# Bitter Rot Management:
## Results of 2024-2025 Field Trials

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## Introduction

Bitter rot is an important summer disease that can significantly affect apple production in Ontario. Studies from the University of Guelph have confirmed that three *Colletotrichum* species are associated with this disease in the province: *C. fioriniae*, *C. nymphaeae*, and *C. godetiae*. Similar to reports from other regions of the Northeast, *C. fioriniae* appears to be the dominant bitter rot species in Ontario, despite the presence of other *Colletotrichum* species. Comprehensive province-wide incidence data are still pending and will be reported in a future article.

These pathogens can infect fruit early in the season without producing visible symptoms. As fruit approach maturity or during storage, infections can develop rapidly, appearing as characteristic sunken lesions that can result in fruit loss (Figure 1 & 2). Recent research indicates that apples are susceptible to *Colletotrichum* spp. infection from fruit set through harvest, highlighting the importance of season-long disease management. To learn more on bitter rot timing, read *Timing of Infection and Management of Bitter Rot in Ontario*.

To support improved bitter rot management for Ontario growers, a fungicide efficacy trial was conducted during the 2024 and2025 growing seasons at the University of Guelph's Ontario Crop Research Centre - Simcoe. Several fungicide treatments were evaluated to determine their effectiveness in reducing bitter rot under Ontario growing conditions.

## Experimental Set-Up

The trial was conducted using a randomized complete block design with two cultivars, Empire and Ambrosia on M.9 rootstock. Five trees were used per replicate and four replicates per treatment. Treatments (Table 1) were selected in collaboration with project partners.

The first fungicide application was made 10 days after petal fall.

For Empire, applications began on:

- May 23, 2024 – when fruit size was approx.. 11 mm
- May 26, 2025 – when fruit size was approx.. 7 mm

For Ambrosia, applications began on:

- May 30, 2024 – when fruit size was approx.. 14 mm
- June 3, 2025 – when fruit size was approx.. 10 mm

Subsequent fungicide applications were applied approximately after 9-17 days or after 50 mm or more rainfall). Spray schedule and rainfall summary for 2024 and 2025 are provided in Tables 2 and 3, respectively.

Applications were made using a $CO_2$-powered backpack sprayer equipped with a TeeJet XR11002-VS

***Figure 1.** Bitter rot on Empire apple.*

***Figure 2.** Bitter rot on Ambrosia apple.*

**Table 1.** Treatments for 2024-2025 bitter rot fungicide efficacy trials, Ontario Crop Research Centre – Simcoe

| Treatment | Trade Name | Active Ingredient(s) | FRAC Group | Rate Applied |
|---|---|---|---|---|
| 1 | Untreated Check (UTC) | water | — | — |
| 2 | Folpan 80 WDG | folpet (80%) | M4 | 3.75kg/ha |
| 3 | Aprovia | benzovindiflupyr (100 g/L) | 7 | 500 mL/ha |
| 4 | Cyclone Plus* + Agral 90 | lactic acid (1.4%) + citric acid (2.54%) | P7 | 1.4% v/v + 0.1% v/v |
| 5 | Switch 62.5 WG* | cyprodinil (37.5%) + fludioxonil (25%) | 9+12 | 975 g/ha |
| 6 | Commercial Standard (CS) | | | |
| | Pristine WG | boscalid (12.8%) + pyraclostrobin (25.2%) | 7+11 | 1.2 kg/ha |
| | Allegro 500 F | fluazinam (40%) | 29 | 1 L/ha |
| | Supra Captan 80 WSP | captan (80%) | M4 | 3 kg/ha |

* Not registered for apples

nozzle, delivering spray volumes of 500–800 L/ha. Weather data was monitored using an on-site Weather INnovations System (Tables 2 & 3).

To ensure disease pressure, trees were inoculated in 2024 on May 24 and May 31 for Empire and Ambrosia, respectively, and in 2025 on May 27 and June 4 for Empire and Ambrosia, respectively. Mesh bags containing Empire fruit inoculated with *C. fioriniae* spores were hung from the top trellis wires to act as a source of inoculum (Figure 3).

