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Volume 30, Issue 1, Winter 2026

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Ontario

ORCHARD MANAGEMENT

Cold Hard Facts:
The Zones Have Shifted

Erika DeBrouwer, *OMAFA Tree Fruit Specialist*

Climate change is real, and although there may be a general notion that the globe is warming, that is not the full picture. Climate change refers to the periodic modification of Earth's climate based on the atmosphere – ultimately meaning – **a long-term shift in average weather patterns of a region**. This has been shown across our nation with certain provinces experiencing weather extremes first-hand.

Canada's plant hardiness (PH) zones have updated to reflect the changes in climate that have been seen over the past few decades. Generally, across our nation PH zones have increased by half a zone to almost two full zones (Figure 1). Canada's PH zones are calculated using the formula below, which was originally developed by Ouellet and Sherk, 1967[a,b,c].

Estimated index of suitability =

$$-67.62 + 1.734\mathbf{X_1} + 0.1868\mathbf{X_2} + 69.77\mathbf{X_3} + 1.256\mathbf{X_4} + 0.006119\mathbf{X_5} + 22.37\mathbf{X_6} - 0.01832\mathbf{X_7}$$

Factors that contribute to calculating PH zones include:

- $\mathbf{X_1}$**:** monthly mean of the daily minimum temperatures (°C) of the coldest month
- $\mathbf{X_2}$**:** mean frost-free period above 0°C in days
- $\mathbf{X_3}$**:** amount of rainfall from June to November
- $\mathbf{X_4}$**:** monthly mean of the daily maximum temperatures (°C) of the warmest month
- $\mathbf{X_5}$**:** winter factor
- $\mathbf{X_6}$**:** mean maximum snow depth
- $\mathbf{X_7}$**:** maximum wind gust in (km/hr) in 30 years

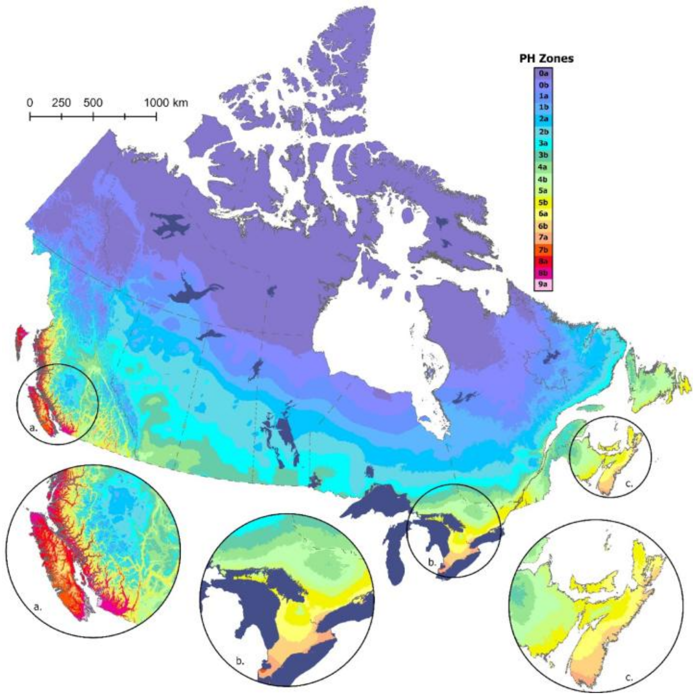

Figure 1. *The Canadian plant hardiness zone map for the 1991–2020 climate period, with insets showing greater detail for: (a) southwestern British Columbia; (b) southern Ontario, and (c) the Maritime provinces of Nova Scotia, New Brunswick, and Prince Edward Island. (McKenney, D.W., et al., 2025).*

Counting the Cold

Canada's PH zone changes are demonstrated in Figures 2A, 2B & 2C showing the progression of zones in the map taking place over 30-year increments, beginning in 1961 and ending in 2020.

These zones are great indicators of general climate trends, but remember as stated, they are – **only indicators** – and should only be used as a guideline.

The Canadian PH zone index integrates a national-scale of climate variables. Certain regions have increased by either a half zone or a full zone, particularly in the southern western region. Using long-term Ontario weather data (Westerveld, 2025) shows how changes in each factor explain where zones are shifting and what that means for Ontario apple growers.

Coldest Month Min. Temperatures

In southern and eastern Ontario there is a trend of increasing temperatures in the winter months, along with roughly an 8.5˚C rise in December temperatures compared to historical numbers (Westerveld, 2025). Warmer temperatures during this time directly increase PH zones and are a main contributor to adjustments in Ontario zones.

Frost-free Period

This has increased by 35 to 40 days overall since 1883, where last spring frosts can be 2 weeks earlier and the first fall frost can be 3 weeks later. A longer frost-free period supports a zone increase in Ontario. This is a core variable in the hardiness index.

Rainfall from June to November

Rain has increased during this period by roughly 80mm each year. This is utilized as a moisture-related stress indicator, meaning that although rainfall is increasing, it isn't a primary driver regarding PH zones in Ontario.

Warmest Month Max. Temperatures

Average temperatures have remained stable, while extreme temperatures have declined. This contributes minimally to the increase in PH zones.

Winter Factor (Severity)

Ontario isn't as cold as it used to be, with winter averages and extreme temperatures increasing overall. The decrease in winter severity within the province supports a rise in PH zone.

Mean Maximum Snow Depth

A reduced snow cover has been a trend over time in Ontario, showing less consistent snow cover. Snow works as a protective insulation factor for the PH zone calculation, contributing to a rise in zone category.

Maximum Wind Gust

This has not been evaluated from an Ontario specific standpoint internally. External sources state that wind would not be a major driver regarding zone shifts in the province.

For further details regarding climate trends in Ontario at 6 different apple locations dating back to 1883, refer to Sean Westerveld's article titled "Climate Changes in Southern Ontario: Potential Impacts on Apple Growers" found in the 2025 Winter Issue of ONcore.

Overall, Ontario's PH zones are primarily increasing because of milder winters and higher minimum temperatures. This means that Ontario, specifically the southern regions will have less extreme winter cold temperatures and longer frost-free seasons. Although these initially may seem like lower risk situations, they are not.

Ripe Realities

The practical imposition associated with these zone changes **could imply** the following:

- Warmer winters may reduce the historic winter injury risk but could increase risk of premature deacclimation – potentially causing damage over time (weak growth, sudden apple decline).
- A longer frost-free period could allow for greater fruit size and suitability for later-ripening cultivars, but earlier budbreak and bloom would increase exposure to spring frost events.
- More rainfall may allow for improved fruit sizing and sustained growth, but could be paired with increased disease pressure, vegetative vigour, shading, and fruit cracking. The timing of rainfall could also require changes management due to equipment use within the orchard.
- Stable summer temperatures means more consistent fruit development, generally benefiting fruit size, firmness, and finish. Although a large proponent to consider is the **lack of night-time temperatures within PH zone calculations.**
- Less stable and warmer winters could lead to a higher risk of injury from warm–cold temperature swings. Rootstocks often lose hardiness before scions during warm spells, so subsequent freezes can girdle or kill rootstock tissue even when tops survive, leading to delayed decline.
- Lower snow depth could reduce insulation of roots and rootstock shank, leading to an increase the vulnerability to freeze–thaw damage during cold snaps.

Ontario's PH zones are increasing mainly because winters are milder and frost-free periods are longer, not because summers are hotter. For apple growers, this could mean (i) fewer trees lost to extreme winter cold and (ii) better potential for fruit size and (iii) use of later-ripening cultivars, **but** also (i) higher risks from earlier budbreak, spring frost damage, (ii) increased vigour and (iii) disease pressure from more rainfall, (iv) and greater vulnerability to winter temperature swings that can damage rootstocks and lead to delayed tree decline. **Together, these pressures may drive change in future management strategies such as thinning and harvest timing, increased pest management, greater attention to rootstock choice (winter stability rather than cold tolerance).**

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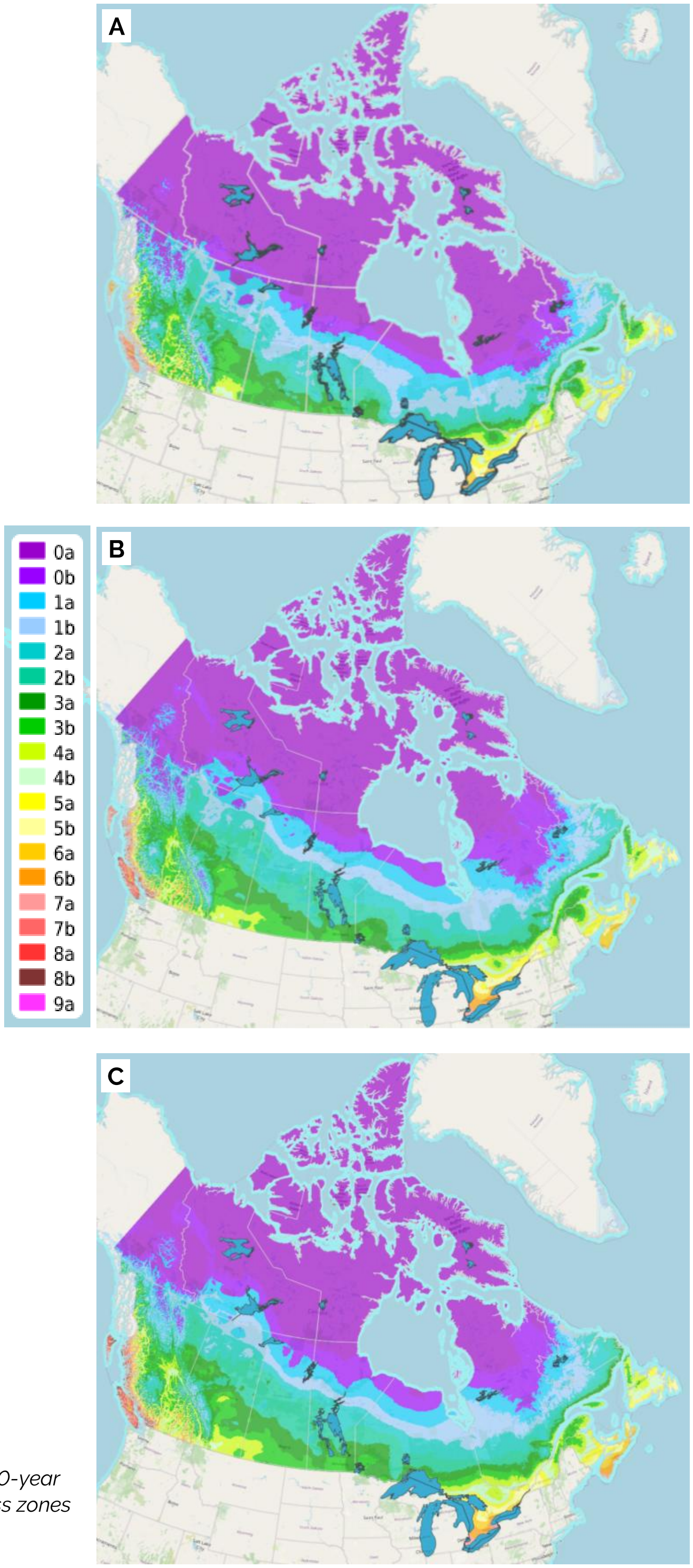

Figure 2. *Canadian plant hardiness zones over multiple decades in 30-year periods (A) Plant hardiness zones from 1961 – 1990 (B) Plant hardiness zones from 1981 – 2010 (C) Plant hardiness zones from 1991 - 2020*

Thinning Response of Ambrosia and Gala Apple Trees to Petal Fall and Late Applications of Accede®, with and without Sevin XLR

John A. Cline, *Professor of Pomology and Tree Fruit Physiology, Ontario Agricultural College, Ontario Crops Research Centre – Simcoe, University of Guelph*

Introduction

Thinning the apple crop early by pruning, blossom thinning or fruitlet thinning is beneficial to reduce fruit set, crop load, and the high labour costs associated with hand thinning. In addition, thinning early to improve fruit size and return bloom, particularly of biennial bearing cultivars such as Honeycrisp, is important.

As part of a multi-year study investigating the efficacy of 1-aminocyclopropane carboxylic acid (ACC), formulated as Accede® (PCP 34861, Valent BioSciences), a experiment was conducted in 2025 on Ambrosia and Gala with the aim of measuring the thinning effectiveness of a petal fall and "late" spray of ACC, and comparing these with hand-thinned and trees left un-thinned. In several of our past studies since 2017, we have found ACC to be a mild thinner and have often obtained inconsistent thinning even when applied at the highest label rate of 400 ppm. Therefore, combining carbaryl (Sevin XLR) with ACC was another objective of this study.

Materials and Methods

In 2025 a block of 'Ambrosia'/Bud 9 trees planted in 2021 spaced 1.1 m x 3.8 m (2424 trees/ha; 981 tress/acre) and a block 'Gala cv. Crimson'/M.9T337 spaced of 1 x 4 m (2500 trees/ha; 1012 trees/acre), both trained to a spindle hedgerow orchard system, were used for this study. Trees were located at the University of Guelph Horticultural Experiment Station, Simcoe, ON was used for this study.

Commercial products used in this study:

- Carbaryl: Sevin XLR (contains 466 g/L carbaryl, Tessenderlo Kerley Inc)
- 6-BA: Maxcel (contains 1.9% 6-benzyladenine, Valent BioSciences)
- ACC: Accede SG ® (contains 40% (w/w) 1-aminocyclopropanecarboxylic acid, Valent BioSciences)
- Non-ionic surfactant: Agral 90 (contains 92% nonylphenoxy polyethoxy ethanol, Syngenta Canada)

A randomized complete block with six replications and seven treatments was used as the experimental design. Treatments were applied according to Table 1. Both Ambrosia and Gala trees were in full bloom on 13 May 2025.

Treatments were applied using a commercial air blast sprayer (Slimline Manufacturing, Model MP3T19P with 19-60SS tower, Penticton, Canada) at 758 kPa (109 PSI). Sprays were applied dilute based on tree row volume (577 L/ha) (Sutton and Unrath, 1988). The sprayer was equipped with 9 nozzles (Four Teejet TXR AITXA8001VK nozzles (top) and five TXR8001VK nozzles (bottom)) per boom (side) and a large axial fan to move the spray into the canopy. To minimize treatment interference caused by spray drift, experimental units were separated by at least one guard tree. Applications were made at a ground speed

Table 1. List of thinning treatments

Treatment	Timing	Days after full bloom (date)
1. Untreated control	-	-
2. Hand thinned control[1]	After "June" drop	37 (June 19)
3. 400 ppm ACC[2]	5 mm (petal fall)	7 (May 20)
4. Carbaryl[3] + 75 ppm 6-BA (Maxcel)[2] ("grower standard")	6-8 mm	13 (May 26)
5. 400 ppm ACC [2]	19-20 mm	29 (June 11)
6. 400 ppm ACC tank mixed with Carbaryl[2,3]	19-20 mm	29 (June 11)

[1] Fruit clusters were singled and fruit were spaced approx. 10 cm apart
[2] All spray treatments included 0.05% Agral 90 non-ionic spray adjuvant
[3] 3.2L Sevin XLR/1000 L water

of 2.9 km/hr (1.8 m/hr). All spray treatments included 0.05% Regulaid® non-ionic spray adjuvant.

The petal fall sprays were applied on 20-May (7 days after bloom) when king fruitlets of Ambrosia were 5.5 mm and Gala were 6.1 mm. The grower standard sprays of carbaryl and 6-BA were applied on 26-May (13 days after bloom) when king fruitlets were 6.4 mm and 7.8 mm for Ambrosia and Gala, respectively. The "late" sprays of ACC and ACC tank mixed with carbaryl were applied on 11-June (29 days after bloom) when king fruitlets were 18.9 mm and 20.6 mm for Ambrosia and Gala, respectively.

The hand-thinned control trees were thinned on 19 June by removing all but one fruit per cluster and spacing fruit ~10 cm apart. Average number and weight of fruit removed by the hand-thinned trees (n=12) was 65 fruitlets for Ambrosia and 32 fruitlets for Gala. Municipal ground water with an average pH of 7.5 to 8.0 and hardness of 281 mg/L to 295 mg/L (Kristin Pressey, Personal Communications) was used as the source water for the spray mixture.

Horticultural Measurements

The following measurements were recorded:

- Weather conditions
- Fruit set (not presented)
- Yield parameters (total yield, marketable yield, number of fruit/tree, average fruit weight)
- Fruitlet diameters during early fruit set
- Tree circumference 20 cm about the ground (to calculate trunk cross-sectional area (TCSA))

Ambrosia fruit were harvested on 1-Oct 2025 and Gala on 11-Sept 2025. During harvest, the total number and weight of fruit was recorded. The number of unmarketable fruit (undersize, poor colour, pre-harvest dropped fruit) were also counted and weighed. Mean fruit size was estimated by dividing the total mass of marketable fruit by the number of fruit in the sample. A random sample of 30 fruit per tree was taken from each experimental unit (60 total fruit) and placed in cold storage (~2°C) for subsequent grading on a commercial colour sorting and sizing grading line in November of 2025.

Results

Weather and Environmental Conditions

Environmental conditions were good for pollination on May 13 and the following four days, then a 15- day period of very unusual cool weather followed from 18-May to 10 June, with daily high temperature below 20°C (Figure 1). This resulted in the traditional chemical thinning window inconducive for chemical thinners, especially the hormonal products NAA, 6-BA and ACC based on product labels. Notwithstanding, to test the efficacy of "early" petal fall sprays of ACC, ACC was applied during this period on May 20, when air temperatures ranged from 3.5-15.6°C on the day of application. In addition, the grower standard spray of 6-BA and carbaryl was applied 26-May when temperatures ranged from 6.2-19.2°C the day of application. This treatment was applied 2-3 days earlier than the target timing of 8-10 mm, but with two days or rain, cool and windy weather forecasted, we proceeded when king fruitlets were 6-8 mm. Late sprays of ACC and ACC tank mixed with carbaryl were applied on 11-June, when temperatures ranged from 13.7-26.2°C the day of application, followed by more seasonably warm weather.

Number of Fruit Per Tree

Treatments had a significant effect on the number of Ambrosia ($P<0.0001$) and Gala ($P=0.0045$) fruit per tree. For Ambrosia (Figure 2), trees treated with the hand thinned control, grower standard of CB+6-BA at 6.4 mm and, ACC combined with carbaryl at 19 mm had less fruit/tree than the untreated control. ACC applied alone at PF and 19 mm had no effect on the number of fruit/tree compared with the untreated control. For Gala (Figure 3), trees treated with the grower standard of CB+6-BA at 7.8 mm and, ACC tanked mixed with carbaryl at 20 mm had fewer fruit/tree compared with the untreated control, but a similar amount as the hand thinned trees. Trees that were hand thinned or treated with ACC applied alone at PF and 19 mm had no effect on the number of fruit/tree compared with the untreated control. Overall, untreated control trees had 103 Ambrosia fruit and 66 Gala fruit/tree when the target numbers were ~66 Ambrosia and ~70 Gala fruit per tree based on a crop load of 7 fruit/cm^2 TCSA.

