Orchard Network

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For Commercial Apple Producers

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FACTSHEET
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Written by: J. A. Cline - Assistant Professor/University of Guelph

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Introduction

This Factsheet provides technical information on the use and benefits of prohexadione-calcium, a new growth-retardant compound for apples, produced commercially as Apogee®. This product was registered in Canada by BASF in the spring of 2005 (PCP #28042). Consult the product label for recommended use patterns and precautions, as well as the latest version of OMAFRA Publication 360, Fruit Production Recommendations, which may have more current information. The product label can be found online at the BASF Canada Inc. website (www.agsolutions.ca) or by searching the PMRA website (www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp).

Research in both Canada and the U.S. and grower use in the U.S. since 2001 have confirmed that Apogee® can provide several benefits when applied to apple trees. Apogee® use reduces terminal shoot growth (ranging from 20%-60%), thus reducing the time required to dormant prune and/or summer prune and, in some instances, can negate the need to

summer prune (see Figure 1, right). As a result, fruit colour can be improved on red-coloured cultivars. Trees treated with Apogee® often have the same number of shoots as untreated trees, but shoots from treated trees can be thicker (greater in diameter) and have compressed internodes. In addition, Apogee® use can reduce the incidence and severity of fire blight on shoots (shoot blight). A high number of Michigan growers have reportedly integrated Apogee® into their program, in part, because of the high risk of secondary fire blight in their region on the cultivars grown (i.e., Royal Gala). Furthermore, growers have cited improved spray coverage and reduced disease pressure as benefits of Apogee®, primarily attributed to reduced growth and the reduction in canopy volume and density.

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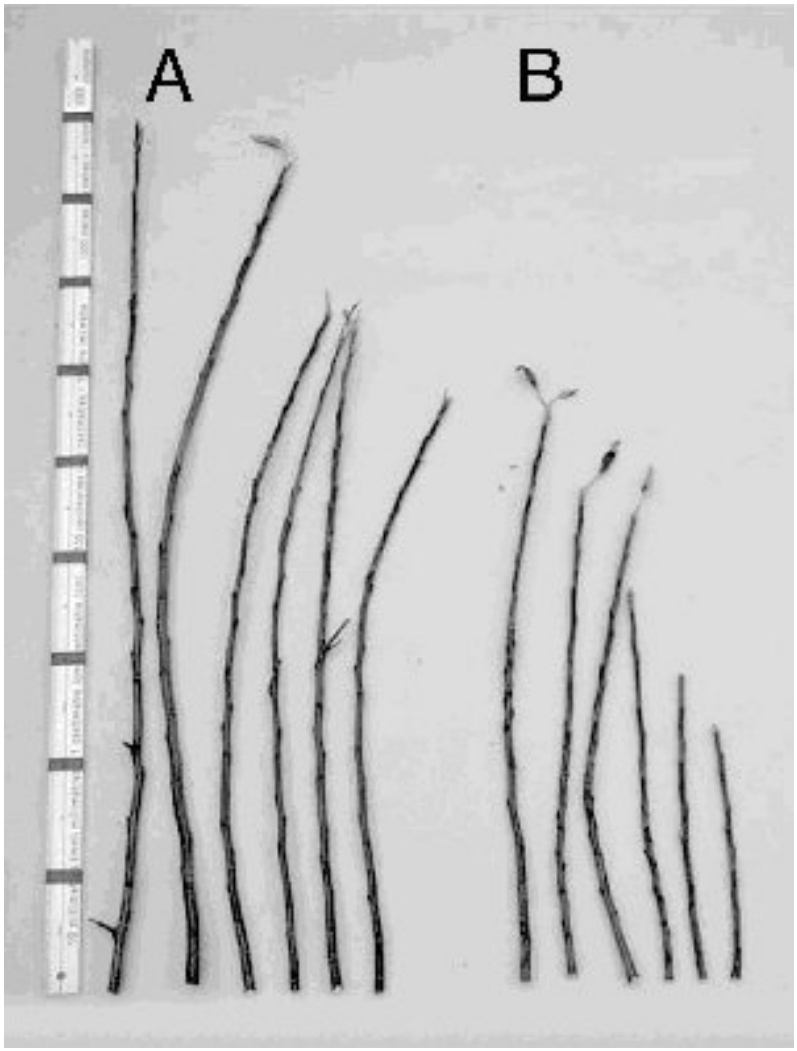
Figure 1. Six representative extension shoots taken from Royal Gala trees. Group A was untreated. Group B was treated with 3 sprays of Apogee® at 125 mg/L at 2-week intervals beginning at petal fall (right). (Metre stick marked at 10-cm intervals).



Recent evidence also indicates that trees sprayed with Apogee® develop phytoalexin-like properties. It appears that Apogee® induces changes in the spectrum and level of flavonoids within the plant, resulting in greater resistance to insects and disease.

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Chemistry and Mode of Action

Apogee® contains 27.5% (w/w) prohexadione-calcium, a compound that is part of a new class of gibberellin biosynthesis inhibitors called the cyclohexanetriones. Prohexidione-calcium is known to reduce terminal growth by inhibiting 2-oxoglutarate-dependent dioxygenases, which are involved in the formation of growth-specific gibberellins (e.g., the conversion of GA20 to GA1), a group of plant hormones that are primarily responsible for regulation of shoot elongation in apple trees. In addition, it is also known that prohexadione-calcium interferes with ethylene biosynthesis and flavonoid metabolism, which can influence other responses in the plant. No negative effect on the number of leaves per shoot has been observed, although preliminary reports from the northeastern U.S. suggest that the prohexadione-calcium can directly reduce fruit growth when used at higher concentrations (e.g., above 125 ppm). Once applied, Apogee® requires about 14 days to slow growth. It degrades in the tree within a few weeks, so at least one repeat application may be necessary to maintain growth control throughout the entire growing season.

Patterns of terminal growth and fruit set characteristics differ among growing regions. Likewise, the response to Apogee® appears to differ depending upon where it is used. Therefore, a regional interpretation of the label is likely necessary to obtain maximum response from this product.

Time of Application, Rates and Cost

Terminal shoot growth in Ontario proceeds rapidly, usually during the first six weeks of the season. Since 2 weeks are required for Apogee® to slow growth effectively, be sure to make the first application when terminal shoots are no longer than 2.5-5 cm. This typically coincides with late bloom or petal fall, when the bourse shoots are beginning to grow and when sufficient leaf area has developed for prohexadione-calcium to be translocated into the leaves - primarily spur leaves early in development. Satisfactory results from the use of Apogee® depend upon making the first application at this time, and no later. It reportedly is not toxic to bees, so the first application can be made before bees are removed from the orchard.

The factors that determine Apogee® application rate are primarily tree size, vigour (influenced by rootstock, cultivar, soil, crop load and site) and whether protection against shoot blight is an objective. The label recommends 45 g of product per 100 L of dilute spray (125 ppm) for medium- to high-vigour trees, and 75 ppm for low- to medium-vigour trees. Make repeat applications at 14-21-day intervals. Based on the 125 ppm rate and a tree row volume dilute rate of 1,000 L/ha, 900 g of product/ha (364 g/acre) will be required. The 2006 suggested grower price for Apogee® in Canada is $251/kg. Therefore, the cost of Apogee® for two applications at the "standard" rate for 1,000 L/ha (TRV dilute) trees will be $226/ha or $91/acre.

Follow the steps on the product label to adjust rates for tree-row volume dilute applications. Table 1, on page 3, shows various rates for sprays applied at 1,000 L/ha (dilute). Apogee® has been used effectively when applied in water volumes less than TRV, provided the canopy has been thoroughly wetted. However, concentrate spraying of plant growth regulators and chemical thinners is not generally recommended.

