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ORCHARD NETWORK

For Commercial Apple Producers

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In this issue…

Orchard Management

Do Yourself a Favour

Leslie Huffman, Apple Specialist, OMAF and MRA

Still debating about planting new apple orchards at the recommended spacing of 1000 trees/acres? I know some growers are still not convinced to plant trees at 13 x 3', or 12 x 4'. After a long, hard look at the economics and horticultural advantages of this spacing, I'm convinced that you should do yourself a favour, jump in with both feet, and plant those trees at these close spacings.

Here is what I'm hearing from growers – and my responses:

1. That's a lot of trees, and a lot of money.
Economic studies in New York have clearly demonstrated that this density is the most profitable, even after paying for all those trees. It is important to plant quality trees that will start cropping early to ensure payback of your investment.

Ministry of Agriculture and Food
Ministry of Rural Affairs
Ontario

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This issue of the **Orchard Network Newsletter** was compiled by Carolyn Prieur, Client Service Representative, OMAF and MRA, Vineland Station

2. My equipment is too big.
It's important to recognize that Tall Spindle trees grow very differently, because the vigour is directed to the leader, not scaffold branches. The cropping scaffolds do not extend into the row as far as our current orchards; in fact, scaffolds are usually less than 2' long. Most equipment with a 60-66" wheel base works well.

3. My trees have too much vigour anyways.
In Tall Spindle, vigour is directed to the leader. Actually for weaker growing cultivars like Honeycrisp, vigorous soil is an advantage. Heavy early cropping also helps contain vigour.

4. Those trees are too tall – my worker's don't like ladders.
The tree height adds yield potential, but usually only one trip up the ladder is needed at harvest. The fruit is well exposed and ripens evenly. There is potential to mechanize with platforms as well.

5. I'm worried about spray coverage on those tall trees.
Sprayers will need minor adjustments to ensure coverage on taller trees, but coverage is usually improved on Tall Spindle because the canopy is less dense. In fact, you should see sunlight through the trees.

6. I don't like wire – I like to walk through the rows.
Working in trellis systems does take some adjustments, but trellis supports are more economical than individual stakes when tree density is more than ~700 trees/acre. Some growers move their lowest wire up as the tree grows to allow ducking through. Properly built canopies have been able to withstand weather damage better than individual stakes, and protect graft unions from twisting.

7. What happens if my crop is lost to frost again?
Losing a crop to frost will delay the breakeven for your investment. However, with judicious use of Apogee, and the pruning technique of whole branch removal, the growth of these closely-spaced trees can stay under control. Fortunately, the high yields and good quality fruit from Tall Spindle orchards is sufficient for investment in frost protection.

8. I have lots of land, and our land prices are much cheaper than in Europe.
The major expense in growing apples is not the cost of land, but labour for pruning and harvest, as well as pesticides. The Tall Spindle system offers higher yields, reduced pesticide costs, as well as labour efficiencies (which can be enhanced with platforms). The extra land can be used to grow more orchards or other profitable crops.

The Tall Spindle system keeps trees healthy and productive, and the expectation is that these orchards will be long-lived through renewal pruning. As long as the cultivars remain in demand, the orchards you are planting now may out-live your equipment. But if you don't plant the trees close enough, early yields will be smaller, and payback will be significantly delayed. If they are too far apart, the planting may never be profitable. Do yourself a favour and plant 1000 trees/acre – you will be happier in the long run.

Precision Pruning – Your First Step of Crop Load Management

Leslie Huffman, Apple Specialist, OMAF and MRA

Cold spring temperatures "allowed" our trees to take a vacation last year, which resulted in large numbers of fruit buds this year. Fortunately, this season is more "normal", and buds have remained dormant, with good potential for full crops.

However, there is a grave danger of setting too many fruit, and the resulting fruit size could be disappointing this year. Large crops are also predicted across North

America, so marketing may be challenging for small apples this fall.

Growing flowers, seeds and fruitlets require large amounts of energy, which comes from the limited reserves stored in the tree. If fruit buds are removed by pruning, the tree can use this energy to make the remaining buds stronger for larger fruit.

Take a few minutes to do a bud count on a few trees of each cultivar. How many buds are needed on each tree? Here are some examples:

Orchard system	Tall Spindle	Slender Spindle	Conventional
Yield goal	1500 bu/ac	1000 bu/ac	800 bu/ac
Tree density	1000 trees/ac	622 trees/ac	145 trees/ac
Tree spacing	11 x 4'	14 x 5'	20 x 15'
Yield per tree	1.5 bu/tree	1.6 bu/tree	5.5 bu/tree
Fruit per tree (100 count)	150 fruit/tree	160 fruit/tree	550 fruit/tree
Branches per tree	24	12	12
Fruit per branch	6-7	13-14	44-46
Buds needed*	12-14	26-28	88-92

*Includes an insurance factor of 2 to ensure that enough buds set. This should be varied by cultivar (eg. 2.5 for Honeycrisp, Jonagold; 2.0 for Empire, McIntosh: 1.8 for Gala)

In most cases, your trees will have many more buds than they need. Using this logic, you can estimate for each of your blocks how many buds per branch you need.

This information should give you the courage to make cuts to remove fruit buds. Dormant pruning is your first opportunity to reduce fruit load by:

- Removing entire branches – take large branches high in the tree, also reduces shading
- Removing fruit spurs – concentrate on the lower parts of each branch, this can be done quickly with your hand or pruners to break them off
- Detailed spur pruning to remove the older part of spurs – this is time consuming but on spur-bound trees, it is the only way to get them to grow.

Remember that reducing crop in the dormant stage results in the biggest increase in fruit size. By avoiding the energy drain of setting fruit, the remaining fruit are significantly larger (and the costs of chemical and hand thinning may be reduced). Reducing your crop load through pruning is a win-win situation.

Precision Crop Load Management – A New Concept

Leslie Huffman, Apple Specialist, OMAF and MRA

The crop load on each tree will be a key factor in the success of your apple crop. The crop load affects fruit size, fruit colour, spray penetration, evenness of maturity, ease of harvest as well as return bloom next year. Each year, we try to reduce crop load through chemical thinning and follow-up hand thinning. However, sometimes the results are disappointing, and at times, disastrous.

Recently Dr. Terence Robinson and the Cornell Fruit Team hosted an Apple Summit on Precision Orchard Management. One of the 8 sessions focused on Precision Crop Load Management, and growers were keenly interested to learn how to better manage their crop loads. A 6-step process was proposed to achieve the proper crop load and maximize profits. It is most suitable for use in high density Tall Spindle orchards, but these principles apply to all orchards.

