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ORCHARD NETWORK

For Commercial Apple Producers

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In this issue...

Orchard Management

High Temperatures May Result in Smaller Fruit

Amanda Green, Tree Fruit Specialist, OMAFRA

Apples sizing has significantly slowed or halted from the end of July until late August. Fruit size has been reported to be smaller and variable across the province. Size reduction could be due to low soil moisture and the response is quite variable, depending upon soil type, rootstock, variety and crop load management. Interestingly though, small fruit has also been found in irrigated orchards and this observed size reduction may be a result of hot temperatures as well.

Ontario has experienced many hot day time temperatures. Norfolk County, Niagara Region and areas surrounding Toronto and Ottawa have had 20-30 days of temperatures above 30°C. The rest of the province has experienced 10-20 days of temperatures above 30°C. The main concern for these high temperatures has been to protect apples from sunburn and bitter rot but heat stress can cause a reduction in fruit size as well.

Early research has shown that temperatures above 30°C and also high night time temperatures can be detrimental to growth. With temperatures above 30°C, net CO_2 fixation is great reduced, resulting in a carbon deficit. From

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research conducted at Cornell, fruit size increases linearly as day/night temperatures increase from 12/7 to 33/28 at 6 mm fruit diameter. After three weeks past bloom or 11-18 mm fruit diameter, fruit growth is greatly reduced. Another study from Israel found that at temperatures above 29°C molecular development and growth process were disrupted and cell-expansion and cell-cycle genes were expressed differently.

There are products and practices that can help to reduce heat stress and improve fruit size as well as prevent against sunburn and bitter rot. Evaporative cooling through overhead irrigation misters can help cool trees down and is commonly used in apple growing regions that experience hotter temperatures, such as Washington State. Sun or heat stress protectant products such as Surround WP, Screen Duo and Caltrac can also help with heat stress.

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Bitter Pit Not Just a Calcium Deficiency

Megan Bender, Horticultural Assistant, OMAFRA; Amanda Green, Tree Fruit Specialist, OMAFRA

Bitter pit is a physiological disorder that occurs on fruit, typically in the postharvest stage. The disease starts internally, showing nearly no external signs at harvest, progressing to sunken gray, brown or black spots on the calyx end after a few days to weeks in low temperature storage. The varieties that are most susceptible to bitter pit include: Honeycrisp, Delicious, Courtland, Fuji, Crispin, Empire, Idared, and Northern Spy.

Figure 1. Bitter pit symptoms on apples

Causes

Bitter pit is predominantly caused by low calcium (Ca) levels in the fruit. Ca provides stability in the cell wall; when there is a deficiency in the fruit, physiological breakdown of cell walls can occur.

Bitter pit relates more to the distribution of Ca in the plant rather than the Ca level in the soil. Ca is absorbed by the roots and moves with water in the xylem through transpiration to the mature leaves. It is taken up into the fruit until mid-July; after which there is very little transport of Ca into the fruit. As the fruit grows, Ca is diluted with in the fruit.

Bitter pit is influenced by nutrient imbalances with Ca such as nitrogen (N), potassium (K), phosphorus (P), magnesium (Mg), and boron (B). The N:Ca ratio affects the occurrence of bitter pit more than the individual Ca level. High levels of Mg and K results in Ca deficiencies, therefore K and Mg foliar sprays can increase bitter pit occurrence. Typically the higher the nutrient ratio of N, K, Mg, P to Ca, the higher the susceptibility to bitter pit. From recent research from Cornell, Honeycrisp is more predisposed to bitter pit as it is found to have a higher leaf Ca level than Gala as well as lower Mg, P, and K levels in leaves than in Gala. The

fruit has higher K:Ca, Mg:Ca, P:Ca, and (K+Mg):Ca ratios in Honeycrisp than Gala in both peel and flesh. Results concluded that Honeycrisp is more vulnerable to bitter pit due to more precise Ca partitioning.

Solutions for Bitter Pit

An excess or lack of soil moisture will affect the accumulation of Ca within plants. This water stress can be improved through irrigation and mulching for dry soils, and tilling for excessively wet soils. Adjusting the pH level (between 6 and 7) through liming or gypsum will help Ca uptake as the availability of minerals vary with the pH level; however, it will take a few years to make a difference. Some smaller actions can be taken such as controlling vigor and managing crop yields to help increase Ca uptake by fruit.

Foliar applications of Ca (calcium chloride or calcium nitrate) have been the most effective for increasing Ca in fruit than soil treatments because Ca is an immobile nutrient. It is recommended by Dr. Lailang Cheng, from Cornell that pre-harvest foliar sprays should begin shortly after petal fall at 1.8-2.4g/1000 litres (1.5-2lbs/100 gallons) of water for at least four applications and then changing the rate to 3.6-4.8kg/1000 litres (3-4lbs/100 gallons) of water for 2 mid-season sprays and continue until harvest. It is more important to make frequent sprays than applying sprays at a certain time during the season. Foliar application of sprays only benefit the fruit if the spray makes direct contact on the fruit, therefore good coverage is important.

Excess levels of N, P, Mg or K will increase Ca deficiencies because they compete with Ca therefore nutrients need to be kept at their optimum level. Ca imbalances with other nutrients predisposes cultivars such as Honeycrisp to Ca deficiencies.

There are a few different methods of detecting Ca deficiencies and bitter pit which include: nutritional status, maturity acceleration, veg growth/tissue analysis, Mg infiltration, and peel nutrient ratios. When testing Ca levels in vegetation, leaves need 1.3-2%. Mg (Mg chloride) infiltration will show evidence of Ca deficiencies 7-10 days after and is inversely related to Ca concentrations in fruit. Peel nutrient levels such as K:Ca, P:Ca, and K+Mg:Ca ratios may also help predict susceptibility to bitter pit and Ca deficiencies as they tend to be higher in some varieties, predisposing them to bitter pit.

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Crop Protection

Bitter Rot in Apples

Michael Celetti, Plant Pathologist Horticulture Crops, OMAFRA; Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA; Amanda Green, Fruit Tree Specialist, OMAFRA

Bitter rot has recently become a serious disease in some Ontario apple orchards. The disease is caused by the fungal pathogen *Colletotrichum fioriniae* (formerly *C. acutatum*). Prior to 2010, bitter rot had caused significant losses in apple growing regions that experience very warm and humid conditions such as in some Southern US states and Central and South America. However, something has changed recently and more bitter rot has shown up in Ontario over the past couple of years.

