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For Commercial Apple Producers

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Orchard Management

At the root of production: Rootstock impacts on growth and yield

Cassandra Russell, Tree Fruit Specialist, OMAFRA

Rootstocks play an integral role in controlling many aspects of fruit production such as nutrient uptake, crop load, fruit size, and susceptibility to pests and disorders. Even with the growing amount of information and resources out there on available rootstocks, there is always more to be understood, especially how different rootstocks perform in various hardiness zones, soil types, production systems, and with various scion(cultivar) combinations.

With more high-density plantings in Ontario of high demand cultivars such as 'Gala', 'Ambrosia' and 'Honeycrisp', rootstock selection of newly planted trees has never been more important. High density plantings require higher investment and with that comes greater economic risk (Robinson et al. 2007). Risk can be escalated if the selection of rootstock is soley based on what is available and does not take into consideration some of the factors listed above.

Ministry of Agriculture, Food and Rural Affairs
Ontario

Malling 9 (M.9) rootstock is a great example of one that is widely available and is the most common rootstock in high density plantings of cultivars such as 'Gala' in the province. The lack of M.9's resistance to fire blight, woolly apple aphid, and poor cold hardiness compared to other options has been known for some time, but is still recognized for being an extremely productive rootstock. Most recently, M.9 rootstocks have overwhelmingly been linked to more cases of sudden apple decline here in Ontario which can lead to removal of young trees prior to reaching full production capacities.

Ongoing research continues to identify suitable rootstocks that can not only meet or exceed production performance of M.9's, but also offer desirable traits such as fireblight resistance and improved cold hardiness. To make recommendations on rootstock selection, long term regional specific studies on various apple rootstock/ cultivar combinations are needed.

Researchers in Virginia recently published results from an apple rootstock trial started in 2011 to assess yield impacts various rootstocks had on three common cultivars including 'Buckey Gala' (Full link: https://www.actahort.org/books/1281/1281_17.htm).

In their trials, they planted a variety of rootstock/scion combinations using 'Buckeye Gala', 'Rising Sun Fuji' and 'Red Yorking' (a common processing variety in Virginia). Rootstocks included in the trial are outlined in Table 1. Tree vigor was assessed by trunk cross sectional area and canopy spread. Harvest yield data was collected between 2013 and 2017 with both including and excluding fruit drops. Results are summarized in Table 2.

Table 1. Rootstocks evaluated by Sherif et al. (2020) for growth and yield trials on 'Buckeye Gala', 'Rising Sun Fuji' and 'Red Yorking'

Rootstock Groupings	Malling rootstocks	Malling Merton rootstocks	Geneva® series rootstocks	Budagovsky rootstocks
Codes	M.7, M.9, M.26	MM.111	G.11, G.16, G.30, G.41, G.935	B.9

They observed the greatest cumulative yield from 'Gala' trees on Geneva series rootstocks, including G.30 and G.935. G.935 had similar yields to commonly planted M.9 but is more resistant to fireblight, *Phytophthora* spp., and exhibits greater tolerance to replant disorders and cold damage. In contrast, B.9 rootstocks paired with 'Gala' resulted in the smallest trees and lowest yields. Overall, Geneva rootstocks evaluated during the course of the study (G.41, G.935, G.11, G.16 and G.30) produced tree size, cumulative yield and yield efficiency that were comparable or exceeded results from the widely-grown dwarfing M.9 rootstock. Due to the added benefit of reported resistance to fireblight, Geneva series could be great potential alternative to the Malling series in Virginia without sacrificing crop yield (Sherif et al. 2020).

Information gathered from US studies such as this should be taken with a grain of salt. It is well understood and documented where similar studies on rootstock/scion combinations tested in different regions, growth and architectural development can vary (Marini et al. 2006, Autio et al. 2011). It is found that nearly a quarter of variations among rootstock/scion combinations can be explained by factors such as wind, temperature variations and growing degree days (Foster et al. 2016). As this information comes from Virginia, results yielded from this study may not hold true for Ontario where soil types and hardiness zones vary greatly. Historically the NC-140 group (full link: http://www.nc140.org/) has led ongoing, multi-region research trials with the main objective of evaluating influence of rootstocks on fruit tree characteristics grown under varied environmental and production conditions. Many US states and provinces such as Ontario, BC and Quebec take part in this group by planting experimental trials to determine how rootstocks grafted on various tree fruits and varieties perform from region to region.

Here in Ontario, Dr. John Cline from the University of Guelph leads rootstock evaluations, some of which are affiliated with the NC-140 research group. Results from ongoing Ontario apple rootstock planting trials are being compiled and we hope to

This Newsletter is brought to you by the Ontario Apple Team:

Cassandra Russell, Simcoe
ONNL Editor
Acting Tree Fruit Specialist
(519) 426-1102
cassandra.russell2@ontario.ca

Dr. Jennifer DeEll, Simcoe
Fresh Market Quality Specialist
(519) 426-1408
jennifer.deell@ontario.ca

Dr. John Cline
University of Guelph, Simcoe
(519) 426-7127, ext. 331
jcline@uoguelph.ca

Kristy Grigg-McGuffin, Simcoe
Horticulture IPM Specialist
(519) 420-9422
Kristy.Grigg-McGuffin@ontario.ca

Hannah Fraser, Guelph
Entomologist-Horticulture
519-824-4120,ext 52671
hannah.fraser@ontario.ca

Anne Verhallen, Ridgetown,
Soil Management Specialist-Horticulture
(519) 674-1614
anne.verhallen@ontario.ca

Dr. Jason Deveau, Simcoe,
Application Technology Specialist
(519) 426-8934
jason.deveau@ontario.ca

John Zandstra
University of Guelph, Ridgetown
(519) 674-1500 ext 63627
jzandstra@ridgetownc.uoguelph.ca

Katie Goldenhar, Guelph
Pathologist—Horticulture
(519) 824-4120 ext 58910
katie.goldenhar@ontario.ca

Denise Beaton
Crop Protection Specialist
(519) 400-3636
denise.beaton@ontario.ca

This issue of the **Orchard Network Newsletter** was compiled by Jacquie De Fields,
Client Service Representative,
OMAFRA, Simcoe Resource Centre

have an update in the next issue of the Orchard Network Newsletter. Until then, previous research updates on Ontario rootstock trials can be found here: http://www.omafra.gov.on.ca/english/crops/hort/news/orchnews/2018/on-0218a3.htm

If considering rootstocks for new plantings, other useful general rootstock information can be found here:

http://www.omafra.gov.on.ca/english/crops/facts/00-007.htm
https://apples.extension.org/apple-rootstock-characteristics-and-descriptions/

Table 2. Effect of ten rootstocks on yield efficiency, total yield and cumulative yield efficiency from 2013-2017 of 'Buckeye Gala' trees grown in Winchester, Va. Table has been adapted from results published by Sherif et al. (2020).

Rootstocks	Yield efficiency (fruit weight, kg/trunk cross sectional area)	Total yield (2013 - 2017) (kg tree^{-1})	Cumulative yield efficiency (2013 – 2017)
G.41	0.69 abc	116.7 b	3.04 a
B.9	0.58 abc	55.0 c	2.71 ab
G.935	0.50 abcd	125.2 ab	2.54 abc
G.11	0.49 abcd	101.7 b	2.47 abc
G.30	0.65 ab	161.3 ab	2.28 bcd
G.16	0.52 abcd	120.0 b	2.05 cde
M.26	0.34 cd	86.1 bc	1.80 def
M.9 Nic 29	0.44 abcd	93.4 bc	1.65 ef
M.7	0.27 d	86.2 bc	1.35 f
MM.111	0.38 bcd	105.3 b	1.31 f

**Yield measurements do not include dropped fruits. Values with the same letter within a column are not significantly different (Tukey's HSD test, p=0.05).*

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Re-Evaluation Round-Up: Updates on Recent Registration Decisions Impacting Apple Growers

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA
Cassandra Russell, Tree Fruit Specialist, OMAFRA

The Pest Management Regulatory Agency (PMRA) has released a number of re-evaluation decisions recently that impact apple growers. Below is a summary of these changes including important dates of last use.
All information on past and present re-evaluations can be found in the Pesticide Product Information Database on the PMRA website (full link: https://pr-rp.hc-sc.gc.ca/pi-ip/index-eng.php).

The PMRA's [Re-evaluation and Special Review Work Plan 2020-2025](https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/decisions-updates/reevaluation-note/2020/special-review-work-plan.html) is also available on the PMRA website and lists anticipated dates for public consultation or final decision for pest control products (full link: https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/decisions-updates/reevaluation-note/2020/special-review-work-plan.html). However, with the on-going pandemic, there may be some delays in the release of certain documents.

Fungicides

Ethylene bisdithiocarbamate (EBDC)
The group of fungicides commonly referred to as EBDCs include the active ingredients, metiram (Polyram DF) and mancozeb (Penncozeb 75 Raincoat, Manzate Pro-Stick, Dithane Rainshield). An earlier review determined the cancellation of metiram due to worker exposure with a last date of use **June 21, 2021**. However, at that time, the PMRA retracted a similar final decision for mancozeb and a new re-evaluation decision was just released in November.

While strict risk-reduction measures have been put in place for use on apples, the good news is registration has been maintained for mancozeb. Registrants and retailers will have until **November 19, 2022** to transition to newly amended labels. See Table 1 for a summary of the risk-reduction measures.

We are currently seeking clarification on the maximum applications per year. Based on the re-evaluation decision, the label will state maximum 4 (full rate) applications per year. It is unclear if half rates will be acceptable and what the maximum number of applications would be. Stay tuned for more information on this and considerations for apple scab management strategies.

Captan
The final decision for the active ingredient, captan will have growers seeing a change in use pattern and formulation for registered products. This decision was based on worker exposure issues. As a result, the currently registered products, Maestro 80 DF and Supra Captan 80 WDG are being phased out and are replaced by formulations with water soluble packaging.