Since 2000, Dr. Terence Robinson and Dr. Alan Lakso have been working on developing a model to explain how trees respond to thinning. The **Carbohydrate (CHO) Model (which is renamed Malusim**) uses weather data to calculate the CHO balance of the tree, which helps predict how susceptible the tree is to thinners. Sunlight and warm temperatures increase the tree's CHO balance, and make it resistant to thinners. On the other hand, cloudy, cool weather decreases the tree's CHO balance, and makes it more susceptible to thinners. This helps decide which day is best to apply thinners and what rate to use. We are working to get this model in Ontario.

Dr. Duane Green from Massachusetts has also been studying thinning response for many years and has proposed a **Fruitlet Growth Model.** By comparing fruitlet size at 3- and 7-days after thinning, you will know the results of chemical thinning within 7 days of application. Fruitlets that keep growing will stay, and fruitlets that stop growing will drop. The results are known days before fruitlets start to change in colour or appearance. We have a spreadsheet to enter your data after measuring fruitlets.

Both of these models are used to make decisions in Steps 2-5 of the Precision Crop Load process. Here are the proposed 6 steps:

Step 1: Precision Pruning (leave 2x the number of buds needed)
→ use Malusim to determine rate for Step 2

Step 2: Bloom thinning spray (60-80% full bloom)
→ use Malusim to determine rate and timing for Step 3

Step 3: Petal fall thinning spray (5-6 mm)
→ check results with Fruitlet Growth Model
→ use Malusim to determine rate and timing for Step 4

Step 4: 10-13 mm thinning spray (if needed)
→ check results with Fruitlet Growth Model
→ use Malusim to determine rate and timing for Step 5
Step 5: 16-20 mm thinning spray (if needed)
→ check results with Fruitlet Growth Model
Step 6: Precision hand thinning
→ use Equilifruit Disk to determine correct crop load (see article on the back)

There are many benefits to **Precision Crop Load Management** including:

- Energy directed to fewer buds - early removal at dormant, bloom and petal fall
- Low risk of over-thinning at bloom and petal fall
- Prediction of optimum rates of chemical thinners using Malusim
- Information to correctly time sprays to avoid over-thinning or under-thinning
- Early assessment of thinning results using the Fruitlet Growth Model
- Reduced costs for hand thinning
- Less risk of biennial bearing due to enhanced return bloom
- Increased profits due to matching fruit size to your markets.
- Larger fruit, since energy is focused on remaining buds
- Reduced harvest costs due to reduced sorting of undersized fruit

Many of the Summit participants plan to try these techniques this year. Further testing and research is needed to assess these steps under Ontario conditions, so it is best to test new techniques on a small acreage. **Always, always**: leave untreated trees, take many observations, and write it all down for future years.

Using Precision Crop Load Management takes us closer to managing our trees at the level required to maximize yields and profits. We know that each year, thinning is a learning process, and no doubt this year will be as well, but we have new tools to help us achieve the results we want.

Crop Protection

It's Time to Consider a Dormant Oil Spray

Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, OMAF and MRA

If you are thinking of using dormant oil spray to target scale, now is the time. With the temperature gradually increasing, buds are swelling and green tip is just around the corner. Timing a dormant oil spray now will prevent any incompatibility issues you could face with an early season fungicide program if oil is delayed until green tissue is present. Details on dormant and delayed dormant oil sprays for scale and mites can be found in the February issue of Orchard Network(Volume 17 Issue 1).

Recently, there has been some concern that oil may reduce the overall health of the trees. Researchers in New York have pointed out that oil is used a minimal number of times during a season and not necessarily every year, and that it "has been used for well over a century…to control mites, scales and even some aphids, with no ill effects on the health of the tree or the current season's crop" (see Scaffolds Volume 22 No. 3). However, growers should remember crop injury can occur if oil is applied within 14 days before or after using fungicides containing sulphur, including captan, or within 48 hours of freezing weather.

Early Season Copper Sprays

Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, OMAF and MRA
Michael Celetti, Plant Pathologist Horticulture Crop Program Lead, OMAF and MRA

The efficacy of copper sprays this time of year to reduce the spread of fire blight inoculum from overwintering cankers has often been debated. Its effectiveness really comes down to how it is applied and post-application weather. Copper provides an unfriendly environment over the bark and bud surfaces of the trees, preventing bacteria from getting established or spreading to blossoms through rain splash or insects. Thus, it must be applied as a high volume spray to ensure sufficient coverage. The bacteria that cause fire blight are dispersed through the orchard before bloom when the initial infections occur. Generally, the greatest flux of bacteria onto the bark occurs at the tight cluster to the pink stage of apple, which can be some time after green tip when copper would have been applied. By this time, copper residues will have been reduced through weathering, especially heavy rains. Therefore, it's important to note, copper does not eliminate the need for streptomycin at bloom, but may reduce the overwintering bacteria.

David Rosenberger at Cornell University recommends that copper sprays should be applied at ¼ to ½" green only since later sprays can result in severe fruit russetting. Because of this, copper sprays may want to be avoided on high value cultivars, such as Honeycrisp. As well, in order for copper sprays to work effectively it is recommended they be applied to all of the trees in the block. Untreated trees, even non-susceptible varieties, provide a safe haven for the bacteria and insect vectors can move the bacteria around easily.

Copper sprays applied to green tissue may also provide some protection against apple scab equivalent to that provided by a reduced rate (~3 kg/ha) of mancozeb, according to David Rosenberger. There may even be

evidence by research done by Kerik Cox at Cornell University to suggest that the annual use of copper at green tip may help to suppress DMI-resistant (ie. Nova, Nustar, Inspire) apple scab, but more work is needed to verify this. In general, copper residues may protect green tissue from scab infection when applied before spores are released. This should not, however, be used as a replacement spray for the first cover of scab protectant fungicides.

Fire Blight Prediction Models

Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, OMAF and MRA Simcoe

Fire blight prediction models help growers time their product applications. Two decision support prediction models, Maryblyt and Cougar Blight, have been developed to help growers and consultants forecast conditions that lead to the infection of apple blossoms. For best results using these models, collect and record information separately from different blocks and cultivars. Daily information on temperature (a Min-Max thermometer works well for this) and rainfall, along with key observations on tree development, including 50% green tip, first bloom and petal fall are important. Green tip is quickly approaching, so now is the time to familiarize yourself with these models if you're planning to use them.

For a free download of the Cougar Blight model, visit: county.wsu.edu/chelan-douglas/agriculture/treefruit/Pages/Cougar_Blight_2010.aspx

For a free download of the Maryblyt model, visit: www.caf.wvu.edu/kearneysville/Maryblyt/index.html

Michael Celetti, OMAF and MRA Plant Pathologist, Horticulture Crops Program Lead will provide regional fire blight risk information again this year that will be distributed regularly through the Ontario Apple Growers.

Managing Apple Scab and Powdery Mildew in 2013

Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, OMAF and MRA

Now that apple scab (and potentially powdery mildew) resistance to sterol inhibitor (SI)(ie. Nova, Nustar, Inspire) and strobilurin (ie. Flint, Sovran, Pristine) fungicides has been determined in Ontario orchards, management strategies for these diseases may need to be adjusted. Growers in New York who are facing a similar situation are incorporating sulphur into their spray programs for powdery mildew control as a low cost solution with minimal resistance potential.