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Orchard Systems

Apogee® is an effective tool for regulating vegetative growth for a number of different orchard systems, planting densities and rootstocks. It has application for larger, widely spaced trees on semi-vigorous rootstocks. Since growth control can be more challenging on this type of orchard system, more frequent and higher concentrations may be required. In contrast, on younger super spindle orchards where annual net growth is desired until the trees have filled their allotted space, Apogee® may be targeted specifically to the lower part of the canopy and perhaps at lower rates to reduce the amount of upright vegetative growth.

Adjuvants and Hard Water

A spray adjuvant (Agral 90, LI-700) should be included to improve uptake of the prohexadione-calcium molecule by the leaf. In addition, where a high calcium or magnesium water source (hard water) is used, it is important to include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee®. AMS acts by lowering the pH of the spray solution and also aids in the translocation of the active ingredient across the leaf cuticle and cuticular membrane. Use a high-quality, greenhouse grade of AMS to avoid plugging nozzles. This is readily available from suppliers such as Vineland Growers and Plant Products for around $20 per 25-kg bag, representing inexpensive "insurance" to ensure product efficacy. If you are on a municipal water system, determine the hardness level of your water from your supplier. If you have a private water supply, have your water tested for hardness (for a fee). Consult www.ene.gov.on.ca/envision/water/sdwa/licensedlabs.htm for a list of accredited labs. The last column in the table lists which labs are accredited for inorganic analysis.

Table 1. Suggested Apogee® rates and timings based on a tree-row volume dilute of of 1,000 L/ha
(Use this chart in conjunction with the product label.)

Level	Tree vigour[1]	1st Spray (May 25[2]) Petal fall	2nd Spray (June 8[2]) Fruit set	3rd Spray (June 22[2]) June drop	4th Spray (July 6[2])	Season total (g/ha)[3]	Product cost per season (2006)	
		grams Apogee®/ha based on 1,000 L/ha TRV Dilute[5]					/ha[4]	/ac[4]
1	Low: 1 spray	450	-	-	-	450	$ 113	$ 46
2	Low: 2 sprays	270	270	-	-	540	$ 136	$ 55
3	Medium: 2 sprays[6]	450	450	-	-	900	$ 226	$ 91
4	Medium/High: 3 sprays	450	450	270	-	1,170	$ 294	$ 119
5	High: 3 sprays	450	450	450	-	1,350	$ 339	$ 137
6	High: 4 sprays	450	450	450	270	1,620	$ 407	$ 165

Orchard and Environmental Factors to Adjust Apogee® Rates and Number of Sprays

Heavy dormant pruning	Increase rate by 10%–20% per hectare per spray.
Longer growing season	Add 3rd or 4th spray.
Low crop load	Move Apogee® Program to next higher level (i.e., tree size).
Questionable coverage	Move Apogee® Program to next higher level (i.e., tree size).
Fire blight supression	Move Apogee® Program to next higher level (i.e., tree size) or apply (65 g/100 L) initial rate.
Cultivars	
Very sensitive to Apogee®	Consider reducing or dropping 3rd and 4th sprays.
Sensitive to Apogee®	Use rates above.
Less sensitive to Apogee®	Consider increasing rate by 10% per hectare per spray.
Special	For spur types, use rates for low-vigour trees and reduce rates by 20% rate.

[1] Vigour is defined as the total amount of shoot growth in a single season. Not to be confused with tree-row volume.
[2] Typical date. The first application will depend on growth development in your area and by cultivar. Apple trees in

Niagara and
southwestern Ontario are often 7-10 days ahead in development compared with trees in Georgian Bay and eastern Ontario.
[3] Maximum seasonal rate should not exceed a total of 5.4 kg of Apogee®.
[4] Prices may vary by supplier. Calculation based on manufacturer suggest retail price of $251/kg and tree row volume of 1,000 L/ha.
[5] Tree row volume (for more details, see www.omafra.gov.on.ca/english/crops/ and click on "Apples." Under "Apples: Pest management,"
click on Guide for Spraying Fruit Trees.). Increase rates when higher water volumes are required for adequate spray coverage.
[6] Suggested base rate. Move to next higher or lower level, based on orchard and environmental factors listed above.

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Tank Mixing

The Apogee® label recommends that calcium sprays should not be tank-mixed with Apogee®. This warning is especially appropriate for calcium chloride and other calcium-containing products. In the presence of calcium, Apogee® will precipitate in the tank, clog nozzles and screens, and reduce tree response.

Increased Fruit Set

In some instances, Apogee® may increase fruit set and make thinning more difficult. This response is not consistent but is more likely at concentrations above 125 ppm (45 g/100 L). Apogee®-treated trees may require more aggressive chemical or hand thinning to reduce the crop load to the desired level.

Other Precautions

There are published reports in the U.S. that Apogee® can cause severe cracking on Empire and Stayman cultivars. The cause is unclear, and cracking has not been observed in research blocks at the University of Guelph, Simcoe, after treatment of Empire trees for several years. Producers who wish to use Apogee® on Empire should be aware of this precaution, and perhaps use it on a limited acreage of their Empire trees for a few years to determine the real risk of cracking in our region. The label also cautions growers that Apogee® may result in a decrease in yield and marketable yield of Cortland. Despite this, clear benefits of using Apogee® on tip-bearing cultivars such as Cortland and Northern Spy have been observed in other regions of Canada, where the shortened internodes of Apogee®-treated trees have produced a more compact tree habit.

Suggested Strategy for Using Apogee®

- Consider using Apogee® on your most fire blight-sensitive, high-value and vigorous-growing cultivars first.
- **C**ompare your present summer and dormant pruning costs with the cost of using Apogee® (widely available at major Ag-chemical suppliers). Count on about 40% reduction in vegetative growth. Don't forget to include the other benefits of Apogee® when making this comparison.
- Consider using Apogee® on terminal-bearing cultivars such as Cortland, Golden Russet and Northern Spy. It has been shown in Nova Scotia to dramatically improve the tree habit of Cortland.
- Apply the first application early - no later than petal fall. Don't forget to add a surfactant and AMS if you have or suspect hard water. A second spray 14-21 days later is almost always required.

- If unsure about what rates to use, start with the standard rate of 45 g Apogee® per 100 L spray solution and apply tree-row volume dilute.
- Direct spray and adjust nozzles to apply more spray to the tops of trees.
- On young trees, consider applying to the top of the canopy only. This may provide added fire blight protection for sensitive cultivars (i.e., Royal Gala), while maximizing growth potential.
- Be sure to leave several unsprayed trees for comparison purposes (and flag them).
- Consider measuring the length of approximately 100 randomly selected extension shoots per cultivar (from treated and untreated trees) on a 7- or 10-day basis until terminal bud set. This will reveal when trees start and stop growing.

Related Links

OMAFRA Publication 360, Furit Production Recommendations
List of Accredited Licenced Laboratories
Guide for Spraying Fruit Trees

This Factsheet was written by Dr. John A. Cline, Assistant Professor, Ontario Agriculture College, University of Guelph, Department of Plant Agriculture, Simcoe Campus. This Factsheet was reviewed by John Gardner, Apple Specialist, Crop Technology, OMAFRA, London.

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10 Common Misconceptions about Thinning Apples Chemically

Author: John Gardner - Apple Specialist/ OMAFRA; Dr. John Cline - Tree Fruit Physiologist/ University of Guelph

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

We've learned a lot about thinning of apples in the last few years here in Ontario. This has been due to a number of factors, including the introduction of newer materials and cultivars, along with the weather variation from year to year.

The following is an unranked listing of what we consider to be some of the biggest misconceptions about thinning the apple crop in Ontario.

1. **Thinning will have a significant impact on the total crop volume a grower can expect from an orchard block.**

   Under conditions that require thinning, a well thinned block will have fewer but larger fruit. While the total volume of fruit will be lower in comparison to leaving the tree unthinned, the crop value (volume x price) should ideally more than compensate for this loss in volume. The real difficulty is forecasting the price differences between various size classes of fruit (i.e., 125's verse 100's). Three other extremely important factors intrinsic to thinning, but difficult to place a financial value on, are the enhanced return bloom the following year, improved efficiency in harvest, and greater ease of marketing larger sized fruit.

