

# ORCHARD NETWORK

*For Commercial Apple Producers*

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In this issue…





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# Orchard Management

## 2022 Virtual Orchard Meet-up Series Orchard Efficiencies: Labour & Technology Summaries

*Erika DeBrouwer, Tree Fruit Specialist, OMAFRA*

The second season of the Virtual Orchard Meetups occurred throughout June and July of 2022. This year's theme was Orchard Efficiency: Labour and Technology. These webinars provided an opportunity to review challenges, best practices, and new recommendations for orchard labour and technology, which were led by a panel of scientists, growers and other experts across North America. There we four webinars in total:

- Webinar 1: Labour – Grower Experiences
- Webinar 2: Labour – Expert Panel
- Webinar 3: Technology – Grower Experiences
- Webinar 4: Technology – Expert Panel

This extension effort was conducted across North America in close collaboration with the International Fruit Tree Association (IFTA), the AI Institute for Transforming Workforce & Decision Support AgAID, and Cornell Institute for Digital Agriculture (CIDA). The Virtual Orchard Meetup series was organized and facilitated by the following:

Anna Wallis, MSU
Bernardita Sallato, WSU Extension
Mario Miranda Sazo, Cornell Cooperative Extension
Daniel Weber, PSU Extension
Kristy Grigg-McGuffin, OMAFRA

### Webinar 1: Labour – Grower Experiences

Robert McGraw, Gilbert Orchards, Washington
Bobby Brown, Orchard Dale Fruit Company, New York
Steve Skelonc, Riverridge Produce Marketing, Michigan
Manus Boonzaier, Algoma Orchards, Ontario

***Operation Overview***

All growers stated similar notes based on their operation size and experience, encompassing where their employees are from, which program they utilize and how involved they are directly with their workers.

Larger operations, including Washington and Ontario, had levels of communication. Where regional/junior managers would be in direct contact with crew bosses/team leaders, which managed crews. Smaller operations had more direct contact with employees.

***Q1. How do you manage your employees?***

All growers agreed that the arrival, orientation, and training was of the utmost importance, but each had a different approach upon arrival.

In Washington, Gilbert Orchards would supply employees with a welcome kit, food and allowed the rest of the day to shower and get comfortable. They would then have a 2- or 3-day orientation, where examples of previous challenges that occurred onsite were gone over to make sure everyone understood who to connect with regarding issues. Robert stressed the importance of meeting every bus that comes to Gilbert Orchards and new employees would be asked to lean on veteran employees for support.

At Orchard Dale Fruit Company in New York, Bobby would have a similar approach where new employees would lean on veterans, but also mentioned the importance of variation throughout the season. For example, he stressed that during certain activities in the orchard, the need to be conducted in a timely manner, where communication is key to make sure jobs are completed efficiently and effectively.

Steve from Riverridge Produce Marketing based in Michigan, also hit on the points that Bobby addressed. Steve stated that training and comfort with the task at hand is of the utmost importance, usually spending an hour in training of the task at hand, whether that be thinning or feathering to make sure employees are comfortable. He mentioned that the language barrier can be difficult with his employees, as most are native Spanish speakers. He hopes to learn the language to better communicate.

In Ontario, Manus agreed with all of the points above, adding that they take employees to get groceries upon arrival. Crews include a bus driver for weekly grocery pickup, as it's a small town so they get groceries in small groups. He also noted that he pays employees in advance upon arrival to get them started with grocery payments or to send home to families, rather than them asking for a loan.

***Q2. Do women work on your operation? How do you make them comfortable?***

Manus and Bobby stated that no women work on their operation. Steve also stated that they don't have female employees but have family housing for those employees who bring their family with them. Robert said that there are various female employees among their operation, mostly cleaning houses and in supervisory roles. There are certain positions that they prefer women to do and have an open hiring system no matter the position.

***Q3. Do you celebrate your employees' culture and vice versa? How does vacation time work in your operation? Do you recruit employees?***

All growers agreed that celebrating everyone's cultures was incorporated in their operation in some sense, whether that be learning their language, celebrating birthdays and holidays, along with playing various sports, such as soccer. Manus stated that there are local groups in his area that work voluntarily and put together events for the workers throughout their time in Ontario.

Robert was quoted, "Culture is the beautiful part of growing apples. I do this job for the people, I love people."

***Q4. How does vacation time work in your operation?***

Vacation was addressed differently based on each operation, but the major differences were shown between Washington and Ontario employers. Robert stated that if certain tasks are accomplished in a timely manner that employees can have a week or potentially a month off to go home. Although this is something that could be achieved in Ontario, the cost associated with flying home is a major deterrent for employees. A lot of employees also have the mindset that they want to stay and work. Manus noted that Algoma alternates weekends where employees don't work two weekends in a row to give employees a break.

***Q5. Do you recruit employees?***

A large difference between the various U.S. employee programs and the employee program in Ontario is recruitment. U.S. growers have the capacity to recruit people from the same areas to keep families and cultures together, while in Ontario this is a limitation. The program that is being utilized in Canada has a wait time of roughly 3 – 5 years, where recruiting is not possible and depending on which country employees are from, there is a slim chance that they would know one another before employment.

***Q5. Piece rate work or hourly rate work?***

This discussion was split between growers, where Washington and Michigan growers pay piece rate, while Ontario and New York pay hourly. Nevertheless, the latter two operations want to trial piece rate compensation in the future. Manus' justification was that incentivizing employees may increase work performance. Bobby agreed with this, but added that metrics on piece work for in-season tasks other than harvest (i.e. pruning, thinning) may be difficult to initialize. One strategy that Bobby mentioned is to incorporate auto-speeds for platforms based on the task at hand and see where his operation costs and efficiencies lie. Steve addressed the pruning piece work stating that employees are paid per cut, and that management usually determines a price per row before starting the task. His perspective is that if employee make more than hourly rate, they would still be out of the block sooner than an hourly employee. Robert had previously performed a trial comparing piece rate work to hourly work in a block where piece rate employee completed tasks sooner and cheaper. He calculated operation costs where piece rate work cost roughly $360 US an acre, while the hourly rate cost roughly $980 US an acre. Despite that, he stated that organization is key for piece rate work to be utilized efficiently and that everything needs to be figured out in advance.

***Q5. What would you like to see in the current labour programs?***

From an Ontario perspective, Manus suggested that a free flow between farms would be more ideal. This would be critical for all producers in Ontario because there is a wide array of commodities being grown and transitioning from farm to farm would allow for highly skilled workers to be available throughout the season. He also mentioned that easier access for workers to stay permanently would be more attractive for highly skilled labourers. One major point that needs to be addressed is the fact that many people don't understand how important agriculture is and how highly skilled workers are. Another point added was that an increase in responsibility allows workers to have more ownership of their task and feel more appreciated in the operation.

## Webinar 2: Labour – Expert Panel

Brooke Doer, PennState Law, Center for Agricultural and Shale Law
Phillip Martin, UC Davis – Newsletter, Rural Migration News
John Van de Vegte, OMAFRA, Engineering Specialist

***Brooke's Presentation Overview***

Brooke's presentation consisted mostly of the H-2A program, so not much applicability, but a few interesting notes are below:

- 33% of H-2A program consisted of fruit and tree nut farms
- 2010 hourly rate was $9.00, in 2019 it was $12.75, wage rates froze from 2020 to 2022

***Phillip's Presentation Overview***

Phillip's presentations also focused on the H-2A program, but from a different perspective. He noted the following:

- Farm wages are increasing faster than non-farm wages
- Labour demand remains stable due to aging workers in U.S.
- Farm labour cost is increasing 67% by 2025

In response to these changes, Phillip stated that an increase in mechanization, migrant workers and reliance on imports would occur. He also suggested a few changes to the H-2A program including employer self-certification and multi-year visas for workers, turn-key crews trained abroad, and finally fewer and larger recruiters based on economy of scale and reputation.

***John's Presentation Overview***

John focused on value-added activities within the operation. For example, bagging apples is value-added, where walking is not a value-added activity. John suggested growers to look at their own operation, whether that be from a specific task or a general overview to make their processes more efficient. In the past he conducted an analysis of various apple orchard operations and inefficiencies ranged from 16 – 20% in over investment of time. This led to further analysis of harvest crew sizes, where he suggested a smaller size of crew would have better efficiencies than a larger crew. In his study, he found that a 22.7% reduction in time to fill a bin occurred with a smaller crew. This is calculated as saving of

$8.67 per bin harvested. The study was performed in the same orchard at the same block with the same team on the same day.

Current State: 15 harvesters fill bin in 9 minutes = 2.25 worker/hr/bin
Trial Results: 8 harvesters fill bin in 13 minutes = 1.74 worker/hr/bin
2.25 worker/hr/bin – 1.74 worker/hr/bin = 0.51 worker/hr/bin

John mentioned that although there is an increase in efficiency, there are more logistics to consider. If a process were to change, John suggested that timely communication of the work plan to everyone involved is key for success. He suggested that growers should measure and analyze what is happening in the orchard to see where inefficiencies are and how to maximize value-added activities. This can be performed through a cycle time study.

A suggestion by John was to evaluate the time it takes to move ladders throughout the season. This would give you a better idea on how much your apples cost once they are above your reach, as the higher up the apple, the more expensive the apple is. He further suggested looking at walk times – whether that be for lunch, to the washrooms, to the bins etc., as walking has been the most common inefficient activity.
Of final note from John - Measure it. To become more efficient, you must have data. Measure it, evaluate it, change it, measure it again and compare it. Data driven decisions will make your orchard more efficient.

## Webinar 3: Technology – Expert Panel

***Cody Lariviere, Washington Fruit, Washington***

Cody has managed 560 acres of apples consisting of Honeycrisp, Cosmic Crisp, Fuji and EverCrisp. He has trialed automated irrigation and soil monitoring to determine optimal timing throughout the day to keep blocks at field capacity. He has also utilized dendrometers on tree trunks and apple fruit to better understand when and how much to irrigate. Having this technology has also allowed him to trial deficit irrigation during various times of the season.

***Justin Finkler, Riveridge Produce Marketing Inc., Michigan***

Justin is the Operations Manager at Riveridge where they have tackled various technologies to aid in efficiencies. The apple orchard that Justin discussed was a V-trellis orchard planted in 2014. Justin mentioned 3 main tools that he used to further advance Riveridge.

- Outfield. Outfield is an orchard management company that utilizes drones to help farmers manage various growth stages of their crop. Justin stated that the data aided Riveridge in respect to bloom analysis and fruit counts.
    - https://outfield.xyz/
- Bandit Cyclone, Automated Ag. The Bandit Cyclone is a vacuum machine (shown in Figure 1) that aids in efficiency of harvest.
    - https://www.automatedag.com/bandit-cyclone
- V-trellis system. Justin stated that many labour efficiencies have occurred from the V-trellis, most notably training and the implementation of piece-rate pay.

**Figure 1.** Bandit Cyclone harvester *(Farmprogress.com)*

***Bobby Brown, Orchard Dale Fruit Company, New York***

Bobby, the owner of Orchard Dale Fruit Company noted many technologies that he has tested in the orchard, but the most notable have been the following.

- Weather stations and modelling system. Bobby has Davis weather stations and uses NEWA for modelling. He stressed the importance of utilizing NEWA modelling systems for chemical thinning.
- Agri-Trak. Agri-Trak is an application that allows farmers to optimize all facets of the farm operation, including labour tracking, time sheets and production records. Bobby has stated that this middle management tool improved accounts of daily activities and payroll.
    - https://agri-trak.com/
- Variable rate nutrition. Bobby utilized a variable rate spreader in his orchard to better apply potassium and lime. This has led to some cost savings.