David Rosenberger from Cornell University recommends sulphur at a rate of 3-5 kg/ha, tank mixed with ½ rate mancozeb plus ½ to full rate captan (depending on tree size and disease pressure), beginning at ½" green. The mancozeb/captan will have good activity on scab, while this low rate of sulphur will suppress powdery mildew. However, if sulphur is being used to control scab or rust, a higher rate (22.5 kg/ha) is required. Where SIs or strobilurins are still working, incorporating early season sulphur sprays can actually help prolong their life by reducing selection pressure for resistance.

Sulphur fungicides with a carrier, such as bentonite clay (e.g., Microthiol Disperss) tend to stick to the tree better than other sulphur products. Mixing with captan or mancozeb could allow for even greater redistribution. However, sulphur may burn leaves or fruit if used before a period of hot temperatures (greater than 25°C). The impact on mites is unknown at this time in Ontario, so growers are advised to monitor for mite flare-ups if using sulphur.

Fontelis and Luna Tranquility are two new products that are available for growers this year, belonging to the SDHI (succinate dehydrogenase inhibitors) fungicide group. While these are registered for both scab and powdery mildew, they have a high resistance potential and should not be used as a stand-alone chemistry, but rather tank-mixed with captan or mancozeb. Fontelis is slightly less effective against mildew but is better on fruit scab than Luna Tranquility.

Some key points for effective scab and powdery mildew control this year include:

- **Reduce overwintering scab inoculum levels** using urea and/or leaf shredding before green tip, or plan to do this in the fall to get a good start on 2014 pressure.
- **Maintain a tight spray schedule with high rates during primary scab infection period**. Powdery mildew does not invade mature leaf tissue, so spread of mildew ceases when trees stop producing new terminal leaves.
- Rain deters powdery mildew development by washing off spores. Instead, mildew thrives in dry weather and high relative humidity, and so **protectant sprays may still be required during dry periods** when there is little risk from apple scab.
- Getting good mildew control following an outbreak will take several seasons. Mildew infected white shoots from last year's failure will persist through the season, but does not indicate current fungicides are failing. **The current season mildew program is designed to prevent spread that would lead to primary infection for next year**.
- **Include a mildewcide, such as sulphur in all sprays beginning at ½" green** until temperatures greater than 25°C or when applying oil. Sulphur lacks post-infection activity, so must be applied early season. A tank-mix that includes mancozeb, captan and sulphur provides excellent protection against scab, rust and mildew.
- **Where they are working, include fungicides from other groups, including SIs, strobilurins, or SDHIs during the critical infection period**, generally at pink and petal fall. Tank mix these products with captan or mancozeb.

- **Avoid using fungicides that are no longer effective in your orchard.** If you are unsure if resistance is present, have your orchard tested. Scab resistance testing is now available at the University of Guelph Pest Diagnostic Laboratory (www.guelphlabservices.com/AFL/plants.aspx#Apple)

Making Sense of Fungicide Groups

Kristy Grigg-McGuffin, Pome Fruit IPM Specialist, OMAF and MRA

Growers are facing new challenges when making apple scab and powdery mildew management decisions. Not only do you have to consider efficacy, pest spectrum, and cost of a fungicide, but also resistance management, mode of action, maximum applications, and as of lately, pre-mixes –or combining 2 different active ingredients.

Fungicides are grouped based on their mode of action, or how the product actually affects the disease. For example, all products in Group 3 have the same mode of action, so using one product is virtually the same as using all other products within that group. One of the main resistance management strategies is to rotate between chemical groups.

With the introduction of new fungicides and pre-mix products, some growers are struggling to keep it all straight. What fungicides can be rotated with one another? What chemical groups are actually in these pre-mixes? The table below provides an inclusive list of fungicides available for apple scab and/or powdery mildew based on their chemical group (note: suppression products, such as Serenade are not included). **In pre-mix fungicides, both groups need to be considered in all rotation decisions.** For instance, Pristine WG (Group 7 & 11) cannot be rotated with: 1) Flint or Sovran (Group 11), OR 2) Fontelis or Luna Tranquility (Group 7).

Some key notes to consider when making management decisions:

- **Group M fungicides** have a multi-site mode of action, which means the resistance potential is very low. Therefore, it is ok to use these fungicides season long. However, this group has NO activity on powdery mildew.
- **Group 3, 7, 9, 11**and **U12 fungicides** have a single-site mode of action, which means the resistance potential is medium to high for these fungicides. Consider tank mixing with protectants from Group M. However, keep in mind that tank-mixing with a pre-mix fungicide essentially means 3 fungicides in one spray. These groups are best suited in an early season program and should be limited to 2-4 applications per season. Scab resistance has been confirmed in Ontario to Group 3, 11 and U12 fungicides
- **Group 29 fungicides** have a low resistance potential and can be used as an alternative to sulphur-based fungicides, such as captan (Group M) when oil is applied and may suppress mites. However, this group is weaker on scab than other groups and has NO activity on powdery mildew.

Airblast Sprayer Start-up Tips

Dr. Jason S.T. Deveau, Application Technology Specialist, OMAF and MRA
Mr. Brian Henderson, Sales Representative, HYPRO/SHURflo
Mr. Murray Thiessen, Consulting Agricultural Mechanic

You should plan for half-a-day per sprayer for your start-up routine. It may not take that long, but pressure gauges snap off, fittings crack, and bearings seize – have a plan for getting replacement parts! (see Figure 1)

Chemical Group	Supra Captan 80 WDG	Maestro 80 DF	Manzate Pro-Stick	Penncozeb 75 DF	Dithane DG	Polyram DF	Scala SC	Vangard 75 WG	Nova 40 W	Nustar	Inspire	Flint	Sovran	Pristine WG	Fontelis	Luna Tranquility	Syllit 400 FL	Allegro 500F
M	•	•	•	•	•	•												
3									•	•	•							
7														•	•	•		
9							•	•								•		
11												•	•	•				
29																		•
U12																	•	
Note: Sulphur and copper also belong to Group M, low resistance potential.																		

Figure 1. It takes time and elbow-grease to get seized parts, such as this fan gear box, moving again. Plan for half-a-day per sprayer when performing your seasonal start-up, and be sure you have a source for replacement parts.

Here are a few bulleted tips for you to consider as you get your sprayers rolling for the 2013 season.