2. **Thinners applied during the daylight hours work better than at other times during the day.**

   Recent research results would have us conclude that the same amount of thinner is absorbed under conditions which are warm and fast drying or cool and slow drying

3. **Thinners must be applied at a specific king fruitlet diameter.**

   There are recommended diameters for best results however, sometimes we just don't get the perfect set of weather conditions for application (rain, wind etc.) and many of the easy to moderately difficult to thin cultivars will respond to thinners up to approximately 14 mm king diameter.

4. **Low water volumes that distribute the thinner through the tree canopy work really well if properly timed.**

   An adequate water volume will always do a better thinning job and reduce the need for follow up hand thinning or repeated applications of thinners. If you want to test this one, just speed up when applying thinners in a

section of row.

5. **If a given rate of thinner works well on one farm then that's the rate that works on all farms in Ontario.**

   Unfortunately it's not that simple. We have found that trees and blocks that have a higher vigour as a result of irrigation, rootstock, soil type, etc will normally require stronger treatments to achieve satisfactory crop load reduction.

6. **I've got a pretty good crop of a hot paying newer cultivar on trees in their 3rd year after planting.**

   "I'm going to hit them with a good rate of NAA and Sevin to make sure I get the size I want". Young trees with an unsettled cropping history are definitely more sensitive to thinners than an older more mature tree of the same cultivar. A better approach may be to use a moderate rate of Sevin XLR and then finish the job by hand thinning if necessary.

7. **Thinning treatments should be cut back drastically with frost damage evident in the orchard.**

   We have found that unless frost damage is considered to be very severe during bloom/fruit set period, thinning treatments should go on as usual. Under frost conditions that produce a severe crop response, growers may have to be selective in where they thin. Tops of trees where lower canopy fruitlets are absent, tree tops can still benefit from a thinning treatment.

8. **It's easy to tell the thinning response of any treatment without a set of control trees.**

   It is very difficult to ascertain how much thinning was achieved without having untreated 'control' trees to compare. Therefore, it is instructive to leave a few representative trees unsprayed at the end or middle of a row (and mark them with flagging tape). This is especially important if you're trying a new treatment regime. I can remember looking at trees at one of the IDFTA tours one year thinking how well they had been thinned only to find out that these trees were the controls and the treated trees had little if any fruit on them.

9. **Thinning treatments always produce a very uniform fruit size.**

   It would be wonderful if this was true. The reality is that thinning treatments usually produce a normal distribution of fruit size through the canopy the same way an untreated tree does. The differences are in the averages. The curve moves in such a way that the largest fruit from the thinned tree are on average larger than the unthinned and the smallest fruit are on average larger than the smallest fruit on the unthinned tree. The exception to this is applying treatments which can cause pygmy fruit formation (for example, late sprays of NAA on Red Delicious).

10. **Doing no thinning is a good option.**

    If this was true, apple growing would be easy enough that everyone would be in it, even more so than at the present. Under Ontario growing conditions and in most years, thinning treatments are required on at least some of the orchard if not the bulk of the acreage.

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Light Management Options for High Density Apple Plantings

Author: John Gardner - Apple Specialist/OMAFRA

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

In discussing limiting factors to apple production in the Northern Hemisphere, available sunlight usually comes into the discussion at some point after the talk on cultivars, water and nutrients slows down. Sunlight of course is the fuel that drives the fruit production process in an orchard. Not only in terms of volume of production but in terms of production quality. In Ontario, the average grower does several things in designing an orchard and while growing the crop during the course of the year to influence the ability of the orchard to take advantage of available light.

Row orientation in a north south direction is very helpful in eliminating the shading problems that occur when one tree in a row shades the next and so on. Rows planted in an east west configuration usually exhibit this condition unless trees are well spaced and have a very open canopy. In high density plantings on very windy sites the grower may decide that a wall of trees planted in a north south orientation is fighting too much wind and thus an air flow friendly configuration may be the only way to go.

Tree shape, canopy thickness, tree height and distance between rows play a big role in determining how light is distributed from the top of the orchard canopy to the bottom.

It is interesting to note that in some areas of the U.S. where apples are cultivated, certain cultivars get a sunburn condition from excessive exposure to very high levels of light and very high incoming levels of radiation including the sometimes damaging UV wavelengths. In California, some cultivars are pruned to keep fruit out of the light with the canopy more or less above the fruit. Particle films technology and the use of waxes that prevent burn from occurring have seen an increased usage pattern in the last decade.

The unfortunate but real circumstance surrounding light utilization in the orchard is that light is really only free to the top of the tree and can only be used once in the canopy before the critical energy (PAR) is taken from the light itself. Once light hits a leaf its energy is used up more or less. The term PAR is often used to describe the Photosynthetically Active Radiation held in a ray of sunshine.

A tree that is pruned to a conical shape with a narrow top and widening lower canopy has more chance of gathering light in a useful and functional way than a tree that is broad at the top or too top heavy with growth (see attached figure).

Figure 1. Harold Schooley demonstrates ripping technique on Gala at a recent pruning demonstration organized by the Southern Georgian Bay Apple Growers Association.

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Granted, the umbrella or rounded tree will produce some good looking fruit in the upper part of the canopy. However, fruit buds and fruit in the lower canopy of rounded trees usually suffer from size and colour problems as the highest quality fruit keeps moving to the top and outer edges of the canopy as the tree matures.

Both axe type trees and spindle types can be trained to this broadly columnar or cone shaped design depending on cultivar and type of support system.

The question of how tall should the trees be in relationship to the distance between the rows comes into play with almost every discussion on pruning and with every pruning demonstration. I usually say that a tree's height should be no more than about 2/3 the distance between the tree rows. In other words if the tree rows are 14 feet apart or 4.2 meters then the trees should be no more than about 2.8 meters tall or about 9.2 feet tall.

Some growers have made the mistake of planting trees on stakes that are too short limiting the height of a well spaced planting. The top 30-60 cm (1-2 feet) of growth that should be there limits the potential profitability. The top of the tree may be where the profit is in the orchard. In this case, it may be wise to extend the stakes to get a taller tree and to make sure that the next plantings are sufficiently tall in relation to row width without compromising efficient light utilization in the orchard.

The vertical axe plantings of the last few years when done textbook perfect do have the ability to gather light over the length of the entire tree by eliminating a large portion of structural wood along the central axis.

Apples in general are endowed with a unique ability to reach for sunlight by shoot extension and by shoot proliferation. The extent of which varies dramatically from cultivar to cultivar. The main driving force in the tree is the group of plant hormones known as gibberellins. In studying the origin of apples, and coming to the realization that apples are essentially a forest species, it makes sense that a young apple seedling should have the ability to stretch up through a

dense canopy in search of light. Apogee® a recently registered growth regulator has the potential in some plantings to reduce the need for pruning by acting as an anti–gibberellin in reducing shoot extension when applied early in the growing season when shoot extension is 1-3 inches in length.

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Light interception by an orchard and light distribution within a tree canopy are determining factors in the performance of a planting. Interception is largely defined as the amount of light that does not strike the orchard floor. In general, when light interception in an orchard in late June reaches 70%, shading within the canopy starts to dominate with losses in fruit quality and subsequently fruit volumes and net returns.

Incoming sunlight has a distinct signature in terms of its quality and direction. This varies dramatically from month to month and also varies during day light hours. At this latitude, we know two things about the fruit we grow. The first is that the best coloured fruit is usually found on the top and west side of the canopy. The second factor is that up to 50% of the apples we grow can sometimes be found growing in poorly lit parts of the tree canopy. With colour development related to both direct light and cool temperatures in the late summer and fall, it's easy to understand why colour is sometimes lacking.

