ORCHARD NETWORK

For Commercial Apple Producers

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In this issue….

ORCHARD MANAGEMENT

Cultivar Update

John Gardner, Apple Specialist, OMAF, London

Once again we are watching the apple cultivar trials here in Ontario for outstanding attributes amongst numbered selections and varieties. It sometimes takes a few years and plenty of potential candidates to see where we may be headed with new material. Amongst the most outstanding of the materials we have seen is Ambrosia®.

Most growers are now familiar with the Ambrosia cultivar and its attributes on the tree. We now have some pretty good evidence that this cultivar stores well in standard CA and maintains it's characteristic good qualities for at least 6 months after harvest.

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This issue of the **Orchard Network Newsletter** was compiled by Client Service Representatives, Marian Desjardine, OMAF, London and Leslie Parks, OMAF, Simcoe.

The fruit is considered to be distinguishable from other apples because of its unique appearance and colour described as a pinkish blush over a cream background. The calyx end of the apple remains a golden yellow colour for most of the crop.

Ambrosia is now a limited acreage cultivar in Canada according to PICO representatives in B.C. Both the USA and Canada will be growing this cultivar. The U.S. has been given the rights to grow 500 acres. This was largely the result of a desire to get production volumes in North America up faster. These plantings in the U.S. will be in the State of Washington, in the Wenatchee area.

To limit acreage of this cultivar in Canada, all trees delivered after July 1st 2006 will be subject to a $3.75 per tree royalty. The future would see more acres planted in North America to match marketing plan objectives. In the future, royalties would presumably be adjusted downwards to stimulate more planting as more acreage is allowed.

Part of the future North American production of Ambrosia will be coming from Ontario, as one of the regions recognized as a producer of this cultivar by its owners. The distinct colour development of Ambrosia is highly dependent on cool nights in the preharvest period. Ontario could provide one of the finest coloured Ambrosia grown in North America.

Summer Pruning and Finalizing Crop Load

John Gardner, Apple Specialist, OMAF, London

One of the great advantages of summer pruning that has really only recently been talked about very much is its apparent influence over the rate of **transpiration of the apple tree canopy** (Figure 1). Trees that are sufficiently summer pruned do not move as much moisture out of the orchard ecosystem than trees left with a full canopy. Coupled with other **water conservation practices** that include mowing, mulching, thinning, and efficient watering, the well-managed orchard has a higher probability of producing a larger fruit. All these practices of course add to the cost of production but create a positive cost/ benefit ratio.

Selective hand thinning fits well with the practice of summer pruning and most growers looking for larger fruit of selected cultivars will remove a lot of inferior looking apples at the same time. By thinning the canopy through selective shoot removal, these poor looking smallish fruit come out of hiding. A small apple will always remain small in relationship to a large apple during the post fruit set period. Small apples do not make up size deficiency during the growing season.

Figure 1. **Thinning down the apple canopy**. Avoid removing an excessive amount of foliage. If you think you have overdone it with summer pruning, you probably have. The figure above shows a good summer pruning job with the removal of some fruit and up to 20-30% of the shoot growth.

This process of canopy management can be started before mid July in earlier areas of Ontario. It does take some practice to know just how far to space fruit apart on the limb to get those larger size classes. If we suggest a rough measurement from stem to stem of 8 inches or ~20 cm, that would leave about 4 inches or 10 cm between the edges of apples grown to a size of 3 inches or 113 count size at maturity.

There remains less and less logic in growing smaller fruit for North American fresh markets in general. One of the outstanding problems facing the average grower is that of **handling a crop of smaller apples**. Not only is it more costly to handle the crop in terms of picking, the value of the crop diminishes significantly with each reduction in size class.

A grower would have to grow several bushels of smaller fruit to equal the value of a couple of bushels of large well-finished apples. Two bushels of 113 size fruit could return as much as 5 or more bushels of around 150 size fruit. This is after the cost of picking with associated wastage from dropped fruit while picking. The cost of harvesting a large crop of small apples could be double the cost of harvesting an average crop of larger apples. Picking crews always move faster in a well-thinned block.

Does It Pay to Fertigate Apples?

John Gardner, Apple Specialist, OMAF, London

This is not an easy question to answer and until recently it would have stumped most knowledgeable horticulturists. In some ways, the answer would almost seem like a slam-dunk. We want a reliable supply of both nutrients and water through the growing season to make sure there are no deficiencies of anything getting to the roots.