A total of nine spray applications were made in 2024 and eight in 2025 for each cultivar (Tables 2 & 3). Empire fruit were harvested on September 9, 2024, and September 11, 2025, while Ambrosia fruit were harvested on September 26 in both years. In-field bitter rot incidence was assessed by recording the number of infected fruit and total fruit per tree in between each spray application and at harvest. In 2024, all fruit were harvested, whereas in 2025, a subsample of 100 fruit per plot was collected.

Following harvest, fruit were stored in cold storage for four months and subsequently held at room

temperature for 7–14 days to allow symptom development. Fruit were then evaluated for symptoms of bitter rot. Mean bitter rot incidence (% fruit with at least one lesion) was used for treatment comparisons using SAS statistical software.

***Figure 3.*** *Mesh bags containing bitter rot inoculated fruit were hung in the orchard to act as a source of inoculum.*

**Table 2.** Application dates for 2024 bitter rot fungicide efficacy trial, Ontario Crop Research Centre – Simcoe

| Application | Date | Cultivar(s) | Interval (days) | Rain (mm) | Commercial Standard Rotation |
|---|---|---|---|---|---|
| **1** | 23-May | Empire | — | — | Supra Captan 80 WSP |
| **2** | 30-May | Ambrosia, Empire | 7 | 59.8 | Allegro 500 F |
| **3** | 11-Jun | Ambrosia, Empire | 12 | 38 | Pristine WG |
| **4** | 24-Jun | Ambrosia, Empire | 13 | 9.6 | Supra Captan 80 WSP |
| **5** | 3-Jul | Ambrosia, Empire | 9 | 66.2 | Supra Captan 80 WSP |
| **6** | 18-Jul | Ambrosia, Empire | 15 | 91.2 | Pristine WG |
| **7** | 31-Jul | Ambrosia, Empire | 13 | 15.4 | Allegro 500 F |
| **8** | 14-Aug | Ambrosia, Empire | 14 | 28 | Supra Captan 80 WSP |
| **9** | 27-Aug | Ambrosia, Empire | 13 | 35.6 | Pristine WG |
| **10** | 10-Sep | Ambrosia | 13 | 35.8 | Supra Captan 80 WSP |

**Table 3.** Application dates for 2025 bitter rot fungicide efficacy trial, Ontario Crop Research Centre – Simcoe

| Application | Empire | | | | Ambrosia | | | |
|---|---|---|---|---|---|---|---|---|
| | Date | Interval (days) | Rain (mm) | Commerical Standard Rotation | Date | Interval (days) | Rain (mm) | Commercial Standard Rotation |
| **1** | 26-May | — | — | Pristine WG | 3-Jun | — | — | Pristine WG |
| **2** | 12-Jun | 17 | 11 | Allegro 500 F | 17-Jun | 14 | 7.6 | Supra Captan 80 WSP |
| **3** | 25-Jun | 13 | 32.4 | Supra Captan 80 WSP | 4-Jul | 17 | 88 | Pristine WG |
| **4** | 4-Jul | 9 | 56 | Pristine WG | 15-Jul | 11 | 42.49 | Allegro 500 F |
| **5** | 15-Jul | 11 | 42.49 | Allegro 500 F | 1-Aug | 17 | 80.4 | Supra Captan 80 WSP |
| **6** | 1-Aug | 17 | 80.4 | Supra Captan 80 WSP | 15-Aug | 14 | 6.8 | Pristine WG |
| **7** | 15-Aug | 14 | 6.8 | Pristine WG | 29-Aug | 14 | 42.8 | Allegro 500 F |
| **8** | 29-Aug | 14 | 42.8 | Allegro 500 F | 12-Sep | 14 | — | Pristine WG |

## 2024 Results

### In-Field Assessments

Bitter rot incidence remained low early in the season on both cultivars but increased steadily towards late August and September (Figure 4). Across assessment dates, fungicide treated plots had lower bitter rot incidence compared with the untreated check (UTC).

Based on pre-harvest rating (9-September) in Empire, FOLPAN and APROVIA provided the highest control (>95%), followed by Commercial Standard (CS) (~90%). SWITCH (67%) and CYCLONE PLUS (74%) provided moderate suppression.

