ONcore

For Commerical Apple Producers

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Ontario

ORCHARD MANAGEMENT

The Economic Crunch: Why It Pays to Collect & Review Your Data

Erika DeBrouwer, *Tree Fruit Specialist, OMAFRA*

The 2023 apple season has been challenging, not only in the form of variable weather conditions through the growing season, but also due to high yields and competition with other apple growing regions on the market. Apples had a bumper crop in 2023 across Canada and the United States, leading to increased pressure on Ontario apple growers, not only to provide top quality fruit, but also to remain competitive in pricing. This past season has been especially challenging given the substantial increases in costs, in the form of labour, fuel, fertilizers, crop protection products, equipment costs, amongst many other inputs.

With this substantial strain on your bottom line, it is of the utmost importance to **not only collect**, but also **to use and review your data** to adapt to the ever-changing environment of agricultural production. This is especially critical if you have already spent money and time on collecting your data – it would be a waste to not use the numbers available at your fingertips.

I want to stress that no matter how much data you collect, it is important. You can look at as many or as little factors as you want, but it is important that you look at them.

Examples

Let's say you are trying out various apple rootstocks on your farm and you want to determine which rootstock is more economically viable. Ideally, to fully compare rootstocks you would plant them by alternating rows so that other factors wouldn't be a potential cause for changes observed within the orchard, such as changes in soil type or fertility, microclimate effects, but understandably this isn't always an option and can add other complexities to the business overall. Comparisons between rootstocks by blocks can still be beneficial, but you must keep in mind these other factors when performing your assessments. A rootstock evaluation is a long-term commitment that requires annual data collection and analysis to make educated decisions about future rootstocks selections.

A list of data that you could consider collecting includes:

- **Mortality:** data on tree death over time, especially within the first 3 years is good to have. Keeping track of the number of trees that weren't planted is also important i.e. snapped graft unions, unhealthy trees, dieback etc.
- **Labour:** annual training and pruning hours. As trees age it is important to compare harvest timings as well.
- **Growth:** amount of growth each year. This is important to calculate your return on investment and the precocity (how quickly it reaches the top wire, and how soon it bears fruit) of the tree.
- **Applications:** all applications (nutrients/pesticides/PGRs), whether they be the same or different between the rootstocks. Even if all applications are the same, the tree response could be different. If applications differ, all the more reason to maintain your records and reflect on why this would be occurring.
- **Yield:** as described above, precocity could be a determinant when choosing a future rootstock. Year over year yields should also be a consideration. Within the yield aspect size, colour and volume needs to be included.
- **Return:** determining your return on investment is critical, which is why return on your yields needs to be addressed. Although these numbers may not come for some time, reviewing them alongside your season overview is a great way to compare what may have worked, and what may not have worked.

For a short-term evaluation, the comparison between hedging a few rows and not hedging a few rows could be looked at. This could be turned into a long-term data collection, but when analyzing it for one year you could collect the data and ask the following questions:

- **Growth:** comparison between the two blocks (hedged vs unhedged).
  - Will hedging increase or decrease growth throughout the season?
  - Do I want to increase or decrease growth?
  - What are my goals for next season? Do I need to encourage renewal branching?
- **Hedging Date:** depending on when you hedge (summer vs winter), tree growth is influenced.
  - Do I want to increase or decrease growth?
  - Will hedging in the winter increase or decrease growth compared to summer growth?
- **Labour:** you can assess the differences between pruning, thinning and harvest time between hedged and non-hedged rows.
  - Would hedging decrease my pruning, thinning or harvest time? Why would it?
  - How would labour be affected long-term if I continue to hedge?
- **Yield & Returns:** evaluating your bins going into storage (size, colour, firmness) and comparing that to your payout is important. Asking for details on your packout is also critical to make decisions in the future.
  - Was there a difference in fruit volume between the rows? If so, why?
  - Was there a difference in returns between the rows? If so, why?

Once this data is collected and evaluated you can ask yourself the following questions:

- Is the cost of owning a hedger worth the investment? What is my ROI?
- Do I want to continue hedging to see the implications over multiple years?
- Would hedging be worth it on multiple varieties?
- Do I have time to hedge all the blocks I want to?

A Critical Tool in your Toolbox

Data isn't often seen as a tool in your toolbox, but it very much is and is one of the most critical. Looking for common patterns and setting benchmarks alone will all you to more informed decisions and enable your operation to run more efficiently and effectively. There are 5 steps to utilizing your numbers responsibly, review Table 1 below for definitions and methods for each step.

Table 1. Steps to Utilizing Your Numbers Responsibly

Step	Definition and Task	Method(s)
Collect	Collecting your data in any method. Be sure that data collection is consistent and repeatable.	Pen and Paper Digital Tools[1] Photo Documentation
Organize	Arranging your data in a way that makes sense to you and others. Data should be easy to read and work with.	Transcribing written material Digital Tools[1] Photo albums separated by block
Analyze	Evaluating your data or having someone do this for you. Utilizing applications or programs could be of benefit. Creating benchmarks for comparative measurements.	Digital Tools[1]
Backup	Saving your data for future analysis and reference.	Photos Computer Files External Hard drive
Make Decisions	Based on the data, make informed changes that could be measured and compared in the future.	Pen and Paper Digital Tools[1] Photo Documentation

[1] Examples of some digital tools: CropTracker, Excel, Google Sheets, Quickbooks, CenterPoint, PCMars, AgSquared, Veggie Compass.

Data Collection

Collecting your data can be performed in multiple ways and there is no wrong way to collect your data, but dividing your orchard is a great start. This allows you to look at your data in chunks to better understand on a smaller scale what is happening within your operation. Whether this division is by block, variety, and/or tree age — as long as it makes sense to you, the data collector, and the data dissector, that is what matters.

Below is Table 2 suggesting data that can be collected throughout the year. This is not an extensive list, which showcases that there are many areas that can be focused on to add value to your operation.

Digital tools can aid you in your orchard management, as many tools would collect and organize this information, but no matter how you collect the data, be sure to look back at it and evaluate how much you are spending on specific tasks. This will enable you to make data-driven changes that will save you time and money in the long-term, along with allowing you to pivot based on seasonal changes.

As Alison DeMarree stated in her presentation at OFVC ***"You cannot manage what you do not measure"***.

For more information on how to begin a digital farm strategy, please look at the resources listed below.

Developing a Farm Digital Strategy 1 ☺— Introduction | Ohioline (osu.edu)

Developing a Farm Digital Strategy 2 — Precision Technology and Data Generation | Ohioline (osu.edu)

Developing a Farm Digital Strategy 3 — Data Management Considerations | Ohioline (osu.edu)

Table 2. Task Data Collection Breakdown

Task	Task Specific Data Collection	Benefit	Repetition of Collection
		GPS Mapping	
Orchard Map	Visual of orchard based on blocks, varieties, ages	Allows access for information sharing i.e. scouts, employees Enables you to analyze bite-sized data based on specific blocks	When changes are made
Soil Mapping (Soil type, structure etc.)	–	Enables better orchard planning • Irrigation setup, row length, block sizes, potential problem areas (low spots) Aids rootstock and varietal selection Aids in tiling decisions	Once
		Maintenance & Applications	
Spraying (all chemistries i.e. pesticides, PGRs, nutrients)	Track passes Chemistry history	Easily accessible for auditing parties Allows for future adjustment of chemistries based on the season Comparison data (rates, timings, weather, and respective affects) *Could save money on future spray applications* *Could save time for auditing parties and employees*	Throughout year
Annual Season Report	Weather Growth Staging	Comparison data (yield, pricing, hours, spray records) *Could save money on spray applications and employee hours*	Throughout year
		Labour	
Pruning	Hours based on block Pruning history	Comparison data (quantity, quality, harvest hours) Enables adjustment of future crop load decisions *Could save money in employee hours*	Annual
Harvest	Hours based on block Location Quantity Quality Price	Comparison data (spray applications, pruning hours) Allows for spray adjustments Enables better labour resources allocation *Could save money in employee hours*	Annual

Blossom Thinning Honeycrisp with Lime Sulphur and Ammonium Thiosulphate (ATS)

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Introduction

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

There is increasing grower interest in thinning multiple times during the spring, starting with judicial pruning, followed by blossom thinning, fruitlet thinning, and finally touch-up hand thinning if necessary. Many growers are already doing this with the overall goal of early thinning to enhance flower bud initiation for the following season's crop, and to reach a target crop load with minimal hand thinning. Managing the crop load of apples remains a significant challenge to producers, in part because of the unpredictability of fruit set, fruitlet abscission, and plant response to thinning compounds.

My research program has conducted blossom thinning experiments over the past decade and decided to revisit these efforts with studies on 'Brookfield Gala' in 2020 and 2021 (see *Orchard Network Newsletter, February 2022, Vol 26, Issue 1*) and on 'Honeycrisp' in 2022 and 2023. The objective of this trial was to evaluate the efficacy of blossom thinning with lime sulphur (LS) and ammonium thiosulphate (ATS), in combination with carbaryl applied at ~10 mm fruitlet thinner. In these experiments we used the pollen tube growth model (PTGM) to time applications of LS and ATS. This report summarizes results from the 2022 and 2023 'Honeycrisp' trials.

Experimental Details

In 2022 and 2023, a block of 'Honeycrisp'/Bud 9 trees planted in 2018 and located at the University of Guelph Horticultural Experiment Station, Simcoe, ON was used for this study. Trees were spaced 1 m x 4 m (2500 trees/ha) and trained to a spindle solid hedgerow orchard system. Treatments consisted of:

1. Untreated control
2. Hand thinned control (flower clusters were singled, fruit spaced ~10 cm apart)
3. 1500 mg/L carbaryl applied at 12 mm king fruitlet diameter
4. 2% ammonium thiosulphate (ATS) at bloom
5. 2.5% lime sulphur (LS) combined with 2% (v/v) mineral oil at bloom
6. 2% ATS at bloom followed by 1500 mg/L carbaryl applied at 12 mm king fruitlet diameter
7. 2.5% LS combined with 2% (v/v) mineral oil followed by 1500 mg/L carbaryl applied at 12 mm king fruitlet diameter.

