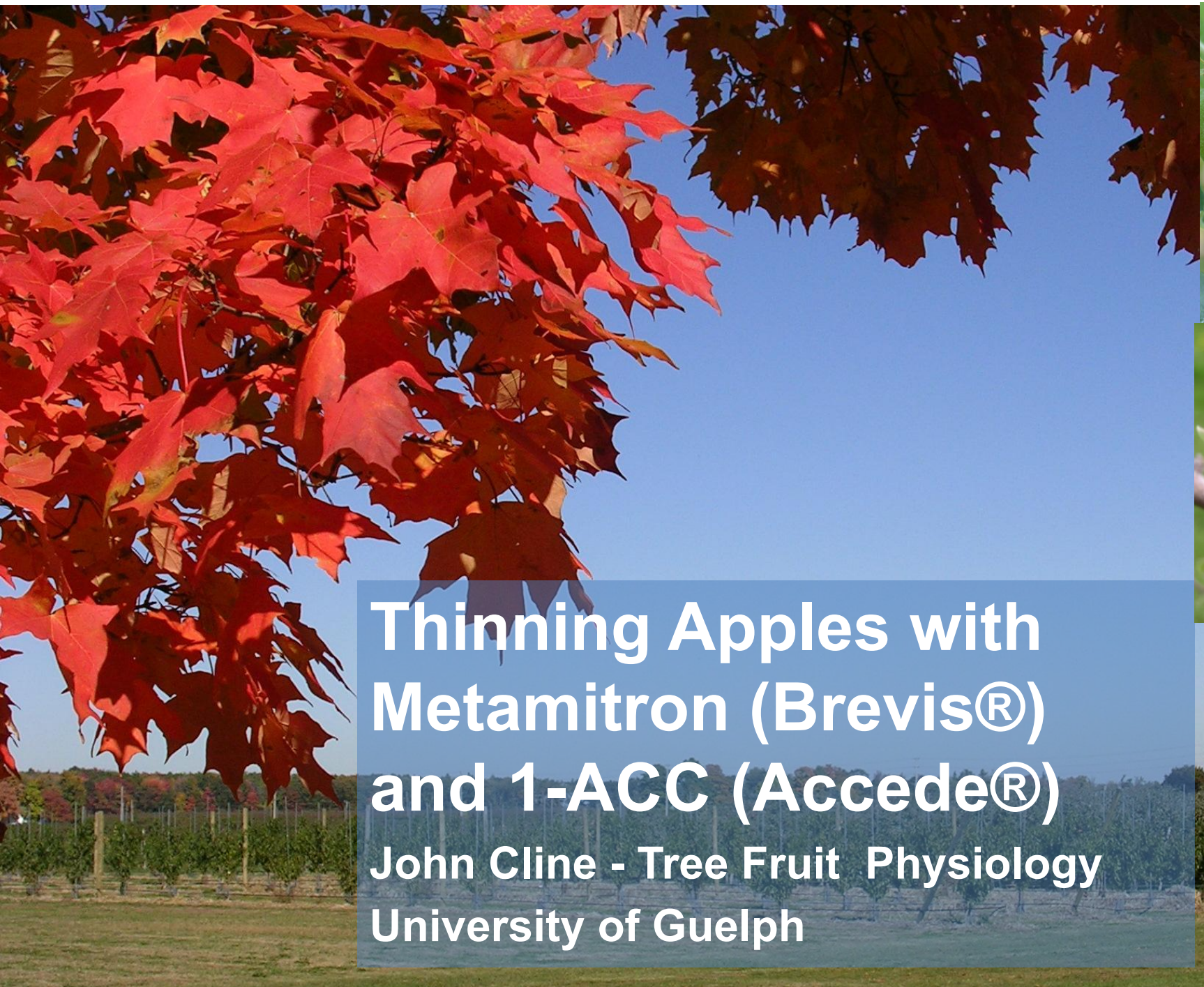

Thinning Apples with Metamitron (Brevis®) and 1-ACC (Accede®)