Based on the pre-harvest rating (26-Septmeber) in Ambrosia, FOLPAN and CS again provided the highest

control (>95%), followed by APROVIA (~93%). SWITCH provided 78% control of bitter rot incidence, and CYCLONE PLUS showed the lowest control (~62%) under higher disease pressure.

### Post-Storage Assessments

In post-storage ratings (Figure 5), UTC showed extremely high disease incidence, exceeding 90% on Empire and approaching 100% on Ambrosia, confirming severe disease development in the absence of fungicide protection during the growing season.

On Empire, FOLPAN, APROVIA, and CS provided 80% or higher control, while SWITCH provided intermediate control. CYCLONE PLUS did not provide effective control and was similar to the UTC.

In Ambrosia, FOLPAN, SWITCH, APROVIA and CS provided 76% and above control. CYCLONE PLUS did not show effective control with values statistically similar to UTC.

## 2025 Results

### In-Field Assessments

Bitter rot incidence remained low on Empire; no treatment differences were observed (Figure 6). Based on pre-harvest rating (11 September) in Empire, FOLPAN and CS provided near complete control (~100%). APROVIA and SWITCH provided strong control (~88–92%), and CYCLONE PLUS showed lower suppression (~42%).

On Ambrosia, disease pressure was moderate in August and September; all fungicide treatments significantly reduced bitter rot incidence compared with UTC (Figure 6). Based on the pre-harvest rating (26 September), CS, APROVIA, and FOLPAN provided excellent control (>95%). SWITCH provided good control (~84%) and CYCLONE PLUS provided moderate control (~75%).

### Post-Storage Assessments

After storage, bitter rot incidence was high, even with low disease pressure seen during the field season (Figure 7).

In Empire, treatments of FOLPAN, SWITCH, APROVIA, and CS provided good control, while CYCLONE PLUS showed little control (2.9%) and was statistically similar to UTC.

For Ambrosia, disease incidence was around 90% in UTC. Treatments of FOLPAN, SWITCH, APROVIA, and