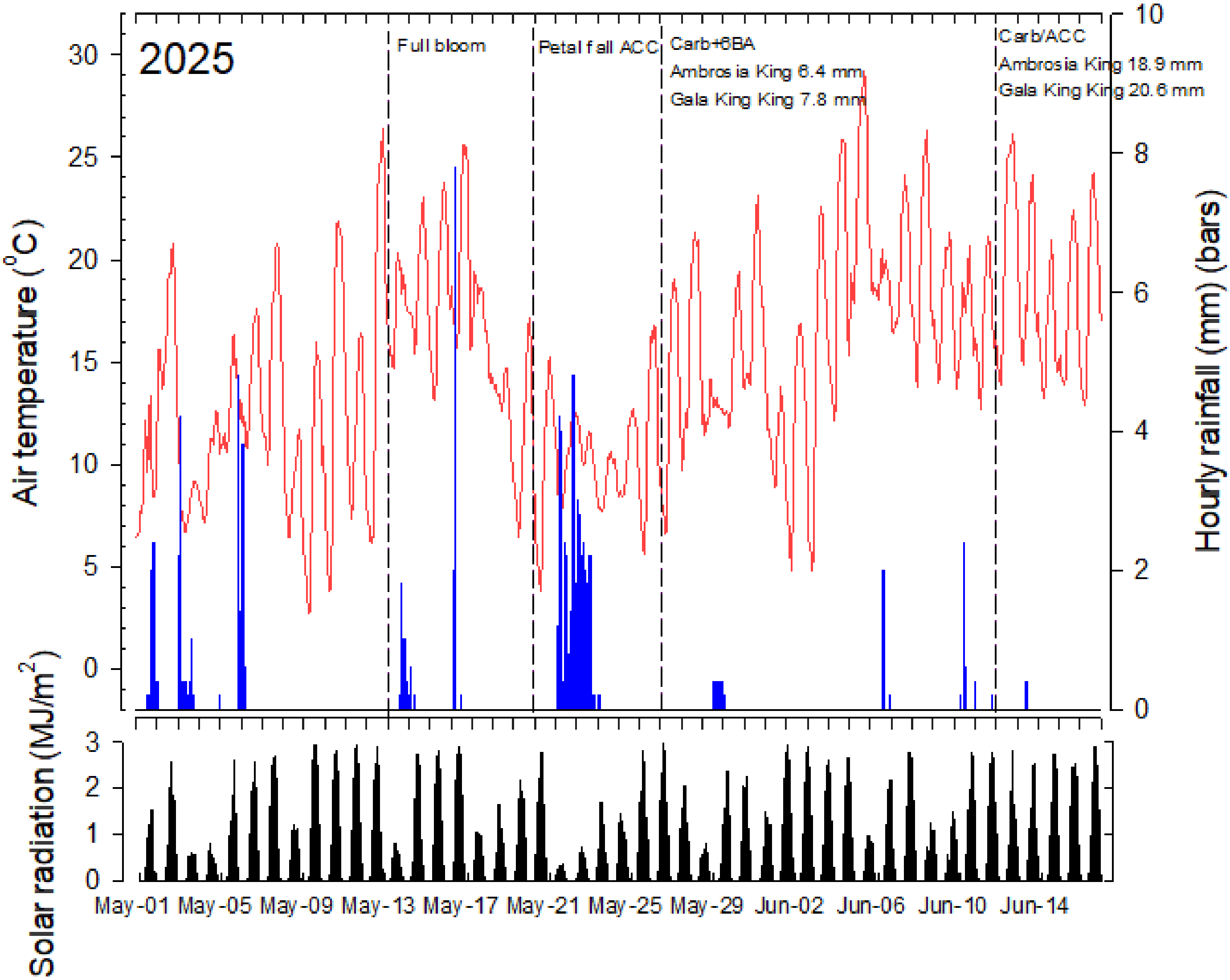

Figure 1. *Air temperature (red line), precipitation (bars), and solar radiation (lower graph) from 1-May to 16-June 2026 at the Horticultural Research Station – Simcoe. Vertical lines indicate date of full bloom and dates sprays were applied with corresponding king fruitlet diameter.*

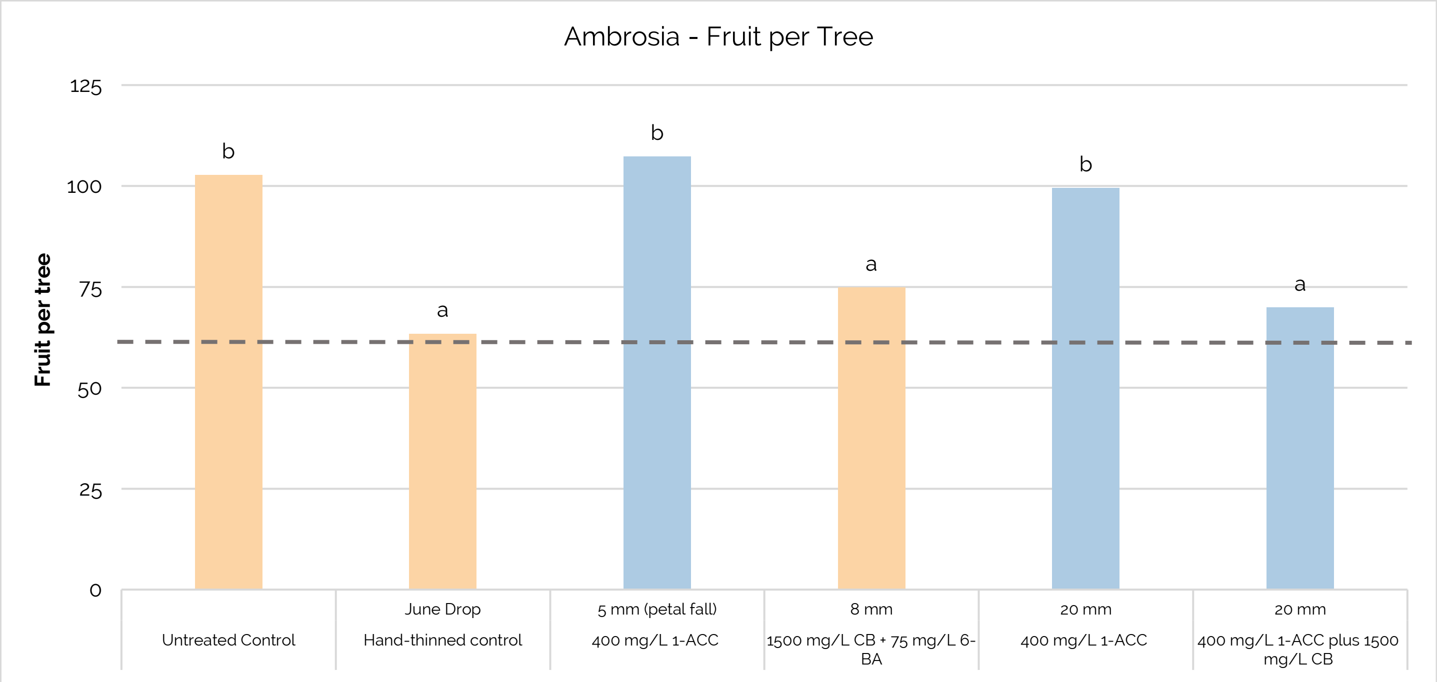

Figure 2. *Influence of ACC (blue bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 6.4 mm and 19 mm fruitlet diameters on number of fruit per tree of 'Gala' trees in 2025. Treatments were applied at: a) petal fall, 5.5 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 6.4 mm on 26-May (13 days after bloom), and c) at 19 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). The horizontal line indicates the target number of fruit per tree. Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

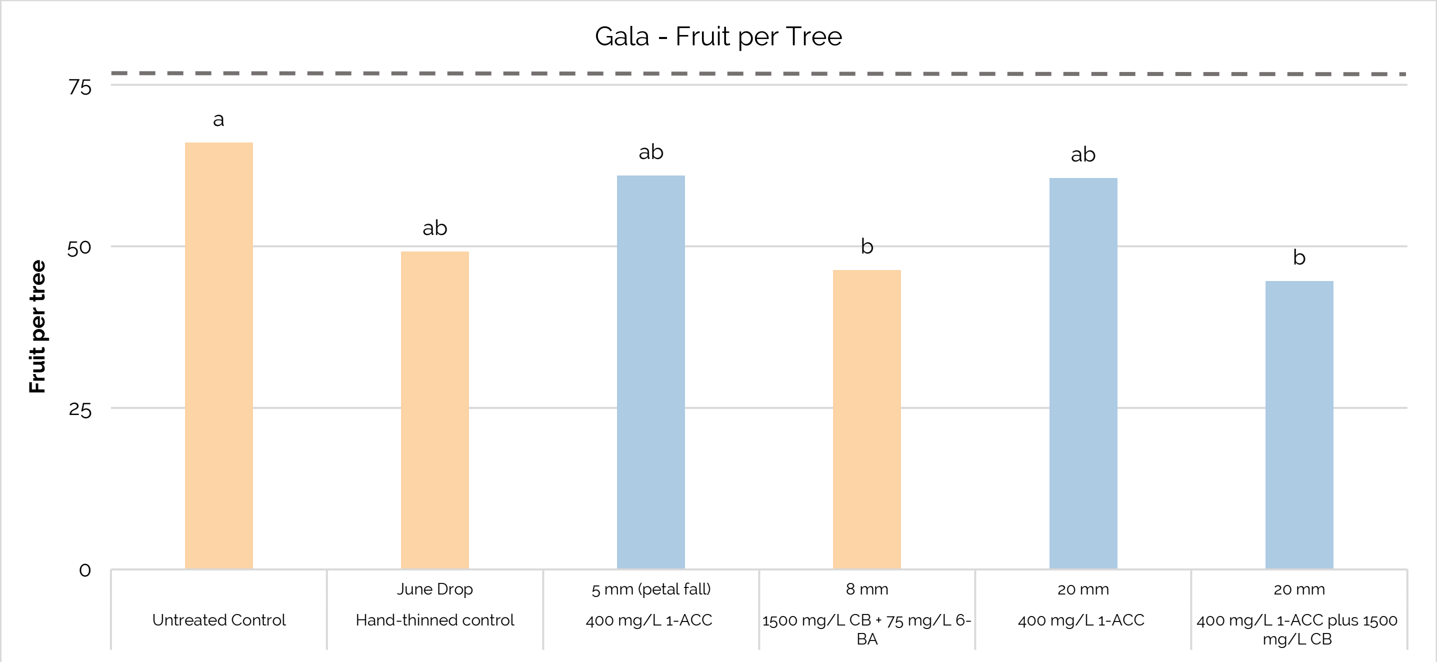

Figure 3. *Influence of ACC (blue bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 7.8 mm and 20 mm fruitlet diameters on number of fruit per tree of 'Gala' trees in 2025. Treatments were applied at: a) petal fall, 6.1 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 7.8 mm on 26-May (13 days after bloom), and c) at 20 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). The horizontal line indicates the target number of fruit per tree. Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

Crop Load

Crop load, which adjusts for slight differences in trees size and is a calculation of the number of fruit divided by the trunk cross-section area, followed a similar pattern as number of fruit per tree. Treatments had a significant effect on crop load of Ambrosia (P<0.0001) but not Gala (P=0.0518) trees. For Ambrosia (Figure 4), trees treated with the hand thinned control, grower standard of CB+6-BA at 6.4 mm and, ACC tank mixed with carbaryl at 19 mm had lower crop loads than the untreated control. ACC applied alone at PF and 19 mm had no effect on crop load compared with the untreated control. For Gala (Figure 5), crop load was statistically similar for all treatments, but numerically trees treated with the grower standard of CB+6-BA at 7.8 mm, and ACC tanked mixed with carbaryl at 20 mm had lower crop loads compared with the untreated control, but similar as the hand thinned trees. Numerically, trees that were hand thinned or treated with ACC applied alone at PF and 19 mm had no effect on crop load compared with the untreated control.

Fruit Weight

Treatments had a significant effect on the average fruit weight of Ambrosia (P<0.0001) but not Gala (P=0.0592) fruit (average based on all harvested fruit). For Ambrosia (Figure 6), trees that were hand thinned, or treated with the grower standard of CB+6-BA at 6.4 mm, and ACC+carbaryl at 19 mm, had 27%, 18% and 19% greater fruit weight than the untreated control, respectively. ACC applied alone at PF and 19 mm had no effect on fruit weight compared with the untreated control (P=0.0592). For Gala (Figure 7), fruit weights were statistically similar for all treatments (P=0.0596).

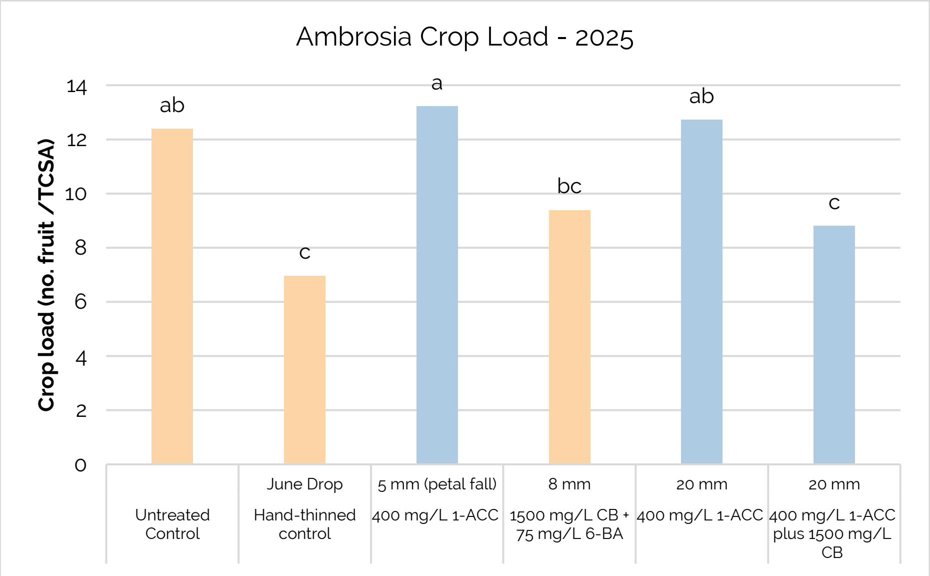

Figure 4. *Influence of ACC (blue bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 6.4 mm and 19 mm fruitlet diameters on crop load of 'Ambrosia' trees in 2025. Treatments were applied at: a) petal fall, 5.5 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 6.4 mm on 26-May (13 days after bloom), and c) at 19 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

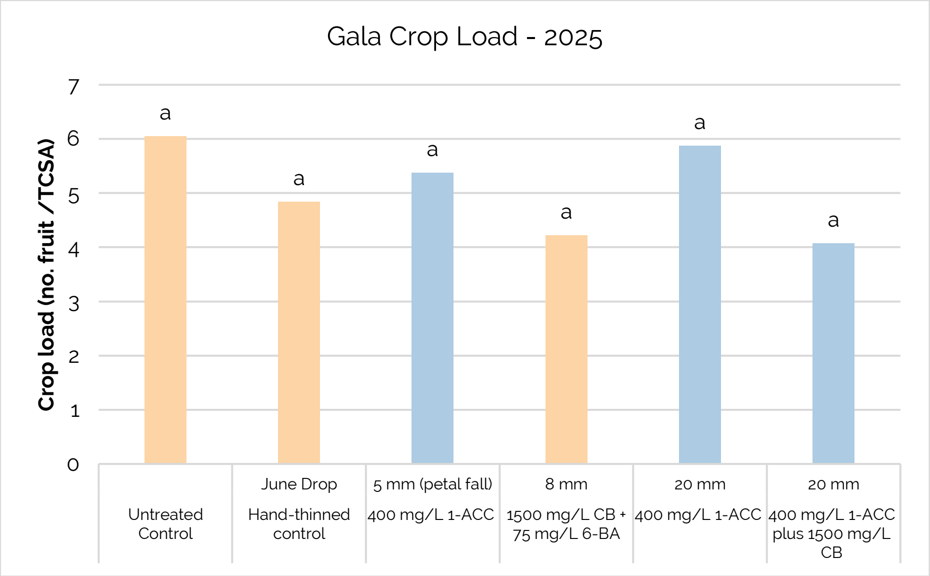

Figure 5. *Influence of ACC (blue bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 7.8 mm and 20 mm fruitlet diameters on crop load of 'Gala' trees in 2025. Treatments were applied at: a) petal fall, 6.1 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 7.8 mm on 26-May (13 days after bloom), and c) at 20 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

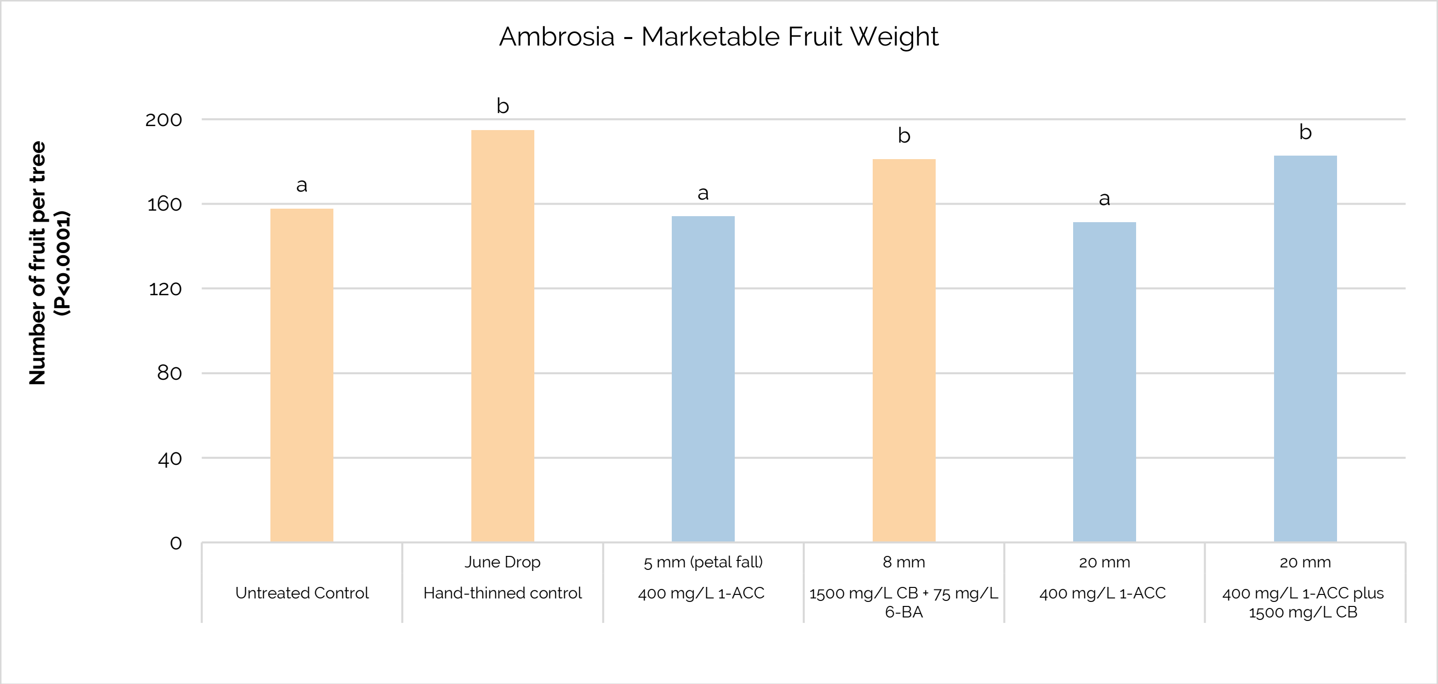

Figure 6. *Influence of ACC (green bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 6.4 mm and 19 mm fruitlet diameters on average fruit weight of 'Ambrosia' in 2025. Treatments were applied at: a) petal fall, 5.5 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 6.4 mm on 26-May (13 days after bloom), and c) at 19 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

