ONcore
For Commerical Apple Producers

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RIPE, READY AND FULL OF FLAVOUR!

HOT TIPS FOR HARVEST PREP:

- Consider the end product of the apple
  - Fresh Apple, Processing Apple, Cider Apple
- If growing a fresh apple — think of where the apple is going
  - Packer, Pick-Your-Own, On-Farm
- Test apple maturity to aid in harvest timing decisions
  - Starch
  - Sugar
  - Acidity
  - Firmness
  - Colour
- Refer to recommended harvest maturity levels based on variety
- Keep records of harvest times and maturity testing
- Monitor for late-season insect pests
- Apply fungicides during warm, wet weather
- Check preharvest interval restrictions before applying any product
- Evaluate success of IPM program through harvest assessments

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ANNOUNCEMENTS

- Ontario Pest Management Conference — November 7th
- Ontario Soil and Crop Improvement Association: Cost-Share Opportunities

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ORCHARD MANAGEMENT

Apple-ing the Science: Field Tests for Peak Ripeness

***Erika DeBrouwer**, Tree Fruit Specialist*

This apple season has been one of the most advanced (temperature and growth stage wise) since the spring. This was noted in the first article of the season "What the Crop: Apple Update: March 12, 2024". The season continued on with this trend, where apple maturity seems to be almost 2 weeks ahead of a 'normal' schedule.

Harvesting your apples when they are ready and mature is of the utmost importance to provide customers with a consistent, tasty, textured and colourful apple that can be eaten every month of the year. To achieve that, ***harvest timing plays an important role in maintaining that quality apple***. Don't let the apple maturity determine where to market your apples, you should be deciding where apples end up and how long they need to be stored to be properly compensated.

Knowing your end customer plays an important role in determining when to harvest as well.

- What product am I selling?
  - Fresh Apple, Processing Apple, Cider Apple
- Am I selling this fresh apple direct to market or is it going into long-term storage?
  - Packer, Pick-Your-Own, On-Farm

These answers will aid you in determining the best practices and harvest times for your crop. There are different recommendations based on long-term stored apples compared on direct-to-market apples.

For information on variety specific harvest maturity indicators, refer to the article titled 'Harvest Maturity is Critical for Storage Life of Apples'.

Starch Levels

Starch levels in apples are a great indicator to determine apple fruit maturity. As apples ripen starch is converted to sugar, and one way to determine how much starch is in an apple is to use iodine. Iodine binds to starch molecules giving the apple a blue/black colour. The more stained the apple is, the less mature the fruit. Michigan State University released a visual variety specific Starch Index Scale that aids in determining when to optimally harvest.

Tools to Measure Starch Levels

There is one convenient way to measure starch levels in apples, but there are two different recipes that give you the same result. Both advise testing once or twice a week starting 2 or 3 weeks before expected harvest. Trees should be:

- A good representative tree
- Tagged once selected for continual testing
- Not be on exterior of rows

Two apples from 5 trees per block should harvest at each assessment, avoiding more mature apples or apples in shaded areas. Testing should be performed right after collection.

Recipe 1: Starch-iodine test using potassium iodide

Recipe 1: Add 10 grams of potassium iodide and 2.5 grams of iodine crystals to 1 liter of distilled water. The solution may need to sit overnight before the iodine is fully dissolved but requires a pharmacist or chemist to mix the solution. Once the solution is ready for use, apple can be cross-sectioned and sprayed or dipped into the solution. Wait roughly 1 minute then evaluate.

Recipe 2: Starch-iodine test using 2% iodine solution

Recipe 2: Purchase a 2% alcoholic solution of medicinal iodine from your local drug store and mix with an equal amount of water. Once the solution is ready for use, apple can be cross-sectioned and sprayed or dipped into the solution. Wait roughly 1 minute then evaluate.

Starch testing is an effective test to aid in determining apple maturity but should be used in unison with other maturity indicators, such as sugar content and colour.

Sugar Content

Sugar content, scientifically termed soluble solids concentration (SSC) or total soluble solids (TSS) is also an important maturity indicator. TSS gives you an idea of how mature the apple is and should be taken regularly as variation in sugar content occurs year to year.

Sugar content tends to be high under the following conditions:

- Reduced moisture
- High temperatures
- High sunlight

Sugar content can also be influenced by:

- Irrigation
- Nutrition
- Weather
- Fruit position on the tree

Trees with high crop loads tend to have lower sugar levels.

Although useful, it should be used in unison with titratable acidity (TA), as the sugar to acid ratio is directly correlated with consumer quality.

Tools to Measure Sugar Content

TSS is measured in °brix which can be tested using a refractometer. There are handheld and tabletop options, along with digital and optical refractometers. These can be purchased from various scientific instrument websites such as: Fisher Scientific, Grainger, Ottawa Fastener Supply, amongst others.

To determine TSS, it is best to squeeze apples using a garlic press and place a small amount on the refractometer. Areas of the apple that have higher sunlight exposure tend to be higher in TSS, along with apples on the exterior of rows. Using the refractometer changes based on the style that is purchase – handheld optical refractometers require you to hold the instrument up to the light and read the percentage of soluble solids, while digital refractometers display the percentage after a few seconds. Remember to rinse, clean and dry off the instrument between each sample using a soft tissue. To calibrate refractometers, you can zero the instrument with distilled water and at 10% with a solution of 10 grams of sucrose dissolved in 90 grams of distilled water.

Acidity

Titratable acidity (TA) is commonly used in cider and wine making, where % (or mg) malic acid is used in apples. TA levels decrease as fruit matures and are most useful when performing consistent measuring on the same tree. It is difficult to determine a range of ideal TA levels as they vary, but it is effective when comparing the rate of change in TA levels for apple maturity. This can be accomplished over time, over multiple years, and over multiple harvests.

