



Volume 28, Issue 4, Fall 2024

Orchard Management

Unlocking Insights: The Value of Data Analysis **p. 2**

Nutrients in the Orchard: A Review on the Nutrients in Fruit Crops Symposium **p. 3**

Shaping Success: The Power of Apple Tree Pruning **p. 5**

The Drivers of Agricultural Sustainability in Ontario **p. 10**

Crop Protection

Unpacking Scab Challenges: Factors Behind Last Season's Apple Scab Management Struggles **p. 12**

Field Efficacy of Selected Fungicides Against Bitter Rot in Ontario **p. 15**

Establishing an Optimal Airblast Carrier Volume **p. 18**

Tank Mixing Update: Implications for Users of Pest Control Products **p. 22**

Ontario's Ambrosia Beetle Survey: Species Insights and Their Impact on Apple Orchards **p. 24**

Gnaw & Order: Strategies to Mitigate Rodent Damage in the Orchard **p. 31**

Postharvest

Effects of Harvest Maturity and Storage Temperature on Internal Browning and Firmness Retention in 'Ambrosia' Apples **p. 34**

WRAPPING UP THE SEASON!



COOL TIPS FOR THE "OFF" SEASON

1. Winterize equipment and attend to repairs (if not already completed)
2. Guard against rodents, where needed
3. Sharpen pruner for upcoming winter pruning
4. Review data, look for trends, and identify your hotspots/pressure points
 - Scouting & Spray records
 - Weather
 - Yields
 - Inputs & Returns
5. Reflect on what worked/didn't work this season, why and how to address problems
6. Develop a 2025 management plan
 - Calculate target crop load for your market
 - Make a pruning plan
 - Think about thinning strategies for upcoming year
 - Identify key pest issues
7. Educate yourself! Read up on previous issues of ONcore and refresh your knowledge on CropIPM
8. Register for the Ontario Fruit & Vegetable Convention
9. **Sip a good cider & relax!**

Stay connected to **ONcore**



Brought to you by the OMAFA Editorial Apple Team:

Erika DeBrouwer
ONcore Editor
Tree Fruit Specialist
(226) 931-4098
erika.debrouwer@ontario.ca

Kristy Grigg-McGuffin
ONcore Editor
Horticulture IPM Specialist
(519) 420-9422
kristy.grigg-mcguffin@ontario.ca

Andrea Vieira
ONcore Art Direction/Design
Publications Officer
andrea.vieira@ontario.ca

ANNOUNCEMENTS

- ✓ Ontario Fruit & Vegetable Convention
- ✓ Summer Student Employment Positions!





ORCHARD MANAGEMENT

Unlocking Insights: The Value of Data Analysis

Erika DeBrouwer, Tree Fruit Specialist, OMAFA
Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFA

Record keeping has long been a pertinent step in the success of any and every business. It is even more critical in the agriculture industry due to the ever-changing climate (environment, market, consumers etc.). Good record keeping allows you to identify the blocks that are economically challenging, year after year and can aid you in changing approaches for more financially impactful options.

To quote the former OMAFA Apple Specialist, Leslie Huffman from previous ONcore articles:

"Each year is different, but if you have notes of similar situations that occurred in the past you can look back on what you did and whether that worked for you and your orchard."

We hope that the overview below helps you to think critically about your orchard economics. It is important to remember that **"You cannot manage what you do not measure."**

Tips

Make sure that your record system provides you the information you need to make good management decisions. It doesn't matter how the information is collected and stored, as long as you can look back and discern the critical points that enable you to improve your operation.

Steps to utilize your numbers responsibly

- Collect
- Organize
- Analyze
- Backup
- Make Decisions

Tricks

Include the following in your harvest records

- Calendar date of harvest
- Yield and quality parameters
 - Starch
 - Firmness
 - Pest issues etc.
- Heat unit accumulation
- Weather data leading up to harvest
 - Specifically night-time temperatures
- Length of time stored and/or when apples were removed from storage
 - If you have access to this information
- Pay out for crop

Questions to ask yourself

- Which blocks produce the most yield?
- Which blocks cost the most to produce?
- Was this year a 'typical' year?
 - Weather
 - Pest pressures
 - Product applications
 - Yields
- Do I need to change my approach based on my data/costs?

Tracking

Use the [Apple Harvest Assessment Sheets](#) for fruit and terminals to aid in record keeping and to provide a snapshot your IPM program efficacy. These can be found in the 2024 Summer Edition of ONcore.

For examples of what records to keep and additional tools to use in-season, please refer to [The Economic Crunch: Why It Pays to Collect & Review Your Data](#) in the 2024 Winter Edition of ONcore.



Nutrients in the Orchard: A Review on the Nutrients in Fruit Crops Symposium

Erika DeBrouwer, *Tree Fruit Specialist, OMAFA*

This symposium was hosted by the International Society for Horticultural Sciences (ISHS) in Wenatchee, Washington, USA. The symposium hosted researchers, extension agents, students, and industry representatives, all of whom shared vast amounts of knowledge about various crops and nutrients. Below are snippets of information from various presenters.

Rootstocks & Their Relations

Dwarfing rootstocks affect nutrient uptake and growth potential

- This could be affiliated with dwarfing rootstock water restrictions, occurring either at the root or graft union, and potentially on leaf stem and leaf hydraulic trait

Strong evidence shows that some nutrients are genetically controlled by rootstock and are consistent year over year

- G.214 has shown to have low nitrogen uptake
- G.969 has shown to be good a calcium uptake
- G.41 and G.890 have better potassium uptake than G.214, G.969, B.9 & B.10

Water relations have been shown to be affected by dwarfing rootstocks, although the implications on nutrient transport are still being studied

Honeycrisp & Bitter Pit

Calcium moves through the tree via transpiration

- This occurs when the tree loses water in the form of water vapour and is significantly impacted by environmental factors:
 1. Temperature: Warmer air holds more water, increasing rates of transpiration
 2. Wind: Windier conditions increase transpiration

3. Relative Humidity: High relative humidity reduces transpiration, while low relative humidity the greater the transpiration
4. Light: Light levels cause stomata to open, increasing the transpiration rate
5. Soil Water: Plants that have adequate soil moisture will transpire at higher rates

Very little calcium accumulation in Honeycrisp occurs from bloom to the end of shoot growth

- Recommend early period targets for ground applied calcium
- Xylem function is critical to the transportation of calcium within the tree and fruit
 - Researchers are developing way to test xylem functionality throughout the season to aid growers
 - Researchers are looking at ways to extend xylem function to mitigate bitter pit

Research about rootstock relationships to Honeycrisp in New York State

- Bitter pit occurrence from least to most occurrence, left to right
 - B.9 < M.9 < G.11 < G.41

Cell division ends 6 – 7 weeks after bloom

- Rapid expansion during cell division occurs in Honeycrisp, which crushes xylem, leading to bitter pit

Little bitter pit was found in the 2023 Honeycrisp crop across Michigan, New York, and Ontario.

- This was projected by Dr. Todd Einhorn (Michigan State University)
 - Studying xylem function and showcased that in 2023 xylem function was extended by 2x in comparison to previous seasons
- This was also projected by Dr. Lailiang Cheng (Cornell University)
 - Studying various nutrient ratios of fruit in advance of harvest to better determine potential incidence long-term



- Dr. Cheng has developed the Peel Sap Analysis where growers can compare potassium to calcium, and nitrogen to calcium levels to notify growers in advance of bitter pit risk
- Bitter pit risk is fairly closely associated with peel sap potassium to calcium, with ranges of risk shown in [Table 1](#)
- Bitter pit is also associated with peel sap nitrogen to calcium ratio, with ranges of risk shown in [Table 1](#)

Table 1. Peel sap analysis ratios related to bitter pit risk

Bitter Pit Risk	Potassium : Calcium	Nitrogen : Calcium
Low Risk	< 25	< 4
Moderate Risk	25 – 30	4 – 6
High Risk	> 30	> 6

Symposium Takeaways

General comments:

- pH can affect root architecture and nutrient uptake
- pH affects rootstocks differently
- Crop load can affect nutrient uptake
- Rootstock and cultivar combinations uptake nutrients differently

Factors affecting nutrient uptake:

- Rootstock
- pH of soil
- Crop load
- Cultivar

Why does this matter to you?

- Future developments of improving certain nutrient uptakes
- Knowledge of what or why there could be issues in certain blocks
- Researchers are still trying to understand dwarfing rootstock effects on nutrient cycling
- Researchers continue to understand the implications of calcium, magnesium and potassium relations to bitter pit on Honeycrisp

Tree nutrient requirements and uptake are yield dependent.

Trees will change the uptake of their nutrients based on their crop load. This has and continues to be studied to better understand the implications of a heavy crop load versus a light crop load. This is critical to understand to become more precise with nutrient application.

Researchers of Note

- Dr. Lee Kalcsits, Washington State University
- Dr. Lailiang Cheng, Cornell University
- Dr. Gennaro Fazio, Cornell University
- Dr. Victoria Fernández, Universidad Politécnica de Madrid

Resources & References

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Shaping Success: The Power of Apple Tree Pruning

Erika DeBrouwer, Tree Fruit Specialist, OMAFA

Pruning your apple trees effectively can considerably change your orchard. Pruning can impact labour costs, labour efficiency, crop load, fruit quality, and pesticide coverage.

When pruning a bearing apple tree, the goal is to maintain maximum high-quality fruit on a continuous basis. When performed effectively, little pruning would be necessary annually.

Important Factors for Effective Pruning

Sharp tools

- Clean cuts are the best cuts, as they can heal more quickly

Tree age

- It is recommended to perform minimal pruning on young trees to allow them time to establish
- Pruning established trees first is recommended to allow for division of labour and higher resiliency in comparison to younger trees

Tree health

- Diseased or damaged trees will take longer to heal from pruning cuts
- Allow for additional time for the healing process and consider how many cuts the tree can handle based on its health status, size and establishment

Pruning plan

- Knowing your desired crop load for the incoming season will aid in the amount and types of pruning cuts that should be performed

Key Rules to Aid Your Green Thumb

1. Shoot growth the following season is proportional to the pruning severity
2. It can take up to two weeks for trees to regain their cold hardiness after pruning
3. Time of year (dormant vs summer) does not impact the amount of regrowth

Types of Pruning Cuts

Pruning cuts are often categorized into two types (i) thinning cuts or (ii) heading cuts.

Thinning Cut

A thinning cut removes an entire spur, branch or limb from its point of origin. It includes spur cuts and cuts made close to the branch collar. Thinning cuts are used to minimize potential of regrowth and promote light penetration in the canopy by removing shading and crowding of limbs. Thinning cuts are preferred over heading cuts due to the implications that heading cuts have on growth changes in the tree.

Spur Cut

A spur cut is a type of thinning cut that removes spurs. It is recommended to remove 1/4 to 1/3 of spurs on heavily spur/tip bound cultivars. Spur cuts are performed to continue rejuvenation of spur/tip bearing varieties and promote production of high-quality fruit.

Bench Cut

A bench cut is a thinning cut, where a horizontal seat is left on the limb. The purpose of a bench cut is to encourage a weaker and/or better angled replacement shoot. It is encouraged to utilize spreading instead of bench cuts in young trees.

Bevel Cut

A bevel cut is also termed a 'Dutch cut'. The bevel cut is performed by making an upward-facing angle cut that preserves a dormant bud on the underside of a shoot. This cut, similar to the bench cut, is meant to encourage a new, weaker, fruiting shoot with a wider angle from the bud below.

Heading Cut

A heading cut removes only a portion of a limb, leaving a section of pruned limb on tree. Heading cuts includes hedging. Heading cuts can be performed throughout the year based on the desired outcome. Early spring heading cuts encourage more lateral bud break, while summer hedging can be done to encourage fruit colouration. Ultimately the main reason heading cuts are utilized is to stimulate localized branching.



Table 1. Relative Influences of Pruning Cuts on Apple Trees¹

Response	Thinning Cuts	Heading Cuts
Apical dominance	• Little effect on remaining growth	• Terminal removes, buds released
Shoot formation	• Fewer vegetative shoots	• Increased numbers and length
Spur formation	• Increased	• Decreased
Tree shape	• Limited effect	• Dramatic effect i.e. hedging
Tree growth habit	• Natural tall rangy	• Compact and upright habit
Fruitfulness	• Limited effect	• Significant decrease
Carbohydrate reserves	• Limited effect	• Dramatic reduction
Nutrition elements	• Limited effect	• Decrease calcium and magnesium • Increase nitrogen
Local stimulus	• Encourage few shoots	• Encourage many shoots

¹ Table developed by Ferree & Schupp, 2003.

Hedging

Hedging is a mechanical form of pruning that can restrict canopy width and height, increase light interception, and encourage use of mechanization (platforms). Hedging can be utilized for various outcomes based on the time of use, such as stimulating growth on weaker trees during dormant and early spring hedging, while hedging before harvest will aid in sunlight penetration.

Based on your desired outcome, you may want to change whether the use of thinning or heading cuts should be utilized, although, as mentioned above, thinning cuts are recommended due to the limited change they have on tree growth physiology (Figures 1 & 2). Table 1 demonstrates the relative responses to the two types of pruning cuts (heading and thinning).