So really, the apparent simple answer is to dissolve the nutrients into a bulk tank and meter them off as needed by way of a solid set irrigation system (Figure 2), thereby providing both water and nutrients. This type of technology was developed in arid climate regions like California and Israel. Some years it's almost semi arid in Ontario with unreliable rainfall patterns while other years bring more rain than we can use.

With the advancements in both irrigation and fertilizer technology in the last decade, it is possible to combine both water and nutrients and deliver them uniformly to the root system of apples in high-density plantings. Researchers at Cornell (Terence Robinson and Warren Stiles) have studied this concept and drawn some conclusions.

We know how important it is to water young trees. These New York researchers have concluded that the use of ground fertilizers is best where some form of irrigation is used to get the fertilizer materials mobilized and working. Average fruit size on young trees was in most cases improved with trickle irrigation plus ground applied fertilizers or fertigation.

What the researchers found on young trees was that the distinction between fertigated trees and trees receiving water plus ground applied fertilizers was not consistent on typical orchard soils in the State of New York. On older trees, the method of application of potassium either through the trickle line or on the ground made no difference. The trickle treatments, however, did move nutrients much deeper into the soil profile than did the ground applied treatments. The depth of penetration of potassium with fertigation was up to 2 feet or 60 cm. Ground applied materials could only be found at a maximum depth of 16 inches or 40 cm.

One alarming factor that was observed was the drop in pH of soils under the fertigation emitters where ammonium nitrate was used to a low of pH 4-5 after 8 years of study. These studies were conducted on finer textured soils and not on light textured soils, which we do see here in Ontario. The researchers do state that soils that are coarse textured and lighter being more subject to drought could see a greater and distinguishable benefit from the fertigation treatment program when compared to unirrigated trees.

They commented on the timing of irrigation and like we have seen here in Ontario it's not wise to wait too long to get started with water applications, even as early as June 1 in an average year. This year of course we could have sold water if anyone needed it.

With fertigation treatments in wet years, Robinson and Stiles recommend using only enough water to get the fertilizer on while in dry years the objective would be to use enough water to replace what has been lost by the trees. The two nutrients most commonly applied through trickle technology are nitrogen and potassium. Magnesium and boron can be applied through methods of fertigation or foliarly. Zinc and calcium are best applied foliarly.

Figure 2. High density planting of apple showing trickle line with pressure compensating emitters.

Hilling Up for Vigour

John Gardner, Apple Specialist, OMAF, London

One of the perennial struggles an apple grower is faced with is how to keep trees from becoming too growthy and vigorous. Trees of most cultivars with rootstocks left to their own ways will for the most part have a tendency to put on too much growth with an inevitable drop in fruit quality and crop volume in the process. Over the years, strategies for controlling tree vigour have varied considerably. They include root pruning, summer pruning, withholding of nutrients, shallow planting and the use of size controlling rootstocks just to highlight a few.

Just to complicate the problem even more, some cultivars are not known to be not nearly vigorous enough, particularly if they are budded to a more size controlling rootstock like B9 or M9 and planted fairly shallow.

Most of the apple trees planted in Ontario for the last two decades have been planted with bud union well above the soil line. This strategy does not work for all cultivar/rootstock combinations. The lack of vigour of the Honeycrisp cultivar has been known for some time and trees planted too shallow on size controlling rootstocks can result in plantings that are too slow to establish in some situations.

One method that may help with this problem is to hill around the base of the tree with soil. The idea here is to have greater root volume and to give the tree more push where a planting appears to be slow coming along. Figure 3 shows soil hilling of Honeycrisp on M9 for this very reason. The desired growth response may take a couple of years but may be entirely worth the effort.

Figure 3. Honeycrisp/M9 with soil hilling to improve tree vigour.

Putting a Roof Over the Orchard – Hail Netting

John Gardner, Apple Specialist, OMAF, London

One of the most common photo shots brought back to North America by travelers wanting to learn more about European fruit production is the shot with apple trees under hail netting. In fact, some areas of Europe are almost entirely netted because of a 100% probability of destructive hail on an annual basis. Growers in some regions of Europe cannot get production contracts unless they are under netting.

This high probability of hail in mountainous regions of Europe is rooted in historical records and the ever-present factor of dramatic changes in elevation and air temperature from the floor of any given valley to its nearest mountain range. It is the mixing of cold air coming off the mountains with the warm air thermals coming from the ground that causes the hail. There are some very obvious advantages with the netting.