In exceptionally well managed plantings with adequate soil moisture, nutrients and crop load management programs in place, it is not uncommon to find up to 1/3 of the crop in a cullage position due to colour, size and perhaps sugar factors. These plantings are not mismanaged. Commonly a grower has done all the right things.

One large and outstanding factor in apple growing that growers in the business come to understand clearly is that although apples look about the same coming off the same tree there can be large differences in the size, shape, and sugar attributes. All these attributes have at least one large governing factor and that is light and light distribution within the canopy.

Recent technologies have brought materials and methods to the marketplace, which allow a grower to virtually eliminate shading problems in well managed high density blocks of apple. In effect, these technologies have the potential to make every apple on the tree look more or less like it comes from the top of the tree. These materials can be broadly classified as reflective ground covers. They take light that is hitting the orchard floor and send it back into the tree canopy. In the past, I have called this light a recycled product. The reflective materials now available include metalized plastics and reusable light reflective blankets, which cover most of the orchard floor between tree rows.

The plastics are usually laid 3-4 weeks ahead of harvest or after mid August when the angle of the sun drops significantly at this latitude. We do have some commercial experience with these materials in Ontario and we know they work. These metalized plastics are generally not reusable. They are laid over the herbicide strip and lifted before winter sets in. The reflective blankets are something we will have to look at as they are put down early in the growing season and are considered to be reusable from year to year.

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Monitor and Maintain Your Drip Irrigation Equipment!

Author: Rebecca Shortt - Irrigation Engineer/OMAFRA
Creation Date: 25 May 2005
Last Reviewed: 25 May 2005

Make it a priority to maintain your drip irrigation equipment at the beginning and end of the irrigation season. All components of your system need maintenance and some may require repair or replacing.

The BC Trickle Irrigation Manual says…..

Have you flushed the lateral lines recently?

Flush lateral lines at the beginning and end of the irrigation season. Begin by flushing one lateral to observe the amount of debris that has accumulated. If the water runs dirty for 5 seconds or more, all the laterals should be flushed.

Flushing also removes air that may accumulate and become trapped. Flushing velocities generally need to be 0.5 to 0.6 m/s to effectively remove air from laterals.

Emitter plugging can be monitored by measuring the flow rate for each zone. If the flow rate begins to decrease over the season, the emitters may be starting to plug. Inspect emitters and make a note if the clogging is caused by a build up of organic material or chemical precipitate. Begin at the end of the lines as these emitters are generally the first to experience plugging. Also check that the filtration system is operating correctly as this may be the reason for the reduced flow rate.

Organic material control – Chlorination

Bacteria and bacterial slimes can be killed by chlorination and then removed by flushing.

Warning: It is your responsibility to ensure chlorine does not enter water source (i.e. creek, ditch, pond, well, etc.). Ensure you have a backflow prevention device on main line between the water source and the point where the chlorine is injected. Ensure you have a check valve on the feed line from the chemical tank to the irrigation system. Ensure chlorinated water will not flow out drip lines in large enough volumes to enter a creek, ditch, pond or other water body.

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Recommendations for intermittent chlorine treatment program:

- Chlorinate system at beginning and end of irrigation season. For water sources high in algae consider chlorinating once a month during the irrigation season
- Use chlorination levels of 10-20 mg/L (should not exceed 40 mg/L)
- Chlorine levels at the end of the lines should be at least 1 mg/L
- Once entire system is filled with chlorinated water let stand for 1-4 hr (longer holding time will be more effective)
- Flush lateral lines after chlorination (to remove dead organic material)

Testing for chlorine levels:

- measure **free** chlorine (total chlorine is not a useful measurement)
- swimming pool kits (measuring free chlorine) can be used
- one indicator called “DPD” turns from clear to darker shades of red with an increasing amount of free chlorine (for concentrations >3.0 mg/L, dilute sample to get a reading)

Selecting a source of chlorine:

Sodium Hypochlorite

- agent usually found in household bleach
- up to 18% available free chlorine
- easy to work with and recommended for use with drip systems
- readily decomposed by light and heat; therefore must be stored in a cool, dark location

Calcium Hypochlorite

- available in granular tablets or pellets
- between 60-70% available free chlorine
- readily soluble in water
- not recommended for water sources with high calcium concentrations
- not recommended for water sources with pH > 8.0

Chlorine Gas

- very corrosive and poisonous
- recommended only for people who are qualified to work with Chlorine Gas

This information and more can be found in the BC Trickle Irrigation Manual (available from R. Shortt, Simcoe, OMAFRA)

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Critical Time for Weed Control in Orchards

Author: Leslie Huffman - Weed Management Specialist (Horticultural Crops)/OMAFRA

Creation Date: 25 May 2005

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Weeds will rob the most growth and fruit size from your trees during the months of May and June. So the smart orchard manager will find time early in the season to minimize weed competition now - in spite of all the other important jobs in the orchard at the same time.

Newly planted trees need to grow quickly and fill their allotted space, so that fruit buds can begin development in mid-summer. Research by Dr. Ian Merwin at Cornell University, New York has shown the effect of early weed control in new orchards. Gala/M26 trees produced their first crop 2 years after planting, and yields were much larger when weeds were controlled early (May) ***in the planting year***, and as well, when weeds were controlled longer (May to July) ***in the planting year***. The competition from weeds occurred even under a full trickle irrigation schedule. Note that these effects were measured 2 years after the weed competition occurred!

Weed competition early in the season will also have an effect on fruit size. In Dr. Merwin's research with Gala, weed control during May and June, as well as during the preharvest month of August gave better fruit size in the first crop year – again, 2 years after the weed competition occurred.

For **bearing apples**, the **Critical Period for weed competition runs from bloom through to 30 days after petal fall**. Remember also that apple trees form next year's fruit buds when terminal buds set - another important time to remove weed competition.

So squeeze a little time now to get your herbicide or mulch on, and use your hoes early to get the most effect from your weed management dollars.

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Extreme Cold Temperatures Over the Past Winter Likely to Cause Winter Injury to Apple Trees

Author: John Cline - Department of Plant Agriculture,/University of Guelph; Rick Gray and Ian Nichols - Ontario Weather Network/University of Guelph

Creation Date: 25 May 2005
Last Reviewed: 25 May 2005

Growers of perennial fruits in Ontario are particularly interested in extreme weather events and how these affect plant survival, plant growth and development. Other that choosing a good site, there is relatively little that can be done feasibly to avoid injury once a orchard or vineyard is established and the cold temperatures strike. While apple, pear, and plum trees are known to be significantly more winter hardy than peaches, cherries, apricots, and some grape species, there are many factors which affect a plant's susceptibility to winter injury. These include but are not limited to cultivar, rootstock, hardening in the fall, snow cover, cultural practices, plant nutritional and carbohydrate status. The purpose of this article is to report on an investigation of extreme weather events over the past winter in Ontario and caution apple growers that some injury can be expected.

Extreme weather is one of the uncontrollable risked associated with fruit production, demonstrated by the past three winters. After the winter of 2001-2002, we reported in the *Orchard Network* (2002, Vol 6, Issue 1, p 12-13) how the unusually mild winter might impact tree fruit production the subsequent growing season. During the spring of 2002, frost injury on the Victoria Day weekend caused significant injury to orchards in the Norfolk area (See *Orchard Network* 2002, Vol 6, Issue 2, p 5-6). And lastly, over the winter of 2002/2003, temperatures on January 27th dropped to -25.4°C in Simcoe, and to the surprise of many, winter injury was observed on Northern Spy, McIntosh, and Crispin (and other cultivar) trees, despite the expectation that apple trees are consider hardy to -30°C.

Based on our experience two years ago, and the fact that widespread damage to tender fruit orchards and vineyards in Niagara are being reported in 2005, some injury to apple trees is anticipated. Fortunately, recent observations at bud swell in our University of Guelph, Simcoe research orchards indicate minimal damage to flower buds. Injury may manifest itself in the spring by cracking of bark on scaffold limbs and shoot dieback on previous seasons' growth.