Epidemics of this disease may arise when warm to hot weather occurs early in the growing season together with rainy periods that extend into the summer. The spores of the pathogen can infect fruit at any time during the growing season from as early as bloom right up until harvest. However, symptoms often show up mid - late season after a period of warm to hot weather accompanied by rain or a thunderstorm. Since there has been very little rain in many apple growing regions this past summer, very few bitter rot symptoms have been observed until now. After the rain that occurred during mid-August, bitter rot began to show up in some orchards in mid to late August.

The initial infection appears as small grey, reddish or

brown spots (Figure 1) that quickly enlarge into circular sunken light to dark brown rots on infected fruit (Figure 2). As the fruit lesions enlarge, a diagnostic V-shaped rot may progress towards the core (Figure 3), but this does not always occur and may not be the most reliable symptom for disease diagnosis. Warm temperatures hasten the rotting process until the fruit becomes shriveled and completely rotten. Severely rotten fruit often fall from the tree prematurely. During humid conditions, cream to salmon-coloured masses of spores are produced on the surface of the rotting fruit which is very diagnostic (Figure 4). These spores can then be rain splashed to other fruit resulting in further infections. If the spores land on fruit just before or during harvest, infection can occur and small bitter rot lesions will develop slowly while in cold storage (Figure 5). Often a few small black spore-producing structures develop within the lesions during cold storage. These small lesions will begin to enlarge within a few days after the fruit is removed from storage.

Figure 1. Bitter rot initially appears as small grey, reddish or tan brown spot on fruit.

Figure 2. Bitter rot develop into a circular sunken lesion.

Figure 3. Bitter rot lesions develop a diagnostic V-shaped rot that progresses towards the core.

Figure 4. Cream to salmon coloured spore masses develop in the sunken bitter rot lesion during humid conditions.

The pathogen can overwinter in infected mummified fruit left on trees or on the orchard floor. It can also colonize cankers caused by other pathogens such as fire blight or black rot. Recently, there have been reports of more bitter rot appearing in orchards that also had fire blight, possibly due to the pathogen surviving in the fire blight cankers and spreading to fruit later in the growing season.

Management of bitter rot is through good orchard sanitation. Removing old fire blight, black rot and other cankers will reduce the potential primary source of this disease in the orchards. Mulching or removing infected fruit on the orchard floor will also help reduce inoculum and the potential of spreading the disease.

Allegro and Pristine fungicides are registered for the control of bitter rot in Ontario apple orchards. While Granuflo/ Thiram is also registered, Ontario experience has found it to provide suppression only. However, some fungicides registered for the management of apple scab and other summer diseases may also provide some protection against infection from the bitter rot fungus. Fungicide applications should be made every 10-14 days during the warm summer months, but shortened to 7 days if frequent rain is experienced. If possible, timing an effective fungicide application just prior to a rain event or thunderstorm will protect fruit from rain splashed spores. Always rotate products to reduce the potential for resistance development. There is some evidence that calcium sprays may also help to protect the fruit; however, the efficacy, timing, rate and frequency of calcium applications is still under investigation.

During times of extreme heat, such as what we experienced this year, sun protectant products may also help boost the immunity of the fruit and protect against bitter rot infection. Bitter rot lesions are often more common on the sun-facing side of ripening fruit. Research has shown that fruit surface temperature can be 14-17˚C higher than air temperature. This, in turn, has been found to make fruit more susceptible to bitter rot infection. Having a clay- or calcium carbonate-based sun protectant product applied prior to a heat event will reduce fruit surface temperatures.

Figure 5. Small grey bitter rot lesions with small black fruiting bodies can develop slowly in cold storage.

Harvest Assessments: Your Apple IPM Report Card

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

In the few weeks leading up to harvest, take some time to assess this year's IPM program. Once harvest gets underway, neither you nor your picking crew will have the time to make these important notes.
To evaluate pest damage, look at a random selection of apples from the tops, sides and bottoms of trees. Anything causing 2-5% damage is of concern.
Good pictures and descriptions of damage that you might encounter can be found online at CropIPM and in Publication 310, Integrated Pest Management in Apples. Look for Appendix H on page 215 in the publication for a harvest assessment page to copy for recording your results.

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 an hour or so 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.

How should you do it? Choose at least 10 (large trees) to 20 (dwarf trees) healthy trees randomly throughout the block. Select 200-400 apples, turning each to see all sides of the fruit without removing it. Choose fruit from different positions on the trees: upper, inner and outer part of the canopy. The key is to choose randomly and write it down!

Also make notes of damage to leaves such as scab, tentiform leaf mines, powdery mildew, apple leaf curling midges, mites and other feeding. This information will be important when planning your IPM program next year.

Early harvest assessments done already this year have indicated an overall successful year for pest management. There were some orchards that struggled with early season caterpillar damage, causing both foliar and fruit damage. As well, some blocks experienced higher pressures of leafcurling midge or mites, resulting in leaf curl or bronzing, respectively. Despite high mullein bug tap numbers, damage was not as extensive as expected in many orchards. Some codling moth fruit damage can be found. In the east, damage from European apple sawfly was relatively low. Fire blight was a major issue in most regions of the province with blossom and shoot blight present. In a few orchards where fungicide programs failed or residues were no longer present, powdery mildew and scab was observed, as well as flyspeck/sooty blotch, black rot and bitter rot.

Dealing with Pre-Harvest and Storage Diseases in Apples

Kristy Grigg-McGuffin, Horticulture IPM Specialist

With the hot temperatures since bloom, conditions have been ideal for the development of fungal pathogens, such as black rot and bitter rot. Recent (and long-anticipated) rains may have resulted in numerous infection periods. 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 (*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. A large number of cases of tree collapse due to black rot cankers were reported this year on young trees (<5-6 years). This was likely a result of winter injury occurring in 2014 and/or 2015, which created a wound at the tree base for the black rot pathogen to enter.

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 the 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.