In Ontario, the use of hail netting is a fairly new concept. However, where high value cultivars are grown in a vertical axe planting, the post and wire structure is basically already there. It just has to be built a little higher using a retrofit of existing posts or by using longer posts (16 foot) in order to get a ridge wire at the 12-foot mark above the row.

The netting appears to be good for at least 12 years and is left in position year round with nets rolled up onto the ridge wire during the winter. In other words, once the netting is up, it stays in the orchard. Light coloured netting is preferred at this altitude to minimize reduction in light intensity under the canopy. The netting may also take some stress off the trees under high heat and UV conditions. Netting in Europe is reported to last in some cases up to 20 years.

Included in the suite of benefits is the obvious reduced risk from hail damaging the crop. Other benefits could include reduction or elimination of fireblight from trauma events caused by wind or hail for instance. Bird damage could conceivably be reduced and a certain amount of insect pressure could probably be eliminated because of the fineness of the mesh. Sprays applied to the canopy would probably stay in place longer and not suffer displacement from rainfall. Spray drift could potentially be mitigated as well.

Like an investment into irrigation systems, hail netting costs look pretty scary at first but when these costs are spread over more than a decade of usage, they become more rational.

The actual netting is interesting from a tensile strength perspective. It doesn't stay flat and smooth during a hail event but stretches and gives to accommodate the weight of the pellets, which can be considerable. At some point the net will dump the ice harmlessly between the rows and reload if the hail lasts any amount of time. The general look is that of a peak and furrow configuration as the pitch plays an important part in shedding the hail that is trapped. What we do not know and can only speculate on at this time is the overall effect on microclimate under the netting. This may include changes in drying times from wetting events or an increase in humidity from the separation of air masses on each side of the roof. Look for increased interest in hail netting as a risk management tool for orchardists and apple growers in particular here in Ontario and the Northeast.

In talking with Mark Lucas at Gintec Shade Technologies Inc., an Ontario supplier of netting for various agricultural purposes, he stresses that planning is key to getting started with netting. If you want to do something in 2005, start the process now. The netting itself is custom made to fit the planting. Most of the cost is in the perimeter hardware according to Mark. This is understandable because it is the ends and sides of the planting that secure the wires, etc.

Mark estimates the costs at around $ 8,000 per acre. This includes posts, wires, hardware, and netting. This cost can vary and could go down with larger plantings. In other words, the bigger you go the less cost per square foot. The actual netting required for an acre is about 10% greater than the square footage of an acre to allow for the dimension of ridge and furrow.

The Italians pioneered much of the technology in regards to hail netting. This is a result of the need to secure supplies of fruit in risky areas for cooperatives to forward contracts with buyers in the rest of Europe.

Figure 4. Retrofitted vertical axe end post, set up for hail netting.

CROP PROTECTION

Summer Disease Control

Michael Celetti, Plant Pathologist – Horticulture Crops, OMAF, University of Guelph, Guelph

The cool wet growing season experienced in Ontario during 2004 has been ideal for the dissemination, infection and establishment of many diseases. Keeping up with the weather and finding time to spray between showers has challenged many growers this year. Unfortunately, the wet weather along with slightly below normal temperatures is also conducive for summer diseases.

In Ontario the two most common summer diseases in apples are Fly Speck (Figure 5) and sooty blotch. The fungi that cause these two diseases rarely penetrate the waxy cuticle but