The last date of sale by retailers for these products was Spring 2020. Growers have until **May 10, 2021** to use up their supply, following the existing container label for rates, restricted entry interval (REI) and preharvest interval (PHI).
The new WSP formulations for Maestro 80 and Supra Captan 80 are available. These labels can be found on the PMRA label search. All required use pattern amendments are reflected on the labels and must be followed when using these formulations. See Table 1 for a summary of this information.

Thiophanate-methyl
The most recent re-evaluation decision to be released was for the active ingredient, thiophanate-methyl (Senator 50 SC). After considerable effort and time for a decision to be made, use on apples has been retained. Currently on the label, there are higher labelled rates for use in British Columbia only. Moving forward, these will be removed and the Eastern Canada rate will become the national maximum application rate. Increased risk-reduction measures will also be implemented including a preharvest interval of 7 days and maximum applications per year of 2. Restricted entry interval remains at 12 hours. Registrant and retailers will have up to 24 months from decision publication date of December 3, 2020 to make appropriate label amendments.

Other fungicides
In addition to the products mentioned above, Granuflo T and Ferbam 76 WDG are also phased for cancellation. See Table 2 for more information on these products.

Insecticides

Phosmet
Originally proposed for cancellation, the re-evaluation decision for the active ingredient, phosmet (Imidan WP) will maintain registration with strict risk-reduction measures in place for use on apples. Registrants and retailers will have until **October 30, 2022** to transition to newly amended labels. See Table 1 for a summary of the risk-reduction measures.

Neonicotinoids
A number of active ingredients belonging to the neonicotinoid insecticide group, including thiamethoxam (Actara 25 WG), imidacloprid (Admire 240 F, Alias 240 SC) and clothianidin (Clutch 50 WDG) have undergone special review for environmental concerns. The final decision for impacts to pollinator health and aquatic invertebrate special review has been released. All 3 active ingredients are being cancelled on apples.

During the re-evaluation for Actara and Clutch, lack of alternatives for the management of brown marmorated stink bug (BMSB) were identified. As a result, a 1-year extension was granted to allow growers to use these products for control of BMSB until 2022. The Clutch label that has now been posted on the PMRA website reflects this change, listing only BMSB for apples. The PMRA, however, has confirmed that growers can still continue to use the container label until April 2021 for all currently registered pests. See Table 2 for more information.

Other insecticides
In addition to the products mentioned above, Matador 120 EC and Silencer 120 EC have been proposed for cancellation. See Table 3 for more information.

Plant Growth Regulators

Ethrel
The re-evaluation decision for the active ingredient, ethephon (Ethrel) was published September 24, 2020 and will maintain registration on non-bearing trees but all uses on bearing trees such as promotion of early colouring, ripening, or loosing apples for harvest has been removed. This therefore revokes the 3 PPM maximum residue limit (MRL) on apples and juice and is now subject to the general MRL of 0.1 PPM.

In addition, stricter risk-reduction measures will now be in place including additional PPE requirements, restrictions on amount of ingredient handled per day, and longer restricted entry intervals for post-application activities on non-bearing trees (10 days for hand pruning/scouting/training, 2 days for transplanting, 12 hours for maintenance/weeding/other activities).

Registrants and retailers will have until **September 24, 2022** to transition to newly amended labels. Similarly, users will also have the same 24-month period from the decision date to transition to the newly amended labels.

Table 1. Use pattern amendments for the fungicide active ingredients, mancozeb (e.g., Dithane Rainshield, Manzate Pro-Stick, Penncozeb 75 Raincoat) and captan (e.g., Maestro 80 WSP, Supra Captan 80 WSP) and insecticide active ingredient, phosmet (e.g., Imidan WP)

Product	Orchard type	Rate	Min. interval between applications	Max. applications per year	Restricted entry interval	Preharvest interval
mancozeb	All types	4.5 kg a.i. / ha [1]	7 days	4 (full rate) [2]	12 hours (general re-entry) 35 days (hand thinning)	77 days
captan	High density (max. canopy width per tree <2 m)	3 kg/ha [3]	7 days	10	2 days (general re-entry) 6 days (hand pruning, training) 15 days (hand thinning, hand harvest)	7 days [4]
captan	Non-high density or standard (max. canopy width per tree >2 m)	3 kg/ha [3]	7 days	2	2 days (general re-entry) 4 days (hand pruning, training) 19 days (hand harvest) 24 days (hand thinning)	7 days [4]
phosmet	All types	1.875 kg a.i./ ha 1	14 days	2 (post-thinning only)	12 hours (general re-entry) 9 days (hand pruning, scouting, training) 22 days (hand harvest)	22 days

[1] Depends on formulation
[2] Currently no information is available on use of half rates. Stay tuned.
[3] Important side note, the high rate is required for effective control of fruit rot, fly speck and sooty blotch. Do not use a reduced rate if these diseases are of concern.
[4] Where restricted entry interval exceeds preharvest interval, use the longer interval.

Table 2. Pest control product cancellations (final decision) on apples

Pesticide Type	Product	Active Ingredient	Last Date of Use
Fungicide	Maestro 80 DF[1]	captan	May 10, 2021
	Supra Captan 80 WDG[1]	captan	May 10, 2021
	Polyram DF	metiram	June 21, 2021
	Granuflo T	thiram	December 14, 2021
	Ferbam 76 WDG	ferbam	December 14, 2021
Insecticide	Actara 25 WG[2]	thiamethoxam	April 11, 2021[3]
	Admire 240 F[2]	imidacloprid	April 11, 2021
	Alias 240 SC[2]	imidacloprid	April 11, 2021
	Clutch 50 WDG[2]	clothianidin	April 11, 2021[3]

[1] These formulation of the active ingredient captan are currently being phased out. New formulations of Maestro and Supra Captan are now available.
[2] Final decision for pollinator health special review.
[3] A 1-year extension was granted for control of brown marmorated stink bug. Last date of use for this pest is Apr 11, 2022.

Table 3. Anticipated date of final decision for pest control products registered on apples

Pesticide Type	Product	Active Ingredient	Proposed Action	Final Decision Expected
Insecticide	Madator 120 EC	lambda-cyhalothrin	cancellation	March 2021
	Silencer 120 EC	lambda-cyhalothrin	cancellation	March 2021

Crop Protection

What's New in 2021 for Publication 360A – Crop Protection Guide for Apples

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

A full revision of Publication 360A, *Crop Protection Guide for Apples* will be available in Spring 2021 for download or purchase from Service Ontario. This will have the latest information on crop protection and resistance management for commercial production of apples. Subscribe to ONfruit.ca to receive updates when the guide will be available online and in print. In the meantime, here is a list of new product additions, label expansions or changes to the apple guide.

New Registrations or Additions

Fungicides

Excalia (inpyrfluxam) *is* a Group 7 fungicide registered for the control of apple scab and powdery mildew at 146-219 mL/ha. Use with an organosilicone adjuvant (e.g., Xiameter) at a rate of 32-62 mL/100 L water if powdery mildew is the primary target. Do not use Excalia after petal fall. For resistance management, tank-mix with a compatible protectant apple scab fungicide from a different group. *Preharvest interval (PHI): petal fall; Restricted entry interval (REI): 12 hours; Maximum # of applications per year (on label): 2 (max. 438 mL/ha).*

Lifegard WG (*Bacillus mycoides* isolate J) is a Group P6 fungicide registered for the suppression of fire blight at a rate of 70-333 g/ha. Use the lower rate in 500 L of water and the higher rate in 1,000 L of water. Lifegard works by activating the tree's defense mechanisms and is most effective when it is applied before infection occurs or when added to a rotation where disease control has been maintained by an effective fungicide program. Begin program at pink and re-apply again at petal fall into summer sprays. Lifegard may be toxic to bees. Do not apply during bloom or when bees are active in the orchard. Initial inducement of plant defense response occurs soon after application, but 3-5 days are required to attain maximum level of protection.

Do not tank-mix with antibiotics (e.g., Streptomycin, Kasumin). *Preharvest interval (PHI): 0 days; Restricted entry interval (REI): 4 hours; Maximum # of applications per year (on label): not stated on label.*

Insecticides

Vayego 200 SC (tetraniliprole) is a Group 28 insecticide registered for the control of European apple sawfly, obliquebanded leafroller and codling moth at 225 mL/ha, oriental fruit moth at 300 mL/ha and suppression of mullein bug, plum curculio and apple maggot at 300 mL/ha. There are no tank-mix concerns with Vayego and strobilurins, copper or captan fungicides. This product is toxic to bees. Do not apply during bloom or when bees are active in the orchard. *Preharvest interval (PHI): 7 days; Restricted entry interval (REI): 12 hours; Maximum # of applications per year (on label): 3.*

Danitol (fenpropathrin) is a Group 3 insecticide registered for the control of apple maggot, codling moth, Japanese beetle, leafhoppers, obliquebanded leafroller, oriental fruit moth, tentiform leafminer and spring-feeding caterpillars at 0.78-1.55 L/ha. This product is highly toxic to beneficial insects and may lead to mite outbreaks. Maximum of 1 application per season. Use post-bloom is discouraged. *Preharvest interval (PHI): 16 days; Restricted entry interval (REI): 24 hours (general re-entry), 7 days (scouting, hand pruning), 16 days (hand harvest), 23 days (thinning); Maximum # of applications per year (on label): 1.*

Bioprotec PLUS (*Bacillus thuringiensis*) is a Group 11 insecticide that has replaced Bioprotec CAF for control of obliquebanded leafroller at 1.8-2.5 L/ha. Product must be consumed by the target insect to be effective. Apply in a high-volume spray to young larvae, early in infestation. Death of insect may take several days. Re-apply at 5-7-day intervals if activity is extended. Acidify spray mix to below pH 7 and apply on cloudy days or in the evening. *Preharvest interval (PHI): 0 days; Restricted entry interval (REI): 4 hours; Maximum # of applications per year (on label): not stated on label.*

Labamba (lambda-cyhalothrin) is a Group 3 insecticide with the same active ingredient as Matador 120 EC and Silencer 120 EC. It is registered for the control of rosy/green apple aphid, leafcurling midge, tentiform leafminer, codling moth, spring feeding caterpillar, obliquebanded leafroller and white apple leafhopper at 83 mL/ha and plant bugs, plum curculio and woolly apple aphid at 104 mL/ha. This product is highly toxic to beneficial insects and may lead to mite outbreaks. Use post-bloom is discouraged. *Preharvest interval (PHI): 7 days; Restricted entry interval (REI): 24 hours; Maximum # of applications per year (on label): 3.*