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.

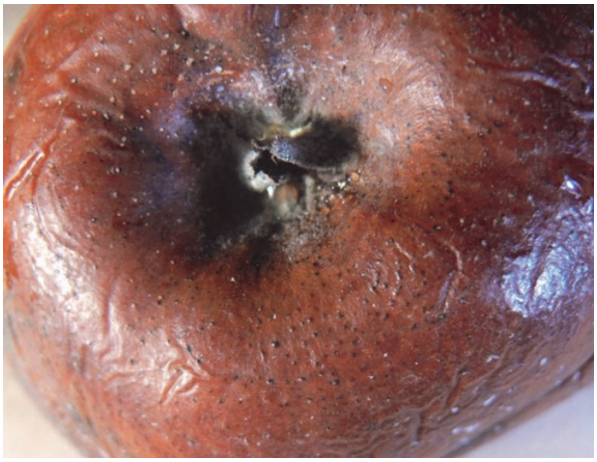


Figure 3. In storage, black rot infected fruit remain firm and may produce tiny pimple-like black pycnidia.

Bitter rot, caused by the fungus *Colletrotrichum fioriniae* overwinters in mummified fruit, crevices in the bark, and cankers. Typically, symptoms appear late summer to harvest (Figure 4). For more details on symptoms, see Bitter Rot in Apples also in this issue of the Orchard Network Newsletter.

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.

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 critical to protect the maturing fruit before harvest if the pathogen is in your orchard.

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 5). Fortunately, scab will not spread from diseased to healthy apples in storage.

Despite the hot, dry year, scab can still be found in many orchards across the province where fungicide programs did not manage primary scab infection. 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°C can reduce the amount of scab by 67, 87 and 36%, respectively.

Figure 5. Pin-point scab lesions appear as jet black spots that may not be apparent at harvest.

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 6) and has a musty odour, while gray mold has fluffy white or grey mycelium and dark grey spores masses (Figure 7) with a "cedar-like" smell only in advanced stages.

Figure 6. Blue mold initially has tufts of white spores that turn blue-green.

Figure 7. Gray mold has fluffy white or grey mycelium and dark grey spore masses.

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. Captan (Supra Captan, Maestro) cover sprays should be applied leading up to harvest in orchards with optimum conditions for pin point scab. Captan or Pristine may provide some protection against rots. While Granuflo T / Thiram and Allegro are also registered for rot, the PHI is 28 days for these products. Scala is registered as a pre-harvest treatment for grey mold. Post-harvest treatments for blue and gray mold are also registered, including Mertect, Scholar or Bio-Save. For more information on pre- and post-harvest fungicides, consult the 2016-2017 Publication 360, Guide to Fruit Production.

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.

Late Season Apple Insect Pests

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA

The extreme heat this summer has caused insect flight and development to be earlier and/or extended in some areas of the province. While harvest will undoubtedly take most of a grower's attention, it is still important to continue monitoring for pests and applying control measures. There are some late season insect pests of apples that will remain active up until harvest and if left uncontrolled can wreak havoc on a potentially good crop.

Apple maggot

Overall, the hot, dry weather has kept apple maggot trap catches relatively low across the province. However, regions that have experienced some rain in recent weeks are seeing an increase in adult flight. Emergence is closely linked to soil moisture – in dry years, pupae can

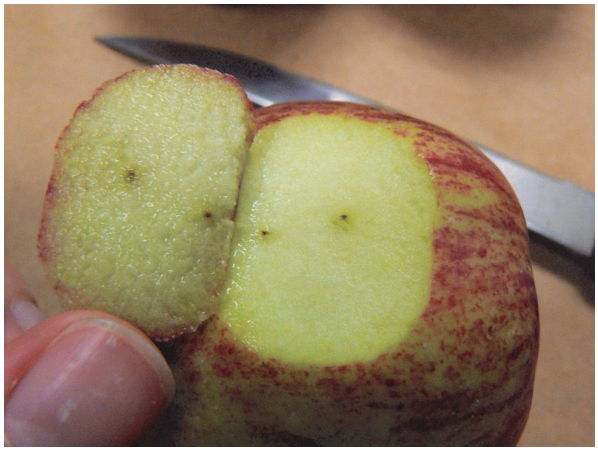


Figure 1. Apple maggot damage

remain in the soil until environmental conditions become more favourable, even into the following growing season. With more rain predicted in the weeks leading up to harvest, there is a possibility of seeing a spike in apple maggot activity. 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).

Codling moth

While there are usually 2 generations of codling moth in Ontario (except near Georgian Bay), it is possible to see a 3rd generation (often known as a suicide generation) in some orchards during warmer than average seasons. Codling moth larvae normally enter diapause during the 3rd week of August. However, in warm years and locations, some pupate instead and go on to produce a 3rd generation of adults. If this occurs, use pheromone traps to establish a biofix when flight activity increases and apply a spray when the following degree days (DDC) accumulate:

- *Imidan, TwinGuard, Delegate, Altacor*: Apply at 138 DDC.
- *Assail, Calypso*: Apply at 111 - 138 DDC. Note – PHI for Calypso is 30 days.
- *Exirel, Confirm, Intrepid*: Apply at 83-111 DDC.

It is important to remember that while some of the chemistries listed above provide effective management of codling moth, they will only provide apple maggot suppression in low pressure orchards (Delegate, Altacor) or none at all (Intrepid, Confirm). Take this into consideration when choosing a late season spray.

Figure 2. Codling moth damage

Oriental fruit moth

Adult flight of oriental fruit moth can last into early October, with damage occurring up to harvest. Monitor pheromone traps in orchards into September to keep an eye on populations. Remember that late season sprays may be needed, especially on light skinned varieties. For growers using mating disruption, Isomate OFM TT are designed to last for the entire season. However the combined Isomate CM/OFM TT only lasts up to 90 days for oriental fruit moth, so late season sprays may be needed.