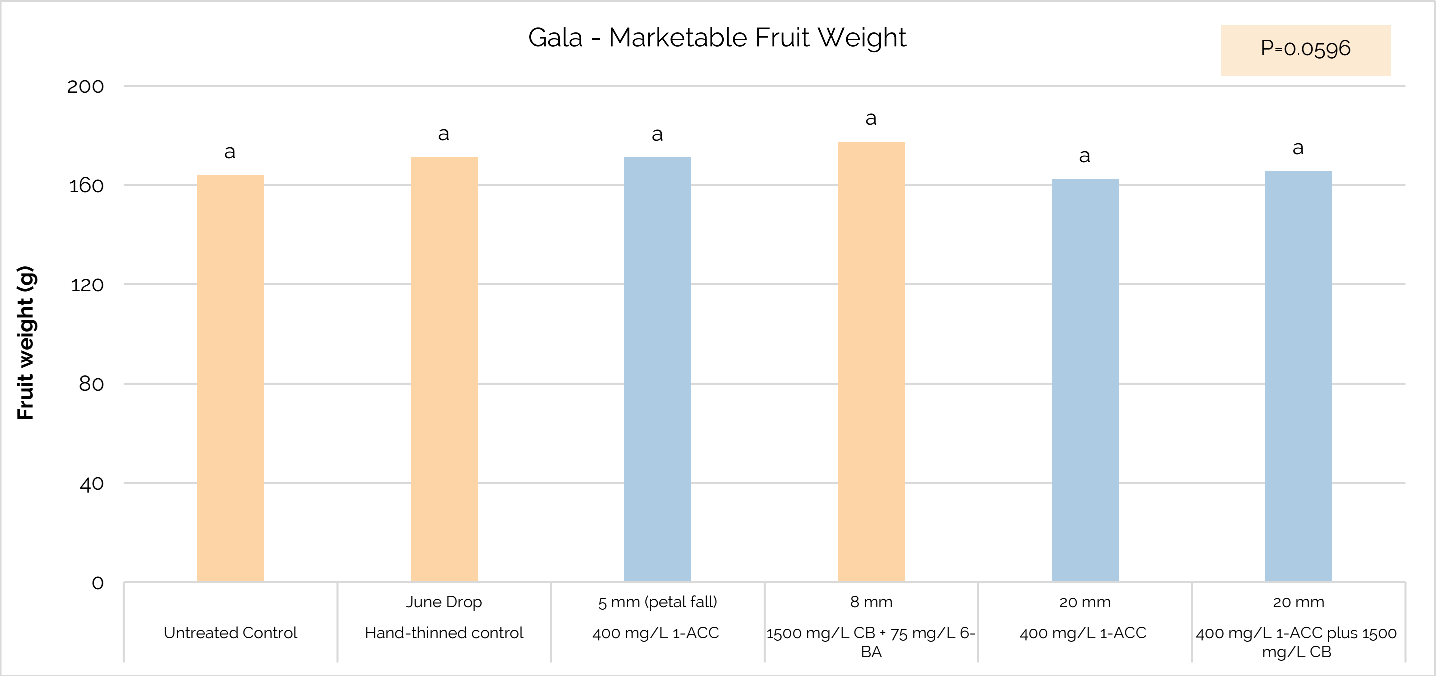

Figure 7. *Influence of ACC (green bars), carbaryl (CB), 6-benzyladenine (6-BA applied at petal fall, 7.8 mm and 20 mm fruitlet diameters on average fruit weight of 'Gala' trees in 2025. Treatments were applied at: a) petal fall, 6.1 mm fruitlet diameter on 20-May 2025 (7 days after bloom), b) 7.8 mm on 26-May (13 days after bloom), and c) at 20 mm on 11-June (29 days after bloom). Trees were hand thinned on 19-June (37 days after bloom). Mean values (bars) with the same letters are not significantly different according to Tukey's HSD test at P=0.05.*

Discussion and Conclusions

Weather conditions during early fruit development were unusually cool for a protracted period following bloom, making fruitlet chemical decision difficult. When more consistent warmer temperatures arrived on 2-June, king fruits were approximately 13 mm in diameter and approaching the outer limits of the ideal 8-15 mm fruitlet diameter thinning window. For this reason, it was a good year to evaluate a "late" timing of Accede®, a product that is promoted for "late" or "rescue" thinning. Unfortunately, there was no thinning response to ACC when applied at petal fall or 19-20 mm. Cool conditions were experienced during and following the PF application, but temperatures were ideal when ACC and ACC tank mixed with carbaryl were applied to 19-20 mm fruit on 11-June.

The reason for the lack of thinning with ACC is not fully understood but is consistent with several previous studies when we began evaluating ACC beginning in 2017. Culemann et al. (2025) suggest that ACC has poor mobility into apple leaves and even less into fruit relative to 6-BA and NAA. Increasing ACC uptake by the addition of salts such as calcium chloride or surfactants that increase the hydration of the spray deposit may increase the horticultural performance under field conditions.

Despite less-than-ideal environmental conditions when the grower standard tank mix of carbaryl and 6-BA was applied at 6-7 mm, this treatment proved effective at reducing fruit number and crop load on Ambrosia trees, but less so on Gala trees.

Ambrosia trees were likely more responsive because of the higher natural fruit set, while Gala trees had a natural fruit set of 6 fruit per cm^2 TCA, which resulted in fruit numbers less than the target crop of ~75 fruit per tree.

A surprising result of this study was to learn the effectiveness of the 'late' spray of carbaryl tank mixed with ACC when fruit were 19-20 mm in diameter (29 days after bloom). This slightly exceeded the allowable timing of XLR up to 25 days after bloom, but in a more typical year when fruit would grow faster under warmer temperatures during early fruit growth, staying with the 25-day limit would not likely be problematic. However, one consideration when using 'late' thinning sprays of Sevin XLR is that it has a 14-day REI for hand thinning (which in this was 25-June), and this may be too restrictive for growers who wish to start hand thinning earlier.

Overall, Sevin XLR appears to be an effective late thinner that has not previously been typically considered in our regional thinning programs. This study will be repeated in 2026 and further ways to explore methods to improve ACC may be investigated.

Acknowledgements

We acknowledge this project is generously funded through the Canadian Agri-Science Cluster for Horticulture 4, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Sustainable Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada, and industry contributors; the University of Guelph; BC Fruit Growers' Association; Ontario Apple Growers; Adama Canada; Les Producteurs de Pommes du Quebec; Nova Scotia Fruit Growers' Association; and the Ontario Agri-Food Innovation Alliance. We gratefully acknowledge the Norfolk Fruit Growers Association for their assistance in fruit grading. We also gratefully acknowledge the technical assistance of Cathy Bakker, Morgan Fernandes-Oliveira, Grace Cooper, and Hayden Bildy.

Disclosures

Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the University of Guelph of the products named and does not imply criticism of similar ones not mentioned.

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CROP PROTECTION

Following the Fire:
Latest Research for Fire Blight Management

Kristy Grigg-McGuffin, *OMAFA Horticulture IPM Specialist*

Fire blight continues to be one of the most economically damaging diseases for apples – especially in young, high-density plantings. Warmer, more erratic spring weather has increased the frequency of high-risk infection periods, while vigorous growth in high density systems allows the fire blight pathogen, *Erwinia amylovora* to move rapidly through trees.

Recent research presented at the 2026 Fire Blight Fruit School, hosted by Washington State University highlighted how a better understanding of the biology of fire blight, environmental influences, and available management tools can help growers stay ahead.

Why Shoot Blight Is So Destructive

Once fire blight moves from flowers into shoots, the game changes. Inside a growing shoot, *E. amylovora* no longer sits on exposed surfaces where sprays can reach it. Instead, the pathogen multiplies and migrates through the cortex into woody tissue (Figure 1).

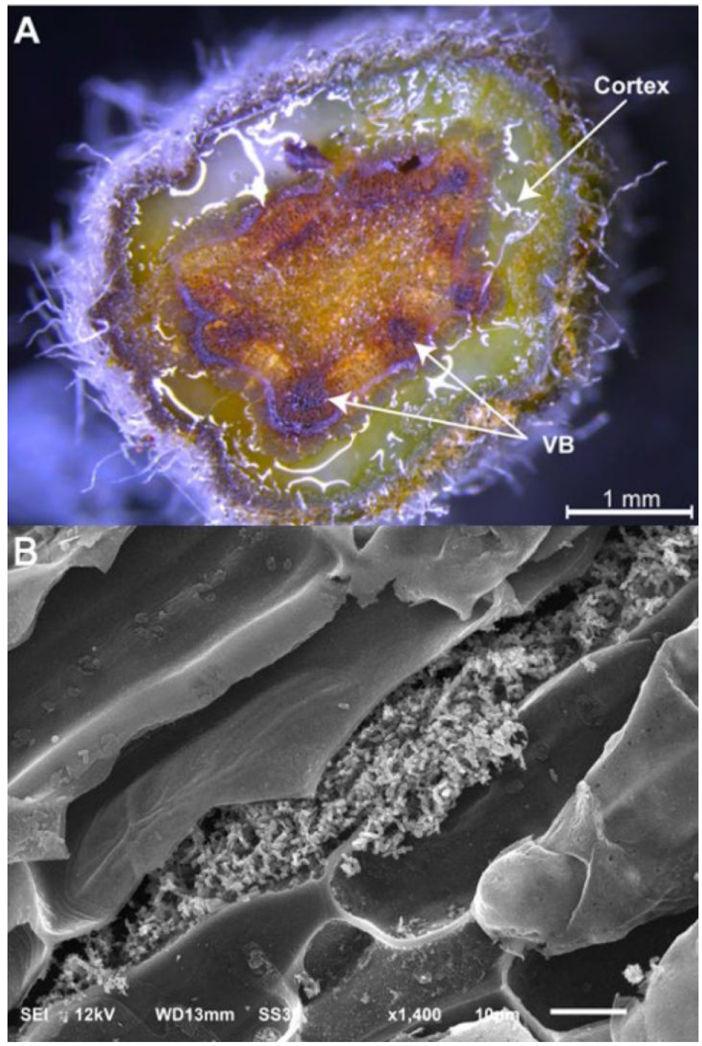

Figure 1. *Micrographs of infected shoot tissue. (A) shows immature ooze developing in the cortex and necrosis in the vascular bundles (VB). (B) shows the buildup of bacterial cells and ooze bursting through plant cells. (Photo: K. Dougherty, Michigan State University)*

Most products that work well on flowers or surfaces **don't reach** bacteria once they're inside the tree. That's why success hinges on **prevention** during high-risk blossom and shoot blight infection periods and **quick removal** in-season once strikes appear.

The conditions during the Ontario growing season are very conducive to shoot blight infection – *don't allow it the chance to spread*!

Rapid Multiplication

E. amylovora can reach >10^9 cells per gram at the shoot tip **before** classic symptoms appear. This means infection can be well established by the time you first notice a shepherd's crook.

Fast Internal Spread

New research has determined the bacteria can move internally through shoots at an average rate of **5 cm (2 in) per day**, up to 10-12 cm (4-4.5 in) per day (Figure 2).

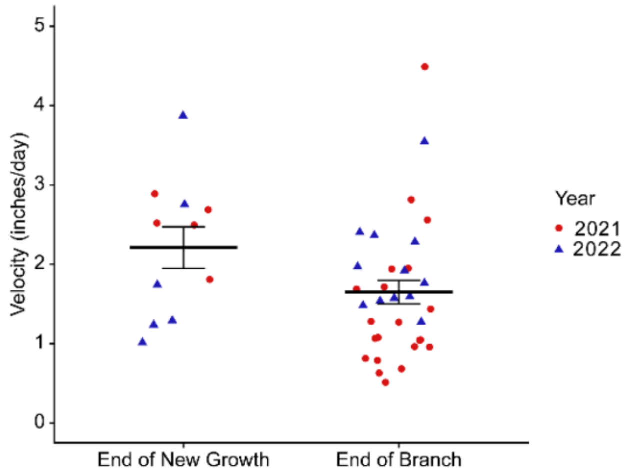

Figure 2. *Velocity of Erwinia amylovora detected at the end of the new growth and at the end of the branch.*

Ahead of Symptoms

E. amylovora has been detected at the start of 2-year wood and even at branch/trunk junctions **days before** visible symptoms develop. This explains those "surprise" cankers that show up after you've already pruned; it was way ahead of you!

Systemic Movement

Once in woody tissue, the pathogen population can move internally towards the roots and **initiate rootstock blight**. Young, high density trees are especially vulnerable:

- Rapid shoot growth creates continuous susceptible targets for infection.
- The short distance from shoot tips to the central leader speeds systemic spread.
- The step from rootstock blight to tree death can be fast – often outpacing the window where pruning could have saved the tree.

Defense Elicitors: Refining Their Role

Multi-state field trials evaluated the use of plant defense elicitors (also known as Systemic Acquired Resistance or SAR) and growth regulators for slowing systemic infections after bloom.

Two main actives evaluated were:

- Prohexadione calcium (e.g., Apogee, Kudos) – reduces shoot growth and strengthens cell walls, slowing bacterial movement.
- Acibenzolar-S-methyl (e.g., Actigard) – stimulates the tree's natural defense response.

Across locations, cultivars, and years, low rates of **prohexadione-calcium alone or in combination with Actigard consistently reduced shoot blight severity**, especially under low to moderate disease pressure.

Actigard is **NOT** registered for use on apples in Canada. Due to the current registered uses, the Pest Management Regulatory Agency has determined that the total allowable health risk has been reached, or the "risk cup" is full and no new uses (e.g., a new crop) can be added to the label.

Several alternative SAR products are registered in Canada and may provide similar – though generally less consistent – benefits when used preventively and as part of an integrated program.

This includes:

- **LifeGard WG** (*Bacillus mycoides*) – a biological plant activator that stimulates host defenses. LifeGard works best when applied before infection, as it takes several days for full defense activation. It is most effective as a preventative tool, not a rescue treatment and should not be tank-mixed with antibiotics.
- **Regalia Maxx** (extract of *Reynoutria sachalinensis*) – a plant extract that induces systemic resistance. Regalia can reduce disease severity under some conditions, but research shows variable performance, especially under high fire blight pressure. It is best used early, preventively, and in rotation rather than a stand-alone tool.

Overall, SARs should be viewed as **complements**, not replacements for antibiotics and growth regulators in fire blight management programs.

Not All Blocks Are Equal

In fire blight studies, not all cultivars respond the same way to management tools. Across multiple states, trials showed that cultivars like Gala and Pink Lady tended to show the greatest reduction in shoot blight with prohexadione-calcium and SAR programs. Fuji and Honeycrisp generally had lower shoot blight severity overall, reflecting lower inherent susceptibility to systemic infections (i.e., more resistant cultivars).

Tree vigour played an equally important role. Highly vigorous trees, particularly in young, high density systems were more likely to develop severe shoot blight and rootstock infections. In these blocks, prohexadione-calcium was consistently one of the most effective tools, as it slows shoot elongation and reduces the amount of highly susceptible tissue.

In contrast, SARs alone were often insufficient in very vigorous plantings unless disease pressure was low to moderate and applications were made early.

Environment Drives Efficacy

Antibiotic alternatives, such as biological and biorational products showed highly variable performance during multi-state trials, and the environment was a major driver:

- **Wind speed** – often improved product performance
- **Humidity** – increased efficacy for some biologicals
- **Solar radiation** – influenced drying conditions of certain products
- **Infection risk level** – high disease pressure reduced control

For example, products like Blossom Protect (Figure 3) performed better under moderate risk and higher wind speeds. Serenade (Figure 4) and essential oil products (e.g., Thyme, Cinnamon) worked best when humidity and drying conditions were favourable. However, under high disease pressure, no biological product matched the efficacy of antibiotics.

Biological products need to be selected and timed carefully, based on weather conditions and infection risk rather than used as a stand-alone replacement for antibiotics during high infection risk periods.

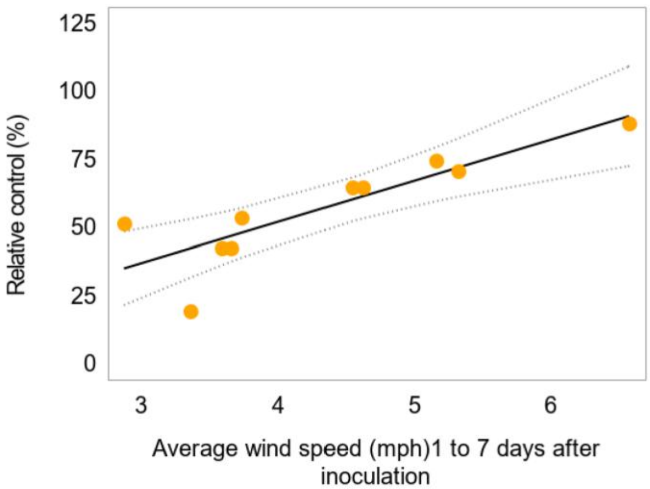

Figure 3. *Relationship between the relative control of blossom blight with Blossom Protect to wind speed over 7 days from infection in Gala apple. (DuPont et al. 2024)*

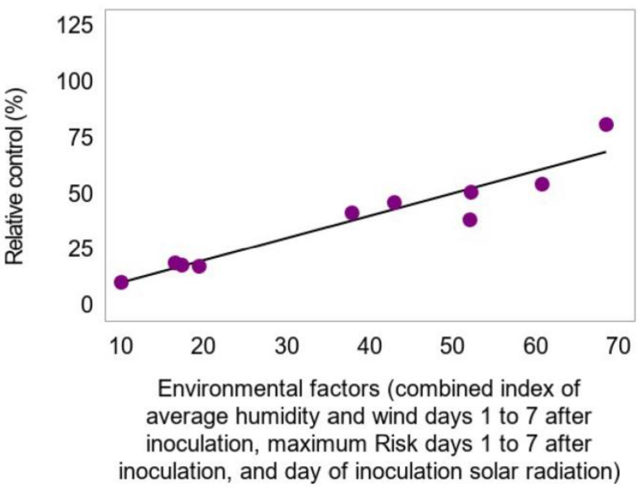

Figure 4. *Relationship between relative control of blossom blight with Serenade to humidity and solar radiation within 7 days of infection in Gala apples. (DuPont et al. 2024)*

Pruning – Most Powerful Tool

Timely removal of infected tissue remains essential for reducing spread of fire blight and preventing tree loss. Ten field trials across multiple states evaluated different pruning strategies, including:

1. **Best management practice (BMP)** – cut 30-45 cm (12-18 in) below visible symptoms, in 2- or 3-yr wood.
2. **Aggressive cutting** – cut 60-75 cm (2-2.5 ft) below visible symptoms.

3. **BMP without tool sanitation**
4. **Ugly stub cuts** – leave a 10-12 cm (4-5 in) stub at trunk
5. **Flush cuts** – cut flush to trunk
6. **Breaking** – break at the joint between 1- and 2-year wood by hand
7. **No removal (control)**

The results reinforce long-standing recommendations – with some important clarifications.

Best management practice still works! Removing infected shoots 30-45 cm (12-18 in) below visible symptoms **consistently reduced tree death and new symptom development**. More aggressive cutting (60-75 cm, or 2-2.5 ft) generally did not improve outcomes and removed more productive wood.

Breaking shoots by hand was fast but often left more cankers behind and increased inoculum for the following year.

In situations where a conservative cut beyond visible symptoms can't be made, leaving an ugly stub of 10-12 cm (4-5 in) can help protect structural wood in some situations (Figure 5). This allows small cankers to form at the end of the stub which can be removed during winter pruning. Cutting an infected branch flush to the trunk increased the likelihood of canker development into the structural wood itself (Figure 6).

Importantly, sanitizing tools during summer pruning did not significantly reduce re-infection when cuts were made far enough below symptoms. In high pressure situations, **speed of removal may be more important than tool sanitation**. Where there is the labour and time to sanitize between cuts, this classic recommendation remains. However, particularly for larger affected areas, young and/or vigorous trees, or during times of high risk of spread, the limiting factor is how quickly you get through a block – assuming you are making appropriate cuts far enough back from the infected area.

When it comes to young trees (1-3 years old), management is a different story. Fire blight can move so quickly that pruning is often ineffective. In these cases, **remove and destroy infected trees promptly**. Focus on protecting adjacent trees using an integrated approach, including vigour management, careful monitoring, and preventive use of SARs, copper or other antibiotic-alternatives to reduce the risk of secondary infections.

Adapting Strategies

One of the biggest themes from this research is that fire blight management requires a season-long integrated approach:

- Use **risk models** to time blossom protection, such as the Ontario Fire Blight Prediction Maps.
- Combine **antibiotics, biologicals, SARs and growth regulators** strategically, based on weather and infection risk. Products registered for fire blight management and their relative efficacies can be found on the Ontario Crop Protection Hub.
- **Manage tree vigour**, where possible.