Poleci 2.5 EC (deltamethrin) is a Group 3 insecticide with the same active ingredient as Decis 5 EC. It is registered for the control of rosy/green apple aphid, mullein bug, plant bugs, spring feeding caterpillar, obliquebanded leafroller, white apple leafhopper at 400 mL/ha, leafcurling midge, codling moth and oriental fruit moth at 400-500 mL/ha and tentiform leafminer at 500 mL/ha. This product is highly toxic to beneficial insects and may lead to mite outbreaks. Use post-bloom is discouraged. *Preharvest interval (PHI): 1 day; Restricted entry interval (REI): 12 hours; Maximum # of applications per year (on label): 3.*

Aceta 70 WP (acetamiprid) is a Group 4A insecticide with the same active ingredient as Assail 70 WP. It is registered for the control of tentiform leafminer, white apple leafhopper and potato leafhopper at 80 g/ha, mullein bug at 80-160 g/ha, rosy apple aphid at 120 g/ha, plum curculio and apple maggot at 120-240 g/ha, codling moth at 170 g/ha, and European apple sawfly and oriental fruit moth at 240 g/ha. Repeated use of Group 4 insecticides may result in mite outbreaks. *Preharvest interval (PHI): 7 days; Restricted entry interval (REI): 12 hours (general re-entry), 48 hours (scouting), 6 days (hand thinning); Maximum # of applications per year (on label): 4.*

Velum Prime (fluopyram) is a Group 7 nematicide/fungicide with preventative, systemic and curative properties for the suppression of certain soil plant pathogenic nematodes and control of certain crop diseases such as powdery mildew. Apply in root zone through drip irrigation at a rate of 500 mL/ha beginning at planting. If Velum Prime has been used, fungicides from a different group should be applied for the first foliar fungicide application. Maintain a minimum 30-day interval between soil applications. *Preharvest interval (PHI): 7 days; Restricted entry interval (REI): 12 hours; Maximum # of applications per year (on label): max. 1 L/ha.*

Plant Growth Regulators

Novagib 10 L (gibberellins A_4A_7) is a plant growth regulator registered for russeting at 1.5-1.9 L/ha. Apply at 7-10 day intervals, beginning at petal fall. Do not apply in water volumes greater than 935 L/ha to reduce the risk of russet caused by spray water. When applied in the same season as prohexadione calcium (Apogee or Kudos), there may be reductions in efficacy of Novagib and/or prohexadione calcium. Do not add any kind of wetting adjuvant or surfactant unless you are sure of its crop safety. During wet or humid periods, use higher rate and shorten intervals between applications, particularly on large trees or susceptible cultivars. Do not use when temperatures are below freezing, above 30˚C or if rain is forecast within 6 hours. Novagib may reduce russeting caused by climatic factors during the first 30-40 days of development but cannot reduce russeting caused by pest, herbicide drift or phytotoxicity. *Preharvest interval (PHI): 28 days; Restricted entry interval (REI): 12 hours; Maximum # of applications per year (on label): 5.*

Label Expansions or Changes

Beleaf *(*flonicamid) is a Group 29 insecticide that has received label expansion for the suppression of plant bugs at the rate of 200 g/ha. Monitor for signs of feeding activity such as ooze near or on the flower buds. Do not use with adjuvants.

Two new FRAC groups have been classified:

- ***BM (microbial)*** – contains biologicals with multiple modes of action including Bio-Save 10 LP (*Pseudomonas syringae*), Blossom Protect (*Aureobasidium pullulans*), Double Nickel LC (*Bacillus amyloliquefaciens*) and Serenade OPTI (*Bacillus subtilis*) which were previously not classified.
- ***P7*** – contains plant defence inducers, Aliette WG (fosetyl al) and Phostrol (mono- and dibasic sodium, potassium and ammonium phosphites) which were previously classified as Group 33.

Information on insect (woolly apple aphid, borer) and disease (apple scab, powdery mildew, fire blight, rust, Phythophthora, replant disease complex) susceptibility ratings of common apple cultivars and rootstocks have been included in the guide to assist with management of these pests.

Product Removal or Cancellations

Several fungicides and insecticides have undergone recent re-evaluations by the Pest Management Regulatory Agency (PMRA). Those products where registration will be cancelled in early spring of 2021, such as Admire 240 F / Alias 240 SC (imidacloprid), Clutch 50 WDG (clothianidin) and Actara 25 WG (thiamethoxam) have been removed – with the exception of Clutch and Actara for brown marmorated stink bug.

For more information on recent re-evaluation decisions important to apple growers, see the December 2020 Orchard Network Newsletter article, Re-Evaluation Round-Up: Updates on Recent Registration Decisions Impacting Apple Growers.

Look Familiar? Apple Mosaic Virus in Ontario Orchards

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

Apple mosaic virus (ApMV) is a common virus of apples in the northeast. Most cultivars can be affected, but some such as Golden Delicious and Jonathan are known to express symptoms more severely. In 2020, there were several confirmations and reports of ApMV on Ambrosia across the province.

Typical symptoms include pale to bright cream blotches, patches, or banding on leaves (Figure 1). These spots may become necrotic as the leaf ages. Premature defoliation can occur. Distribution of symptoms throughout the canopy are often erratic or confined to a single limb or area. Often, symptoms can be more severe in years with cool to moderate springs.

Figure 1. Variation in expression of apple mosaic virus on Ambrosia. Typical symptoms are pale to bright cream blotches, patches or banding on

In most cases, there is no impact to yield. However, vigour can be impacted and affect bud set in severe cases. Virus can also make the tree more susceptible to other stressors like disease, winter injury or drought.

This virus is mechanically transmitted only. There are no known insect vectors or indication of field spread, other than potentially through root grafting in high density situations. Management is through the use of virus-free budwood.

OMAFRA will be doing a preliminary survey this winter to determine incidence of virus in the province. This will involve collection of 1-year wood from January 2021 to bud break. If you suspect there may be virus present in your orchard, please email or call/text Kristy Grigg-McGuffin (kristy.grigg-mcguffin@ontario.ca, 519-420-9422) or Katie Goldenhar (katie.goldenhar@ontario.ca, 519-835-5792).

Parasitism and Development of Degree Day Model for Apple Leafcurling Midge

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

In the last few years, apple leafcurling midge (ALCM, *Dasineura mali*) has become relatively well established in many orchards across the province. Injury from this pest can now be found in all growing regions, with pressure ranging from minimal (<1% of terminals infested) to severe (>80% of terminals infested) in both dwarf and semi-dwarf blocks.

Typical damage caused by this gall-forming midge can cause leaves to form a tight curl (gall) around the insect (Fig. 1). The galls interfere with or stunt normal growth and development of trees, especially in nursery or young plantings. In most cases, impact is minimal on older trees except when pest pressure is high (>60% leaf area damaged). Reduction of photosynthetic leaf area can adversely affect total carbon acquisition, fruit size and bud formation (Allison et al., 1995).

Figure 1. Typical damage caused by apple leafcurling midge.

Monitoring

Several studies from Europe have demonstrated a relationship between the number of ALCM caught on a pheromone trap for a particular generation and the number of galls that developed subsequently (Cross et al., 2009). It was estimated that a single ALCM male caught corresponds to approximately 140 galls/ha for that generation, provided there are sufficient shoots and new growth. In 5 Norfolk County orchards monitored in 2020, the average trap catch at petal fall was upwards of 1,500 – 2,000 ALCM / day (Fig. 2), which equals the potential for 210,000 – 280,000 galls / ha / day for a single generation alone.

Figure 2. Daily trap catch of apple leafcurling midge can be in the '000s in high pressure orchard blocks.

Commercial pheromone lures are available for use. While price per lure has decreased significantly in recent years, they are still rather costly. However, trapping helps to monitor onset of activity in the orchard and determine population pressure. The proposed economic threshold of 9 ALCM/trap/day (Cross & Hall, 2009) may work for low pressure sites, but those orchards with moderate to high pressure can see populations quickly exceed this threshold in only a matter of a few days.

Current monitoring includes:

- Trapping – Deployed at tight cluster.
- Scouting – Presence of a) females laying eggs in new terminals (Fig. 3), b) presence of orange eggs in unfurled leaves of terminal (Fig. 4), c) early onset of leaf curling (Fig. 5) or d) change of larva colour from cream to orange prior to pupating (Fig. 6).
- For more detailed description of life stages, see a previous Orchard Network Newsletter article, Apple Leafcurling Midge: What to Look For and When (full link: http://www.omafra.gov.on.ca/english/crops/hort/news/orchnews/2017/on-0217a8.htm)

Figure 3. Female apple leafcurling midge laying eggs in unfurled leaves of terminal.

Figure 4. Apple leafcurling midge eggs in folds of newest leaves of terminal.

Figure 5. Galls formed by apple leafcurling midge.

Figure 6. Late instar apple leafcurling midge turn bright orange before dropping to soil to pupate.

Biology

Since 2014, OMAFRA has been involved in national projects looking at the biology and management of this pest. One of these projects was just recently published in *The Canadian Entomologist* journal (Cossentine et al., 2020).

Based on trap captures, it has been determined ALCM has 3 distinct generations with flight beginning as early as tight cluster or pink in some regions (Fig. 7). Depending on the season, activity of the third generation can extend well into the fall. For example, in 2020, adults were still caught in traps and larva was present in late season terminal growth or root suckers until late October.

