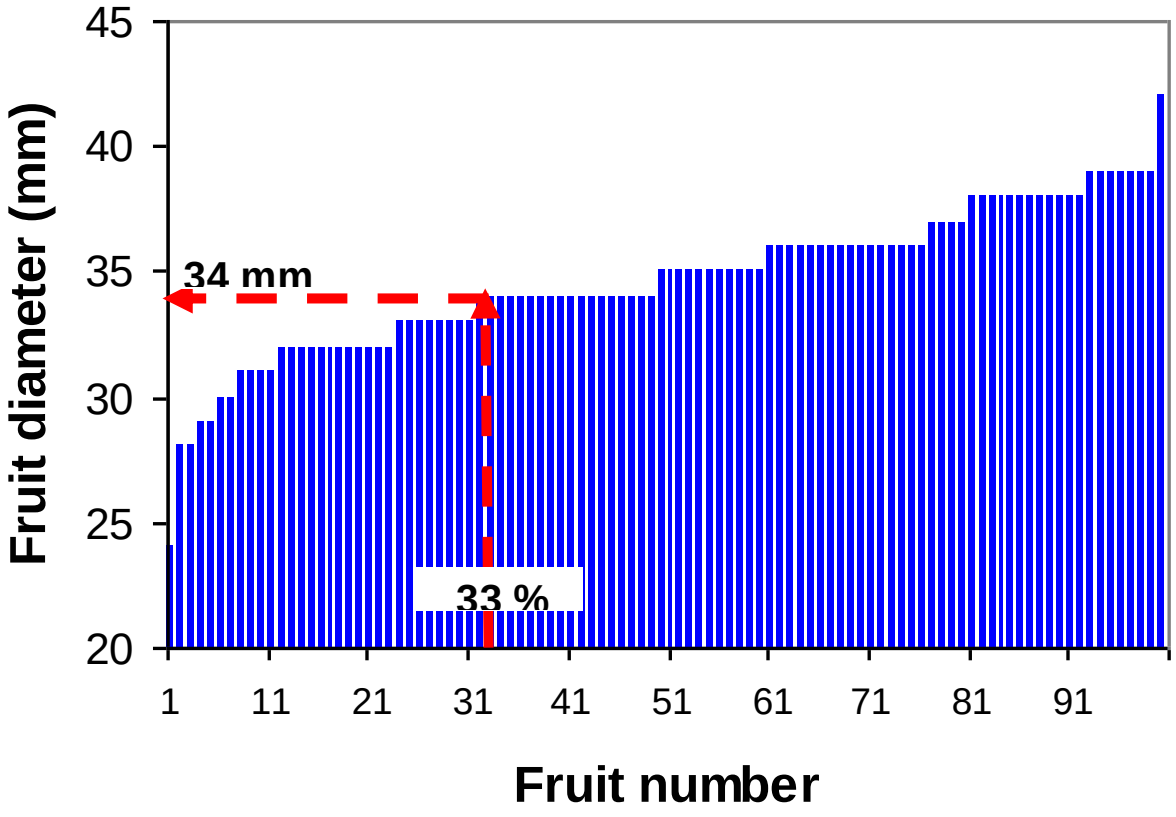
2. Target crop load = 300 fruit per tree

You will need to remove 150 fruit from each tree or 33 % of the fruit to reach your TARGET CROP LOAD

3. To make sure you remove the <u>smallest</u> 150 fruit (33%) you will need to check the diameter of the 33rd smallest fruit in the sorted size data