In conjunction with the Ontario Weather Network, isotherm (temperature) maps of minimum temperatures on Dec 20th, Jan 21st, and Jan 28th, the coldest days this past winter in Southern Ontario, were produced to indicate the extent and degree in which low temperatures may influence the presence of winter injury.

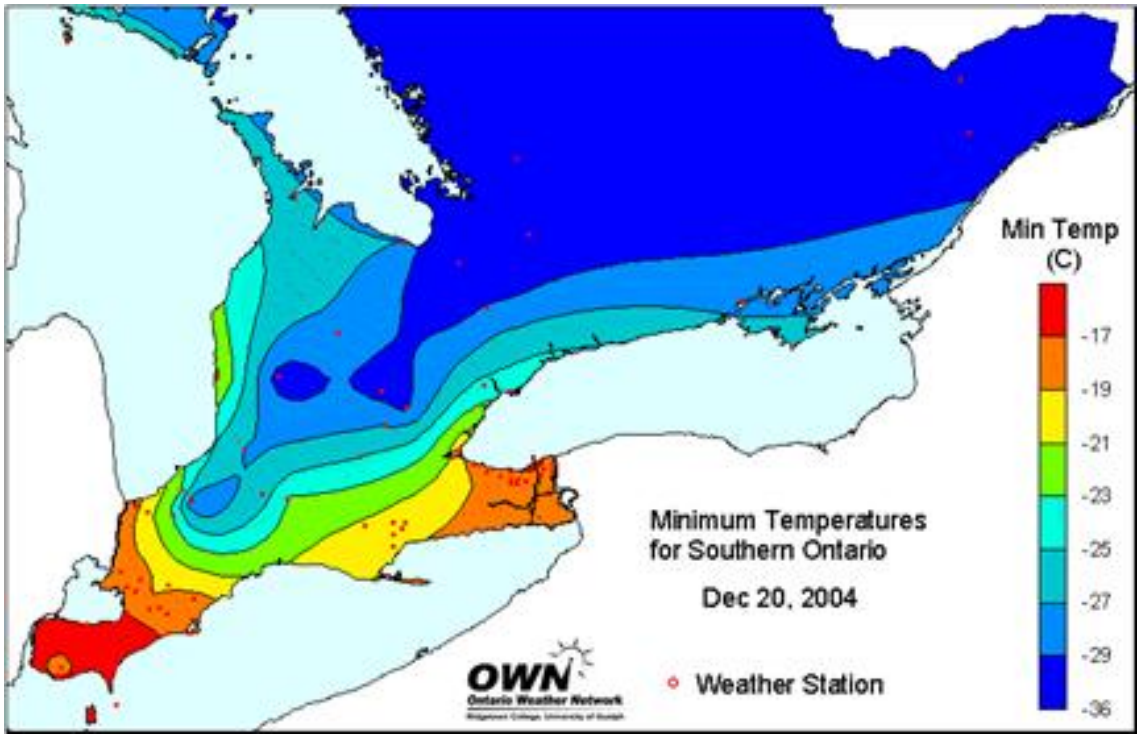

Figure 1. Minimum air temperature isotherms on December 20, 2004, based on weather stations operated by the Ontario Weather Network.

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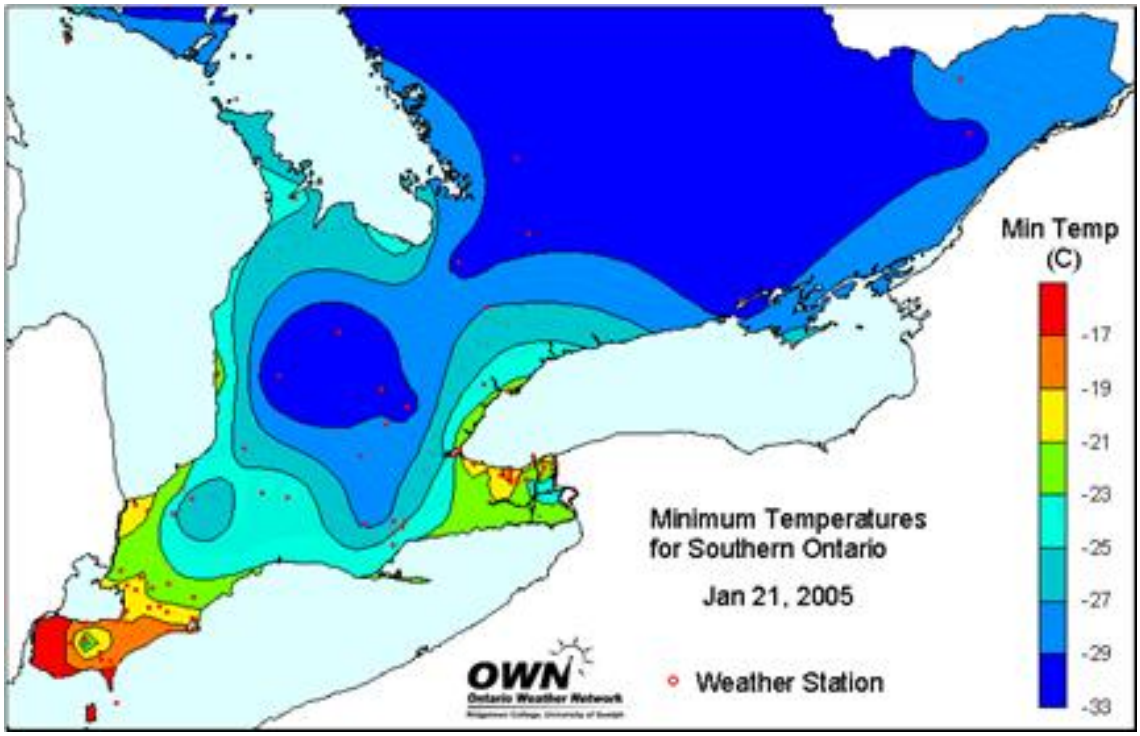

Figure 2. Minimum air temperature isotherms on January 21, 2005

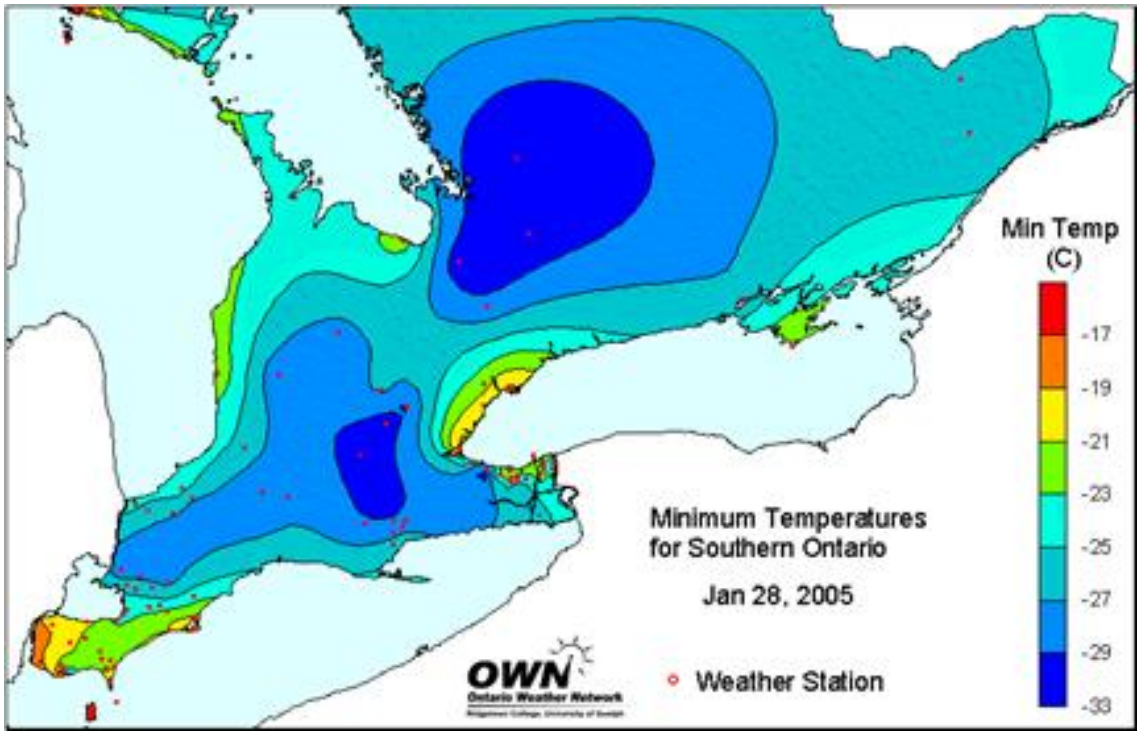

Figure 3. Minimum air temperature isotherms on January 28, 2005

Unfortunately, the mapping of temperature microclimates is not possible given the low scale of the map and large number of weather stations in a given area to show temperature differences.