Commercial products used in this study:

- Carbaryl: Sevin XLR contains 466 g/L carbaryl Tessenderlo Kerley Inc., Phoenix, Arizona
- ATS: 12-0-0-26S Norwich Fertilizer, Norwich, ON (Liquid formulation)
- Lime Sulphur: Lime Sulphur, 30% calcium polysulphide, Loveland Products, Cananda Inc., Dorchester, ON
- Mineral Oil: Purespray Green Spray Oil 13E, Intelligro, Mississauga, ON

Disclaimer: *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.*

All spray treatments included 0.05% Regulaid® non-ionic spray adjuvant. The experimental design consisted of a randomized complete block with 5 replications in 2022 and 6 replications in 2023. All sprays were applied using a commercial air blast sprayer at 1379 kPa, at approximately 350 L/ha, which equated to tree-row-volume (TRV) pesticide dilute. To minimize treatment interference caused by spray drift, experimental units were separated by at least one guard tree.

Pollen Tube Growth Model

A propriety computer model known as the pollen tube growth model (PTGM), was used to time when to apply and re-apply the blossom spray[1,2]. Using cultivar specific style length and pollen growth rate, the model predicts the time required for the flowers to be fertilized after the pollen reaches the flower stigma. In addition, the predicted time to apply blossom thinners is based on the desired number of flowers to be fertilized per tree, which is approximately 25% higher than the target number of fruit per tree.

Blossom thinners were applied at approximately 30% full bloom when a target number of king flowers were open but prior to any significant number of lateral flowers opening (Figure 1). Blossom sprays were repeated 71 h later (2022) and 124 h later (2023). Although the PTGM is available for use in the Great Lakes region at NEWA, it is not readily available in Ontario. However, it can be accessed by subscription to RIMPRO.

Fruitlet thinners were timed by periodically measuring the longitudinal diameter of 50 king and 50 lateral fruits (5 fruits of each across 10 trees) using digital calipers. The date of full bloom was 19-May 2022 and 15-May 2023. The hand-thinned control trees were thinned on 17-July 2022 and 7-July 2023 by removing all but one fruit per cluster and spacing fruit ~10 cm apart.

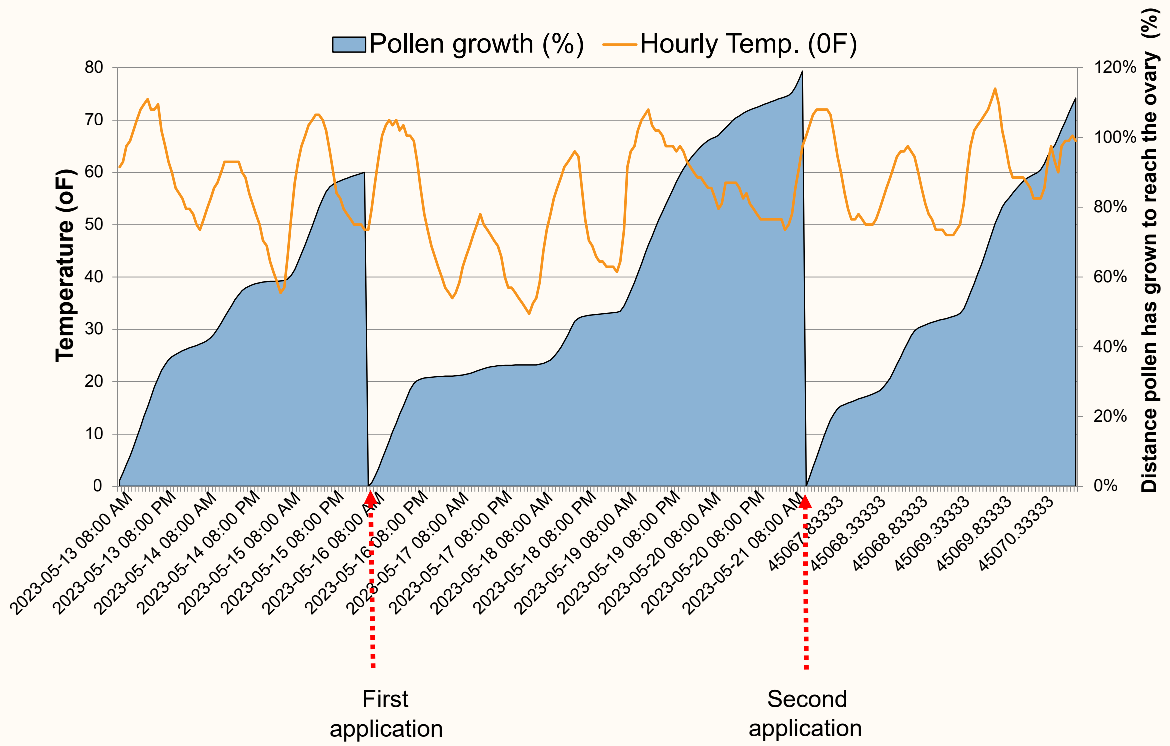

Figure 1. *Example of the graphic output of pollen tube growth in relation to temperature using the PTGM. Arrows indicate the recommended time of first and second applications of blossom thinners in 2023. The first application is applied when the average number of king flowers open per tree matches 100-125% of the target fruit number per tree at harvest.*

Horticultural Measurements

Tree trunk circumference at 30 cm above the graft union was measured at the beginning and end of each growing season, from which trunk cross-sectional area (TCSA) was calculated. Four scaffold branches — two on the east and two on the west side of the tree — were selected prior to bloom to determine fruit set. On 11-May 2022 and 9-May 2023, the number of flower clusters per branch were counted on each marked limb. The number of fruit set per limb were counted again after natural abscission ('June drop') on 29-July 2022 and 23-June 2023. These datasets were averaged and used to calculate percent fruit set (number of fruit set divided by number of flowers).

Leaf fruit phytotoxicity was assessed on various dates by rating the incidence and severity (0=none, 1= very slight; 2= slight, 3= moderate, 4= high, 5= very high). The incidence and severity of leaf necrosis was also assessed in a similar rating style (0=none, 1= very slight; 2= slight, 3= moderate, 4= high, 5= very high).

Fruit were harvested on 20-Sept 2022 and 21-Sept 2023. 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) and placed in cold storage (~20C) for subsequent grading on a commercial colour sorting and sizing grading line in November of 2022 and 2023.

Results

See Table 1 for results.

Fruit Set

In 2022, there was a significant treatment effect on mean fruit set ($P < 0.0029$) (Figure 2). The untreated control had the highest fruit set whilst the LS blossom thinning treatment had the lowest fruit set with a reduction of 58% compared to the untreated control. The ATS blossom thinning followed by CB fruitlet thinning treatment resulted in a 51% decrease in fruit set compared to the untreated control. The grower standard CB fruitlet thinning treatment only resulted in only slightly reduced fruit set and was statistically similar to the hand thinned and untreated control.

Fruit set in 2023 was markedly lower than 2022. Thinning treatments also had a significant effect on mean fruit set in 2023 ($P = 0.0002$) (Figure 2). The ammonium thiosulphate (ATS) blossom thinning treatment resulted in the highest mean fruit set whilst the ATS blossom thinning followed by carbaryl (CB) fruitlet thinning treatment had the lowest fruit set. CB fruitlet thinning alone resulted in a 33% reduction in fruit set compared to the untreated or hand thinned control

Table 1. Flower phenology and dates of blossom and fruitlet thinner using the pollen tube growth model

	Date	
Stage	**2022**	**2023**
First pink	May 09, 2022	May 03, 2023
Dates of full bloom	May 19, 2023	May 15, 2023
Target number of fruit per tree	29	74
Target kings flowers open based on PTGM[1] model	May 15, 2022, 8:00 AM	May 16, 2023 12:00 PM
Actual date/time of first blossom thinner	May 15, 2022, 11:00 AM	May 16, 2023 8:00 AM
PTGM forecasted second blossom thinner	May 17, 2023, 11:00 AM	May 20, 2023 10:00 AM
Actual date/time of second blossom thinner	May 17, 2023, 10:47 AM	May 21, 2023 8:00 AM
Hours between first and second blossom thinning spray	71	124
Carbaryl fruitlet spray (10 mm king fruit diameter)	Jun 02, 2022	May 30, 2023

[1] *PTGM - Pollen tube growth model.*

although this reduction was not statistically significant based on the mean separation. The treatments that combined blossom thinning and fruitlet thinning resulted in significant reductions in fruit set of 41-46% compared to the untreated control. Application of LS, ATS or LS followed by CB fruitlet thinning resulted in similar mean fruit set to the grower standard CB fruitlet thinning treatment. Overall, ATS or LS alone did not reduce fruit set compared to the untreated control treatment.

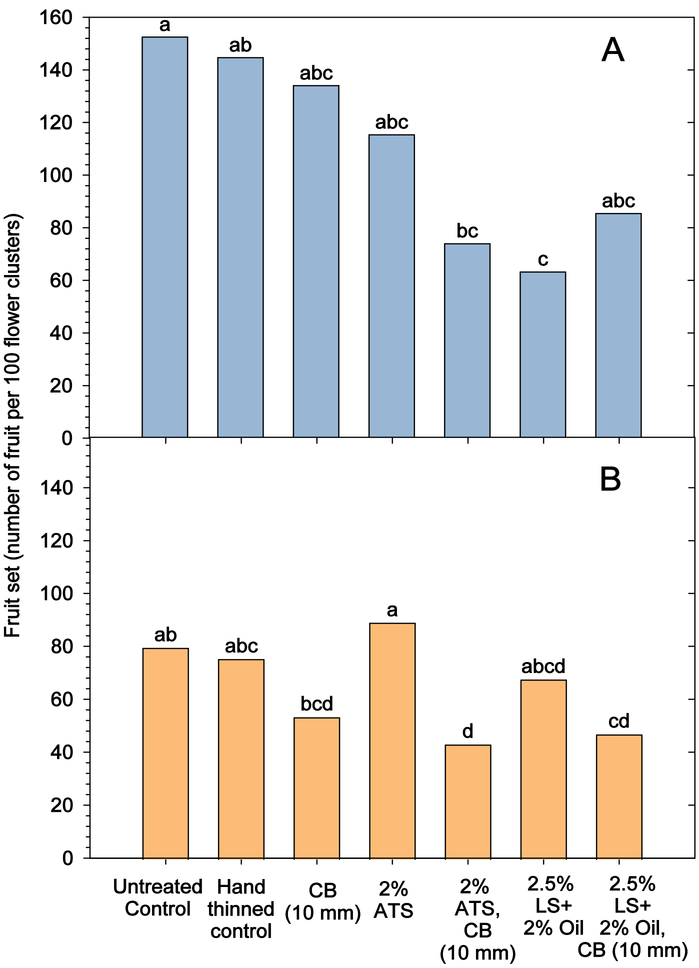

Figure 2. *Fruit set of Honeycrisp trees in response to blossom and fruitlet thinners in 2022 (A) and 2023 (B). Mean values with the same letter within a given year are not significantly different according to Tukey's HSD test at P=0.05.*

Yield Parameters

Application of blossom and fruitlet thinners in 2022 reduced total fruit yield by 22-41% compared to the untreated check, but results were just shy of statistical significance at P = 0.0788 (Figure 3). Of the other measured yield parameters, including crop load, percent marketable fruit, mean fruit weight (Figure 2) and crop load (data not shown), only the total number of fruit per tree was significantly affected by the thinning treatments (P = 0.0314) (Figure 4). Only the hand thinned control and ATS followed by CB fruitlet thinning treatment significantly reduced total number of fruit compared to the untreated control.