- **Visual inspection, general cleaning and lubrication.** Do an operational check of the sight gauge (it should not be opaque), regulator and valves. Inspect the frame for corrosion or broken welds – it might even need a paint job. Test the hitch integrity, safety chains and the tank mount, too. Clean and inspect the fan blades, housing, screen and trash guard. Be sure to clean and lubricate the power take-off telescoping shafts and the shields. Wheel bearings and tire pressure should be inspected. An article on wheel maintenance can be found here: www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2012/30hrt12a2.htm

- **Pump Maintenance.** One of the most common causes for faulty pump performance is "gumming" or corrosion inside the pump. You should get into the habit of flushing the pump and the entire system with a solution that will chemically neutralize whatever you sprayed that day. This will dissolve most residues remaining in the pump and will also leave the inside of the pump clean for the next use.

  Diaphragm Pumps
  Hypro recommends changing oil after 40 hours of break-in operation and every 500 hours after that. Diaphragms should be replaced every 500 hours and check valves should be replaced every 1,000 hours. Generally Speaking, EPDM (Black Diaphragms) are a better choice for airblast sprayers while the Desmopan (Amber Diaphragms) are a better choice for lawn care sprayers.

  Centrifugal Pumps
  Corrosion is the biggest concern. When you winterized your sprayer, you should have cleaned it and flushed it with a 50% solution of permanent-type automobile antifreeze (Prestone® , Zerex® , etc.) containing a rust inhibitor. Alternately, you could have filled the pump with Fluid Film® and then drained and saved the excess for the next application. The ports should have been plugged to keep out air during storage.

- **Flush the lines.** If they aren't already off, remove the nozzles, strainers and filters. Run a few tanks of clean water through the system with the agitation running. This is when rust, scale, anti-freeze and who-knows-what-else breaks free of the sprayer tank and lines. Run them until the discharge is clear, then clean and replace the nozzles, strainers and filters.

- **Search for leaks.** With the tank full, check it for leaks. If the agitator shaft is leaking a little, tighten the packing. If it has bottomed-out you will have to repack it. Get the sprayer up to pressure and look for wet areas on all hoses and connections. If your booms drain through the nozzles when the boom is off, consider new nozzle bodies with check-valves. They cost about $40.00 each (does not apply to Turbomist®).

- **Check your strainers and filters.** If you don't already have three levels of filtration (including the tank-opening basket) then consider slotted (not mesh) strainers behind the nozzles in the nozzle body. If you don't use them because they plug up, then look to your agitation system: If there is sludge at the bottom of your tank when it's empty, then your pesticide is not mixed or staying suspended properly. That leads to clogged strainers and nozzles. It may also be your sprayer hygiene: You should be washing nozzles and strainers after each spray day.

- **Are you sure your pressure gauges are accurate?** The relief valve should always be in the by-pass position during sprayer start up. If you get a pressure spike during start-up and the needle buries, then the gauge will always read high and must be replaced. An opaque, leaking, or otherwise old gauge should be replaced. Consider purchasing a really good gauge (e.g. www.winters.com) rather than a $20 dollar version from a farm supply store. New or old, test your gauge for accuracy. A tool to do this can be found here: www.omafra.gov.on.ca/english/crops/field/news/croppest/2012/06cpo12a3.htm

So, there are lots of other tips – more than we could include here. Always consult your sprayer manufacturer's manual. There's also a checklist at the end of Factsheet 10-047 "Calibrating Airblast Sprayers". Consider printing and laminating a copy for use with a dry-erase marker again and again: www.omafra.gov.on.ca/english/crops/facts/10-047.htm

Happy Spraying!

Tank Mixing and Pesticide Compatibility – "The Jar Test"

Dr. Jason S.T. Deveau, Application Technology Specialist, OMAF and MRA
James D. Reiss, Precision Laboratories, LLC
Helmut Spieser, Agricultural Engineer, OMAF and MRA

Are you considering a new tank mix this year? Perhaps two new fungicides, or an adjuvant you want to try? Be sure you know what you're doing before you risk an untested tank mix. Users of commercial class pest control products for crop protection or vegetation management are permitted to apply unlabelled tank mixes of registered pest control products as long as:

- each partner is registered for use in Canada on the crop,
- the tank mix only includes an adjuvant when specifically required by one of the mix partners,
- the application timing of each partner is compatible with crop and pest staging,
- each partner is used according to the product label,
- no partner is specifically excluded on any other partner label.

The order in which you add each product to the tank or inductor is critical. Making sure you have the right mix, in the right order, is made easier with the free app from Precision Laboratories (www.mixtankapp.com) which works on Android and iPhone/iPad systems.

At the start-up screen, select "Mix Guide" (see Figure 1). Then, select the category of the product you wish to tank mix (see Figure 2) and then select the product(s) from the alphabetized list. The app analyzes your selections and suggests the best order to add them to the tank. Note that these are US products, which means they may have different names in Canada, if they are registered at all. The app has other appealing features you can explore, such as saving your mixes for future reference, and accessing instructional videos.

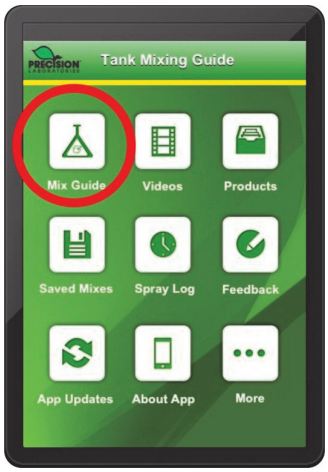


Figure 1. Precision Laboratories' Tank Mixing App Start-Up Screen

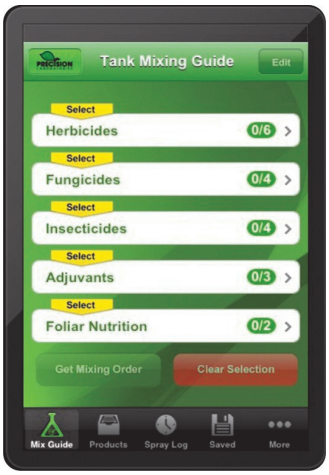


Figure 2. Select from five categories and choose up to 19 tank mix partners

Always check the product labels for information on compatibility of spray materials. "Compatibility" refers to the physical and/or chemical compatibility of two or more products in a solution. If you are concerned, you should perform a jar test. Always wear personal protective equipment and do it in a safe and ventilated area, away from sources of ignition.

1. Measure 500 ml of water into a one litre glass jar. This should be the same water you would fill a spray tank with.
2. Add ingredients according to Table 1, stirring after each addition.
3. Let the solution stand in a ventilated area for 15 minutes and observe the results. If the mixture is giving off heat, these ingredients are not compatible. If gel or scum forms or solids settle to the bottom (except for the wettable powders) then the mixture is likely not compatible (see Figures 3 and 4 for examples of physical incompatibility).
4. If no signs of physical incompatibility appear, test the mixture using a spray bottle on a small area where it is to be applied. Look for phytotoxic indications, such as plant damage, and monitor efficacy (which is hard to do unless you actually fill the sprayer and try it on a few plants).