Figure 5. *An ugly stub pruning cut leaves a 10-12 cm (4-5 in) stub at the trunk to allow a small fire blight canker to form. This canker can be removed during winter pruning. (Photo: T. DuPont, Washington State University)*

Figure 6. *A flush cut of an infected branch against the trunk can result in fire blight canker development directly into the structural wood. (Photo: T. DuPont, Washington State University)*

- **Act quickly** to remove infections during the season.
- Focus on **preventing shoot blight**, not just reacting to it. Continue to monitor weather and infection risk beyond just bloom time and keep insect feeding damage to a minimum.

Even good programs can sometimes lose to fire blight.

- Under extreme risk (hot, humid and wet), protection can be overwhelmed and certain products such as biologicals can have reduced reliability.
- Unsettled weather events such as strong winds, heavy rain, and hail can introduce bacteria into a block from surrounding areas.
- Susceptible cultivars and rootstocks show more rapid spread, causing a small infection to quickly accelerate into a much larger issue.
- When shoots are rapidly growing, the growth rate itself and the microscopic wounds of the expanding leaves can outstrip what defense priming or protectants can provide. Another reason prohexadione-calcium can help post-bloom.

Anticipate. Regulate. Remove.

Fire blight wins when it gets a head start.

The best programs don't chase it – they stay ahead through prevention, vigour management, and fast response.

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Data Drives the Label:
Understanding Restricted Entry & Harvest Intervals

***Kristy Grigg-McGuffin**, OMAFA Horticulture IPM Specialist*

I'm sure every grower has experienced the brain teaser of a product label: a 12-hour restricted entry interval (REI) paired with a 7-day preharvest interval (PHI). Or even more confusing, a 3-day REI alongside a 1-day PHI.

At first glance, that can feel inconsistent. If residues are low enough for harvest, why can't workers re-enter sooner? And in other cases, why can workers safely re-enter well before fruit can be picked?

The answer lies in the science behind pest control product regulation. These intervals aren't meant to match – they're derived from **fundamentally different risk assessments** to address distinct exposure scenarios and toxicological endpoints.

Two Intervals, Two Risks

Restricted Entry Interval (REI)

The REI is the minimum time that must pass before workers can re-enter a treated orchard without personal protective equipment (PPE).

Its purpose is to mitigate **occupational exposure** – people pruning, thinning, scouting, fixing irrigation, or other routine tasks where exposure to a chemical could occur through skin contact (dermal exposure) or breathing in residues (inhalation).

Preharvest Interval (PHI)

The PHI is the minimum time between the last application and harvest.

Its purpose is to protect **consumers**, ensuring that pesticide residues on fruit are below legally established limits, or Maximum Residue Limit (MRL) at the time of harvest.

REIs and PHIs are established for different populations, different exposure routes, and different risk scenarios.

What's Behind the Label?

In Canada, pest control products are regulated federally by Health Canada's Pest Management Regulatory Agency (PMRA).

> A **pest control product** is defined under the *Pest Control Products Act* as any product, substance, or organism – whether naturally occurring or manufactured – that is used directly or indirectly to **control, suppress, or alter a biological process** in a way that manages a pest or modifies plant physiology.
>
> This includes – but is not limited to – conventional and organic insecticides, fungicides, herbicides, rodenticides, biological control agents, plant growth regulators, pheromones, mating disruption.

Before a pest control product is registered, registrants (e.g., chemical companies) must submit extensive data packages to PMRA, which include:

- Toxicology studies
- Residue chemistry data
- Occupational exposure studies
- Environmental fate and ecotoxicology studies

From there, PMRA conducts independent risk assessments using conservative assumptions and built-in safety factors – often 100-fold or greater – to account for variability between species and among a population (e.g., at risk members such as children or pregnant women). These assessments determine whether risks to human health and the environment are acceptable when products are used according to label directions.

Toxicology – *How Harmful Is It?*

Toxicology studies determine what the product can do to human health and at what exposure level effects begin to occur.

This includes:

- Acute toxicity
- Short- and long-term studies
- Chronic effects
- Specialized endpoints – neurotoxicity, carcinogenicity, endocrine effects

Residue Chemistry – *How Much Is On The Crop… And How Fast Does It Decline?*

Residue studies track how pesticide residues behave on and in the crop over time following application, including field trials/sampling, processing (e.g., washing, storage), and storage stability.

Occupational Exposure – *How Much Are Workers Exposed To?*

These studies estimate how much pesticide workers are exposed to during and after application, from handling (mixing, loading, spraying) to post-application activities.

Environmental Fate – *Where Does It Go After It's Applied?*

Environmental fate studies examine how the product behaves in soil, water and air, including how quickly it breaks down, leaching potential, persistence in different conditions, and run off or drift potential.

This determines potential risks to surface and ground water, as well as non-target organisms (e.g., beneficial insects, aquatic species) and used to inform label directions related to environmental protection, such as buffer zones, application timing and use restrictions.

How PHIs Are Determined

Preharvest intervals are driven by residue decline studies.

Assessments apply the product under defined use patterns and measure how much residue remains on fruit over time. These data are used to:

- Establish Maximum Residue Limits (MRLs)
- Model dietary exposure across the population
- Compare exposure to toxicological thresholds (like acceptable daily intake)

The PHI is then set at the point where residues are expected to fall below the MRL – with a margin of safety – under worst-case conditions. This includes maximum application rates, minimum intervals between applications, and environmental conditions that may slow degradation.

How REIs Are Determined

Restricted entry intervals are based on worker exposure, not what ends up on the fruit at harvest.

Assessments consider:

- Transferable residues on leaves and fruit
- Worker activities (e.g., thinning vs scouting vs harvest)
- Duration and frequency of contact (e.g., time spent in a treated area, frequency of re-entry events, frequency of contact with treated surface)
- Dermal absorption and inhalation potential

Because these assessments often focus on short-term exposure risks, they tend to use conservative assumptions about how much residue a worker might contact during a workday.

Why REIs & PHIs Don't Match

Different Exposure Pathways

PHIs deal with ingestion – what consumers eat, whereas REIs deal with contact and inhalation – what workers touch and breathe.

A pesticide can break down quickly enough to be safe to eat, but still remain on leaf surfaces long enough to pose a risk through skin contact.

Different Safety Assumptions

Worker exposure models often assume:

- Repeated contact with treated surfaces (i.e., hand picking many fruits over a workday)
- Extended work periods in the canopy

Dietary exposure models assume:

- Low-level intake spread across many foods (i.e., a person eats an apple a day)
- Intermittent exposure over time

These differences can push REIs longer than PHIs – or vice versa depending on the residue characteristics.

Different Data Availability

Not all products have detailed, crop-specific worker exposure data.

When data is limited, regulators rely on standardized assumptions. These are intentionally conservative, and they can result in longer REIs than might be necessary under real orchard conditions.

Orchard Practices Matter

Restricted entry intervals are highly sensitive to what actually happens in the field:

- Nature of the task (e.g. high-contact vs low-contact activities)
- Canopy density and architecture (e.g., dense canopy vs 2D fruiting wall)
- Frequency of worker entry after application
- Crop stage at application (e.g., bud break vs harvest)

Preharvest intervals, on the other hand, are less influenced by these factors because they focus on residue levels at harvest – not worker behaviour.

Old Labels vs New Science

Some products on the market today were registered under older assessment frameworks.

Newer registrations or product re-evaluations often include:

- More refined exposure data
- Improved modelling approaches
- Activity-specific adjustments

This can lead to shorter – or more tailored – REIs compared to legacy products or what labels had prior to a re-evaluation.

Grower Input Matters

This is where science meets reality – and where growers play a critical role.

Risk assessments are **only as good as the assumptions behind them** about how products are actually used:

- When applications are made
- How dense the canopy is
- What spray volumes are used
- How often workers enter treated blocks
- What tasks they perform – and for how long
- What PPE is used

If those assumptions don't reflect real-world practices, the result is often overly conservative restrictions.

Providing accurate use information helps:

- Refine exposure models
- Support activity-specific REIs
- Defend important used during PMRA re-evaluations

Without that input, regulators default to "worst-case" scenarios – which can limit flexibility on the label.

How Can You Help?

Document Real Practices

Track what actually happens after an application from how soon workers need to go back into a block, what tasks they are doing (scouting, thinning, pruning, etc), and how long are they in the canopy during the task.

Even informal records help build a more accurate picture of task-specific exposure, which is a major driver of REIs.

Also report to your industry rep or your friendly OMAFA extension specialist 😊 if a label requirement is difficult to implement. Consistent, evidence-based feedback helps identify where risk assessments may need refinement.

Participate in Surveys & Generating Crop-Specific Data

When opportunities come up through grower organizations, extension, or industry groups – participate! This could include pesticide use surveys, Cost of Production survey, residue or efficacy trials, work activity studies, or observational field research.

Make sure researchers, extension, regulatory and industry groups are aware of new training systems,

mechanization trends, and changes in labour practices.

Again, without crop-specific and activity-specific data, regulators default to conservative assumptions that may not be reflective of real-world practices.

Engage with Grower Organizations

Work through groups like the Ontario Apple Growers or commodity boards that:

- Submit input during PMRA consultations
- Support minor use registrations
- Advocate during re-evaluations

Regulatory decisions are often influenced by the quality and quantity of real-world use information submitted during these processes. The more voices at the table, the better!

Provide Feedback During PMRA Consultations

When the PMRA opens consultations, especially during re-evaluations, growers can:

- Submit comments on feasibility of proposed REIs/PHIs
- Highlight mismatches with actual orchard practices
- Provide context on labour and timing constraints

This is one of the few formal pathways where real-world constraints can directly influence regulatory outcomes.

The Bottom Line

Intervals like REIs and PHIs aren't arbitrary – and they're not supposed to match.

They are the result of two separate risk assessments designed to protect workers in the orchard (REIs) and consumers at the table (PHIs). When the numbers don't align, it's not a contradiction – as illogical as it may seem sometimes. There's science behind it.

And the more accurately real-world orchard practices are reflected in that science, the more practical labels become. Exposure models are only as current as the systems they're based on. Outdated assumptions can lead to outdated labels.

To learn more about Restricted Entry Intervals and Preharvest Intervals, read the Pest Management Regulatory Agency's Understanding Restricted-Entry Intervals for Pesticides (Figure 1).

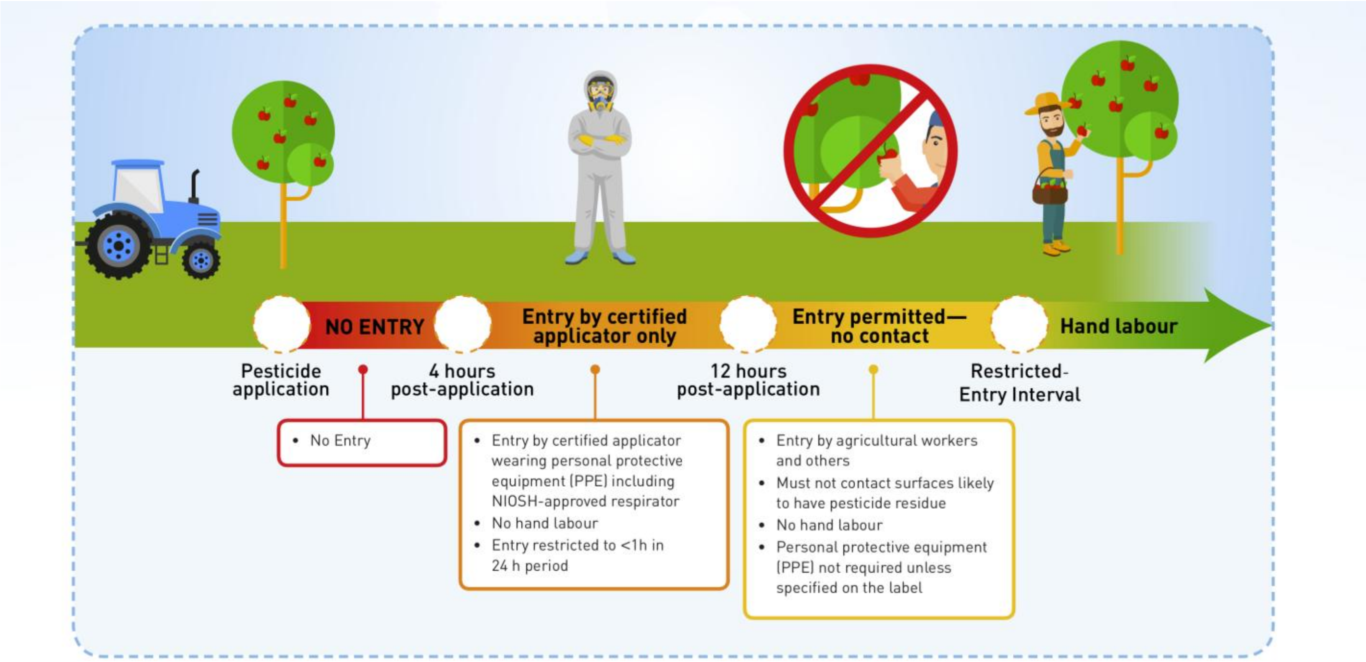


Figure 1. *A restricted-entry interval (REI) is the period of time that a person must not do hand labour in treated areas after a pesticide has been applied. Complying with REI directions is a legal requirement and part of pesticide safety (Pest Management Regulatory Agency, Understanding Restricted-Entry Intervals for Pesticides)*

Bitter Rot Management:
Results of 2024-2025 Field Trials

***Asifa Munawar**, Research Associate, University of Guelph*

Introduction

Bitter rot is an important summer disease that can significantly affect apple production in Ontario. Studies from the University of Guelph have confirmed that three *Colletotrichum* species are associated with this disease in the province: *C. fioriniae*, *C. nymphaeae*, and *C. godetiae*. Similar to reports from other regions of the Northeast, *C. fioriniae* appears to be the dominant bitter rot species in Ontario, despite the presence of other *Colletotrichum* species. Comprehensive province-wide incidence data are still pending and will be reported in a future article.

These pathogens can infect fruit early in the season without producing visible symptoms. As fruit approach maturity or during storage, infections can develop rapidly, appearing as characteristic sunken lesions that can result in fruit loss (Figure 1 & 2). Recent research indicates that apples are susceptible to *Colletotrichum* spp. infection from fruit set through harvest, highlighting the importance of season-long disease management. To learn more on bitter rot timing, read *Timing of Infection and Management of Bitter Rot in Ontario*.

To support improved bitter rot management for Ontario growers, a fungicide efficacy trial was conducted during the 2024 and 2025 growing seasons at the University of Guelph's Ontario Crop Research Centre - Simcoe. Several fungicide treatments were evaluated to determine their effectiveness in reducing bitter rot under Ontario growing conditions.

Experimental Set-Up

The trial was conducted using a randomized complete block design with two cultivars, Empire and Ambrosia on M.9 rootstock. Five trees were used per replicate and four replicates per treatment. Treatments (Table 1) were selected in collaboration with project partners.

The first fungicide application was made 10 days after petal fall.

For Empire, applications began on:

- May 23, 2024 – when fruit size was approx.. 11 mm
- May 26, 2025 – when fruit size was approx.. 7 mm

For Ambrosia, applications began on:

- May 30, 2024 – when fruit size was approx.. 14 mm
- June 3, 2025 – when fruit size was approx.. 10 mm

Subsequent fungicide applications were applied approximately after 9-17 days or after 50 mm or more rainfall). Spray schedule and rainfall summary for 2024 and 2025 are provided in Tables 2 and 3, respectively.

Applications were made using a CO_2-powered backpack sprayer equipped with a TeeJet XR11002-VS

***Figure 1.** Bitter rot on Empire apple.*

***Figure 2.** Bitter rot on Ambrosia apple.*

Table 1. Treatments for 2024-2025 bitter rot fungicide efficacy trials, Ontario Crop Research Centre – Simcoe

Treatment	Trade Name	Active Ingredient(s)	FRAC Group	Rate Applied
1	Untreated Check (UTC)	water	—	—
2	Folpan 80 WDG	folpet (80%)	M4	3.75kg/ha
3	Aprovia	benzovindiflupyr (100 g/L)	7	500 mL/ha
4	Cyclone Plus* + Agral 90	lactic acid (1.4%) + citric acid (2.54%)	P7	1.4% v/v + 0.1% v/v
5	Switch 62.5 WG*	cyprodinil (37.5%) + fludioxonil (25%)	9+12	975 g/ha
6	Commercial Standard (CS)			
	Pristine WG	boscalid (12.8%) + pyraclostrobin (25.2%)	7+11	1.2 kg/ha
	Allegro 500 F	fluazinam (40%)	29	1 L/ha
	Supra Captan 80 WSP	captan (80%)	M4	3 kg/ha

* Not registered for apples

nozzle, delivering spray volumes of 500–800 L/ha. Weather data was monitored using an on-site Weather INnovations System (Tables 2 & 3).

To ensure disease pressure, trees were inoculated in 2024 on May 24 and May 31 for Empire and Ambrosia, respectively, and in 2025 on May 27 and June 4 for Empire and Ambrosia, respectively. Mesh bags containing Empire fruit inoculated with *C. fioriniae* spores were hung from the top trellis wires to act as a source of inoculum (Figure 3).

A total of nine spray applications were made in 2024 and eight in 2025 for each cultivar (Tables 2 & 3). Empire fruit were harvested on September 9, 2024, and September 11, 2025, while Ambrosia fruit were harvested on September 26 in both years. In-field bitter rot incidence was assessed by recording the number of infected fruit and total fruit per tree in between each spray application and at harvest. In 2024, all fruit were harvested, whereas in 2025, a subsample of 100 fruit per plot was collected.

Following harvest, fruit were stored in cold storage for four months and subsequently held at room temperature for 7–14 days to allow symptom development. Fruit were then evaluated for symptoms of bitter rot. Mean bitter rot incidence (% fruit with at least one lesion) was used for treatment comparisons using SAS statistical software.

Figure 3. *Mesh bags containing bitter rot inoculated fruit were hung in the orchard to act as a source of inoculum.*

Table 2. Application dates for 2024 bitter rot fungicide efficacy trial, Ontario Crop Research Centre – Simcoe

Application	Date	Cultivar(s)	Interval (days)	Rain (mm)	Commercial Standard Rotation
1	23-May	Empire	—	—	Supra Captan 80 WSP
2	30-May	Ambrosia, Empire	7	59.8	Allegro 500 F
3	11-Jun	Ambrosia, Empire	12	38	Pristine WG
4	24-Jun	Ambrosia, Empire	13	9.6	Supra Captan 80 WSP
5	3-Jul	Ambrosia, Empire	9	66.2	Supra Captan 80 WSP
6	18-Jul	Ambrosia, Empire	15	91.2	Pristine WG
7	31-Jul	Ambrosia, Empire	13	15.4	Allegro 500 F
8	14-Aug	Ambrosia, Empire	14	28	Supra Captan 80 WSP
9	27-Aug	Ambrosia, Empire	13	35.6	Pristine WG
10	10-Sep	Ambrosia	13	35.8	Supra Captan 80 WSP

Table 3. Application dates for 2025 bitter rot fungicide efficacy trial, Ontario Crop Research Centre – Simcoe

Application	Empire				Ambrosia			
	Date	Interval (days)	Rain (mm)	Commerical Standard Rotation	Date	Interval (days)	Rain (mm)	Commercial Standard Rotation
1	26-May	—	—	Pristine WG	3-Jun	—	—	Pristine WG
2	12-Jun	17	11	Allegro 500 F	17-Jun	14	7.6	Supra Captan 80 WSP
3	25-Jun	13	32.4	Supra Captan 80 WSP	4-Jul	17	88	Pristine WG
4	4-Jul	9	56	Pristine WG	15-Jul	11	42.49	Allegro 500 F
5	15-Jul	11	42.49	Allegro 500 F	1-Aug	17	80.4	Supra Captan 80 WSP
6	1-Aug	17	80.4	Supra Captan 80 WSP	15-Aug	14	6.8	Pristine WG
7	15-Aug	14	6.8	Pristine WG	29-Aug	14	42.8	Allegro 500 F
8	29-Aug	14	42.8	Allegro 500 F	12-Sep	14	—	Pristine WG

2024 Results

In-Field Assessments

Bitter rot incidence remained low early in the season on both cultivars but increased steadily towards late August and September (Figure 4). Across assessment dates, fungicide treated plots had lower bitter rot incidence compared with the untreated check (UTC).