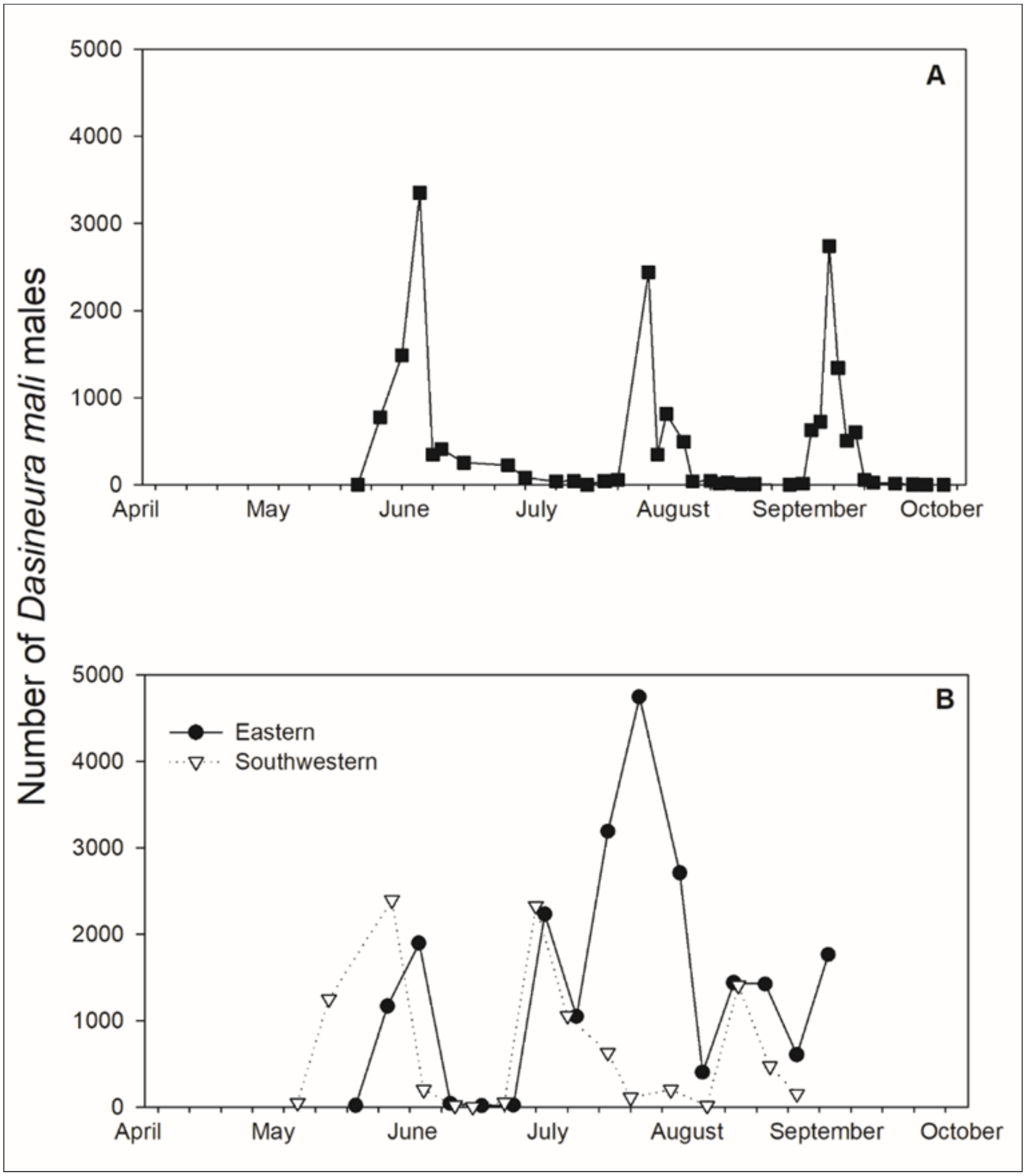

Figure 7. Pheromone trap captures of apple leafcurling midge in 2016 in A) Nova Scotia and B) Ontario orchards showing 3 distinct generations: mid-May to mid-June, mid-July to early August and late August to September or later. (Cossentine et al., 2020)

In most orchards monitored in Nova Scotia, Ontario and British Columbia, pest pressure and terminal damage increased as the season progressed (Fig. 8). However, in Ontario, the earlier generations have been shown to cause extensive damage from the onset of activity which stresses the importance of early intervention if this pest has been a problem in previous years.

An interesting finding to come out of the 2014-2016 national study was while populations from Nova Scotia, Ontario and British Columbia were morphologically similar, molecular analysis showed two genetically distinct groups: one from Nova Scotia and the other from Ontario and British Columbia. This could suggest either a high level of intraspecific genetic variation, especially if there were multiple invasions of ALCM in Canada, or that these two populations are cryptic, or separate species. In either case, genetic variability can play a role in how a species responds to control strategies; what works for one region, may not work for another.

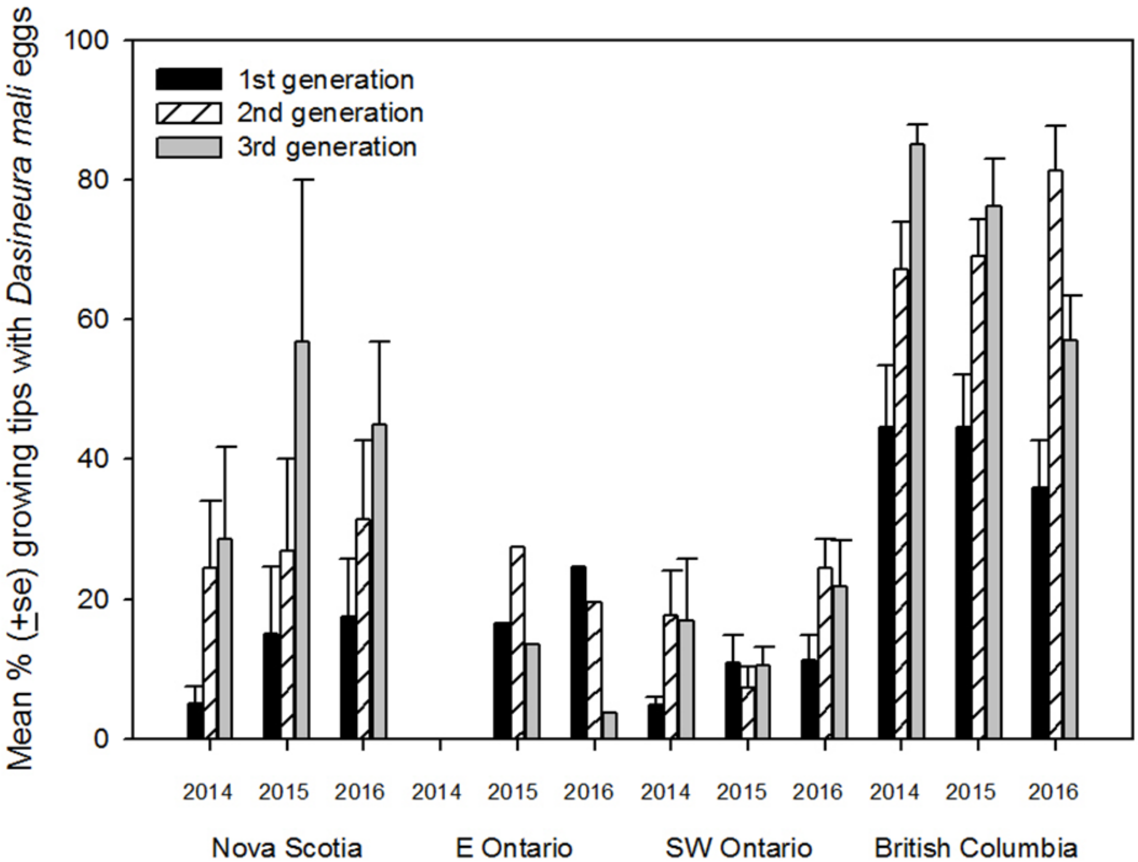

Figure 8. Mean percent terminal apple growing shoots infested with apple leafcurling midge eggs in each of the three generations, 2014-2016 (Cossentine et al., 2020).

Biological Control

In Europe, establishing and encouraging natural enemy populations is an important part of ALCM management. Several classical biological control introductions of parasitoids, *Inostemma contariniae*, *Platygaster marchali* and *Platygaster demades* were made in New Brunswick and Nova Scotia in the 1980's and 1990's, respectively. However, establishment, spread and impact of these introductions on ALCM populations have not been documented.

During the 2014-2016 national study, infested terminals were collected from all monitored orchards in Nova Scotia, Ontario and British Columbia. Leafcurling midge populations were reared at the Agriculture and Agri-Food Canada laboratory in Ottawa to identify potential parasitoid species.

The level of parasitism ranged from 2-40% of infested galls, with orchards using minimal spray or reduced-risk insecticide programs having greater incidences of parasitism. The parasitoid species complex differed among provinces, with *P. demades* being most abundant in Nova Scotia, *Lyrcus nigroaeneus* in Ontario and *Synopeas myles* in British Columbia (Table 1).

While *L. nigroaeneus* is native to Ontario, the other two species associated with the Ontario ALCM populations are exotic to the region: *P. tuberosula* was an introduced biological control of wheat midge and *S. myles* is a known parasitoid of the invasive swede midge. This study is the first known global record of *S. myles* parasitizing leafcurling midge.

Apart from this parasitism study, over the years of monitoring for ALCM in Ontario, it is clear that natural enemies play an important role. Mullein bug (Fig. 9a), minute pirate bug (Fig. 9b) and lady beetles are voracious feeders of ALCM larva and eggs. Be sure to note the presence of natural enemies while monitoring for ALCM and consider these populations when selecting control product. Refer to Table 3-6. *Toxicity of Pesticides to Honeybees and Mite/Aphid Predators* in the 2020-2021 Publication 360A, Crop Protection Guide for Apples.

Table 1. Parasitoid species associated with apple leafcurling midge infested orchards in Nova Scotia, Ontario and British Columbia, 2014-2016.

Province	Parasitoid species	Number of specimens
Nova Scotia	*Platygaster demades* (Walker)	391
	Platygaster tuberosula Kieffer	3
	Synopeas myles (Walker)	1
Ontario	*Lyrcus nigroaeneus* (Ashmead)	615
	Platygaster tuberosula Kieffer	30
	Synopeas myles (Walker)	1
British Columbia	*Synopeas myles* (Walker)	3,026
	Platygaster demades (Walker)	5
	Platygaster tuberosula Kieffer	1

Adapted from Cossentine et al. (2020)

Figure 9. (a) Mullein bug nymph and (b) minute pirate bug are common natural enemies of apple leafcurling midge.