Figure 3. Physical incompatibility in the tank

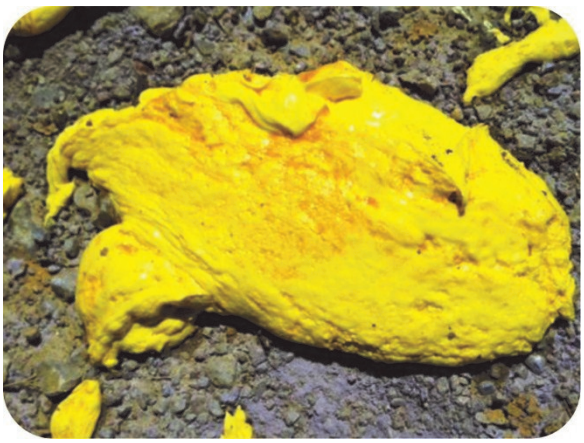


Figure 4. Gelatinous mess made by using an inductor as a mixing vat for incompatible products

Table 1 - Tank mix order for performing a pesticide compatibility test

Order	Ingredient	Quantity for 500 ml or g of product labeled for 1,000 L of final spray volume
1.	Compatibility agents	5 ml (1 teaspoon)
2.	Water-soluble packets, wettable powders and dry flowables	15 grams (1 tablespoon)
3.	Liquid drift retardants	5 ml (1 teaspoon)
4.	Liquid concentrates, micro-emulsions and suspension concentrates	5 ml (1 teaspoon)
5.	Emulsifiable concentrates	5 ml (1 teaspoon)
6.	Water-soluble concentrates or solutions	5 ml (1 teaspoon)
7.	Remaining adjuvants and surfactants	5 ml (1 teaspoon)

Commercial compatibility kits are available, such as the kit from Precision Laboratories. This kit contains three plastic "jars" and five disposable micropipettes (see Figure 5). By following the instructions included with the kit, you can easily reduce large labelled volumes (such as 1.0 kilogram of product in 500.0 litres) of multiple products to small volumes at the same ratio. These kits can be purchased for ~$20.00 (including delivery) by calling 1-800-323-6280.

Remember: a compatibility test will only reveal physical incompatibility between products in a tank mix – they **will not** reveal any other form of antagonism, such as products inactivating one another, or the potential for phytotoxicity. The only way to know for sure is to apply the mix to a few test plants and keep an eye on them over the season.

Figure 5. Contents of a commercially-available compatibility test kit

Apple Proliferation Disease

Michael Celetti, Plant Pathologist, Horticulture Crops Program Lead, OMAF and MRA

The Canadian Food Inspection Agency (CFIA) recently announced the discovery of a regulated and quarantine disease called apple proliferation (AP), in an apple orchard in Nova Scotia. This is the first detection of apple proliferation in North America and it is not known to be present in Ontario or any other apple growing region of North America at this time. The United States Department of Agriculture has been informed and an investigation is ongoing to determine the source of this disease introduction into Nova Scotia. AP is considered a critical disease of apples and has been found in many European countries where it causes significant apple tree decline and yield loss.

AP is caused by a phytoplasma (*Candidatus* Phytoplasma *mali*) which is a bacteria-like organism that does not have a cell wall. Without a cell wall the phytoplasmas can only survive inside the plant host or insect vector. Most phytoplasmas only invade and live in the nutrient and sugar conducting tubes called the phloem of susceptible host plants. Other examples of plant diseases caused by phytoplasmas in Ontario include X-disease in peach and Aster yellows that infects many vegetable crops each year. Unfortunately plant diseases caused by phytoplasmas are difficult to manage.

Apple trees infected with the AP phytoplasma often produce multiple auxiliary buds very close together at the end of one or several branches. These buds develop into dense secondary shoots at the end of a branch resulting in a "witches broom" appearance. The symptom of multiple shoots spaced close together growing at the end of the same branch is called 'proliferation' from which this disease gets its name. Similarly, shoots and spurs on infected trees may develop multiple leaves close together in a rosette. These rosettes of terminal leaves will often break dormancy late in the growing season and are often covered with powdery mildew. Leaves on infected trees are often smaller with large stipules, lighter green or sometimes yellowish in colour. The leaves will turn red instead of the normal yellow colour often observed in the fall and defoliate prematurely. Some or many flower buds on infected trees may break dormancy in late summer or early fall and the resulting blossoms are often larger with a longer than usual stock or peduncle. Sometimes the flower petals develop into green leaf-like structures. Fruit produced by severely infected trees are smaller, with less sugar, less acid, and appear flat and pale green. This disease can cause 30-100% marketable yield loss.

There are many reports of alternative hosts of the AP phytoplasma including European pear (*Pyrus communis*), pink periwinkle (*Catharanthus roseus*), hazel (*Corylus avellana*), grapevine (*Vitis vinifera*), many *Prunus* spp., Ribes (*Ribes rubrum*), hawthorne (*Crataegus monogyna*),

lily cv. Siberia (*Lilium* spp.), dahlia (*Dahlia* × *cultorum*), native tobacco (*Nicotiana occidentalis*) and cultivated tobacco (*Nicotiana tabacum*) however, these hosts act as reservoirs of the AP phytoplasma and not much is known about the effect of AP phytoplasma on theses hosts. Field bindweed (*Convolvulus arvensis*) and Bermuda grass (*Cynodon dactylon*) have also been reported to be hosts but not confirmed.

The AP phytoplasma is spread when contaminated bud wood or rootstocks are grafted to make new trees. Long distance spread occurs when infected trees are transported to another region. Once it is introduced into a region, the phytoplasma can be spread from tree to tree within an orchard and to other nearby orchards by specific piercing and sucking insect vectors. The main insect vector of AP in Europe is a tiny psyllids (*Cacopsylla melanoneura*) that is not known to occur in North America. The other two vectors capable of spreading this pathogen are the privet leafhopper (*Philaenus spumarius*) and meadow spittle bug (*Fieberiella florii*) that are known to occur in both Ontario and British Columbia. Research has also shown that both the privet leaf hopper and meadow spittle bug are not very efficient vectors of the AP phytoplasma and do not occur on apple trees very often. Regardless they do show up from time to time in orchards and there is the potential for this disease to spread if introduced into Ontario.

Insect vectors acquire the phytoplasma during feeding activities on infected plants. Once acquired, the phytoplasma moves throughout and multiplies within the insect vector's body for a period of time before it can be transmitted in a persistent manner to other hosts plants. This latent period is temperature dependent and ranges from a few days to several weeks. After the insect vector picks up the phytoplasma and incubates it, the vector insect remains invective for the rest of its life. Studies have shown that the AP phytoplasma can overwinter in some adult vectors and their offspring.

The AP phytoplasma are often not evenly distributed within infected trees for several years. During the summer months AP phytoplasma can be found in both the above ground plant parts and roots of infected trees, however when temperatures decrease during the fall and winter months, the AP phytoplasmas moves into the roots where they over winter and cannot be detected in the above ground plant parts until they move back during the following spring probably with sap flow.