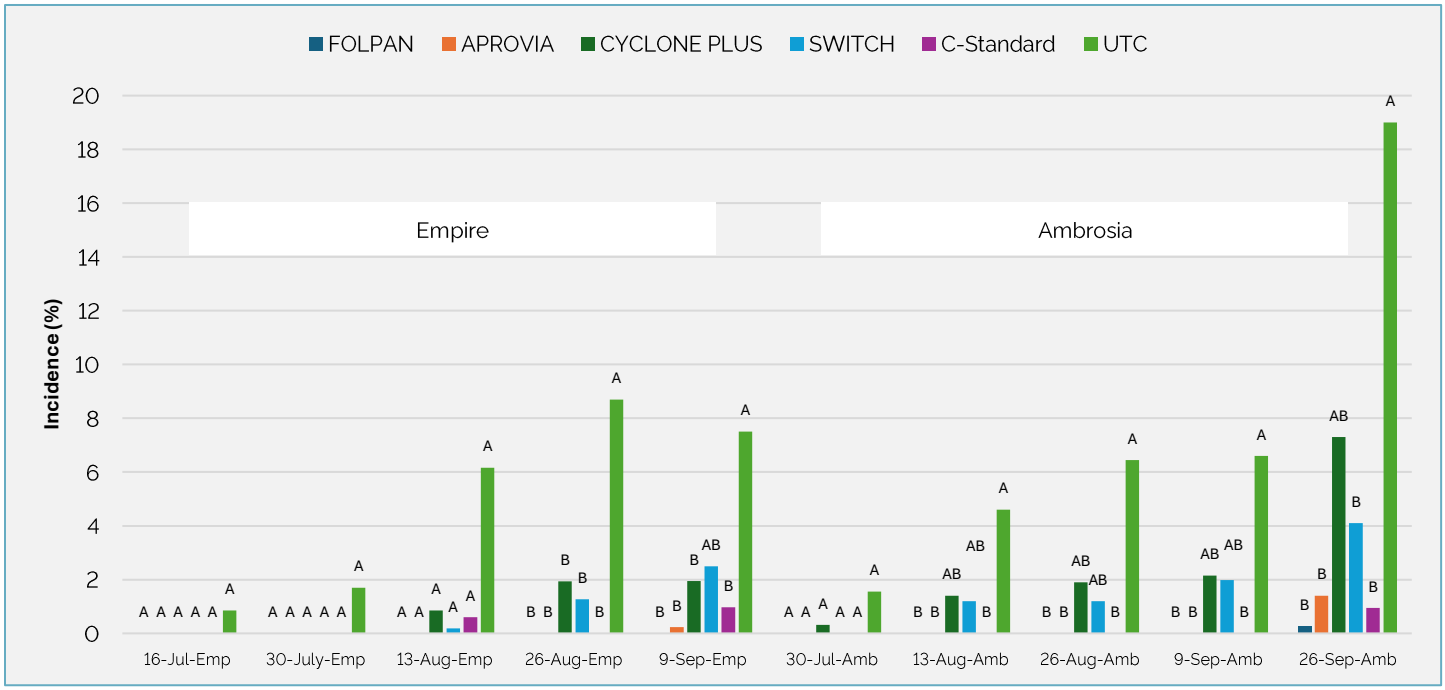


***Figure 4.*** *Mean percent incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2024. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05).*