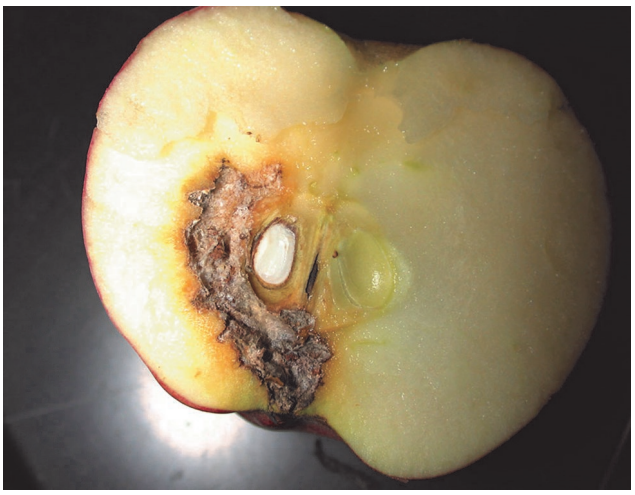


Figure 3. Oriental fruit moth damage

Obliquebanded leafroller

Although both larvae and damage can be found in orchards at the present time and up to harvest, we have passed the point where managing this pest is worthwhile. Late season obliquebanded leafroller development is not synchronized, and sprays affect only the small portion of the population that is active at this time. Instead of spraying, keep an eye out for late season damage during harvest. If damage is found, be sure to apply a petal fall spray targeting leafroller next spring.

Figure 4. Obliquebanded leafroller damage

Fire Blight: Consider An Aggressive Orchard Management Approach

Kristy Grigg-McGuffin, Horticulture IPM Specialist, OMAFRA; Michael Celetti, Plant Pathologist Horticulture Crops, OMAFRA

The 2016 season has been a very difficult fire blight year in many apple orchards across the province, including in less susceptible varieties and orchards that have never had fire blight before. While the fire blight bacteria are always present in an orchard, the risk of infection varies year to year depending on environmental factors, management practices and overall tree health. Unfortunately, this year had ideal conditions at bloom for fire blight infection, including a long secondary bloom in many areas. Protection products such as Streptomycin degrade rapidly in UV and are only effective for about 2 days before reapplication is needed. Growers who did not spray a protectant product preventatively during bloom, spray frequently enough or at the proper timing, or did not remove secondary blossoms likely saw fire blight symptoms in their orchard.

The first line of defense for fire blight management in an orchard is prevention. There is no silver bullet to eradicate this disease once it becomes well established. Growers that dealt with fire blight this year should consider an aggressive orchard management approach, including the following:

Prune out infected tissue – Removing sources of inoculum as soon as possible will significantly reduce secondary infection. However, aggressive pruning early in the season on vigorous trees can worsen the situation by stimulating succulent shoots that will be susceptible to infection. Consider delaying pruning of older trees (>8-10 years) with many strikes until terminal bud set or when dormant. Keep in mind, however, that delayed removal of inoculum increases the risk of trauma blight in the event of severe wind, rain or hail later in the season.

Other key points to remember when pruning infected tissue:

- Cut at least 30 cm beyond the visible infected tissue (Figure 1), preferably into 2nd or 3rd year wood.
- Only prune out strikes when there are 2-3 consecutive days of low humidity and temperatures below 25^{0}C.
- Regardless of when you prune, disinfect pruning tools between each cut by soaking them in a solution of 1 part bleach to 5 parts water or in a 65 -70% alcohol solution.
- Prevent the spread of fire blight by not dragging infected material through the orchard. Cuts can be left in the row middles to dry up before removing or mulching them down.
- Scout the orchard for fire blight cankers (Figure 2) which can harbour active bacteria over the winter. Prune out limbs infected with cankers or, if necessary, remove the entire tree during the dormant season.

Figure 1. Visible margin of fire blight infection below which tissue appears healthy.

Figure 2. Fire blight canker becomes sunken with cracked margins. Bacteria ooze can be seen on the surface of canker in spring.

Remove root suckers – These adventitious shoots (Figure 3) are a fire blight management concern for several reasons:

- *Provide an entry point for fire blight* –Rootstocks that become infected from the scion often die a year later, whereas rootstock infection through a sucker die the same year. Susceptible rootstocks like M9 and M26 can die quickly after infection through root suckers.
- *Provide an entry point for systemic herbicides (eg. glyphosate, amitrole)* – These herbicides may weaken the tree and make them more susceptible to disease like fire blight.

- *Attractive to late season sucking insects* – Since root suckers continue to grow after terminal bud set, they can become an ideal site for insect pests later in the season. Sucking insects may transmit fire blight.

Figure 3. Root suckers of apple tree can provide entry point for fire blight bacteria. *Photo: J. Clements, University of Massachusetts*

Use registered control products – Consider applying a dormant copper next spring to kill bacteria that ooze out of overwintering fire blight cankers. Sprays can be applied from dormant through to green tip. However, green tip is the preferred timing of application as heavy rainfalls after application can partially wash off copper, reducing efficacy. Delaying copper after green tip can result in phytotoxicity and severe fruit russetting, depending on the copper product used.

Open blossoms tend to be the primary avenue for fire blight infection. Protecting these blossoms with timely applications of antibiotics (Streptomycin, Kasumin) and/or biologicals (Blossom Protect, Bloomtime, Serenade) is critical for management. Applications should be made when conditions are predicted to be conducive for bacteria build-up in the orchard using a forecasting model, such as CougarBlight or Maryblyt. Always rotate products to reduce the potential for resistance development.

Secondary blossoms (referred to as “rattail” or “tag” bloom) often open when environmental conditions for infection are high or extreme. Since they open much later than the majority of blossoms, they are often unprotected and therefore extremely vulnerable to fire blight infection. If possible, remove secondary blossoms immediately since they rarely produce marketable fruit and are more of a liability. Otherwise, continue with a bloom control program when a forecasting model predicts that there is a fire blight infection risk.

ORCHARD MAX

What is OrchardMAX?

Jason Deveau, Application Technology Specialist, OMAFRA

OrchardMAX is a free app developed by the Ontario Ministry of Agriculture, Food and Rural Affairs to improve sprayer efficiency and effectiveness in apple orchards. The app is based on the **Crop-Adapted Spraying** model, which was tested in semi-dwarf and high-density apple orchards in Ontario and Nova Scotia from 2013 to present day. The primary goal of the app is to help the sprayer operator achieve consistent coverage, no matter the architecture of the orchard block, throughout the season. Research has demonstrated that following the process improves coverage while reducing wasted spray by an average of 20% over the season.