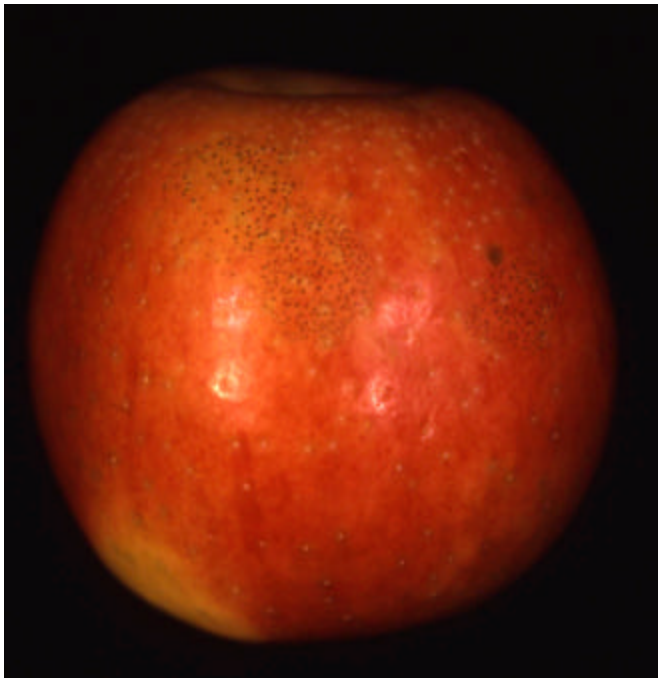

Figure 5. Fly speck symptoms appear as a colony of tiny black specks on the surface of apples.

live on the surface of the fruit. Unfortunately, the unsightly superficial blemishes they create can make the affected apples unmarketable. The fungi also live in the buds and bark of apple trees without causing any damage, however, when wet conditions together with temperature ranging between 18-27^{o}C persist, the fungi produce spores that are rain splashed to developing fruit. Infections can take place as early as 2-3 weeks after petal fall. During periods of cool humid conditions the fungi colonize areas of the apple fruit surface. Symptoms often do not appear in the orchard until 3-4 weeks after the infection. Hot temperatures greater than 30^{o}C inhibit the growth of these fungi.

Many of the fungicides used to control apple scab probably keep early infections under control. However, later in the season, particularly when wet cool weather persists, the fungi produce spores that cause secondary infections when scab control is no longer required.

Repeated summer sprays of Captan or Maestro applied at the full rate will reduce the severity of colonization by these superficial fungi. Flint 50 WG, a new fungicide registered this past year on apples, has also been shown to provide very

good control of these summer diseases. Although this product is more costly than Captan or Maestro, an application or two in August may protect a good apple crop from becoming infected with the summer diseases this season. Flint is in the strobilurin group of fungicides along with Sovran and only four applications of strobilurin fungicides are allowed in apples per season to reduce the risk of resistance developing.

Apple Clear-Wing Borers Take Flight

Hannah Fraser, Entomologist – (Horticultural Crops), Program Lead, OMAF, Vineland

In an effort to obtain a few good adult specimens of dogwood borer for demonstration purposes, I spent one fine morning about 10 days ago picking through the burr knots of several apple trees in the Simcoe area. My quest for dogwood borer pupae ended up being a success, and in the last few days, several male and females emerged (to be unceremonially whisked off to the freezer, pinned, and put on display). Indeed, it appears that the flight is underway in the field as well, with reports of catches in pheromone traps coming in.

The dogwood borer (DWB), *Synanthedon scitula*, is one of two clear-wing moths attacking apple trunks; the other is the apple bark borer (ABB), *Synanthedon pyri*. Adults of both species are predominantly black with yellow stripes on the abdomen and yellow legs; they resemble small wasps at first glance. The DWB has a total wingspan of 12-22 mm (females tend to be on the larger size). Wings are mostly transparent, with board black tips on the forewings. Two thin yellow markings are evident on the 2nd and 4th abdominal segment; these are more pronounced in the female moth (Figure 6). The anal tuft is rounded. The ABB is very similar to the DWB in terms of size and banding, but has a distinct reddish-orange spot located on the forewing, and a larger, wedge-shaped black anal tuft.

Learning to identify the adult males on pheromone traps is important, as males of several other species are attracted to the lures used for DWB. I have found one excellent guide for identification of clear-wing moths, though it may now be out of print: "A Guide to the Clearwing Borers (Sesiidae) of the North Central Unites States" (North Central Regional Publication No. 394, 1991). You can find a few nice images of several species at http://www.forestpests.org.

Figure 6. Adult dogwood borer.

Clear-wing borers overwinter as full-grown larvae under the bark*. They pupate the following spring, with emergence beginning in late June or early July; flight may continue into August. Females lay eggs on the surface of burr knot formations. Hatching larvae bore into the burr knots, eventually moving to the cambium, and pushing out a reddish brown frass as they feed. Size-controlled rootstocks at particularly vulnerable to attack. Feeding by larvae results in a slow decline following several years of infestation.

A combination of Pounce (permethrin) plus Superior oil applied one or two times (2-3 week intervals) to the trunk area beginning at peak pheromone catch is recommended in areas prone to damage and susceptible rootstocks (M9, M26). The use of pheromone traps for monitoring adult activity is recommended. See OMAF Publication 360 for additional information on timing of insecticide applications, and Publication 310 for details of the biology and management of these orchard pests.