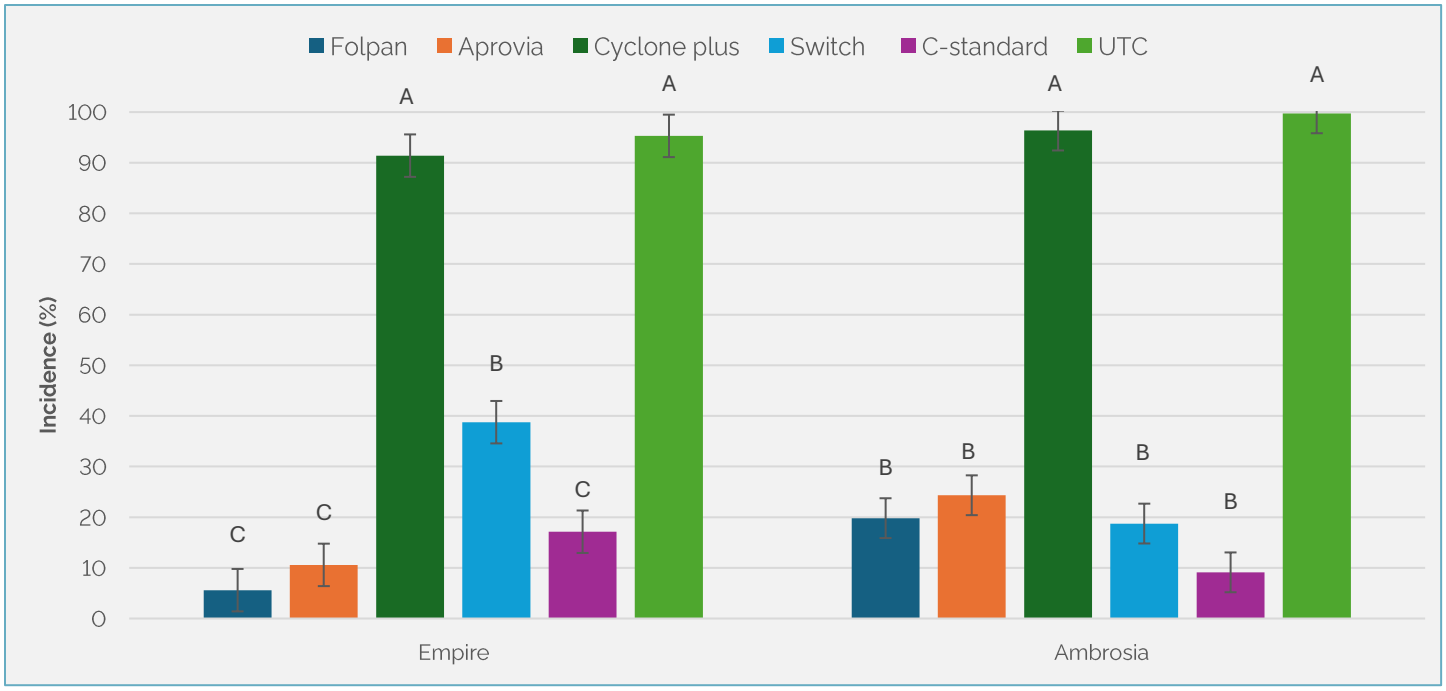


***Figure 5.*** *Mean percent post-storage incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2024. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05)*

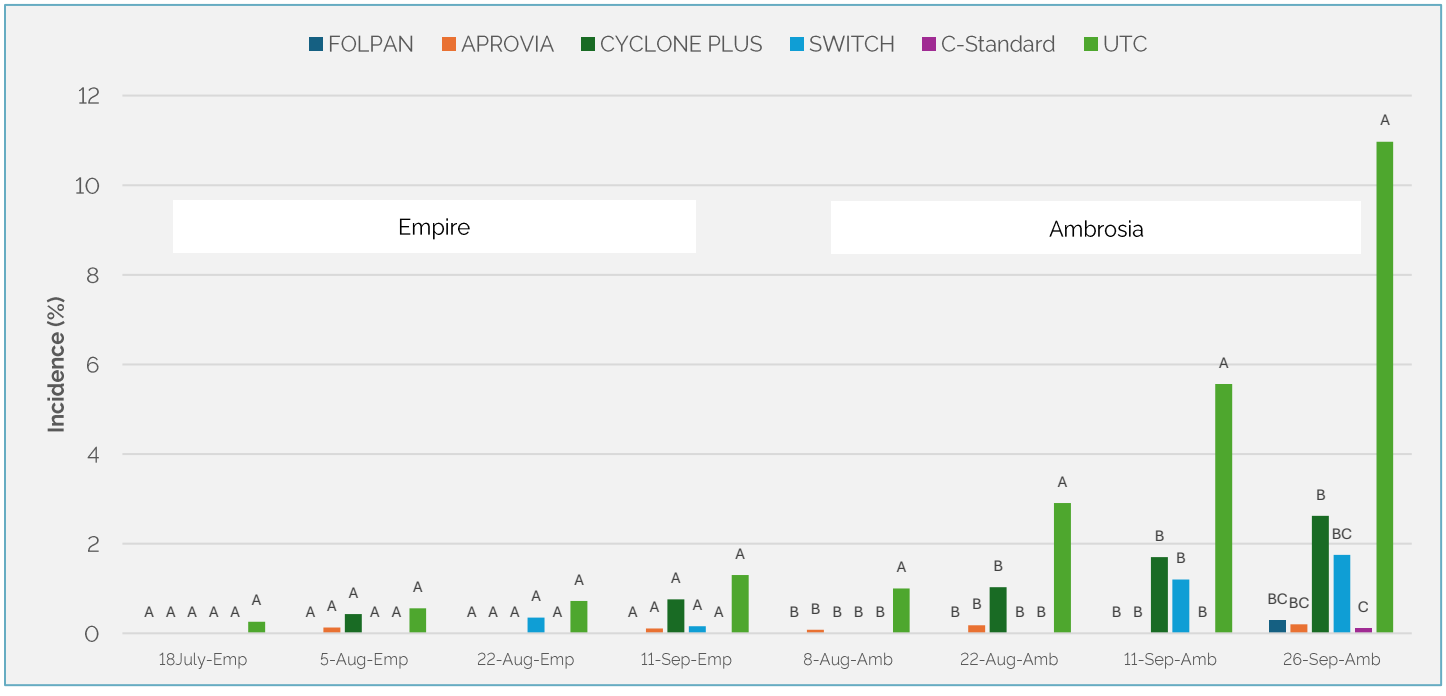


***Figure 6.*** *Mean percent incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2025. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05).*