Once the phytoplasma is introduced into an orchard, management relies on controlling the vectors within and outside the orchard. The immediate removal of alternative hosts in and around the orchard as well as infected trees helps reduce the source of the phytoplasma. New orchards should be planted with non-infected trees produced from budwood obtained from disease-free, phytoplasma-tested mother trees.

Postharvest

Effects of Preharvest Weather Conditions on Firmness of 'McIntosh' Apples at Harvest Time

M. Lachapelle and G. Bourgeois (AAFC-QC), and J. DeEll (OMAF and MRA, Simcoe)

Apple fruit firmness is one of the main attributes indicating fruit quality at harvest. It is affected by numerous factors during the entire growing season. The effects of weather conditions during apple fruit development are often mentioned as a result of their impact on attributes linked to fruit firmness: fruit size, calcium concentration, water content, etc. In this study, the effects of weather conditions on 'McIntosh' apple firmness at harvest time were analyzed. Fruit were harvested at nine sites in Quebec and Ontario over 15 years (1996–2011). For each case, weather parameters were analyzed from full bloom until harvest, either in monthly sub-periods from May until September or in terms of days from full bloom (DFB) until harvest. Regression results highlighted the negative effect of lower air temperature conditions from 31 to 60 DFB, higher air temperature conditions and precipitations from 61 to 90 DFB, and higher temperature conditions from 91 DFB until harvest on 'McIntosh' apple firmness level at harvest. Precipitation from 61 to 90 DFB alone explained 39% of 'McIntosh' apple firmness variation at harvest time. The prediction of apple firmness at harvest time could be helpful for producers to adjust their marketing and storage strategies according to apple quality level.

Comparison of annual firmness levels at harvest in 'McIntosh' apples shows a slow decrease since the 1990s for Ontario and Quebec regions (Fig. 1). However, studies still have to be conducted on multiple comparisons between apple productions before and after the 1990s to detect the main factor explaining this decrease. Simple modifications in orchard management practices, apple tree loads per orchard, crop load, handling techniques, or fruit quality indices used to detect maturity levels might imply modifications of firmness levels at harvest (Harker et al., 1997). It has been suggested that the deterioration in textural properties of apples may be linked with development of more intensive growing systems within the orchard and greater standards for apple caliber, which lowers the overall firmness values at harvest. In England, this downward trend in apple firmness has been shown on 'Cox's Orange Pippin' apples, where between1966 and 1984, firmness after storage has declined by more than 10 Neutons (N)* despite improvement in controlled-atmosphere regimes over the years (Horscroft, 1989). The interpretation of such data remains problematic as a result of variations in methods for measuring firmness and fruit size, storage technologies, and length of storage period as the fruit industry becomes more sophisticated.

** 1 lb = 4.5 N*

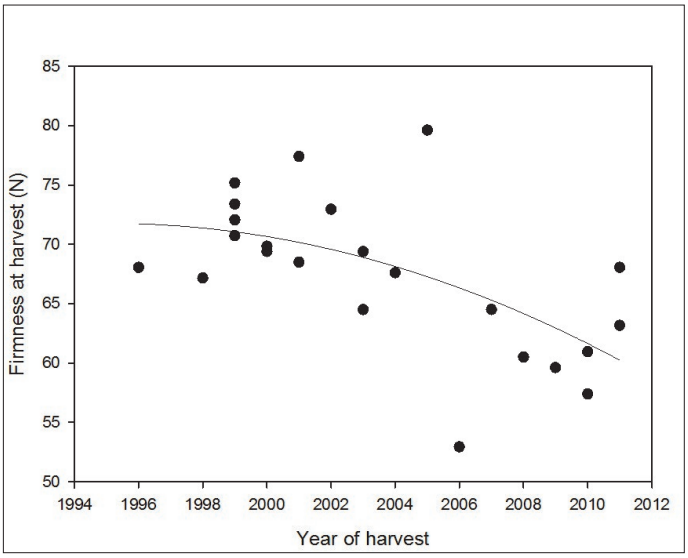


Fig. 1. 'McIntosh' apple firmness levels at harvest (N) as a function of years of harvest, for all sites and years of harvest included in this study, with a tendency curve plotted to the data. Note that ~62-72 N = ~14-16 lbs

The full paper can be found In HortScience, April 2013.

References:

Harker, F.R., R.J. Redgwell, I.C. Hallett, and S.H. Murray. 1997. Texture of fresh fruit. Hort. Rev. 20:121–224.

Horscroft, J. 1989. Production factors influencing the textural qualities of apples. PhD thesis, Wye College, Univ. London, London, UK.

Postharvest Apple Research Updates - from Outside Ontario

Dr. Jennifer R. DeEll, Fresh Market Quality Program Lead - Hort Crops, OMAF and MRA

The following is a collection of scientific abstracts from colleagues around North America that may be of interest to the Ontario apple industry.

Development of Stem-end Internal Browning and Cracking in Cold Stored 'Gala' Apples Is Related to Fruit Size - J. Lee, J. Matthies, and D. Ruddell (USDA–ARS, Wenatchee, WA)
'Gala' apple fruit can be susceptible to the development of stem-end browning and cracking (splitting) disorders during cold storage. Previous work indicated fruit stem-end browning incidence increases with fruit size. The objective of this work was to further investigate the effect of fruit size on the development of stem-end browning, cracking and other physiological characteristics of 'Gala' apples previously held in cold storage. Fruit segregated at harvest based on size (small: 120–175 g; large: 250–350 g) were stored at 0.5 °C in air for up to 6 months. Large fruit developed more stem-end browning and cracking compared with small fruit during cold storage, and browning and cracking incidence and severity increased during shelf life. Large fruit had lower internal ethylene concentration after 6 months plus 0 or 7 days at 20 °C. However, large fruit had higher respiration rate during storage and after the shelf life period. Fruit stem-end lightness (*L**) and hue angle (*ho*) declined during and after cold storage, with *L** and *ho* decreasing significantly more for large fruit. While small fruit fresh weight and circumference decreased during storage, large fruit circumference increased along with cracking incidence but fresh weight decreased during storage. These physiological changes appear to contribute to the susceptibility of larger fruit to stem-end browning and cracking more so than smaller fruit. (*Proc. ASHS, 2012*)