* An excellent key for identification of the larval stages of borers (American plum borer, dogwood borer, apple bark borer, roundheaded apple tree borer, others) in apple can be found at www.ento.vt.edu/Fruitfiles/AppleBorerKey.html

Using Surround for Managing Apple Maggot?

Hannah Fraser, Entomologist – (Horticultural Crops), Program Lead, OMAF, Vineland

Readers of the ONNL know that Surround WP Crop Protectant (kaolin clay) has been registered for the broad spectrum suppression of several key insect pests in pome fruit, including pear psylla, tarnished plant bug, leafrollers, apple maggot, and plum curculio, among others. John Gardner, Apple Specialist and co-editor of the ONNL, has written several articles on the merits of using this product as a protectant against sunburn and heat stress. We anticipate label expansions for Surround in other crops within the next few years.

Trials conducted in Ontario in 2001 and 2002 indicate that this product is an effective tool for limiting damage caused by the apple maggot. For a summary of results, see http://www.gov.on.ca/OMAFRA/english/crops/hort/news/orchnews/2003/on0203a5.htm.

Surround does not work in the same manner as insecticides. Growers using Surround for managing apple maggot need to keep in mind that this product works by forming a barrier between the fruit and the pest: Maintaining adequate coverage during pest activity periods is critical.

What constitutes “adequate coverage”? Fruit should have a uniform, hazy whitewashed appearance, with the developing colour still evident under the coating. Growers often question the need for re-application following a rain event. We have found that a light rain may actually help to redistribute the product on the surface of the fruit; at any rate, you must wait until the foliage and fruit are dry before determining the need for re-application. Heavy rainfall, new growth and wind erosion can affect the coverage.

Figure 7. Insufficient coverage.

Figure 8. (More than) Sufficient coverage.

Apple maggot overwinters in the soil as pupae. Since adult emergence and activity runs from late June through September (peaking in August), this means that Surround coverage must be maintained until quite late in the season. Keep in mind that emergence is closely linked to soil moisture levels. In dry years the apple maggot pupae may actually remain in the soil until the following growing season. In 2004, lack of soil moisture is likely NOT an issue for the development and emergence of apple maggot – make sure to monitor for this pest as part of your IPM program!

NOTE: Washing will be required where this product is used in the management of late season pests. Most residues are readily removed with packing line brushes and forced water sprays, coupled with approved washing detergents. However, some residues may still be evident in the calyx and stem ends, particularly with red-skinned varieties. The use of waxes can improve fruit appearance, in this

case. Speak to the packer regarding the use of this product near harvest, as waxing is not accepted for fruit destined to certain markets.

For additional information on the biology and management of apple maggot, see http://www.gov.on.ca/OMAFRA/english/crops/hort/news/hortmatt/2003/17hrt03a9.htm and http://www.gov.on.ca/OMAFRA/english/crops/facts/apmaggot.htm.

Attack of the Leaf Curling Midge

Kathryn Carter, Pome Fruit IPM Specialist, OMAF, Simcoe

Have you ever seen tightly curled leaves that are dry and crusty on your apple tree? If you open these leaves and look inside you will see several orange maggot like larvae feeding on the surface of the leaf. What are these weird and wonderful insects? They are the larvae of the apple leaf curling midge.

The adult apple leaf curling midge is a small fly approximately 1.5 to 2.5 mm in length. The adults mate, and females lay their eggs on apple leaves that are partially unfolded. The eggs hatch and the emerging larvae begin to feed on the apple leaves. The larvae are initially red coloured, however, they eventually turn bright orange in colour when fully mature. The larvae spend most of their lives in the rolled up leaf. Generally, a curled leaf contains 20 to 30 larvae, however, as many as 500 larvae can been found in an infested leaf. The margins of infested leaves are rolled in towards the mid-vein of the leaf. Larval feeding prevents the infested leaf from unfolding, and the leaf continues to become more tightly rolled as the leaf continues to grow.