Based on pre-harvest rating (9-September) in Empire, FOLPAN and APROVIA provided the highest control (>95%), followed by Commercial Standard (CS) (~90%). SWITCH (67%) and CYCLONE PLUS (74%) provided moderate suppression.

Based on the pre-harvest rating (26-Septmeber) in Ambrosia, FOLPAN and CS again provided the highest

control (>95%), followed by APROVIA (~93%). SWITCH provided 78% control of bitter rot incidence, and CYCLONE PLUS showed the lowest control (~62%) under higher disease pressure.

Post-Storage Assessments

In post-storage ratings (Figure 5), UTC showed extremely high disease incidence, exceeding 90% on Empire and approaching 100% on Ambrosia, confirming severe disease development in the absence of fungicide protection during the growing season.

On Empire, FOLPAN, APROVIA, and CS provided 80% or higher control, while SWITCH provided intermediate control. CYCLONE PLUS did not provide effective control and was similar to the UTC.

In Ambrosia, FOLPAN, SWITCH, APROVIA and CS provided 76% and above control. CYCLONE PLUS did not show effective control with values statistically similar to UTC.

2025 Results

In-Field Assessments

Bitter rot incidence remained low on Empire; no treatment differences were observed (Figure 6). Based on pre-harvest rating (11 September) in Empire, FOLPAN and CS provided near complete control (~100%). APROVIA and SWITCH provided strong control (~88–92%), and CYCLONE PLUS showed lower suppression (~42%).

On Ambrosia, disease pressure was moderate in August and September; all fungicide treatments significantly reduced bitter rot incidence compared with UTC (Figure 6). Based on the pre-harvest rating (26 September), CS, APROVIA, and FOLPAN provided excellent control (>95%). SWITCH provided good control (~84%) and CYCLONE PLUS provided moderate control (~75%).

Post-Storage Assessments

After storage, bitter rot incidence was high, even with low disease pressure seen during the field season (Figure 7).

In Empire, treatments of FOLPAN, SWITCH, APROVIA, and CS provided good control, while CYCLONE PLUS showed little control (2.9%) and was statistically similar to UTC.

For Ambrosia, disease incidence was around 90% in UTC. Treatments of FOLPAN, SWITCH, APROVIA, and

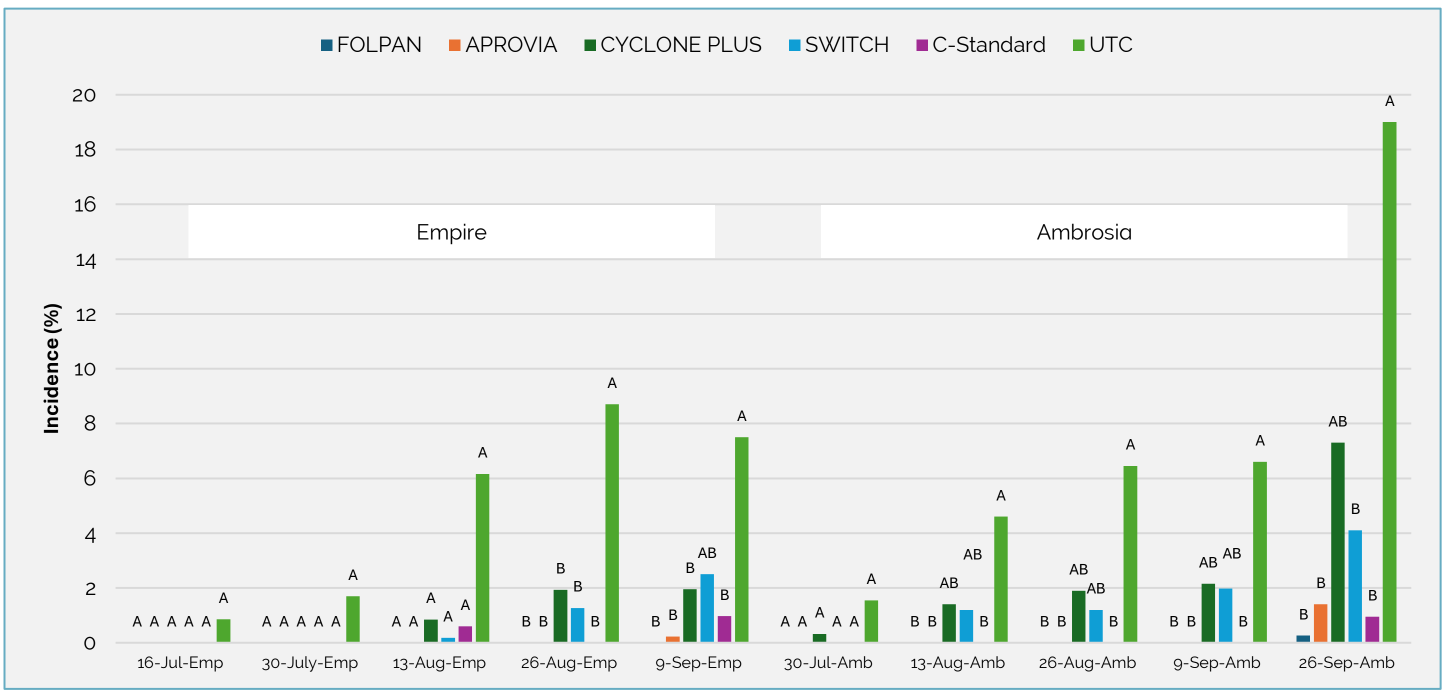


Figure 4. *Mean percent incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2024. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05).*

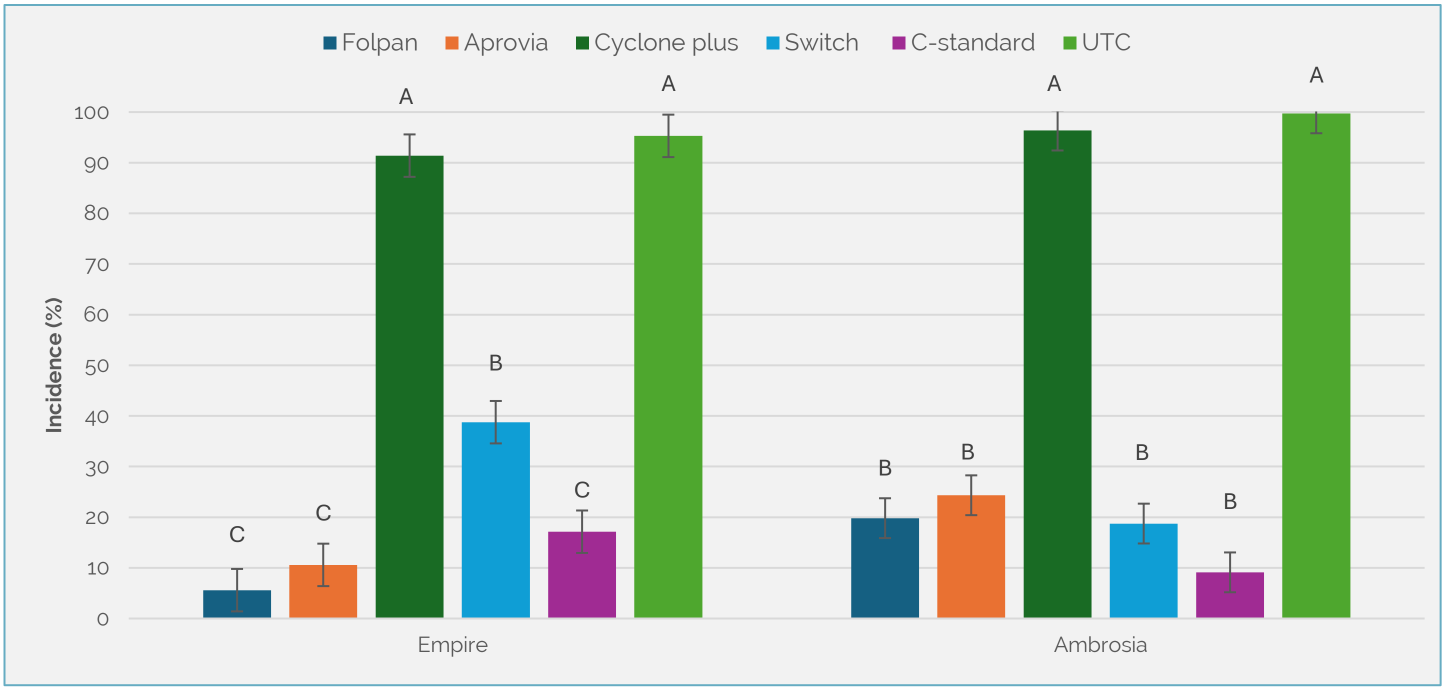


Figure 5. *Mean percent post-storage incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2024. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05)*

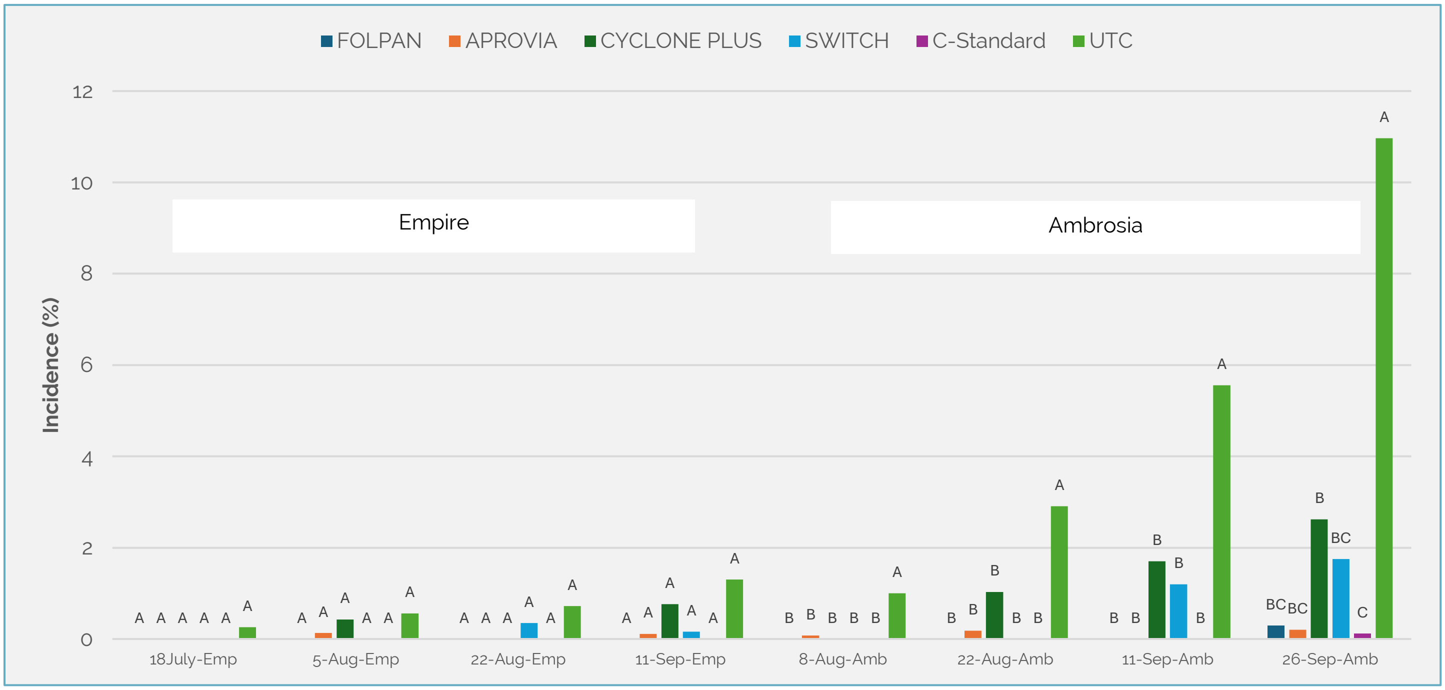


Figure 6. *Mean percent incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2025. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05).*

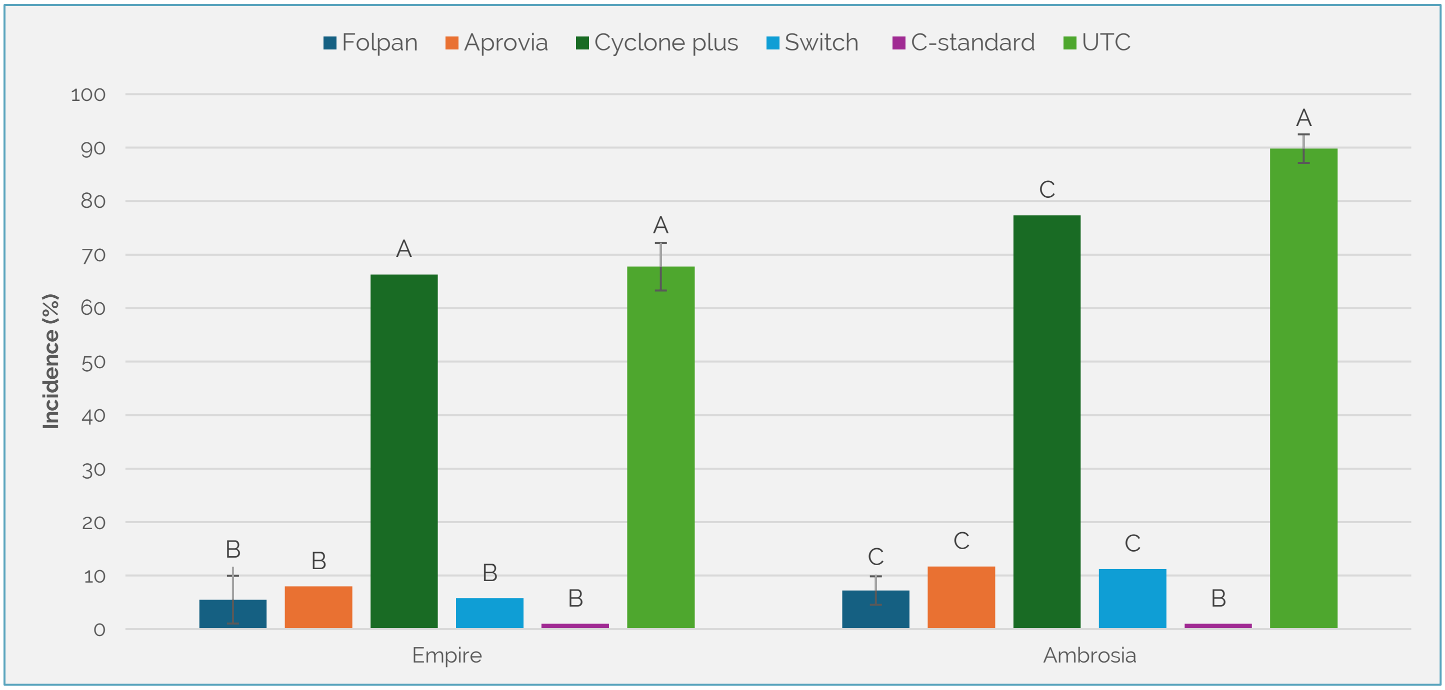


Figure 7. *Mean percent post-storage incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2025. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05)*

CS again provided high control, whereas CYCLONE PLUS provided poor control of 14% compared with the UTC.

Conclusions

FOLPAN, APROVIA, and CS (a rotation of PRISTINE, ALLEGRO, and CAPTAN) consistently provided the most effective bitter rot control in both 2024-2025.

SWITCH provided effective control in 2025 when the disease pressure was low and moderate suppression when the disease pressure was high in 2024.

CYCLONE PLUS offered moderate in-season suppression in both years but no effective control in post-storage assessments.

Fungicide label expansions are underway to include control of bitter rot on the Aprovia and Folpan 80 WDG labels.

Management Considerations for 2026

This research has demonstrated that apples can be infected at any stage of development, even if symptoms are not seen until after storage. Spores are active as early as May and fungicides need to be applied preventatively – fungicides cannot treat an existing infection.

Bitter rot targeted fungicides should start at petal fall and continue on a 14-21 day interval to keep fruit protected. If favourable weather persists (frequent rains with warm conditions), shorten the application interval. If possible, time an effective fungicide application prior to a rain to protect healthy fruit from rain-splashed spores.

The following products are currently registered for bitter rot:

- Allegro / Downforce (FRAC 29, PHI 28 days)
- Pristine (FRAC 11 & 7, PHI 5 days)
- Merivon (FRAC 11 & 7, PHI 0 days)

- Maestro/Supra Captan (FRAC M4, PHI 15 or 19 days depending on orchard density)
- Regalia Maxx (FRAC P5, suppression only, PHI 0 days)

As indicated from this research, products like Folpan/Follow (FRAC M4, PHI 0 days) or Aprovia (FRAC 7, PHI 30 days) may provide some efficacy on bitter rot when the product is applied at the registered rate for diseases listed on the product label. Always rotate fungicide FRAC groups to reduce the potential for resistance development.

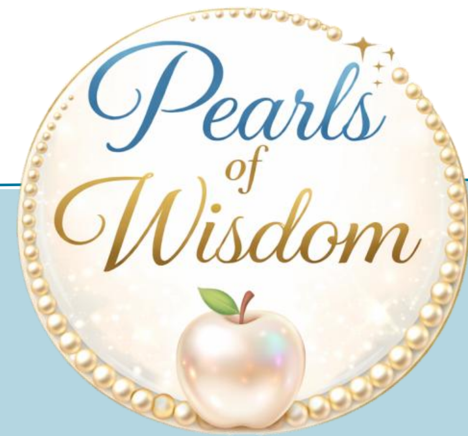
Orchard sanitation to reduce inoculum is important for bitter rot management. Mulch or remove fruit on the orchard floor following hand thinning and harvest to reduce inoculum and the potential of spreading the disease for the following year. Removal of dead wood, cankers produced by other diseases such as fire blight, and fruit mummies (where possible) may also reduce the disease.

Acknowledgements

University of Guelph Pathology Team (Simcoe): Asifa Munawar, Lisa Weber, John Watson, Katerina Jordan

Project Collaborators: Kristy Grigg McGuffin (Ontario Ministry of Agriculture, Food & Agribusiness - OMAFA), Katie Goldenhar (OMAFA), Kelly Ciceran (Ontario Apple Growers), Ali Shawkat (Agriculture & Agri-Food Canada, Nova Scotia), Mary Ruth McDonald (University of Guelph).

The author is grateful to our team members and collaborators for their efforts in making this project successful. The author also thanks Ontario Apple Growers and Ontario Agri-Food and Innovation Alliance for funding this proposal.



Some of the best orchard advice isn't new – it's proven! As ONcore marks its 30th volume, we're revisiting a few *'pearls of wisdom'* from past issues that still hold up in today's orchards.

REDUCING DISEASE INOCULUM IN APPLE ORCHARDS

Disease	Overwinter Structures	Symptoms	Key elements in Activation/ Infection	Inoculum Reduction
Black Rot	Fruit mummies Bark Canker infections	- frog eye leaf spot - limb canker - fruit rot (black-red halo)	Rainfall after bud break-conidia by water, spores by air/rain duration	- Flail chop prunings - Mummies, brush piles, burn-destroy
Powdery Mildew	Infected terminals Laterals with fruit buds	- shoots stunted - matted Mycelium - fruit-russet & netting	Conidia infect young leaves, blossom & fruit/high R.H. temps. 20-22° C	Dormant prune infected terminals
Botryosphaeria Rot	Cankers Colonized dead bark Mummified fruit	- fruit lesions show up with tan centre surrounded by red halo	Rainfall during growing season spores germinate at 28-32° C	- Remove all dead limbs, cankers, mummies - Chop & flail prunings
Sooty Blotch & Fly Speck	Infected branches and twigs in orchard and brambles	- sooty stain or stippled fly speck late in season	Conidia dispersed by spring & early summer rains. High R.H., warm temp. Incubates 3 weeks	Open tree canopy for faster drying during summer months. Remove brambles in or near orchard
Canker and Wood Rot	Cankers on tree limbs	- weak trees - dying limbs - fruit rots (various)	Spring - fall rain moving conidia & ascospores. Wind dispersion when dry. Pathogen grows at 3-33° C	- Remove cankers - Prune to collar area on limb-watch pruning crews carefully- long stubs infection prone.
Scab	Leaf litter-orchard floor	- leaves - fruit	Scab rains in spring- Free moisture for spore germ - temp, wetting critical	- Mulching of leaf litter
Fireblight	Cankers on trees	- collapse of all tissues starting at bloom	Warm, wet conditions at bloom. Splashing rain, insect vectors	- Eliminate cankers - Complete removal of severely damaged trees.