The first extreme cold event occurred on December 20th, 2004 (Figure 1). Apple trees at this time should have been adequately hardened off to withstand the low temperatures experienced within the major apple producing regions. A second cold event on January 21 (Figure 2), where temperatures fell below -29ºC in central Ontario primarily away from the Great Lakes. Orchards situated in the Trenton and Belleville areas may have experienced some damage. A third, and likely the most damaging extreme cold event, occurred on January 28th (Figure 3). Temperatures in Simcoe, for example, dropped to -27 ºC. Winds during this time were from the north-east, and only slight (indicate an inversion may have been likely). Air temperatures between -25 ºC and -27 ºC were reported between west Niagara as far west as the border with Michigan. Temperatures in many parts of the Niagara Peninsula were below -24 ºC, sufficiently cold to cause widespread damage to peaches and *vinifera* grapes. It appears that southern Georgian Bay, south-western Ontario, and eastern Ontario apple growing regions experienced less severe temperatures during this event.

Of equal concern perhaps is the fluctuation in temperature experienced on January 13th. For example, at 1 pm in Hamilton on Jan 13th a low-pressure system with 45 km/hr winds from the southwest resulted in air temperatures reaching 16.6ºC. Temperatures between 6 and 7 pm fell 8ºC and continued to decrease at a rate of 1ºC/hr to -11ºC the following day. If interested, you can follow the Environment Canada Website link below to determine actual temperature drops at your nearest Environment Canada station.

Previous winter hardiness studies indicate that loss in hardening can be very rapid when buds are exposed to warm temperatures. In a previous study with 'Haralson' apple trees, as much as 15 ºC of hardiness was lost in the bark during a 1 day exposure to 20 ºC (Howell and Weiser, 1970). Therefore, this large swing in temperatures experienced on Jan 13-14th (by as much as 29ºC; Figure 4) may have resulted in some winter injury. The extent of this was greatest around the south central regions of Ontario.

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Concluding Remarks

Every winter brings a unique set of climatic events and multiple factors influence the winter hardiness of your trees. The difference in temperature between observing no winter injury and having severe injury can be as little as 4ºC (i.e. -26ºC vs -30ºC). If injury is expected, look for bark and/or shoot injury in the low areas of your orchard first and on weaker trees. Consult Table 1 for a list of cultivars that are more prone to injury. If snow cover was adequate, it is unlikely that the rootstock will be affected. Look for signs of weak growth and development on limbs as the spring advances. Sacrifice a suspect tree by cutting it down, make a cross-section of wood from the main trunk and look for darkening of the xylem (called 'black heart'). Unfortunately, there is little that can be done to recover from winter injury. Reports from New York indicate that sprays of zinc and other micronutrients sprays may help, but this has not been tested in Ontario.

Table 1 – Classification of the winter-hardiness of apple cultivars based on reported differential cold-hardiness after test winters and artificial-freezing tests (from Forsline, 1983, Chilton et al., 1994; Quamme et al., 1999; Friedrich and Fisch, 2000)

Tender	Moderately Tender	Hardy	Very Hardy
Crispin (Mutsu)	Braeburn	Cortland	Antonovka
Golden Delicious	Elstar	Empire	Columbia
Jonagold	Gala	Fuji	Dolgo
Sinta	Granny Smith	HoneyCrisp	Haralson
	Northern Spy	Jersey Mac	Kerr
	Sunrise	McIntosh	Wealthy
	Cameo	Spartan	Elstar
	Dayton	Autumn Gold	
		Chinook	
		Delicious	
		Earligold	

For further information or questions, feel free to contact Dr. John Cline, Pomologist, University of Guelph, (Tel: 519-426-7127 Ext 331; Email: jcline@uoguelph.ca).

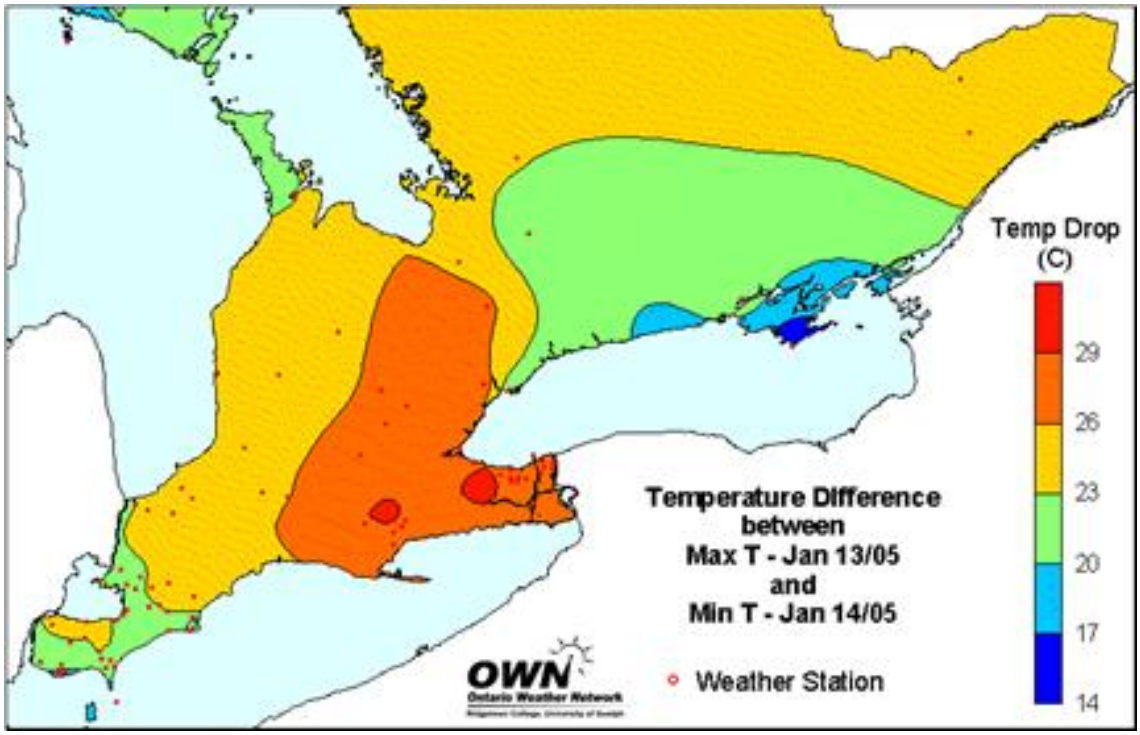

Figure 4. Change in air temperature on January 13 and 14, 2005

Useful Websites

Weather and forecasts with specific agricultural pest and disease models can be found on the Weather INnovations website.

Daily Forecasts and Historical Climate Data can be found on the Environment Canada wedsite.