Mature larvae exit the curled leaves and fall to the ground. After a heavy rainfall the larvae emerge from the leaves and move into the soil beneath infested trees. The insects pupate and the adults emerge. Apples are the only host of the leaf curling midge. Some varieties with lush terminal growth may be preferred due to the availability of egg laying sites, however, all cultivars are susceptible to infestation.
These insects are not considered to be an economic pest of apples, however, high insect populations in nurseries or in young trees may result in reduced photosynthesis, and may stunt the growth of terminal shoots. In the past this insect has likely been controlled by broad spectrum insecticides applied against key pests. However, these insects are becoming more prevalent in orchards as we move away from using broad spectrum insecticide programs.

It is very difficult to manage this pest using insecticides since the midges are well protected inside the curled-up leaves. Currently Matador (pyrethroid) is the only product registered to control this pest. However, translaminar insecticides such as Admire (imidacloprid) and Assail (acetamiprid) may also be efficacious against this pest.

So There are Weeds in Your Orchard Now - Are They Important?

Leslie Huffman, Weed Management Specialist (Horticultural Crops), OMAF, Harrow

Many orchards have weed escapes by mid-summer, and growers want to know when and how to "get rid" of them. We have many tools to control of these weed escapes at this time, but perhaps a better question is: Should we spend much effort to eradicate weeds from the orchard floor at this time in the season?

Why control weeds?
The main concern with weeds is their competition with our crops for moisture and nutrients. Some additional concerns about weeds in orchards include:

- hampering harvest operations
- reducing fruit quality on low hanging branches
- harbouring insect and disease pests
- increasing weed seed bank for future years
- encouraging rodents

Remember that weeds can have some beneficial effects as well:

- maintaining soil organic matter (OM), to improves structure and fertility
- tying up N and releasing it for next year
- protecting soil from compaction
- reducing erosion
- providing refuge for beneficial insects

Dr. Ian Merwin at Cornell University in New York has been researching some of these questions in apple orchards for the last 15 years.

When to control weeds?
Gala apples on M26 planted in 1991 were followed for 5 years. Controlling weeds during May and June (60 days) gave the best growth and yields (both early and total). Waiting until July and/or August to clean up weed escapes reduced tree growth, early cropping and total cumulative yield.

Where to control weeds?
Previous research in the UK and US had reported that increasing the weed-free area under trees increased growth and yields in apples and peaches, peaking around 8 to 10 m^2 per tree. However, these were not irrigated. The trees in Dr. Merwin's experiments were irrigated, and he found that 2 m^2 per tree gave the same yield as trees with a weed-free area of 6 m^2.

How to control weeds?
Ian Merwin and Warren Stiles tried several systems to control weeds. In 1986, an orchard was planted with Empire & Jonagold/MM111 with these ground cover treatments:

1. glyphosate in May and July (Roundup)
2. preemergence herbicides in May (Gramoxone + Solicam + Karmex)
3. mowed sod
4. mechanical tillage each month
5. crown vetch cover crop
6. hay-straw mulch applied each May

Much information has been learned from this study that was continued until 1994. Here are some of the weed control observations:

- Mowed grass sod (Treatment 3) reduced yields compared to pre and post herbicides (Treatments 1 & 2). (50kg/tree compared to ~80+ kg/tree)
- Pre and post herbicides (Treatments 1 & 2) gave similar yields over the 6 years. Note that using only 2 applications of glyphosate produced many weed escapes by late summer and through the fall. (40% cover on soil by winter)
- A 1.5m (5 ft.) wide weed-free strip gave the same yields as a 2.5 m (8 ft.) wide strip.
- Although weed control and yields were good in mulch plots, 25% of the trees died of *Phytophthora* root rot or rodent damage.
- Moderate weed competition late in the season can improve fruit quality.

What can we learn from this research?

- Focus weed control efforts early in the season. Weak weed growth in late summer and through harvest has many desirable effects.
- Weed-free strips under trees can be reduced in some orchards, especially where irrigation is used. However, a weed-free area under trees is needed because mowed sod is very competitive with trees.
- Several weed management systems can achieve the desired results, including pre and post herbicides or mulch systems. The key is to minimize any negative effects e.g. rodents, diseases, spray drift, water quality.
- Weed escapes in late summer may be a sign of good management - using weeds to protect soil and water quality, harbour beneficial insects, and produce firmer and highly coloured apples while encouraging trees to harden off for winter.

POSTHARVEST

Research Updates from the 101st Annual Conference of the American Society of Horticultural Science (ASHS)

Dr. Jennifer DeEll, Fresh Market Quality Program Lead, OMAF, Simcoe

The following summaries are a few of the notable oral and poster contributions related to the postharvest handling and storage of apples that were recently presented at the ASHS meeting in Austin, Texas.