Development of Degree Day Model

While the biology of ALCM is becoming well understood, management still remains a problem. Even with a systemic insecticide such as Movento, application timing is critical to target the appropriate life stages. Typically, growers don't notice there is a problem until galls appear which is often too little, too late. A degree-day model could help provide information necessary to know when appropriate measures should be applied.

Since 2018, seasonal trap catch and weather data from 38 sites across Canada, including 16 sites from Ontario, have been used to determine 5, 50 and 95% adult emergence for each generation. This model development is being led by the Bioclimatology and Modelling Research Team with Agriculture & Agri-Food Canada in Saint-Jean-sur-Richelieu, QC. Regional models are being developed due to the variation in Canadian climate from wet/warm (lower Fraser Valley, BC) to wet/cool (Maritimes) to temperate/dry (Quebec and Ontario) as well as varied winter temperatures and snow cover. All models are using a biofix of March 1st and base temperature of 9˚C.

In Ontario, we are currently validating the models based on trap catch from orchards in Niagara, Simcoe and Harrow. Figure 10 shows a comparison of the preliminary model predictions to the actual ALCM activity from 5 Norfolk County orchards. This evaluation will continue in 2021 with an updated model containing 3 years of trap data.

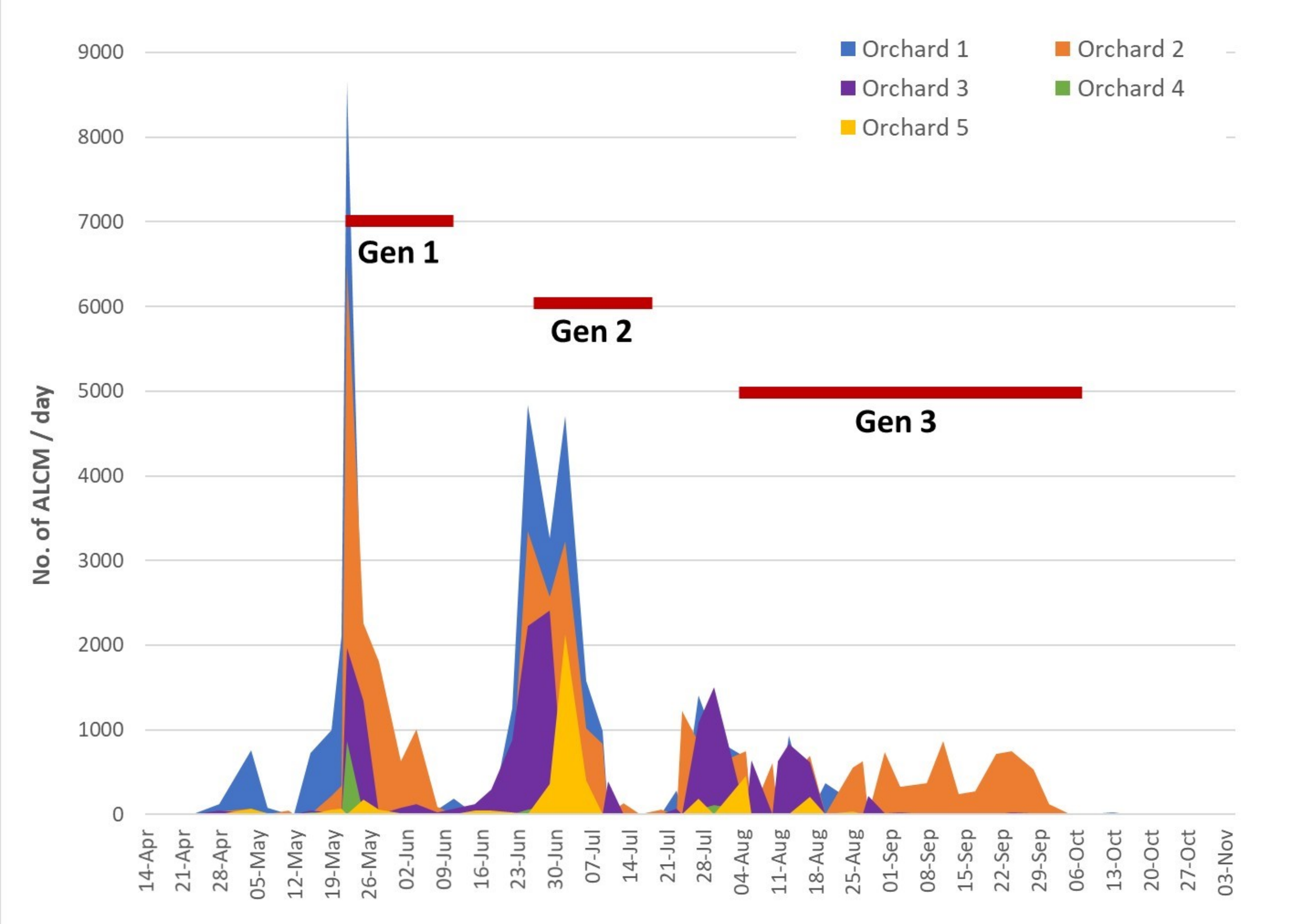

Figure 10. Number of apple leafcurling midge adult males trapped per day from 5 orchards in Norfolk County, ON from April to November 2020. Red lines represent predicted period of activity for first, second and third generations (Gen 1, Gen 2 and Gen 3, respectively) based on a regional degree day model using 2018 data only.

Acknowledgements
These projects were generously funded through the Agriculture and Agri-Food Canada (2014-2016) and Canadian Agri-Science Cluster for Horticulture 3, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Canadian Agricultural Partnership initiative, the Canadian Horticultural Council, and industry contributors (2018-present).

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Using Genetic Tests to Confirm Herbicide Resistant Weeds in Ontario Horticulture Crops: 2020 Project Summary

Kristen Obeid, Weed Management Specialist – Horticulture, OMAFRA

Background

Since 2016, this project has created 16 genetic quick tests (5 more in progress) to assist in identifying herbicide resistance in 12 weed species and confirmed 94 new cases of herbicide resistance in horticulture crops. These tests deliver a diagnostic and a recommendation to the grower within the same growing season. Traditional resistance testing in the greenhouse can take from three months to a year to get results back to growers. Now, leaf tissue instead of seed is collected. DNA is extracted from the leaf tissue to determine if there is a change in the sequencing resulting in a mutation making the plant resistant.

Tests have also been developed to differentiate between Brassica and Amaranthus (pigweed) species. Tests differentiating pigweed species have been instrumental in confirming new cases of waterhemp in Ontario, Manitoba and Quebec. Once confirmed, the waterhemp was tested for Groups 2, 5, 9 and 14 resistances.

Table 1. Genetic tests currently utilized by the labs

Weed Species	Herbicide Group	Resistance & Tests
Large crabgrass	1	Metabolic: ACCase gene amplification
Common chickweed	2	Target-site (P197Q & unpublished)
Common ragweed	2	Target-site (W574L)
Eastern black nightshade	2	Target-site (A205V)
Green pigweed	2	Target-site (S653N & W574L)
Giant foxtail	2	Target-site (unpublished)
Redroot pigweed	2	Target-site (S653N & W574L)
Waterhemp	2	Target-site (S653N & W574L)
Common ragweed	5&7	Target-site (V219I)
Green pigweed	5&7	Target-site (A251V, S264G*, V219I & F274L)
Lamb's-quarters	5	Target-site (S264G)
Redroot pigweed	5&7	Target-site (A251V, S264G*, V219I & F274L)
Waterhemp	5&7	Target-site (A251V, S264G*, V219I & F274L)
Brassica spp.	9	Presence of transgene
Canada fleabane	9	Target-site (P106S)
Waterhemp	9	Metabolic: EPSPS gene amplification
Waterhemp	14	Target-site (ΔG210 in PPX2L)
Amaranthus spp.	-	Species identification
Brassica spp.	-	Species identification

**S264G mutation only induces resistance to Group 5 herbicides, not Group 7*

In 2018, the protocols for these tests were shared with the Pest Diagnostic Lab of the Quebec Ministry of Agriculture, Fisheries and Food (MAPAQ) and the weeds lab of AAFC's Harrow Research and Development Centre as a pilot project and made available to extension personal in Ontario and Quebec to submit samples, providing the diagnostic service to growers.

In 2019, all samples were sent from Ontario to the Pest Diagnostic Lab of the Quebec Ministry of Agriculture, Fisheries and Food (MAPAQ), whom provided the testing for free. In 2020, MAPAQ could no longer accept samples form out of province.

In 2020, Harvest Genomics (www.harvestgenomics.ca) signed an agreement with AAFC to obtain the protocols and started to provide the service to Ontario growers for a fee. The funding obtained from the project sponsors has been utilized to pay for this service. Due to COVID-19 there was a decrease in field sampling. Funds that were not utilized in 2020 will be carried forward to provide the same service to Ontario growers in 2021. No funding will be invoiced or requested for 2021. For the organizations that committed to funding for 2021, we request that the project be extended to 2022.