Characteristics of a 'Gala' Apple Fruit Internal Browning Storage Disorder - J. Matthies, J. Lee, and D. Ruddell (USDA–ARS, Wenatchee, WA)
Factors contributing to development of an internal browning storage disorder developing primarily at the stem-end in 'Gala' apple fruit were investigated. Initial storage temperature, storage duration, controlled atmosphere (CA) CO_2 concentration, delayed CA establishment, use of diphenylamine (DPA) and/or 1-methylcyclopropene (SmartFresh), and fruit weight were evaluated. Browning can occur during storage or during a subsequent 7 day shelf-life period. Large fruit are at increased risk of browning development. Browning develops in fruit stored at 0.5 °C in air or CA (1.5% O_2, 1-5% CO_2). Storage at 0.5 °C for 7 days in 17% O_2 + 3% CO_2 then air or CA does not enhance browning development. In 2 of 3 crop years, SmartFresh-treated fruit developed browning sooner compared to controls. DPA does not control browning development regardless of storage environment or use of SmartFresh. Cooling fruit to 0.5 °C after 7 days at 10 °C reduces or eliminates browning development regardless of SmartFresh use. Delayed SmartFresh treatment does not impact browning development but results in poor quality if fruit are held 7 days at 10 °C prior to 0.5 °C. The results indicate this disorder may result from chilling injury, and that chemical inhibition of ethylene action can enhance fruit susceptibility. Prompt treatment with SmartFresh and cooling fruit to 10 °C for the initial 7 days after harvest can reduce or prevent disorder development while maintaining fruit quality comparably to fruit treated with SmartFresh and cooled to 0.5 °C after harvest. (*Proc. ASHS, 2012*)

Evaluating the Synchronicity of Flesh and Peel Ripening in Standard and New Cultivars of Apples - P.M.A. Toivonen, Y. Mostofi, C.R. Hampson, and P.A. Wiersma (AAFC - Summerland, BC)
Generally internal ethylene concentration (IEC) and starch clearing index (SCI) are used to evaluate apple maturity for harvest in North America. These two methods provide good information on the flesh maturation of apples. Chlorophyll decline in apple peel was recognized as a potential criterion for maturity assessment in the early 1990s, but has not been practical to use because of

the time required to extract chlorophyll from the peel. Recently, non-destructive instruments measuring apple peel chlorophyll using spectral reflectance of two chlorophyll-related near infrared bands has enabled instantaneous assessment of peel chlorophyll and thus allows interpretation of maturity. In this study, 'Royal Gala', 'Golden Delicious', 'Fuji (strain Nagano 1)', Aurora Golden Gala™, Nicola™, SPA493, and SPA365 were monitored for changes in IEC, SCI, and chlorophyll content during maturation in Fall 2011. Decline in chlorophyll content was linear with advance in maturity for all cultivars tested. In most cultivars of apples tested, the IEC, SCI, and chlorophyll changes were well synchronized. This indicates that that non-destructive chlorophyll assessment may be an alternate tool for monitoring apple maturation and could also enable mapping of orchards to improve uniformity of maturity at harvest. In some apples, however, changes in chlorophyll content were not well synchronized with IEC and SCI changes. For an apple such as 'Fuji', it may mean that the harvest criteria using non-destructive technology should be adjusted specifically for that cultivar. In other cultivars, for which peel and flesh maturation is even more asynchronous, at least in Fall 2011, suggesting that there may be concerns for maturation in those cultivars that need further investigation. (*Proc. ASHS, 2012*)

AVG Combined with NAA Control Preharvest Drop of 'McIntosh' Apples Better than Either Chemical Alone - T.L.Robinson, S.A. Hoying, M. Miranda' and K. Lungerman (Cornell University, NY)
In some years aminoethoxyvinylglycine (AVG, trade name ReTain) imperfectly controls pre-harvest drop of 'McIntosh' apple. These years are warm with daytime temperatures over 35 °C (95 °F) in August. In 2008–2011, we evaluated whether the combination of AVG and napthaleneacetic acid (NAA) would give better preharvest drop control of 'McIntosh' apple than AVG or NAA alone. AVG (832 g ReTain/ha or 416 g ReTain/ha) was applied 3, 2 or 1 week before normal harvest. At either the 2 or 1 week before normal harvest, a combination of AVG and 20 mg/L NAA was also applied. Pre-harvest fruit drop from untreated control trees exceeded 20% by 21 Sept. and by the end of September had reached 60% drop. The traditional drop control treatment of 20 mg/L NAA applied alone on 7 Sept. did not reduce drop at any date. AVG applied alone reduced fruit drop if applied 3 or 2 weeks before normal harvest but not when applied 1 week before harvest. The addition of 20 mg/L NAA to the AVG sprays, either 2 or 1 week before harvest, improved pre-harvest drop control compared to AVG alone. The combination spray applied 2 weeks before harvest resulted in the lowest pre-harvest drop of any treatment. However, if AVG+NAA was applied 1 week before harvest then its efficacy was reduced but was still similar to AVG alone applied 3 or 2 weeks before harvest. When a reduced rate of AVG (416 g/ha) was combined with NAA, the efficacy in preventing drop was very similar to the full rate of AVG. A hypothesis to explain the improved drop control of 'McIntosh' apples from combining NAA and ReTain is: when NAA is used alone to control pre-harvest drop, it controls the genes associated with abscission zone formation but as a negative side effect it stimulates ethylene production which advances ripening including color formation and softening. With 'McIntosh', the high production of ethylene often overwhelms the stop drop effect of NAA. In contrast, ReTain acts by controlling ethylene biosynthesis but in hot years, pre-harvest drop of 'McIntosh' is not adequately controlled indicating that abscission zone genes are not totally under the control of ethylene and that ReTain does not control these genes adequately under stress conditions. When NAA and ReTain are sprayed together, NAA controls the genes associated with abscission better than ReTain while ReTain blocks the production of ethylene caused by NAA. (*Proc. ASHS, 2012*)

Effects of repeated 1-MCP treatments on ripening and superficial scald of 'Cortland' and 'Delicious' apples – X. Lua, J.F. Nock, Y. Maa, X. Liu, and C.B. Watkins (Cornell University, NY)
Postharvest 1-methylcyclopropene (1-MCP) can maintain fruit quality and inhibit development of superficial scald, a physiological storage disorder found in apple fruit, but the extent of the inhibition can vary by cultivar. In this study, we investigated whether multiple applications of 1-MCP, which are now permitted by a label modification of the commercial 1-MCP product, SmartFresh, might improve scald control. 'Cortland' and 'Delicious' apples were untreated, treated on the day of harvest with the antioxidant inhibitor of scald, diphenylamine (DPA), or with 1 ppm 1-MCP at different intervals after harvest. Treatment times (days) were 1, 4, 7, 1 + 4, 4 + 7, 1 + 4 + 7, 7 + 14, 7 + 28, 7 + 42, or 7 + 84. Internal ethylene concentrations (IECs), flesh firmness, and accumulations of (precursors to superficial scald) α-farnesene and conjugated trienols (CTols) were measured at harvest, at the time of treatment, and at intervals during air storage at 0.5 ^{o}C for up to 36 weeks. Scald was completely inhibited by DPA and all 1-MCP treatments in 'Delicious'. However, effective control of scald in 'Cortland' was obtained with 1-MCP treatments within the first 4 days of harvest, either alone or in combination. Scald control with delayed 1-MCP treatments resulted in poorer scald control that was comparable to that obtained with DPA. IECs and α-farnesene accumulation were similar in untreated and DPA treated fruit, but inhibited by 1-MCP. However, differences among 1-MCP treatments became more evident with increasing storage periods. Inhibition of IECs and α-farnesene accumulation was greater in fruit treated on days 1, 4, 1 + 4, 4 + 7, 1 + 4 + 7, than on day 7 alone. A second application of 1-MCP on day 14 to fruit treated on day 7 increased inhibition of IECs, α-farnesene and CTol accumulations, but increasing delays before the second 1-MCP treatment resulted in progressively less inhibition of these factors. Similar effects of treatment on IECs, α-farnesene and CTol accumulations were found for both cultivars, even though no scald was detected in treated 'Delicious' apples. The results indicate that initial 1-MCP treatments should be applied to faster ripening cultivars such as 'Cortland' within a few days of harvest. (*Postharvest Biol. Technol., 2013*)

