The Bitter Rot Saga

What *Colletotrichum* Species Are Present & Are They Still Sensitive to Pyraclostrobin?

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The thunderstorms are here which means one thing – bitter rot season is back, and we have new information to bring to you regarding fungicide use.

Spores of the pathogen causing bitter rot are active as early as petal fall. Fungicides need to be applied preventatively – fungicides cannot treat an existing infection. Infection can occur throughout the season from petal fall to harvest as favourable conditions persist (this fungus prefers a nice 26°C with a minimum of 5 hours leaf wetness), so you should now be on a rotation of effective fungicides for bitter rot. The Winter 2026 ONcore (Vol 30 Iss 1) reported on the Ontario fungicide efficacy trials, *Bitter Rot Management: Results of 2024-2025 Field Trials*.

As we are relying on few fungicide FRAC groups (FRAC = fungicide resistance action committee) to manage bitter rot, and FRAC 11 (QoI) fungicides come with an inherently high resistance risk, it is critical to monitor for resistance to catch it early and adjust management accordingly. And guess what? FRAC 11 resistance has been found.

New Info But Not Surprising

But first, we need to know what species of *Colletotrichum* we have in Ontario to understand how to better manage the disease.

Research from the University of Guelph has confirmed that three main *Colletotrichum* species are associated with bitter rot in Ontario: *C. fioriniae*, *C. nymphaeae*, and *C. godetiae*. These all belong to the *Colletotrichum acutatum* species complex. Like reports from regions of the Northeast U.S., *C. fioriniae* is the dominant bitter rot species (96% of fruit isolates), despite the presence of other *Colletotrichum* species.

Colletotrichum species can cause quiescent infections, meaning they can be present in tissue and not cause disease but potentially serve as an inoculum source. From 2023-2025, 147 isolates were collected from a total sample of 10,130 (!) asymptomatic leaves in orchards across the province. 91% of isolates were identified as *C. fioriniae*, 5% as *C. godetiae*, and 3% as *C. nymphaeae*. Two species from the *C. gloeosporioides* species complex were identified: *C. aenigma* and *C. sojae*.

A total of 74 isolates were collected from 284 total symptomatic fruit samples. All belonged to the *C. acutatum* species complex: 96% were identified as *C. fioriniae*, 3% as *C. nymphaeae*, and 1% as *C. godetiae*.

These 221 isolates (147 from leaves; 74 from fruit) were further characterized for their sensitivity to pyraclostobin, the FRAC 11 active ingredient in Pristine & Merivon.

Group 11 Resistance Present But Not Widespread… Yet

The 221 *Colletotrichum* isolates were evaluated for sensitivity to pyraclostrobin (FRAC 11) using colony growth assays at concentrations of 0, 0.01, 0.1, and 1 ppm.

The distribution of percent inhibition at 1 ppm (Figure 1) showed that most isolates (96.4%) were sensitive to pyraclostrobin (😊). However, eight isolates (3.6%) showed resistance to pyraclostrobin, defined as an average percent inhibition less than 20% (😵). Of these eight isolates, six were *C. nymphaeae* and two were *C. fioriniae*.

Seven of these isolates were selected for molecular testing of the G143A mutation, a well-established mutation conferring resistance to FRAC 11 fungicides. All seven isolates were positive for this mutation.

In addition to the plate testing showing reduced sensitivity in a small number of isolates, detecting the G143A mutation in Ontario-collected *Colletotrichum* isolates is an indication of the presence of resistance in the orchard and requires a strict adherence to fungicide resistance management practices before we potentially see field control failures.