Tools to Measure Acidity

Acidity can be measured with colourimetric kits. The wine industry uses tartaric acid to measure acidity, while the cider industry uses malic acid. This is because malic acid is the most common acid in apples, while tartaric is the most common in grapes.

Firmness

Firmness is a common indicator of storage performance and is important for the longevity of apple storage. Apple firmness can be affected by:

- Seasonal and orchard variability,
- Tree vigour
- Fruit size
- Nitrogen and calcium levels in the fruit
- Use of growth regulators

Tools to Measure Firmness

Firmness is measured using either a handheld plunger, termed a penetrometer, or a tabletop penetrometer (i.e., Guss – Fruit Texture Analyzer). Handheld penetrometers can be used in the field but should be performed with a solid base underneath of the apples. Apples should be peeled (removed of skin) in the area that is being tested for firmness. The penetrometer should also have an 11-mm diameter plunger.

Colour

Colour is also an indicator of apple maturity, whether that be red, striped red, green, or yellow skin. Foreground (blush) and background colour are important maturity indices, although over-maturity can be an issue when relying solely on colour indicators.

Blush Colour

Blush colour is commonly used for commercial grading, where red-coloured varieties are normally graded better with redder colouring. Even though this is the case, if apples stay on the tree for too long and are harvested after their peak maturity these apples will have a higher prevalence for postharvest issues, especially if the apples are committed to long-term storage. The apples will not meet the expectations of the consumer or the grower, as there is a higher chance of postharvest issues, including disorders and lower quality of desirable traits (texture and firmness).

Background Colour

Background colour is one of the most important indicators of harvest maturity. This is especially important in Gala, Honeycrisp, Fuji, and Ambrosia. Fruit stored for long periods of time generally should be harvested when the change in background colour starts from green to yellow, while background colours that are more yellow or cream should be targeted for more immediate sale.

Tools to Measure Colour

Focusing on background colour, British Columbia developed a colour chart for the harvest timing of Ambrosia.

Additional Tools

There are many other tools that are currently being used in the scientific community to further our knowledge of apple fruit maturity, but most aren't easily accessible, are still being tested or not able to be used easily in the field i.e., internal ethylene content. One of the most important tools that is available to everyone and should be considered, is record keeping.

Records

Recording harvest date, the weather that season, your management practices along with fertilizer applications are all important to look back on annually. Each year is different, but if you have notes of similar situations that occurred in the past you can look back on what you did and whether that worked for you and your orchard. Remember to include:

- calendar date of harvest
- yield and other quality parameters
- length of time stored/when apples were removed from storage (if you have access to this)
- pay out for crop
- and it would be good to check heat unit accumulation and night-time temperatures for reference

Remember that these strategies should be used in collaboration with one another to give you a better idea of when to harvest.

Key Points

Overall, there are many tools that can be used to assist with the success of your apple production and increase the potential of your apples providing you with top market value throughout its stored life. Of all the maturity indicators, background color, starch content, and firmness are the most important factors in guiding harvest timing. Many varieties overlap with harvest timing, making it difficult to decide which apples should be taken off the tree and which should stay on. Knowing your market and recording maturity indicators will benefit you.

For a more direct comparison of the benefits and challenges affiliated with each type of test/tool, please refer to Table 1.

This is an updated and more concise article composed from the August 2022 Orchard Network Newsletter titled "Field Tools to Determine Apple Maturity" written by Erika DeBrouwer & Dr. Jennifer DeEll, OMAFRA

If you are an Ontario apple grower, please reach out to Kelly Ciceran at the Ontario Apple Growers to get your hands on an Ambrosia Colour Chart to aid in your harvest timing decisions.

Table 1. Benefits and Challenges of Field Maturity Testing Tools

Measurement	Tool/Test	Benefits	Challenges
Starch	Potassium iodide test	• Good representative of sugar accumulation • Can be performed in the field or in a lab setting	• The recipe needs to be prepared by a pharmacist or chemist • Iodine solution needs to be made fresh • Solution is poisonous • Can be difficult to perform in orchard
	2% iodine solution test	• Good representative of sugar accumulation • More convenient regarding supplies than potassium iodide test • Can be performed in the field or in a lab setting	• Is more costly than recipe 1 • Iodine must be diluted • Can be difficult to perform in orchard
Sugar	Refractometer	• Not too expensive (depending on which version) • Can be used in the field • Not too time consuming	• More accurate to be used in unison with acidity testing • Can be difficult to perform in orchard
Acidity	Colourmetric kits	• Not too expensive • Can be used in the field • Not too time consuming	• More accurate to be used in unison with sugar content testing • Needs to be tested over time, over multiple years, over multiple harvests
Firmness	Handheld penetrometers	• Not too expensive • Can be used in the field • Not too time consuming	• Variable readings
	Tabletop penetrometers	• Not too time consuming • More accurate than handheld penetrometers	• More expensive than handheld penetrometers • Require space • Fruit must be brought inside to test
Colour	Colour chart	• Easy to use • Can be used in the field	• Not many field-based tools for measuring colour accurately • Variety specific colour charts aren't available for all varieties • Up to user to discern appropriate colour

Additional Resources

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CROP PROTECTION

Apple IPM Check-Up

Your Orchard's Annual Harvest Assessment

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

This is your friendly IPM specialist reminding you that it's time for your annual check-up!

Do you know how effective your pest management program was this year? With only a small time commitment required, a harvest assessment can provide information on what part of your management program went well (or not so well).