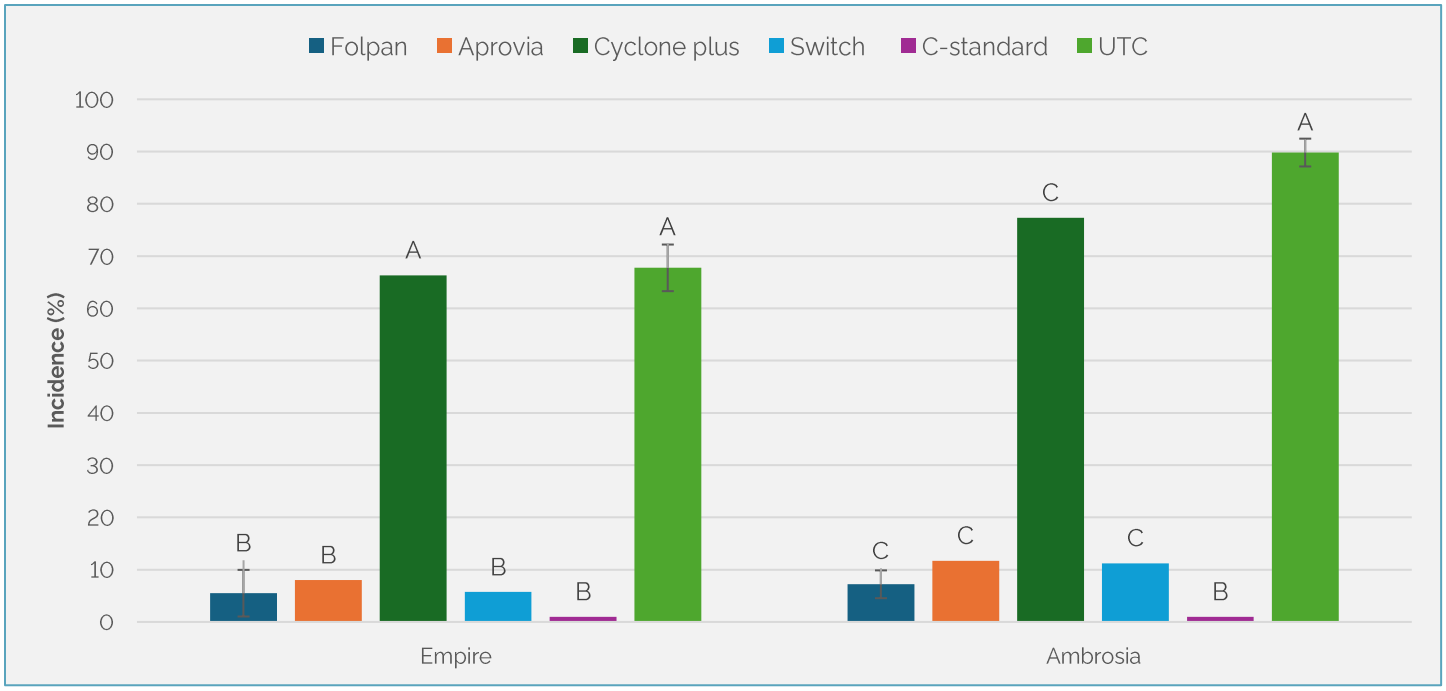


***Figure 7.*** *Mean percent post-storage incidence of bitter rot on cultivars Empire and Ambrosia apples following different fungicide treatments in 2025. Bars represent mean disease incidence ± SE. Treatments sharing the same letter within a cultivar are not significantly different (p=0.05)*

CS again provided high control, whereas CYCLONE PLUS provided poor control of 14% compared with the UTC.

## Conclusions

FOLPAN, APROVIA, and CS (a rotation of PRISTINE, ALLEGRO, and CAPTAN) consistently provided the most effective bitter rot control in both 2024-2025.

SWITCH provided effective control in 2025 when the disease pressure was low and moderate suppression when the disease pressure was high in 2024.

CYCLONE PLUS offered moderate in-season suppression in both years but no effective control in post-storage assessments.

Fungicide label expansions are underway to include control of bitter rot on the Aprovia and Folpan 80 WDG labels.