OrchardMAX will:

- Accept Metric or US Imperial units
- Create an inventory of your orchard airblast sprayers
- Create an inventory of your orchard blocks
- Determine optimal sprayer settings based on the average size, shape and density of the trees in the block
- Propose a pesticide dose for each block, including ideal nozzle rates, water volume and product(s) per tank
- Develop a permanent spray record that can be emailed to the user for archival

OrchardMAX won’t:

- Exceed label rates
- Calibrate your sprayer
- Confirm spray coverage
- Account for environmental conditions such as wind, humidity or temperature
- Advise a volume below 400 L/ha (about 42.5 US g/ac)
- Advise a dose that is less than 1/2 the label rate (that may seem low, but consider a first-year planting)
- Work on other orchard crops (e.g. cherry, pear, etc.). So far, it has only been tested in apples.

Recognizing that this app can only approximate ideal sprayer settings based on data entered by the user, **minor adjustments are still required on the part of the sprayer operator**. Specifically, the sprayer operator must still **calibrate and adjust the sprayer air** to match the tree and the environmental conditions and **confirm coverage using water-and-oil sensitive paper**.

Why you should try it:

Financial savings: The app will help you match your sprayer settings to the crop you're trying to protect. That means you will find out if you are over- or under-spraying the tree canopy and by how much. This information, combined with feedback from water-sensitive paper, will improve canopy coverage and very probably improve the quality of the apple crop. Additionally, the app may lead to reduced pesticide volumes, which reduces environmental contamination and saves money.

Explore different spraying scenarios: Perhaps you're considering a new planting and you would like to know how many tanks it would take to spray an orchard block for a given speed, or row spacing. Perhaps you are considering a sprayer with a larger tank to reduce the number of refills, or a smaller tank to prevent rutting and you want to see how that affects your spray efficiency. Maybe you're considering decreasing your fill time by using a **tender or nurse truck**. Enter the parameters and see how it affects your spray day BEFORE you invest.

Create permanent spray records: The app will create a library of spray records that are emailed directly to you. So, like any new practice, you have to put in a little time and effort to realize the full benefit of the app. Try it on a few blocks in the first year, make the changes to your spray program and review the results. As you get used to this new method for spraying, and see the improvement, you can continue to expand its use to the entire operation.

How it works:

First you have to enter information about your operation. **This only has to be done once.**

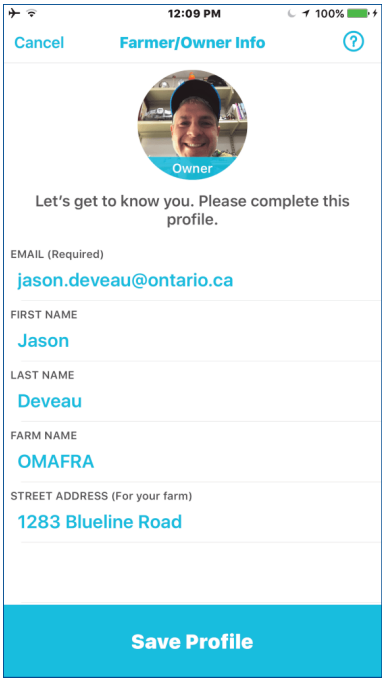
1. Enter your profile information
2. Complete the Inventory
3. Information for each sprayer in your operation
4. Information about each sprayer operator
5. Information about each physiologically different orchard block (e.g. Trellised Gala on 10′ rows is quite different from mature semi-dwarf Empires)

Now you are ready to calculate rates for a spray day.

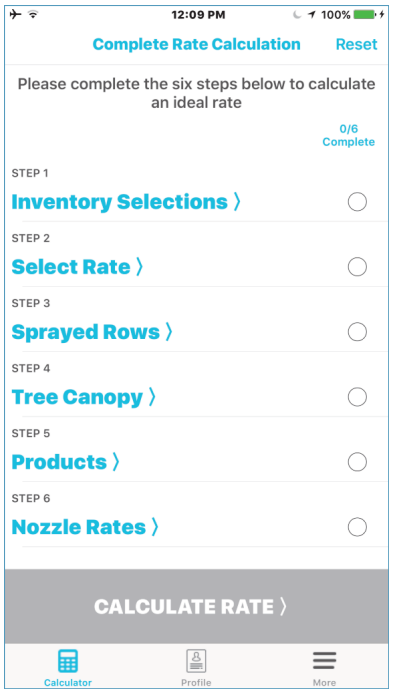
1. Choose the Sprayer, Operator and Block from your Inventory
2. Decide if you want to use label-rate, or an optimized rate based on tree size
3. Determine if you will spray every row, or alternate rows (You cannot choose to optimize your rate AND spray alternate rows)

Enter information about the tree shape and density (This accounts for pruning and time-of-season). This is mostly visual, where the user chooses from a series of pictures

- Enter label rate and preferred rate for each pesticide in the spray mix



Enter Farmer/Owner information



Select sprayer, operator and block from inventory, then enter spray-day data to calculate rate and sprayer settings.

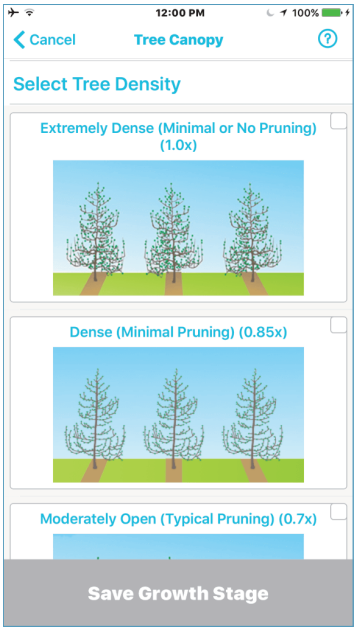
The software then lets you know how much carrier and/or pesticide can be saved if you nozzle your sprayer according to it's prescription.