Advantages to doing a harvest assessment

- Knowledge of this year's problems will help you **better prepare** your IPM program next year.
- Provides an accurate read of not only the **type** of damage but also the **extent** of damage in a block or orchard.
- Preparedness for **early season** pest management needs such as sprayer calibration, urea and/or leaf shredding for scab control, dormant oil for San Jose scale or early season copper and other fungicides for fire blight, scab and powdery mildew.
- Understanding what practices worked and what didn't will **save money** in input costs for future management programs.
- Improves **fruit quality** for any late season pest issues that may be observed and can be managed prior to harvest. This is particularly helpful if your scout has finished.
- Highlights any **susceptible varieties** or **hot spots** in a block or orchard, which allows targeted monitoring and potential spot treatments in future years.
- Provides a **historical record** for reference and increased awareness of potential challenges.

How should you do it?

In the field:

- Choose at least 10 (large trees) to 20 (dwarf trees) healthy trees randomly throughout the block.
- Select 200-400 apples (20-40 apples per tree), turning each to see all sides of the fruit without removing it.
- Randomly choose fruit from different positions on the trees: upper, inner and outer part of the canopy.
- Keep records for reference. Looking for a template? Refer to the scouting sheets following this article for fruit and terminal damage assessments.

If a field assessment is just not feasible prior to harvest, a post-harvest evaluation of fruit can be done. However, this type of assessment will only provide information on severity of damage and not the location in the block this damage occurred. Examine 400-500 randomly selected fruit for each variety from harvest containers. If damage is found, you may want to increase the sample size to thoroughly assess the damage.

Which block should you do?

To get the best idea of what's happening in your orchard, assess all blocks. If time is limited, give yourself half an hour to one hour per block and select representative areas of the orchard. If you assess the same block every year, you can compare your results and notice trends over time.

What should you look for?

Anything causing **2–5% damage** is of concern. For higher value cultivars, consider 1-2% damage for pests causing direct injury to the fruit. Look for presence of:

- Larvae or larval feeding from oriental fruit moth, codling moth or other caterpillars
  - Oriental fruit moth: tunnel from calyx or stem end; tunnel in flesh of fruit

  - Codling moth: piles of frass at hole which can be side or bottom of fruit; tunnel to seed cavity of fruit
  - European apple sawfly: ribbon-like scar spiralling from calyx
  - Obliquebanded leafroller (or other spring-feeding caterpillars): surface feeding; scarred and misshapened fruit; leaves often webbed to fruit
- Black caps of San Jose scale and/or halos on fruit surface
- Distorted fruit caused by spring feeding caterpillar or rosy apple aphid
- Pits or stings caused by tarnished plant bug, stink bug or apple maggot
- Raised bumps by mullein bug, plum curculio (Figure 1) or other plant bug
- Blotches/lesions caused by scab (Figure 2), sooty blotch/fly speck, rust or calyx end rot
- Lace-like russetting caused by powdery mildew
- Fruit rot
  - Black rot: firm lesion; black fruiting bodies
  - Bitter rot: sunken lesion; orange to salmon-coloured spores
- Vertebrate feeding such as deer, turkey or other birds

As you walk through the orchard, also make note of damage to leaves, branches and graft unions caused by pests such as fire blight, scab, powdery mildew (Figure 2), leafroller, tentiform leafminer, leafcurling midge, mites and borer.

This season has been difficult to manage fungal diseases such as scab, powdery mildew and frog-eye leaf spot (black rot). With the heat and wet weather continuing, late summer diseases such as fruit rots, fly speck and sooty blotch are likely to show in some blocks close to harvest (or possibly even in storage). Insects followed the early season and damage can be found from spring-feeding caterpillar, plum curculio, stink bug, woolly apple aphid, San Jose scale, apple maggot, leafcurling midge, potato leafhopper and Japanese beetle to name a few. Keep these pests in mind while making your assessments.

Go to Ontario CropIPM for more information on the pests mentioned above including descriptions and pictures of typical damage.

Remember, simply determining this year's IPM report card will put you ahead of the game for next year's management program.

Figure 1. *Plum curculio damage Mutsu.*

Figure 2. *Apple scab and powdery mildew on Idared.*

Apple Harvest Assessment Sheet (TERMINAL)

Block: _____

Cultivar: _____

Date: _____

Sampling protocol: Established trees - 10 terminals per tree (10 trees total)
Young trees - 5 terminals per tree (20 trees total)

Pest	Tree									
	1	2	3	4	5	6	7	8	9	10
	Number of damaged terminals									
Insect										
Aphid (Green apple aphid)										
Aphid (Rosy apple aphid)										
Aphid (Woolly apple aphid)										
Japanese beetle										
Leafcurling midge										
Leafhopper (Potato leafhopper)										
Leafhopper (White apple leafhopper)										
Obliquebanded leafroller										
Oriental fruit moth (terminal flagging)										
Spring feeding caterpillar										
Tentiform leafminer										
Mites										
Other										
Disease										
Apple scab										
Powdery mildew										
Frogeye leaf spot										
Rust										
Fire blight										
Other										
Other										
Nutritional										
Deer										
Unknown										
Total damage										

Apple Harvest Assessment Sheet (FRUIT)

Block: _____

Cultivar: _____

Date: _____

Sampling protocol: Established trees - 40 fruit per tree (10 trees total)
Young trees - 20 fruit per tree (20 trees total)

Pest	Tree									
	1	2	3	4	5	6	7	8	9	10
	Number of damaged fruit									
Insect										
Apple maggot										
Codling moth										
European apple sawfly										
Mullein bug										
Obliquebanded leafroller										
Oriental fruit moth										
Plant bug										
Plum curculio										
Rosy apple aphid										
Scale										
Spring feeding caterpillar										
Stink bug										
Other										
Disease										
Apple scab										
Bitter rot										
Black rot										
Calyx end rot										
Fly speck / sooty blotch										
Powdery mildew										
Rust										
Other										
Other										
Deer										
Bird										
Hail										
Russetting										
Unknown										
Total damage										

Maggot Troubles

The Unwelcome Guest in Your End-of-Season Apple Crop

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

With the high soil moisture across many regions of the province, apple maggot emergence has been fairly consistent this season and some orchards are seeing higher than normal pressure. This activity can carry on until the first hard frost, which means late season sprays may be needed if insecticide residues are no longer present (generally 2-3 weeks, depending on product).