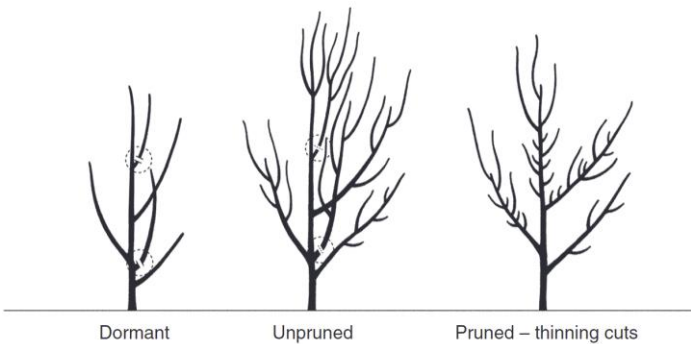


Figure 1. Illustration showing growth change of two dormant thinning cuts. (Source: Ferree and Schupp, 2003).

Steps to Making Snip Decisions

Step 1: Know Your Numbers

Based on your orchard setup, the first step is to determine how many fruit buds you need to meet your yield goals. Table 2 demonstrates three different orchard systems on Ontario. For each of your blocks, developing a similar chart would be beneficial.

To develop a chart like the one above you need to know your ideal fruit size (count) and yield. Table 3 is an example of how to calculate and develop a table for your orchard block.

Step 2: Dissect Your Buds

Once this is developed, the next step is to look determine your fruit to total bud ratio and further adjust your pruning. You can achieve this in mid-winter, and although it can be difficult to differentiate between fruit

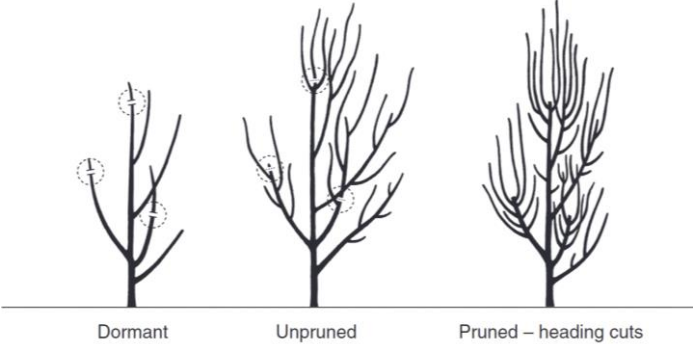


Figure 1. Illustration showing growth change of three dormant heading cuts. (Source: Ferree & Schupp, 2003)



Table 2. Precision pruning chart showcasing different orchard systems

	Tall Spindle	Slender Spindle	Conventional
Yield Goal	1500 bu/ac	1000 bu/ac	800 bu/ac
Tree Density	1000 trees/ac	622 trees/ac	145 trees/ac
Tree Spacing	11 x 4'	14 x 5'	20 x 15'
Yield Per Tree	1.5 bu/tree	1.6 bu/tree	5.5 bu/tree
Fruit Per Tree (100 count)	150 fruit/tree	160 fruit/tree	550 fruit/tree
Branches Per Tree	24	12	12
Fruit Per Branch	6 – 7	13 – 14	44 – 46
Buds Needed Per Branch ¹	12 – 14	26 – 28	88 – 92

¹ This number should change based on variety, comfort, orchard history, and fruit to total bud percentage.

Table 3. Example chart for precision pruning calculations

	Calculation	Example
Yield Goal	Based on your target	1000 bu/ac
Tree Density	Based on orchard block	1200 trees/ac
Tree Spacing	Based on orchard block	12 x 3
Yield Per Tree	Yield goal / tree density	0.83 bu/ac
Fruit Per Tree	Yield goal x fruit size (88) / tree density	73 fruit/tree
Branches Per Tree	Based on a count average (5 tree minimum)	24
Fruit Per Branch	Fruit per tree / branches per tree	3
Buds Needed Per Branch	Fruit per branch x insurance factor ¹ (1.8 for Gala)	5

¹ This number should change based on variety, comfort, orchard history, and fruit to total bud percentage.

and leaf buds, if you conduct this now it will aid in pruning more efficiently and planning your pruning strategy accordingly.

To determine your fruit to bud ratio:

1. Collect a random sample of 30 to 50 buds that you believe are going to be flowering spurs
2. Slice vertically down the centre of each bud (Figure 3) with a razor blade. The cleaner the cut the better.
3. Using a magnifying glass, hand lens, or microscope, identify if the bud is floral or vegetative (Figure 4)

4. Determine the percentage of flower buds to total buds.

$$\text{Fruit buds} / \text{Total buds} \times 100$$

Example: You collect 50 buds, where 32 buds appear to be floral. 32 fruit buds / 50 total buds x 100 = 64%

5. Implement this into your pruning plan

Taking the example from Table 2 where you want 73 fruit/tree and the insurance factor is 1.8 = 131 buds. This means you want 131 buds, but if your floral bud percentage is 64, then you would need to leave 215 buds per tree (131 buds x 1.64 = 215 buds). On a branch basis 215 buds / 24 branches = 8 or 9 buds per branch.

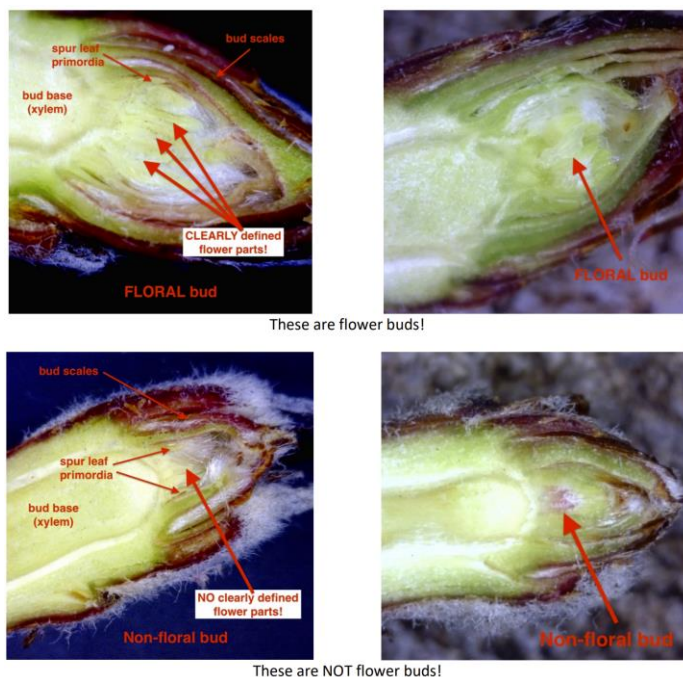


Figure 3. Photos showing the difference between 'Honeycrisp' floral buds (top left & top right) and 'Honeycrisp' vegetative buds (bottom left & bottom right) (Source: [Precision crop load management of Honeycrisp: flower bud identification and precision pruning](#))

Step 3: Master the Concepts

These numbers are to give you a guideline for strategies to prune more effectively, but it always important to consider the following:

- Last years crop load (high or low)
 - If your crop potential is light, prune a demonstration tree and perform a final bud count. This allows you to adjust if more fruiting is needed.
 - If your crop potential is heavier, removing more large branches with fruiting buds is recommended. Crop reduction in dormancy allows for larger fruit production throughout the season as less energy is expended on other fruit that would be thinned.
- Bud size
- Cropping history
- Rootstock
- Absence of spur buds

I would also encourage a refresh of some pruning strategies and cuts to understand the potential cause and effect of each pruning cut.

Shear genius pruning rules to follow include the "10 Pruning Rules" developed by Bas van den Ende. These rules were developed to deliver high yields and packouts for apples and pears.

1. Prune your block with the weakest trees first and your strongest last
2. Remove big wood using the 3-to-1 rule
3. Make thinning cuts in preference to heading cuts
4. Make pruning cuts on the undersides of limbs
5. Maintain correct height of the trees or canopies to avoid inter-row shading
6. Postpone cutting (topping) the heads until the structure of the tree has been formed
7. Contain the length of a scaffold by pruning back into 2-year-old or older wood
8. Keep your fruiting wood young using the 1-2-3 rule of renewal pruning
9. Delay heading branches to avoid blind wood
10. Get rid of old, tired spurs

For a more descriptive understanding please refer to the link provided: <https://www.goodfruit.com/good-to-know-ten-pruning-rules/>.

Step 4: Outline a Strategy

Each block and variety may need a different approach. It is important to integrate your numbers, think about what strategies would be best for each block, for your management style and for your crew. It is recommended to develop a pruning plan for the blocks that are the most challenging first, as they would need more attention than other blocks.

Step 5: Execute and Adjust

Be mindful of the weather conditions and tree health before pruning. Be sure to make adjustments as the season progresses. Remember to maintain your records to compare and look back at methods that worked or didn't work and to deduce why these practices were or were not successful for you.



References & Resources

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[Good to Know: Ten Pruning Rules](#)

[Good to Know: The 1-2-3 Rule for Renewal Pruning](#)

Tools for the Economic Spray Job

Want to know the real cost of spraying your orchard?

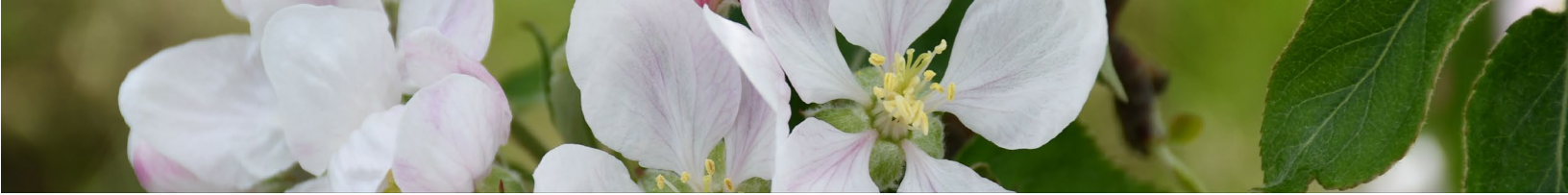
Watch “Spray Economic: A Deep Dive” where Alison DeMarree and Dr. Jason Deveau break down the numbers.

Alison gives first-hand knowledge and shares her own farm numbers to contrast 2 different orchard sprayer costs.

Jason goes over a tool that can be utilized to calculate your sprayer costs. This tool was developed by Dr. David Mankelow (Plant & Food Research New Zealand) and can be found at the link below:

<https://sprayers101.com/airblast-workrate/>





The Drivers of Agricultural Sustainability in Ontario: (And What This Means for You)

Steph Vickers, *Horticulture Sustainability Specialist, OMAFA*

Sustainable agriculture is essential for ensuring long-term food security, environmental health, and the economic viability of growers. But the word "sustainability" is now at the forefront of agricultural value chains and the political landscape. There are many drivers behind this recent emphasis on sustainability in the agri-food industry:

1. Climate change and environmental impacts
2. Policies, regulations, and strategies
3. Consumer demand
4. Market and value chain pressures

Climate Change and Environmental Impacts

Environmental risks and disruptions are a reality of farming in Ontario and are being exacerbated by climate change. This includes an increased frequency and intensity of extreme weather events and unpredictable weather patterns, particularly precipitation. These environmental impacts have motivated some agri-food companies to respond by improving the resiliency of their supply chains through sustainability initiatives.

Policies, Regulations and Strategies

Policies, regulations, and strategies are also shaping the meaning of sustainable agriculture. Within Canada, the new Sustainable Canadian Agricultural Partnership (SCAP) includes cost-share programs targeted towards improving soil health, water quality, and productivity. The federal government is also developing a Sustainable Agriculture Strategy that will "set a shared long-term direction for collective action to improve environmental performance in the sector, support farmers livelihoods and strengthen the business vitality of the Canadian agricultural industry." Outside of

Canada, a significant example is the European Green Deal which is a set of policy initiatives with the aim of making the European Union climate neutral by 2050.

Consumer Demand

Consumer insight surveys have demonstrated an increased demand for sustainably produced food. Although these self-reported survey responses likely differ from consumers' actual choices in a grocery store (especially with recent inflation), agri-food retailers are certainly behaving as though consumer demand for sustainable products is increasing.

Market and Value Chain Pressures

An increased awareness of environmental degradation, climate change, and social issues has altered the landscape in which businesses operate. Shareholders and investors in agri-food businesses are increasingly interested in more "sustainable" investments. Environmental, social, and governance (ESG) are three non-financial themes used to inform the long-term risk of an investment, and ESG reporting is increasingly integrated into financial disclosures. Within the next year, standards are expected to be released in Canada that outline requirements for the disclosure of sustainability related information for publicly traded companies.

Consequently, many agri-food companies are developing sustainability programs or initiatives and making public commitments to improve certain sustainability metrics. The current emphasis is on environmental sustainability (the "E" from ESG), particularly decarbonization. New regulations and guidance are emerging for agri-food companies to account for, report, and set targets for greenhouse gas (GHG) reductions in their value chains. This has created a situation whereby agriculturally-generated GHG emissions have become a target for accountability by downstream value chain members.