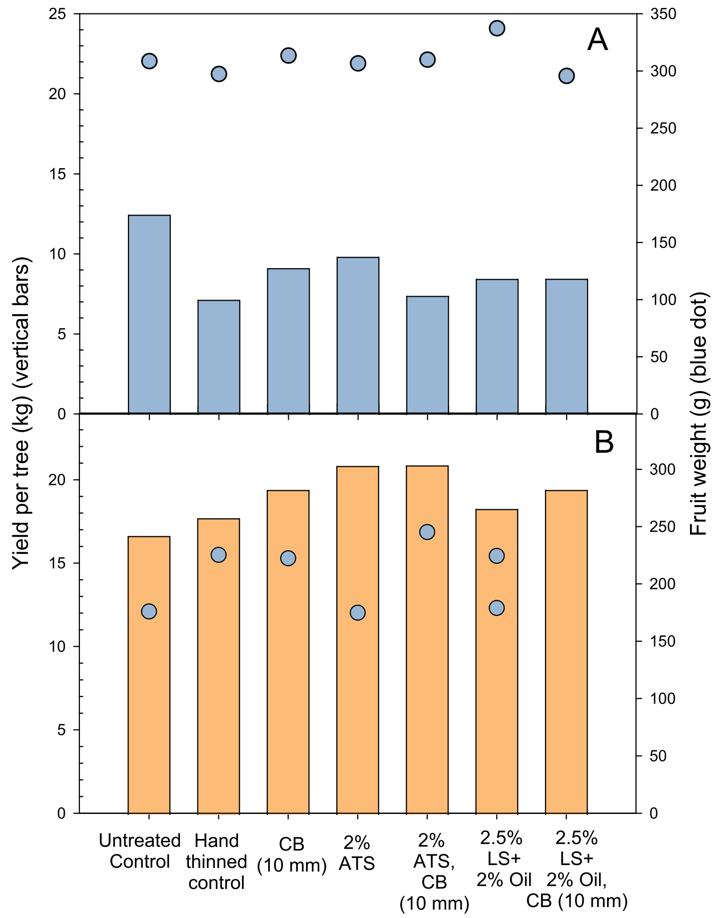

Figure 3. *Total yield per tree (bars) and average fruit weight (blue dots) of Honeycrisp in response to blossom and fruitlet thinners in 2022 (A) and 2023 (B). Mean values with the same letter within a given year are not significantly different according to Tukey's HSD test at P=0.05.*

In 2023, total fruit yield was not significantly affected by the thinning treatments (Figure 2), however treatments did affect mean fruit weight (P<0.0001). The untreated control and ATS treatments had the smallest fruit, while in contrast, the hand thinned control treatment and trees which included the CB fruitlet treatment had the greatest fruit weight (Figure 3). There were significant treatment effects on total number of fruit (P = 0.0113) but there were few statistically significant differences among the treatments according to the mean separation (Figure 4). Blossom thinning with ATS resulted in the greatest number of fruit whilst the hand-thinned control and ATS followed by CB fruitlet thinning treatments had the lowest number of fruit per tree. Orthogonal contrasts (not shown) indicated that application of blossom thinners alone had a greater number of fruit per tree compared to CB fruitlet thinning alone and blossom thinning followed by CB fruitlet thinning.

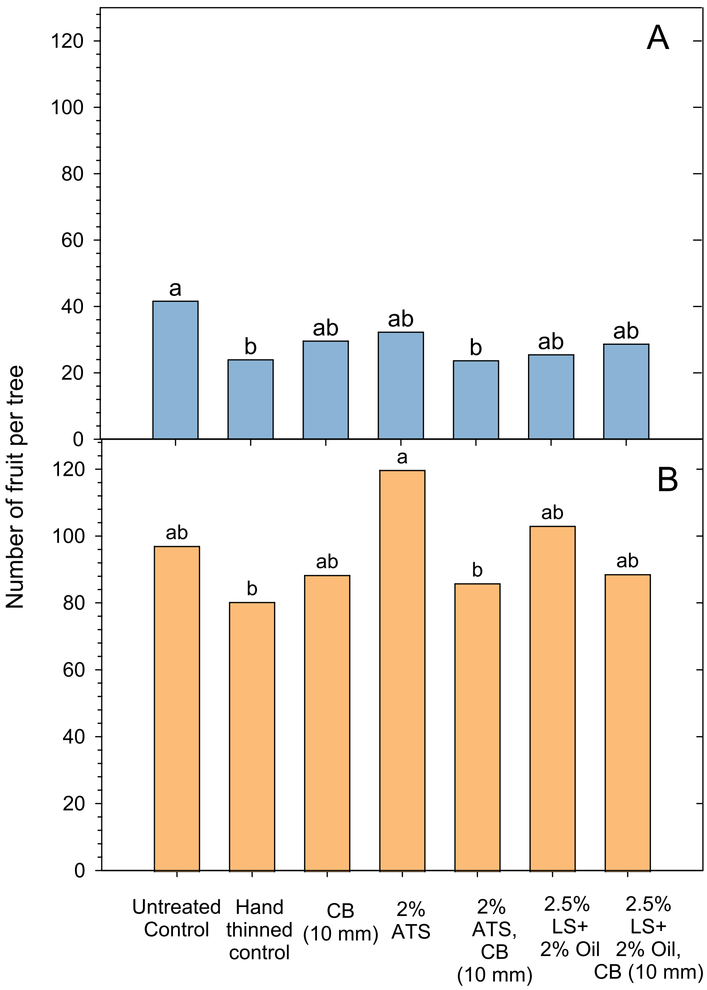

Figure 4. *Number of Honeycrisp fruit per tree in response to blossom and fruitlet thinners in 2022(A) and 2023(B). Mean values with the same letter within a given year are not significantly different according to Tukey's HSD test at P=0.05.*

Return Bloom

Return bloom was measured in the spring of 2023 by determining the percentage of flowering spurs on eight lateral branches per tree. The untreated control trees had the lowest return bloom (59%) followed by the HTC trees (65%). Trees treated with LS plus oil and carbaryl was the only treatment that had statistically higher return bloom (80%) compared to the untreated control treatment — all the other treatments had return bloom ranging from 64 to 75%, which were statistically comparable to the HTC and untreated controls. Return bloom for the 2023 experiment will be measured in the spring of 2024, post-publication of this article.

Leaf Phytotoxicity

Leaf necrosis was observed in all treatments in 2022 and 2023, but severity was low, ranging from slight to very slight (data not shown). In 2022, incidence of necrosis on 15- and 23- June was significantly higher for trees treated with fruitlet sprays of carbaryl alone. There were no measurable differences in leaf phytotoxicity following application of ATS or LS at any of the assessment dates in either year of the study compared with the untreated control trees.

Product Costs

The approximate cost of blossom thinners needs to be considered in the context of a thinning program and weighed with the benefits. Based on list prices received in February 2024, the product costs were as follows:

2.5% Lime Sulphur + 2% oil

- 25 L Lime Sulphur @ $13.42/L =$335.50
- 20 L Purespray green (13E) @ $9.24/L = $184.80
- 0.5 L Agral 90 @ 19.35/L = $9.68
- Total = $530/1000 L x 2 applications = $1060/1000 L spray solution

2% ATS (12-0-0-26S)

- 20 L @ $1.26/L = $25.20*
- 0.5 L Agral 90 @ 19.35/L = $9.68
- Total = $34.88/1000 L x 2 applications = $70/1000 L spray solution

** the 2024 price for ATS liquid appears to vary widely based on supplier as one supplier quoted $3.25/L.*

Conclusions

This two-year study investigated foliar blossom thinning with lime sulphur combined with mineral oil as well as ammonium thiosulphate. Application times were informed by the proprietary pollen tube growth model. Applications of 2.5% LS plus oil reduced fruit set of Honeycrisp and the number of fruit per tree in one of two years of the study while ATS did not reduce fruit set of Honeycrisp in either year of the study. In both years of the study, when carbaryl was applied alone as a fruitlet thinner, it was ineffective in reducing fruit set, number of fruit per tree, and crop load. However, there was added benefit when fruitlet sprays of carbaryl were applied following ATS and LS. In 2022, although fruit set per tree was high, the number of fruit per tree at harvest was low. Further, there was a poor relationship between fruit set and number of fruit per tree in 2022. Leaf phytotoxicity was minor on trees treated with ATS and LS plus oil and not different than the untreated control trees.

While there may be added fungicidal benefits of using LS, this study suggests the costs of blossom thinning with LS, which are estimated to be $1,060/ha (assuming two sprays of 1000 L/ha), outweigh its thinning benefits. Blossom thinning with ATS is clearly more cost-effective, with an estimated cost of $70/ha (assuming two sprays of 1000 L/ha), but proven and consistent efficacy was not observed in this study.

Towards this end, future work should investigate whether concentrations of ATS higher than 2% (v/v) will provide adequate thinning when applied at bloom without causing phytotoxicity to the sensitive developing spur leaves and fruit. Another approach is to develop other safe blossom thinning chemicals to use in precision thinning spray programs where sequential thinners are applied to reduce crop load, especially for biennial cultivars like Honeycrisp.