Apple maggot damage can occur in two ways. The female creates oviposition stings on the fruit surface by laying her eggs under the skin, leaving a sunken or dimpled appearance (Figure 1). After hatching, the larvae tunnel within the fruit and cause breakdown and discoloration of the pulp (Figure 2). Invasion by disease fungi, such as *Alternaria* spp. and *Pseudomonas* spp. leads to further decay and heavily infested fruit can become completely rotten.

In Table 1, adapted from research done by John Wise at Michigan State University (2019), the characteristics of apple maggot products are summarized.

Organophosphates (Imidan) and neonicotinoids (Aceta, Assail, Calypso) are the only insecticide groups that have activity on the adults as well as a curative effect on the eggs and larvae due to their ability to penetrate into the flesh of the fruit.

The timing of apple maggot sprays usually coincides with codling moth control applications, and as a result a single insecticide spray can often be used to manage both of these pests. It is important to remember that while some chemistries such as Altacor or Delegate provide effective management of codling moth, they will only provide apple maggot suppression in low pressure orchards. Exirel seems to have good activity on apple maggot. However, this product cannot be tank-mixed or used in sequential applications with strobilurins, copper or captan fungicides.

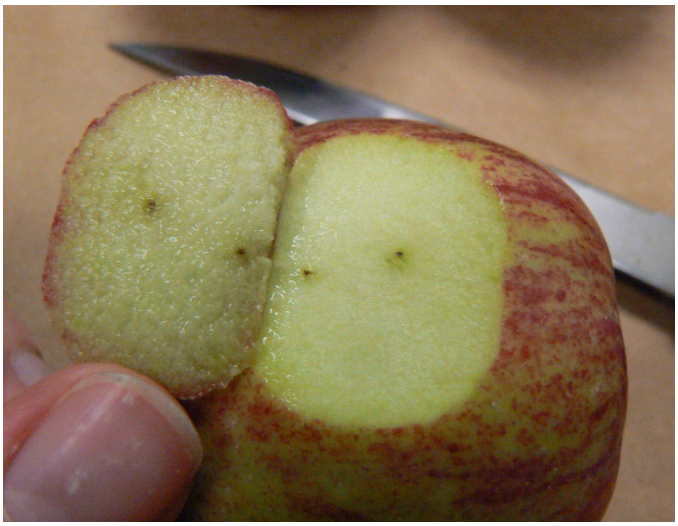

***Figure 1.** Apple maggot oviposition sting on fruit.*

***Figure 2.** Internal breakdown and discoloration of fruit as a result of apple maggot larval feeding.*

The previously mentioned products as well as the neonicotinoids have residual activity that lasts 10-14 days, so re-application will be necessary. The organophosphate, Imidan is effective in managing both codling moth and apple maggot in orchards, and the residual lasts 18-21 days. For most products registered for apple maggot, re-application will likely be necessary following a significant rainfall (>1 inch rain). See Table 1 for rainfast rating of each chemical group.

Table 1. Summary of insecticides used to manage apple maggot

Product Name	Chemical Group	Life-Stage Activity	Efficacy	Residual Activity	Mite Flaring Potential	Rainfast Rating
Imidan	1B	Egg, larva, adult	Excellent	14+ days	Low	Low
Ambush, Danitol, Perm-Up, Pounce, Ship, Up-Cyde	3	Adult	Fair-Good	7-10 days	High	Moderate – High
Aceta, Assail, Calypso, Cormoran, Theme	4A	Egg, larva, adult	Good-Excellent	10-14 days	Low – Moderate	Moderate
Delegate, Twinguard, GF-120	5	Adult	Fair	7-10 days	Moderate	Moderate – High
Altacor, Exirel, Harvanta, Vayego	28	Adults	Fair-Good	10-14 days	Low	Moderate – High
Surround	Not classified	Adult (deterrent)	Fair	7-10 days	Low	Unknown

Adapted from John Wise, MSU: https://www.canr.msu.edu/news/managing-apple-maggots-with-insecticides and https://www.canr.msu.edu/news/rain-fast_characteristics_of_insecticides_on_fruit

Surround (kaolin clay) can be an effective tool for managing apple maggot. However, applications must be applied to orchards prior to adult emergence, and be maintained as long as flies continue to be captured. At this point in the season, it is too late to begin using this product effectively if it is not already in place. In orchards where Surround is being applied, use starch iodine tests to monitor fruit maturity in the last 2 weeks of crop development.

Border sprays of organophosphate insecticides such as Imidan applied to the outer 20 m of an orchard without a resident maggot population may sufficiently intercept any adults flying in from surrounding wild hosts. However, with consistently high trap catches or if damage is detected during routine monitoring of the orchard, return to a full cover spray program. Also be sure to keep an eye on preharvest interval restrictions. Not all alternative products registered for apple maggot have the same activity as Imidan and efficacy of border sprays has not yet been established. **Therefore, alternative products are not recommended in a border spray program at this time.**

Sanitation measures, including the removal and destruction of culled fruit following harvest will eliminate any larva that have not yet exited the fruit to pupate. Removing alternative hosts, including hawthorn or wild apple within 100 m of the orchard may also reduce pressure from migrating flies the following year.

To eliminate any live larvae in harvested apples, a cold storage period of 8 weeks at temperatures below 5˚C is effective in killing them. This practice may satisfy the export restrictions of some countries.