Related Links

- Weather INnovations Inc
- Environment Canada Climate Data

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Biological Control of Fire Blight in the Orchard with Bacteriophages

Author: E. Barszcz, K. Schneider, W. S. Kim and A.M. Svircev - SCPFRC/AAFC; J. Boulé and P. Sholberg - PARC/AAFC; S. M. Lehman and A. J. Castle/Brock University

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

Agriculture and Agri-Food Canada (AAFC) provided funding for three years, to study the control of fire blight pathogen in the orchard and the development of bacteriophages as biological control agents. The research was administered under the Improving Farming Systems and Practices Initiative Related to Pesticide for Reduced Risk Environmental Strategy (IFSP).

In Canada, the severity of fire blight outbreaks varies from year to year in pear and apple orchards. The presence of disease depends on spread and multiplication of *Erwinia amylovora*, a bacterial plant pathogen, in host tissue. The disease cycle involves the environment (spring temperatures of 18-25 °C and moisture), the presence of the bacteria in the orchard (orchard history) and the susceptibility of the host (cultivars and rootstocks). Primary infections take place when the bacteria *E. amylovora*, colonizes newly opened blossoms. These bacteria multiply on the flower pistil reaching high numbers during warm wet weather. The presence of moisture allows the bacteria to move from the pistil to the floral cup where it invades the plant tissues through natural openings. The key strategy for controlling fire blight is prevention of initial spring blossom infection. Our research involves use of bacteriophages, bacterial viruses from the orchard, to attack and kill the fire blight bacteria on the floral cup. We have collected, isolated and purified a large number of these unique bacterial viruses and are in the process of identifying the most effective bacteriophages. Forced pear blossoms are used in a model system to study the efficacy of the bacteriophages. Thanks to a supply of pear and apple shoots from local growers during the winter months, we are able to screen and identify promising bacteriophages. Under laboratory and field conditions we are studying how the bacteriophages should be applied in order to best prevent blossom infections. The efficacy of the bacteriophages needs to be comparable to streptomycin, an antibiotic used to control fire blight, providing a significant challenge for the research team.

The research team is studying the environ-mental impact of the bacteriophages. In order to learn how biocontrol agents interact with other microbes in the orchard, Dr. Won-Sik Kim (NSERC Visiting Fellowship) has developed a very sensitive protocol that can detect the bacteria and phages simultaneously.

For more information, please contact Antonet Svircev at Agriculture Canada, Vineland. Click on DirectInfo - Employee Directory and do an employee search for Svircev.

Related Link

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New Products Available for Apple Growers in 2005

Author: Kathryn Carter - Pome Fruit IPM Specialist/OMAFRA

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

The 2005 season has started and most apple growers are curious about what new products are available to them this year for use in their IPM program. A list of the new products that are registered for apple are available in the 2005 supplement for Publication 360 Fruit Production Recommendations, which can be downloaded off the OMAFRA website or hard copies can be obtained at your local OMAFRA office. For those of you who just can not wait, here is a brief update of the new products that are registered for use in apple orchards in 2005.

Intrepid 240F (methoxyfenozide) is an insect growth regulator that will provide control of tentiform leafminer, oriental fruit moth, codling moth, and obliquebanded leafroller (OBLR). It is a 2nd generation Confirm and is considered to have longer residual. This product is effective against larvae and has strong ovicidal activity. Cross resistance to organophosphates, Confirm (tebufenozide) and Intrepid, has been documented in some OBLR populations. In orchards where pesticide resistance is suspected, the use of insecticides to control OBLR should be restricted to *Bacillus thuringiensis* (B.t,) (Dipel, Foray or Bioprotect), or the naturalyte insecticide Success.

Acramite (bifenazate) is a new reduced risk miticide, from a new chemical family, and acts by disrupting the nervous system of the mite. It provides long residual control for up to 28 days. It is effective against two-spotted spider mite (TSSM) (eggs and all life stages) and European red mite (ERM) (target motiles not eggs), but has no effect on rust mites. The low rate for mites can be effective in managing TSSM and ERM when used early in the season, however, the high rate is necessary for managing high mite populations.

There are two other new products recently registered for apple, Apogee (a plant growth regulatory for managing shoot blight in apples) and Petro Canada Spray oil (an emulsifiable horticultural spray oil for managing scale and ERM). Currently, OMAFRA can not make any recommendations on these products until they are reviewed by the Fruit Technical working group, but stay tuned for more info on these products in future Orchard Network newsletters.

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Stinging Insects of Apple - Floats like a Butterfly, Stings like a Bee

Author: Kathryn Carter - Pome Fruit IPM Specialist/OMAFRA

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

Over the past few years there has been an increase in fruit damage from stinging insects in apple orchards. Some researchers suggest that decreasing the use of broad spectrum insecticides (organophosphorous insecticides) and increasing in the use of target specific reduced risk pesticides may be increasing the populations of stinging insects in some apple orchards. Stinging insects often migrate into orchards from surrounding areas, so their numbers can increase unexpectedly. Monitoring for these pests is very challenging since they move very quickly and often the only indication of their presence is damaged fruit. Pest identification is critical for managing the pest and reducing fruit damage at harvest. They are several stinging insects that attack Ontario apples, including mullein bug, tarnished plant bug, stink bug and green apple bug.

Tarnished Plant Bug

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (TPB) (Figure 1), is one of the most common stinging insects in Ontario. The adult overwinters under leaf debris in protected areas and becomes active on warm days in the early spring. They begin to feed on fruit buds from silver tip to tight cluster (Figure 2), often causing fruit buds to drop. TPB feeding on flowers and developing fruit from early pink to 2 weeks post bloom results in scarring and deformation of fruit at harvest (Figure 3). Research has shown that TPB damage is not a concern on older fruit. It appears that older fruit are either unattractive to TPB or they simply do not show signs of injury.

Figure 1 - Tarnished plant bug nymph

Figure 2 - Tarnished plant bug damage

Figure 3 - Tarnished plant bug damage on fruit

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Pesticides are registered to manage TPB, however, this pest is difficult to monitor since adults often fly into the orchard from surrounding areas and damage the fruit before their presence is known. Therefore, it is very difficult to manage this pest chemically. Generally pre-bloom and petal fall sprays of insecticides aimed at controlling caterpillars, tentiform leafminers, and plum curculio usually control TPB. In orchards with a history of TPB damage, the application of a pyrethroid (Ripcord or Matador) should be applied as soon as damage is observed in fruit clusters.

There are several cultural controls that can be used to help minimize damage from this pest. Avoiding mowing during bloom can provide TPB with alternate food sources (dandelion pollen, etc.), and may result in reduced injury. Proper weed management in the orchard and in the surrounding environment may also help to minimize TPB damage. Researchers believe that overwintering TPB adults are lured into the orchard (or are lured to stay in the orchard) by the presence of suitable hosts (clover and other broadleaf weeds). As a result, managing broadleaf weeds in and around your orchard, could help to make your orchard less attractive to TPB, potentially resulting in a reduction in fruit damage. A recent study conducted in Nova Scotia found that an early application (late May) of a laneway herbicide for broadleaf weeds, significantly decreased TPB damage in an orchard.

Mullein Bug

Mullein bugs (*Campylomma verbasci*) (Figure 4) are a common pest in Ontario apple orchards. They overwinter as an

egg inserted into the bark of the tree. Egg hatch begins at the pink to king bloom stage of red Delicious and continues until petal fall. Often insect emergence is synchronous with peak hatch occurring at early petal fall. A cold snap at this time could result in a split hatch, making chemical control more difficult.

Mullein bug (MB) nymphs feed on developing flowers and young fruitlets. Damage on fruit first appears as reddish pimples on the fruit, which eventually turn brown and become corky (Figure 5). Severe blemishes and malformation of the fruit caused by MB may decrease the marketability of the fruit. Mullein bug is only considered a pest from 2 weeks before and after the bloom stage of tree development, after which it becomes an important predator feeding on mite and aphid pests found in apple orchards throughout the summer.