Figure 1 shows examples of the different scopes included in a business's GHG accounting. From the perspective of agri-food retailers like Loblaw's or Walmart:

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- Scope 1 includes emissions generated by sources that the organization owns or controls directly, e.g. emissions from owned vehicles
- Scope 2 includes emissions from purchased energy, e.g. emissions from purchased electricity
- Scope 3 includes emissions from upstream and downstream sources across their supply chain, e.g. emissions from agricultural production

What Does This Mean for Ontario Apple Growers?

As an Ontario apple grower, it does not mean that you need to begin calculating your farm-level GHG emissions today, but it is important to be aware of this trend and the ways it could impact you and your operation in the future. These potential impacts will depend on your business model/buyers and scale of operations. If you supply apples to a large retailer, it is likely they have sustainability initiatives, but these initiatives differ in their scope, approach, and sophistication. As Canadian standards are released to account for GHG reductions in agricultural value chains, these programs will align more and more in the future.

It's also likely that sustainability programs will expand to encompass goals beyond decarbonization (e.g. biodiversity).

In these circumstances, the Ontario Apple Growers and Ontario Tender Fruit Growers are supporting growers with a joint project funded in part by Agriculture and Agri-food Canada that is looking at GHG emissions and sequestration in Ontario apple and tender fruit orchards. The project is in its second of five years, so stay tuned for updates. It is important to remember that agricultural sustainability is a complex topic with a continually moving target and very few standards for Canadian contexts, but there is massive opportunity for Ontario apple and tender fruit growers to have positive outcomes.

If you have any questions or would like more information about topics included in this article, please feel free to contact me at stephanie.vickers@ontario.ca or 519-852-5627.

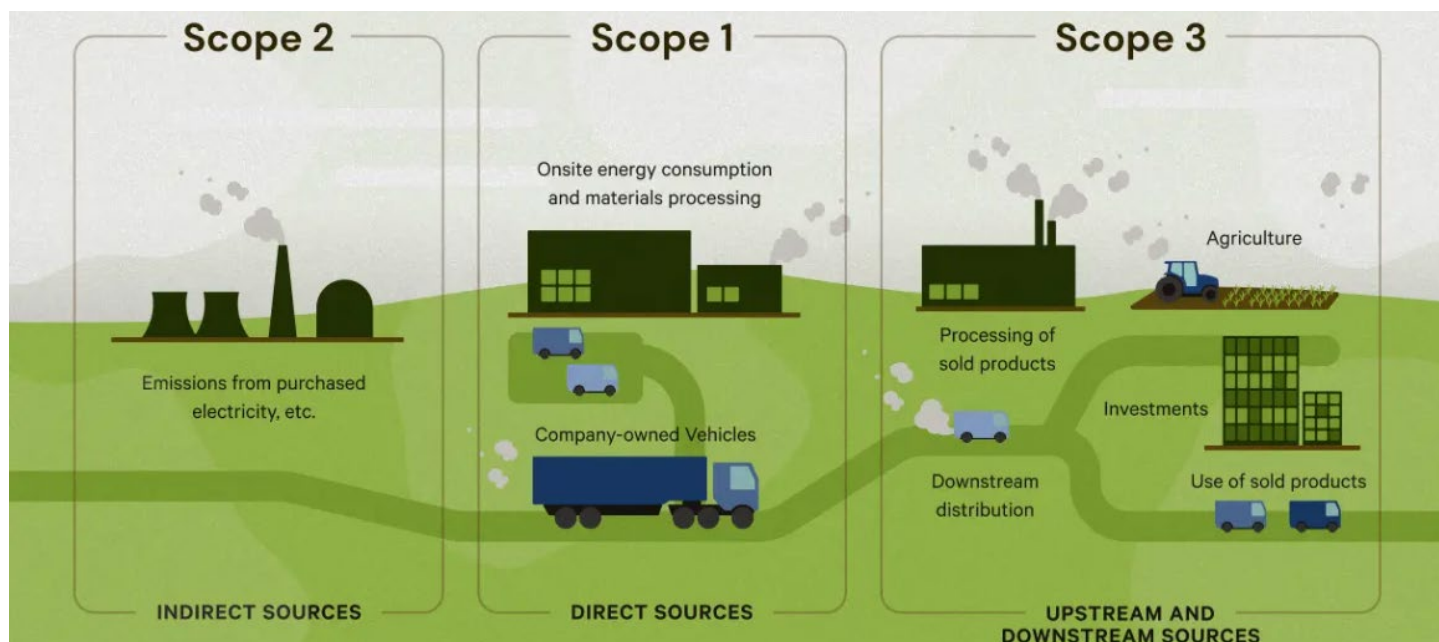


Figure 1. Scope 1, 2, and 3 emission in the agricultural supply chain (Source: [Scope 3: In the Spotlight of Climate Action | Regrow Ag](#))



CROP PROTECTION

Unpacking Scab Challenges: Factors Behind Last Season's Apple Scab Struggles

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFA

Whether you began seeing signs of leaf scab early season or dealt with fruit scab at harvest, it seems you weren't alone this year. Managing scab was a challenge for many growers across the province. It's often easy to point the finger at product efficacy, but there may be several contributing factors involved in why (or why not) scab may get ahold in an orchard.

Understand Thy Enemy

Effective management starts first with understanding the biology of the disease. Scab overwinters on the orchard floor in infected leaves from the previous season. Spores begin to mature in the spring around the same time as the tree is emerging from dormancy. Mature spores are released during times of moisture – dew or rain – and result in primary infection. This infection period continues until all overwintering spores are depleted (typically a few weeks after petal fall).

Infection spreads throughout the season by secondary infection, or the spores released from primary lesions. The secondary cycle can continue well into the fall (as we saw this year) if conditions are conducive to infection.

For more information on apple scab biology, infection periods and general management, refer to [CropIPM](#).

Winter Vacation

The 2023-2024 winter was fairly mild for most regions of the province with little snow cover. Temperatures were actually warm enough in February to start accumulating growing degree days. Regions in the northeastern US that monitor ascospore development reported early maturation. This means it's possible there were more spores released in those first scab infection



events of the season than we typically experience. If sufficient fungicide protection wasn't on during these events, infection could occur.

April Showers Bring May... Scab?

Once the trees break dormancy and green tissue is present, primary infection can occur if the following three conditions are met:

- Mature ascospores are present in the leaf litter
- Weather conditions favour ascospore discharge and infection
- Fungicide protection is inadequate to prevent infection

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The early bud break and cool, wet spring this season made for ideal conditions for scab infection.

Leaves are most susceptible to infection until they are fully expanded. While the amount of lush growth in many blocks was a welcome sight over the season, it did leave trees more prone to disease.

Residues, Rains and Risky Gaps

The rain did not seem to take a break this season and neither did disease. What that meant for many growers, unfortunately, was that there were times when fungicide residue was washed off or rains prevented timely fungicide application.

A general rule of thumb often used is that 1 inch (2.5 cm) of rain removes approximately 50% of protectant fungicide residue and over 2 inches (5 cm) of rain will remove most of the residue. While systemic fungicides tend to perform better than protectant (or contact) fungicides in rainy periods, they do still require a certain amount of time prior to a rain event to be taken into the leaves – which isn't always as easy as it sounds.

During conditions conducive to disease development, it is important to maintain tight intervals between fungicide applications. Most labels will have the minimum interval listed. For protectant fungicides, a tight interval program would be 5-7 days. Where possible, do not extend intervals beyond 14-21 days if there are any concerns of disease. As a fungicide application ages, the efficacy of that product is reduced.

Getting Covered

There were many reports from growers in various regions of the province about the frequent windy conditions this season. Spray coverage can be affected by wind in several ways:

- Wind direction – can carry droplets away from intended target
- Wind speed – affects how far the droplets travel
- Consistency – wind gusts can make coverage inconsistent

In addition to wind, spray coverage can also be affected by water volume, nozzles orientation, sprayer

calibration, alternate row spraying, etc.

Areas of the canopy that are often missed due to poor coverage are within the tree due to spray not reaching through or at the top of larger trees. Routine monitoring can miss early signs of scab infection in these parts of the tree if not done thoroughly. I saw numerous situations this year where scab lesions were overlooked.

See [Sprayers101](#) for more information on assessing coverage.

Fungicide Action

Just like how understanding the biology of the pest is important, understanding the type of activity of a fungicide ensures you're getting the most efficacy from the product. For more information on characteristics of common apple scab fungicides, refer to the [Ontario Crop Protection Hub](#).

Contact vs (locally) systemic

Contact fungicides such as copper, captan or mancozeb remain on the plant surface and do not penetrate into the plant tissue. Therefore, they need to be applied prior to infection.

Systemic fungicides are taken up into the plant. Locally systemic products such as Group 3, 7 and 11s move only a short distance from the point of application, such as one side of the leaf to the other (known as translaminar). While this movement often occurs relatively quickly, there does need to be sufficient tissue available for absorption so efficacy of systemic fungicides may be less in early season before there is significant growth (prior to tight cluster).

Preventative vs curative

Preventative fungicides act as a protective barrier, either killing or inhibiting the pest pathogen. They do not have post-infection activity and, for some (such as certain biological fungicides), require time to establish or trigger a response. Most contact fungicides are preventative or protectants and do not stop infection.

Curative fungicides can stop infection after it has occurred, also known as kickback activity. Usually this is within the early stages of initial infection and not post-symptom. For scab resistance management, however, it is best to not rely on curative properties primarily as



most as single-site fungicides and highly prone to resistance development.

Leaf scab vs fruit scab

Not all fungicides are equally effective on leaf and fruit scab. For example, Group 3 and 11 fungicides are not as strong on fruit scab and should not be used beyond petal fall if scab is present in the orchard.

In recent discussions with northeastern pathologists, it was suggested Group 7 fungicides may fall into this category as well. This could explain why some orchards were suddenly seeing fruit scab without any prior leaf lesions, or so they thought. Upon closer inspection, these researchers were finding small lesions along the midvein of leaves – too small for the average eye but enough to cause secondary infection.

Neighbourhood Problem

Ascospores, or early season spores are carried to the tree by wind and can be carried long distances in air currents. This means, like many other orchard pest issues, apple scab can be a neighbourhood problem. During storm events or windy conditions, spores can be brought in from adjacent areas. So, just because your orchard has been clean of scab in previous years, does not mean you are fully out of the woods during scab risk periods.

Conidia, or secondary spores are heavier and tend to move short distances by wind, typically keeping to within the same tree or trees nearby.

Resistance

Resistance to Group 1, 3, 11 and U12 fungicides has been documented in Ontario. After ruling out all other factors that could have contributed to scab infection, you may want to consider your use history of certain products or groups and whether they are no longer effective in your orchard.

For best resistance management practices, where possible, rotate between chemical groups and tank-mix single site fungicides with a protectant (assuming label states you can). Refer to the [Ontario Crop Protection Hub](#) for more details on resistance management. Speak to your retailer if you have concerns about a specific product.

Forward Thinking

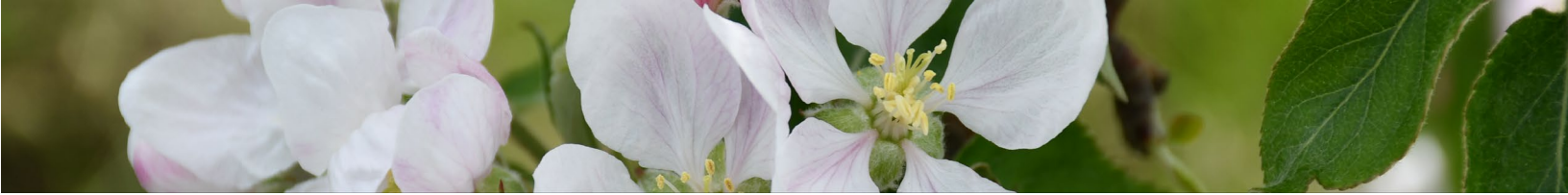
It is important to note that there are several other factors not listed in this article that may have contributed to a scab problem this season – limited fungicide options, water quality, etc. Those mentioned here are merely to begin the reflection process. Now is the time to look back at spray records, scouting reports, infection periods and weather events to consider all plausible causes.

It is also time to begin developing a scab management plan for the upcoming season. If scab was a challenge this year, there will be overwintering inoculum ready to go come spring. Be prepared with early intervention by considering a spring urea spray or flail mowing leaves to help breakdown the leaf litter and reduce that inoculum load. For more information, see the article [Scab-Free Apples Start with a Clean Orchard](#) in the last issue of ONcore.

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Field Efficacy of Selected Fungicides Against Bitter Rot in Ontario

Asifa Munawar, Research Associate, University of Guelph

Introduction

Bitter rot ([Figure 1](#)) is a significant summer disease affecting apple orchards in Ontario. The predominant pathogen responsible is *Colletotrichum fioriniae*, which follows a hemibiotrophic life cycle. This lifecycle allows the fungus to persist in host cells asymptotically before inducing cell death, leading to the formation of visible lesions. Symptoms often emerge suddenly, particularly close to harvest or during storage.