***Gerbe Botden, Botden Orchards Ltd, Ontario***

Gerbe is the Operations Manager of Botden Orchards Ltd which has 500 acres of apples. Gerbe has trialed various technologies on-site, the (a) Irrometer Watermark Sensor and (b) Vivid Machines.

- Irrometer Watermark Sensor. This is a soil moisture sensor where Gerbe adjusted irrigation levels throughout the season based on field capacity to slow or encourage growth. He also scheduled irrigation based on soil type, noting that sandier soils may require shorter intervals but more frequent irrigation timings, while clay soils may require longer intervals to fill the root zone. Gerbe noted that he uses fertigation, which also adds to the complexity of nutrient application on soil type.
- Vivid Machines. Vivid Machines has a camera system, termed Vivid-X Vision System, where the camera can be mounted to equipment to analyze fruit counts, fruit size and has potential to scout for pest management. Gerbe has stated that the benefits included accurate crop estimates, where knowing the volume and size of apples in advance assisted in bin needs. Gerbe was able to ground truth the technology by utilizing data from his family run grader, where Vivid was within 10% of the apple count.

***Q1. What technology has had the biggest impact in labour and production efficiency on your farm?***

All growers answered this question differently, demonstrating that each technological advancement effects growers in various ways and that not every technology is for every grower.

Gerbe answered this question first and stated that excel has been the best application for him on his operation. He has used it since 2013 for various data collections – including leaf sampling, soil sampling, growth curves, fruit counts and fruit sizing. He has been diligent about collecting data for every block every week to keep his data consistent and comparable. One keynote from Gerbe was that year after year a consistent method to assess is very important when comparing results. He also stated that it not strictly about cutting costs, it's about reaching our target and managing resources to grow the best quality fruit. He would like to see a tool that collects and analyzes data from across the orchard rather than a small subset sample from each block.

Bobby stated that high biggest technology was in orchard design in respect to labour, sunlight, and airflow for each variety. Following a similar sentiment, Justin stated trees per acre was his biggest technology, but suggested this was regarding return per acre and decision-making tools as a manager.

Cody reiterated the importance of precision and automated irrigation, where normally he would spend 40 hours a week on irrigation. He also noted the benefits of knowing fruit quality and size in advance, along with the biggest impact being not over or under watering trees.

***Q2. How do you ground truth your technologies?***

Gerbe stated that he also packs apples, so he is able to track defects, sizes and counts. Gerbe could then trace back to the block and make adjustments. Gerbe had a few suggestions regarding any trials in orchard:

- Be sure to have a control
- Don't compare different soil types
- Have a big enough dataset, a bigger dataset gives more accuracy

On that last note, Justin chimed in stating that it is also important to not get lost in the trials and make sure that any trials you do that they are worth your time.

***Q3. What models do you utilize in your orchard?***

All growers used different modelling systems which are RIMPro, sunburn protection model, NEWA and MaluSim.

***Q4. What technology have you tried that doesn't work for your operation?***

All growers have had different experiences with technology, where fruit imaging didn't work for Cody in a V-trellis system, Bobby stated that LiDAR spraying technology didn't work for him, but this was over 10 years ago. Gerbe mentioned use of a 3-row recycling sprayer, granted this was a prototype and has since purchased a new 3-row sprayer. Gerbe also stated that the pneumatic leaf blower didn't work for his operation given bruising, Justin stated that this happened with his neighbours as well. A point to consider is the nutrition aspect where leaves bring in nutrients in the fall before going dormant. Justin mentioned trialing various platforms, were some worked, and some didn't, but has seen improvement in

his orchard. He also reiterated Cody's fruit imaging comments but stated that this technology has improved tremendously and is still in its infancy.

***Q5. What labour intensive action would you like to make more efficient?***

Gerbe and Justin both stated that harvest would be the most important due to the amount of labour currently needed at that time. Gerbe stated that a robotic picker that handles the fruit gently and keeps quality is of the utmost importance. Justin added that blossom and fruitlet thinning is something else that he would like to see be done more efficiently. Cody stated that automated irrigation, fruit counting, and automated tractors would aid in decreasing labour in the orchard, while Bobby stated that anything that requires feet on the ground should have a set pace as this would maximize efficiency.

## Webinar 4: Technology – Expert Panel

***Q1. All experts were asked to introduce themselves and go over what technologies they have worked on.***

***Ines Hanrahan, Washington Tree Fruit Research Commission***

Ines introduced herself as the Executive Director at the Washington Tree Fruit Research Commission (WTFRC), along with a commercial tree fruit grower. The WTFRC have focused on 3 key themes:

- Smart Orchard Development
  - Started 2 years ago to allow companies to trial their equipment, compare to one another, and allow scientists to test experimental trials. This has been extremely important regarding sensor technology and has enabled commercialization of digitalization in the orchard.
  - The orchard has also become a teaching orchard for students and orchardists.
  - The orchard has brought to attention the importance of synchronizing data intake and consolidate everything on a dashboard for ease of use and interpretation.
- International Collaboration
  - Technology adaptation cycles are faster than they used to be, where researchers, companies, growers, extensionists etc., should all be involved from the beginning.
  - Ines stated that an example of this is the substantial cost that private companies incur to develop harvest robots, where they could cost $50-100 million from the time of inception to commercial release. Involvement of various stakeholders has the potential to increase funding opportunities, decrease the knowledge gap and enable grower participation.
  - WTFRC has partnered with international companies to further progress technologies available for American growers.
- Harvest Robots
  - WSTFRC has had harvest robot prototypes tested in the harvest season of 2022.
  - There isn't any information regarding commercial release for them, but Ines stated that the technology is significantly further along than 5 years ago.
  - She stressed the importance of cost, the ability for the machine to work for 80 days straight, and to pick at rate that can amortize itself.

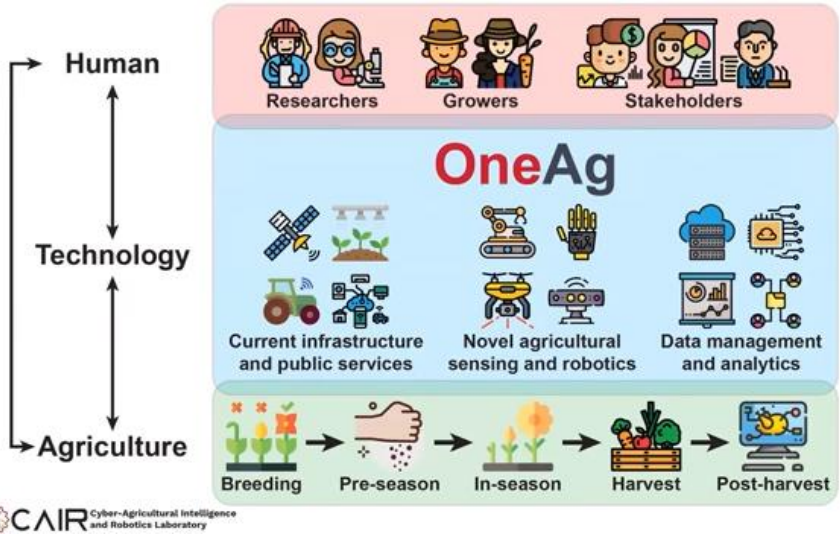



**Figure 2.** OneAg illustration *(Yu Jiang, Cornell)*

***Yu Jiang, Cornell University***

Yu introduced himself as an assistant professor at Cornell University, where he has focused on agriculture sensing, robotics and AI technologies in specialty crops. During Yu's introduction he noted the importance of the Cornell Initiative for Digital Agriculture (CIDA) where they have started an integrated approach for multiple disciplines to develop technology together. CIDA has 4 areas of interest including systems analytics, outreach & application, digital innovation and finally discovery & design. A similar concept is through Cornell's OneAg approach, which is illustrated below (Figure 2).

***Long He, Pennsylvania State University***

Long introduced himself as an assistant professor at Pennsylvania State University, where has focused on robotics and automated technologies in tree fruit systems. His projects encompass green fruitlet thinning, robotic approaches to pollination, precision crop load management, precision and automated irrigation, along with intelligent spraying systems. Figures 3 and 4 demonstrate some of the work Long has worked on.


**Figure 3.** (a) picture showing AI system detection of flowers/king bloom (b) picture showing AI system detection flower clusters and flower development
*(Long He, Pennsylvania)*

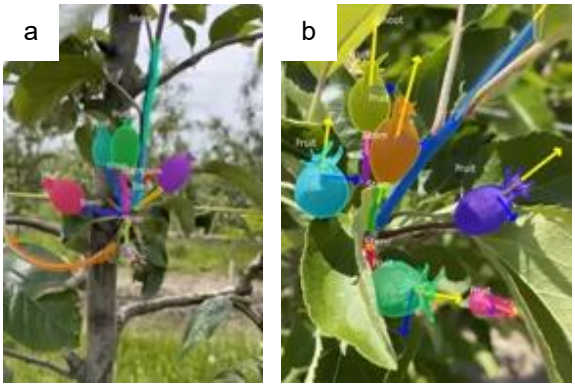



**Figure 4.** (a) picture showing AI system detection of fruit and stem (b) picture showing AI system detection for fruit orientation and identification
*(Long He, Pennsylvania)*

***Matthew Whiting, Washington State University***

Matthew introduced himself as a professor and extension specialist at Washington State University (WSU), where has expertise in tree physiology, precision, and automated agricultural systems. During his time at WSU, he has developed relationships with various stakeholder and emphasized the importance of connections at beginning stages of any project. He broke down 4 strategies to develop a successful project:

1. Take a total systems approach, include economics, sociology, engineering, horticulture, molecular biology, breeding/genetics, postharvest etc.
2. Consider scalability
3. Avoid costly, single-use tools
4. Don't plant another orchard – unless you are thinking 10-15 years into the future

***Q2. What has limited adoption of technologies at the commercial level?***

Matthew stated that there is a significant transition time with technologies, for example high-density orchard systems. Long stated that growers rely on success stories of technology that are cost effective, Yu agreed and added that the significant upfront cost of new technologies deters growers. Ines stated that grower to grower talk counts more than scientific data, but once a new technology is in the system growers learn quickly and adapt accordingly. This has been successful in the past when utilizing a stepwise approach. She also stated that businesses that have great customer support have been the most successful. And in closing Ines said that growers rely on new technology but look at it from a cost-benefit approach, they want to see it via workshops, demonstrations and through other growers before making decisions. Overall, experts stated that technology advancement takes time for growers to acclimate and costs a significant amount.

***Q3. How do you know that you are targeting the needs of growers/industry?***

In a well-rounded response, Matthew stated that including industry from the beginning of a project aid in concept development. Partnering with commercial entities is good and encouraged, but all stakeholders should know each other's objectives. Matthew then added that building consortiums and commissions also adds extreme value to get industry and growers involved.

***Q4. Are there any concerns for safety for autonomous sprayers? What considerations should growers and operators be thinking about?***

Ines and Matthew have first-hand knowledge of working with autonomous sprayers. Ines stated the importance of addressing the 'fear factor' that growers may face due to the legislation when adopting these technologies. She has had a proactive approach and worked with the State Department of Agriculture, as they had put out statements regarding

autonomous vehicles. She said that working with the government body in a partner compacity has aided in adaptation and study of autonomous sprayers and allowed for a proactive approach within the industry. Matthew added that occupational health and safety personnel should be included in any project that may impact worker safety.