The limitations of this study are that all thinning studies need to be interpreted with caution because annual variations in the tree response to thinning can occur, and cultivars may also respond differently to the blossom thinning compounds and the rates used in this study. Further, in the absence of the pollen tube growth model, other research[3] suggests applying the first blossom thinner at 20% open bloom followed by a second application within 48 hr, with lower temperatures extending this interval to 72 hr[3]. Overall, the benefits of early crop load reduction using blossom thinners need to be balanced with the product costs, potential low efficacy, risk of frost, leaf phytotoxicity and potential fruit russeting.

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Approaches to Ontario Apple Replant Disease

Practices, Products, & Rootstocks

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This article lists multiple practices and products that growers can used to alleviate apple replant disease (ARD) in new orchard replantings. No one practice, product, or rootstock can provide a complete solution and the more approaches that are used, the more successful replant will be. Approaches should be chosen based on grower equipment, availability, resources, and orchard conditions.

What is Apple Replant Disease

ARD is a complex soil disease that develops on the apple root-soil interface due to previous fruit tree root exudates and decomposition of plant matter, which results in impaired growth of new orchards. ARD impairs root and shoot growth, shortens internodes, damages roots, and delays or decreases fruit yields[1].

What causes Apple Replant Disease

Abiotic conditions and biotic components all contribute to ARD, though microbial organisms appear to play a primary role in the disease[2,3]. Fungi, oomycetes, bacteria, and nematodes all appear to be involved in the disease complex[1-4].

Cultural Practices

Root Removal

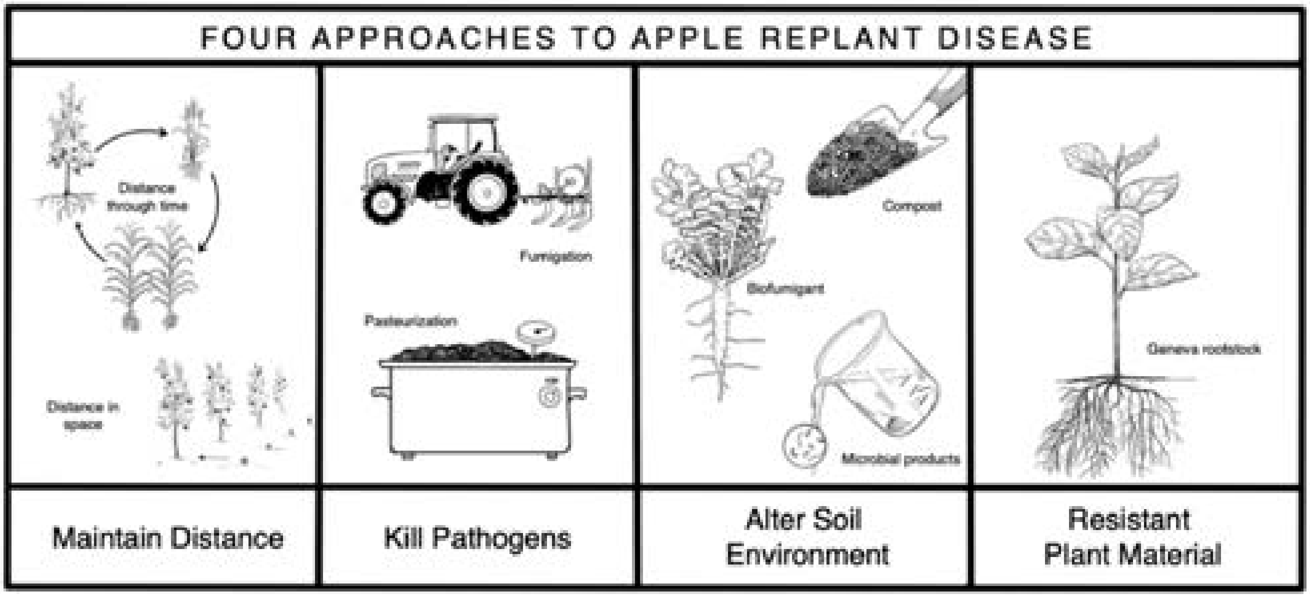
It is crucial to remove all possible roots during tree removal. Apple roots and bark release allelopathic compounds when they decompose that impair tree growth[5]. These compounds can also support microbial pathogen growth in the soil[6-8].

Notes: This approach is inexpensive and can be achieved with a variety of equipment. However, these compounds build up during the life time of the tree. Removing dead biomass can significantly reduce the severity of ARD but does not undo factors that contribute to it.

Row Offset

ARD is immobile and planting new trees between old rows can avoid much of growth impairment[9].

Notes: This approach can allow old rows to be treated while new tree grow. ARD has been found to persist in soil for decades[1], so may run out of space for rows without other treatment.



Compost

Incorporating compost into soil introduces a high diversity of beneficial soil microbes and the nutrients to support them. This can lead to shifts in microbial community and the development of 'suppressive soils' [10].

Notes: This approach is inexpensive and can be achieved with simple equipment and low labour. Compost substrates and their microbial communities can be highly variable, and therefore cannot provide a consistent method of disease control or suppression for commercial levels[2].

Biofumigation

Plant material (fresh biomass or seedmeal) from Brassicaceae species is incorporated into soil and releases glucosinolates to suppress ARD[11]. These plants have demonstrated control of various infectious species through nematicidic and fungal suppressant compounds, these also support beneficial bacterial families[12]. Common Species include Brassica juncea, Sinapis alba, Eruca sativa and Raphanus sativus[13].

Notes: Very effective but rarely fully abates ARD.

Additional resources: Ontario fumigators can be found at https://omafra.gov.on.ca/english/crops/resource/soilfum.htm

Anaerobic Soil Disinfestation

Organic matter and excess moisture are added to the soil to create an anaerobic environment. Anaerobic microbial decomposition products suppress soil pathogens, nematodes, and weeds[14,15].

Notes: While ASD has shown promising soil disease control, the success of this method is highly subject to environmental factors such as soil texture, organic matter, consistent soil moisture and temperature, and the pathogen species present[15,16].

Additional resources: Ohio State University Fact Sheet https://ohioline.osu.edu/factsheet/hyg-3315

Biocontrol Products

Bacterial Biocontrol

Several species of beneficial bacteria that live on plant roots are able to control pathogens and/or stimulate plant growth[1,17,18]. Many of these bacteria produce anti-fungal compounds which helps with disease control and phytohormones to promote tree growth.

The most well studied species come from Bacillus, Pseudomonas, Streptomyces. Other genera include Agrobacterium, Entrobacter, Erwinia, and Rhizobium19.

Commercial available products can be found by entering microbial genus names into the Ontario Crop Protection Hub. Enter genus into Fungicide search bar at https://cropprotectionhub.omafra.gov.on.ca/products.

Fungal Biocontrol

Several species of beneficial fungi that live in or on plant roots are able to control pathogens, nematodes, and/or stimulate plant growth.[1,20-22] Some fungi, such as mycorrhizae, induce systemic resistance in trees and boost plant defences.

The most well studied fungal biocontrol are from the genus Trichoderma. Other potential biocontrols may come from Penicillium[23] and Gliocladium[24].

Commercial available products can be found by entering microbial genus names into the Ontario Crop Protection Hub. Enter genus into Fungicide search bar at https://cropprotectionhub.omafra.gov.on.ca/products.

Chemical Fumigant

Chloropicrin

Chloropicrin is widely used in a variety of crops, including apples, to control soil-borne pathogens and nematodes[25]. It is widely regarded as one of the most effective remaining alternatives to MeBr to treat plant pathogenic fungi and bacteria, and is used widely in many countries[26].

Notes: chloropicrin is a very effective treatment but rarely fully abates ARD. Applications can decrease soil bacterial diversity and result in greenhouse gas release from soil[27,28].

Additional resources: Ontario fumigators can be found at https://omafra.gov.on.ca/english/crops/resource/soilfum.htm

Resistant Rootstocks

Rootstocks that have demonstrated resistance in most studies

G.214 Similar size to M.9

Demonstrates ARD resistance. Is a good and productive replacement for M.9 in replant sites29. Very fire blight resistant, crown and root rot tolerant, cold hardy, good yielding, and transplants well30.

G.210 Similar size to M.7

Is considered a great option for week scions in replant soil or organic production29. Grows very well where G.210 was previously planted31. It is very fire blight resistant, crown and root rot tolerant, cold hardy, good yielding29,32.

Partially Resistant Rootstocks

Rootstocks that have demonstrated resistance in some studies

G.11 Similar size to M.26

Poor vigour in sandy soil but roots easily[30,33]. Seems to display more resistance to nematodes than fungal aspects of ARD[34]. It is woolly apple aphid and fire blight resistant; crown and root rot tolerant; cold hardy; and productive[32].

G.41 Similar size to M.9 T337

One of Geneva's highest performing rootstocks and is a good choice for high-density replant settings[29]. Has some graft union problems and is not a good choice for Honeycrisp rootstocks or following M.9 plantings[30,31,35]. Considered very fire blight resistant, crown and root rot tolerant, cold hardy, and good yielding[35].

G.890 Similar size to M.7/MM.106

Demonstrates partial ARD resistance. Shows good growth in light soils and other difficult soil conditions, and propagates well in stoolbeds[29,30]. It is a good option for medium-density plantings[29]. Some concerns regarding bitterpit[30], may not be a good choice for Honeycrisp. Very fireblight resistant, crown and root rot tolerant, cold hardy, good yielding, and has high vigour and deep root growth[32,36].

G.935 Similar size to M.26

Due to its vigour, this rootstock is recommended for replanted soils or plantings with weak scion cultivars[29,30]. Trees on G.935 have grown well following a variety of rootstocks; G.935 demonstrated the best growth following G.21031. Very fireblight resistant, crown and root rot tolerant, cold hardy, and good yielding[32].