Current evidence from our lab suggests that the fungus can infect apples at any stage from fruit set to harvest. To provide Ontario growers with better tools for managing this disease, an efficacy trial was conducted at the Ontario Crop Research Centre, Simcoe in a 3-year-old orchard during the 2024 growing season. Two cultivars, Empire and Ambrosia, were selected for the study.

Experimental Details

The trial employed a randomized complete block design, with five trees per treatment and four replicates. Treatments ([Table 1](#)) were selected in collaboration with OMAFA specialists and collaborators.

A CO₂-powered backpack sprayer equipped with a TeeJet XR11002-VS nozzle was used to apply treatments at 500–800 L/ha spray volumes. The first application occurred 10 days after petal fall: May 23, 2024 for Empire (fruit size ~11 mm) and May 30, 2024 for Ambrosia (fruit size ~14 mm). Fungicide applications continued biweekly or after 50 mm of rainfall, whichever came first. Weather data were monitored using an on-site [Weather INnovations System](#). A total of nine spray applications were made for each cultivar.

To ensure disease pressure, trees were inoculated with fungal spores on May 24 (Empire) and May 31 (Ambrosia). The mesh bags containing inoculated fruit



Figure 1. Bitter rot lesion in cultivar Empire (top) and Ambrosia (bottom) as observed in the 2024 efficacy trial.

with *Colletotrichum* spores were hung from the top trellis wires to act as a source of inoculum.

Empire was harvested on September 9, 2024, and Ambrosia on September 26, 2024. The number of bitter rot-infected fruit and total fruit per tree were recorded biweekly and at harvest. To account for variability in the total number of fruits per tree, the mean bitter rot incidence was calculated using weighted percentages. Data analysis was performed using statistical software (SAS). For post-harvest evaluation, the fruit are currently being stored in a cooler until February 2025.

Results

Empire

Bitter rot symptoms were first observed in UTC plots on July 16, 2024, and in fungicide-treated plots on August 13 ([Figure 2](#)). Early in the season, disease incidence was



Table 1. Treatments for 2024 bitter rot fungicide efficacy trial at Simcoe.

Treatment No.	Treatment	PCP / Active Ingredient	FRAC Group	Pre-harvest interval (days)	Max. # of applications per year
1	Untreated Check (UTC)	-	-	-	-
2	Folpan	27733 / folpet 80%	M04	1	6
3	Aprovia	31981 / benzovindiflupyr 100 g/L	7	30	2 L/ha
4	Cyclone Plus*	34762 / lactic acid 1.4% + citric acid 2.54%	NC	n/a*	n/a*
5	Switch*	28189 / cyprodinil 37.5% + fludioxonil 25.0%	9+12	n/a*	n/a*
6	<i>Commercial Standard (C-standard) rotation of Pristine, Captan and Allegro</i>				
	Pristine	27985 / pyraclostrobin 12.8% + boscalid 25.2%	7+11	5	4
	Supra Captan	33641 / captan 80%	M04	15	10 (high density)
	Allegro 500F	27517 / fluazinam 40%	29	28	5

* Not registered on apples

low in treated plots, with Cyclone Plus (0.85%), Switch (0.2%), and the commercial standard (C-standard, 0.6%) all showing no statistically significant differences compared to UTC (6%).

By August 26, Cyclone Plus and Switch reduced disease incidence by 78% and 85%, respectively, compared to the UTC. Folpan-treated plots showed no bitter rot symptoms throughout the season and at harvest. The disease reduction was also 100% in Aprovia treated plots except at harvest. At harvest (September 9), Aprovia demonstrated the highest reduction in bitter rot (97% control) after Folpan (100% control), followed by the C-standard (87%), Cyclone Plus (74%), and Switch (67%).

Ambrosia

Bitter rot symptoms first appeared on July 30, 2024 in the UTC and Cyclone Plus-treated plots ([Figure 3](#)). Disease incidence persisted in Cyclone Plus and Switch-treated plots during subsequent assessments (13, 26 August, and 9, 26 September), with no statistically significant differences compared to the UTC except for Switch on September 26.

At harvest, Folpan provided the best disease reduction (98.6%), followed by C-standard (95%), Aprovia (93%), Switch (78%), and Cyclone Plus (62%). The commercial standard performed better in cultivar Ambrosia than in

Empire, likely due to the latter's higher susceptibility.

Conclusions

Folpan, Aprovia and C-standard were the most effective fungicide programs for controlling bitter rot in both cultivars, with consistent performance throughout the season. Switch provided moderate control, while Cyclone Plus was effective early in the season but less near harvest. Aprovia, with its 30-day pre-harvest interval (PHI), is a promising option for early-season control.

This trial will be repeated in 2025 to validate these findings and assess the consistency of results.

Acknowledgements

Pathology team at Simcoe: Asifa Munawar, Lisa Weber, John Watson, Katerina Jordan

Project Collaborators: Kristy Grigg-McGuffin (OMAF), Katie Goldenhar (OMAF), Kelly Ciceran (OAG), Ali Shawkat (AAFC, 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 (OAG) and Ontario Agri-Food and Innovation Alliance for funding this proposal.

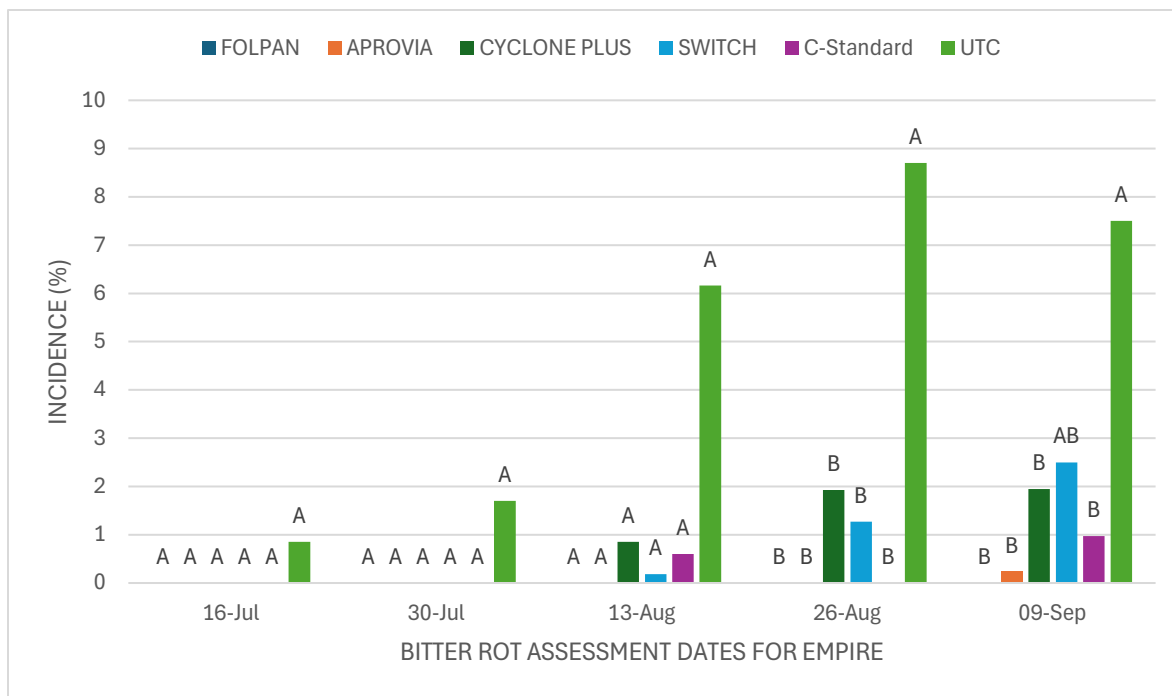


Figure 2. Mean percent incidence of bitter rot as recorded on cultivar Empire during the 2024 growing season after applying the test fungicides. The mean percent incidence within treatments for each assessment date followed by different letters is significantly different.

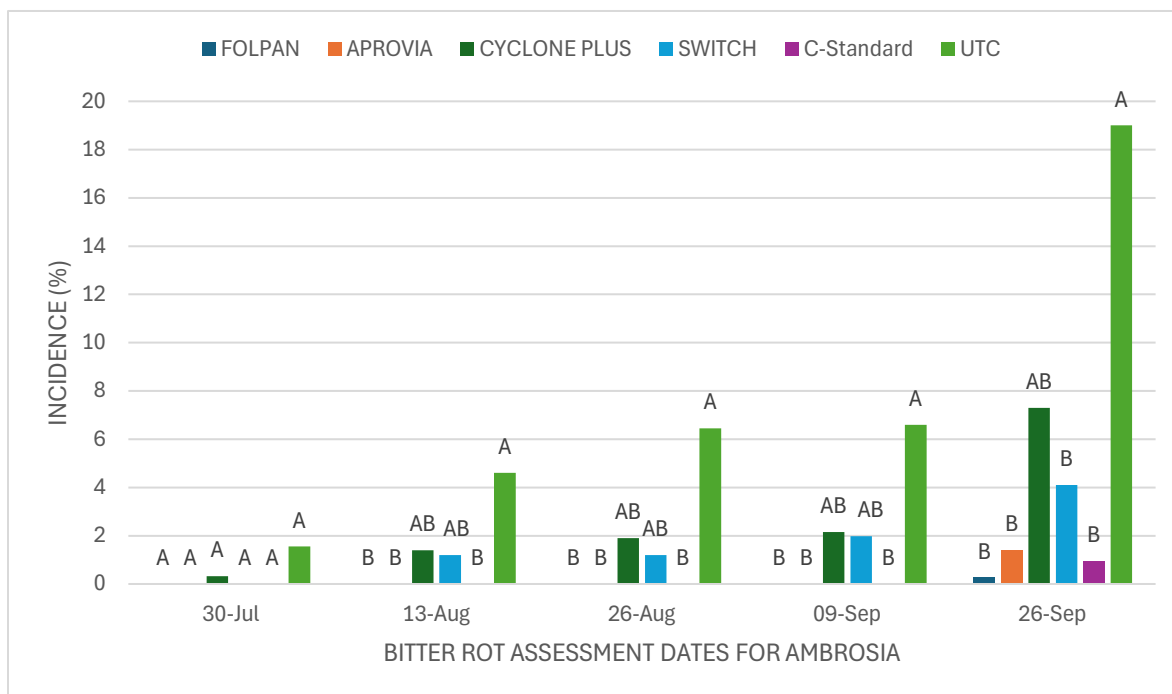


Figure 3. Mean percent incidence of bitter rot as recorded on cultivar Ambrosia during the 2024 growing season after applying the test fungicides. The mean percent incidence within treatments for each assessment date followed by different letters is significantly different.



Establishing an Optimal Airblast Carrier Volume

Jason Deveau, *Application Technology Specialist, OMAFA*

North American product labels may or may not include carrier volume recommendations. When they do, it could be based on a two-dimensional value like the planted area, or perhaps on row length which is more appropriate for trellised crops that form contiguous hedge-like canopy walls. Volume may be tied to product concentration, which sets minimum and maximum volumes based on product rates. Or, more commonly, volume recommendations take the form of vague guidelines such as "Spray to drip" or "Use enough volume to achieve good coverage".

In all cases, spray efficacy and efficiency can be greatly improved by dialing-in the carrier volume to optimize coverage uniformity and reduce off-target spraying. This is easier said than done because the optimal spray volume is case-specific. It depends on a complicated relationship between:

Weather condit [Grab your reader's attention with a great quote from the document or use this space to

emphasize a key point. To place this text box anywhere on the page, just drag it.]

- ions (e.g. temperature, humidity, wind speed and direction)
- Sprayer design (e.g. air handling, droplet size and flow distribution over the boom)
- Traffic pattern (e.g. every row or alternate row)
- Product chemistry (e.g. mode of action and formulation).
- Target (e.g. Crop morphology, planting architecture)

It is the final variable, the nature of the target, which is the focus of this article. To learn more about the other variables, grab a copy of [Airblast101](#).