***Q5. What should we say to people who are fearful of losing their jobs when adopting new technologies?***
Although people may think they would lose their positions, technologies are adapted to make everyone's jobs a bit easier and more pleasurable, stated Ines. She also added that many technologies are made to take out back breaking work and enable for year-round employment. Yu added that technologies would have to be maintained and therefore people would have to be trained to keep the data driven systems in operation, this in turn could create more jobs and allow for better opportunities to utilize skills and knowledge in the orchard. He also suggested that a digital agriculture certification, for people with mechanical and automation skills, could allow for more specialized hires on farm.

***Q6. Do you have any final takeaway messages?***
Ines wanted to reiterate that every farmer is a data miner – whether that be on a piece of paper, in their head or in excel sheets. Rather than relying on paper and excel sheets, tools have been made to make informed decisions easier for growers. Ines stressed the importance of adopting these tools to aid in orchard decisions, but also added that farmers should never lose their green thumb, as with the ever-changing environment, plants evolve, and so must we.
Yu added that things in the apple industry are being developed by passionate people, which could lead to a brighter future.

Long stated that growers are always interested in technology and having a decision support tool, such as sensors, apps, camera systems etc. decrease human effort for the longterm. Currently we are between manual and robotic systems, i.e. human assisted platforms, which is a significant step forward, although to fully transition there must be extension involved to aid in information and knowledge.
Matthew stated that people are the most important when thinking about orchard systems, especially when developing any technology. Technology coming into the industry is inevitable and it is just beginning to take off. The best way to successfully advance a technology is to collaborate, get feedback from growers and stakeholders, and take a whole systems approach.

In a final sentiment: Labour and technology will always be hand in hand and will inevitably change the way we work.

There are many similarities across the United Stated and Canada within the apple industry, these events aid in fostering relationships and sharing information, with the ambition to assist growers. The Virtual Orchard Meet-up Series will continue in 2023, stay tuned for future announcements.

If you would like to watch the videos at your own leisure please follow this link: https://www.youtube.com/watch?v=KhhJBbGmwa4&list=PLYLbxsK4pTXXJukcnyYvdjQE5V0NpKyX3. For any further inquiries please reach out to Erika DeBrouwer either by phone or email (226-931-4098, erika.debrouwer@ontario.ca)

## Using 4R's for Nitrogen Management in Horticultural Crops

*Tejendra Chapagain, Soil Fertility Specialist, OMAFRA*

Nitrogen is a major input for crop production in Ontario. However, nitrogen use efficiency (NUE) is low, with only about 40-65% of the total applied fertilizer N recovered in crops. Therefore, effective N management provides opportunities for enhancing fertilizer nitrogen use efficiency and for reducing the environmental footprint of crop production, which minimizes fertilizer requirements and saves input costs. This is possible by using 4R nutrient stewardship.

The 4R's are all about making key decisions on fertilizer products along with the timing, placement, and rates of application. And high fertilizer nitrogen prices are providing an incentive to manage N this spring with as much efficiently as possible.

Most chemical N fertilizers used in Ontario are ammonium-based that are usually applied from mid-April thru June. For the most effective use of N fertilizers, split application is suggested compared to one-time application which means application of N fertilizers two or more times to the crops to better time fertilizer N with crop demand.

For example, an in-furrow or band application of starter N at planting followed by side dressing of N fertilizer in June when seedlings are at $V_6$-$V_7$ stage of their growth is effective in corn. But in non-fertigated fresh market tomatoes, pre-plant application of nitrogen followed by side-dressing after the first fruits are set is recommended. You should avoid late side dressing to protect the roots and to minimize blossom-end rot.

On the other hand, the most efficient uptake of soil-applied nitrogen into the tree occurs during active spring growth, so it is recommended to apply nitrogen in the spring after active tree growth begins in tree fruits. Application of nitrogen in a 1- to 2-foot band under the drip line or broadcast throughout the orchard are common but it is important to note that we should increase the rate by 20%–30% for a broadcast application compared to side-banding. The fact we increase the broadcast rate tells us that broadcasting fertilizer is not as efficient. We can lose up to 50% of the N through ammonia ($NH_3$) volatilization compared to banding or in-furrow application.

Fertigation is an efficient method of nutrient application in fruits and vegetables in which fertilizers are injected through an irrigation system. In this system, nutrients are applied daily or weekly compared to 1-2 applications in soil application of granular fertilizers. Therefore, synchronization of nutrient supply and crop demand enhances nutrient-use efficiency. It also reduces labor and ground water contamination.

Variable Rate Technology (VRT) is another tool that allows farmers to apply fertilizers, water, chemicals, and seed at different rate across a field. There are two types of VRT: map-based and sensor-based. Map-based VRT adjusts product application based on a pre-generated map of the field. However, sensor based VRT uses mounted sensors that measure soil properties or crop characteristics in real-time.

The adoption of Best Management Practices such as addition of organic manures or compost, crop rotation with legumes, cover cropping and green manuring can add 10-200 kg N/ha, depending on the amount applied, crops selected, soil types, and growing condition.

Also, the use of enhanced nitrogen fertilizers such as slow-release fertilizers, controlled release fertilizers and those containing nitrification or urease inhibitors also minimize N losses and improve crop nitrogen use efficiency in field and horticultural crops.

Soil and plant tissue testing might help you to determine how much nitrogen is required for your crops. Large soil test deficiency can be addressed at pre-plant while in-season demand can be met through fertilizers and foliar applications. Therefore, spending few dollars in testing soils every three years or plant tissues every year could return thousands from your farm. It can also save money on other nutrients and find pH problems.

## Enhanced Nitrogen Fertilizers: Improving Efficiency and Saving Money

*Tejendra Chapagain, Soil Fertility Specialist, OMAFRA*

Fertilizer nitrogen (N) is a major input for crop production in Ontario. However, nitrogen use efficiency (NUE) in the farmlands is low, as only about 40-65% of the total applied fertilizer N is recovered in crops. Nitrogen fertilizers that are not taken up by the crop can either be immobilized by microbes or vulnerable to losses as ammonia ($NH_3$), nitrate ($NO_3$–N), nitrous oxide ($N_2O$), and di-nitrogen ($N_2$). Losses of N can contaminate water bodies, release potent greenhouse gas (e.g., $N_2O$) and create particulate aerosols (e.g., $NH_3$) that impact human health.

There are various enhanced nitrogen products developed with the objective of reducing N losses and to improve crop N use efficiency in field and horticultural crops. Those Enhanced Nitrogen Fertilizers are mainly divided into two groups.

1. **Enhanced Efficiency Fertilizers (EEF):** are forms of N fertilizers that include additives, physical barriers or different chemical formulations that control fertilizer release or alter reactions. This category is further divided into two groups:
    - ***Slow-release fertilizers*** are low soluble and more complex than regular fertilizers that usually requires microbial degradation to release plant available N. Examples are Urea Formaldehyde (35% cold water insoluble N and 38% total N) and Methylene Urea (40% N of which 60% is water soluble).
    - ***Controlled release fertilizers*** are granulated fertilizers coated with other additives (e.g., polymer, sulphur, etc.) that releases nutrients gradually into the soil in a controlled way. Examples are Sulphur coated Urea (30-40% N) and Polymer coated urea (18-44% N). Environmentally Smart N which we call ESN with 44%N, is an example of polymer coated urea that is designed to slow down the rate of N release to better match the crop demand than conventional urea.

2. **Stabilized Fertilizers (SF):** Fertilizer products in which inhibitors are added to the fertilizers to retard bacterial or enzymatic activities in the soil. Examples are:
    - ***Nitrification inhibitors (NIs):*** They retard bacterial oxidation of ammonium to nitrate by nitrosomonas and nitrobactor. They maintain ammonium in the ammonical form to prevent nitrate leaching and nitrous oxide emissions.
    - ***Ureas inhibitors (UIs):*** They slow the conversion of urea to ammonium by ureas enzyme. The UIs are used only in conjuction with Urea fertilizers mainly to decrease volatilization loss from surface application of Urea fertilizers.
    - ***Double inhibitors:*** Fertilizers that combined urease and nitrification inhibitors to reduce both ammonia and nitrous oxide losses (e.g., SuperU).

It is important to note that soil conditions (e.g., temperature, moisture content and osmotic potential) may influence N release from enhanced N fertilizers. In general, N release is positively correlated with soil temperature and moisture. Enhanced Efficiency Fertilizers will be most effective in seasons where N loss from the soil may be high due to high rainfall, light soil texture and low organic matter content.

In terms of cost, enhanced N fertilizers provide additional value or benefits to the fertilizer and thus they are expensive than regular fertilizers. Also, even within enhanced N fertilizers, Enhanced Efficiency Fertilizers (EEFs) may cost more than Stabilized Fertilizers (SFs). Even within Enhanced Efficiency Fertilizers, slow-release fertilizers have price similar or higher than controlled release fertilizers. Most recent studies in central and eastern Canada have indicated that the cost of enhanced N fertilizers can be offset by reduce N rates because of lower losses (more of a sure thing) and/or higher yields (not clear a sure thing).

***References***

Carson, L.C. and Ozores-Hampton, M. 2014. Description of Enhanced-Efficiency Fertilizers for Use in Vegetable Production (Online). HS1247/HS1247: Description of Enhanced-Efficiency Fertilizers for Use in Vegetable Production (ufl.edu).

Mezbahuddin, S., Spiess, D., Hildebrand, D., Kryzanowski, L., Itenfisu, D., Goddard, T., Iqbal, J. and Grant, R. (2020). Assessing Effects of Agronomic Nitrogen Management on Crop Nitrogen Use and Nitrogen Losses in the Western Canadian Prairies. *Front. Sustain. Food Syst.* 4:512292. doi: 10.3389/fsufs.2020.512292

# *Crop Protection*

## Tank Mixing Update – Implications for Users of Pest Control Products

*April 2023 – J. Mosiondz (OMAFRA) with input from J. Deveau (OMAFRA)*

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

Health Canada's Pest Management Regulatory Agency (PMRA) recently announced changes to their tank mixing policy with the release of a new guidance document on December 22nd, 2022, entitled "PMRA Guidance Document Tank Mix Labelling". This represents a reversal from their previous position (released in October 2009), which permitted unlabeled tank mixes so long as certain criteria were met.

Under the new policy, a tank mix can only be applied if there are statements on the product label that specifically allow tank mixing. This could appear on the label in one of two forms given below. Additional instructions such as mixing order, or instructions for performing capability testing such as the jar test method may also be included in these statements.

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

Option 2: The label includes a general tank mixing statement (see below) which permits tank mixing as long as both tank mix partner labels include the statement. Note that product labels may contain both the general tank mixing statement and a specific list of tank mix partners.