- From a nozzle catalog, enter the nozzle rates for each position within 5% of OrchardMax's prescription

The software then assembles a spray record which can be emailed for you to keep in your records. The spray record includes all the information you need about spraying that block. Here's is an example:

APPLICATOR:
Operator Name: I.B. Sprayin'
Estimated Duration: 2:29 hr:min/block

CROP:
Block Name: Northwest Gala Planting
Crop (Variety or Varieties): Gala and Honeycrisp
Pre- or Post Petal Fall: Pre Petal Fall
Average Row Spacing: 5.0 Meters
Highest Tree Height: 5.0 Meters
Average Canopy Width: 2.0 Meters
Canopy Density: Extremely Dense (Minimal or No Pruning)



SPRAYER:
Sprayer Name: Red Airblast Sprayer
Sprayer Make: Brand X
Travel Speed: 5.0 km/h
Intended Output for Boom: 20.0 L
Tractor Gear: 4
Operating Pressure: 5.0 bar

NOZZLE OUTPUTS:
Nozzle 1: 4 Liters/min
Nozzle 2: 3.8 Liters/min
Nozzle 3: 4.1 Liters/min
Nozzle 4: 4.1 Liters/min
Nozzle 5: 4 Liters/min

OPTIMIZED VALUES:
Estimated Total Carrier Needed: 960.0 L/ha
Estimated Total Carrier Needed: 4,800.0 L/block
Average spray time without turns or refills: 0:24 hr:min/ha
Average spray time with turns and refills: 0:29 hr:min/ha
Total spray time with turns and refills: 2:29 hr:min/block
Area Sprayed per tank: 1.04 ha
Refills: 0.96 per ha
Refills for entire block: 4.80 per block

Product Name: Fungicide powder
Preferred product rate: 1,000.00 g/ha
Suggested product rate: 960.00 g/ha
Suggested product rate by area: 960.00 g/ha
Product added to full tank: 1,000.00 g/Tank
Product added to Partially-full Tank: 800.00 g/Tank
Volume of Carrier Water in Partially-full Tank: 800.00 L

PRODUCT SAVED:
40.00 g/ha

These are ideal results, always confirm coverage with water sensitive paper and make adjustments where needed

Where can I get it?

Right here! Select your operating system and you will be taken to the respective store and begin downloading. Please **rate the app** so we know it's being used and can work to improve it. Please **opt in to provide us with usage information** so we can see how it's being used – this is **entirely private** and we will not contact you.

For more information:
The OrchardMAX app was developed by AgNition Inc. with funding from Growing Forward 2.

For more information on the Crop-Adapted Spraying model behind the app, to provide constructive feedback, or to report bugs, please contact jason@sprayers101.com.

Low Oxygen Storage of 'Empire' Apples

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

'Empire' apples were harvested on September 29th, 2015. Fruit maturity at harvest was 6.5 ppm internal ethylene, 4.8 starch (Cornell chart), 17.6 lb firmness, and 9.8% soluble solids.

Controlled atmosphere was established on October 2nd and the following storage regimes at 2-3°C were evaluated:

1) 2.5% O_2 + 2% CO_2
2) 1.5% O_2 + 1% CO_2
3) 1.5% down to 0.6% O_2 over ~2-3 months + less than 1% CO_2 (SafePod technology (Figure 1))

Figure 1: SafePod technology with apples. SafePod measures the fruits' response to atmospheric stress by monitoring its respiration rate, which will be the primary metabolic process to change when oxygen becomes too low and there is potential for fruit injury. This allows for the lowest safe oxygen concentration to be used in apple storages.

'Empire' fruit with or without SmartFresh treatment (1 ppm, 24 hours) at 1 day after harvest were held in Regimes 1 (2.5% O_2) and 2 (1.5% O_2). All fruit held in Regime 3 (SafePod) were not treated with SmartFresh at harvest time. However, upon opening of the SafePod, half of the apples were then treated with SmartFresh at that time.

All fruit were removed from storage on June 6th, 2016. There were few differences in apple quality at the time of removal from storage. However, large differences existed after 7 and 14 days at room temperature (RT, ~23°C). After ~8 months of storage plus 14 days at RT, 'Empire' from SafePod with SmartFresh treatment upon opening were firmer (+ 2-3 lb) than fruit from all other storage regimes (Table 1). 'Empire' from SafePod also developed very few disorders (0-1.5% incidence), regardless if subsequently treated with SmartFresh or not. In contrast, 'Empire' from Regimes 1 (2.5% O_2) and 2 (1.5% O_2) developed more storage disorders, especially if treated with SmartFresh at harvest time (up to 28%).

Table 1: Quality of 'Empire' apples after ~8 months of storage in 2.5% O_2, 1.5% O_2, or 0.6% O_2 (SafePod) at 2-3°C, plus 14 days at room temperature (~23°C).

	Internal Ethylene (ppm)	Firmness (lb-force)	Soluble Solids (%)	Malic acid (mg)	External CO_2 injury (%)	Flesh Browning (%)	Core Browning (%)
0.6% O_2 (SafePod)							
No SmFr	733 A	11.4 B	10.3 A	378 BC	0 C	0.7 B	0.7 B
+SmFr at opening	684 A	13.2 A	10.0 A	411 AB	1.5 C	0.7 B	0 B
2.5% O_2							
No SmFr	719 A	10.3 C	9.9 A	338 D	3.7 C	1.3 B	24.5 A
+ SmFr at harvest	469 B	11.3 B	10.0 A	427 A	28.0 A	11.2 A	26.6 A
1.5% O_2							
No SmFr	669 A	10.5 C	10.2 A	371 CD	2.3 C	1.9 B	6.4 B
+ SmFr at harvest	465 B	11.0 B	10.2 A	426 A	12.4 B	15.2 A	22.0 A
Significance	****	****	NS	****	****	****	****

- Values represent the average of 20 or 30 apples, plus an additional 150-200 for disorders on Day 14
- SmFr = SmartFresh treatment at 1 ppm for ~24 hours at 2-3°C
- NS, **** = Not significant and significant at P<0.0001, respectively
- Means within the same column at a given time with the same letter are not significantly different at P<0.05

Acknowledgements

The author gratefully acknowledges support from the Ontario Apple Growers, Norfolk Fruit Growers' Association, and Storage Control Systems, Inc. (Sparta, Michigan) during the course of this research. The project was funded in part through *Growing Forward 2* (*GF2*), a federal-provincial-territorial initiative. The Agricultural Adaptation Council assists in the delivery of *GF2* in Ontario.