The Plant Canopy and Planting Architecture Dictate Volume

Quite often, the target in airblast applications is the plant canopy. The plant canopy is the collective structure containing all plant surfaces. This could be the foliar portion of a single pecan tree, a panel of grapes, or a bay of container crops. The planting architecture describes how those canopies are arranged on the planted area ([Figure 1](#)). If we consider the canopy and

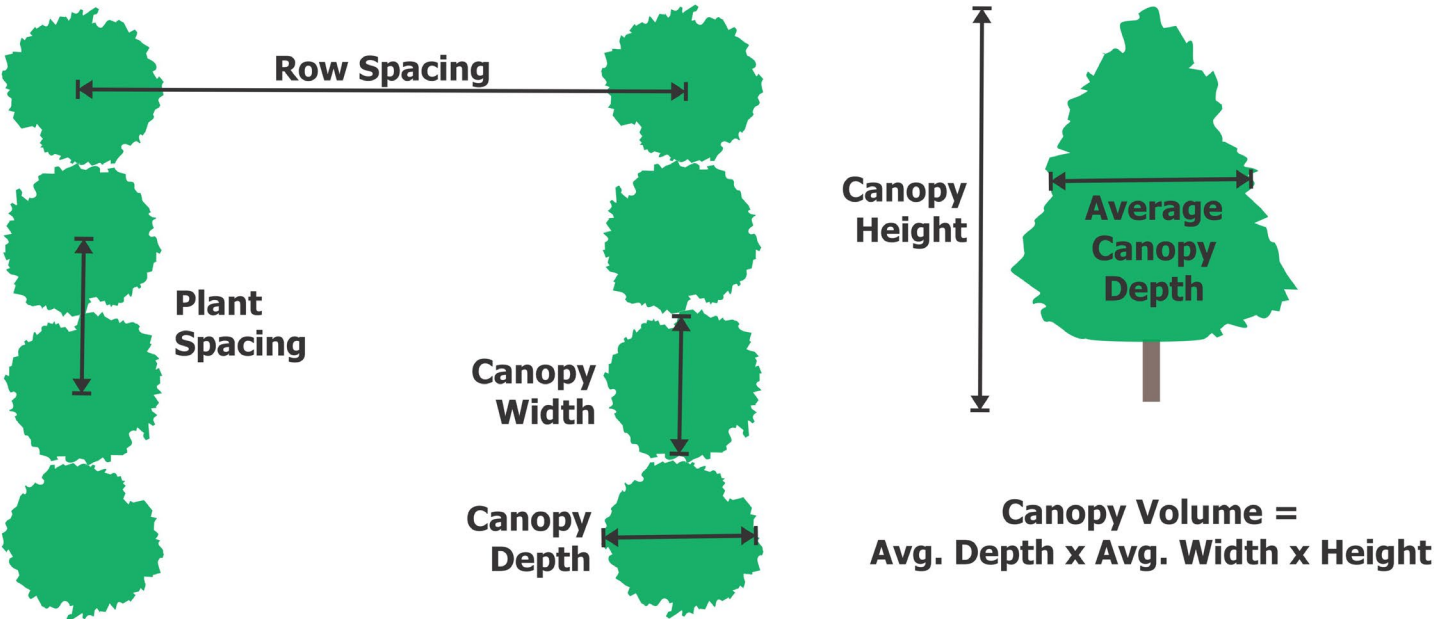


Figure 1. Six geometric characteristics of the plant canopy and planting architecture.



architecture geometrically, we can make relative statements about the volume required when all other variables are equal ([Table 1](#)).

Table 1. Relationship to carrier volume of six geometric characteristics of the plant canopy and planting architecture

Geometric Characteristic	Relationship to Carrier Volume (per unit planted area)
Row Spacing	The greater the row spacing, the less volume needed.
Plant Spacing	The greater the plant spacing, the less volume needed. This assumes gaps between the canopies (i.e., not a contiguous hedgerow)
Canopy Depth*	The greater the canopy depth, the more volume needed.
Canopy Width*	The greater the canopy width, the more volume needed.
Canopy Height*	The higher the canopy, the more volume needed.
Canopy Density	The denser the canopy, the more volume needed.

* The product of average canopy depth, width and height is the canopy volume. This value forms the basis for many dose expression models and historic carrier volume calculators such as Tree Row Volume.

Canopy Density

Let's focus on a single plant canopy. Research has demonstrated that with the possible exception of canopy height, canopy density has the greatest influence on optimal sprayer settings. Density describes the amount of matter inside a canopy relative to the volume of space it occupies. The denser the canopy, the more surface area there is to cover and the more difficult it is for spray to penetrate. While air handling plays a significant role in improving coverage, a denser canopy will almost always require a greater carrier volume.

When two morphologically-diverse blocks share an alley ([Figure 2](#)), a two-sided, every-row sprayer should employ settings suitable for the larger of the two. It's more important to ensure good coverage on the big block than to save on the smaller. Once the hybrid row is sprayed, settings should be modified to suit the block.



Figure 2. When two blocks with different canopy architecture share an alley, sprayer settings should be suitable for the larger of the two.

For most perennial crops, canopy density changes over the growing season. The influence of age and staging on canopy size and density will depend on the crop variety, plant health and canopy management practices. The practical implication is that as the canopy grows and fills it typically warrants an increase in spray volume. As illustrated in [Figure 3](#), the volume used should reflect the current stage of canopy development. If a volume suitable for the densest and largest stage of development is used all season, it will create a great deal of waste early in the season. However, if volume is increased incrementally to reflect canopy growth, a better fit between coverage and volume will minimize waste.

In [Figure 3](#), volume is increased around petal fall, but the fit could be improved with more increments. Caution is advised to ensure the volume is raised (if required) prior to immediate need, particularly during key developmental stages like bud break or bloom where fungicide coverage is critical.

There are exceptions to this rule:

- Many nursery crops and mature evergreens often do not require changes to volume.
- High density apple orchards may or may not require an increase in volume.

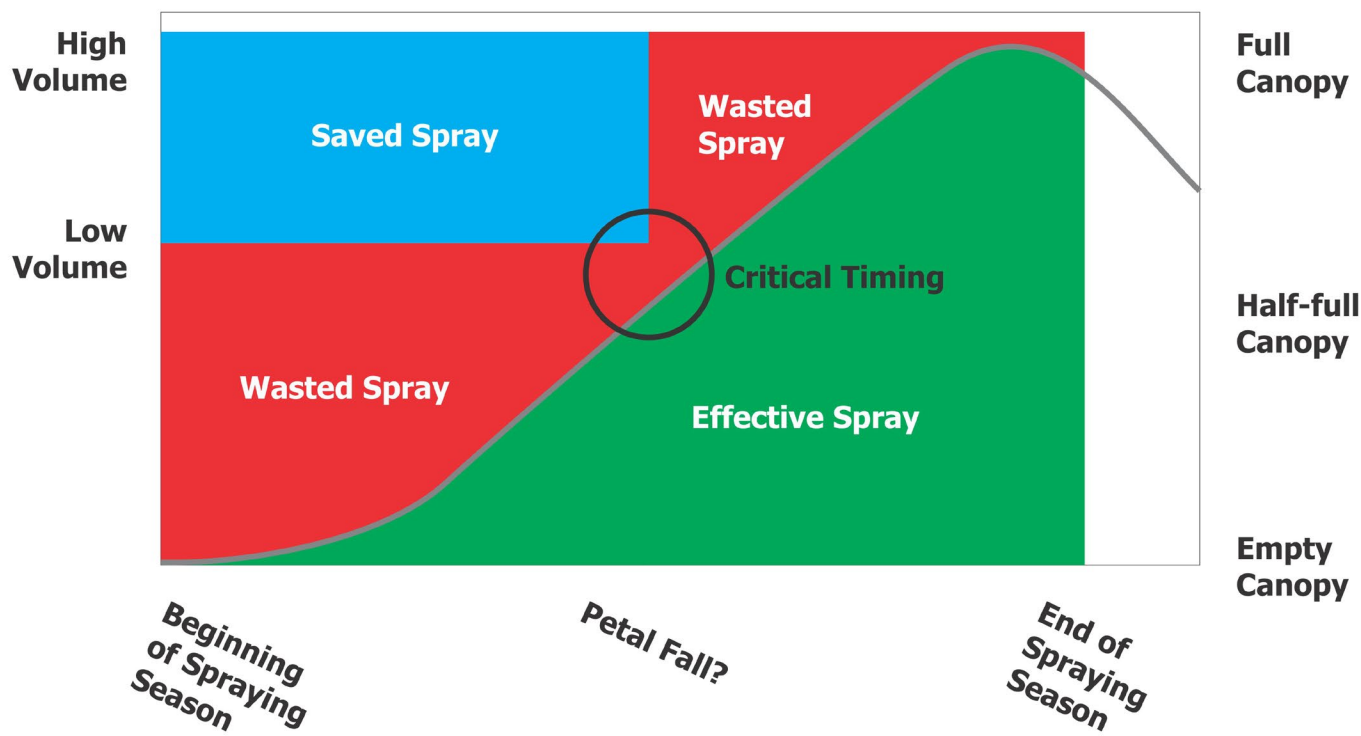


Figure 3. The curved line represents the leaf area in a canopy (Y-axis, right) increasing over the growing season (X-axis). The volume of the spray (Y-axis, left) providing effective coverage is indicated in green. Spraying the same volume throughout the season means a lot of over-spray (red) early in the season. The target simply isn't there yet. Using less volume early season and changing about midway through the season, or as required by canopy development, has the potential to save a lot of spray (blue) without compromising spray coverage. Note that the first volume should give sufficient coverage to reach mid-season, and the second volume should be sufficient to reach the end of the spraying season. Always err on the side of excessive coverage to buffer against the impact of unanticipated variables.

Early in the season, sparse canopies have low profiles that result in very low catch efficiencies. In other words, a great deal of spray misses the target. The amount of waste is a function of the application equipment design and the weather conditions. Most low-profile axial airblast systems envelop the target in spray with limited means of reducing air energy sufficiently, or to turn off the spray between trees. Further, sparse canopies do not restrict wind, which means ambient wind speed tends to be higher early in the season compared to when the trees become wind breaks. This creates a drift-prone situation and higher volumes are often used to compensate for the loss. The collective result is that excess spray volume is inevitable early season. As the canopies fill, the wind is reduced and catch efficiency

increases, so trees intercept more spray without having to raise volumes. This balance eventually tips, however, and an increase in volume may be advisable.

Adjusting spray volume settings to reflect the canopy can save money and reduce environmental impact during early-season applications and in young plantings. Mix the tank as you normally would to maintain the pesticide concentration on the label, but adjust the sprayer output to match the plant size.

Performed correctly, you will be able to go further on a tank without compromising efficacy. This crop-adapted spraying method and the relationship between spray volume, concentration and dose are described further on Sprayers101 (in [this article](#) and [this article](#)).



Estimating Volume From Canopy Geometry

It is challenging to decide on an appropriate spray volume. Many operators resort to historical or regional practices and do not make adjustments to reflect their specific situation. Others refer to models such as Tree Row Volume (a.k.a. Canopy Row Volume) which relates canopy volume per planted area to spray volume. In this case, catch efficacy is expressed as a coverage factor, which is determined through experimentation specific to the crop, environment and sprayer.

$$\text{Tree Row Volume} = (\text{Avg. Canopy Height} \times \text{Avg. Canopy Spread} \times \text{Planted Area}) \div \text{Row Spacing}$$

$$\text{Spray Volume} = \text{Tree Row Volume} \times \text{Coverage Factor}$$

In New Zealand, coverage factors for dilute applications to deciduous canopies range from 0.007 to 0.1 L/m³ (0.00052 to 0.00075 US gal/ft³). The range captures variation in canopy density and any product-specific coverage requirements. Oil sprays, for example, require more surface coverage than most products. While closer to “the truth”, the Tree Row Volume method is still only an estimate.

If the operator has no prior experience with the crop or the sprayer and wants a sanity-check on their estimated spray volume, we propose the following guidelines for full canopy dilute application to mature crops using every-row traffic patterns. The volumes may seem high, but recognize we have selected a very challenging scenario.

- Small canopies (E.g. bush, vine, cane, high-density fruiting wall): 500 L/ha (55 US gal./ac.) to 1,000 L/ha (110 US gal./ac.).
- Medium canopies (E.g. tender fruit, pome): 750 L/ha (80 US gal./ac.) to 1,250 L/ha (135 US gal./ac.).
- Large canopies (E.g. tree nut, citrus): >2,000 L/ha (214 gal./ac.) and up to 7,000 L/ha (748 US gal./ac.).
- For sprayer operators that think in 100 m row lengths, consider 20 L volume per 100 m row length per 1 m canopy height.

Further Resources

SPRAYERS101

- [Perspective on rates, volumes and coverage](#)
- [How to evaluate airblast coverage](#)
- [Assessing airblast coverage](#)
- [Diagnosing airblast coverage](#)

Fruit Notes

- [Spray mixing instructions considering tree row volume](#)

New England Winter Fruit Meeting

- [Tree Row Volume: What it is, why it matters and how to use it](#)

Thanks to [Mark Ledebuhr](#) of Application Insight LLC for his contributions to this article.

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Tank Mixing Update: Implications for User of Pest Control Products

Josh Mosiondz, Minor Use Coordinator, OMAFA

*This article was previously written and released in April 2023. The Pest Management Regulatory Agency's tank mixing policy is **set to take effect on December 22nd, 2024**, meaning all protective applications made in the 2025 field season and beyond **must be made in accordance with the new rules set out by this policy change**. Ensure you review all crop protection product label statements to ensure compatibility when placing your orders for the 2025 field season.*

Tank mixing, a practice commonly performed by growers across the agricultural spectrum, is an important practice used to reduce the number of sprayer passes per season, prevent resistance development, and to improve product performance.

Health Canada's Pest Management Regulatory Agency (PMRA) recently announced clarifications to the tank mixing policy in a new guidance document on December 22nd, 2022, entitled "[PMRA Guidance Document Tank Mix Labelling](#)".