John Cline - Tree Fruit Physiology
University of Guelph

Learning Objectives

1. Importance for active crop load management

2. New Thinning Compounds
    A. 1-ACC (Accede®) – ethylene
    B. Metamitron (Brevis®) – photosynthetic inhibitor

Apple Thinning

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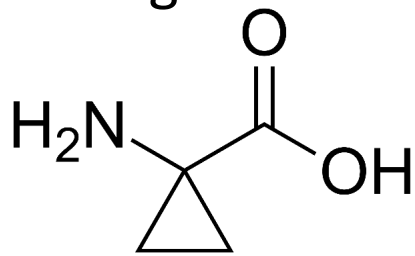
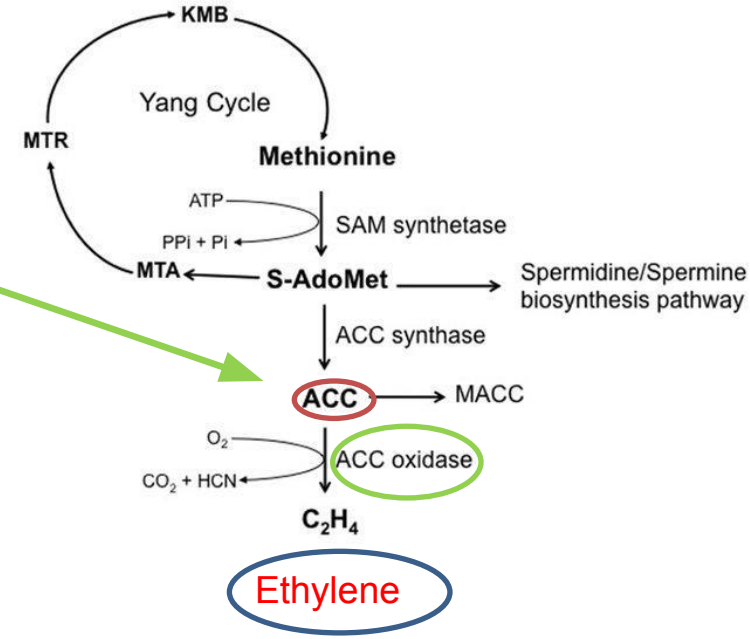
What is 1-ACC

- Chemical Name: 1-Amino-cyclopropane -1-carboxylic acid
- Naturally occurring amino acid found in plants



- 1-ACC, discovered in 1979, is a precursor of ethylene in the ethylene biosynthesis pathway (Adams and Yang, 1979)
- In sufficient concentrations, ethylene accelerates flower and fruit drop, enhances fruit colour and ripening
- Is xylem and phloem mobile (Morris and Larcombe, 1995)

Ethylene Biosynthesis Pathway



Arc et al, 2013

Chemical Thinner Options

Blossom Thinners	Fruitlet Thinners	Products in Development
Lime-Sulphur (tanked mixed with) mineral oil	Carbaryl - Sevin XLR (carbamate insecticide)	Metamitron (Brevis) - Adama
Ammonium thiosulphate (12-0-0-26S)	6-BA (MaxCel, Cilis Plus) – Cytokinin	
NAA – Fruitone, Maintain®	NAA – (Fruitone-N/L, Maintain)	
	ACC (Accede®) - Valent BioSciences	

Status of Brevis® and Accede® (not OMRE approved)

Product	Company	Mode	Ideal Timing	Status
Brevis (metamitron)	Adama Agricultural Solutions	Photosynthesis inhibitor	6 - 15 mm	Product launch **January 2025 - USA** January 2026 - Canada Currently registered in other countries (Australia, Israel, New Zealand, Chile, Argentina, parts Europe, S. Africa)
1-ACC (Accede®)	Valent BioSciences	Stimulates ethylene production	Petal fall – 25 mm*	Approved in Canada and the United States

* based on manufacturer information provided on the product label

Accede® Rates and Timing for Thinning Apples

Registered in June 2023 in Canada

Accede® SG label states:

Accede® SG
PLANT GROWTH REGULATOR
SOLUBLE GRANULE

- First registered in Canada in 2024 (Apples)
- 40% ACC (w/w) soluble granular formulation
- Rate: 200-400 ppm (500-1000 g product/ha) assuming a spray volume of 1000 L/ha based on tree row volume dilute
- Timing: from full bloom until the average diameter of the king fruitlets is 25 mm.
- Accede is most active when king fruitlet diameter is 15 to 20 mm.
- Product price approx.: $C 593 per 567 grams of formulated product (Feb 2024)
- $523 to $1046/ha based on 1000L/ha

Accede® Label Details

- Do not make more than 2 applications per season
- Accede may be used in a program with other thinning products, such as Maxcel® (label is silent on tank-mixing)
- Maintain spray solution pH between 5 and 8
- Do not apply Accede to injured or stressed plants or fruits (drought stress, freeze or frost injury)

Accede® Label Details (continued)

- Do not apply Accede® during bloom if there is a frost event - wait until damage to buds or flowers can be assessed
- Do not apply Accede® if rain is expected within 8 hours of application.
- Applications will be most effective when the maximum temperature on the day of application and for the following 2-3 days is 18°C (64°F) or higher.
- Avoid spraying Accede® when ambient temperatures exceed 30°C on the day of application and for the following 2-3 days.