Storage and Handling Options for 'Sunrise' Apple

Peter M.A. Toivonen, Senior Research Scientist, Summerland Research and Development Centre, Summerland, British Columbia

Since its commercial release in the mid-1990's, 'Sunrise' apple has been prized as a summer apple with exceptional taste and crunchiness. However, the challenge for this apple is, that if it is stored and handled as other varieties are, it softens at shelf temperatures at a very rapid rate and can become mealy within a few days on the counter (Lane et al., 1996; Lau, 2012). The reason for this is that 'Sunrise' is chilling sensitive and should not be stored below 15 °C (Toivonen and Lu, 2005; Qui et al., 2009) much like what is recommended for vine ripe greenhouse tomatoes.

Lau (2012) proposed two general options for handling and storage of 'Sunrise'; 1) place them in cold storage, display in a refrigerated display and advise the consumer to keep refrigerated until consumption or at least until within two days before they will be consumed, or 2) treat with 1-MCP and store at 20 °C, display in an unrefrigerated display and advise the customer to not refrigerate the apple prior to consumption. In our laboratory experience with 'Sunrise' apple, we echo the recommendations made by Dr. Lau. The one comment that I feel needs to made is that successful or consistent adherence to the advice for retailers and consumers under option 1 is not likely to occur in practice. Therefore, my opinion is to recommend that 'Sunrise' growers or shippers consider the possibility of treating their fruit **with 1-MCP and handling at temperatures ranging from 15-20 °C** and recommending that distributors and retailers handle them warm, much like greenhouse tomatoes. Jeffrey Cassidy of AgroFresh has developed a protocol for treatment of 'Sunrise' apples at elevated temperatures (personal communication) and so application of this approach could be relatively straightforward for those interested in exploring this option. Our work has also shown that a second application 1-MCP one week after the first application will enhance the quality retention in 'Sunrise' apples when held at 20 °C (Toivonen and Lu, 2005).

Lau (2012) made recommendations for a very narrow harvest window for 'Sunrise' not treated with 1-MCP and stored at 0 °C before marketing (starch index between 2.3 and 2.9 and having a firmness of between 15.7-16.6 lb). Quality declines faster for fruit picked after the recommended harvest window and storage disorders become significant if the fruit are picked at starch index greater than 4.4. However, if 'Sunrise' apples are treated with 1-MCP at elevated temperatures and stored for three

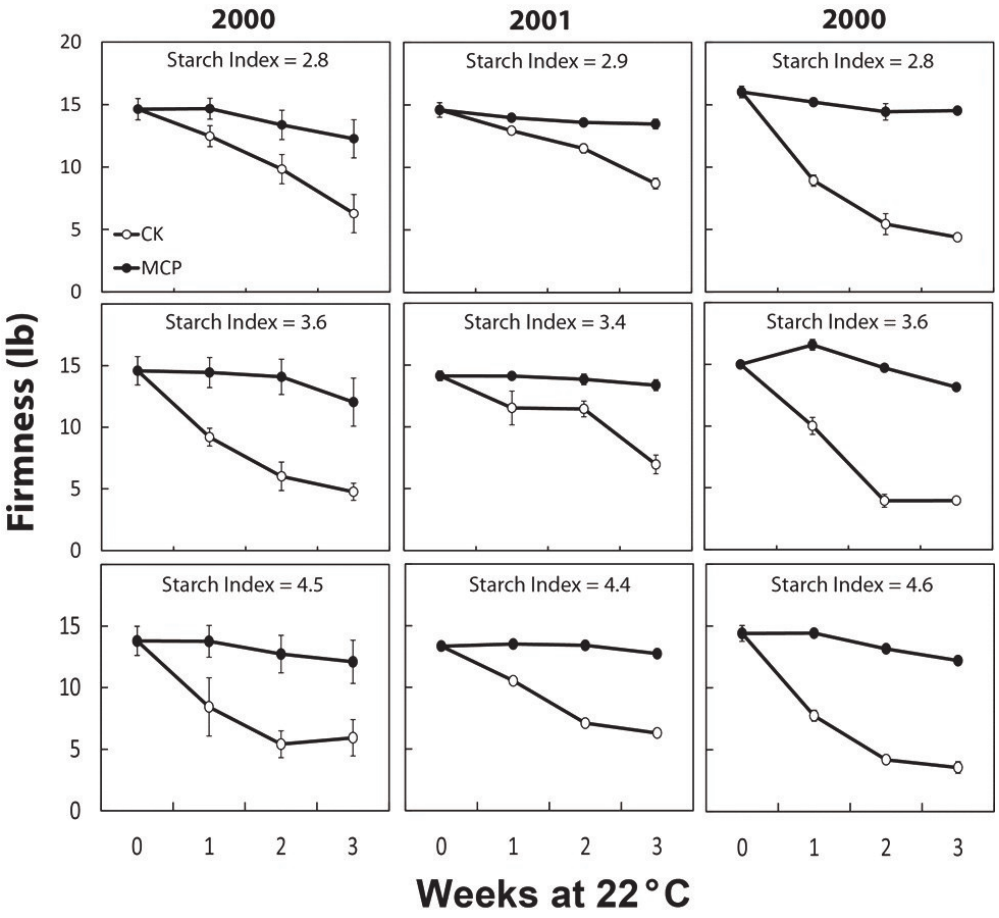


Figure 1. Changes in firmness for 'Sunrise' apples held at 22 °C in three seasons (2000 to 2002). The first harvest in each of the three years was at the commercially recommended harvest date. The latter two harvests occurred one and two weeks after the initial commercial harvest. Apples for the 1-MCP treatment were treated 14 hours with 0.25 ppm of 1-MCP at 22 ° C. Each data point represents four replicates of 10 apples each and the error bars represent standard errors of the means.

weeks at 22 °C, there is good firmness and acidity retention (Figure 1 and 2) despite a wide range of harvest maturities tested over three years. No storage or senescence related disorders were observed in that work. **Lau (2012) recommended that one month of holding is possible when apples are treated with 1-MCP and held at room temperature.**

The conclusion for 'Sunrise' is that it is a very good summer apple, but it needs to be treated like a greenhouse tomato and stored, shipped, displayed and held at between 15-20 °C. In order to achieve a reasonable storage/shelf life, at least one, but optimally two, 1-MCP treatment(s) are recommended to have a shelf life of about 1 month for this apple. The apple should be **harvested at a starch index of 2.3-2.9**, but if handled at elevated temperatures as recommended and treated with 1-MCP, there may be some forgiveness for later harvested 'Sunrise' apples. Firmness at harvest is extremely important with a suggested average firmness of 15 lb being the lowest acceptable target for commercial marketing.