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

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

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

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

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

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

*There may be registered labels that have tank mix scenarios like this. Note that this is not allowed for new tank mix label amendments. Further, any product labels that have tank mix scenarios like this must be amended to alleviate the contradictory scenario. To do this,

using the last scenario in Table 1 as an example, one of the following must occur: 1) remove the Product X tank mix from the Product Y label, 2) remove the exclusionary statement from the Product X label, or 3) add a specific tank mix for Product Y on the Product X label. Source: PMRA Guidance Document Tank Mix Labelling 2023

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

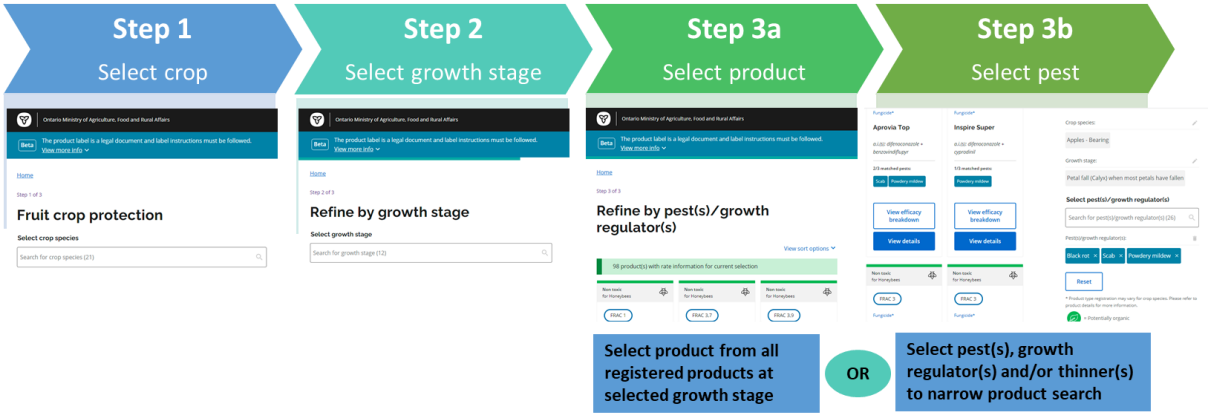
For growers, and other users of pest control products, this effectively means they may continue to tank mix as previously done for the 2023 and 2024 field seasons. However, when ordering and purchasing product in late fall 2024 and winter 2024-2025, users will need to ensure that desired tank mix partner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

Parties affected by this new policy change are encouraged to review the guidance document in its entirety for a full explanation and further detail on these changes. For any outstanding questions you may have regarding these new guidelines after reviewing the guidance document, please contact the PMRA Info Service at pmra.info-arla@hc-sc.gc.ca. Further information on tank mixing practices can also be found on the Sprayers101 website.

# New Updates to the Ontario Crop Protection Hub

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

Since launching the **Beta version** of the Ontario Crop Protection Hub (full link at end of article) in Spring 2022, OMAFRA has continued to work on system improvements based off user feedback to meet the needs of the agri-food sector more effectively.
Find the crop management solution in only a few simple steps:



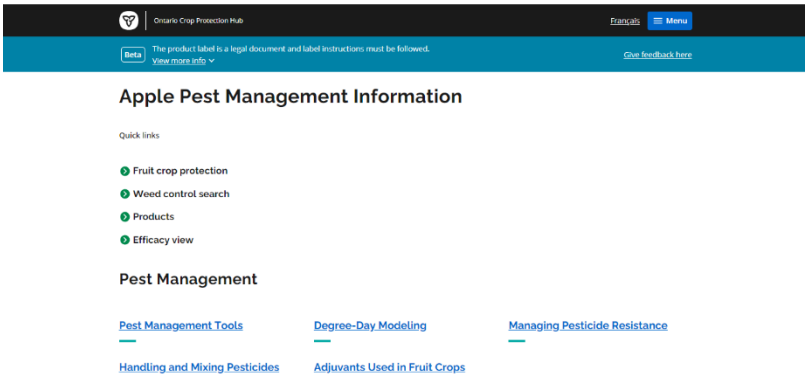

The following are some new enhancements that may be of interest to apple growers:

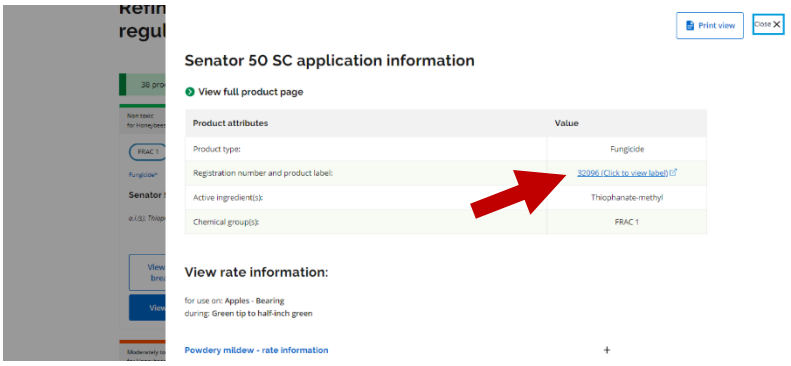
### Apple Pest Management Information page

For users looking only for apple-related information, you may want to bookmark the Apple Pest Management Information page (full link at end of article) to use as your regular starting point into the Hub.

On this page you will find:

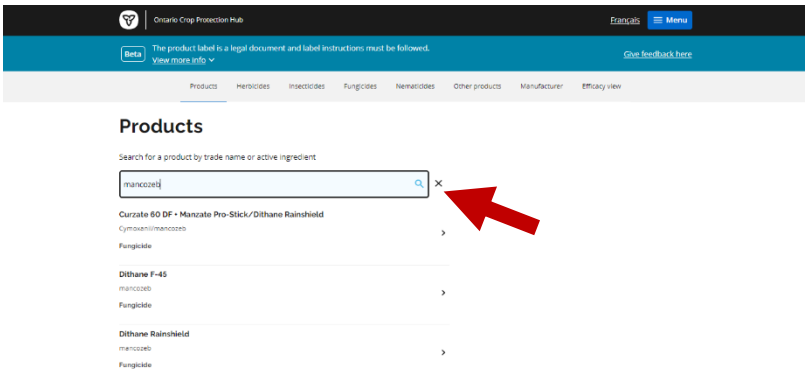
1) **Fruit Crop Protection and Weed Control searches –** Use these tools when looking for guidance on product choice, program planning and rate information.
2) **Product search –** Use this tool when looking for use pattern information (REI, PHI, etc) of a known product.
3) **Efficacy view –** Use this tool to generate disease and insect efficacy tables for all products registered on apples.
4) **Supplemental tables and resource materials** – Additional reference tables and chapters that were in Publication 360 related to pest management, thinners and plant growth regulators can now be found here.




### *Direct link to PMRA label*

Within the crop protection searches, all product listings include a direct link to the PMRA label database for quick reference. Simply click on "Registration number and product label" under Product Attributes.

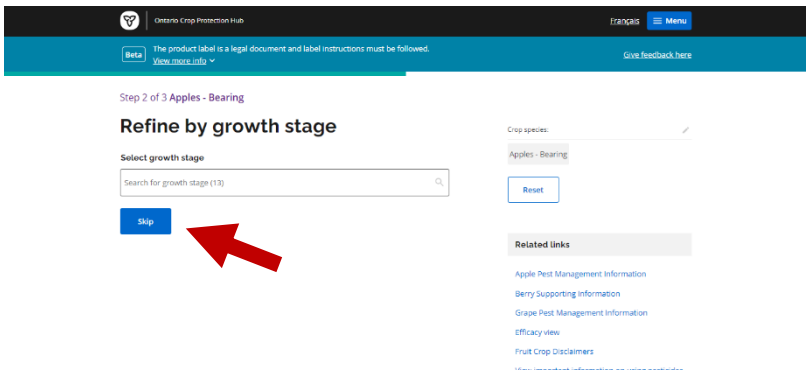



### *Search bar included in product search*

Within the Product search (note, this is the product database not the Fruit Crop Protection search), users now have the ability to quickly type in the specific trade name or active ingredient they are looking for. These listings can be used for label access, manufacturer information, crop registration, REI/PHI/max applications, pest efficacy and toxicity to beneficials.

### *COMING SOON! Skip growth stage and print capabilities*

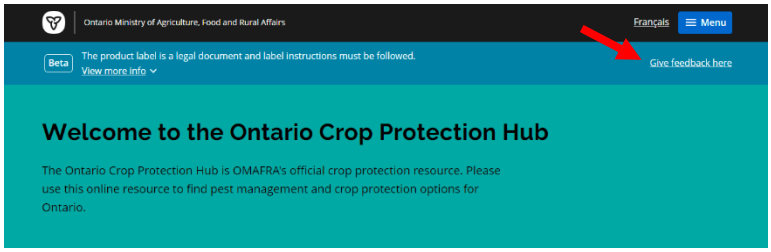
Soon to be released for fruit crops will be the ability to bypass the growth stage filter option to see the full list of registered products. Stay tuned for more information when this feature is available.



User feedback has continued to emphasize the importance of print capabilities or offline access of crop protection information. We understand this need and continue to prioritize this in the system development. Options will become available in the coming months. In the meantime, should you require printed copies of any apple crop protection information, please contact Kristy at kristy.grigg-mcguffin@ontario.ca or 519-420-9422.

***Looking for more information?***
At the end of March, a Lunch N Learn webinar was offered for apple growers on some new features and tips to using the Ontario Crop Protection Hub. A recording of this webinar can be found here (full link at end of article). Passcode: G#$Z0QBu

Your feedback remains important to help continue this improvement! There is a feedback form link at the top of the webpage and available here: https://forms.office.com/r/ jCh0uW5LRw




***Full links:***
**Ontario Crop Protection Hub:** https://cropprotectionhub.omafra.gov.on.ca/

**Apple Pest Management Information page:** https://cropprotectionhub.omafra.gov.on.ca/supporting-information/apples/apple-crop-landing

**Recording of Ontario Crop Protection Hub Lunch N Learn Webinar for Apple Growers:**
https://us06web.zoom.us/rec/share/ZQD6Tg9hd8_4OcT9niAYWjyClEngP5OjyqqPqjRdRiAFzumAU7ZDvGUfRpHB97hZ.mlxbxPc_W2UcIBy1
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## Are You IPM Ready?

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

With the new growing season on our doorstep, now is the time to get your tools ready for an effective IPM program. Consider the following checklist to help you prepare:

- Refresh your knowledge of identification, biology and monitoring techniques for common insect and disease pests by taking an IPM Training Workshop. OMAFRA specialists offer a series of free IPM workshops starting early May. Watch for more information and registration links on the ONfruit, ONvegetable and ONspecialtycrop blogs. The Apple IPM video series can be found on the ONhortcrops YouTube channel: https://youtube.com/playlist?list=PLjTx-zm9InXAbdQ5PtsyHIzF2_YABqb3c

- **If you prefer a more self-directed refresher, check out Ontario CropIPM.** Here you will find interactive online training and information on pests and management, including scouting calendars, threshold guides, information on using traps and identification keys.

- **Make sure your farm map is up-to-date**. In as much detail as you can, outline new plantings or blocks that have been removed including information such as cultivar, planting dates, etc. Circle where pest problem areas have been in the past, such as mite or weed hot spots, or where you've had issues with diseases. Use your map to develop a reporting template for your scout or workers to quickly identify where they have found problems.

- Familiarize yourself with using traps, weather monitoring equipment and degree day models to predict precise timing of pest control strategies. For some pests, degree day models have been developed to predict pest development stages and precisely time products.

- To use these degree day models, you will need to put up monitoring traps and have access to weather data. For trapping supplies, visit the OMAFRA website for a list of pest monitoring equipment suppliers. Be sure to store all pheromone lures in the fridge until you are ready to put them out.

- Weather monitoring equipment, including temperature, humidity, rainfall and leaf wetness gauges are also important tools for disease forecasting. This information can be used to determine key infection periods or identify infection risk.

- Will you have a scout monitoring your farm this year? **Set up a communication plan with the scout to report findings, such as a weekly scouting template or email.** Keep the scout up to date on when and what crop protection materials have been applied and when it is safe to re-enter the field.

- Planning to monitor your farm on your own? **Designate someone on your farm to monitor on a weekly basis**. Having this determined before the season starts will help ensure this job doesn't get forgotten when all sorts of other issues are pushing you in different directions.
- **Make up a pest management kit with the right tools for monitoring.** This should include a 16-20x hand lens, traps, collection bags and vials, flagging tape, pocket knife, notebook or record sheets, markers, a copy of the farm map and resources on hand, including the new Ontario Crop Protection Hub.

- **Lastly, stay informed with current pest management topics in the province by subscribing to the ONfruit blog.** To receive the most timely information, sign up to receive a notification via email as soon as something new is posted.