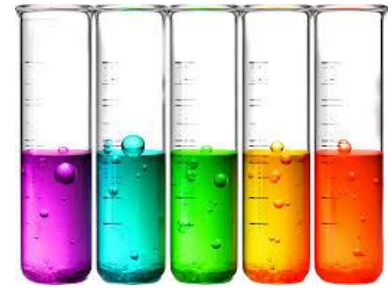
ACC Research Study Objectives

Accede® SG
PLANT GROWTH REGULATOR
SOLUBLE GRANULE

- Determine the optimal rate and most effective time to apply foliar applications of 1-ACC to thin apple trees
- Measure any negative effects of 1-ACC on tree health, including leaf yellowing and leaf drop
- Measure the effects of 1-ACC on fruit quality (including fruit size, size distribution, and maturity)
- Conduct a cost-benefit analyses

  Costs: product cost, potential negative effects on the tree

  Benefits: reduced hand thinning, improvement in fruit size



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Experimental Plan

- Design: Randomized Complete Block
- Replications: Minimum of 6
- Treatments applied to single or two adjacent trees
- 1 ‘guard’ tree was left between sprayed trees

Equipment: commercial tower or air blast sprayer

Water volume: tree row volume dilute

All trees were trickle irrigated

Accede® apple thinning studies at the Simcoe Research Station

Year	Cultivar	Type of Trial
2014-2015	Gala	Timing (400 ppm at 15, 20, 25 mm)
	Gala	Rate (150, 300, 450 ppm)
2017-2018	Ambrosia	Rate and timing
2020-2022	Gala Crimson Crisp	Timing study Bloom application
2023	Ambrosia	Late application (20 mm fruitlet diameter at 400 ppm)
2024	Gala	Late application (20 mm fruitlet diameter at 400 ppm)

Applications made with air blast sprayer, tree row volume dilute and included a non-ionic surfactant

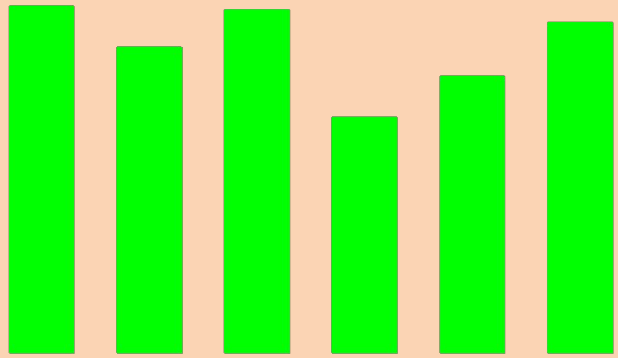
Gala – ACC Timing Study

In a 2-year study on Gala, ACC did not thin in 2021.

In 2022, ACC thinned only when applied at 18.5 mm

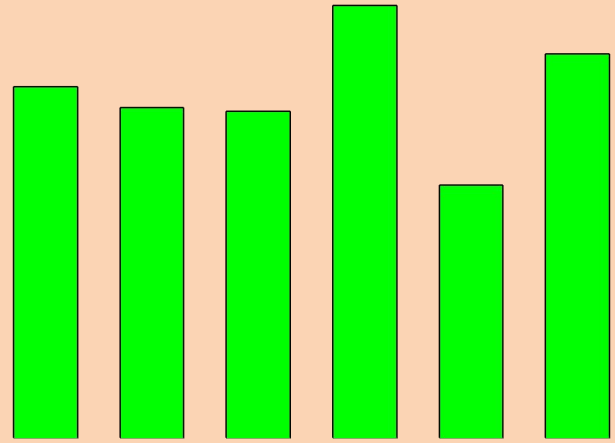
Data credit: L. Reis

2021



Data credit: L. Reis

2022



Summary of ACC research results

Gala

- In 2015, 300 and 450 ppm ACC was effective reducing the crop load of Gala when applied at 17 mm
- In 2015, 400 ppm ACC was ineffective in thinning Gala at 22 and 25 mm