From Orchard to Storage

Dealing With Pre-Harvest and Storage Diseases in Apples

Kristy Grigg-McGuffin, *Horticulture IPM Specialist*

With the warm, humid and wet conditions since bloom, things have been ideal for the development of fungal pathogens, such as black rot and bitter rot. As harvest quickly approaches, take the time to consider management of these diseases and prepare for other storage issues that may arise. Since many storage issues are actually initiated in the orchard, careful thought should go into control at this level. Often pre-harvest symptoms are not obvious and infection can come as quite a surprise when fruit is later brought out of storage.

Black Rot

Black rot (*Botryosphaeria obtuse*) overwinters in cankers on twigs, branches and trunk, as well as on mummified fruit. This often makes apple cultivars which retain mummified fruit, such as Gala, Honeycrisp, Cortland and Northern Spy more susceptible to infection, as well as trees damaged by winter injury or fire blight.

Late season black rot infection on fruit often appears just before harvest as black spots, often associated with mummified fruit left from chemical thinners (Figure 1). Eventually, the lesions enlarge into a brown rot with concentric dark and light rings (Figure 2), which late in the season or in storage, may develop tiny pimple-like black pycnidia (Figure 3). The flesh of fruit infected with black rot remains firm, in contrast to several other apple rots and may increase storage decays after harvest, frustrating growers and packers alike.

Bitter Rot

Bitter rot, caused by the fungus *Colletotrichum fioriniae* overwinters in mummified fruit, crevices in the bark, and cankers. Typically, symptoms appear late summer to harvest. Initial bitter rot infection appears as small reddish or brown spots that quickly enlarge into circular sunken light to dark brown rots on infected fruit (Figure 4). As the external fruit lesions enlarge, a diagnostic V-shaped rot may progress towards the core

Figure 1. *Late season black rot infection appears as black spots on fruit associated with mummified fruit left from chemical thinners.*

Figure 2. *Black rot lesions enlarge with concentric dark and light rings.*

Figure 3. *In storage, black rot infected fruit remain firm and may produce tiny pimple-like black pycnidia.*

but this does not always occur (Figure 5). During humid conditions, cream- to salmon-coloured masses of spores are produced on the surface of the rotting fruit and can be rain splashed resulting in further infections which often develop slowly while in cold storage.

Figure 4. *Bitter rot appears as sunken spots, surrounded by a red halo. Masses of salmon-coloured spores are produced on the surface of the enlarged lesion.*

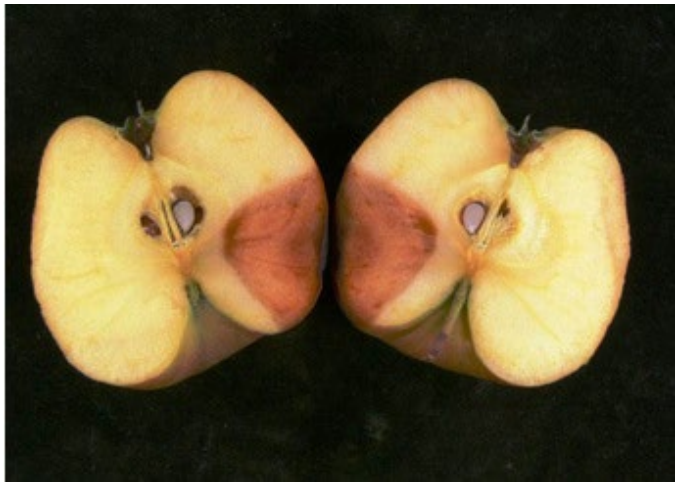

Figure 5. *Bitter rot lesions can form a V-shaped rot extending towards the core.*

Unlike black rot, the bitter rot fungus does not require fruit wounding to establish an infection and can directly penetrate the fruit skin. Because of this, it's important to maintain regular fungicide applications during warm, wet weather before harvest. Registered fungicides and preharvest interval information can be found on the Ontario Crop Protection Hub.

Pin-Point Scab

Pin-point scab (*Venturia inaequalis*) develops when fruit become infected during the last several weeks before harvest. Fruit with late season infections may not exhibit symptoms at harvest. However, lesions can develop on fruit during the first 30-45 days in cold storage. They appear as either pin-point sized lesions or jet-black spots (Figure 6). Fortunately, scab will not spread from diseased to healthy apples in storage.

With scab present in many orchards across the province where fungicide programs did not manage primary infection, the risk for pin-point scab is high. Optimum conditions for pin-point scab include:

1. Abundant scab inoculum
2. Lack of fungicide residue before harvest, and
3. Wetting periods longer than 30-36 hours.

Unlike foliar infections, pin-point scab can be substantially reduced by the presence of a dry period between wetting events. Research has shown that a 24-hour dry period commencing 24, 48 or 72 hours after inoculation at 20^{o}C can reduce the amount of scab by 67, 87 and 36%, respectively.

Figure 6. *Pin-point scab lesions appear as jet black spots that may not be apparent at harvest.*

Storage Rots

Blue and **gray molds** (*Penicillium expansum* and *Botrytis cinerea*, respectively) are two important diseases of stored apples. Both pathogens require a wound to cause disease, which most frequently occurs during picking and handling operations. Spores can survive long periods of unfavourable conditions, as well as from season to season on picking boxes, contaminated bins, storage walls and packing equipment. The pathogens may also invade fruit that are over mature at harvest or fruit held in storage too long.

The symptoms of blue mold begin as soft watery light brown areas around injuries or lenticels on the fruit surface. Fruit affected by gray mold is spongy, light to dark brown, and diseased tissue is not separable from the healthy tissue. Blue mold initially has tufts of snow-white spores that turn to blue-green (Figure 7) and has a musty odour, while gray mold has fluffy white or grey mycelium and dark grey spores masses (Figure 8) with a "cedar-like" smell only in advanced stages.