Cropload Affects Fruit Quality of Honeycrisp Apple - *Terence L. Robinson and Christopher B. Watkins, Cornell University*
A wide range of croploads (0-15 fruits per cm^2 of TCA, truck cross-sectional area) on 4- and 5-year old Honeycrisp/M9 trees were investigated for two years, by manual hand thinning soon after bloom. Fruit ripening and quality were evaluated at harvest, as well as after 5 months of storage in air at 38 and 33°F. Cropload was negatively correlated with tree growth, return bloom, fruit size, fruit red color, fruit sugar content, fruit starch content, fruit firmness, fruit acidity, bitter pit, senescent breakdown, fruit rot, and superficial scald, while cropload was positively correlated with leaf blotch symptoms,

fruit internal ethylene concentration at harvest, and soggy breakdown in storage. Overall, croploads greater than 10 resulted in no bloom the next year, as well as poor fruit size, color and flavor, but these fruit tended to have the least storage disorders. Moderate croploads (7-8) resulted in disappointing return bloom and mediocre fruit quality. For optimum quality and annual cropping, relatively low croploads of 4-5 were necessary.

Contamination of Apple Fruit with Diphenylamine during Storage - *Charles F. Forney, Jun Song, and Michael A. Jordan, AAFC, Nova Scotia*

Diphenylamine (DPA) residues have been detected on apples not treated with DPA and this is problematic in markets where DPA residues are not acceptable. Concentrations of DPA in the atmosphere of commercial storage rooms was monitored during the storage season and the adsorption of DPA onto wood and plastic bin material, plastic bin liners, foam insulation, and apple fruit was assessed. DPA was to found to volatize from treated apples and bins into the storage room air, where it was adsorbed onto storage room walls, bins, bin liners, and other apples. DPA was found in the atmosphere of storage rooms containing apples that were not treated with DPA. Wood and plastic bin material, bin liners, and foam insulation all had a high affinity for DPA and were determined to be potential sources of contamination.

Bioflavonoids of Apples: Effects of Genetic Variability, Fruit Parts and Processing - *Vicky W. Lee, H.P. Rupasinghe, and Chung-Ja Jackson, University of Guelph*

Apples are excellent sources of dietary phenolics, in particular flavonoids and chlorogenic acid, which are potent antioxidants that may play important roles in the prevention of chronic diseases. This study investigated the major phenolic profiles in eight Ontario-grown apple cultivars. Total antioxidant capacity (TAC), total phenols content (TPC), and flavonoids levels were the highest in Honeycrisp and red Delicious, moderate in Idared, Spartan, Granny Smith, and Cortland, and the lowest in Crispin and Empire. Apple peel contained 2 to 10-fold higher TAC, TPC, and 10 major flavonoids than the core and flesh tissue.

Effects of Postharvest Delay Before Application on Responses of Apple to 1-MCP - *Chris B. Watkins and Jacqueline F. Nock, Cornell Univeristy*

The effects of 1, 2, 3, 4, 6, and 8-day delays between harvest and 1-MCP treatment on McIntosh, Cortland, Jonagold, Empire, and Delicious apple quality stored in air for 2 and 4 months, and in CA for 4 and 8 months, were investigated. In addition, 1, 7, 14, and 21-day delays on Cortland, Jonagold, Empire, and Delicious quality were evaluated, after 5 months in CA. The data showed that responses of apple cultivars to 1-MCP can be affected by delay of treatment, but that within each cultivar the effects vary with harvest maturity, storage type, and length of storage. In terms of firmness retention, 1-MCP efficacy was acceptable up to a 7-day delay between harvest and treatment in Cortland, Jonagold, and Empire, and up to a 14-day delay for red Delicious.

Research Updates from the 5th International Postharvest Symposium

Dr. Jennifer DeEll, Fresh Market Quality Program Lead, OMAF, Simcoe

The following summaries are a few of the notable oral and poster contributions related to the postharvest handling and storage of apples that were recently presented at the International Postharvest Symposium in Verona, Italy.