Ambrosia

- In 2017 and 2018, 200-400 ppm ACC applied at 8-15 mm was infective in reducing crop load. There was no thinning when 400 ppm ACC applied at 15-20 mm.
- In 2023, 400 ppm ACC at 22.5 mm was effective by reducing crop load when applied after first thinning spray of carbaryl and 6-BA

Crimson Crisp

- In 2022, 300 to 600 ppm ACC did not thin when applied at full bloom

Highlights of Thinning Apples with Accede®

- Variable results with ACC for thinning Ambrosia and Gala over eight studies covering eight years.
- ACC has not been consistently effective when applied at the 20-25 mm fruitlet diameters
- We recommended that other thinning products be applied separately or in combination with Accede® for effective thinning. However, we have limited experience testing these combinations in our own research
- ACC has caused some leaf yellowing and leaf drop but not at a level that is physiological concerning

Considerations for using Accede®

- Use higher rates (400 ppm) in orchards that have a history of being difficult to thin or in cultivars known to be difficult to thin
- A non-ionic surfactant such as Regulaid (0.05-0.125% v/v) may improve consistency of performance and response
- Apply your other bloom and fruitlet thinners as usual, consider Accede if additional late thinning is required
- Leave and flag untreated rows for comparison purposes
  - Effects on return bloom (in 2025)

Metamitron (Brevis)

Journal of Horticultural Science ›
Volume 60, 1985 - Issue 4
Journal homepage

Original Articles

Peach and apple thinning by shading and photosynthetic inhibition

R. E. Byers, C. G. Lyons, Jr K. S. Yoder, J. A. Barden & R. W. Young

Pages 465-472 | Accepted 03 Apr 1985, Published online: 27 Nov 2015
Cite this article https://doi.org/10.1080/14620316.1985.11515653

Why is light and heat important for fruit set?

During the period when thinners are applied, the carbohydrate supply from current photosynthesis is in balance with the demand from the different organs (roots, spur leaves, fruit), with the daily balance depending on the amount of sunlight and the temperatures experienced for that day

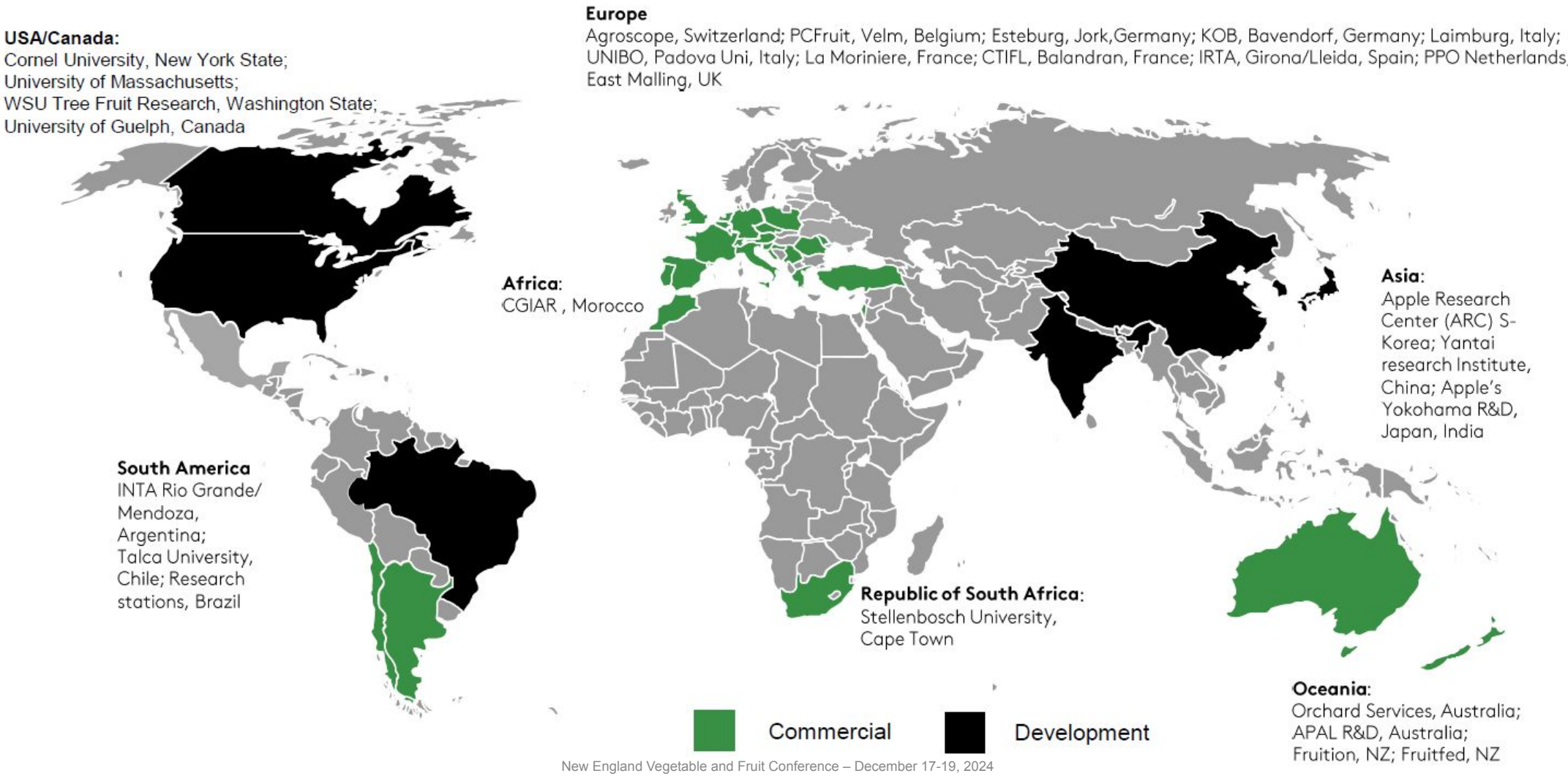
A shortage of carbohydrates results in competition between fruit and shoots