Pre-harvest chemical controls are available that will help reduce both pre-harvest and storage diseases. If possible, include one of these chemicals during your last cover spray. For more information on pre- and post-harvest fungicides, refer to the Ontario Crop Protection Hub.

As you're getting your orchards ready for harvest, the following are some general management techniques to keep in mind to reduce postharvest fruit rots:

This Season

- ***Handle fruit carefully during harvest*** –bruised or wounded fruit are susceptible to storage diseases.
- ***Harvest fruit at proper maturity*** –the more mature, the more susceptible a fruit is to storage diseases.
- ***Minimize inoculum sources*** –use clean bins, limit the amount of soil and plant debris brought in and sanitize storage equipment.
- ***Keep fruit cool after harvest*** –warm temperatures encourage pathogens to grow.

Next Season

- ***Practice orchard sanitation to remove inoculum sources*** –prune out cankers or dead branches, and remove rotten or mummified fruit.
- ***Apply calcium sprays*** to improve fruit quality.
- ***Prune*** to increase air flow, promote faster drying time and ensure better spray penetration.

Figure 7. *Blue mold initially has tufts of white spores that turn blue-green.*

Figure 8. *Gray mold has fluffy white or grey mycelium and dark grey spore masses.*

Scab-Free Apples Start with A Clean Orchard

Reduce Apple Scab with Orchard Sanitation

Kristy Grigg-McGuffin, *Horticulture IPM Specialist*

Did you know can save time and money usually invested in fungicide applications by reducing the initial scab inoculum load going into the season?

This has been a difficult season for many who have been dealing with scab escapes in the orchard, whether that was from a missed infection event, fungicide wash-off, poor coverage or possibly fungicide performance issues. Get ahead of scab control for next year this fall!

Consider some of the following when deciding if orchard sanitation is worthwhile:

- 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.
- Presence of scab this season has a HUGE impact on next year's pressure. 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[1].
- 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).

Apply 45 kg of agricultural urea per 1,000 L of water/ha to the orchard floor after 95% leaf drop (November) or in the spring (April) before bud break. Urea works in a number of 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.
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[2].

A fall application of urea does not have a negative impact on winter hardiness or the fruitfulness for subsequent years. If snow cover remains until bud break, this may reduce the time for a spring urea application to work and reduce the effectiveness of the treatment. In orchards requiring lower rates of nitrogen, a fall application may also be preferred to reduce the impact of the nitrogen.

In addition to a urea application, scab inoculum can be reduced 80-90% by shredding overwintering leaves in November or April[2,3]. 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.

References

[1] Gadoury D.M., and MacHardy, W.E. 1986. Forecasting ascospore dose of Venturia inaequalis in commercial apple orchards. Phytopathology 76:112-118.

[2] Sutton, D.K., Mac Hardy, W.E., and Lord, W.G. 2000. Effects of shredding or treating apple leaf litter with urea on ascospore dose of Venturia inaequalis and disease buildup. Plant Dis. 84 1319-1326.

[3] Vincent C., Rancourt, B., and Carisse, O. (2004). Apple leaf shredding as a nonchemical tool to manage apple scab and spotted tentiform leafminer. Agriculture, Ecosystems and Environment 104: 595-604.

POSTHARVEST

Harvest Maturity is Critical for Storage Life of Apples

***Dr. Jennifer DeEll**, Horticulture Fresh Market Quality Specialist*

For successful long-term storage, apples must be harvested when they are physiologically mature but not fully ripe. Each cultivar must be harvested at the proper maturity to achieve maximum storage life and marketing season, while minimizing postharvest losses.

If apples are harvested too early, they are of poor color, small size and have little flavor. They will usually fail to ripen or may ripen abnormally, and the overall quality will be poor. High water loss, low sugar content, high acidity, low aroma volatile production, and high starch content are characteristics of immature apples that contribute to inadequate flavor development. Immature apples are also more likely to develop storage disorders like superficial scald, external CO_2 injury and bitter pit.

Harvesting apples too late can result in a short storage life. Such apples are too soft for long-term CA storage and are more susceptible to mechanical injury and disease infection. Over-mature apples may develop poor eating quality, mealiness, and off-flavors. They are more susceptible to internal browning, watercore and breakdown, as well as chilling-related disorders such as soft scald and soggy breakdown in susceptible cultivar like 'Honeycrisp'.

Numerous methods have been suggested for determining harvest date, but no single test is completely satisfactory, and some are too unpredictable, complicated, or expensive. Days after full bloom is overall somewhat constant but can vary in a year with weather extremes. Therefore, days after full bloom should be used as a general reference to indicate the approximate date when apples might reach harvest maturity, which is then confirmed using tests such as internal ethylene concentration (IEC), starch-iodine staining, flesh firmness, and soluble solids content (sugars).

In general, and especially for older cultivars, IEC of 1 ppm is considered to be the ultimate threshold above which fruit ripening and flesh softening are initiated and progress rapidly. Harvest for long-term storage should be completed before 20% of the apples have an IEC higher than 0.2 ppm. More recent cultivars, such as 'Honeycrisp', do not always follow that rule. 'Ambrosia' is low producer of ethylene, so the presence of ethylene is more important than exact concentration.

Using the starch-iodine test, most apples destined for long-term storage should have 100% of the core tissue starch degraded (no stain) with greater than 60% of the flesh tissue still having starch present (stain). Again, recent cultivars do not always follow that rule, such as 'Honeycrisp'. It is also important to note that not all apples mature and ripen in the same manner each year, and often there will be a need to compromise between correct maturity and the required firmness and sugar levels for market.

Table 1 represents harvest guidelines for apples destined for long-term CA storage. Extreme weather during the growing season can influence fruit maturity, so actual values may vary during such seasons. Of course, you also need proper color to market the fruit.