Figure 4 - Mullein bug nymph

Figure 5 - Mullein bug damage

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Monitoring for MB begins at bloom and continues through until petal fall. Mullein bug populations are monitored by limb tapping and insecticides are recommended if 7-9 nymphs are found in 25 traps. Currently Admire is the preferred product for managing this pest. Diazinon is also registered for MB but it is considered to be harsh on beneficial insects.

Stink bugs

Stink bugs are another well known pest in apple orchards. Early season stink bug feeding creates the formation of a dimple on the surface of the fruit, with a trail in the fruit flesh (Figure 6). Mid to late season stink bug damage is similar to cork spot, but can be distinguished by the presence of a feeding puncture. Although stink bug injury can occur throughout the season, recent studies suggest that 1-2 months prior to harvest fruit appear to be more susceptible to stink bug damage.

Figure 6 - Stink bug damage

Unfortunately stink bugs are very difficult to monitor and currently there are no thresholds for this pest. The use of insecticides is not recommended for managing stink bug populations. Some research suggests that managing weeds in the orchard may help to reduce stink bug damage.

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Green Apple Bug

Research conducted in the 1980s found that the green apple bug *Lygocoris communis* (Knight), can cause a significant amount of fruit damage in unsprayed apple orchards in Quebec and in some commercial orchards in Ontario. The eggs overwinter in the young bark of apple trees and begin to hatch during bloom. The nymphs feed on developing fruitlets through the petal fall period. Apple green bug injury appears as raised russetted bumps on the fruit (Figure 7). Another insect called the apple red bug causes smooth russetting to appear on the surface of the fruit. The green apple bug and the apple red bug are not considered to be economic pests of apple by some. Unfortunately, they can make a mess in some years and with some cultivars. There are no special sprays recommended for these pests in Ontario apple orchards.

Figure 7 - Apple green bug damage to fruit

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Browning Potential of New Apple Varieties for Fresh-Cut

Author: Dr. Jennifer DeEll - Fresh Market Quality Program Lead/OMAFRA; Dr. Peter Toivonen - Postharvest Physiologist/ AAFC

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

One of the largest costs in producing fresh-cut apple slices is the anti-browning solution. Therefore, the elimination or any reduction in the amount of solution required would be very beneficial to the producer. Some apple varieties brown more quickly and severely than others upon cutting, depending on the inherent amount of responsible enzymes and antioxidants. The objective of this preliminary study was to evaluate the browning potential of several new apple varieties, including 'Ambrosia', 'Aurora Golden Gala', 'Galarina', 'Goldrush', 'Honey-crisp', and two selections from Quebec. Fruit from each variety were harvested during the commercial harvest period in 2004 and stored at 0-1ºC for 3-4 months. Several fruit were then removed periodically throughout the storage duration and sliced within 1 hour. After cutting, the slices were rinsed in running tap water, allowed to drip dry, and placed into zip-lock bags. Slices in bags were held at 5ºC for 1 week and then assessed for browning. The two Quebec selections showed the least amount of browning, with slight to none. The other varieties all exhibited some degree of moderate to severe browning. Results suggest that growing location may also be a factor in browning potential.

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1-MCP Treatment has Variable Effect on Postharvest Decay in Apple cvs. Empire and McIntosh

Author: Dr. Deena Errampalli - Research Scientist/AAFC; Dr. Jennifer DeEll - Fresh Market Quality Program Lead/OMAFRA; Dr. Dennis Murr - Professor/University of Guelph

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

A two year study was conducted to determine the effect of 1-MCP on decay in stored apples. 'Empire' and 'McIntosh' apple fruit that had been wounded immediately after optimum harvest for long-term storage (as determined by internal ethylene content and starch staining) were treated with/without 1 $\mu L \cdot L^{-1}$ 1-MCP for 24 h at 0°C. Fruit were then stored for up to 120 days either in air at 0-1°C or in standard controlled atmosphere (SCA; 'McIntosh' at 3°C, 2.5% O_2 + 2.5% CO_2 for the first 30 days, then 4.5% CO_2 thereafter; 'Empire' at 2°C, 2.5% O_2 + 2.0 % CO_2). Decay incidence was recorded after 30, 60, 90, and 120 days after 1-MCP treatment in apples that were kept in air. No decay was observed at 30 and 60 days after treatment in both cultivars held in air. A higher incidence of decay was observed in wounded plus 1-MCP treated 'McIntosh' apples than in wounded only apples after 90 and 120 days in air and in SCA storage. 1-MCP had a variable effect on decay in 'Empire' apples, where higher decay incidence was observed in wounded plus 1-MCP treated apples than in wounded only apples at 90 days, but the reverse trend was found at 120 days after treatment. In summary, 1-MCP had a variable effect on decay incidence in different apple cultivars, and this variability in response is an important consideration in any program utilizing 1-MCP treatment.

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Tree Fruit BioProducts Research Initiative in Nova Scotia

Author: Dr. Vasantha Rupasinghe - Tree Fruit BioProducts Research Chair/Nova Scotia Agricultural College

Creation Date: 25 May 2005

Last Reviewed: 25 May 2005

The Nova Scotia apple industry has recognized the importance of nutraceuticals and other bioproducts in finding alternative markets. To explore the potential new opportunities of these new sectors to the apple industry, the Nova Scotia Fruit Growers' Association (NSFGA), with support from the federal government and Nova Scotia Department of Agriculture and Fisheries (NSDAF), established a *Tree Fruit BioProducts Research Chair* position at the Nova Scotia Agricultural College (NSAC). Dr. Vasantha Rupasinghe was hired to fill this new position located within the Department of Environmental Sciences, NSAC in October 2003. Prior to the current position, Dr. Rupasinghe served as a research scientist at the Guelph Center for Functional Foods in Ontario.

Dr. Rupasinghe's research program aims to enhance the economic value of apples and to assure the sustainability of the Nova Scotia apple industry through the innovation of novel apple-based bio-products as alternative agricultural commodities. Scientific evidence has begun to accumulate showing that a group of phytochemicals known as flavonoids (these belong to the family of polyphenolics) has the potential to act as new therapeutic agents that may play important roles in alleviating chronic health-related dysfunctions in mammalian species, including humans. Tree fruits such as apples are highly concentrated with flavonoids, and the potential exists to explore the ability of apple-derived specific phytochemicals to play a significant role in human health.

New infrastructure valued at $560,000 has been acquired through funding provided by the Canada Foundation for Innovation (CFI), the Nova Scotia Research and Innovation Trust (NSRIT), and NSFGA to establish a new natural product chemistry laboratory at NSAC to support this program. In addition to the new equipment at NSAC, the program will also be assisted by the pilot plant facilities of the Food Technology Center at Charlottetown, PEI.

More specifically, research under this program is looking at the development of technologies for production of value-captured food ingredients and phenolic extracts from apple skin. Not only are the peels of apples high in phenolics and dietary fiber but they are also one of the major food processing by-products in Nova Scotia accounting for 4 million pounds each year. Research is also underway investigating novel ways of extending the shelf life of sliced apples so that the products can be shipped to distant markets. With consumer demand for healthier and more convenient foods on the increase, the market potential of value-added fresh-cut apples is now being realized. Funding for the above studies is provided by NSDAF through the Technology Development Program, NSFGA and Scotian Gold Cooperative Limited, Kentville.

The research program is multi-disciplinary in nature and consists of market analysis, germplasm assessments, processing and product development, natural products chemistry, and biological activity studies of tree fruit constituents. Market studies are being conducted in collaboration with the Industry Development and Business Services Branch of NSDAF and Department of Business and Social Sciences, NSAC. A preliminary investigation on market potential for

apple-based bio-products was completed and a 2-year collaborative project to conduct economic analysis on competitiveness, opportunity assessment, and cost-benefit analysis related to bio-products development was approved to receive $150,000 through NSDAF to hire a research economist in December 2004.

For more information about the research program, please contact Dr. Vasantha Rupasinghe at Nova Scotia Agricultural College.

Related Link

- Nova Scotia Agricultural College

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