# Planning for a Season with Limited Group M Fungicides

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

This year will be the first for apple growers to tackle disease management with reductions to Group M fungicides in full effect. Unfortunately, as of writing this article, we have not seen any changes to mancozeb labels which means for 2023, the maximum number of applications of this active ingredient that can be applied to apples will be limited to 4, regardless of rate used. Now is the time to start planning your disease management program to strategize how and when to use the tools left to manage apple scab and summer diseases.

Below are some important management points to consider at different times during the season:

## Dormant

***Orchard sanitation***

- Applying urea fertilizer at 45 kg/ha (mixed with 1,000 L of water/ha) and/or shredding fallen leaves with a flail mower are two practical and inexpensive methods to minimize scab pressure (and apple blotch, if this is a problem).
- Ideally, these practices should be done in the fall and/or before green tip if possible, but there may still be some benefit if this is delayed shortly after bud break.

***Copper***

- Copper sprays applied to green tissue may provide some protection against apple scab overwintering in buds equivalent to mancozeb applied at this stage.
- The use of a softer copper registered for season-long control such as Cueva could be extended in those early spray timings to ½" green or tight cluster in blocks with low scab inoculum (ie., free of scab last year).

## Green Tip to Tight Cluster

- Best disease management is EARLY disease management!

- While mature spores are released more during warm rains than in colder ones, they can still cause infection, nonetheless, if they land on green tissue.

***Protectant fungicides***

- Maintain a protectant program every 5-7 days during periods conducive to disease development or following heavy (greater than 1") rain.
- Protectant fungicides such as captan, folpet or mancozeb do not provide effective post-infection or anti-sporulant activity.
    - If sprays are applied in less than ideal conditions (ie., windy, alternate rows or washed off in rain), the risk of scab infection is increased.
- Folpet (active ingredient of Folpan/Follow) belongs to the same multi-site group (Group M4) as captan but was not affected by the recent PMRA re-evaluations.
    - General re-entry is 12 hours, with the exception of hand thinning (6 days) and hand harvest (1 day)
    - Similar cautions to captan apply to folpet products, including incompatibility with oil-based products and surfactants. May cause russetting on some varieties when used during bloom to 30 days after petal fall.
- Protectant fungicides do not control powdery mildew.
    - Include 3-5 kg/ha sulphur (Microthiol Disperss, Microscopic Sulphur, Kumulus, Cosavet DF Edge) with the protectant sprays until tight cluster when more effective mildew products will be used.

***Alternative fungicides***

- Allegro (Group 29) is considered a low resistance risk product so could be considered as a protectant option or tank-mix partner. However, use is limited to 5 applications per year.
    - Since this product is effective against bitter rot, black rot (suppression), fly speck/sooty blotch and mite suppression, save some uses for summer management.
- During cool, wet springs, protectant fungicides may not be enough. Consider one of the products listed in Table 1 that perform well in cooler temperatures and provide post-infection activity. These could take the place of early season mancozeb to help save uses for more critical timings.
    - Syllit and Scala should be used early season only, up to tight cluster and pink, respectively.
    - Consider any issues with powdery mildew and/or rust in previous years. If these have been a problem, use a Group 9-containing product that also has activity on these diseases as well, such as Inspire Super or Luna Tranquility.
    - Buran (garlic extract) which is registered for scab and powdery mildew can also be used as an eradicant, or for early post-infection activity following a rain event when protectant efficacy may be reduced. This product does not have pre-infection activity for scab.
- In warmer, dryer springs, consider products such as Fontelis or Aprovia Top at the tight cluster stage, both of which have efficacy on scab, powdery mildew and rust.

**Table 1.** Registered fungicides for apple scab for use during cool, wet springs.

| Product | Properties | Timing | Max app | Scab efficacy | Other disease |
|---|---|---|---|---|---|
| **Syllit** (U12) | retention, redistribution, anti-sporulant | Green tip – tight cluster | 2 | +++(+)[1] | No |
| **Scala** (AP) | post-infection, retention | Prebloom | 2 | ++(+) | No |
| Inspire Super (DMI+AP) | post-infection, retention, redistribution, anti-sporulant | Prebloom | 4[2] | ++++ | mildew, rust |
| Luna Tranquility (SDHI+AP) | post-infection, retention | Prebloom | 4[2] | +++(+) | mildew |
| Buran (NC) | post-infection, anti-sporulant | Season long (<22˚C ideal) | --[3] | ++(+) | mildew |

++ = suppression; +++ = good control; ++++ = excellent control

[1] Dodine resistance is stable in ON and some scab populations may not be sensitive to this product.
[2] As stated on label. For resistance management, limit to 2 applications from fungicide group per year if possible.
[3] Information is not specified on the product label.

## Pink to Petal Fall

- By tight cluster or pink, apples are entering a time of critical infection period for scab and powdery mildew with higher daily temperatures, large amounts of lush growth and rapid maturation of spores.

***Protectant fungicides***

- Mancozeb offers good efficacy on rust, apple blotch (Marssonina) and various rots which are active during this timing. With limited allowable applications of mancozeb (4 applications per year, regardless of rate used), you may want to keep some uses available for this timing.
- It's best to avoid the use of captan and folpet in general during this growth period to avoid phytotoxicity by complicated tank-mixes, use of adjuvants or other incompatibility issues. Instead, save captan or folpet for summer disease control.
- Biological multi-site products to consider as tank-mix alternatives include Buran, Serenade.

***Systemic fungicides***

- Incorporate systemic fungicides (Groups 1, 3, 7 and 11). See Table 2 for disease efficacy ratings.
    - Unlike protectant fungicides, which have multi-site activity and low resistance potential, systemic fungicides are typically single-site and are at high risk of resistance development.
- Some groups, in particular Group 7 and 11s have efficacy on fruit rots, fly speck and sooty blotch. It may be worthwhile to save 1-2 applications for summer use.

**Table 2.** Efficacy of registered systemic fungicide groups on apple scab, powdery mildew, rust, black rot, bitter rot and fly speck/sooty blotch on apples.

| Fungicide Group | Scab | Powdery mildew | Rust | Black rot | Bitter rot | Fly Speck / Sooty Blotch |
|---|---|---|---|---|---|---|
| **1** (Senator) | +++ | +++ | -- | +++[1] | +[1] | ++++[1] |
| **3** (Cevya, Fullback, Nova) | +++(+)[2] | ++++ | ++++ | ++ (Cevya only) | -- | +++ (Cevya only) |
| **3+7** (Aprovia Top) | ++++ | +++ | +++ | -- | -- | +++ |
| **3+9** (Inspire Super) | ++++ | +++ | ++++ | -- | -- | +++(+) |
| **7** (Aprovia, Excalia, Fontelis, Kenja, Sercadis) | ++++ | ++(+) | +++ (Fontelis only) | -- | -- | -- |
| **7+9** (Luna Tranquility) | ++++ | +++(+) | -- | -- | -- | -- |
| **7+11** (Merivon, Pristine) | +++(+) | +++(+) | -- | +++(+) | ++++ | ++++ |
| **11** (Flint) | ++++[2] | ++++ | -- | +++[1] | ++(+)[1] | ++++ |

+ = poor control or partial suppression; ++ = suppression; +++ = good control; ++++ = excellent control
[1] Not registered on this disease.
[2] Resistance is present in ON to some products from this group.

## Summer Sprays to Harvest

- If primary scab was controlled, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season.
    - Maintain a regular 14-21 day fungicide program until harvest to protect against summer disease, especially during conditions conducive to infection (ie., warm, wet weather).

- Consider the preharvest interval (PHI) restrictions that may apply (ie., based on tree size, export restrictions, etc), particularly with early-maturing cultivars.
- See Table 3 for preharvest intervals and disease efficacy ratings.

**Table 3.** Efficacy of summer fungicide options on scab, black rot, bitter rot and fly speck/sooty blotch on apples.

| Product | PHI | Scab | Black rot | Bitter rot | Fly Speck / Sooty Blotch |
|---|---|---|---|---|---|
| **captan** | 15 days (HD) | +++(+) | +++(+) | +++ | ++ |
| **folpet** | 1 day | +++ | +++ | -- | ++ |
| **Pristine** | 5 days | +++(+) | +++(+) | +++(+) | +++(+) |
| **Merivon** | 0 days | +++(+) | +++(+) | +++(+) | +++(+) |
| **Allegro** | 28 days | ++ | + | +++ | +++ |
| **Buran** | when dry | ++(+) | -- | -- | ++(+)[1] |
| **Regalia** | when dry | +(+) | ++ | ++ | +(+) |
| **Serenade** | when dry | +(+) | ++[1] | ++[1] | ++[1] |

+ = poor control or partial suppression; ++ = suppression; +++ = good control; ++++ = excellent control
-- = information not known
[1] Not registered on this disease.

## Resistance management

- Fungicides are grouped based on their mode of action, or how the product actually affects the disease. For example, all products in Group 3 have the same mode of action, so using one product is virtually the same as using all other products within that group.
- In pre-mix fungicides, both groups need to be considered in all rotation decisions.
- One key strategy to good resistance management is rotating between products of different chemical groups. Figure 1 shows which fungicides belong to Groups 3, 7, 9 and 11.
    - For instance, since Aprovia Top belongs to Group 3 and 7, it should not be followed by other Group 3 (Cevya, Fullback, Nova), Group 3+9 (Inspire Super), Group 7 (Excalia, Fontelis, Kenja, Sercadis), Group 7+9 (Luna Tranquility) or Group 7+11 (Merivon, Pristine).
- For resistance management:
    - Where possible, include at least half rate protectant fungicide
    - Do not use products containing the same chemical group in consecutive applications.
    - Do not use Group 3 fungicides including Nova, Fullback and Inspire Super after bloom as they are weak on fruit scab. Trials with Cevya have indicated good efficacy on fruit scab.
    - Do not use systemic fungicides for post-infection activity.

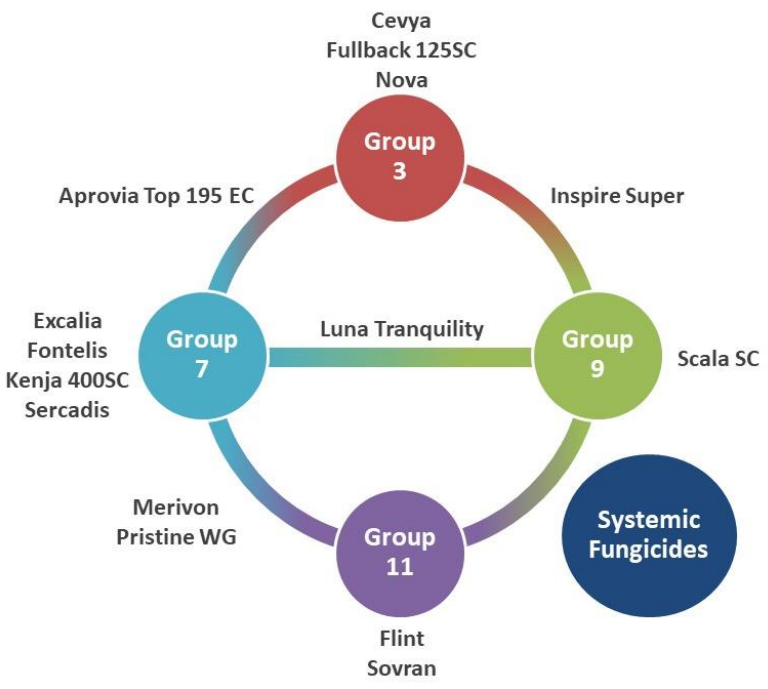


**Figure 1.** Schematic diagram of Group 3, 7, 9 and 11 fungicides, including pre-mixes registered for use on apples.

## Summary

The following description and Figure 2 summarizes many points from this article but is only an example conventional scab management program and does not include all control options available. **Select products that fit best for your operation, cultivars, resistance management program and disease pressure as well as current weather conditions.** Product choices in this example were based on a hypothetical cool, wet spring followed by a warm, humid summer and used a somewhat "worst-case scenario", or combination of 4x mancozeb (77-day PHI) and 2x captan (19-day PHI).