Apples can be segregated into lots at harvest by their storage potential. The following types of apples should not be designated for long-term storage because of their potential for problems:

1. Large fruit from lightly cropped trees
2. Fruit from excessively vigorous trees
3. Fruit from young trees just coming into bearing
4. Fruit from interior portions of trees that are heavily shaded
5. Early-picked fruit high in starch
6. Late picked fruit with advanced maturity
7. Fruit with low seed count (< 5 per fruit)

The delta absorbance (DA) meter has been recently added into the toolbox for evaluating fruit maturity. It provides a measure of chlorophyll content (green color) of the fruit. In comparing our Ontario data through collaborations with colleagues in Minnesota and Maine, we found no consistent effect of DA values among apple cultivars, growing location, orchard blocks, and harvest times. However, the DA meter could be a useful tool if one takes the time to develop standardized readings during the harvest period for a given cultivar and orchard block.

Table 1. Starch index values, firmness and internal ethylene concentration at harvest for apples going into long-term storage.

Cultivar	Starch Index (1-8)*	Firmness (lb)	Internal Ethylene (ppm)
Ambrosia	2.5 - 4	>17	<1
Cortland	2.5 - 3.5	>15	>0.2 in <20%**
Crispin / Mutsu	3.5 - 4.5	>17	>0.2 in <20%
Delicious (Red)	2.5 - 3.5	>17	>0.2 in <20%
Empire	2.5 - 3.5	>17	>0.2 in <20%
Gala	2.5 - 3	>18	<1
Golden Delicious	3 - 4	>16	>0.2 in <20%
Honeycrisp	~ 5	>15	Not useful
Idared	3 - 4	>15	Not useful
McIntosh	2.5 - 3.5	>15	>0.2 in <20%
Northern Spy	2.5 - 3.5	>18	>0.2 in <20%

* Cornell Starch Iodine Index Chart (1-8)
** No more than 0.2 ppm in less than 20% of apples

Common Controlled Atmosphere Storage Regimes for Apples

Dr. Jennifer DeEll, *Horticulture Fresh Market Quality Specialist*

Table 1. Common controlled atmosphere storage regimes for apples

Cultivar	O_2 (%)	CO_2 (%)	Temp (°C)	Comments
Ambrosia	1.2-1.7	1-1.5%	0.5-1	<1% O_2 with fruit monitoring (SafePod, etc..); slow cooling with 1-MCP
Cortland	1.5-2.5	1.5-2	0.5-2	Highest temp with 1-MCP; sensitive to CO_2
Crispin / Mutsu	1.5-2.5	1.5-2.5	0-0.5	
Delicious (Red)	1-2	1-2	0-0.5	<1% O_2 fruit monitoring (SafePod, etc..)
Empire	1.5-2.5	1-2	2	Extremely sensitive to CO_2; if not treated with DPA keep CO_2 <0.5% for 1st month
Fuji	1.5-2	0.5-1	0-1	Sensitive to CO_2; delay CA with 1-MCP
Gala	1-2	0.5-1.5	0.5-2	Highest temp with 1-MCP; <1% O_2 with fruit monitoring (SafePod, etc..)
Golden Delicious	1-2	1-2	0-1	<1% O_2 with fruit monitoring (SafePod, etc..); slow stepwise cooling with 1-MCP
Granny Smith	1.5-2	0.5-2	0-1	<1% O_2 with fruit monitoring (SafePod, etc..)
Honeycrisp	2-3	1-3	3 (after conditioning at 10°C for 7 days)	Delay CA for 1st month
Idared	1.5-2.5	1.5-2.5	0-1	
Jonagold	1.5-2.5	1.5-2	0-1	Highest temp with 1-MCP
McIntosh	2.5	2 for 1st month, then 4.5	3	Sensitive to CO_2 with 1-MCP
Northern Spy	1.5-2.5	1.5-2	0-0.5	Sensitive to CO_2
Spartan	2-3	2-2.5	0.5-1	

Adapted from DeEll, J.R. 2020. Pome fruits: Apple quality and storage, p. 293-298. In: M.I. Gil and R. Beaudry (eds). Controlled and Modified Atmosphere for Fresh and Fresh-cut Produce. Elsevier Academic Press, United Kingdom.

ANNOUNCEMENTS

Ontario Pest Management Conference
Thursday, November 7, 2024

The 21st Annual Ontario Pest Management Conference (OPMC) will be held in **Guelph, ON** on **November 7, 2024**. The OPMC features research on all aspects of pest management associated with plant, animal and human health.

This year's theme is ***'From Theory to Practice: Innovations in IPM'*** and features speakers on automation, robotics and other forms of innovative technology and/or practices to manage insects, disease and weeds.

Stay tuned to the conference website www.ontariopmc.ca for more details. Registration opens September 1st.

For the 2024 conference, OPMC will be soliciting abstracts for

1. ***CropLife Graduate Student Oral Competition*** (sponsored by CropLife Ontario Council) – 6 spots total: first place $750 award and plaque, second place $250 award
2. ***CropLife Graduate Student Poster Competition*** (sponsored by CropLife Ontario Council) – 6 spots total: first place $750 award and plaque, second place $250 award
3. ***C. Ron Harris Undergraduate Student Poster Competition*** (sponsored by OPMC) – 4 spots total: one $500 award and plaque for the winning undergraduate (or diploma) student
4. ***General Oral*** – non-competitive. Limited spots available. Priority will be given to CropLife sponsors and presentation which fit the theme.
5. ***General Poster*** – non-competitive

Refer to the Call for Posters/Oral Presentations section on the OPMC website for details and instructions on submissions. **The submission period for all categories closes on Friday, September 20th.** For questions on the submissions, please email ontariopmc@gmail.com.