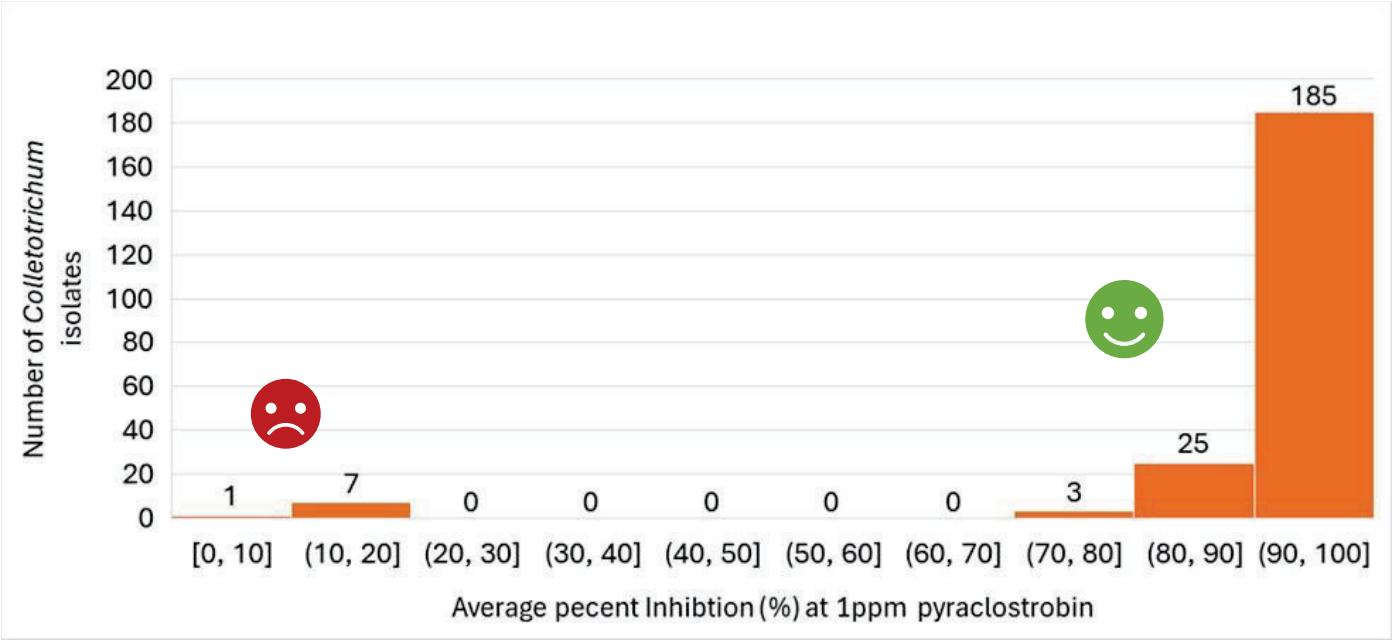

Figure 1. *Distribution of Colletotrichum isolates based on percent inhibition from pyraclostrobin (1 ppm) using colony growth inhibition assay.*

Use Resistance Management Strategies Now

Orchard sanitation to reduce disease inoculum is a critical first step for bitter rot management, especially given our limited fungicide options. Mulch or remove fruit on the orchard floor following hand thinning (and harvest) to reduce inoculum. Removal of dead wood and cankers produced by other diseases and fruit mummies will also help reduce the disease pressure in your orchard. Anything you can do to reduce leaf wetness periods – such as canopy management and good air circulation – will also aid in reducing the disease (remember the disease triangle!).

The following products are currently registered in Canada for bitter rot in apples:

- Allegro / Downforce (FRAC 29)
- Pristine (FRAC 11 & 7)
- Merivon (FRAC 11 & 7)
- Maestro/Supra Captan (FRAC M4)

It is important to be aware that the Group 7s in both Pristine (boscalid) and Merivon (fluxapyroxad) **ARE NOT EFFECTIVE** on bitter rot, and using these products specifically for bitter rot control is relying on the Group 11 (pyraclostrobin) as a **SOLO PRODUCT**.