Results

Table 2. 2020 Results to date in Ontario (15 fields are still being analyzed)

Crop	Weed	Herbicide Group	Total Fields	Positive Tests	%
Carrots	Lamb's-quarters	5	1	0	0
Carrots	Green pigweed	2, 5, 7**	1	1	100
Carrots	Pigweed species	5, 7	1	1	100
Corn	Pigweed species	5	1	1	100
Kidney Beans	Pigweed species	2, 5, 7	1	0	0
Onion	Green pigweed	2, 5, 7	1	0	0
Peas	Pigweed species	2*, 5, 7	6	6	100
Potatoes	Lamb's-quarters	5	1	1	100
Potatoes	Pigweed species	2, 5, 7**	4	4	100
Seed Corn	Pigweed species	2, 5***,7	2	2	100
Soybeans	Canada fleabane	9	1	1	100
Soybeans	Common ragweed	2, 5, 7	1	1	100
Soybeans	Eastern black night-shade	2, 5, 7	1	0	0
Soybeans	Lamb's-quarters	5	1	0	0
Soybeans	Waterhemp	2	7	6	86
		5, 7		0	0
		9		3	43
		14		7	100
Sweet Corn	Pigweed species	5	1	1	100
Tomato	Pigweed species	2, 5***, 7	1	1	100
Total			**32**	**27**	**84**

**Resistant to Group 2 only*
***Resistant to Groups 5&7 only*
****Resistant to Group 5 only*
Note: Pigweed species includes redroot pigweed and green pigweed

Since 2016, the most significant trend is the increase in the number of fields with multiple resistant species:

- Common ragweed resistant to herbicide Groups 2 and 5 in pumpkins and 2, 5 and 7 in soybeans
- Redroot and green pigweed resistant to herbicide groups 2 and 5 in tomatoes
- Redroot and green pigweed resistant to herbicide Groups 5 and 7 in carrots and potatoes
- Waterhemp resistant to herbicide Groups 2, 5, 9 and 14 in asparagus, peppers, soybeans and corn

Another significant trend is the increased documentation of Canada fleabane resistant to glyphosate (Group 9) in apples, grapes, carrots, onions and pumpkins.

This testing has been instrumental in documenting new cases of herbicide resistant weeds. 80% of submitted weed samples tested positive. Once confirmed producers were provided the resistance profile enabling a change in management to mitigate spread. Producers, agri-business and consultants that participated in the project were pleased with the timely results and welcomed the in-season management recommendations.

There are many more undocumented cases of herbicide resistant weeds in Canada. The resistance mechanism is unknown for most of them. The major concern is their distribution and economic impact for producers. Knowing where resistant biotypes are located will improve management and maintain the longevity of our crop protection tools.

Project partners include: AAFC, AAFC-PMC, Bayer CropScience Inc., FMC Corporation, FVGO, MAPAQ, OAG, OFVGA, OPVG and Syngenta Canada Inc.

Spotted Lanternfly Getting Too Close for Comfort!

Denise Beaton, Crop Protection Specialist, OMAFRA
Hannah Fraser, Entomologist – Horticulture, OMAFRA

Early Detection is Critical

Keep a watchful eye out for the invasive planthopper, **spotted lanternfly** (*Lycorma delicatula*) (Fig. 1). This voracious sap-feeding insect attacks various crops, landscape ornamentals and hardwood trees. Established populations have NOT been found in Canada (yet) but is moving closer and closer to our Ontario border with recent detections in New York and Michigan.

Early detection of any spotted lanternfly sightings is CRUCIAL so we can act quickly and limit its spread. **Report any suspected finds immediately** to the Canadian Food Inspection Agency (CFIA) online or by calling 1-800-442-2342. (full link: https://www.inspection.gc.ca/about-cfia/contact-us/contact-cfia-online/eng/1299860523723/1299860643049)

Figure 1. Spotted lanternfly adult. (Photo: Emelie Swackhamer, Penn State University, Bugwood.org)

Distribution

Native to Asia, spotted lanternfly was identified in Pennsylvania in 2014. Despite containment efforts, this pest has spread further and established populations are now found in various regions across the United States (Fig. 2). In September 2020, the CFIA confirmed the identification of two dead spotted lanternflies on commercial trucks travelling from Pennsylvania to Quebec, illustrating the pests' capacity for being spread quickly over large geographic areas by human activities.

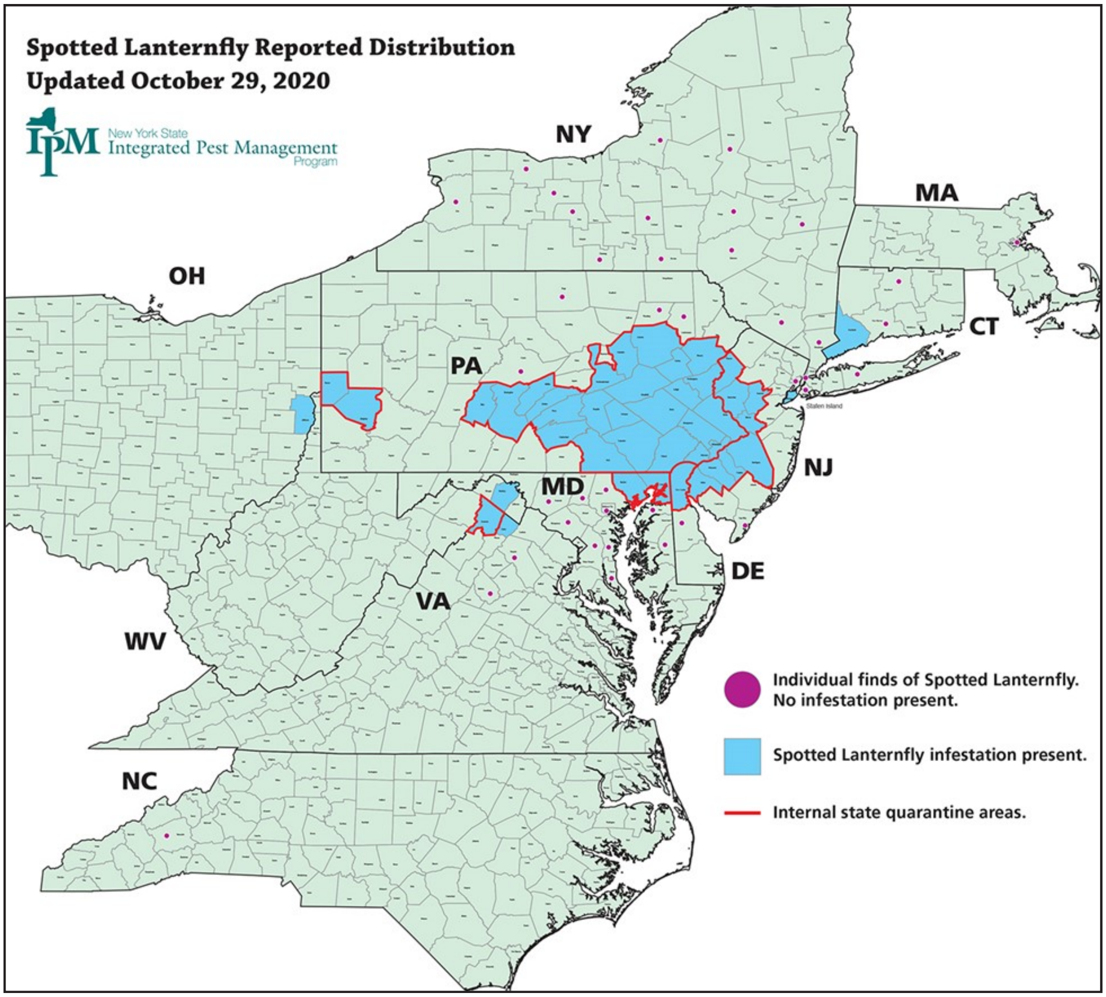

Figure 2. Map of spotted lanternfly reports in the northeastern regions of the United States, as of October 29, 2020 (Source: New York State Integrated Pest Management, Cornell University)

Crops at Risk

There are over 70 documented hosts in North America, including grapevines, fruit trees (apple, peach, plum, cherry), hops and hardwoods (black walnut, maple).

Aggregations (swarms) of nymphs and adults damage plants directly by feeding on plant sap, and indirectly by excreting large amounts of honeydew (sugary waste) that promotes the development of sooty mold and interferes with photosynthesis. The sooty mold also attracts insects such as ants, wasps and bees.

Reports of economic injury in Pennsylvania have occurred in commercial vineyards, where swarm feeding has resulted in yield loss, decreased sugar content in harvested grapes, and weakening and death of vines (Fig. 3). For trees, heavy feeding from spotted lanternfly feeding doesn't usually kill the tree but is a stressor and some dieback can occur.

Figure 3. Swarm of spotted lanternfly on grapevines. (Photo: Erica Smyers, Penn State University)

Be Prepared

The spotted lanternfly is an excellent hitchhiker. Adults can cling to cars moving at high speeds for long distances. Females indiscriminately lay eggs on any smooth surface (vehicles, stones, lawn furniture, etc.); egg masses are difficult to detect, can be moved over great distances, and represent the life stage adapted to overwintering.

With so many different pathways and potential points of entry, monitoring presents a big challenge. In 2016 and 2018, OMAFRA monitored high risk areas using sticky tree bands (Fig. 4). No spotted lanternfly was detected, but it was like looking for a needle in a haystack. Ontario is a big province!

In 2019, a Spotted Lanternfly Education and Outreach Committee was. Members include the Invasive Species Centre, CFIA, OMAFRA, Ontario Federation of Anglers and Hunters, industry representatives and city foresters. Currently, the best plan of attack for Ontario is to have as many trained eyes as possible on the look-out for this unique-looking invasive insect.

Figure 4. OMAFRA putting up a sticky tree band to monitor for spotted lanternfly in 2018.

Know What to Look For

In the mid-Atlantic states, overwintering egg masses are laid through the fall. The egg masses usually have about 30 to 50 eggs and are laid in parallel lines. Fresh egg masses are covered in a waxy coating (Fig. 5a) that wears off over time (Fig. 5b & 5c).

Figure 5(a). Spotted lanternfly fresh egg mass. (Photo: Pennsylvania Department of Agriculture, Bugwood.org)

Figure 5(b). Spotted lanternfly older egg masses. The waxy coating is starting to crack. (Photo: Emelie Swackhamer, Penn State University, Bugwood.org)

Figure 5(c). Spotted lanternfly eggs with the waxy coating coming off and some eggs have hatched. (Photo: Emelie Swackhamer, Penn State University, Bugwood.org)

Nymphs begin to appear in the late spring. The first three instars are small and black with white spots (Fig. 6a). They feed and move almost constantly. Keep a close eye on grapes, tree-of-heaven, black walnut, butternut, willow, birch, sumac and roses around your property as nymphs seem to prefer these hosts.

Fourth instar nymphs have distinct red patches (Fig. 6b). Late instar nymphs tend to cluster together on preferred hosts, such as tree-of-heaven and black walnut.