Fruit are weaker sinks than leaves and vegetative growth during fruit set

Metamitron Study Objectives

- Determine the optimal rate and most effective time to apply foliar applications of metamitron to thin apple trees
- Measure any negative effects of metamitron on tree health, including leaf yellowing
- Measure the effects of metamitron on fruit quality (including fruit size, size distribution, and maturity)
- Evaluate BreviSmart decision support model
- Investigate one vs two applications and use in combination with other chemical thinners

Metamitron (Brevis™ status globally (as of 2021) Source: Ton Bresseling, ADAMA



Summary of our Research


628

Canadian Science Publishing

ARTICLE

Multi-year investigation on the rate, timing, and use of surfactant for thinning apples with post-bloom applications of metamitron

John A. Cline, Catherine J. Bakker, and Amanda Beneff

Cline, J.A., Bakker, C.J. and Beneff, A., 2022. Multi-year investigation on the rate, timing, and use of surfactant for thinning apples with post-bloom applications of metamitron. *Canadian Journal of Plant Science*, *102*(3), pp.628-655.

What has our research shown?

- Metamitron is an effective thinner for Ambrosia and Gala, and Honeycrisp, but there have been years that it has not worked
- Most effective when king fruitlet diameter is 8-15 mm
- Inclusion of a non-ionic surfactant (Agral 90) has not made any effect on efficacy
- Thinning response is linear with increasing concentration
- In six out of the seven experiments metamitron reduced fruit set, but only in four experiments did metamitron reduce the number of fruit per tree or crop load compared with the untreated control trees.

Summary of our Research on Metamitron

What has our research shown?

- Petal fall (5–7 mm) applications of metamitron were less effective than later timings.
- Leaf phytotoxicity has been minimal in all our studies (using air blast sprayer)
- Thinning response increased with higher rates of MET in four of the seven studies.