The elimination of overwinter sites in the orchard for various diseases can help eliminate the immediate sources. These sources of inoculum can be more troublesome where a grower has chosen a softer approach with fungicides. The chart describes some of the major disease and ways to reduce their potential impact before the growing season gets started.

– John Gardner, April 1997

See It? Stop It. Don't Spread It!
Spotted Lanternfly Update

***Hannah Fraser**, OMAFA Horticulture Entomologist*

A New Pest On Ontario's Radar

Spotted lanternfly (*Lycorma delicatula*, SLF) is an invasive planthopper that threatens Ontario's agricultural sector (Figure 1). The pest was accidentally introduced to the United States (US) from its native range in China and has since spread to multiple states including those bordering Ontario.

Due to its proximity and the numerous pathways for entry, the risk of introduction to Canada is considered very high. To help mitigate against the spread, the Canadian Food Inspection Agency (CFIA) added SLF to their list of regulated pests in 2018.

For information on CFIA's decision for managing the risk of SLF in Canada and the pest risk management options that were considered see Pest Risk Management Decision Document for Spotted Lanternfly (RMD-22-03).

Why The Concern?

Although SLF will feed on a diverse range of agricultural crops and landscape plants, grapevines are one of the few preferred season-long hosts. Prolonged feeding by adults can weaken the vine, leading to loss of winter hardiness, reduced or no return bloom or crop, and vine death. High numbers have also been correlated with a reduced yield and fruit quality the following year. But **so far**, grapevines appear to be the only agricultural crop that supports sustained feeding and where economic injury has been confirmed.

Adding insult to injury, SLF is a nuisance pest that can ruin the enjoyment of being in outdoor spaces. Adults can be overwhelming when they gather in large swarms during the fall flight period, affecting everyone

***Figure 1.** Adult spotted lanternfly*

from patrons of wineries to urban dwellers walking beneath tree-covered paths. Their heavy feeding produces honeydew, which rains down onto plants, decks, and vehicles, creating a sticky mess that develops into black sooty mould and attracts stinging insects, adding another layer of discomfort and risk for anyone working outdoors.

Feeding Behaviour

Nymphs are not picky eaters and will feed on just about any tender shoot (SLF doesn't feed on fruiting structures) as they grow, and they are constantly on the move in search of things on which to dine. But as they mature and plants begin to senesce or die back, their host range narrows considerably. By late summer and early fall, adults have moved onto woody trees, shrubs, and vines.

You may have read that tree fruit (apple and tender fruit), hops, and a few other crops are at risk. But so far, observations in the US indicate these are **transient**

hosts that SLF spend very little time on before moving on to something better-suited to their voracious sap-sucking requirements (grapevines, invasive tree of heaven, maple, walnut, and a few other tree species), needed to fuel their movement, sexual maturity, and egg-laying.

In addition to grapevines, heavy feeding has contributed to the death the invasive tree-of-heaven and black walnut saplings. Spotted lanternfly is a plant stressor and repeated attacks may contribute to the long-term weakening of established plants and trees. Research and time will help inform plant health risks to commodities other than grapevines.

Current Status in Ontario

Though the CFIA has not confirmed any established populations in Canada, there have been some notable sightings and interceptions (live and dead) of SLF including several in southwestern Ontario and in Niagara. CFIA categorizes observations as:

- **Sighting:** Reports that the CFIA is aware of, including those made on public reporting sites (for example, iNaturalist Canada, Facebook, etc.), but where CFIA followed-up on these, and could not confirm the report, as no SLF specimen was found.
- **Interception:** Live SLF, confirmed by the CFIA, in contained situations (e.g. warehouse) with no evidence of release to the Canadian environment; and/or dead SLF, confirmed by the CFIA.
- **Detection:** Live SLF, confirmed by the CFIA, in the Canadian environment
- **Established population:** Evidence of a reproducing population in the Canadian environment, confirmed by the CFIA.

Given the established populations across the border in Michigan, Ohio, and New York, it's only a matter of time before SLF hitches a ride here on a vehicle or boat (if it hasn't already). Enhanced surveillance in these and other high-risk areas is a priority of the CFIA and its partners.

Preventing Spread

The CFIA has published their directive on requirements for various articles moving from regulated (once established) to non-regulated areas in Canada to help prevent the spread. Nursery stock (woody trees, vines, and shrubs) and logs of deciduous species with bark attached have specific phytosanitary documentation requirements to allow movement out of a regulated area.

But the directive also states that **all things** moving from a regulated area to an unregulated area must be free from all life stages of SLF prior to being moved. This catch-all statement applies to everyone, including growers, businesses, agencies, and the public. Growers and agri-businesses need to be thinking about vehicles, farm equipment, harvest bins, and anything else that gets moved off the farm.

The adults are big and showy (Figure 2), but their egg masses are easily missed (Figure 3 & Figure 4). And SLF females lay their eggs on … almost anything. Don't be a vector by packing this pest: learn to identify SLF life stages and make sure to inspect your incoming and outgoing loads.

Figure 2. *Adult spotted lanternflies are large, brightly coloured insects with black-spotted tan to grey wings. When the forewings are open, the exposed hindwings are bright red with spots.*

Figure 3. *Freshly laid spotted lanternfly egg masses have a white, waxy coating (left) that turns grey-brown, dries, and cracks over time (right).*

Figure 4. *Older spotted lanternfly egg masses lose the coating and look like seeds arranged in vertical rows. The slits in this photo indicate these eggs have hatched.*

If you think you've found SLF (alive or dead), TAKE a picture or a video, COLLECT a sample, and REPORT it to the CFIA.

For more information see Spotted lanternfly prevention practices for producers.

New to the Toolbox:
Latest Registrations for Apples

***Kristy Grigg-McGuffin**, OMAFA Horticulture IPM Specialist*

Over the past year, there have been several changes to products available for use in Ontario. The following highlights updates **provided by registrants** for apple growers.

The most up-to-date information is available through the Ontario Crop Protection Hub online.

New Product Additions

Cyclone Plus (34762, lactic + citric acid)

Group NC fungicide registered for control of fire blight, Potentially organic – check with certifying body.

- **Rate:** 1.4% v/v
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** no restrictions

Downforce AG (34723, fluazinam)

Group 29 fungicide registered for control of scab, flyspeck, sooty blotch, cedar-apple rust and bitter rot, and suppression of black rot and quince rust. May provide suppression of mites, as well. This active ingredient is the same as Allegro 500 F.

- **Rate:** 1.0 L/ha
- **REI:** 24 hours
- **PHI:** 28 days
- **Max. applications:** 5

EcoSwing (35206, *Swinglea glutinosa* extract)

Group BM1 fungicide registered for suppression of scab, Potentially organic – check with certifying body.

- **Rate:** 1.75-2.35 L/ha
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** 10

Magister SC (34544, fenazaquin)

Group 39 fungicide /21 insecticide registered for control of powdery mildew and mites.

- **Rate:** 1.75-2.34 L/ha
- **REI:** 12 hours (general) / 24 hours (scouting, pruning, training) / 17 days (hand thinning)
- **PHI:** 10 days
- **Max. applications:** 1

Migiwa 20 SC (35443, ipflufenoquin)

Group 52 fungicide registered for control of scab and powdery mildew,

- **Rate:** 165-220 mL/ha
- **REI:** 12 hours
- **PHI:** 7 days
- **Max. applications:** 3 (max. 666 mL/ha)

Milstop (28095, potassium bicarbonate)

Group NC fungicide registered for control of powdery mildew, Potentially organic – check with certifying body.

- **Rate:** 2.8-5.6 kg/ha
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** 10

Property 300SC (32534, pyriofenone)

Group 50 fungicide registered for control of powdery mildew,

- **Rate:** 300-366 mL/ha
- **REI:** 12 hours
- **PHI:** 14 days
- **Max. applications:** max. 1.464 L/ha

Sefina (33265, afidopyropen)

Group 9D insecticide registered for rosy apple aphid and green apple aphid.

- **Rate:** 0.2 L/ha
- **REI:** 12 hours

- **PHI:** 7 days
- **Max. applications:** 4 (max. 0.8 L/ha)

Serifel (30054, Bacillus amyloliquifaciens)

Group BM2 fungicide registered for control of fire blight. Potentially organic – check with certifying body.

- **Rate:** 0.56 kg/ha
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** no restrictions

Shenzi 400 SC (34974, chlorantraniliprole)

Group 28 insecticide registered for control of codling moth, dogwood borer, European apple sawfly, obliquebanded leafroller, oriental fruit moth,, spotted tentiform leafminer, and spring feeding caterpillar, and for suppression of apple maggot, Japanese beetle, and white apple leafhopper. This active ingredient is the same as Altacor.

- **Rate:** 180-250 mL/ha
- **REI:** 12 hours
- **PHI:** 5 days
- **Max. applications:** 3 (max. 563 mL/ha)

Vantana (35050, fluazinam)

Group 29 fungicide registered for control of scab, flyspeck, sooty blotch, cedar-apple and rust, and suppression of black rot and quince rust. May provide suppression of mites, as well. This active ingredient is the same as Allegro 500 F.

- **Rate:** 1.0 L/ha
- **REI:** 24 hours
- **PHI:** 28 days
- **Max. applications:** 5

Label Expansions

Lifegard (32526, *Bacillus mycoides*)

Group P6 fungicide registered for suppression of scab, powdery mildew, flyspeck and sooty blotch in addition to previously registered pests, Potentially organic – check with certifying body.

- **Rate:** 70-333 g/ha
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** no restrictions

OxiDate (PCP 33469, hydrogen peroxide + peroxyacetic acid)

Group NC fungicide registered for suppression of flyspeck and sooty blotch in addition to previously registered pests, Potentially organic – check with certifying body.

- **Rate:** 1.0% v/v
- **REI:** 4 hours
- **PHI:** 0 days
- **Max. applications:** 8

Product Removals

Apollo SC (21035, clofentezine)

No longer manufactured by company.

Calypso 480 SC (28429, thiacloprid)

Registration cancelled.

Cosavet DF Edge (31869, sulphur)

No longer manufactured by company.

Labamba (33576, lambda-cyhalothrin)

Registration cancelled on apples.

Matador 120 EC (24984, lambda-cyhalothrin)

Registration cancelled on apples.

Silencer 120 EC (29052, lambda-cyhalothrin)

Registration cancelled on apples.

TwinGuard (31442, sulfoxaflor + spinetoram)

No longer manufactured by company.

Versys (33266, afidopyropen)

No longer manufactured by company. Replaced by Sefina (33265).

Zivata (32427, lambda-cyhalothrin)

Registration cancelled on apples.

POSTHARVEST

Oxygen Level Influences Storage Temperature Choice for 'Gala' Apples

Dr. Jennifer DeEll, *OMAFA Fresh Market Quality Specialist*

In recent years, varying storage temperatures ranging from 0 to 3°C have been recommended for controlled atmosphere (CA) storage of 'Gala' apples throughout different growing regions. Exact temperatures are dependent on several factors, such as use of plant growth regulators in the orchard or as postharvest treatments, and storage oxygen concentrations.

Past research in Ontario found 1-2°C to be optimum for long-term CA storage of 'Gala' apples treated with 1-methylcyclopropene (1-MCP). This conclusion was based on reduced internal browning in 1.5 or 2.5% oxygen regimes at those temperatures.

The objective of this current study was to evaluate 0.5 versus 3°C for storage of 1-MCP-treated 'Gala apples in lower oxygen levels, 1.2 or 0.6%. These temperatures were chosen due to recommendations for their use outside of Ontario. In addition, slow cooling to 0.5°C was evaluated, due to positive results we found several years ago while using the higher oxygen levels in Ontario.

'Gala' apples (Brookfield strain) were collected from a ReTain-treated orchard during the commercial harvest period in Norfolk County, Ontario (Figure 1). Internal ethylene concentration was less than 0.5 ppm at harvest and firmness averaged 20.8 lbs, soluble solids concentration (Brix) 10.6%, and starch 2.0 on the Cornell chart. Boxes of 'Gala' were placed into 0.5 or 3°C, or 9°C and slow cooled down to 0.5°C over 5 days. CA storage was then established with 1.2 or 0.6% oxygen. All apples put into storage were considered marketable, free of disorders and disease. Apples were stored for 8 months and then evaluated for quality after 1, 7, and 14 days at room temperature.

Storage temperature had a significant effect on the percentage of clean marketable 'Gala' apples after 8 months in 1.2% oxygen (Table 1). Slow cooling to 0.5°C with 1.2% oxygen resulted in the highest percentage of clean apples (91%), followed by immediate storage at 0.5°C (73%) and 3°C with the least (54%). This effect of temperature was not found in 0.6% oxygen, where 80-86% of the apples remained clean.

Stem-end browning and internal browning were the major storage disorders (Figure 2), with significantly more developing in 1.2% than 0.6% oxygen and temperature having an effect. Slow cooling to 0.5°C in 1.2% oxygen reduced the amount of browning to 8%, compared to 23 and 42% incidence with immediate cooling to 0.5 or 3°C, respectively. This effect of temperature was not found in 0.6% oxygen, where only 11 to 17% of the apples had browning regardless of temperature.

Some stem-end cracking also developed in storage (Figure 3) and the highest incidence of 9% was found in 1.2% oxygen with immediate cooling to 0.5°C. Regardless of oxygen concentration, apples cooled immediately to 3°C had 5 to 6% cracking, while slow cooling to 0.5°C significantly reduced cracking to 1%.

There was no main effect of low oxygen on firmness, however apples stored at 3°C were almost 1 lb softer than those at 0.5°C regardless of cooling rate in 1.2% oxygen (Table 2). There was no effect of days at room temperature on firmness, indicating no firmness loss after removal from storage. This was likely due to the 1-MCP treatment at harvest treatment.

Internal ethylene concentration remained low (<0.5 ppm) throughout storage and subsequent shelf-life at room temperature. There was significantly higher soluble solids concentration in apples slow cooled to 0.5°C and stored in 0.6% oxygen, compared to those in 1.2% oxygen at 3°C (Table 2). Malic acid was significantly lower in apples held in 1.2% oxygen at 3°C than those at 0.5°C, but this effect was not found in 0.6% oxygen.

Results demonstrate that oxygen concentration must be considered when deciding the best storage temperature for 1-MCP-treated 'Gala' apples. Firmness can be sacrificed and browning increased by storage at 3°C, especially as oxygen increases.

Lower temperatures are always preferred for 'Gala' not treated with 1-MCP, to maintain fruit firmness and limit greasiness.

Acknowledgements

Thanks to the Ontario Apple Growers, Norfolk Fruit Growers' Association, Apple Marketers' Association of Ontario, AgroFresh Inc., Pommes Philip Cassidy Inc., GRB Ag. Technologies Inc., and Storage Control Systems Inc., for their continuous support.

Figure 1. *'Gala' apples for this study at harvest time.*

Figure 2. *Internal browning (left) and stem-end browning (right) in 'Gala' apples after 8 months of storage in 1.2% oxygen.*

Figure 3. *Stem-end cracking in 'Gala' apple after 8 months in CA storage.*

Table 1. Percentage of clean marketable apples and disorders in 'Gala' apples after 8 months of storage in 0.6 or 1.2% oxygen at 0.5 or 3°C.

Oxygen (%)	Temperature (°C)	Clean (%)	Browning (%)	Cracking (%)
0.6	3	80^{DE}	17^{BC}	6^{B}
	0.5	83^{CDE}	13^{BCD}	2^{CD}
	Slow to 0.5	86^{BCD}	11^{CDE}	1^{D}
1.2	3	54^{F}	42^{A}	5^{BC}
	0.5	73^{E}	23^{B}	9^{A}
	Slow to 0.5	91^{ABCD}	8^{CDE}	1^{D}

Values within a column with the same letter are not significantly different at *P* <0.05.

Table 2. Quality of 'Gala' apples after 8 months of storage in 0.6 or 1.2% oxygen at 0.5 or 3°C.

Oxygen (%)	Temperature (°C)	Firmness (lb)	Soluble solids (%)	Malic acid (mg/100 ml)
0.6	3	18.8^{B}	12.3^{AB}	427^{B}
	0.5	18.9^{AB}	12.5^{AB}	439^{B}
	Slow to 0.5	18.8^{B}	13.0^{A}	436^{B}
1.2	3	18.3^{C}	12.2^{B}	396^{C}
	0.5	19.0^{AB}	12.6^{AB}	482^{A}
	Slow to 0.5	19.2^{A}	12.8^{AB}	494^{A}

Values within a column with the same letter are not significantly different at P <0.05.

RESEARCH HIGHLIGHTS

Apple Fruitlet Thinning Gala with Metamitron Applied in Sequence, Tank-mixed, and at Different Timings

Owen Rowland *[1] &* ***John A. Cline****[2], University of Guelph, Ontario Agricultural College, Ontario Crops Research Centre – Simcoe*

[1]MSc. Student, Dept. of Plant Agriculture

[2]Professor of Pomology and Tree Fruit Physiology

Introduction

Crop load management of apple trees through chemical or hand thinning is one of the most important practices growers can use to improve fruit quality. Reducing fruit set improves fruit size and colour, and thinning early can increase return bloom in biennial bearing cultivars. Additionally, successful thinning through chemical means can help mitigate the high labour costs that comes with hand thinning orchards after June drop.

However, effectively reducing crop load to a desired level with chemical thinning is inconsistent and hard to predict. In 2026, a new chemical thinner, Brevis™ 150 SC (PCP 35694; active ingredient is metamitron), has been approved for use on apples and pears in Canada. Brevis™ has been registered previously for thinning apples in many European and Asian countries, and several studies have been conducted in Canada and the United States to evaluate its efficacy.

To add to several years of ongoing research on Brevis™ in Simcoe, a trial was initiated in the spring of 2025 to test the thinning performance of Brevis™ when applied as a late thinner, when applied in two treatments sequentially, and when tank-mixed with other common chemical thinners.

Experimental details

In 2025, a 4-year-old research orchard of 'Crimson Gala'/M.9 T337 rootstock located at the University of Guelph, Ontario Crops Research Centre – Simcoe was used for this study. 'Gala' was selected due to its prominence in the Ontario apple industry and because it is a moderately difficult to thin cultivar. Trees were spaced at 1.2 m x 3.75 m (2222 trees/ha; 899 trees/acre) and trained using a high-density spindle system. The experimental design consisted of a randomized complete block design with six replications and 14 treatments. Table 1 demonstrates the treatments that were applied to two tree plots.

Commercial products used in this study:

- Carbaryl - Sevin XLR Plus, Tessenderlo Kerley, Inc., Phoenix, USA
- 6-BA – Maxcel, Valent Canada, Guelph, Canada
- NAA – Fruitone L, AMVAC Chemical Corporation, Los Angeles, USA
- Metamitron – BREVIS 150 SC, ADAMA Canada Ltd., Winnipeg, Canada
- Nonylphenoxy polyethoxy ethanol - Agral 90, Norac Concepts, Guelph, Canada

All spray treatments included the non-ionic surfactant Agral 90 at 0.05% (v/v). Treatments were applied using a commercial air blast sprayer (Turbo-mist model M3PT19P airblast sprayer with 19-60SS tower, Penticton, Canada); to minimize treatment interference caused by spray drift, experimental units were separated by at least one guard tree.