Figure 6(a). Spotted lanternfly early instar nymphs are black with white spots. (Photo: Emelie Swackhamer, Penn State University,

Figure 6(b). Spotted lanternfly late instar nymphs are red and black with white spots. (Photo: Richard Gardner, Bugwood.org)

Adults appear mid-July and are active until they are killed by cold temperatures. They are large (25 mm long) and easy to identify: front wings are pale with black spots at the front and dark net-like bands at the tip (Fig. 7a), while rear wings have bands of red, black and white (Fig. 7b). In vineyards, adults tend to show up along borders first. There are reports that spotted lanternfly adults are poor flyers; however, they can travel a long distance with the right conditions.

Figure 7(a). Spotted lanternfly adult. Front wings are pale with black spots at the front and dark net-like bands at the tip. (Photo: Emelie Swackhamer, Penn State University, Bugwood.org)

Figure 7(b). Spotted lanternfly adult. Rear wings have bands of red, black and white. (Photo: Richard Gardner, Bugwood.org)

There is one generation of spotted lanternfly per year (Fig. 8). Recent observations show that spotted lanternfly does not require tree-of-heaven to survive, but comprehensive information on host use requires additional research.

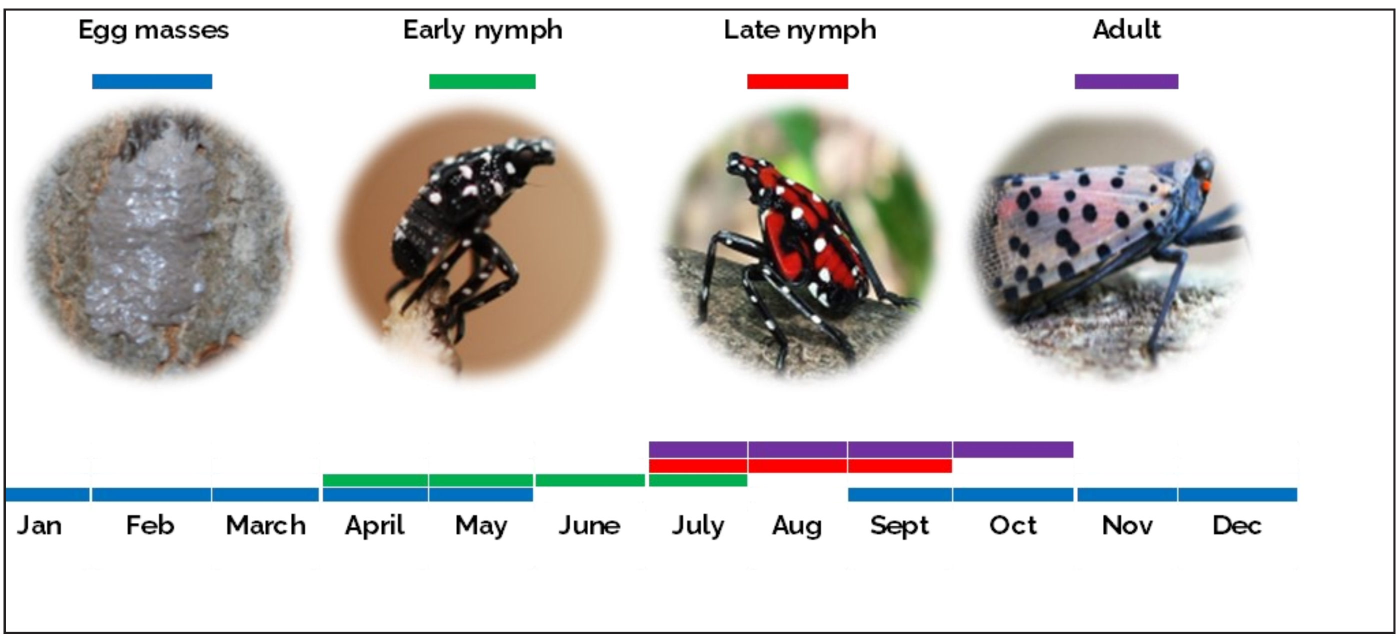

Figure 8. Lifecycle of spotted lanternfly. Timing of each life stage is based on information from Pennsylvania, US. (Photos: Lawrence Barringer, Pennsylvania Department of Agriculture)

Management in the United States

In the US, research is being conducted to develop better tools for monitoring and management. You will find the latest information on Penn State Extension's spotted lanternfly website (full link: https://extension.psu.edu/spotted-lanternfly). Current management in the US includes:

- **Remove and destroy egg masses -** Scrape off into a container and place in alcohol (hand sanitizer, rubbing alcohol, other). Check vehicles, farm equipment and other hard surfaced items thoroughly for egg masses if coming from infested areas.
- **Remove tree-of heaven –** May help reduce numbers but may not be practical if present in large numbers. Herbicides can be applied to control suckers. Since other hosts may prove suitable to complete development, attempts at eradicating tree-of-heaven as a management strategy may prove ineffective.
- **Use sticky tree bands** - Helps reduce numbers of nymphs. To avoid catching non-target organisms, use large-gauge mesh over the band, or alternatively, inward-facing sticky bands to intercept nymphs as they climb up host trees. Research to develop better traps is ongoing.
- **Encourage natural enemies** – This includes spiders, assassin bugs, praying mantis and others that prey on spotted lanternfly. Relying on natural enemies alone may not be enough to control a high population. Parasitic wasps have been identified in China but require evaluation for non-target effects.
- **Use insect-pathogenic fungi -** Fungal pathogens, such as *Beauveria bassiana*, are being evaluated. The entomopathogenic fungus *Baktoa major* has been found in association with SLF in Pennsylvania and appears to be highly virulent against the pest.
- **Apply insecticides –** Products containing bifenthrin, thiamethoxam, dinotefuran, carbaryl, fenpropathrin, malathion or zeta-cypermethrin provide effective control of nymphs and adults. Chlorpyrifos is the only active ingredient that gave high mortality of eggs. Mineral oil has shown egg mortality of up to 71%. For landscape trees, they have used tree injections, trunk sprays or soil drenches with certain neonicotinoid insecticides with excellent results. **Currently, we do not have any registered uses for the control of spotted lanternfly in Canada**; however, the pest has been prioritized through the Minor Use Program for the high-risk crops.

Post Harvest

Lenticel Breakdown in Apples: from the Orchard to Storage

Dr. Jennifer DeEll, Fresh Market Quality Specialist – Horticulture Crops, OMAFRA

Susceptibility to lenticel breakdown is often determined in the orchard, but the symptoms usually develop or become worse after harvest. Lenticels begin to dry out or crack, and the disorder is characterized by dark or blackened lenticels, or small superficial brown spots circling the lenticels. These lesions become sunken over time and eventually allow pathogens to enter, causing rots (Figure 1).

Figure 1. Lenticel breakdown in 'Gala' apple after storage

Micro-cracks develop in the fruit cuticle when apples are growing quickly. Lenticels are most susceptible to cracking and desiccation because they are exposed and provide access points for irritants and water, which eventually lead to cell death and pitting. Irritants can be dust, orchard sprays, agri-chemicals, or salts dissolved in water, especially when there are rapid large temperature changes as well.

Plenty of lenticel breakdown was observed in Ontario apple orchards during the 2020 growing season (Figure 2). According to Kristy Grigg-McGuffin (OMAFRA), researchers within the Great Lakes region saw symptoms like lenticel breakdown in previous years related to the use of certain methyl benzimidazole carbamates, or Group 1 fungicides during periods of rapid fruit growth. However, it is not known at this time whether the currently registered Group 1 product, Senator 50 SC (thiophanate-methyl) can cause this type of injury.

Other pre-harvest factors that increase the risk of lenticel breakdown include: mineral imbalances, especially high (K+Mg)/Ca and N/Ca ratios; rapid changes in weather resulting in rapid fruit growth; and advanced fruit maturity at harvest, like when delaying harvest for color development. Lenticel damage is set-up pre-harvest when fruit are growing, but often disorder symptoms are expressed after postharvest handling.

Apples harvested with advanced maturity are highly susceptible to lenticel breakdown. Extended storage duration for the maturity of the fruit will also increase susceptibility.

Dump tank chemicals, soaps and detergents, waxes, and 1-MCP treatments can further aggravate lenticel breakdown. A large temperature difference between cold fruit and warmer hot water on the packing line will also exacerbate the problem.

Adhering to good pre- and postharvest practices can help reduce the risk of lenticel breakdown. Shorten the storage period for high risk fruit and minimize large temperature swings. Harvesting at optimum fruit maturity is a very important key factor!

Figure 2. Lenticel breakdown in 'Gala' apple observed in the orchard (Source: C. Russell, OMAFRA).

Risk of Storage Disorders in Apples for 2020-21 Storage Season

Dr. Jennifer DeEll, Fresh Market Quality Specialist – Horticulture Crops, OMAFRA

CIPRA is a computer-based program developed by the research team of Dr. Gaétan Bourgeois (AAFC-QC) that uses weather data to predict the risk susceptibility of apples to specific storage disorders (Bourgeois, DeEll, and Plouffe). According to CIPRA models using weather data until September 15, 2020 from Delhi (Norfolk County, ON), there is little risk of chilling-related flesh browning disorders developing in apples here during the current storage season (Figure 1).

Using specific models for bitter pit and soft scald development, CIPRA with weather data from Environment Canada shows varying risk susceptibility around Ontario (Table 1). East of Toronto has the highest risk for both bitter pit and soft scald during storage this season, while Collingwood area around the Georgian Bay has the lowest risk.

Regardless of growing season and annual risk susceptibility, it is important to use the recommended storage temperatures and regimes for specific apple cultivars. 'Honeycrisp', 'Empire', and 'McIntosh' are especially susceptible to chilling-related disorders (i.e. soft scald, soggy breakdown, flesh browning, low temperature breakdown, core browning) and therefore, symptoms can develop by using lower than optimum storage temperatures in any year. Late harvested apples are also more prone to developing chilling-related disorders, such as flesh browning in 'Empire' or soft scald and soggy breakdown in 'Honeycrisp'.