- Honeycrisp and Ambrosia: 175 mg/L metamitron was effective
- Gala: rates at or above 263 mg/L metamitron were required to thin
- In general, rates up to 3 L/ha are required (the base rate is 1.8 L/ha)

Adama Label Recommendations

- Apply at 1.8 L/ha (base rate)
- Adjust rates using BreviSmart computer model
- Timing: petal fall to 20 mm
- Wait approximately 8 days for second applications
- A non-ionic surfactant may increase thinning efficacy

Chlorophyl Fluorescence

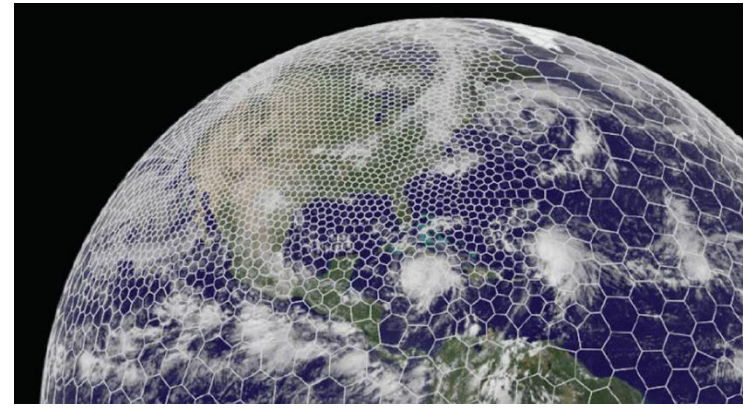
- Metamitron, carbaryl and 6-BA were applied on 29 May 2023 [14 d after bloom]
- Spray volume of 800 L/ha.

photosynthetic performance index

Dark-adapted chlorophyll fluorescence

BreviSmart Decision Support

- Website: brevismart.adama.com
- Grower Decision Support System
- Recommends application timing and rate
- Proprietary Algorithm
  - Environment: (IBM Hi-Res Global Forecasting Model – 3 km resolution)
    - Nigh time temperatures (8 pm – 8 am; 14^{o}C)
    - Solar radiation
  - Crop
    - Fruitlet size



1st Application

- May 20
- Fruitlets 8-10 mm

BreviSmart®

Grower Name: Simcoe Research Station
Plot Name: Gala
Level of thinning: Moderate to thin (i.e. Gala)
Date: 20-May-2024
As soon as spraying conditions are suitable apply BREVIS® according to the following recommendation:
Expected thinning conditions are **Good**.

Recommendations:
Green : Keep your common used dose of BREVIS® (-/+ 5% according green shade)

Diameter of the central "King" fruit in mm

Date	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
11-May-2024															
12-May-2024															
13-May-2024															
14-May-2024															
15-May-2024															
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23-May-2024															
24-May-2024															
25-May-2024															
26-May-2024															

Important: If daytime high temperature exceeds 84°F/29°C on the target day of application or 1-5 days after, do not apply Brevis until daytime temperatures are below 84°F/29°C or reduce Brevis rate