1. **Dormant -** Begin with a delayed dormant copper application between silver tip and ½" green. This will have efficacy on any early season activity of overwintering fire blight cankers or scab infection periods.
2. **Green tip to pink -** Consider a protectant fungicide program such as mancozeb (especially at pink for rust control), folpet and/or Allegro. For high-density orchards where more applications of captan are allowed (maximum 10 per year), this active ingredient could also be considered here. Be cautious of potential tank-mix incompatibilities when using folpet or captan (for this reason, use is not shown at this timing in Figure 2). Early season alternatives, particularly in cooler springs could include Sylitt, Scala, Inspire Super or Luna Tranquility or post-infection timing using Buran.
3. **Bloom into first covers -** Incorporate systemic fungicides belonging to Groups 1, 3, 7 and/or 11 tank-mixed where possible with mancozeb.
4. **Summer -** A rotation of Merivon/Pristine tank-mixed with half-rate captan or folpet, Allegro, Serenade, Regalia and Buran as summer cover sprays will provide good control of scab, fruit rots and fly speck/sooty blotch. Allegro can be used up to 3 consecutive sprays before rotating to another fungicide group.
5. **Preharvest -** A late season application of folpet or Merivon/Pristine just before harvest (if not exporting) will protect against pinpoint scab and any other fungal infections that may occur.
6. **Postharvest -** Reduce inoculum by applying urea and/or flail mowing in the fall following harvest or as soon as the orchard can be entered in the spring.

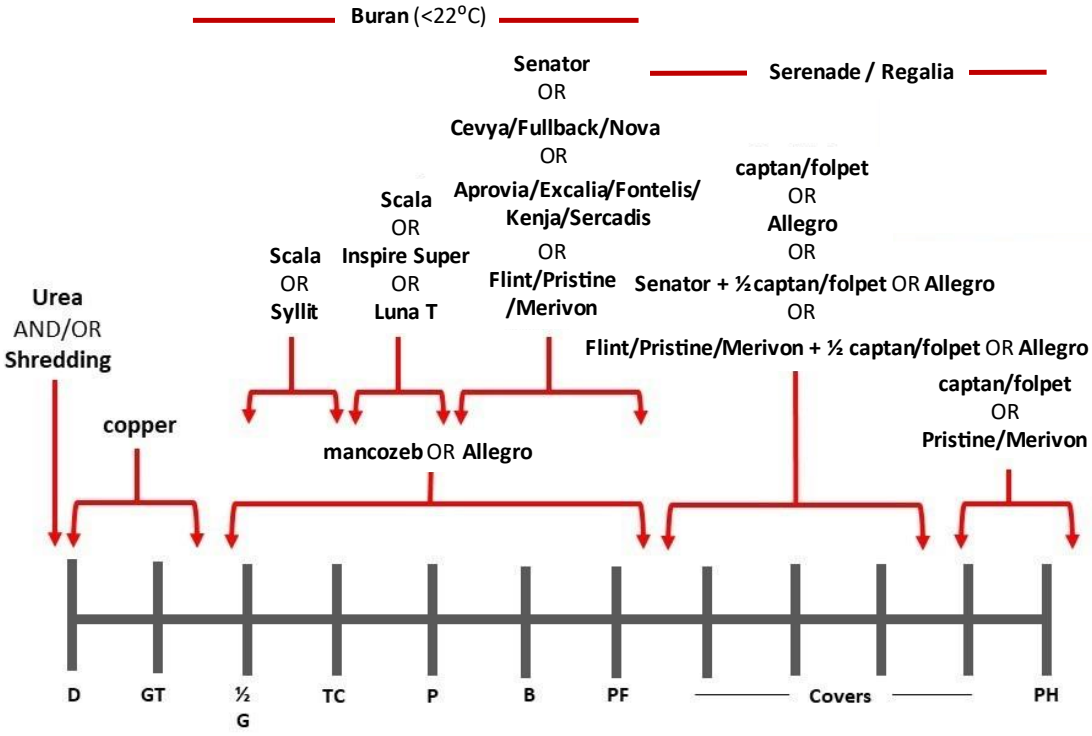


**Figure 2.** Example of a full-season apple scab management program during a cool, wet spring followed by a warm, humid summer. Fungicides or groups highlighted from tight cluster through summer covers may also provide efficacy on powdery mildew, rust, fly speck, sooty blotch, black rot and bitter rot.

# Green Tip is Here – Are You Prepared for Early Spring Pest Management?

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

## Orchard Sanitation: First Line of Defense

The first line of defense for pest management in an orchard is prevention. There is no silver bullet to eradicate something like disease once it becomes well established. This means management is a year-long process to reduce inoculum in the orchard and prevent the spread to healthy trees or fruit.

- Prune out dead or diseased branches and rotten or mummified fruit that often habour overwintering pests, such as fire blight, black rot or bitter rot.
- Get rid of wood or cull piles and stumps that may have provided overwintering sites for insects, such as codling moth and plum curculio.
- Clean up the orchard floor of leaves, branches and fruit.

## Fire blight

### *Pruning cankers*

If you haven't already, early spring is a good opportunity to clean up any remaining infected limbs, cankers or – in the case of rootstock blight – trees that will act as sources of inoculum and get as much fire blight out of the orchard as possible. These overwintering cankers will be the source of disease in the coming year as the bacteria is sitting in vascular tissue in the canker margins. As the tree begins to push in the spring, these cankers become active and the bacterial cells start to multiply. Generally, as temperatures increase above 18ºC, the enlarging cankers start oozing bacterial-laden sap that may or may not be visible. The bacteria are then carried by insects or rain splashed to developing tissue – whether that's blossoms or shoot tips.

Dormant pruning is effective for many reasons. Firstly, the fire blight pathogen, Erwinia amylovora is not active in the cold temperatures and therefore will not spread on pruning shears, tools or infected tissue. This means there's no need to disinfect tools between cuts like with summer pruning. Secondly, the cankers are easier to see in the orchard without foliage blocking or shading your view.

Spend some time to thoroughly scout for cankers while pruning. Try to do this more than once during the early spring and at different times during the day to have different light direction. While this does take additional time, that extra work may save you trees down the road by removing inoculum sources.

For more information on what to look for when pruning fire blight infected trees, see the February 2023 Orchard Network Newsletter article, Dormant Pruning for Fire Blight Management.

### *Plan ahead*

It's time to also start thinking about in-season fire blight management as bloom can come quickly. Having products ready and at your fingertips will allow you to act fast should conditions for infection occur. Don't get caught unprepared!

- Consider an immune-boosting product such as an SAR (Systemic Acquired Resistance) like Lifegard or Regalia Rx at late tight cluster to pink.
- Have enough control product – antibiotics (Streptomycin, Kasumin), copper (Cueva) and/or biologicals (Blossom Protect, Serenade, Buran, Double Nickel, Oxidate) to cover all rows of susceptible blocks every 2-3 days during bloom.
- Become acquainted (or refresh your memory) with forecasting models such as Cougar Blight or MaryBlyt if you will be running these for your farm. Otherwise, bookmark the Ontario Fire Blight Prediction Maps in your browser for quick reference during bloom. These maps are updated 3 times per week with a 7-day predicted risk forecast.
- Make a plan for management
    - What products you will use? Consider your options including product rotation for resistance management: antibiotics, copper, biologicals, Apogee/Kudos, etc.

- How will you use them? For instance, prebloom SAR? Biologicals early bloom? Antibiotics full bloom to petal fall? King bloom petal fall Apogee/Kudos or could timing be sooner? Understanding how the product works (preventative, systemic, plant response, etc) will help determine appropriate application timing.
- Don't forget to consider your action plan in case of trauma blight.

But first and foremost, be prepared to apply a dormant copper spray at silver tip to ½" green to help protect the spread of bacteria from any oozing cankers that were missed during dormant pruning.

***Dormant copper***

The effectiveness of a dormant copper spray really comes down to how it is applied and post-application weather. Copper provides an unfriendly environment over the bark and bud surfaces of the tree, preventing bacteria from getting established or spreading. Thus, it must be applied as a high-volume spray to ensure sufficient coverage.

Dormant copper such as Copper Spray, Copper 53W, Cueva, Parasol and Kocide can safely be applied up to ¼" green (possibly ½" green) without risk of phytotoxicity. However, the use of a softer copper registered for season-long control such as Cueva could be extended in those early spray timings to ½" green or tight cluster in blocks with low scab inoculum (ie., free of scab last year) to provide some scab protection.

Residual activity typically last about 7-10 days under ideal spring conditions. However, once rainfall exceeds 2" from last copper application, it should be assumed all residue has been washed off. Using 1-2% dormant oil, unless the label states otherwise, will act as a sticker/spreader to help with copper as well as provide efficacy on scale, European red mite and suppression of powdery mildew. However, Cueva is formulated with a fatty acid so there is little benefit to adding oil as a sticker for this product. Keep in mind if using dormant oil, do not apply captan, folpet or sulphur products within 14 days of application since oil can enhance penetration of these products into sensitive tissue, resulting in phytotoxicity issues. There are other cautions around the use of oil, which will be discussed below.

## Scab

***Reducing primary inoculum***

Practical and inexpensive, inoculum-reducing strategies such urea and mowing can be an important component to an effective scab management program and contribute to the reduction of overwintering ascospores that will infect green tissue at the start of the season. This is especially important given the reduced arsenal of available fungicides effective against scab Ontario growers now face. Table 1 summarizes research from New Hampshire that looked at the impact of inoculum pressure on primary scab infection the following spring. An orchard with 20% overwintering leaf scab has the potential to produce 7,000 times more ascospores than an orchard with less than 1% overwintering leaf scab (Gadoury and MacHardy, 1986).

**Table 1.** Primary scab infection activity based on overwintering inoculum levels, New Hampshire[1]

| Leaf scab in fall (%) | Ascospore production the following spring | | |
|---|---|---|---|
| | Total ascospores produced/acre ('000) | Ascospores/acre released at green tip ('000)[2] | Potential lesions/acre from green tip infection period[3] |
| **<0.5** | 888 | 18 | 0.18 |
| **1-3** | 9,262 | 185 | 1.85 |
| **4-10** | 242,559 | 4,851 | 48.5 |
| **20** | 6,090,000 | 121,812 | 1,218 |

[1] Adapted from Gadoury and MacHardy (1986)
[2] Assuming 2% of ascospores released.
[3] Assuming 1% of released spores cause infection. Actual infection will vary depending on climate and spraying conditions.

You can save time and money usually invested in fungicide applications by reducing the initial scab pressure going into the season:

- In a typical year, only a small proportion of ascospores are actually mature early season. Therefore, reducing (or eliminating) the risk of infection, and potential need for chemical control, at green tip.

- Scab spores do not travel far and most infections start from within the orchard. Again, getting the inoculum out greatly reduces the risk of infection.
- Most fungicides tend to work better in low-inoculum orchards, particularly when dealing with our Ontario spring weather.
- The trend in new product registrations is towards single-site fungicides which have high resistance potential. Reducing scab inoculum means less selection pressure placed on these products (ie., longer life of these products).