Announcements

Apple IPM/Scout Training Workshop

Margaret Appleby, IPM Systems Specialist, OMAF and MRA

Mark your calendars for the 2013 Apple IPM/Scout Training Workshop on Wednesday, May 8 in Simcoe. Growers who want to have an IPM refresher course, as well as summer scouts and consultants are all welcome to attend.

- 9 am to 3 pm (registration at 8:30 a.m.)
- Simcoe OMAF and MRA Resource Centre, Blueline Rd. and Hwy #3
- Session ends with an orchard visit for hands-on monitoring.
- There is no charge to attend.

Topics covered will include:

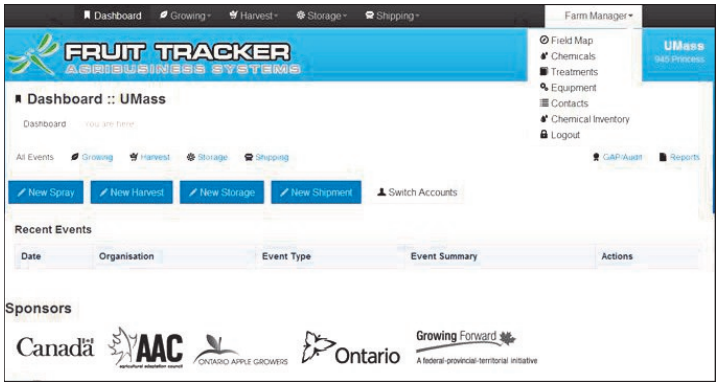
- Understanding apple tree phenology and orchard practices
- Learning about monitoring techniques
- Understanding apple diseases and insects
- Understanding the beneficial insects and mites
- Finding the information you need

Get primed for the day by having a look at the Apple module in Ontario CropIPM
www.omafra.gov.on.ca/IPM/english/apples/index.html
www.ontario.ca/cropIPM

Please preregister by contacting the Agricultural Information Contact Centre (toll free) at 1-877-424-1300.

Apple Tracker

Are you setting up your Apple Tracker file for this growing season? Here is a good video/YouTube on the features that will help you get started.
YouTube: youtube/NBT1DC9UNfA
Downloadable: www.fruittracker.com/resources/video/FruitTracker-101.mp4



Save the Dates

IFTA Summer Study Tour
Gettysburg, Pennsylvania
July 16-18, 2013
www.iffruittree.org
Includes the Penn State Fruit Research and Extension Center Field Day, and tours of 9 innovative orchards. Pre- and post-conference tours available.

Ontario Apple Summer Tour
Norfolk County
Tuesday, July 23, 2013
In conjunction with the CHC Apple Working Group summer meeting
Features Tall Spindle orchards, IPM trials, postharvest research, packing facilities, and much more.
Details to follow, all are welcome.

Food Safety Snippets

Instructional Posters for On-Farm Food Safety

Wayne Du, OMAF and MRA

Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs (OMAF and MRA) has developed a series of Good Agriculture Practices posters that are available **free of charge** to producers.

The posters are 8 ½ x 11" in size and available in English/Spanish or French/Spanish versions. They are rip and weather resistant making them durable enough to use in and around your farm.

The posters provide visual instructions for best practices on a variety of topics, including:

- Hand washing
- Proper use of hand sanitizers
- Food handling
- Proper toilet use
- Food storage and packaging
- Transportation

Food safety practices contribute to competitive, productive and sustainable agri-food business. For more information and to see our posters, visit the Ontario Ministry of Agriculture and Food and the Ministry of Rural Affairs website at www.ontario.ca/goodagpractices or call us to order your posters, 1-877-424-1300.

Using the Equilifruit Disk

Leslie Huffman, Apple Specialist, OMAF and MRA

The Equilifruit Disk is a tool to help you assess the level of crop load that each apple tree and/or branch can carry – to maximize yield and fruit quality, while ensuring return bloom. It can be difficult to workers to visualize how many buds to prune off, or how many fruit to remove when hand-thinning, but this tool has been very useful to make those decisions.

The Equilifruit Disk was developed in France as a spur pruning gauge, and tested for our climate by Dr. Jim Schupp in Pennsylvania as a hand thinning gauge. Here are the components of the disk:

- The edge has circular cut-outs to fit around a branch
- Each cut-out has 3 sets of numbers:
    - The branch diameter (in mm)
    - The F-number shows the number of fruit to leave
    - The delta number (in the triangle) – the range + or – from the F-number
- A central hole that is useful for a lanyard or wall hook to avoid losing

Scientists have shown that the diameter of the trunk is a good indication of how many fruit the tree can carry (expressed as fruit/cm2 of trunk cross-sectional area (TCSA). Because we are moving to renewal-style pruning (e.g. Tall Spindle), this concept is now applicable to each branch, which is easier for workers to visualize.

Here are some tips to use the disk:

- Measure after June drop
- Place disk approximately 1” from the trunk to avoid the branch collar
- Count number of fruit on the limb
- If too many, remove in this order: damaged fruit, small fruit, clustered fruit
    - For example, your branch is 12 mm, you should leave 7 fruit +/- 2.

Dr. Schupp found there is a tendency to over-thin by hand, especially using a rule-of-thumb like spacing at 6-7”. His research shows the Equilifruit Disk provides a consistent crop load adjustment after inadequate chemical thinning with a subsequent increase in fruit size with minimum yield reduction. He suggests using the Equilifruit disk to provide example trees for workers, to train and re-calibrate them.

Read more about his research at www.plant.uoguelph.ca/treefruit/documents/20121212_J_Schupp.pdf

Agricultural Information Contact Centre: 1-877-424-1300
E-mail: ag.info.omafra@ontario.ca
Northern Ontario Regional Office: 1-800-461-6132

www.ontario.ca/omafra