Today's date and fruit size of 1st calculation

Refer to boundaries of the use as recommended on the label

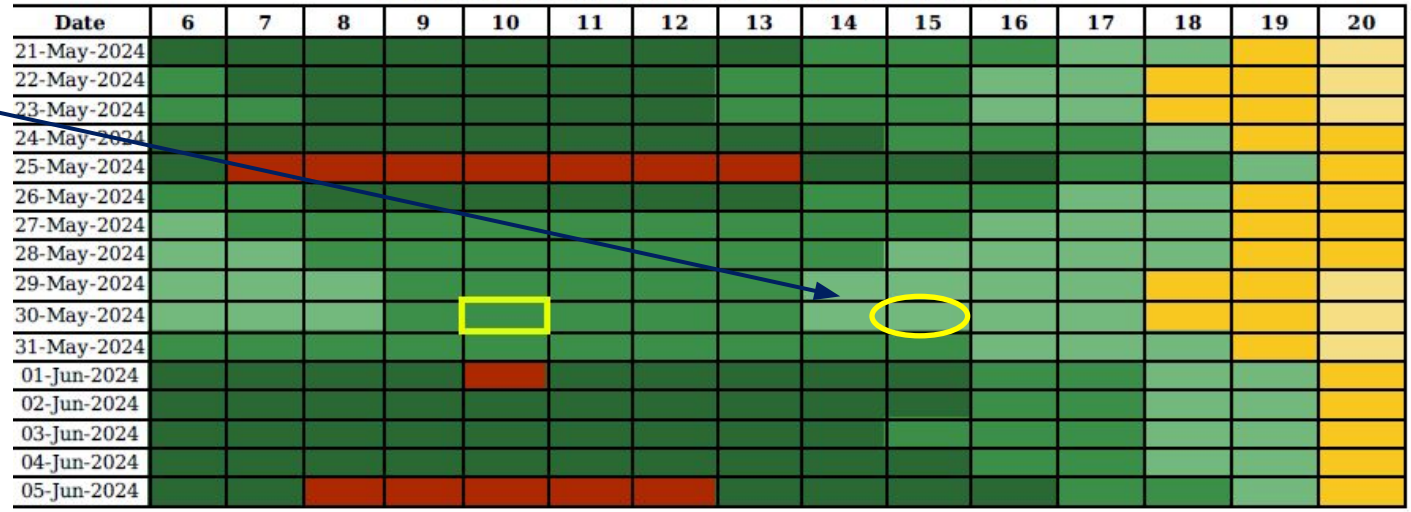
2nd Application

- May 30
- Fruitlets 15 mm

Grower Name: Simcoe Research Station
Plot Name: Gala
Level of thinning: Moderate to thin (i.e. Gala)
Date: 30-May-2024
As soon as spraying conditions are suitable apply BREVIS® according to the following recommendation:
Expected thinning conditions are **Good**.

Recommendations:
Green : Keep your common used dose of BREVIS® (-/+ 5% according green shade)

Diameter of the central "King" fruit in mm



Important: If daytime high temperature exceeds 84°F/29°C on the target day of application or 1-5 days after, do not apply Brevis until daytime temperatures are below 84°F/29°C or reduce Brevis rate

Refer to boundaries of the use as recommended on the label

Rate Determination

	Starting Rate - pt/a (l/ha)	
Orchard thinning propensity	East	West
Easy-to-thin	1.0 (1.2)	1.5 (1.8)
Medium-to-thin	1.5 (1.8)	2.0 (2.3)
Hard-to-thin	2.0 (2.3)	2.5 (2.9)

Note: Grower or Crop Advisor determines propensity to thin

Note: West coast - always include non-ionic surfactant (e.g., Regulaid) at 0.125% v/v (1 pint per 100 gallons water)

Rate range East of the Rockies is 1-2 pt/a (1.2-2.3 l/ha) and 1-3 pt/a (1.2-3.5 l/ha) in the West of the Rockies
Adjust rate up or down depending on variety, rootstock, blossom population, winter injury and fruit set and thinning history
Adjust rate depending on the results for running a carbohydrate model (BreviSmart or *Cornell Apple Carbohydrate Thinning Model*)
If you use BreviSmart, adjust rate up or down based BreviSmart output
- Yellow = increase rate – 0.25 - 0.5 pt/a (0.29 – 0.58 l/ha)
- Green = stay at starting rate
- Red = wait to spray or reduce rate – 0.25 – 1.0 pt/a (0.5 – 1.2 l/ha) – do not go lower that 1.0 pt/a (1.2 l/ha)
- If daytime temperature will exceed 84F (29C) on day of application reduce rate as per "Red Directions or wait until temperatures are lower than 84F (29C).

Brevis Rate Adjustment

Table 1. Brevis (150 g/L) rate determination

		Adjustment to Brevis rate based on BreviSmart (L/ha)					
Cultivar thinning propensity	Eastern North America Recommended rate of application (L/ha)	Yellow		Green		Red	
Easy	1.2	1.49-1.78	+25-50%	1.2	(no change)	1	-17%
Medium	1.8	2.1-2.4	+16-32%	1.8	(no change)	1.1-1.3	-27-40%
Difficult	2.3	2.6-2.9	+12-24%	2.3	(no change)	1.1-1.8	-21-33%

Precautions:

[1] the first Brevis application should be made at or just following petal fall when 'king' fruitlets are 6-7 mm in diameter fruit.

[2] if daytime temperatures exceed 29°C on the day of application or 5 days after application, reduce the rate of application or considering waiting to spray until cooler temperatures are experienced. The primary concerns are the effect of high temperatures on leaf phytotoxicity and overthinning

[3] if a second application in required, apply when king fruitlets are 12-15 mm diameter and no later than 10 days after the first application. Also, consider directing the spray to the top 50% of the canopy only.

Metamitron Key Highlights

- Metamitron is an effective thinner
- Most effective when king fruitlet diameter is 8-15 mm
- Thinning response is linear with increasing concentration
- Generally - rates above 1.8L/ha are required
- Inclusion of a non-ionic surfactant did not affect efficacy --but I personally include one to ensure product uptake
- Generally – two sprays are required OR combining it with other thinning compounds in a thinning program

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Amanda Beneff

Cathy Bakker

Younes Mostofi

Summer students

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