***Applying urea***

Urea works in several ways:

1) It directly inhibits the development of ascospores,
2) It stimulates the growth of naturally occurring organisms that are antagonistic against the scab fungus, and
3) It facilitates the breakdown of the leaves.

Since the early 2000's, research has shown this practice to be effective in reducing over-wintering spores. Research from the University of New Hampshire showed a 97% reduction in ascospore productivity in leaves sprayed with 5% urea just before leaf-fall, 50% reduction when urea was applied to the leaf litter when approximately 95% of the leaves had fallen, and 70% reduction when urea was applied to the leaf litter in spring (Sutton et al., 2000).
For the later areas of the province, if you haven't already done so this spring, apply 45 kg of agricultural urea per 1,000 L of water/ha to the orchard floor before bud break.

***Leaf shredding***

In addition to a urea application, scab inoculum can be reduced 80-90% by shredding overwintering leaves (Sutton et al., 2000; Vincent et al., 2004). Rake or blow leaves from under trees and shred them using a flail mower. This helps encourage leaf decay and may re-orient the leaves to prevent spores from discharging up into the trees.

***Early season management***

Consider the following:

- Leaves are susceptible to infection as soon as green tissue is present, especially if you had scab in your orchard last year.
- Green tip to tight cluster is a period of extensive new growth. Keep covered with a good protectant fungicide program and re-apply every 5-7 days during periods conducive to disease development or following heavy (greater than 1") rain.
- During cool, wet springs, protectant fungicides may not be enough. Consider using post-infection products that perform well in cooler weather such as Syllit, Scala, Inspire Super, Luna Tranquility or Buran.
- Ascospores mature slowly early season and infection takes longer, peaking over bloom period so plan to save your systemic scab products (eg., Group 3, 7 and 11) for when there is more leaf area and infection risk is greatest.
    - For example, more than 20 hours of leaf wetness are required for primary ascospore infection at an average temperature of 5ºC. This goes down to only 6 hours during average temperatures of 15-25ºC.
- For more details on disease management with reduced Group M fungicide use, see the article *Planning for a Season with Limited Group M Fungicides* in this issue of Orchard Network Newsletter.

## Powdery Mildew

Dormant buds infected with powdery mildew are typically feathered, pointed or shriveled and usually break dormancy later than healthy buds. This means susceptible, green tissue may already be present when the first conidia are produced. If conditions are ideal, even a small powdery mildew population can quickly explode if not managed properly. With the mild winter we've experienced, be prepared for early season management of this pest.

Protectant fungicides used for early season scab management do not have activity on powdery mildew. Tank-mixing a low rate of sulphur (3-5 kg/ha) with captan, folpet and/or an EBDC, beginning at ½" green, will provide good activity on scab

while also suppressing powdery mildew. This early season program will help free up other chemistries such as Group 3, 7 and 11s for later use when plenty of new growth is present.

Some key points for effective powdery mildew control this year include:

- Maintain a tight spray schedule with high rates during primary scab infection period. Powdery mildew does not invade mature leaf tissue, so spread of mildew ceases when trees stop producing new terminal leaves.
- Rain deters powdery mildew development by washing off spores. Instead, mildew thrives in dry weather and high relative humidity. So, protectant sprays may still be required during dry periods when there is little risk from apple scab.
- Getting good mildew control following an outbreak will take several seasons. Mildew infected white shoots from last year's failure will persist through the season, but does not indicate current fungicides are failing. The current season mildew program is designed to prevent spread that would lead to primary infection for next year.
- Include a mildewcide, such as sulphur in all sprays beginning at ½" green until temperatures are greater than 25°C or when applying oil. Sulphur lacks post-infection activity, so must be applied early season. A tank-mix that includes captan/folpet, EBDC and sulphur provides excellent protection against scab, rust and mildew.
- If pressure was low last year, oil applied for mites may provide suppression of powdery mildew. Use a 2% solution (20 L/1,000 L water) for dormant sprays or a 1% (10 L/1,000 L water) solution for summer sprays. Do not use captan-, folpet- or sulphur-containing products within 14 days of an oil application.
- Where they are working, include fungicides from other groups, including Group 3, 7 and 11s during the critical infection period, generally at pink to first covers.

### *Dormant oil*

Spring-applied dormant oil can seem at times a risky game to play, hoping the right growth stage will align with the right weather conditions. However, by preparing early for this spray and following the forecasted weather, dormant oil can be an effective tool for managing some rather difficult-to-control pests. Insect development and activity is driven by temperature; the milder it is, the faster the insect matures. This improves the efficacy of how oil works as well as ensures a lower risk of phytotoxicity concerns.

Over the years, there has been some question whether oil may reduce the overall health of the trees. To date, there is no scientific evidence to support these claims. Oil has been used for many years across apple growing regions of the world to control various overwintering pests with no ill effects on the health of the tree when properly applied.

#### *How Does It Work?*

Oil sprays work mainly by suffocation. Coating the insect – which means in a high-volume spray to reach all the cracks in the tree bark – prevents normal respiration from the air holes (spiracles) where they breathe. This works best on the immobile and immature stages where:

1) the insect can't move away to avoid the spray,
2) the scale coverings have still not hardened and oil can penetrate, and
3) respiration rate is the highest.

However, oil can also interfere with egg development, prevent settling of scale crawlers and deter feeding by pests such as aphids which is why summer oil programs are also worthwhile.

#### *What Pests Does It Target?*

There are several species of scale insects affecting apples; San Jose scale (SJS) is the most common in Ontario orchards. This insect overwinters as an immature scale under bark and emerges just prior to bud break. As the immature scales feed, they exude a waxy substance that forms a protective layer. Dormant oil sprays are the best timing for this pest before they develop that waxy covering.

Without the foliage to block the spray, dormant oil applications can get reasonable coverage of limbs and trunk where the overwintering SJS population is located. Targeting individuals at this stage will help reduce the population that will produce the summer generation crawlers. Postbloom management targets these crawlers which move from the infested

area to maturing fruit. These sprays can be very effective at reducing the amount of fruit damage; however, they do not always provide good control of the crawlers that move elsewhere such as to new branches, a different spot on the trunk or to an adjacent tree. In other words, you could find yourself in a continuous cycle of managing fruit damage if the SJS population is not suppressed. While it may be hard to find time and good weather early season, an oil application is well worth it.

European red mites overwinter as eggs on roughened bark around the bases of buds and spurs, or in the inner parts of the tree close to the main trunk and branches. Oil sprays should be applied before egg hatch, between half-inch green and tight cluster.

While delayed dormant oil applications primarily target scale and mites, you may see some additional efficacy against other pests at this timing including impeding egg hatch and movement of aphids and some spring feeding caterpillars, interfering with egg laying and development of apple leafcurling midge and preventing release of overwintering powdery mildew spores as infected buds open.

***Is It Too Late for Dormant Oil?***

Depending on the target pest, the term “dormant” oil can be rather misleading as sprays can be applied from the true dormant state prior to bud break up until pink. Unfortunately, optimal dormant timing for scale is not necessarily the same for mites.

If monitoring indicates scale is a bigger issue in the orchard, oils need to be applied before or shortly after bud break. This efficacy against scale is significantly reduced with later oil applications for European red mite as they develop a waxy protective layer that impedes the oil from effectively penetrating and preventing respiration.

However, if European red mite populations are the problem, sprays can be delayed. Ideal timing is half-inch green to tight cluster but can be delayed to pink; however, blossoms can be quite sensitive to oil under adverse conditions so consider using a lower rate at this timing.

***Precautions***

Original precautions around the use of dormant oil were developed prior to the refinement processes that are carried out now with the commonly registered products. Most impurities that were associated with phytotoxic effects with some of the older “heavy” horticultural oils are removed through extra filtration and distillation. If you have concerns with using oil, especially with sensitive varieties like Red Delicious, Empire, Mutsu and Ambrosia, consider the newer generation oil products such as Purespray Green Spray Oil 13E, Suffoil-X or Vegol as these are registered for both dormant and summer use.

However, even highly refined “summer” oils can cause crop injury when they are applied:

- when temperatures are consistently below 4C
- within 48 hours before or after a freezing event
- in slow drying or prolonged wet conditions
- with or too close to products containing sulphur, captan or folpet
    - do not apply oil within 14 days before or after these products
    - restrictions also apply to Vegol Crop Oil with copper compounds
- above label rate
    - higher labeled concentrations can be used for dormant applications vs summer applications (e.g., 2% solution vs 1% solution of Purespray for dormant vs summer use, respectively)
    - High water volumes are essential for good coverage
- to plants are under moisture stress
- when temperatures are very high (above 25°C)

Always read the product label for additional instructions and precautions.

### Prebloom Insecticides

In recent years, with the changing spring climate, new or emerging early season pest issues, challenges with immediate post-bloom control and the varying bloom times of different varieties, relying on a petal fall management program alone does not always provide full protection from insect damage. More discussion is happening around the benefits of a prebloom program, which is a practice many growers have tended to move away from. Without prebloom insecticides, natural enemy populations can build, there is less risk of exposure to pollinators and it's money saved on input costs. However, rosy apple aphid, leafcurling midge, European apple sawfly, tarnished plant bug, spring-feeding caterpillars, mullein bug and plum curculio are just some of the pests that can cause extensive early season damage and are strongly dependent on the temperature prior to and during bloom.

Consider the following factors when deciding if a prebloom insecticide is worth it:

1. **Presence of insect pest(s) in orchard that has historically caused injury to developing flowers or fruitlets** – Has the particular pest caused significant economic damage in the past such that injury is anticipated again this year? Understanding the biology and period of activity of the target pest will help determine if control at pink will reduce populations compared to an early petal fall application. For instance, in Ontario:
    a. Monitoring of apple leafcurling midge has found pre-bloom adult activity typically beginning tight cluster.
    b. Rosy apple aphid activity starting at tight cluster can be common in cool, wet springs.
    c. European apple sawfly adults emerge pink through to bloom, laying eggs in the flower base.
    d. Plum curculio activity generally starts moving back into the orchard at bloom, with the greatest migration occurring within 14 days after petal fall.
    e. Mullein bug hatch is typically synchronized with peak emergence at early petal fall, but a cold snap during this time may result in split hatch.

2. **Whether a pink application of a particular product may deter a beekeeper from bringing hives into the orchard** – It might be worthwhile to speak to your beekeeper about your prebloom control considerations. Some may not bring their hives into an orchard that has used a particular product or group of products despite the insecticide being applied prior to the bees coming in.

3. **Likelihood of making a timely petal fall application** – Do your blocks have a mix of early and late blooming varieties that may delay a petal fall application? Is the bloom period predicted to be cool, wet and therefore prolonged? Has there ever been a time that the hives were not removed early enough? Any delay to a petal fall application can have serious implications in an orchard block with high pest pressure such as sawfly, plum curculio, mullein bug or oriental fruit moth.

A number of prebloom insecticide options are available depending on the target pest. Refer to the Ontario Crop Protection Hub for a full list of registered products, efficacy on early season insects as well as toxicity to beneficial insects.

Do not apply insecticides while apples are in bloom. The Bee Act makes it an offence to do so in Ontario. Time any prebloom or immediate postbloom applications to minimize exposure to any native pollinators that may be active in or around the orchard. Under normal circumstances, spraying after 8 pm allows spray to dry before bees are exposed to it the next day. Spraying during early morning is the next best time, when fewer bees are foraging, but spraying should be completed well before 7 am. Always read the most current product label for guidance.

## Clearing the Cobwebs on Copper

*Katie Goldenhar, Plant Pathologist – Horticulture,OMAFRA*

Do you really know how copper fungicides work? With so many on the market, if you're considering using a copper product in your disease management program, there are some important factors to consider.