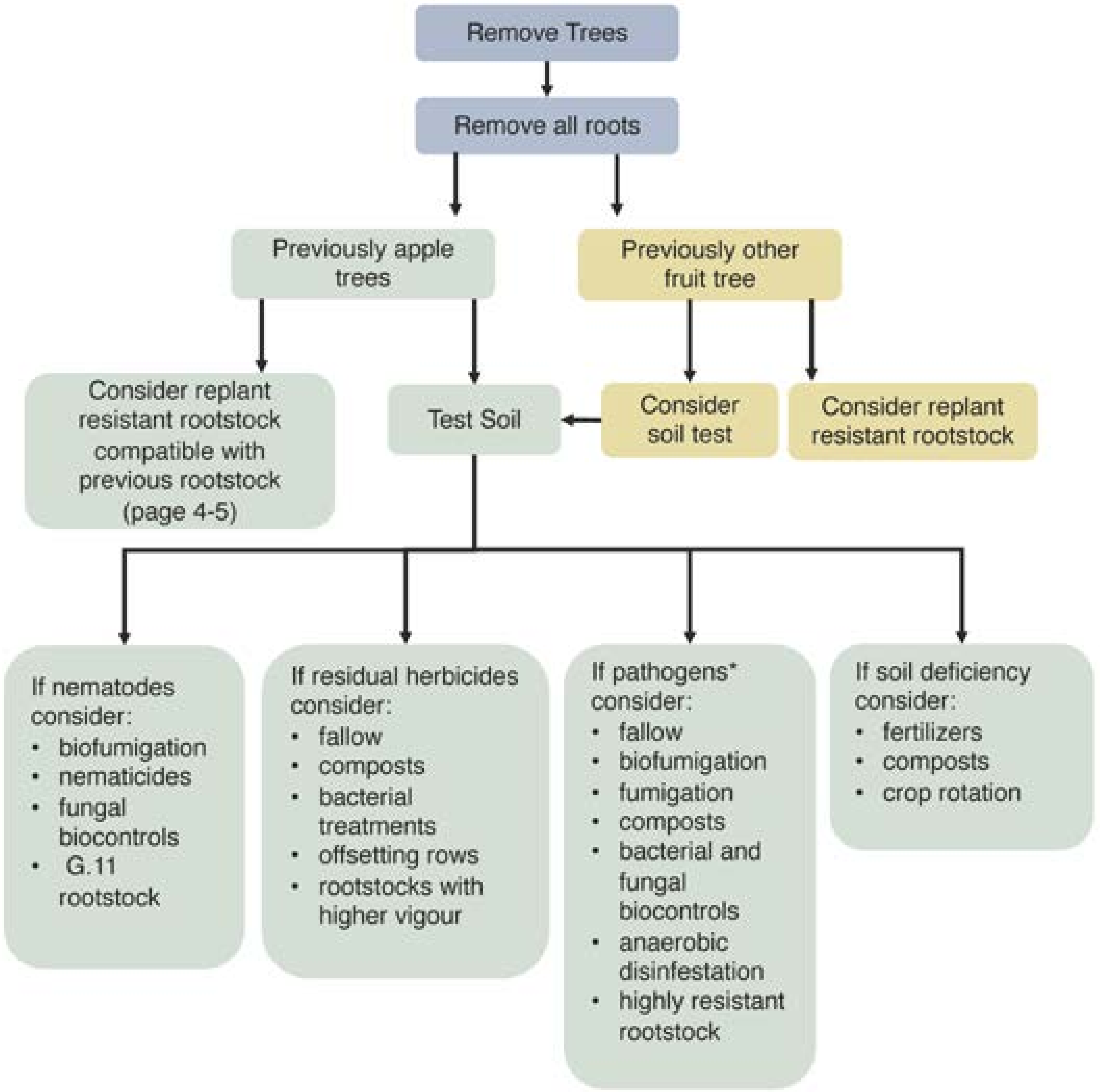
G.969 Similar size to M.7

Is easy to propagate in stoolbeds and develops strong root systems[29]. G.969 is considered an excellent choice for weaker cultivars in high-density plantings [29,36]. It is also very fireblight resistant, wooly aphid resistant, crown and root rot tolerant, cold hardy, and good yielding[29,32].

B.10 Similar size to M.9 T377

Has demonstrated some ARD resistance in recent UoG study. Very cold hardy rootstock with good root anchorage, stress tolerance, and yield efficiency. It is also fireblight tolerant[37].

Replant Steps And Possible Treatment Options



**Pathogens that may contribute to ARD*

Fungi & Oomycetes: *Ilyonectria* (formerly *Cylindrocarpon*), *Fusarium*, *Rhizoctonia*, *Phytophthora*, and *Pythium*[2,4,37,38].

Bacteria: *Chitinophara*, *Hyphomicrobium*, *Nitrospira*, *Devosia*, *Sphingomonas*, *Planctomyces*, *Lysobacter*[3].

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CROP PROTECTION

Ontario Herbicide Resistant Weeds Database

Kristen Obeid, *Weed Management Specialist — Horticulture, OMAFRA*

An online repository of all herbicide resistant weed testing results since 1998 can be found on the *Resistant Weeds Dashboard* (arcgis.com). Users can search for herbicide resistant weed species and create distribution maps. (Figure 1) is an example for Canada fleabane.

Testing Services for Herbicide Resistant Weeds

There are two testing solutions available in Ontario. The plant bio-assay service offered by the Tardif lab at the University of Guelph requires that mature seed is collected in the fall and submitted. Plants are then grown from that seed and sprayed at various doses of the herbicide(s) suspected. Results are provided typically by March. The service is provided at no cost to Ontario farmers. The molecular testing service requires plant tissue that is roughly "quarter sized", so a single leaf is often adequate. Results can be obtained within a couple of weeks, but it is a fee-based service. Fortunately, there is a funded surveillance project that will process samples at no cost. A 2023 *Sampling Protocol for Collecting Fresh Plant Tissue for Genetic Herbicide Resistance* guide for this project can be found at fieldcropnews.com.

Links to Testing Services

Free plant bioassay testing by the University of Guelph, *Weed Submission for Herbicide Resistance Testing.* Plant Agriculture, uoguelph.ca.

Molecular testing by TurnKey Genomics Inc. (Private Lab) turnkeygenomics.ca.

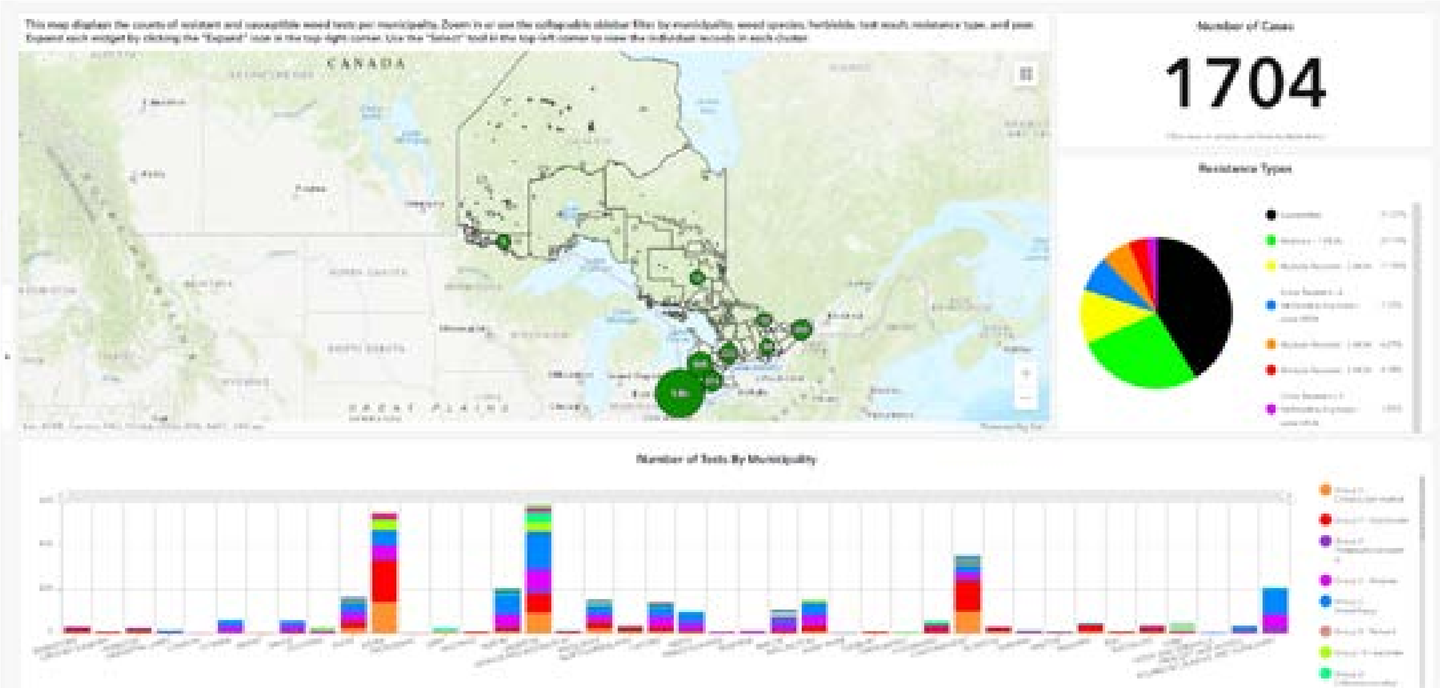

Figure 1. *Sample of GIS dashboard (as of February 16, 2024) for Canada fleabane. Source: ArcGIS.com.*

WANTED

Dead & Dying Apple Trees

Justin Renkema, *Research Scientist, Agriculture & Agri-Food Canada*
Kristy Grigg-McGuffin, *Horticulture IPM Specialist, OMAFRA*

If you are removing or planning to remove young apple trees from your orchard, we would like to have some of the trees for a project on beetles.

Bark and ambrosia beetles are small, black, wood-boring beetles that create galleries in trees and weaken them. Since 2019, we have assessed the communities of ambrosia beetles in and around apple orchards in Ontario, and now we would like to know which species are actually colonizing and harming your trees.

If you would like to contribute young (1-8 year old) dead or dying trees:

1) Contact Kristy Grigg-McGuffin by phone/text 519-420-9422 or email kristy.grigg-mcguffin@ontario.ca

2) Arrange a date and time for us to collect the trees you removed (preferably the same day you are removing) OR we can come to cut dead/dying trees from your block

3) Save the main trunk of the tree, from the graft union up to the first few main limbs

4) Provide information about removed trees, such as cultivar, rootstock, age, planting density

In the lab, we will hold trees in plastic bins until beetles emerge, and other trees will be cut into sections to find beetles and their galleries. Once we have results, we will let you know which species and how many were found in your trees. Knowing the species and their abundance will help develop future management strategies.