At the time of writing, there has already been plenty of soft scald observed this season in 'Honeycrisp' stored below the recommended temperature of 3°C, as well as in those without conditioning at 10°C prior to storage at 3°C. Therefore, it is important to manage your storage regimes and apple marketing accordingly.

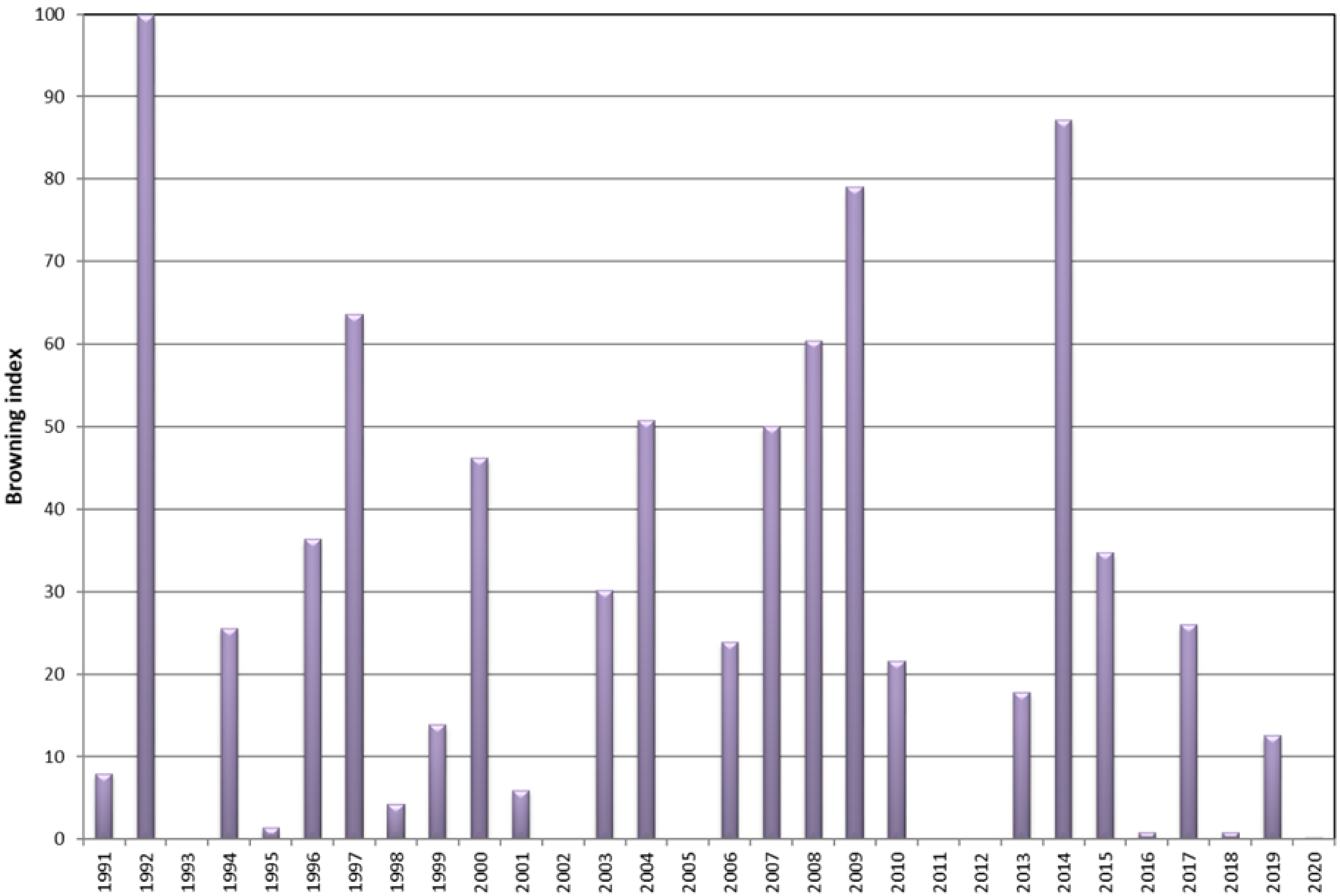

Figure 1. Risk of developing chilling-related flesh browning disorders during the past 30 years (1991-2020), for the region of Simcoe-Delhi (Norfolk County), Ontario.

** Graph supplied by D. Plouffe, AAFC-QC*

Table 1. Risk of developing bitter pit or soft scald in four apple producing regions of Ontario

Region	Risk % Bitter pit	Risk % Soft scald
Delhi	0	26
Brantford	2	32
Collingwood	0	8
Oshawa	21	15

** Data supplied by D. Plouffe, AAFC-QC*

Announcements

Participate in a study monitoring pathogens in orchards using bees

Raj Vansiya, Student Researcher, Agriculture and Agri-food Canada
Jonathan Griffiths, Research Scientist, Agriculture and Agri-food Canada

Are you interested in a new approach to identify pathogens in your orchards? We are seeking growers who are willing to allow us to screen for plant pathogens using bees on their farms. We are developing a method of monitoring tree fruit orchards and blueberry farms to screen for pathogens using genomics-based sequencing approaches. We are interested in sampling from a variety of tree fruit orchards (apples, cherries, peaches, pears, plums) and blueberry farms. By collecting pollen and bee samples from an orchard, we can get a good idea of any pollen transmittable pathogens present in the orchard. Major pollen transmitted viruses include Apple Mosaic Virus, Prunus Necrotic Ringspot Virus, and Tomato Ringspot Virus. We are hoping to work with growers in the region to obtain pollen and bee samples during pollination of orchards and blueberry farms. We would need access to your farm during the month of May and the permission of the owner of the beehives to sample. For more information, please reach out to **Raj Vansiya at 647-884-7853 or raj.vansiya@canada.ca,** or Research Scientist Jonathan Griffiths at jonathan.griffiths@canada.ca.

New book on air-assisted spraying available soon

Dr. Jason Deveau, Application Technology Specialist, OMAFRA

We're happy to announce the development of **"Airblast101 – Your Guide to Effective and Efficient Spraying, 2nd edition"**. The book began in 2010 as a classroom-based workshop for Ontario's airblast sprayer operators. It was intended as a primer and decision-support tool for operators to become safer, more effective and more efficient.

After several prior iterations, the first textbook edition was made freely available in 2015 as an ePub, or at cost in hard copy. It won the 2016 Canadian Agri-Marketing Association's "Certificate of Merit" in the Special Publications Category. Well over a thousand copies have been circulated worldwide… but it was never really intended for an international audience.

And so, in late 2019, US sprayer specialist Mark Ledebuhr (Application Insight LLC) and NZ sprayer specialist Dr. David Manktelow (Applied Research and Technologies Ltd.) kindly agreed to co-author a second edition. Once completed, it will once again be freely available as an ePub, or at cost via print-on-demand publishing.

We anticipate availability by the end of 2020. We will continue to update interested parties on our progress and how to eventually order copies at https://sprayers101.com/airblast101/

Why a second edition?

The familiar "Airblast 101" title is, perhaps, no longer accurate. The original emphasis was on the classic, low profile radial design developed in the 1940's when it was recognized that pushing spray with air gave better coverage with less water. These sprayers continue to dominate in specialty crops around the world because they are simple, economical, and can operate effectively across a wide range of canopy forms and planting geometries.

But, air-assist sprayer design has evolved and diversified. With this new edition we've broadened the scope to include all air-assist sprayers. We hope to introduce you to equipment and practices you may never have personally encountered. We will also give you the tools to assess their relevance to your operation. This required a deeper dive into the physics of spraying, but we've kept the tone conversational and relied heavily on illustration to make concepts accessible.
The new edition continues to focus on three central themes:

- Understanding the forces that influence air and spray droplet behaviour.
- How to configure a sprayer to optimize coverage and minimize waste.
- How to evaluate spray coverage.

So, perhaps you're new to air-assist spraying and deciding which sprayer is right for your operation. Perhaps you're an experienced operator re-evaluating your practices. Maybe you're a farm manager, a government pesticide regulator, an agricultural extension specialist, an equipment manufacturer, a consultant, an agrichemical sales representative or a researcher. No matter your perspective, if you're interested in air-assisted spraying, the new edition will have something for you.

Contents

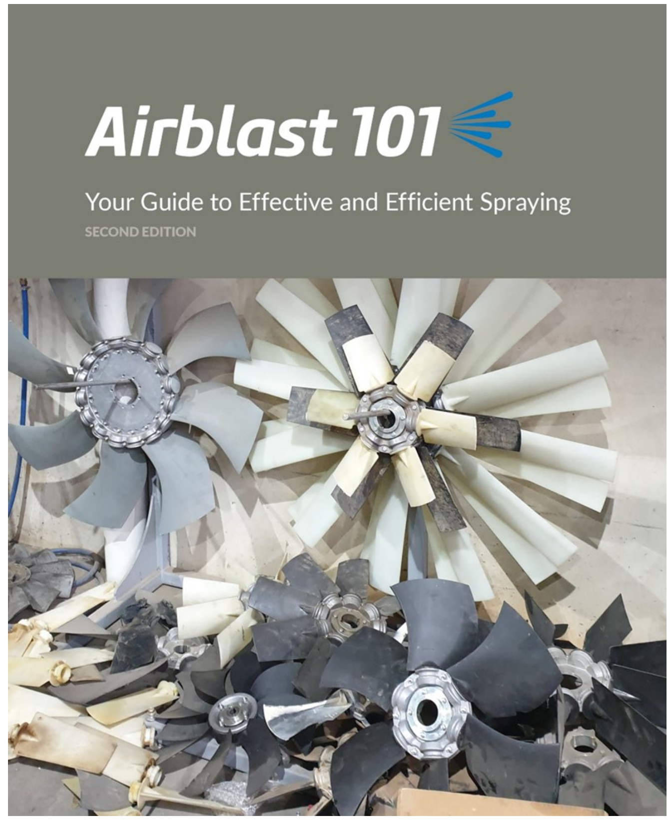

Figure 1. Cover of Airblast101 – Your Guide to Effective and **Efficient Spraying, 2nd edition.**

Agricultural Information Contact Centre: 1-877-424-1300
www.ontario.ca/omafra