Previously, products could be tank mixed if there were no restrictions on any of the partner labels. Under the updated policy, a tank mix can only be applied if the partner labels specifically allow tank mixing. This could appear on the label in one of two forms given below. Additional instructions such as mixing order, or instructions for performing compatibility testing such as the jar test method may also be included in these statements.

Option 1: The label specifically identifies permitted tank mix partners (e.g., "Product X may be tank mixed with products A, B, and C" ...);

OR

Option 2: The label includes a general tank mixing statement (see below) which permits tank mixing as

long as both tank mix partner labels include the statement. Note that product labels may contain both the general tank mixing statement and a specific list of tank mix partners.

"This product may be tank mixed with (a fertilizer, a supplement, or with) registered pest control products, whose labels also allow tank mixing, provided the entirety of both labels, including Directions For Use, Precautions, Restrictions, Environmental Precautions, and Spray Buffer Zones are followed for each product. In cases where these requirements differ between the tank mix partner labels, the most restrictive label must be followed. Do not tank mix products containing the same active ingredient unless specifically listed on this label.

In some cases, tank mixing pest control products can result in reduced pesticide efficacy or increased host crop injury. The user should contact [insert registrant name] at [insert contact information] for information before applying any tank mix that is not specifically recommended on this label".

- PMRA's generic tank mixing label statement as per Tank Mixing Labelling Guidance Document 2023.

It is also important to note that some product labels might have an exclusionary statement that specifically does not allow tank mixing (e.g., Do not mix or apply this product with any additive, pesticide or fertilizer except as specifically recommended on this label). If a product's label contains this type of exclusionary statement, then it can only be tank mixed with the specific tank mix partners appearing on its label. To help guide interpretation of the label statements related to tank mixing, the guidance document includes a table to describe various scenarios and whether or not tank mixing would be allowed ([Table 1](#)).

Registrants are required to update their labels to align with these changes within two years of the publication date of the guidance document (i.e., by December 22, 2024). Likewise, according to a March 17, 2023, update to the guidance document, sprayer operators can continue their current tank mix practices during the two-year transitional period. On December 22, 2024, the PMRA policy will be in full effect; All practices, labels, marketing materials and educational materials must then be consistent with the new policy.



Table 1. Permissibility of tank mixing based on various combinations of label statements related to tank mixing

Product X label says	Product Y label says	Can I tank mix? (Y/N)
Nothing (silent on tank mixing)	Nothing (silent on tank mixing)	N
General tank mix statement	Nothing (silent on tank mixing)	N
Nothing (silent on tank mixing)	General tank mix statement	N
General tank mix statement	General tank mix statement	Y
General tank mix statement	Tank mix with Product X	Y
Tank mix with Product Y	General tank mix statement	Y
Tank mix with Product Y	Nothing (silent on tank mixing)	Y
Nothing (silent on tank mixing)	Tank mix with Product X	Y
Tank mix with Product Y	Tank mix with Product X	Y
Tank mix with Product Y	Exclusionary statement (and label does not include a specific Product X tank mix)	N*
Exclusionary statement (and label does not include a specific Product Y tank mix)	Tank mix with Product X	N*

* There may be registered labels that have tank mix scenarios like this. Note that this is not allowed for new tank mix label amendments. Further, any product labels that have tank mix scenarios like this must be amended to alleviate the contradictory scenario. To do this, using the last scenario in Table 1 as an example, one of the following must occur: 1) remove the Product X tank mix from the Product Y label, 2) remove the exclusionary statement from the Product X label, or 3) add a specific tank mix for Product Y on the Product X label. Source: PMRA Guidance Document Tank Mix Labelling 2023

For growers, and other users of pest control products, this effectively means they may continue to tank mix as previously done for the 2023 and 2024 field seasons. However, when ordering and purchasing product in late fall 2024 and winter 2024-2025, users will need to ensure that desired tank mix partner labels permit tank mixing with each other to ensure their pest control product sprays applied in 2025 comply with the new guidelines.

Parties affected by this new policy change are encouraged to review the [guidance document](#) in its entirety for a full explanation and further detail on these changes. For any outstanding questions you may have regarding these new guidelines after reviewing the guidance document, please contact the PMRA Info Service at pmra.info-arla@hc-sc.gc.ca.

Further information on tank mixing practices can also be found on the [Sprayers101](#) website.

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Ambrosia Beetle in Ontario: Species Insights and Their Impact on Apple Orchards

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFA
Justin Renkema, Entomologist, AAFC Vineland

Not So “Boring” Problem

Ambrosia beetles are a group of bark beetles that can attack and kill young fruit trees. Although these beetles typically attack trees under physiological stress such as flooding, winter injury or those weakened by pests, some species in this complex can attack apparently healthy trees. Three species, in particular - *Xylosandrus germanus*, *Xylosandrus crassiusculus* and *Xyleborinus saxesenii*, have been causing substantial damage in high-density apple orchards in northeastern US.

In general, the adult beetles are small, about 2 to 3 mm in length. In the springtime, mated females leave their overwintering sites in search of new trees to colonize. Females bore into the trunk or branches to create tunnels and branched chambers called galleries where her developing brood will grow (Figure 1). New mated females emerge from these tunnels early to mid-summer and bore into new trees. This generation typically overwinters. However, new evidence suggests a partial 3rd generation in New York¹.



Figure 1. Cross section of a young apple tree with ambrosia beetle within a gallery. (Photo: L. Tee²)

Fungus Farmers

Ambrosia beetles do not digest the woody tissue of host plants. Instead, the beetles have an *obligate mutualistic relationship* – species are entirely dependent on each other – with a group of ectosymbiotic fungi called ambrosia (hence their name – nothing to do with the Ambrosia apple!!). Ambrosia fungi are carried into the gallery on the beetle's body when she colonizes the tree and becomes the food source for both the female and her developing brood. The presence of the fungi disrupts the nutrient and water flow in the tree, causing sap to collect at the gallery surface (Figure 2).

The ambrosia fungi alone do not kill a tree; however, the combination of high beetle density and fungal activity can cause wilting and eventual tree death. The secondary introduction of other plant pathogens such as fire blight or black rot into these beetle galleries can also cause tree decline.

While signs of infestation in an orchard can be challenging to find, common symptoms include small D-shaped entry / exit holes (1 mm diameter) (Figure 3), often with oozing sap, discoloured or blistering bark, and sawdust “toothpicks” from tunnel excavations that protrude from the holes (Figure 4). Some growers have reported that heavily infested trees appear to spontaneously collapse, failing to leaf-out in the spring or wilting in season (Figure 5).

Unusual Suspects

In surveys since 2016 using slow-release ethanol traps along orchard perimeters (Figure 6), several species of ambrosia beetle have been identified in Ontario apple growing districts, including:

- *Xylosandrus germanus* (black stem borer)
- *X. crassiusculus* (granulate ambrosia beetle)
- *Xyleborinus saxesenii* (fruit tree pin-hole borer)
- *X. attenuata* (no common name)
- *Anisandrus dispar* (European shot-hole borer or pear blight beetle)
- *A. maiche* (no common name)
- *A. sayi* (no common name)



Figure 2. Ambrosia beetle infestation can cause sap to ooze from gallery surface.



Figure 4. Sawdust "toothpicks" protruding from small entry holes caused by ambrosia beetle.



Figure 3. Signs of ambrosia beetle infestation can include small entry holes (1 mm diameter).



Figure 5. Collapsing apple trees heavily infested with ambrosia beetle.



Figure 6. Slow-release ethanol trap used to collect ambrosia beetle.

Of the species collected from Ontario orchards, 95% of all captures are *X. germanus*, *X. saxesenii* and *A. maiche*.

Suspect 1: Black stem borer (*X. germanus*)

Black stem borer ([Figure 7](#)) is an invasive species from Asia, though has been detected throughout North America since 1932. This has been a long-standing pest of ornamental or fruit trees, particularly nurseries. Black stem borer prefers stressed trees but can attack healthy ones.



Figure 7. Black stem borer, *Xylosandrus germanus* (Photo: J. Hulcr³)

Suspect 2: Fruit tree pinhole borer (*X. saxesenii*)

Fruit tree pinhole borer ([Figure 8](#)) is originally from Europe / North Asia but can be found worldwide in temperate regions. With an extensive host range, this borer has been considered a pest by some experts, but others have found it only in dead wood.



Figure 8. Fruit tree pinhole borer, *Xyleborinus saxesenii* (Photo: J. Hulcr³)

Suspect 3: *A. maiche*

The newer invasive is *A. maiche* – no common name yet ([Figure 9](#)). This species originates from China, East Russia and Korea. It has been in North America since at least 2005 and Ontario since 2013. Its appearance is similar to the black stem borer which makes identification tricky and was reported in dying apple trees in New York this year⁴.



Figure 9. Unnamed ambrosia beetle species, *Anisandrus maiche* (Photo: J. Hulcr³)

Finding the Action

Regional activity

In the regional surveys conducted in 2019 and 2021, the distribution of these three main ambrosia beetle species was relatively similar across observed regions



in Ontario (Figure 10 & 11). The exception was in 2019 in the Niagara region (District 4) where fruit tree pinhole borer was 30% of the total catch. In general, fruit tree pinhole borer was more common in Niagara than in other apple growing regions. Collections were not made in District 3.

The phenology, or flight activity of black stem borer was quite different between 2019 and 2021 (Figure 12 & 13). In 2019, there was a small spring emergence followed by a much larger summer emergence mid-July to late August for some regions. Whereas in 2021, the spring emergence was large, and the summer emergence was almost negligible.

The same trend was true for fruit tree pinhole borer in Niagara. It's likely that larger weather and climatic variables are driving differences in phenology between years, and understanding or predicting emergence patterns would be helpful for management.

For *A. maiche*, the main emergence peak tended to be towards the end of the summer in both years surveyed at all regions. This could mean that management timing of *A. maiche* would be at a different time of the season than for black stem borer.

We are currently working through species identification from ambrosia beetle collected during 2024. Based on the flight activity from each growing district, most regions likely saw primarily black stem borer (Figure 14). However, more information on this to come!

Edge effect

Ambrosia beetle has often been described as a perimeter pest of orchards, moving in from adjacent landscape. To study this, slow-release ethanol traps were hung along the edge and within the interior of orchards in District 1 and 2 in 2019 and 2021.

In both locations, there were 2 times more black stem borer and *A. maiche* captured along edges than in the interior in both years (Figure 15). However, edge traps did not appear to capture ambrosia beetle earlier than interior traps.

Location, location, location

In 2024, we investigated if there was a difference in the number and species of ambrosia beetle emerging from different parts of infested trees. Ambrosia and Gala cultivars on M9 and G11 rootstock were sampled from 2 orchards with high ambrosia beetle pressure.

Each tree was divided and sampled into 3 parts:

- Rootstock that was above ground, cut at graft union (5-23 cm from soil)
- Lower trunk (first 30 cm)
- Upper trunk (38-112 cm)

Over 3500 beetles from 30 trees were collected, with an average of 128 beetle per tree. Overall, the average beetle density in rootstocks was 5 and 10 times higher than in lower and upper trunks, respectively (data not shown).