Copper is one of the original fungicides and yet there are constantly new copper products coming to the market. Copper is an inorganic compound that does not breakdown like organic compounds and therefore too much copper fungicide use can lead to build up in the soil, negatively impacting soil health, so judicial use is required.

Copper is a general, non-selective biocide, meaning it works as a bactericide, fungicide and when used incorrectly, herbicide. When copper particles degrade in water, they release ions that inhibit critical enzymes in cells. Hence, the use of any copper product will come with cautions to avoid phytotoxicity. Copper products are the most effective on pathogens that need free water to infect the plant (like bacteria) and is one of the only crop protection materials that can help manage bacterial diseases such as fire blight and blister spot in apples (Figure 1). Copper can also provide some efficacy against certain fungal diseases such as apple scab.

**Figure 1.** Pictures illustrating (left) fire blight, (middle) blister spot and (right) scab on apple.

There are two main types of copper products: soluble and fixed.

Soluble copper products have copper ions available in solution and are all available when sprayed. Residue is quicky removed from overhead irrigation or rain. Currently, there is only one type of copper (copper sulfate pentahydrate) that falls within the soluble category, and it is not registered on apples in Canada. In the US, Mastercop and Phyton are registered.

Fixed or insoluble copper products contain copper that releases ions at slower rates that continue after application when there are wetting events. Particles can persist on the leaf after drying and continually release ions when there is moisture present. Not all fixed coppers are the same level of insolubility, for example copper hydroxide (ex. Parasol WG) is more soluble in water than basic copper sulfate (ex. Copper 53W), while copper oxychloride (ex. Copper Spray) falls between the two. Copper octanoate (Cueva) is more soluble than fixed coppers, but approximately 26 times less soluble than copper sulfate pentahydrate. Typically, there is longer residual control with fixed coppers. The challenge is that there needs to be enough ions present to kill the target pathogen without injuring the crop. Generally, fixed copper products reduce the chances of phytotoxicity since not all the ions are present at once. Adding hydrated lime can make any copper product less soluble but some coppers are not compatible with lime, so always consult the product label.

An important factor to consider when using copper is that copper does not move within a plant – it stays where it lands and has no post-infection activity. Spray coverage and preventative applications are important when applying a copper product. Copper particle size is another factor influencing efficacy, primarily determined by how finely the product is ground. Large particles will easily be removed by wind or rain after application has dried whereas small particles will provide better coverage of the leaf, adhere to plant surface, and provide longer residual control.

In Canada, the metallic copper content is present on the label as the percent available elemental copper. Table 1 shows some copper products registered in Canada and their corresponding copper content. If you want to compare the amount of copper being applied in each product, multiply the metallic copper content by the rate per hectare. For example, in apples, the max rate of Copper 53W is 3kg/ha so multiplied by the 53% metallic copper content means that there is 1.59 kg of metallic copper per hectare being delivered.

**Table 1.** Copper products registered in various crops and their corresponding metallic copper content. Always consult the product label before use.

| Product | Registered on apple? | PCP# | active ingredient | metallic copper | Bee toxicity rank[1] |
|---|---|---|---|---|---|
| **Copper 53W** | yes | 9934 | basic copper sulphate | 53% | III |
| **Copper Spray** | yes | 19146 | copper oxychloride | 50% | II |
| **Parasol Flowable** | yes | 25901 | copper hydroxide | 24.4% | II |
| **Cueva Commercial** | yes | 31825 | copper octanoate | 1.8% | III |

[1]from University of California - Ranking of pesticides according to whether (I) the product should not be applied to flowers, (II) the product should not be applied to flowers except between sunset and midnight, or (III) no bee precaution except what is listed on label. https://ipm.ucanr.edu/bee-precaution-pesticide-ratings/

Copper fungicides belong to the FRAC group M1. The "M" stands for multi-site and is thought to be at low risk for resistance development. However, there are cases of copper resistance in bacterial pathogens of vegetable crops developing when frequent and repeated applications were used. Fungicide resistance management guidelines should be used to maintain economical control for the future.
Other factors to consider include:

- **pH** – generally, the lower the pH, the more soluble copper becomes which increases the chance of phytotoxicity
- **tank mixing (compatibility and phytotoxicity)** – it is well known that foliar fertilizers and phosphorous acid products cannot be used with copper
- **weather factors** – slow drying will increase the chance of phytotoxicity and heavy rain may reduce residue
- application rate and frequency

The more questions you ask the better, so reach out to your OMAFRA specialist, agronomist, or copper fungicide supplier for more information on disease management using copper.

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## Don't Give a Free Ride to the Spotted Lanternfly


*Hannah Fraser, OMAFRA Entomologist – Horticulture*


Spotted lanternfly (SLF), *Lycorma delicatula*, is an invasive sap-feeding planthopper native to Asia. First identified in Pennsylvania in 2014, it has spread to at least 14 states. While live specimens have not been found in Canada, active populations have been found right across the border in Buffalo, New York, and in Pontiac, Michigan.

### What is it?

Spotted lanternfly is an excellent hitchhiker. Long distance spread to new areas is typically associated with people inadvertently moving overwintering egg masses. Females lay eggs indiscriminately on just about any flat surface. The egg masses are up to 2 cm long (similar in size to those of spongy moth) and covered by a grey, waxy coating that has a putty-like appearance. Over time, the waxy surface becomes dull, making egg masses difficult to detect on some surfaces (Figure 1).

**Figure 1.** Spotted lanternfly females and egg masses on a vineyard post
(Photo: Heather Leach, Penn State Extension)

Adults are large (2.5 cm in length) and brightly coloured. Early instar nymphs are black with white spots, while fourth instars are bright red with white and black spots. Nymphs are excellent jumpers.

Although adults are not considered strong flyers, they are capable of repeated bouts of flight, resulting in natural spread of several km per year. There is one generation per year (Figure 2).

### What is the damage?

Spotted lanternfly is a plant stressor. Large numbers can weaken or kill plants. Aggregations (or swarms) of nymphs and adults damage plants directly by feeding on plant sap, and indirectly by excreting large amounts of sugary honeydew that promotes the development of sooty mould and interferes with photosynthesis.

There are over 70 documented hosts in North America, including grapevines, fruit trees, and hardwoods like black walnut, maple, and one of its preferred hosts, the invasive tree-of-heaven.

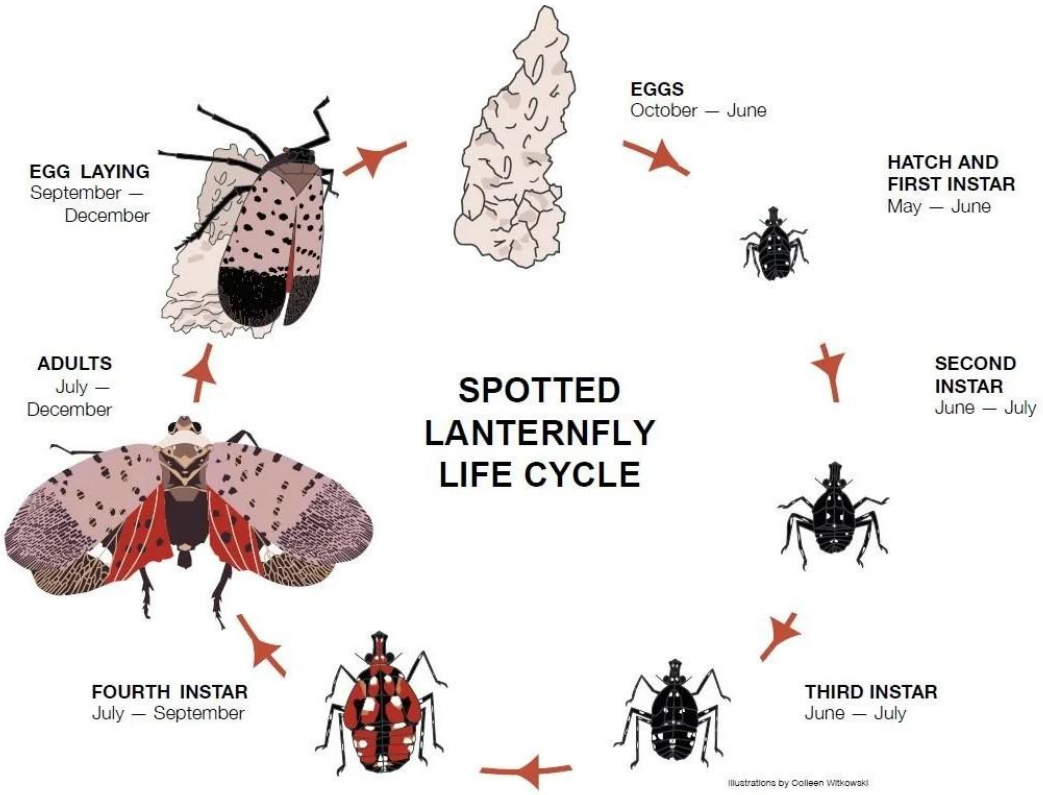


**Figure 2.** SLF has one generation per year in Pennsylvania (Photo: Colleen Witkowski, Penn State University)

To date, reports of economic injury in the US have been confined to commercial vineyards, where swarm feeding has resulted in yield loss, decreased sugar content in harvested grapes, and weakening or death of vines. There is ongoing research on the impacts to tree health in black walnut and maple, both of which are commonly attacked by late instar nymphs and adults in the fall. There have been some dramatic images of SLF swarms on apple, but so far, activity on tree fruit seems to be limited to brief periods in the fall, possibly as the pest searches out more preferred hosts.

### Looking for more information?

If you are interested in finding out more about SLF, the Invasive Species Centre has developed an online course to provide training on the identification, biology, impacts, pathways for spread, and reporting: https://invasivespeciestraining.ca/courses/spotted-lanternfly-training/ (funded through the Canadian Agricultural Partnership's AgriRisk Initiatives Program). This self-guided online course is free of cost and can be used to obtain Continuing Education Credits from the Ontario Certified Crop Advisor Association.

If you are travelling through infested areas or bringing in supplies from affected regions in the US (see distribution map: https://cals.cornell.edu/new-york-state-integrated-pest-management/outreach-education/whats-bugging-you/spotted-lanternfly/spotted-lanternfly-reported-distribution-map), be mindful you're not inadvertently moving eggs or other life stages. Early detection is crucial for effective response and in limiting or slowing the spread.
If you think you have found SLF, take pictures and report any suspected finds immediately to the Canadian Food Inspection Agency at https://inspection.canada.ca/about-cfia/contact-us/contact-cfia-online/eng/1299860523723/1299860643049.

# *Announcements*

## 2023 Apple IPM Workshop

This year's Apple IPM Workshop will be offered virtually for anyone interested in chatting the basics of apple IPM from monitoring techniques, safety protocols and tips for success when scouting orchards.

REGISTER NOW!
Thursday, May 4th
10:00 am – 1:00 pm
Zoom (virtual)
Click here to register (full link below)

All presentations in the Apple IPM Workshop Series can be found on the ONhortcrops YouTube channel at https://www.youtube.com/playlist?list=PLjTx-zm9InXAbdQ5PtsyHIzF2_YABqb3c. Watch the presentation series ahead of the meeting and bring your pest- or scouting-specific questions.

Registration for other OMAFRA IPM workshops including Introduction to IPM is now open. For details on dates and location, see https://onfruit.ca/2023/04/05/register-now-free-ipm-scout-training-workshops/.

Full registration link:
https://omafra.my.site.com/survey/ArdiraSurvey/SurveyResponse.app?recordId=a1G5W000000m63a&logicalId=5af37fa9-f571-3795-b1eb-09737c966a90

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