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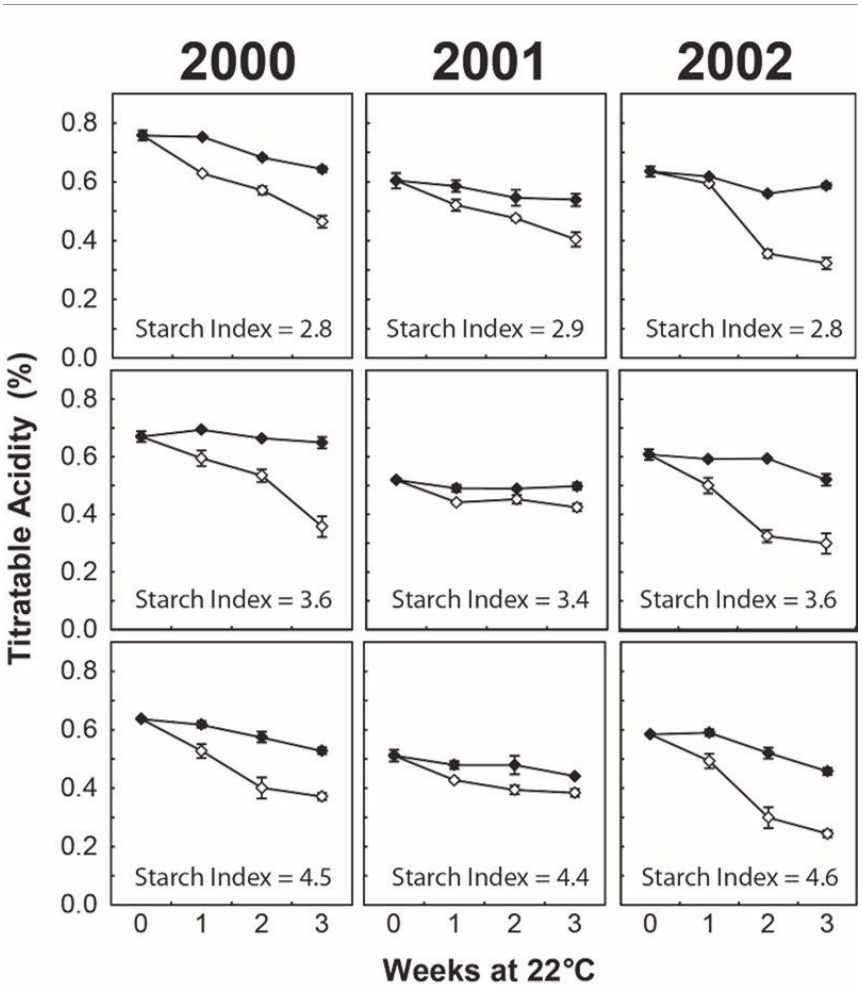

Figure 2. Changes in titratable acidity for 'Sunrise' apples held at 22°C in three seasons (2000 to 2002). The first harvest in each of the three years was at the commercially recommended harvest date. The latter two harvests occurred one and two weeks after the initial commercial harvest. Apples for the 1-MCP treatment were treated 14 hours with 0.25 ppm of 1-MCP at 22 °C. Each data point represents four replicates of 10 apples each and the error bars represent standard errors of the means.

Ontario CleanFARMS

OBSOLETE COLLECTION CAMPAIGN

Return your unwanted or obsolete pesticides and livestock medications

Farmers: safely dispose of your unwanted agricultural pesticides and livestock/equine medications from **September 20-30, 2016** at one of the following locations, *for no charge.*

Tuesday, September 20	
Brodhagen	Hoegy's Farm Supply
Guelph	Woodrill Farms
Glencoe	Parrish & Heimbecker

Wednesday, September 21	
Brussels	Brussels Agromart
Ailsa Craig	Hensall District Co-op
Aylmer	Max Underhill's Farm Supply

Thursday, September 22	
Beamsville	NM Bartlett
Forest	Lakeside Grain & Feed Ltd
Kitchener	GROWMARK Inc

Monday, September 26	
Bothwell	Hagerty Creek
Alliston	Alliance Agri-Turf
Tara	Sprucedale Agromart
New Hamburg	Good Crop Services
Lancaster	Munro's Agromart

Tuesday, September 27	
Tupperville	Agris Co-op
Wellandport	Clark AgriService
Bradford	Bradford Co-op
Walkerton	Huron Bay Co-op
Alfred	Synagri

Wednesday, September 28	
Paincourt	South West Ag Partners
Princeton	Cargill
Oakwood	Oakwood Ag Centre
Harriston	Cargill
Casselman	Agro Culture 2001

Thursday, September 29	
Blenheim	Thompsons
Bolton	Alliance Agri-Turf
Trenton	TCO Agromart
Dundalk	Huron Bay Co-op
Richmond	Synagri

September 27-29	
Verner	Verner Ag Centre
Gore Bay	Northland Agromart
Pembroke	M&R Feeds and Farm Supply
Arnprior	M&R Feeds and Farm Supply
Thornloe	Temiskaming Ag Centre
Thunder Bay	Thunder Bay Co-op

Friday, September 30	
Courtland	Cargill
Orangeville	Holmes Agro
Picton	County Farm Centre
Leamington	Agris Co-op
Chesterville	Synagri

Collection sites will only be accepting targeted products from 9 a.m. until 4 p.m. at each location on the date indicated.

Program supported by:

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For more information, please call CleanFARMS at 877-622-4460 or visit www.cleanfarms.ca

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