## Management Considerations for 2026

This research has demonstrated that apples can be infected at any stage of development, even if symptoms are not seen until after storage. Spores are active as early as May and fungicides need to be applied preventatively – fungicides cannot treat an existing infection.

Bitter rot targeted fungicides should start at petal fall and continue on a 14-21 day interval to keep fruit protected. If favourable weather persists (frequent rains with warm conditions), shorten the application interval. If possible, time an effective fungicide application prior to a rain to protect healthy fruit from rain-splashed spores.

The following products are currently registered for bitter rot:

- Allegro / Downforce (FRAC 29, PHI 28 days)
- Pristine (FRAC 11 & 7, PHI 5 days)
- Merivon (FRAC 11 & 7, PHI 0 days)

- Maestro/Supra Captan (FRAC M4, PHI 15 or 19 days depending on orchard density)
- Regalia Maxx (FRAC P5, suppression only, PHI 0 days)

As indicated from this research, products like Folpan/Follow (FRAC M4, PHI 0 days) or Aprovia (FRAC 7, PHI 30 days) may provide some efficacy on bitter rot when the product is applied at the registered rate for diseases listed on the product label. Always rotate fungicide FRAC groups to reduce the potential for resistance development.

Orchard sanitation to reduce inoculum is important for bitter rot management. Mulch or remove fruit on the orchard floor following hand thinning and harvest to reduce inoculum and the potential of spreading the disease for the following year. Removal of dead wood, cankers produced by other diseases such as fire blight, and fruit mummies (where possible) may also reduce the disease.


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**REDUCING DISEASE INOCULUM IN APPLE ORCHARDS**

| Disease | Overwinter Structures | Symptoms | Key elements in Activation/ Infection | Inoculum Reduction |
|---|---|---|---|---|
| Black Rot | Fruit mummies<br>Bark<br>Canker infections | - frog eye leaf spot<br>- limb canker<br>- fruit rot (black-red halo) | Rainfall after bud break-conidia by water, spores by air/rain duration | - Flail chop prunings<br>- Mummies, brush piles, burn-destroy |
| Powdery Mildew | Infected terminals<br>Laterals with fruit buds | - shoots stunted - matted Mycelium<br>- fruit-russet & netting | Conidia infect young leaves, blossom & fruit/high R.H. temps. 20-22° C | Dormant prune infected terminals |
| Botryosphaeria Rot | Cankers<br>Colonized dead bark<br>Mummified fruit | - fruit lesions show up with tan centre surrounded by red halo | Rainfall during growing season spores germinate at 28-32° C | - Remove all dead limbs, cankers, mummies<br>- Chop & flail prunings |
| Sooty Blotch & Fly Speck | Infected branches and twigs in orchard and brambles | - sooty stain or stippled fly speck late in season | Conidia dispersed by spring & early summer rains. High R.H., warm temp. Incubates 3 weeks | Open tree canopy for faster drying during summer months. Remove brambles in or near orchard |
| Canker and Wood Rot | Cankers on tree limbs | - weak trees - dying limbs<br>- fruit rots (various) | Spring - fall rain moving conidia & ascospores. Wind dispersion when dry. Pathogen grows at 3-33° C | - Remove cankers<br>- Prune to collar area on limb-watch pruning crews carefully- long stubs infection prone. |
| Scab | Leaf litter-orchard floor | - leaves<br>- fruit | Scab rains in spring- Free moisture for spore germ - temp, wetting critical | - Mulching of leaf litter |
| Fireblight | Cankers on trees | - collapse of all tissues starting at bloom | Warm, wet conditions at bloom. Splashing rain, insect vectors | - Eliminate cankers<br>- Complete removal of severely damaged trees. |


Some of the best orchard advice isn't new – it's proven! As ONcore marks its 30th volume, we're revisiting a few *'pearls of wisdom'* from past issues that still hold up in today's orchards.

*The elimination of overwinter sites in the orchard for various diseases can help eliminate the immediate sources. These sources of inoculum can be more troublesome where a grower has chosen a softer approach with fungicides. The chart describes some of the major disease and ways to reduce their potential impact before the growing season gets started.*

*– John Gardner, April 1997*