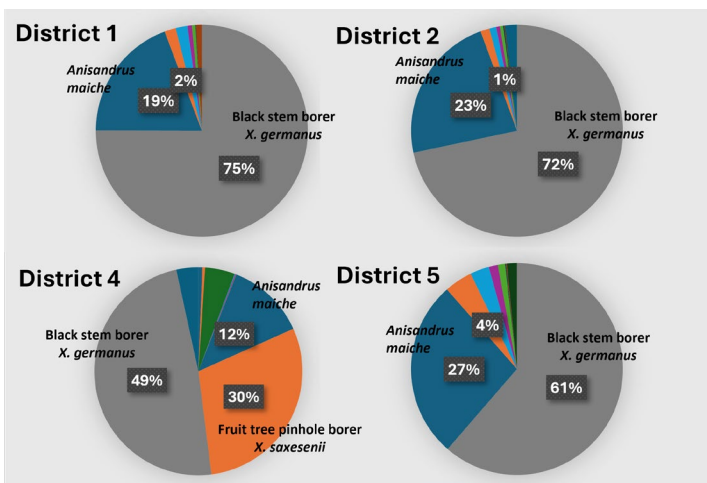


Figure 10. Ambrosia beetle species by apple growing district, 2019

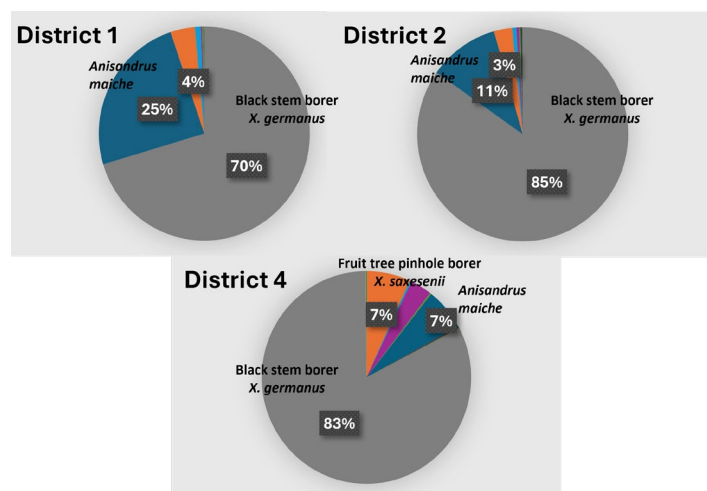


Figure 11. Ambrosia beetle species by apple growing district, 2021

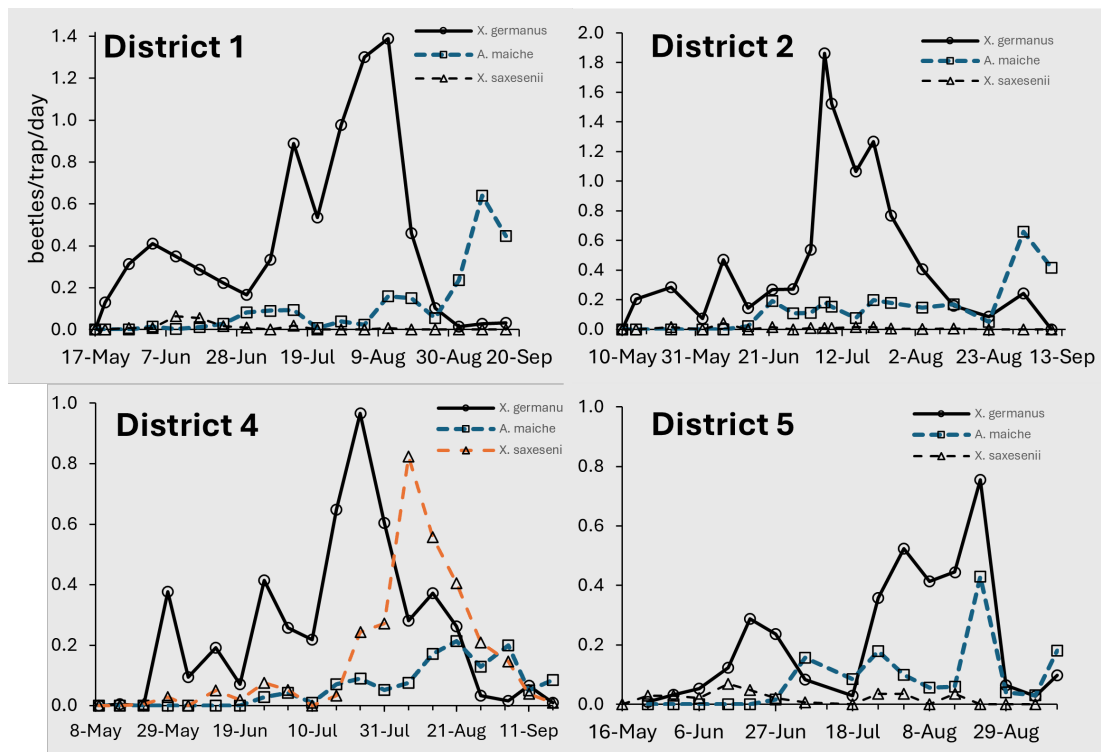


Figure 12. Ambrosia beetle trap captures (by species) by apple growing district, 2019

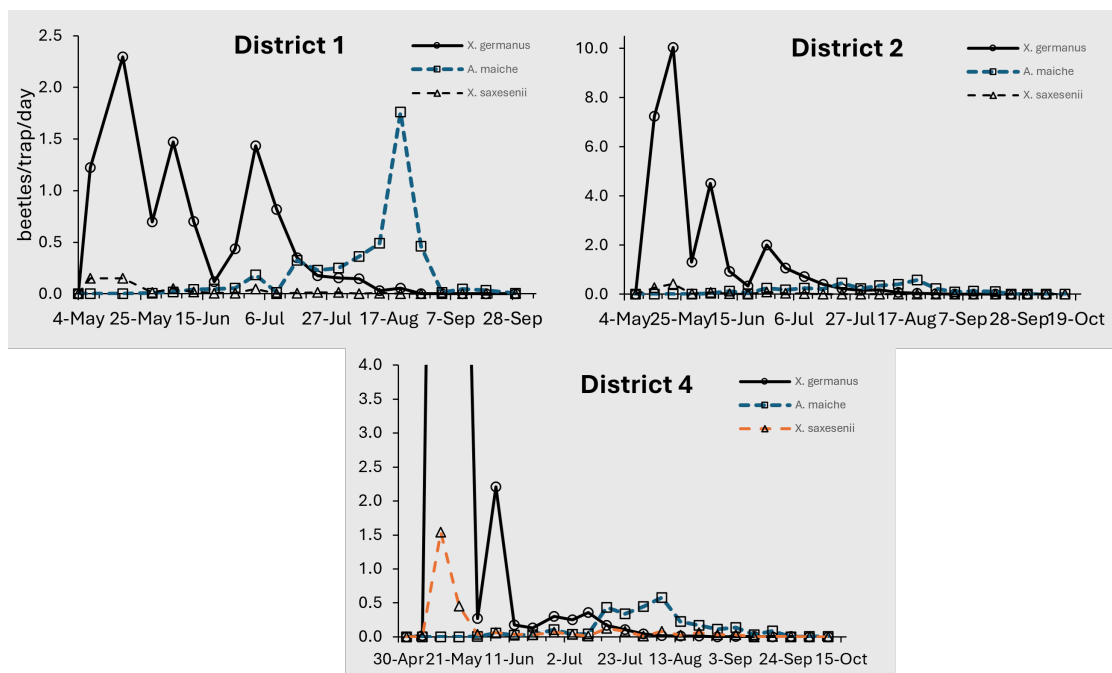


Figure 13. Ambrosia beetle trap captures (by species) by apple growing district, 2021

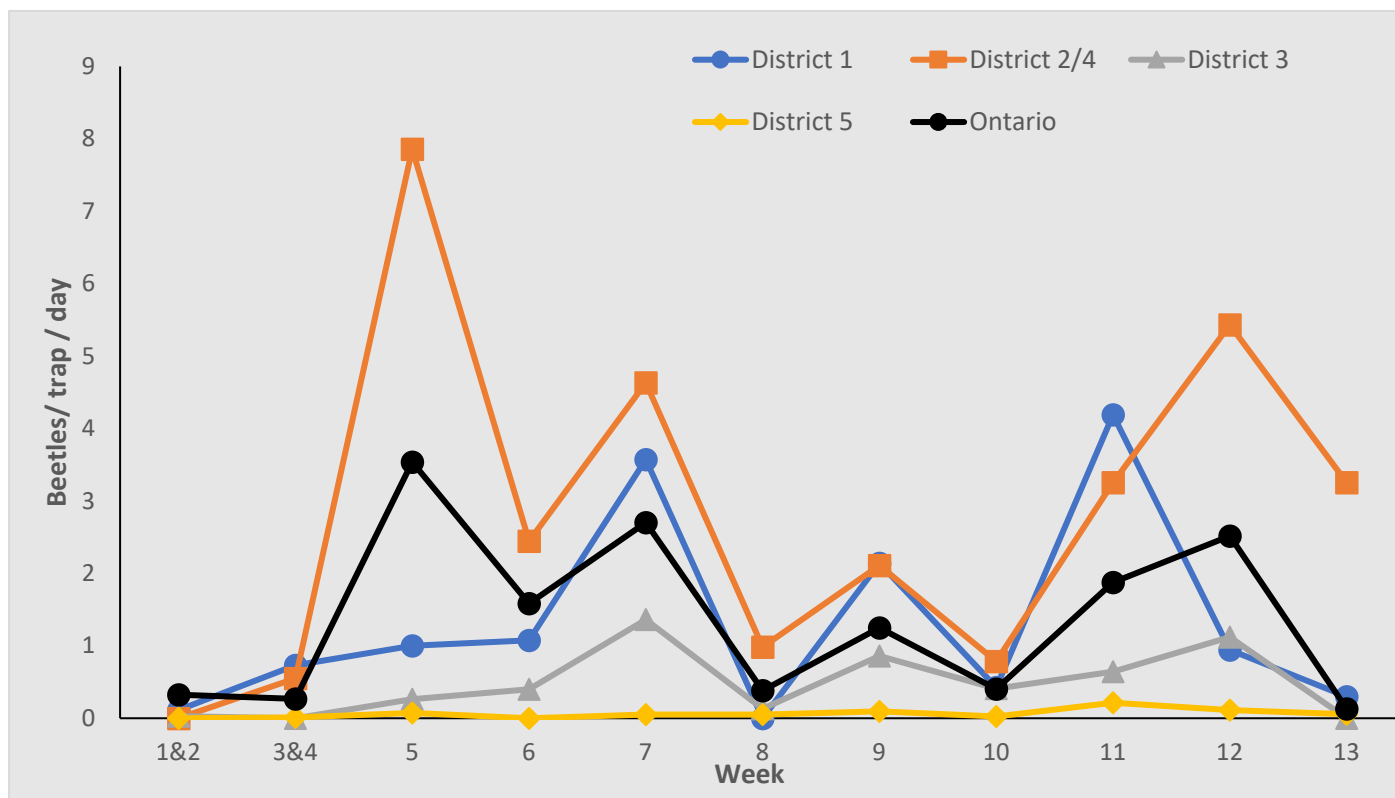


Figure 14. Ambrosia beetle trap captures by apple growing district, 2024

However, if we look at the distribution by species, black stem borer was more abundant in trees (similar to 2023 samples not presented here) and more equally distributed in the tree than the *Xyleborinus* spp. (Figure 15).

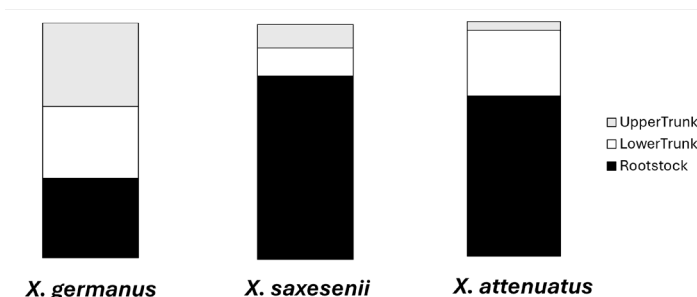


Figure 15. Total number of ambrosia beetle species, *Xylosandrus germanus*, *Xyleborinus saxesenii* and *X. attenuatus* in 3 sections of apple tree: rootstock, lower trunk and upper trunk (n=3500 beetles).

So, What to Do?

Unfortunately, trunk sprays have limited effectiveness since beetles spend the majority of their lifecycle inside

the tree. Preventative application of repellents (e.g., pyrethroids) may deter or kill females as they attempt to find a host and excavate new galleries.

Understanding the species present in an orchard will help determine appropriate timing for application. Regular monitoring of beetles is required to determine early and peak activity periods of those species causing damage.

In the absence of registered insecticides to target colonizing females, the only management strategy we have available in Ontario is the removal of dead branches and dying trees. Since beetles will complete their life cycle inside the wood of the tree, all infested tissue should be burned.

Maintaining tree health, such as proper irrigation, good fertility and management of pests can prevent beetle colonization as well as help trees with low levels of infestation to recover.

This project will continue to look at contributing factors



to ambrosia beetle infestation in orchards as well as potential management strategies for this pest.

Acknowledgements

We would like to thank our project collaborator, Hume Douglas (Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, ON), technical support from AAFC and OMAFA technicians and students as well as participating growers.

Funding has been provided by:

- Sustainable Canadian Agricultural Partnership
 - Horticulture Cluster (2023-2028)
 - Surveillance, Monitoring & Diagnostics (2024)
- AAFC AgrilInnovate Program (2018-2021)

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² Breth, D., Agnello, A., Cox, K., Tee, E. & Warren, H.R. 2015. Black Stem Borer - A New Pest in Apples. *Proceedings from the Empire State Producers Expo*. Syracuse, NY.

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⁴ Tobin, K.N., Moore, M.E., Lizarraga, S., Petzoldt, J., Reese, C., Lovett, B. & Rivera, M.J. 2024. First report of *Anisandrus maiche* (Coleoptera: Curculionidae: Scolytinae) infesting apple trees. *Zootaxa*, 5506(2): 261-271.



Gnaw & Order: Strategies to Mitigate Rodent Damage in the Orchard

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFA

With the cool weather, comes the return of rodents back into the orchard as their summer food supply is depleted. Every year, voles (mice) and rabbits can cause significant economic injury to trees. They typically establish a system of surface runways and underground tunnels, in the case of voles.

Critter Clues

Look for indications of rodents in the orchard, such as girdling of bark, burrowing, droppings, or chewed apples. Though often kept in check by their many natural predators, it is possible for populations to increase quickly if access to shelter, food and protection is readily available.

In fall and winter, rodents feed on the bark, particularly on young trees ([Figure 1](#)). The feeding injury is often more extensive in winters with continuous, prolonged snow cover. Complete girdling of the trunk will kill the tree. Depending on snow depth, rabbit damage can occur higher on the trunk or lower scaffolds ([Figure 2](#)). Voles, such as pine voles which burrow underground, feed mainly on rootlets and strip the bark off larger roots. It's possible damage to roots can be worse than the visible damage above the ground.