Orchard Pests Chillin' in the Mild Winter

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

As hard as it is to say what a "normal" winter is like now in Ontario, I think it's fair to say we haven't had much of one regardless. While certain areas of the province have experienced some snowfall and winter-like weather over the last couple of months, we really haven't seen extremely low temperatures that could reduce overwintering pest populations. Unfortunately, little is really known about predicting mild winter impacts on pests in the northern hemisphere but there are some factors worth considering.

Mild Winter Impacts on Insects

Survival in a "normal" winter

In general, most insect pests that overwinter in Ontario orchards are adapted to the cold temperatures. Many go into what is known as diapause, which is a type of hibernation, while others seek shelter, utilize warming techniques (ie., produce insect "antifreeze"), or a combination of these.

For example, codling moth overwinter in diapause in a pre-pupal stage snug within a cocoon, or hibernacula, under the protection of leaf litter or loose bark at the base of the tree (Figure 1A). Japanese beetle and apple maggot overwinter as larvae and pupae respectively in the soil, insulated from the extreme temperatures by the snow cover (Figure 1B). European red mite and several species of aphids overwinter as eggs by producing specialized proteins that prevent their cells from freezing (Figure 1C).

In a typical winter, insect populations often experience winter kill to some degree, depending on many factors within the micro-climate of the orchard, such as air drainage, snow cover and extreme temperature.

Figure 1. *Overwintering insects in the orchard. (A) Codling moth hibernacula under loose bark on apple limb. (B) Japanese beetle larva in soil, Source: North Carolina Cooperative Extension, (C) European red mite eggs on tree trunk.*

Survival in a mild winter

It would be easy to assume warmer temperatures would therefore increase the chance of pest survival. In some cases, it likely does. A mild winter with sufficient snow cover to compensate for fluctuating temperatures could favour winter survival. With a warm, dry spring, this could result in a quick emergence of European red mite, rosy apple aphid, tarnished plant bug and mullein bug.

However, there are a number of factors that influence survival and whether insect pressure will be high in the spring:

Insect development is dependent on temperature — If temperatures exceed the lower developmental threshold for an insect (for example, many have a base temperature of 10°C), they will resume activity and/or growth. This reduces their cold tolerance during times of fluctuating temperatures and increases mortality.

Food access is limited — When insects come out of dormancy, they depend on stored fats until a food source (crop, nectar, prey, etc) becomes available. If activity begins ahead of normal, they can run out of stored reserves and starve.

Snow provides insulation — Insects that overwinter aboveground are exposed to fluctuating/freezing temperatures without snow cover, which could lead to increased mortality compared to a year with insulating snow.

Soil temperatures are more constant — Insect that overwinter underground are likely not affected by a mild winter or fluctuating temperatures due to the insulating nature of soil. With the high soil moisture levels last fall, insects may not have needed to burrow deep into the soil compared to dry years. However, so long as the frost layer remained relatively shallow, even survival in the higher soil has likely not been impacted.

Beneficial insects are impacted too — All factors also apply to beneficial insects such as ladybeetles, lacewings and predatory mites. Assuming food sources are available when these populations become active, beneficial activity could help with increased early season pest emergence. However, beneficials like ladybeetles overwinter in ground cover and are at high risk of exposure without the protective snow cover.

Considerations for degree day accumulations? With the higher daytime temperatures, it is possible that certain pests with low development thresholds have begun to accumulate degree days this winter. You may want to consider using a January 1st biofix in addition to March 1st for comparison if you have concerns.

Early growing season = longer pest development season — A concern of an early emergence of overwintering pests is the potential for more time for the population to build or for populations to peak earlier than expected – such as during bloom when insecticides can't be applied. A longer growing season (and pest development season) could even result in seeing some pests getting in an extra generation per year. For instance, potato leafhopper is predicted to go through an extra generation per season if it arrives 2-3 weeks earlier than normal.

Mild Winter Impacts on Disease

Survival in a "normal" winter

Similar to insect pests, diseases that overwinter in Ontario orchards are also adapted to the cold temperatures. Most typically overwinter protected from cold weather in infected branches or cankers (e.g., fireblight), in leaves on the orchard floor (e.g., apple scab, Marssonina), in dead wood or mummified fruit in the tree or on the ground (e.g., black rot, bitter rot), or in alternate hosts to be carried in from other areas on wind currents (e.g., rust).

Figure 2. *Healthy apple bud (left) and powdery mildew infected apple buds (right).*

Survival in a mild winter

The exception to this would be powdery mildew, which overwinters as mycelium in dormant fruit and shoot buds that were infected the previous season (Figure 2).

These infected buds lack winter hardiness and can see 95% winterkill at temperatures of -24°C. Following a mild winter, early season powdery mildew risk is often high, especially in blocks with a history of this disease.

Unlike insects, disease development is also strongly linked to moisture. While temperatures can encourage spore maturation, wet or humid conditions are typically needed for infection events to occur. In general, if warm temperatures persist into the spring along with wet weather, it is very likely some diseases will show up earlier than in previous years.

Southwest Injury

Southwest injury, or winter sunscald can often be an issue during times of mild daytime winter temperatures. Injury is often confined to the southwest side of the trunk and main scaffold branches due to mid-afternoon sun exposure when temperature is often highest.

Damage occurs when exposed bark warms up on sunny days and previously dormant cells within the tree become active in response to the warmth. These cells lose some of their cold-hardiness and are injured when temperatures drop below freezing. Resulting damage causes discoloration or vertical cracks. Monitor closely when cold, still nights follow warm, sunny days.

Another similar type of trunk splitting can occur after the sap starts flowing in early spring. If a drop in temperature below freezing occurs after the tree has broken dormancy, the sap can freeze and create a long crack in the bark of the trunk.

While a physiological issue, injured trees may become more susceptible to pests such as canker diseases or borers during the growing season, entering the damaged areas.

Timing of Infection and Management of Bitter Rot in Ontario

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

As many growers have experienced, the cryptic nature of bitter rot makes it challenging to control as the timing of infection does not always coincide with the onset of symptoms, which often don't appear until after harvest. With few effective products available, understanding the biology of this disease is important. Through an OMAFRA-University of Guelph Alliance project, a team of researchers from Dr Katerina Jordan's lab led by Dr. Asifa Munawar began investigating the timing of fruit infection and how it relates with weather data.

The following is a summary of Dr Munawar's report.

Experimental Details

Inducing Infection

From petal fall to preharvest in 2021-2022, 25 clusters of 'Empire' were inoculated weekly using cheesecloth soaked in either a spore suspension of *Colletotrichum fioriniae* or water (Figure 1A). Treated fruit were covered with bags for 4 weeks (Figure 1B). After the first 7 days, cheesecloth was removed and then marked at the site of treatment (Figure 1C). Signs of bitter rot lesion development was assessed biweekly. Any assessed fruit that showed symptoms within the marked area was removed. At harvest, the remaining treated fruit was stored for 5 months at 4°C and assessed for symptoms 2 weeks after being held at room temperature.

Natural Infection

In the same block of Empires in 2021-2022, 50 asymptomatic fruit were randomly collected weekly from petal fall to preharvest to determine if natural infection occurred. From each collection, half of the fruit were plated on media until fruit size was 49 mm, while the other half were kept at 4°C and assessed for symptoms 2 weeks after being held at room temperature.

Spore Trapping

In each treatment tree, rain traps (3 traps/tree) were hung to determine presence of natural inoculum (Figure 2). The spore solution was plated on media for 7-14 days after each collection to identify pathogens present (Figure 3). Weather data loggers were also set up in the study orchard to monitor temperature, precipitation, relative humidity and leaf wetness.

***Figure 1.** Inducing bitter rot infection on developing Empire apple. (A) Cheesecloth soaked in suspension of Colletotrichum fioriniae wrapped around fruitlet to initiate infection. (B) Treated fruit covered in plastic bag to enhance symptom development. (C) Treated/ assessment area marked after cheesecloth removed.*

Figure 2. *Funnel-like passive trap hung in tree to collect spores released during rain events to determine presence of natural bitter rot inoculum.*

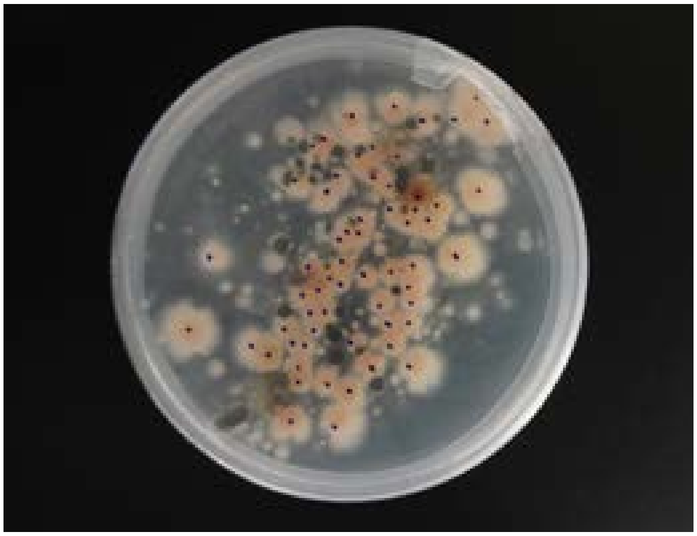

Figure 3. *Spores collected weekly from rain traps were plated on media to identify pathogens present.*

Results

Inducing infection

In total, 16 and 15 weekly inoculations were made from petal fall to harvest in 2021 and 2022, respectively.

In 2021, the earliest symptoms were observed on June 30 (15 days post-inoculation), when fruit was 35 mm in size (Figure 4). Weather conditions throughout May were not favourable for infection, though symptoms did develop in all treatments more than 29 days post-inoculation. Control treated fruit did not develop symptoms in the field (data not shown). Symptomatic fruit was observed in storage as well (Figure 5). Immature fruit collected throughout May did develop lesions in storage even though infection risk was low. However, the percentage of bitter rot incidence was low on immature fruits compared to more mature fruit in July and August. Natural inoculum caused low incidence on control fruit.