At the pink bud stage of bloom, trees were assessed for uniformity of bloom, and trees which were atypical in size, bloom, or health were excluded from the trial. The trees were in full bloom on 12-May, 2025. The 6-7 mm fruitlet diameter treatments were applied between 7:30 am and 2:30 pm on 26-May (14 days after full bloom; DAFB), and the 15-17 mm treatments were applied between 12:21 pm and 12:43 pm on 7-June (26 DAFB). Based on measurements taken on days most closely

Table 1. Treatments applied to 4-year-old Crimson Gala in 2025

	Treatment
1	Untreated control
2	Hand-thinned control (flower clusters were singled, fruit spaced ~10 cm apart)
3	'Industry standard' 1500 mg/L carbaryl tank-mixed with 75 mg/L 6-BA applied at 6-7 mm fruitlet diameter
4	498 mg/L (1.8 L/ha) metamitron applied at 6-7 mm fruitlet diameter
5	637 mg/L (2.3 L/ha) metamitron applied at 6-7 mm fruitlet diameter
6	804 mg/L (2.9 L/ha) metamitron applied at 6-7 mm fruitlet diameter
7	498 mg/L (1.8 L/ha) metamitron applied at 15-17 mm fruitlet diameter
8	498 mg/L (1.8 L/ha) metamitron tank mixed with 75 mg/L 6-BA applied at 6-7 mm fruitlet diameter
9	498 mg/L (1.8 L/ha) metamitron tank mixed with 10 mg/L NAA applied at 6-7 mm fruitlet diameter
10	498 mg/L (1.8 L/ha) metamitron tank mixed with 1500 mg/L carbaryl applied at 6-7 mm fruitlet diameter
11	498 mg/L (1.8 L/ha) metamitron applied at 6-7 mm fruitlet diameter, followed by 498 mg/L metamitron applied at 15-17 mm fruitlet diameter
12	498 mg/L (1.8 L/ha) metamitron tank mixed with 75 mg/L 6-BA applied at 6-7 mm fruitlet diameter, followed by 498 mg/L metamitron applied at 15-17 mm fruitlet diameter
13	498 mg/L (1.8 L/ha) metamitron tank mixed with 10 mg/L NAA applied at 6-7 mm fruitlet diameter, followed by 498 mg/L metamitron applied at 15-17 mm fruitlet diameter
14	498 mg/L (1.8 L/ha) metamitron tank mixed with 1500 mg/L carbaryl applied at 6-7 mm fruitlet diameter, followed by 498 mg/L metamitron applied at 15-17 mm fruitlet diameter

preceding and following the days treatments were applied, king fruitlet diameters on 26-May were 6.4-7.2 mm (n=50) and on 7-June were 14.2-17.5 (n=50). Hand-thinned control trees were thinned on 24-June by removing all but 1 fruit per cluster and spacing fruit ~10 cm apart. The average number of fruit removed by the hand-thinned trees (n=12) was 101 fruit.

Horticultural Measurements

Tree trunk circumference was measured at 30 cm above soil level at the beginning and end of the growing season to calculate trunk cross-sectional area (TCSA). To measure fruit set, two main scaffold branches – one on the east and one on the west side of the tree – were selected prior to bloom. On 02-May 2025, the number of flowering clusters per branch was counted on each selected limb. The number of fruit set on the limbs was counted again after June drop (08-July 2025). These data were averaged to calculate percent fruit set (number of set fruit divided by number of flower clusters)

Fruit were harvested on 15 and 16-September, 2025. During harvest, all fruit were picked from each experimental tree and the total weight and number of fruit per tree was recorded. Mean fruit weight was calculated by dividing total tree yield by number of fruit per tree. Additionally, a sample of 60 fruit per two-tree plot was randomly selected from throughout the canopy and kept in cold storage (1-3 ˚C) for grading on a commercial colour sorting grading line at the Norfolk Fruit Growers Association.

Graded fruit were designated as "marketable" or when they had greater than 50% surface red blush, a blush hue greater than 165˚ on a HSV hue angle map, were greater than 120 g, and were free of detectable scarring, bruising, or other defects. Fruit were separated according to individual weight into 15 size categories expressed as an average count size of number of apples required to fill a 20 kg box. The weight of total fruit in each of the count size categories was calculated for each tree based on the categories shown in Table 2.

Table 2. Weight categories and size calculation

Category	Weight (g)	Count Size
1	< 91	216
2	91 – 102	198
3	103 – 110	175
4	111 – 120 g	163
5	121 – 130 g	150
6	131 – 144	138
7	145 – 159	125
8	160 – 180	113
9	181 – 205	100
10	206 – 225	88
11	226 – 250	80
12	251 – 282	72
13	283 – 322	64
14	323 – 376	56
15	≥ 377	48

Results

Fruit Set

There was a significant treatment effect on fruit set ($P<0.0001$) (Figure 1). Trees that were treated with a single late application of 1.8 L/ha metamitron (MET), single applications of MET tank-mixed with 6-BA or carbaryl, and all sequential applications had significantly lower fruit set compared to the untreated control. Neither the hand-thinned control nor the industry standard treatments resulted in fruit set that differed from the untreated control. Similarly, all early treatments of MET applied alone (1.8, 2.3, and 2.9 L/ha at 6-7 mm) failed to lower fruit set. The single late application of 1.8 L/ha MET did reduce fruit set compared to the untreated control and the single early application of 1.8 L/ha MET, which could be due to differences in weather conditions at the times of application. Sequential MET applications (application at 6-7 mm followed by application at 15-17 mm, 12 days apart) reduced in fruit set compared to the untreated control and the single applications of both 1.8 and 2.3 L/ha MET. Applying MET tank-mixed with 6-BA reduced fruit set significantly compared to both the untreated control and the single early application of 1.8 L/ha MET. Further, 1.8 L/ha MET tank-mixed with carbaryl at 6-7 mm, and this same treatment followed by MET at 15-17 mm reduced fruit set the greatest of all treatments. The single application of MET tank-mixed with NAA had fruit set that was similar to the single early application of 1.8 L/ha MET, which was significantly higher than the other two single application tank-mix treatments.

Yield, Crop Load, and Fruit Size

Thinning treatments had a significant effect on total fruit yield per tree ($P\leq0.0001$), total number of fruit per tree ($P\leq0.0001$), mean fruit weight ($P\leq0.0001$), and crop load ($P\leq0.0001$) (Figure 2 and 3). Trees that were treated with a single late application of 1.8 L/ha MET, single applications of MET tank-mixed with 6-BA or carbaryl, and all sequential applications had significantly lower total yield per tree compared to the untreated control, all other treatments did not differ significantly in total yield. Similar to the fruit set treatment relationships, none of the single early applications of MET (1.8, 2.3, 2.9 L/ha) produced yields that differed from the untreated control, while the single late application of 1.8 L/ha MET and the sequential applications of MET alone did.

Again, all tank-mixed treatments also differed significantly from the untreated control in total fruit yield except for the single application of MET tank-mixed with NAA. Trees that were treated with a single early application of 1.8 L/ha MET (135 g), and a single application of MET tank-mixed with NAA (127 g) were the only treatments with fruit weights that did not differ from the untreated control (125 g) (Figure 2). All other treatments resulted in mean fruit weights that were significantly and some markedly higher than the untreated control. Every thinning treatment reduced the total number of fruit/tree compared to the untreated control except for the single application of MET tank-mixed with NAA (Figure 3). Untreated control trees ad on average 199 fruit/tree while the single application of MET tank-mixed with NAA had 173 fruit/tree, all other treatments ranged from 48 – 150 fruit/tree.

Hand-thinned control trees and those treated with the single late application of 1.8 L/ha MET, single applications of MET tank-mixed with 6-BA or carbaryl, and all sequential application treatments had significantly lower crop loads than the untreated control. Relationships in the mean differences of crop

load are very similar to those of previous parameters like total fruit yield per tree; single early applications of MET (1.8, 2.3, 2.9 L/ha) did not differ from the untreated control, but the treatments of the single late application of 1.8 L/ha MET and the single application of MET tank-mixed with 6-BA produced crop loads more similar to an ideal crop load of ~7 fruit per cm2 TCSA alongside the hand-thinned control. The single application of MET tank-mixed with carbaryl and the sequential applications of MET alone and MET tank-mixed with 6-BA followed by MET applied at 15-17 mm all resulted in crop loads of 5.6 fruit/cm2 TCSA that may indicate slight overthinning relative to a desired target crop load of 6-8 fruit/cm2 TCSA, but didn't differ significantly from the more optimal hand-thinned control. However, the treatment of MET tank-mixed with carbaryl followed by MET applied at 15-17 mm resulted in a crop load that was significantly lower than both the untreated control and the hand-thinned control (3.5 fruit/cm2 TCSA) indicating overthinning.

Despite relatively cool weather conditions during and following early applications at 6-7 mm (maximum daily temperature of 19 ˚C on 26-May, ranging from 14-23 ˚C for 5 days following), multiple treatments demonstrated thinning efficacy. It is generally not recommended to use hormonal thinners like 6-BA and NAA when temperatures are below ~20 ˚C, however MET's photosynthetic inhibition mode of action may provide more flexible environmental conduction in contrast to hormonal thinners.

Fruit Size Distribution and Marketability

Thinning treatments had a significant effect on fruit size distribution except for fruit in the 64- and 72-count box size categories (Figure 4). Fruit from the untreated trees had the greatest distribution of fruit in multiple size categories. Most fruit of the untreated control peaked in the 138-count size category. Trees of the hand-thinned control peaked in the 113-count size category as did most other treatments, excluding the single early application of 1.8 L/ha metamitron (MET), the single application of 1.8 L/ha MET tank-mixed with NAA, the single application of 1.8 L/ha MET tank-mixed with carbaryl, the sequential application of 1.8 L/ha MET applied alone followed by MET, and the sequential application of 1.8 L/ha MET tank mixed with carbaryl followed by MET. Applications of 1.8 L/ha MET applied alone and a single application of 1.8 L/ha MET tank mixed with NAA had most of their fruit peak in smaller fruit size categories, 125- and 138-count box size respectively, with distributions more similar to the untreated control. The treatments of the single application of 1.8 L/ha MET tank mixed with carbaryl, the sequential application of 1.8 L/ha MET applied alone followed by MET, and the sequential application of 1.8 L/ha MET tank mixed with carbaryl followed by MET all had most of their fruit in the larger, 100-count box size category, though they did have notably lower total yields compared to other treatments. The untreated control trees also had more undersized fruit (box sizes 175-216) compared to all other treatments in the 175-count size category, all treatments except the single application of 1.8 L/ha MET tank mixed with NAA in the 198-count size category, and all treatments except the early application of 1.8 L/ha MET applied alone and the single application of 1.8 L/ha MET tank mixed with NAA in the 216-count size category.

Thinning treatments also had a significant effect on the percent of marketable fruit ($P \leq 0.0001$) (Figure 5). The only treatments that did not differ significantly from the untreated control, which had 51% marketable fruit, were the early single applications of 1.8, 2.3, and 2.9 L/ha MET, which had 67, 71, and 74% marketable fruit respectively, the single application of 1.8 L/ha MET tank-mixed with NAA, which had 50% marketable fruit, and the sequential application of MET tank-mixed with NAA followed by a late application of MET, which had 78% marketable fruit. All other treatments had a markedly higher percentage of marketable fruit compared with the untreated control treatment, which the former ranged from 80 – 85%.

Key Conclusions

- Tank-mixing metamitron with other chemical thinners like 6-BA and carbaryl appears to have an additive effect on the thinning efficacy in 'Gala'.
    - Despite relatively cool weather when applied, metamitron tank-mixed with other thinners still resulted in a thinning response.
    - For unknown reasons that require further investigation, metamitron when tank-mixed with NAA had reduced thinning efficacy.
- Metamitron was efficacious as a "late" thinner when applied at 15-17 mm as a single application, or as a

sequential treatment to earlier thinners.

- Sequential applications that included metamitron appeared to cause over-thinning in 'Gala', as indicated by excessively low crop loads and yields. Treatments containing metamitron tank-mixed with carbaryl caused overthinning at the rates used.
- In general, treatments that reduced fruit set also reduced crop load; treatments like 1.8 L/ha metamitron applied at 15-17 mm and 1.8 L/ha metamitron tank-mixed with 6-BA resulted in crop loads that were very similar to the hand-thinned control.
- Multiple tank-mix and sequential treatments with high thinning efficacy resulted in a higher percentage of marketable fruit and larger count size apples.
- Crop load must be balanced with yield and cannot come at the expense of a reduced marketable yield and crop value.

Overall, this study demonstrates that metamitron was an effective apple fruitlet thinner when applied at 15-17 mm, sequentially, or in combination with other chemical thinners, but only a mild thinner when applied alone at 6-7 mm. We anticipate that in commercial orchards rates of 6-BA, carbaryl and NAA for tank mix and sequential sprays can be adjusted to avoid overthinning.

These datasets are preliminary and therefore must be interpreted with some caution as thinning responses can vary based on weather, tree age, cultivar, and other factors. This trial will be repeated in 2026.

Acknowledgements

We acknowledge this project is generously funded through the Canadian Agri-Science Cluster for Horticulture 4, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Sustainable Canadian Agricultural Partnership initiative, the Fruit and Vegetable Growers of Canada, and industry contributors; the University of Guelph; BC Fruit Growers' Association; Ontario Apple Growers; Adama Canada; Les Producteurs de Pommes du Quebec; Nova Scotia Fruit Growers' Association; and the Ontario Agri-Food Innovation Alliance. We gratefully acknowledge the Norfolk Fruit Growers Association for their assistance in fruit grading. We also gratefully acknowledge the technical assistance of Cathy Bakker, Morgan Fernandes-Oliveira, Grace Cooper, and Hayden Bildy.

Disclosures

Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the University of Guelph of the products named and does not imply criticism of similar ones not mentioned.

Pearls of Wisdom

We've been on a thinning roll this issue, so why stop now?

In 1998 apple growers were informed about the new Sevin formulation – Sevin XLR Plus. While a different product is being used today, the active ingredient remains the same.

As research advances and scientific understanding improves, chemistries continue to be refined and updated.

Although products and recommendations evolve over time, the need for effective thinning in remains a consistent and central consideration in apple production.

THINNING RECOMMENDATIONS HAVE NEW LOOK

John Gardner

If you're looking for rates of Sevin 50W for chemical thinning in Publication 360, you won't find them anywhere. Sevin XLR Plus has replaced 50W as the recommended source for carbaryl, the active ingredient so long relied upon by the industry to thin unwanted apple fruitlets, since Sevin 50W is no longer manufactured.

Sevin XLR Plus provides the same thinning response by apple trees but with a very important exception. The primary difference between the 50W formulation of Sevin and the XLR Plus formulation is that the XLR Plus residues do not absorb further with rewetting according to the manufacturer. In other words, it works through it's first and only period of absorption. Therefore, you cannot rely on additional thinning affect from Sevin XLR Plus after the initial application, according to the manufacturer.

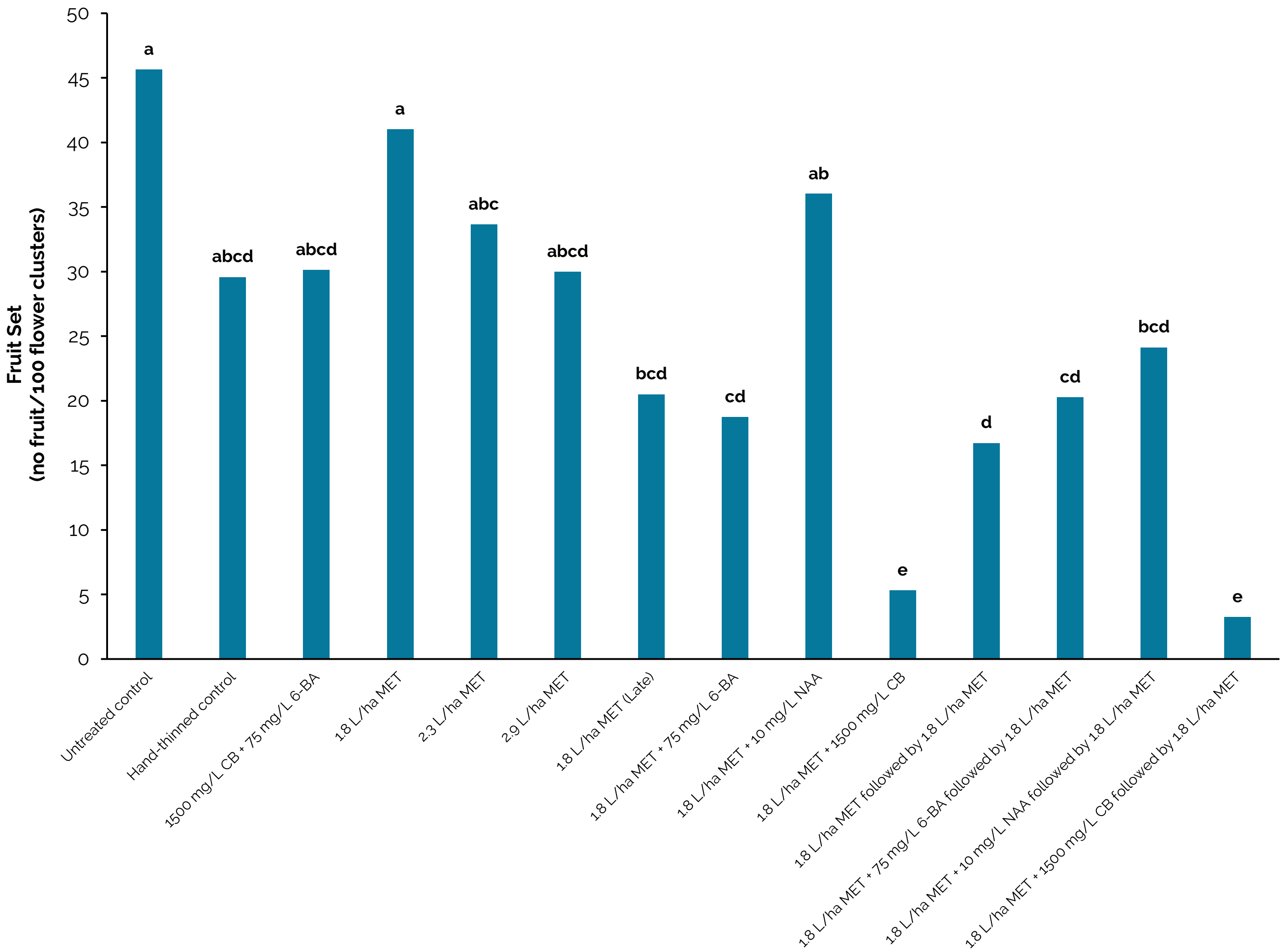


Figure 1. *Influence of metamitron (MET), carbaryl (CB), 6-benzyladenine (6-BA), and 1-naphthelenacetic acid (NAA) applied at various rates, timings, and combinations on fruit set of 'Crimson Gala' trees in 2025. Treatments including a "+" indicate the chemical thinners were tank-mixed for application. Treatments were applied at 6-7 mm king fruitlet diameter on 26-May 2025, and components of a treatment denoted with "Late" or "followed by" were applied separately at 15-17 mm king on 7-June 2025. Mean values with the same letter are not significantly different according to Tukey's HSD test at P=0.05. Note that counts were taken following hand-thinning, so fruit set values of the hand-thinned control treatment reflect that.*