Managing the Menace

Rodents need shelter, food and protection from predators to survive. Manage populations by eliminating one or more of these requirements. There are several cultural or physical management options to consider:

- Mow grass to 8–15 cm. Avoid using a sickle-bar mower, which may produce a thatch layer that provides cover for voles.
- Remove all mulch, prunings, apples and other debris around the base of trees, in tree rows or adjacent to the orchard to limit potential shelter areas.
- Use tree guards to protect the bark of newly planted



Figure 1. Rodent damage around base of tree can result in girdling, reduced vigour and eventual tree death.

trees. Extend the guards at least 45 cm above the soil level and minimum 5 cm below. Keep in mind, when snow is deep, guards generally don't give protection against rabbits.

- Ensure guards are not interfering with trunk expansion.
- Use light coloured guards as dark materials increase the temperature of bark on sunny days in winter, leading to potential injury if temperatures drop at night.
- Maintenance of guards is important if left on the tree in subsequent years. Litter and debris can build up inside loose guards providing good shelter and habitat for voles and insect pests such as dogwood borer.



Figure 2. Rabbit damage can occur higher on the trunk during winters with deep snow.

- Repair or replace loose guards.
- Clean out debris in the spring and fall.
- White exterior latex paint on trunks and lower scaffolds protects against southwest or winter injury or herbicide damage but does not prevent rodent damage if used alone (*Figure 3*).
- Repellents can be mixed into paint to give an undesirable odour or taste to discourage feeding. Unfortunately, the more common repellent, Skoot is not widely available after the cancellation of thiram production for disease control. Alternatives to Skoot are available such as essential oils. However, repellents in general can have reduced efficacy long-term.



Figure 3. Rodent damage can occur on young trees painted with white latex paint only.

- While trapping is not effective for controlling high populations, it can be used to monitor or control small populations.
- Shooting rabbits can help keep numbers low, but first consult with local authorities regarding firearm bylaws and regulations.

Battling with Bait

Where other practices are insufficient, toxic baits are available for use against voles in orchards. Always speak to your local Ontario Ministry of Natural Resources office and check the label to ensure the product can be legally used. Growers and landowners are responsible for ensuring all relevant legislation is followed.

- Use mouse baits (rodenticides) where voles have caused damage in the past or are likely to be found in the winter (e.g., near brush piles, woodlots, hedgerows or fences). Begin baiting before there is significant snow cover.



- Bait stations are most effective if dropped apples are picked up and removed from the orchard before first snowfall.
- Alternate between a zinc phosphide bait and an anticoagulant bait to prevent voles from becoming bait shy and avoiding bait for a period of months.
- Use bait stations to extend the life of the bait and create a safe haven for rodents to feed. Bait stations will also keep poisonous bait out of reach of pets and other non-target animals.
- An inverted T bait station (Figure 4) made of 3.8 cm (1.5-inch) ABS pipe is the most common type of bait station available. In this station, place several spoonfuls of bait in the neck, which is capped to protect the bait from the elements. Longer necks can be used in areas where there is substantial snowfall. Set about 25 stations/ha (10/acre).
- Check stations regularly to monitor the disappearance of bait.
- Some baits can be broadcast below the grass cover around the base of trees. However, use this method with caution to prevent exposure to non-target animals. Refer to specific directions on the label for more information.

Safety First!

It is important to handle poison baits safely. Consider the following points when carrying out a vole management program:

- Use only baits registered for use on targeted rodent and in apple orchards.
- Mark all poison bait storage containers POISON.
- Store poison baits away from children, pets and livestock.
- Do not inhale zinc phosphide dust or fumes.
- Do not keep bait containing zinc phosphide in a building used by people or animals.
- Do not use bait mixing equipment or bait application equipment for any other purpose.

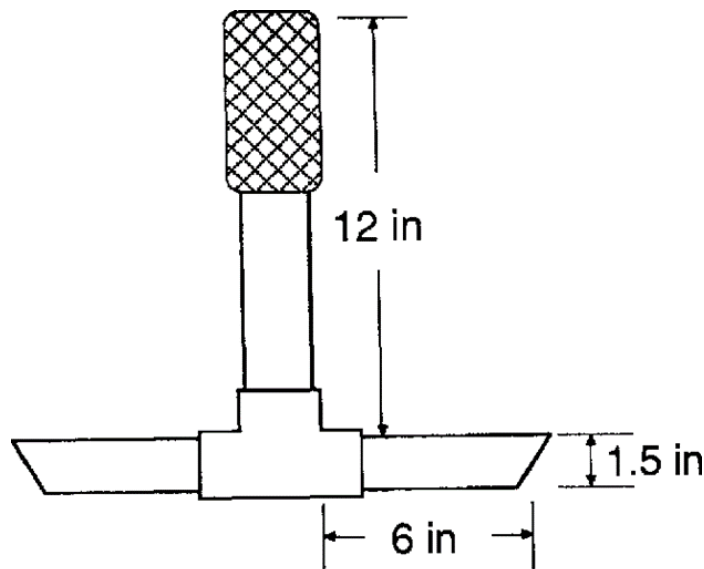


Figure 4. Standard design for an inverted T bait station. (Tobin & Richmond, 1987)

- Wear rubber gloves or other protective gloves when handling bait, as you would when handling hazardous insecticides.
- Wash your hands after handling poison baits.
- Keep dogs and cats that are enthusiastic mousers away from the nursery for at least 2–3 days to prevent them from catching dying mice.
- Do not handle dead mice or voles with your bare hands.
- Dispose of dead mice and voles away from human and animal contact.

References

Tobin, M.E. & Richmond, M.E. (1987). Bait stations for controlling voles in apple orchards. Eastern Wildlife Damage Control Conference.

POSTHARVEST

Effects of Harvest Maturity and Storage Temperature on Internal Browning and Firmness Retention in 'Ambrosia' Apples

Dr. Jennifer DeEll, Fresh Market Quality Specialist, OMAFA

Optimum harvest maturity for long-term storage of 'Ambrosia' apples has been determined to be when background color still shows more green than yellow and delta absorbance readings (IAD from DA meter) are around 0.7 to 0.5. 'Ambrosia' with IAD values near 0.5 and below should not be stored for extended periods, and those with less than 0.3 should be marketed as soon as possible. Starch values from 2 to 4 can be useful in some years, but starch degradation does not always correlate with color change and other ripening processes. 'Ambrosia' produces very little ethylene during maturation on the tree, making internal ethylene a poor maturity indicator for this apple. Constant measures of <1 ppm internal ethylene concentration can be found throughout the harvest period and storage. 'Ambrosia' harvested with advanced maturity tend to become mealy and soften more rapidly, as well as develop more disorders and greasiness during storage.

The objective of this study was to evaluate the effects of 'Ambrosia' harvest timing (fruit maturity at harvest) on internal browning and apple quality in relation to storage temperature. 'Ambrosia' was harvested from the same commercial orchard and trees on September 29 (H1) and October 4 (H2). Apples were cooled overnight to either 0.5 or 3°C and then treated with 1-methylcyclopropene (SmartFresh, ~1 ppm) for 24 hours the following day. All apples were held in controlled atmosphere (CA) storage with 1.2% O₂ + 1% CO₂ for 8 months.



Figure 1. 'Ambrosia' apple with internal browning.

Harvesting 5 days later resulted in significantly more internal browning ([Table 1](#), [Figure 1](#)).

Storage at 3°C reduced internal browning, BUT also resulted in significant firmness loss compared to 0.5°C. 'Ambrosia' stored at 3°C were 1.6 and 2.3 pounds softer than those held at 0.5°C, within a day of removal from storage. Therefore, increasing storage temperature to reduce internal browning will sacrifice fruit firmness retention.

These results have led to current investigations evaluating delayed and stepwise cooling to 0.5°C.

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; as well as Sky Lesage and Younes Mostofi for their technical assistance.



Table 1. Harvest maturity and quality of ‘Ambrosia’ apples after 8 months of CA storage (1.2% O₂ + 1% CO₂) at 0.5 or 3°C plus 1 day at room temperature (RT, ~20°C).

	At harvest			8 months CA + 1 day at RT		
	Ground colour (1 – 5) ¹	IAD ²	Starch (1 – 8) ³	Storage temp. (°C)	Internal browning (%)	Firmness (lb)
H1	2.3	0.6	2.3	0.5	17	16.5
				3	0	14.9
H2	2.6	0.6	3.2	0.5	53	16.7
				3	17	14.4

¹ B.C. colour chart for ‘Ambrosia’ apples
² IAD = index of absorption difference, from delta absorbance (DA) meter
³ Starch index determined using the Generic Starch-Iodine Index Chart for Apples by Blanpied and Silsby (1992), where 1 = 100% starch staining and 8 = no starch

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 1st - Brantview Apples and Cider
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 1st - Thornbury Craft Company, Premium Apple Cider
 2nd - Stock & Row, Slow & Low
 3rd - Fielding Craft Cider Co., Dry Hard Cider
- 2024 Specialty Craft Cider**
 1st - Ardiel Cider House, Big John Lightly Hopped
 2nd - Shiny Apple Cider, Shiny Apple Cider Strawberry Chamomile
 3rd - Fielding Craft Cider Co., Hopped & Hazy
- 2024 Heritage/Traditional Craft Cider**
 1st - Thornbury Craft Company, The Jonah
 2nd - The Little Cider Company, Farmhouse
 3rd - Dirty Dog's Cider Company, Cox's Orange Pippin





ANNOUNCEMENTS



Ontario Fruit and Vegetable Convention

Wednesday Afternoon

2:00PM Effective Spraying: What Can Go Wrong and How to Get It Right

- Dr. David Manktelow, Applied Research & Technologies Ltd., New Zealand

2:30PM FUNDamentals of Fungicides

- Katie Goldenhar, British Columbia Ministry of Agriculture and Food

3:00PM The Use of Plant Growth Regulators in Apples – Why, When, and How to Use Them

- Dr. Poliana Francescatto, Valent BioSciences

3:30PM Targeting Success: Effective Spraying Practices (Panel)

- Dr. David Manktelow, Applied Research & Technologies Ltd., New Zealand
- Katie Goldenhar, British Columbia Ministry of Agriculture and Food
- Dr. Poliana Francescatto, Valent BioSciences

Thursday Morning

9:30AM Apple Market Trends & Outlook (Panel)

- Graeme Smith, Loblaw's International
- Kirk Kemp, Algoma Orchards
- Erika DeBrouwer, Ontario Ministry of Agriculture, Food & Agribusiness
- Dr. Rachael LeBlanc, Vineland Research

10:30AM Crop Protection Regulatory Updates for 2025

- Chris Duyvelschoff, Ontario Fruit and Vegetable Growers Association

11:00AM Best Storage Practices for Ambrosia, Gala, and Honeycrisp Apples

- Dr. Jennifer DeEll, Ontario Ministry of Agriculture, Food and Agribusiness

Thursday Afternoon

2:00PM Understanding Adjuvants for Improved Pesticide Application

- Dr. David Manktelow, Applied Research & Technologies Ltd., New Zealand

2:30PM Getting More Ontario Apples into the Shopping Cart

- Peter Chapman, SKU Food, Nova Scotia

3:00PM Finding Your Niche or New Market Opportunities (Panel)

- Cathy McKay, Nature's Bounty
- Glen Smyth, Appleflats

3:30PM Outbreak to Outsmart: Strategies to Manage Apple Scab

- Kristy Grigg-McGuffin, Ontario Ministry of Agriculture, Food and Agribusiness



Summer Student Employment Positions

The Ontario Ministry of Agriculture, Food and Agribusiness – Agriculture Development Branch in Simcoe (Norfolk county) and Vineland, Ontario are seeking highly motivated, enthusiastic and energetic team players. These positions will provide an excellent opportunity for those interested in a career in horticulture production, pest management, plant pathology, entomology, research, or the agricultural service sector. These positions will provide the opportunity to learn about plant diseases, insect pests and production in several fruit crop sectors within the province.

The successful candidates will be responsible for both field and office work. Field work includes setting up research plots, assessing pest populations, scouting for pest issues, recording insect trap data, conducting pest surveys, assisting in data collection and research plot maintenance in fruit crops. Office work may include data entry, improving online resources, as well as literature reviews.

Student – Agriculture Development (Horticulture Jobs)

Apply By: Saturday, January 11, 2025 11:59 pm EST

Organization: Ministry of Agriculture, Food and Agribusiness (OMAFRA)

Division: Agricultural Development Branch

City: Simcoe, Vineland

Language of Position(s): English

Job Term: Temporary for up to 18 weeks

Job Code: Student 2 – Student Level 2

Salary: \$18.05 Per Hour*

*Indicates the salary listed as per the OPSEU Collective Agreement.

Job ID: 223816

[Online Job Posting and Application Form](#)

When applying, be sure to select '**Fruit Crops**' and '**Simcoe**' and/or '**Vineland**' from the list of work preferences.

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