As indicated from the University of Guelph fungicide studies reported in the Winter 2026 ONcore, *Bitter Rot Management: Results of 2024-2025 Field Trials*, the fungicides Folpan/Follow (FRAC M4) and Aprovia (FRAC 7) will provide efficacy on bitter rot when the product is applied at the registered rate for diseases listed on the product label.

Always (and forever) rotate and tank-mix fungicide FRAC groups to slow the development of fungicide resistance. *Which strategy is better?* There is no clear evidence of either being better, but it comes down to how many sprays you need to control the disease and how many options you have.

In the case of bitter rot, we have one effective active ingredient in each of the FRAC Groups (7, 11 and 29). Rotation is going to be your best option for the single sites, tank mixing with a biofungicide under low to medium pressure or a group M4 (folpet, captan) under high pressure. Reducing the use of fungicides from each FRAC group is a key aspect to resistance management strategies, so ensure you are using your fungicide as they are needed to reduce unnecessary selection pressure.

This is a good news story – thanks to the research done by the University of Guelph team on Ontario orchards, in addition to understanding the disease cycle, causal agents and new fungicide options, we now know that we have very low levels of resistance and can do everything in our power to slow the development.

Acknowledgements

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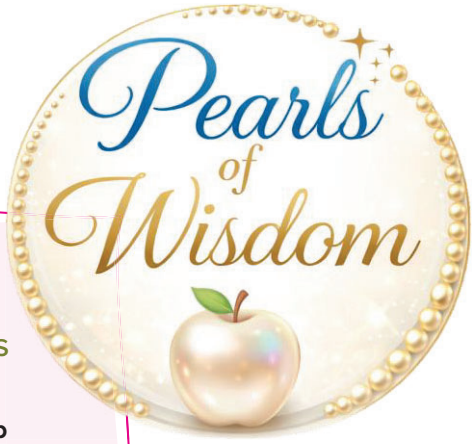

Celebrating IPM adoption over ONcore's 30 years!

Modelling for scab
Volume 3 Issue 2
April 1998

NEW TECHNOLOGY IN MANAGING APPLE SCAB

Bernie Solymar

In 1990, Ontario led the world by adopting the MacHardy-Gadoury model for predicting when apple scab infections occurred. The table, which replaced the old Mill's table, took into account the fact that primary ascospore release was largely suppressed during the night. Only very small (insignificant) amounts of ascospores are released during hours of darkness in orchards considered "free" of scab. According to research by Drs. Bill MacHardy and David Gadoury at the University of New Hampshire, ascospore release is largely concentrated between the hours of 8:00 a.m. and 7:00 p.m. (Daylight Saving Time). These revelations have saved Ontario apple growers an average of 2 fungicide sprays per season.

In 1998, a further revision of the MacHardy and Gadoury model will appear in *Publication 360, Fruit Production Recommendations*. Based on new research by Dr. Gadoury, now at Cornell University, the minor modifications take into account that scab infections can occur in less time than previously thought (i.e., at 6 °C primary infections occur in 18 hours rather than 23 hours).

The second major finding by Dr. Gadoury and his colleagues was a technique to more accurately determine the completion of the primary scab season. This model requires growers to record average daily temperatures beginning at bud break. Each day degree-days are calculated based on the following equation:

$$\frac{\text{Daily max}(^\circ\text{C}) + \text{Daily min}(^\circ\text{C})}{2} = \text{Deg Day}$$

Degree days are summed each day and a running total is maintained. This number is then used as follows:

The end of the primary scab season, when all spore release has been exhausted within a confidence limit of 90% is when an approximate total of 700 degree-days are reached.

In the past, OMAFRA has used the squash mount technique to estimate this event. However, this technology was abandoned several years ago since it did not provide accurate indications of actual airborne spore levels. The new method provides a better way to predict the completion of the primary infection season by apple scab. Combined with the Potential Ascospore Dose (PAD) method to determine, in the fall, the levels of overwintering inoculum the management of apple scab has become a much more accurate and exacting science.