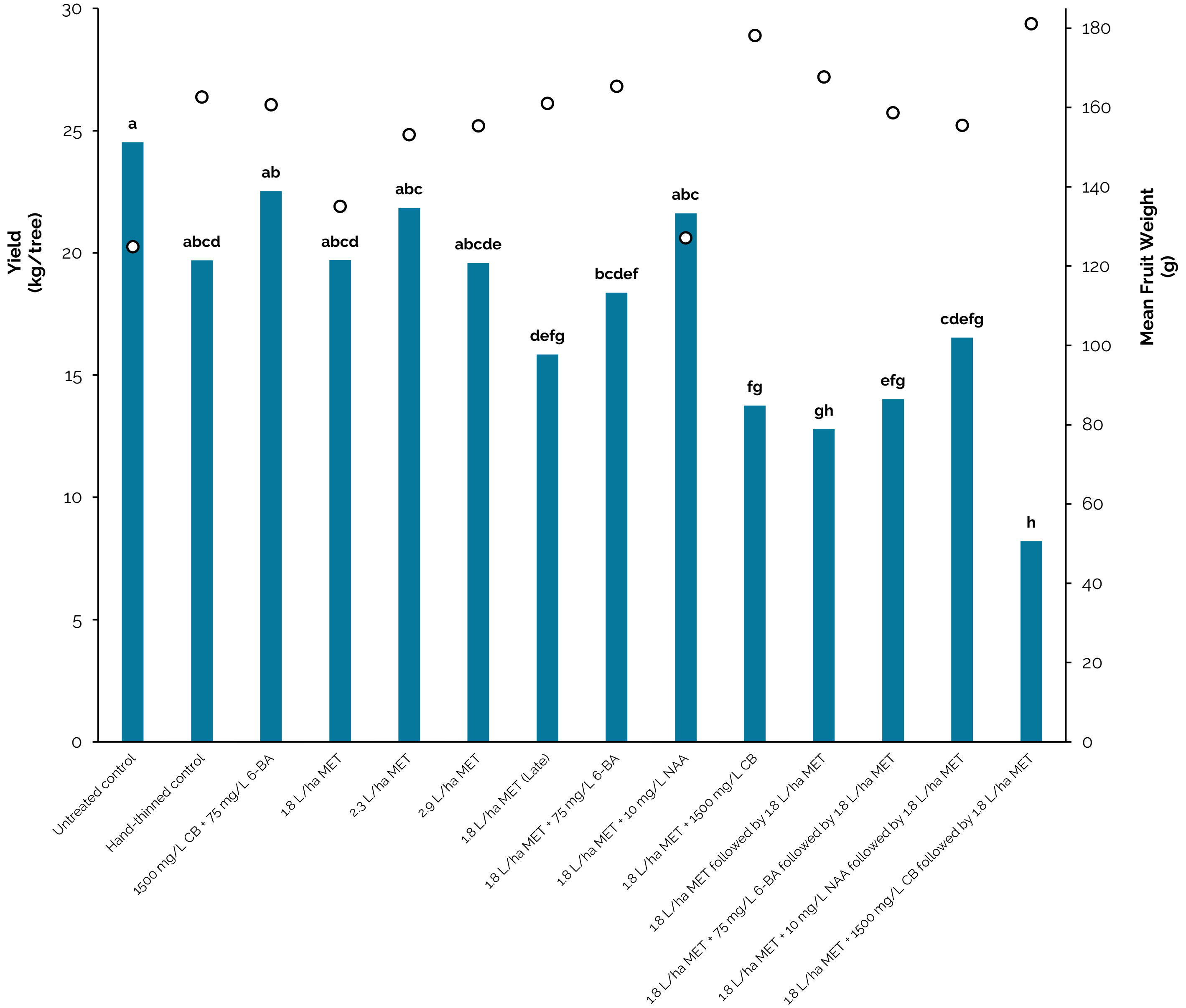


***Figure 2**. Influence of metamitron (MET), carbaryl (CB), 6-benzyladenine (6-BA), and 1-naphthelenacetic acid (NAA) applied at various rates, timings, and combinations on total yield per tree (bars) and average fruit weight (dots) of 'Crimson Gala' trees in 2025. Treatments including a "+" indicate the chemical thinners were tank-mixed for application. Treatments were applied at 6-7 mm king fruitlet diameter on 26-May 2025, and components of a treatment denoted with "Late" or "followed by" were applied separately at 15-17 mm king on 7-June 2025. Mean yield values with the same letter are not significantly different according to Tukey's HSD test at P=0.05.*

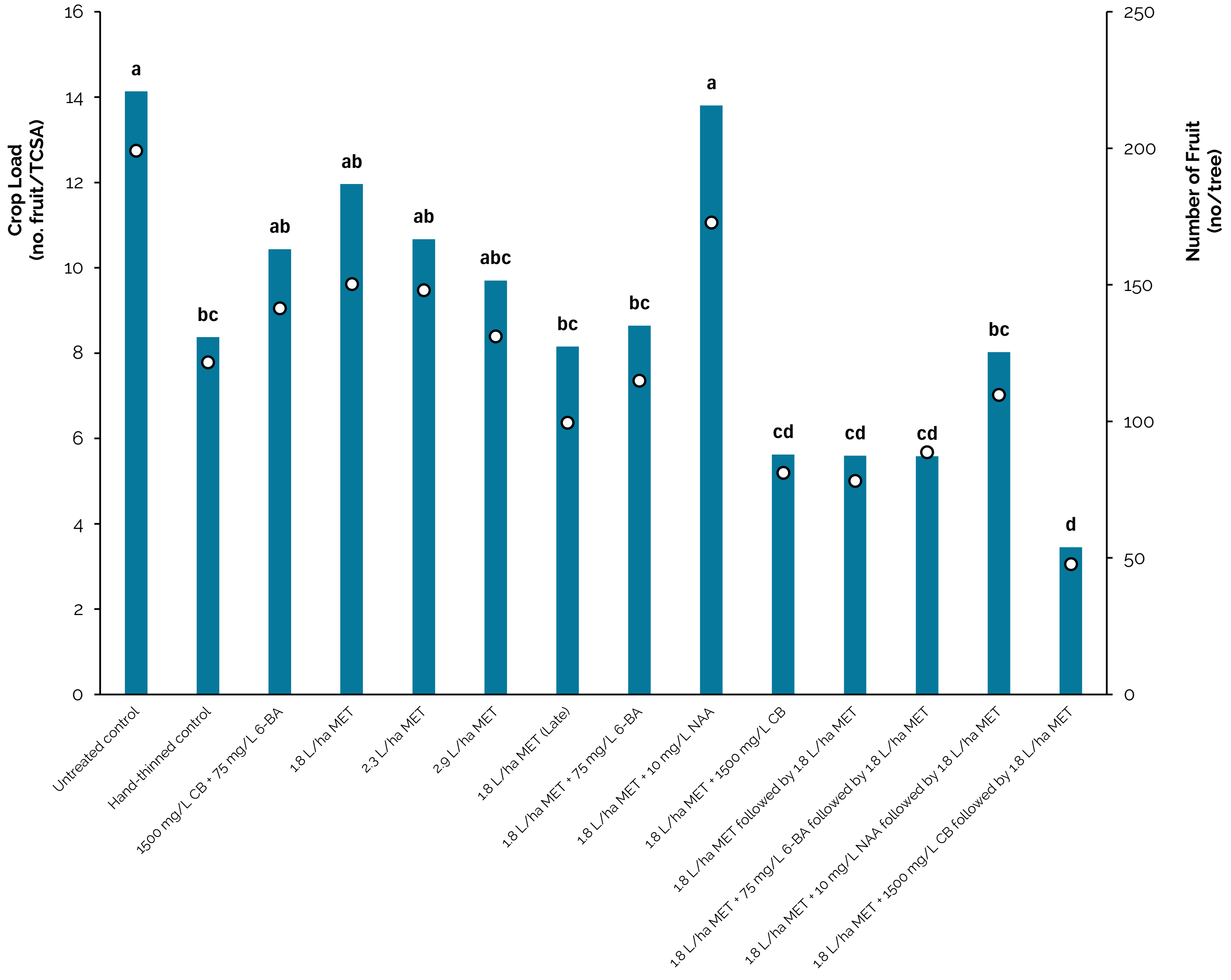


Figure 3. *Influence of metamitron (MET), carbaryl (CB), 6-benzyladenine (6-BA), and 1-naphthelenacetic acid (NAA) applied at various rates, timings, and combinations on crop load (bars) and number of fruit per tree (dots) of 'Crimson Gala' trees in 2025. Treatments including a "+" indicate the chemical thinners were tank-mixed for application. Treatments were applied at 6-7 mm king fruitlet diameter on 26-May 2025, and components of a treatment denoted with "Late" or "followed by" were applied separately at 15-17 mm king on 7-June 2025. Mean crop load values with the same letter are not significantly different according to Tukey's HSD test at P=0.05.*

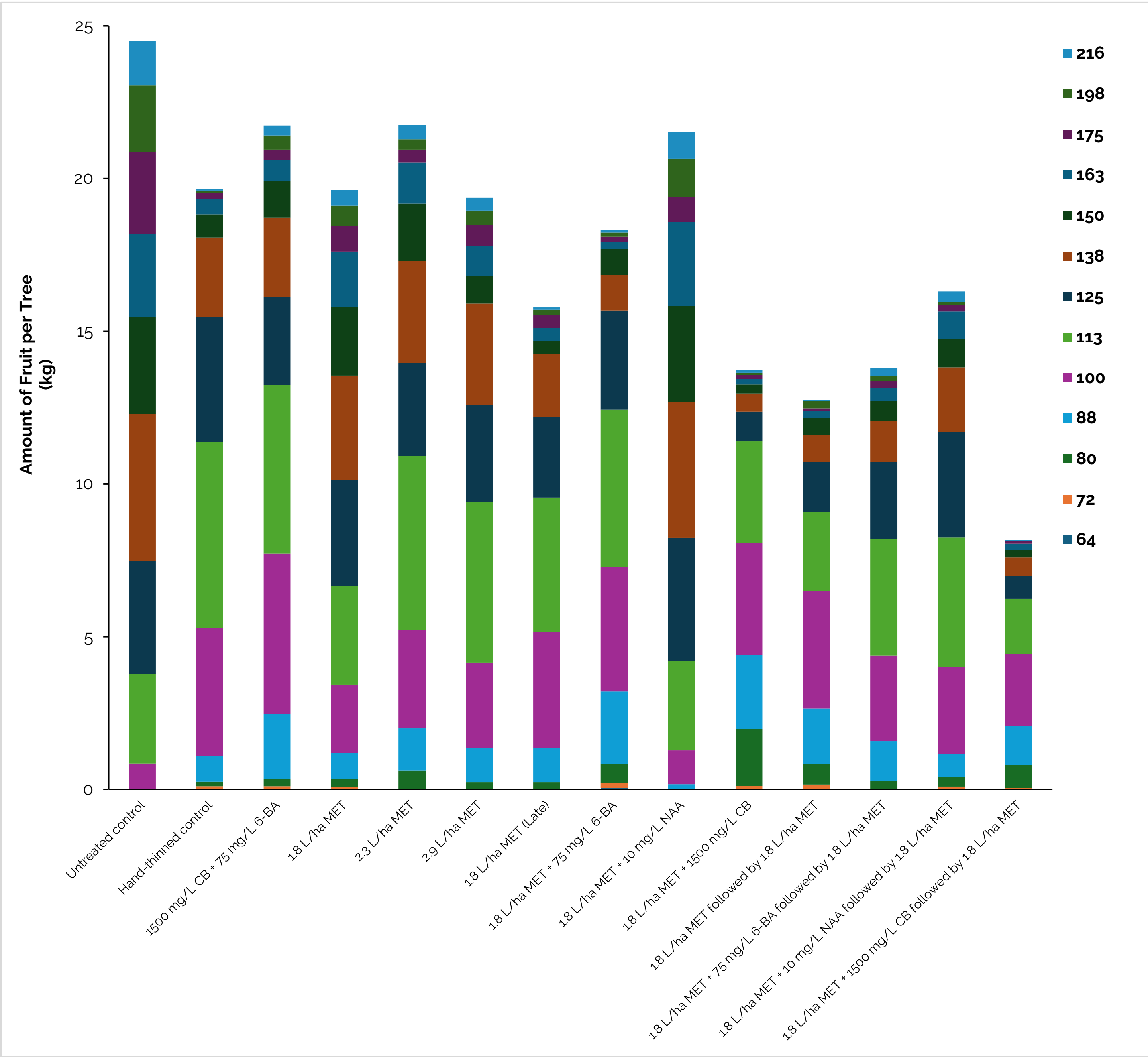


Figure 4. *Influence of metamitron (MET), carbaryl (CB), 6-benzyladenine (6-BA), and 1-naphthelenacetic acid (NAA) applied at various rates, timings, and combinations thinning treatments on size distribution of 'Crimson Gala' fruit in 2025 based on fruit count/box size categories. Fruit diameter equivalents for each count size: 48 = >98 mm (3 ⅞"), 56 = 95-98 mm (3¾-3 ⅞"), 64 = 92-95 mm (3⅝-3¾"), 72 = 89-92 mm (3½-3⅝), 80 = 84.5-89 mm (3⅜-3½"), 88 = 83-84.5 mm (3¼-3⅜"), 100 = 79-83 mm (3⅛-3¼"), 113 = 76-79 mm (3-3⅛"), 125 = 73-76 mm (2⅞-3"), 138 = 70-73 mm (2¾ -2⅞"), 150 = 67-70 mm (2⅝-2¾"), 163 = 64-67 mm (2½-2⅝"), 175 = 60-64 mm (2⅜-2½"), 198 = 57-60 mm (2¼-2⅜"), 216 = <57 mm (2¼"). Treatments including a "+" indicate the chemical thinners were tank-mixed for application. Treatments were applied at 6-7 mm king fruitlet diameter on 26-May 2025, and components of a treatment denoted with "Late" or "followed by" were applied separately at 15-17 mm king on 7-June 2025.*

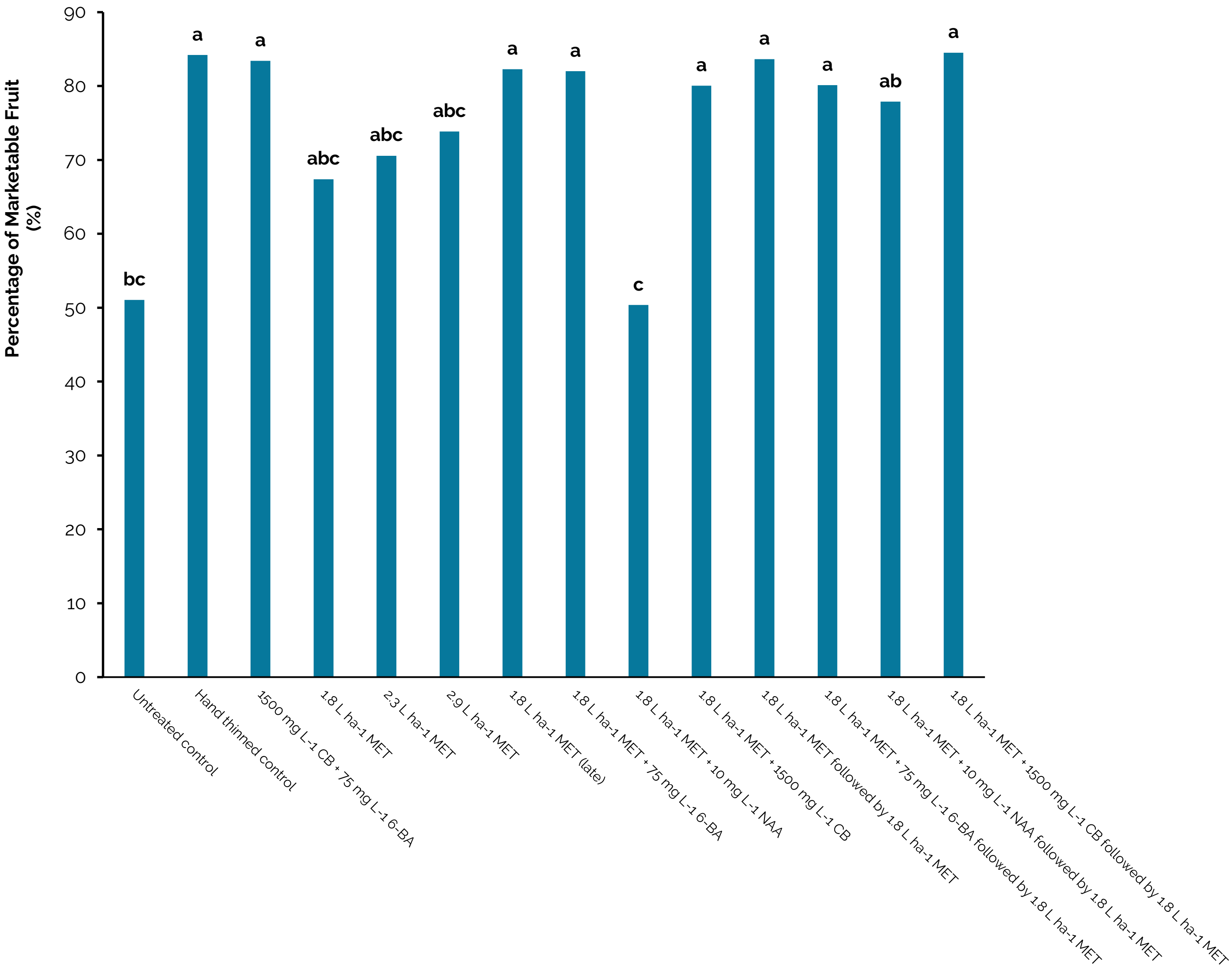


Figure 5. *Influence of metamitron (MET), carbaryl (CB), 6-benzyladenine (6-BA), and 1-naphthelenacetic acid (NAA) applied at various rates, timings, and combinations on proportion of marketable fruit of 'Crimson Gala' trees in 2025. Treatments including a "+" indicate the chemical thinners were tank-mixed for application. Treatments were applied at 6-7 mm king fruitlet diameter on 26-May 2025, and components of a treatment denoted with "Late" or "followed by" were applied separately at 15-17 mm king on 7-June 2025. Mean values with the same letter are not significantly different according to Tukey's HSD test at P=0.05.*

ANNOUNCEMENTS

Sweet, Sweet Victory!

We would like to wish the warmest congratulations and thanks to all of those who participated in the **11th Annual Ontario Sweet Cider Competition** and **10th Annual Ontario Craft Cider Competition.**

We are happy to say that the Sweet Cider Competition had its highest entrant numbers since 2020! We hope to keep the competition housed at OFVC to continue the momentum.

The Craft Cider Competition filled its capacity in the Modern category, with the Fruit/Botanical, Hopped/Barrel Aged and Heritage categories showing 80%, 53% and 53%, respectively. This year we separated the specialty categories to allow for more Ontario cider participation and recognition, along with supporting judges to effectively evaluate the entries.

We would also like to pass along our graditute to the Ontario Apple Growers for sponsoring the 2026 Ontario Sweet Cider Competition, along with the Ontario Craft Cider Association for sponsoring the 2026 Ontario Craft Cider Competition.

A Very Special Thank You!

We would like to express our sincere appreciation to the organizers, volunteers, and judges who made these competitions possible. These competitions would not be possible without their time, expertise, and dedication.

Save The Date! Apple IPM Workshops

Mark your calendar – the 2026 Apple IPM Workshop is just around the corner!

Whether you're brushing up on scouting skills, looking to sharpen your pest management decisions, or new to the world of apple IPM, this workshop is designed to review key pest concepts ahead of the growing season.

May 4, 2026 – 9:00 AM – 12:00 PM (virtual)

A half-day Zoom session featuring live discussion on key pest timings and scouting basics.

May 5, 2026 – 9:30 AM – 3:30 PM (in-person)

A full-day session at the Ontario Crops Research Centre in Simcoe ON with a combination of indoor and outdoor components (weather dependent), including hands-on identification and scouting practices.

Workshops will cover the core components of IPM, including pest identification, life cycles, and scouting approaches in an orchard.

All presentations in the Apple IPM Workshop Series can be found on ONfruit in Apple IPM Resources. Watch the presentation series ahead of the meeting and bring your pest- or scouting-specific questions. Additional resources will be provided following the workshop.

Registration is now open!

CLICK HERE TO REGISTER

Registration is also available by calling the Agriculture Information Contact Centre at 1-877-424-1300.

Looking for more? Additional IPM workshops will be available this spring, including:

- Introduction to IPM
- Strawberry & Raspberry
- Tender Fruit
- Grape
- Brassica Crops
- Carrot & Onion
- Potato
- Tomato & Pepper
- Sweet Corn, Peas & Beans
- Cucurbit
- Ginseng
- Hazelnut