‘Size Thinning’ Method

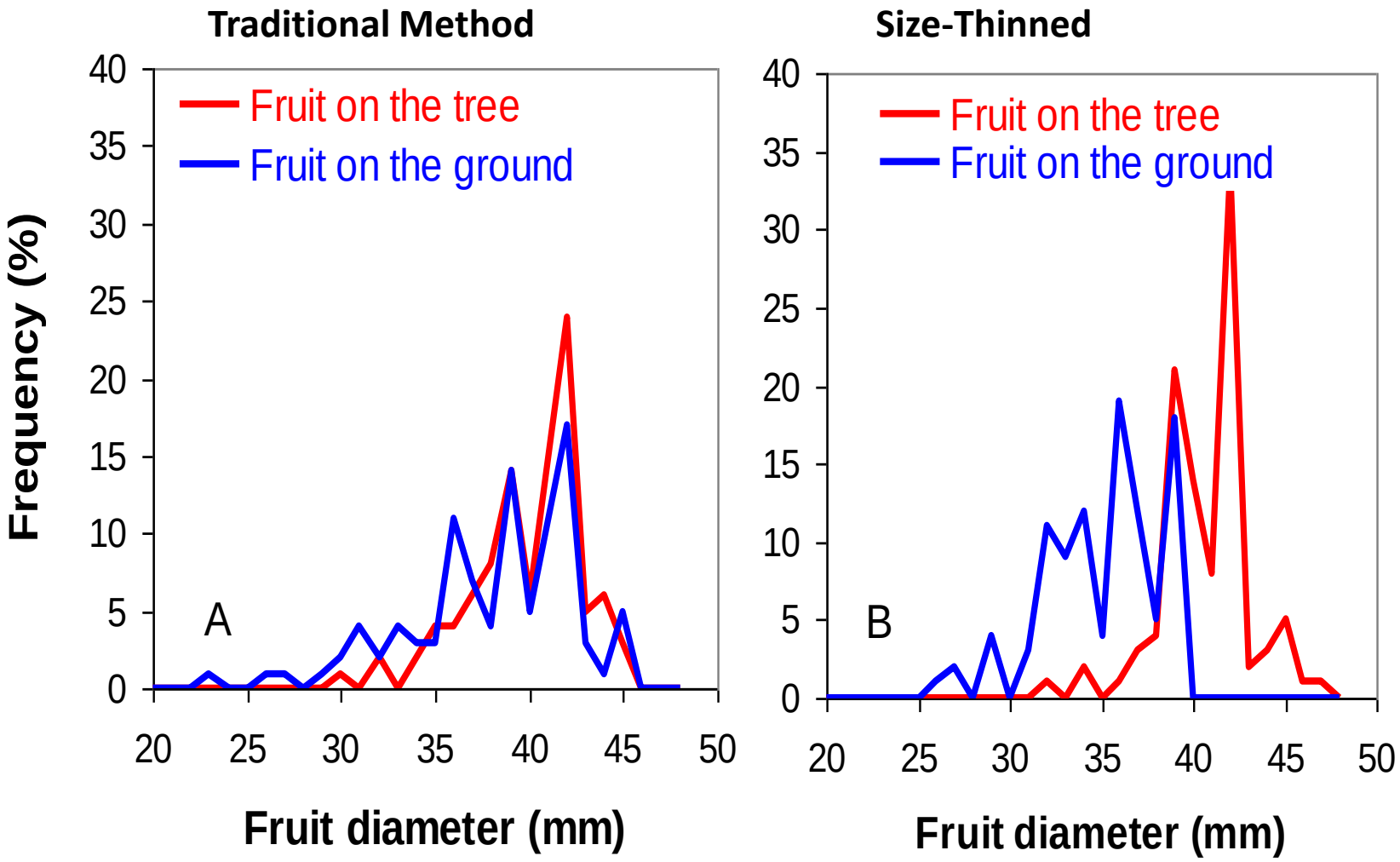
- *Example…*



Give your thinning crew a fruit that is 34 mm in diameter and instruct them to remove all fruit this size and smaller from the tree

Size Thinning achieves two things…
- ***ensure that only the smallest fruit are removed, and***
- ***ensure a crop load target is met***

‘Size Thinning’ Method



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Acknowledgements

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