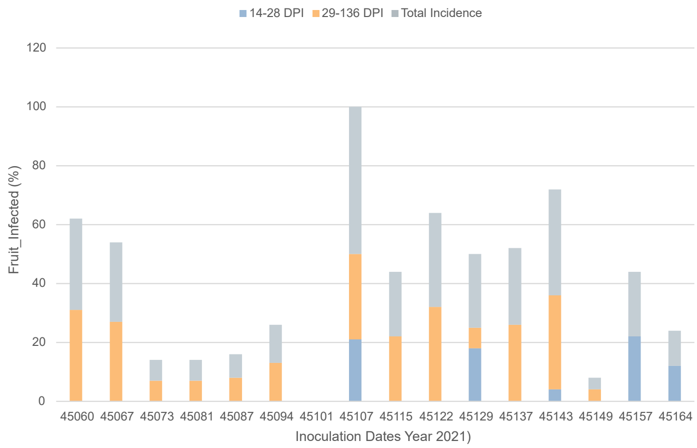

Figure 4. *Disease incidence of bitter rot in the field on inoculated fruit, 2021.*

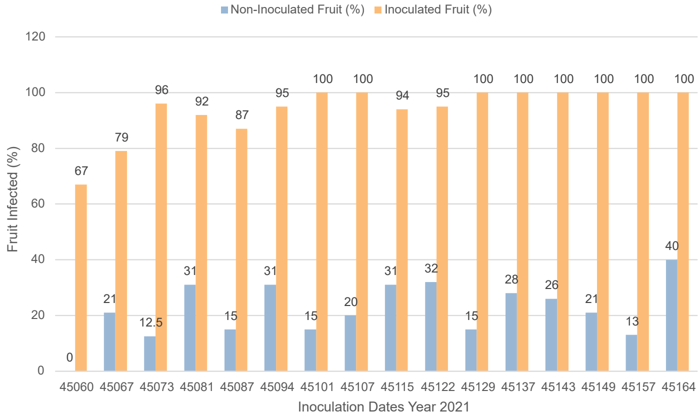

Figure 5. *Disease incidence of bitter rot on inoculated and non-inoculated fruit after storage, 2021.*

In 2022, the earliest symptoms were observed on May 20 (14 days post-inoculation), when fruit was 6.4 mm in size (Figure 6). Weather conditions in May were more favourable for infection compared to June and July which had a lower percentage of symptoms observed in treatments. Similar to 2021, the incidence of symptom development of treated fruit in storage was high throughout the season (Figure 7). Control fruit showed low to medium level of disease incidence due to natural inoculum.

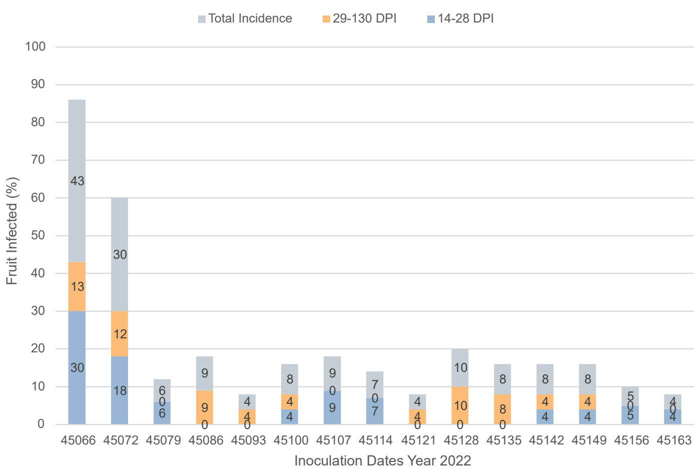

Figure 6. *Disease incidence of bitter rot in the field on inoculated fruit, 2022.*

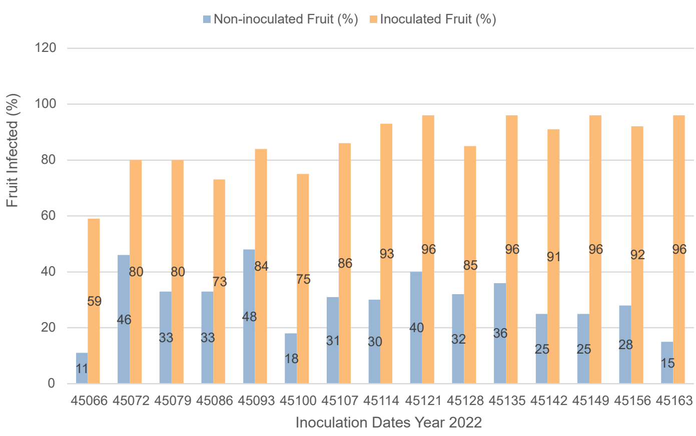

Figure 7. *Disease incidence of bitter rot on inoculated and non-inoculated fruit after storage, 2022.*

Natural Infection

In 2021 and 2022, occurrence of natural infection coincided with increases in conidia collected in spore traps (Figure 8), (Figure 9A),(Figure 9B). While low levels of inoculum were detected early season, these populations did not build significantly until later in the season during both years.

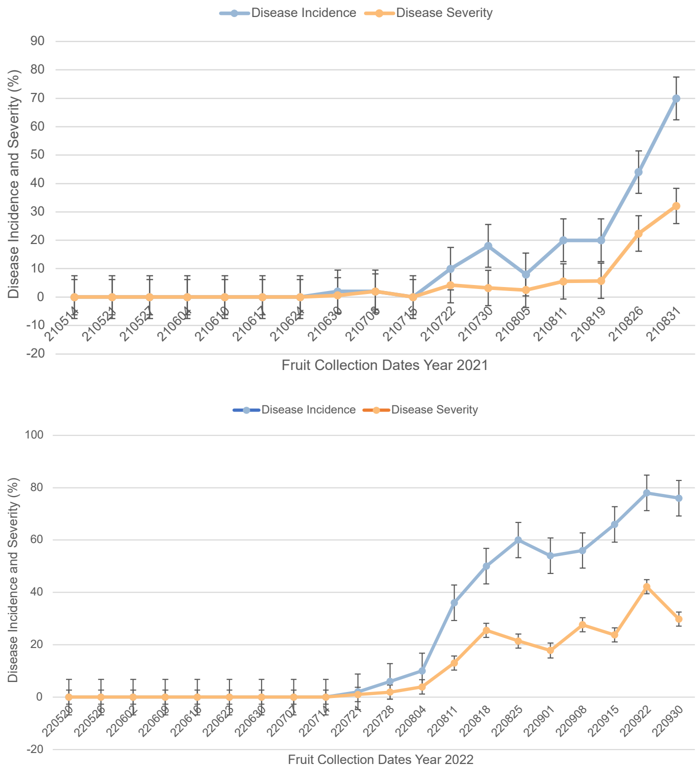

Figure 8. *Natural disease incidence and severity of bitter rot on fruit, 2021 (top) and 2022 (bottom).*

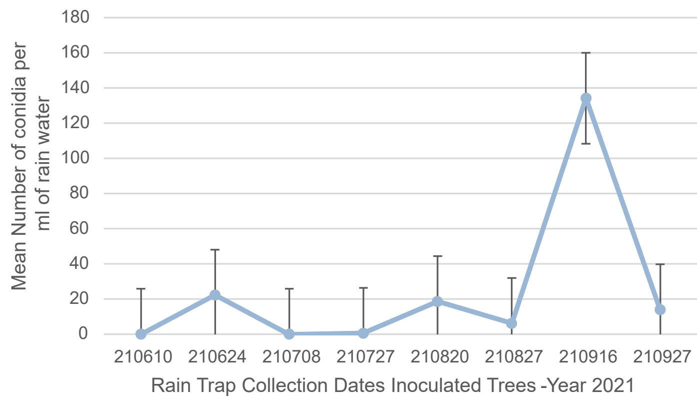

Figure 9A. *Mean number of Colletotrichum fioriniae conidia per ml of collected rainwater, 2021.*

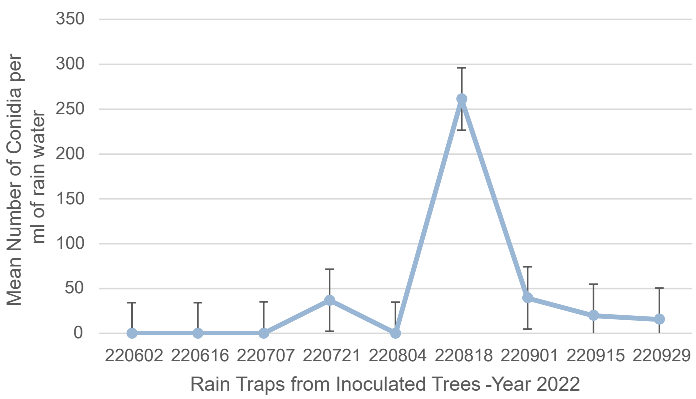

Figure 9B. *Mean number of Colletotrichum fioriniae conidia per ml of collected rainwater, 2022.*

Conclusions

Based on these findings, fruit can become infected with bitter rot from petal fall to harvest (Figure 10). However, in a natural setting, there tends to be less natural inoculum available early in the season (May to mid-July) and conditions are not often as favourable for symptom development. In any case, under ideal infection conditions, symptoms can develop 14-28 days after infection but can remain latent upwards of 130 days post-infection if conditions are less than ideal.

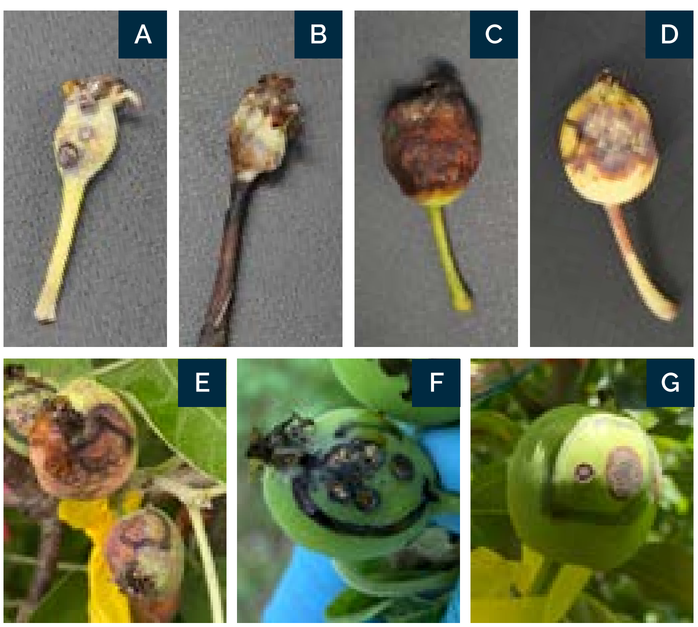

Figure 10. *Symptoms of bitter rot on inoculated fruit, ranging from A-B: 6.5 mm, C: 15 mm, D: 15.25 mm, E: 16-21 mm, F: 17 mm, G: 30 mm.*

Management

As highlighted by this research, 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 disease such as fire blight and fruit mummies (where possible) may also reduce the disease.