Ontario Soil and Crop Improvement Association
Cost-Share Opportunities

Special Provisions for Financial Difficulties

Funded under Sustainable Canadian Agricultural Partnership

Ontario farmers who are experiencing financial difficulty may be eligible for cost-share support for financial advisory services to complete a Farm Financial Analysis. Documentation supporting financial difficulty is required with the application.

- Intake Opens: March 1, 2024
- Intake Closes: February 28, 2025
- Project Completion: March 15, 2025

Eligible applicants may receive one-time funding of 100% cost-share up to maximum of $5,650 (inclusive of HST)

The Special Provisions for Financial Difficulties Program is delivered by the Ontario Soil and Crop Improvement Association (OSCIA). Program information can be found at: https://programguides.ontariosoilcrop.org/program/special-provisions-for-financial-difficulties/

Resilient Agricultural Landscape Program: Water Retention Features

Funded under Sustainable Canadian Agricultural Partnership

Resilient Agricultural Landscape Program (RALP) funding supports the rejuvenation or the establishment of water retention or shallow groundwater type features on agricultural landscapes in Ontario. The feature must be a minimum of 15 feet deep to qualify

for funding.

Water retention features result in more resilient agricultural landscapes with an increased ability to help farmers adapt to changing climate conditions and manage fluctuations in water resources, creating more resilient agricultural production and providing many other ecological and water quality benefits.

- Intake Opens: June 3, 2024
- Intake Closes: when available funding has been allocated.
- Project Completion: December 15, 2024

Eligible applicants may receive:

$6,000/acre for rejuvenating an existing water retention feature and/or shallow groundwater type feature (minimum depth 15 feet after rejuvenation)

$10,000/acre for establishing a new water retention feature and/or lined reservoir type feature (minimum depth 15 feet)

The Resilient Agricultural Landscape Program is delivered by the Ontario Soil and Crop Improvement Association (OSCIA). Program information can be found at: https://programguides.ontariosoilcrop.org/program/water-retention-features/

Resilient Agricultural Landscape Program: Tree and Shrub Planting

Funded under Sustainable Canadian Agricultural Partnership

Resilient Agricultural Landscape Program (RALP) funding supports the rejuvenation of existing or establishment of new tree and/or shrub plantings on agricultural landscapes in Ontario.

Tree and shrub plantings result in more resilient agricultural landscapes with an increased ability to sequester carbon, reduce soil erosion, and provide many other ecological and water quality benefits. To learn more about the benefits of trees on agricultural lands, visit Trees on farms | ontario.ca.

- Intake Opens: June 3, 2024
- Intake Closes: when available funding has been allocated.
- Project Completion: December 15, 2024

Eligible applicants may receive:

$1,000/acre for rejuvenating existing tree and/or shrub windbreak, shelterbelt, or riparian buffer plantings to increase density and reduce erosion risks

$3,000/acre for establishing new tree and/or shrub windbreaks, shelterbelts, riparian buffers, or block plantings

The Resilient Agricultural Landscape Program is delivered by the Ontario Soil and Crop Improvement Association (OSCIA). Program information can be found at: https://programguides.ontariosoilcrop.org/program/tree-and-shrub-planting/

Sustainable CAP is a five-year (2023-2028), $3.5-billion investment by federal-provincial and territorial governments to strengthen competitiveness, innovation, and resiliency of the agriculture, agri-food and agri-based products sector. This includes $1 billion in federal programs and activities and a $2.5 billion commitment that is cost-shared 60 per cent federally and 40 per cent provincially/territorially for programs that are designed and delivered by the provinces and territories.

On-Farm Climate Action Fund: Cover Cropping

Funded under Agriculture and Agri-Food Canada

For farmers who want to undertake a **new practice** of cover cropping, where the planted cover crop will be left **undisturbed over the winter** (i.e., the crop cannot be chemically or physically terminated in the fall or winter). A **new practice** is a practice that has not been previously implemented by the applicant on the acres being applied for and can include planting cover crops to be left over-winter either for the first-time or where they have previously been terminated or harvested in the fall.

If a cover crop being applied for is to be harvested or grazed, a minimum of 6 inches of growth must be left undisturbed over winter (November to March).

Approved projects must result in a planted cover crop in 2024.

- Intake Opens: August 1, 2024
- Intake Closes: when available funding has been allocated.
- Project Completion: January 31, 2025

Eligible applicants may receive 65% of eligible project costs, up to a maximum cost-share payment of $20,000 per project.

The Resilient Agricultural Landscape Program is delivered by the Ontario Soil and Crop Improvement Association (OSCIA). Program information can be found at: https://programguides.ontariosoilcrop.org/program/cover-cropping/

Honey Bee Health Initiative

Funded under Sustainable Canadian Agricultural Partnership

To help support beekeepers in maintaining healthy honey bee colonies as well as grow their number of colonies to increase the sustainability of the beekeeping industry in Ontario.

- Intake Opens: June 3, 2024
- Intake Closes: when available funding has been allocated.
- Project Completion: December 15, 2024 & February 15, 2025

Eligible applicants may receive 50% cost-share funding up to a maximum of $25,000 per registered commercial beekeeper and $4,500 per registered hobbyist beekeeper.

The Honey Bee Health Initiative is delivered by the Ontario Soil and Crop Improvement Association (OSCIA). Program information can be found at: https://www.ontariosoilcrop.org/honey-bee-health-initiative/

Sustainable CAP is a five-year (2023-2028), $3.5-billion investment by federal-provincial and territorial governments to strengthen competitiveness, innovation, and resiliency of the agriculture, agri-food and agri-based products sector. This includes $1 billion in federal programs and activities and a $2.5 billion commitment that is cost-shared 60 per cent federally and 40 per cent provincially/territorially for programs that are designed and delivered by the provinces and territories.

Ontario Soil and Crop Improvement Association

There are many opportunities currently available, please follow the link below for more information: OSCIA-Delivered Program Guides (ontariosoilcrop.org)