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.

Allegro (FRAC group 29, PHI 28 days), Pristine (FRAC group 11 & 7, PHI 5 days), Merivon (FRAC group 11 & 7, PHI 0 days), Maestro/Supra Captan (FRAC group M, PHI 15 or 19 days depending on orchard density) and Regalia Maxx (FRAC group P5, suppression only, PHI 0 days) are registered for bitter rot. Always rotate fungicide FRAC groups to reduce the potential for resistance development.

Acknowledgments

This research was conducted by the University of Guelph pathology research team: Dr. Asifa Munawar, Dr. Katerina Jordan, Dr. Mary Ruth McDonald, Vivian Adam and Erik Ellenbeger.

The team is thankful to the Ontario Apple Growers and Ontario Agri-Food Innovation Alliance Research Programs for providing funding for this research.

DA Meter as an Indicator of Apple Maturity

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Younes Mostofi, *Research Assistant, OMAFRA*

The delta absorbance (DA) meter provides a non-destructive measure of relative chlorophyll content, known as the *Index of Absorbance Difference* (IAD). This can be related to fruit ripeness and apple quality. However, there remains a lack of understanding about seasonal variability and consistency of IAD readings, and how this relates to other popular maturity indices, such as internal ethylene concentration or starch index for apple.

The overall objective of this study was to evaluate IAD of four major apple cultivars in Ontario during the commercial harvest window over multiple years, as well as its relationship with fruit firmness, internal ethylene concentration, and starch index values. 'Honeycrisp', 'Ambrosia', 'Gala' and 'McIntosh' apples were sampled during the commercial harvest period from orchards located in Ontario and Quebec. 'Honeycrisp' was evaluated for 7 years, while the other cultivars were evaluated for 4 years.

Average IAD values, firmness, internal ethylene concentration, and starch index values of the apples at harvest time are presented in (Table 1). Overall, 'McIntosh' had the highest IAD (1.03 to 1.33) and 'Gala' had the lowest (0.19 to 0.56).

There was plenty of variability in the correlations between IAD and other maturity indices over the years (Table 2). IAD correlated to firmness in only one year for each cultivar and it was a negative relationship for 'Honeycrisp' and 'McIntosh' but a positive relationship for 'Ambrosia' and 'Gala'. IAD correlated negatively with internal ethylene concentration in all cultivars, but not consistently throughout all years. The strongest correlations were found between IAD and starch index values. However, these negative correlations were not significant in all years and never significant for 'McIntosh'.

Overall, IAD may relate to harvest maturity, but it did not correlate closely or consistently with other apple maturity indices, varied greatly year-to-year, and was cultivar dependent. IAD measures are not consistently related to fruit maturity every year, making reliability difficult to attain. Furthermore, results indicate that IAD alone is not a reliable indicator to establish ripening stage and harvest time; despite sometimes being associated with the evolution of on-tree fruit maturation. Apples with similar background color can have different firmness and starch indices, and these can vary greatly between years and orchards as well as respond differently to preharvest factors and weather. These results agree with previous studies reporting that the DA-meter alone cannot replace common fruit maturity indices, but it could be used as an additional tool for evaluating maturity in certain conditions.

Acknowledgements

Thanks to the Ontario Apple Growers, Norfolk Fruit Growers' Association, Apple Marketers' Association of Ontario, AgroFresh Inc., Storage Control Systems Inc., Pommes Philip Cassidy Inc., and GRB Ag. Technologies Inc. for their continuous support, as well as Sky Lesage for technical assistance. Research in part was funded through the Canadian Horticultural Council's Canadian Agri-Science Cluster for Horticulture.

Table 1. Average IAD, firmness, internal ethylene concentration, and starch index of ‘Honeycrisp’, ‘Ambrosia’, ‘McIntosh’ and ‘Gala’ apples at harvest time during multiple years

Year	IAD[1] (DA meter)	Firmness (lb)	Internal ethylene (ppm)	Starch index (1-8)[2]
Honeycrisp				
1	0.55	15.8	14.2	6.2
2	0.51	14.4	3.0	6.9
3	0.36	14.0	10.2	7.3
4	0.59	16.6	7.5	6.3
5	0.38	15.8	4.9	5.9
6	0.67	15.1	18.2	4.9
7	0.41	15.7	38.5	6.4
Ambrosia				
1	0.49	15.4	0.8	1.9
2	0.54	17.2	0.2	2.4
3	0.44	16.2	0.6	2.7
4	0.42	17.2	0.3	6.5
McIntosh				
1	1.18	15.6	29.0	5.7
2	1.23	15.9	2.6	4.7
3	1.26	16.7	0.5	2.4
4	1.03	14.3	0	4.2
Gala				
1	0.29	21.5	6.3	3.1
2	0.19	17.6	0.8	5.6
3	0.29	20.8	1.7	2.7
4	0.56	20.1	0.6	4.3

[1] IAD = index of absorption difference, from DA meter.
[2] 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.

Table 2. Correlation coefficient and significance of IAD and firmess, internal ethylene, or starch index at harvest for four apple cultivars during each year

Year	IAD[1] and Firmness (lb)	IAD and Internal Ethylene (ppm)	IAD and Starch Index (1-8)[2]
Honeycrisp			
1	NS	-0.40 ****	-0.59 ****
2	NS	NS	NS
3	-0.35 *	NS	NS
4	NS	-0.49 ****	-0.37 ****
5	NS	-0.64 ****	-0.81 ****
6	NS	-0.38 **	-0.42 **
7	NS	-0.42 ****	-0.49 ****
Ambrosia			
1	NS	NS	NS
2	NS	NS	NS
3	NS	-0.58 ****	-0.31 **
4	0.41 **	-0.34 *	-0.61 ****
McIntosh			
1	NS	-0.69 ***	NS
2	-0.32 ***	NS	NS
3	NS	NS	NS
4	NS	NS	NS
Gala			
1	NS	NS	NS
2	NS	NS	NS
3	0.65 ****	-0.81 ****	-0.82 ****
4	NS	NS	NS

[1] IAD = index of absorption difference, from DA meter.
[2] 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.
Notes: NS, *, **, ***, **** = not significant or significant at P ‹0.05, P‹0.01, P‹0.001, or P‹0.0001, respectively. Negative and positives values indicate negative or positive relationships between IAD and indicated measure.

ANNOUNCEMENTS

Ontario Cider Competition Winners

OFVC 11th Annual Ontario Sweet Cider Competition Winners

The 11th Annual Ontario Sweet Cider Competition was held in Simcoe, ON on January 31, 2024. Entries were made with 100% Ontario grown apples. Thank you to the Ontario Apple Growers for sponsoring this event.

OFVC 9th Annual Ontario Hard Cider Competition Winners

The 9th Annual Ontario Craft Cider Competition was held in Niagara Falls, ON on February 20, 2024. A commercial producer for the purpose of this competition is considered a producer with a manufacturer's license issued by Alcohol and Gaming Commission of Ontario (AGCO). Thank you to the Ontario Craft Cider Association for sponsoring this event.

There were three categories judged this year:

1. Modern Craft Cider
2. Heritage/Traditional Craft Cider
3. Specialty Craft Cider

Modern Craft Cider

Ciders are made from 100% Ontario apples only with no other fruits permitted.

Want to learn more about the winners?
Check out their websites below.

1. Thornbury Craft Co.
2. Stock & Row Cider
3. Fielding Craft Cider Co.

Heritage/Traditional Craft Cider

Cider are made using bittersweet/bittersharp apple varieties, often referred to as Heirloom Varieties, that are now grown in Ontario. These apples are often only used to make cider. These 'old world' apples often have higher tannins and more acidity which add more complexity to cider.

Want to learn more about the winners? Check out their websites below.

1. Thornbury Craft Co.
2. The Little Cider Company
3. Dirty Dog Cider Company

Specialty Craft Cider

Cider in this category includes:

A. Fruit Ciders: made from 100% Ontario apples with other fruits or fruit juices.

B. Hopped Ciders: made from 100% Ontario apples infused with hops.

C. Botanical Ciders: made from 100% Ontario apples with spices, herbs, and vegetables.

D. Barrel Aged Ciders: made from 100% Ontario apple ciders where the wood barrel ageing or fermenting imparts a significant flavour contribution/character to the cider.

Want to learn more about the winners? Check out their websites below.

1. Ardiel Cider House
2. Shiny Apple Cider
3. Fielding Craft Cider Co.

Current Funding Opportunities

Agri-Tech Innovation Initiative

The Initiative will be delivered under three funding streams. Intake opens Feb 15th 2024 and closes **March 28th 2024 at 11:00 am**. Across the streams, cost-share funding ranges from 35–50% of total eligible project costs. For full application guidelines visit the Agri-Tech Innovation Initiative webpage.

https://onfruit.ca/2024/02/09/agri-tech-innovation-initiative-opening-february-15th/

The Grow Ontario Accelerator Hub

The Grow Ontario Accelerator Hub provides support to innovative Ontario based companies to advance more solutions and technologies to market. This will be facilitated by providing mentoring and advisory services in agri-food business acceleration, growth planning and investment readiness, as well as to provide supports to businesses across the agri-food supply chain with respect to adoption of innovation.

https://bioenterprise.ca/the-grow-ontario-acceleration-hub/

Ontario Soil and Crop Improvement Association Funding Opportunities

There are 2 open funding opportunities and close when funding has been fully allocated:

1. Nature Smart Climate Readiness Program
2. Honey Bee Health Initiative

There are also 2 upcoming funding opportunities:

1. Species at Risk Partnership on Agricultural Lands (SARPAL)
2. Species at Risk Farm Incentive Program (SARFIP)

https://programguides.ontariosoilcrop.org/program/?cat=species-at-risk-farm-incentive-program