Commercialization of SmartFresh™ (1-MCP) in the South African Apple Export Market - *Ian Couch et al., ExperiCo, South Africa*

The two most important factors affecting SmartFresh efficacy were percentage of starch breakdown and flesh firmness at treatment. Apples treated with a starch breakdown of less than 40% exhibited the best firmness retention during 4 months of cold storage (> 1 kg, compared to control fruit). Industry recommendations for fruit maturity at the time of SmartFresh treatment are as follows: Royal Gala with 20-60% starch breakdown and 7.7-8.4 kg firmness, Golden Delicious with 20-55% starch breakdown and 7.0-7.8 kg firmness, Granny Smith with 25-50% starch breakdown and 6.8-7.8 kg firmness, Pink Lady with 30-70% starch breakdown and 7.3-8.7 kg firmness, and red cultivars with 20-50% starch breakdown and

7.0-7.5 kg firmness. SmartFresh completely controlled superficial scald development and maintained better fruit firmness than non-treated fruit in all cultivars. A conceptual prediction model that uses fruit maturity variables at the time of treatment (e.g. flesh firmness, skin color, starch content, soluble solids, acidity, and internal ethylene levels) to predict the potential benefit (e.g. firmness and skin color retention, and superficial scald and bitter pit control) of SmartFresh has been developed and is currently being evaluated commercially.

Factors Affecting Efficacy of 1-MCP to Maintain Quality of Apple Fruit after Storage - *L.C. Argenta, J.P. Mattheis, and X.F. Fan, Brazil and USDA, Washington*

The degree to which ripening processes are inhibited and fruit quality maintained by 1-MCP is dependent on several factors. Responses induced by 1-MCP increase with increased concentrations from 10 ppb to 2 ppm, and saturation responses occur in 12 hours when 1 ppm 1-MCP is applied. In general, fruit temperature during treatment is not critical. Experiments conducted with Delicious and Gala apples harvested over a 4-week period indicated that fruit harvested after optimum maturity for long-term CA can benefit from 1-MCP. However, the potential for long-term storage of late harvested fruit remains low compared to apples harvested earlier. The duration of responses induced by 1-MCP can also be influenced by an interaction between fruit maturity and treatment concentration. Riper fruit may require higher 1-MCP concentration (1 ppm) for maximum duration of induced responses. The length of delay between harvest/cooling and treatment is another critical factor in 1-MCP efficacy. Experiments conducted with Granny Smith and Gala apples indicated that maximum control of fruit softening, superficial scald, and senescent breakdown is achieved by treatment as soon after harvest as possible. Effects of 1-MCP on fruit firmness retention and acidity of Gala apples during 28 weeks of storage were more evident in regular cold air storage than in CA. However, the combination of 1-MCP and CA storage can provide greater benefits then either treatment alone.

Effects of 1-MCP Treatments on Mealiness in Early Red One Apples - *Y. Soria et al., Spain*

Firmness is the most widely used attribute to describe fruit texture, but apples of similar instrumental firmness may differ considerably in their acceptability to the consumer. This is because they can possess quite different textures in terms of crispness and juiciness, which are related to mealiness. The objective of this study was to determine the effects of 1-MCP on mealiness in Early Red One apples picked at different maturity stages. Immediately after harvest, apples were treated with 625 ppb 1-MCP and then stored in air at 0.5°C for 6 months. Independent of harvest date, 1-MCP treated fruit exhibited higher values of firmness, crispness, and juiciness. Only slight differences in mealiness were found between the 1-MCP treated and untreated fruit immediately after removal. In contrast, after 7 days shelf-life, 1-MCP treated apples were significantly less mealy when harvested less mature. These results show that 1-MCP may be an interesting tool for reducing mealiness in apples.

Interactions of 1-MCP and Low Oxygen CA Storage on Apple Quality - *Jennifer R. DeEll, Dennis P. Murr et al., OMAF and the University of Guelph, Ontario*

The objective of this study was to investigate the interactions of 1-MCP and low O_2 CA storage on apple quality. 'McIntosh', 'Empire', 'Gala', and 'Delicious' apples harvested at optimum maturity for long-term storage were treated either with 1 ppm 1-MCP or without 1-MCP at 0°C for 24 hours. After treatment, 'McIntosh' and 'Empire' apples were placed into standard CA (3% O_2 + 2.5% CO_2 for 30 days then 4.5% CO_2 thereafter and 2.5% O_2 + 2.5% CO_2 for 'McIntosh' and 'Empire', respectively) at 2.5°C, and four low O_2 regimes (1% and 0.7% O_2, each with or without 0.7-1% CO_2) at either 2.5°C or 0°C. 'Gala' and 'Delicious' apples were also placed into standard CA (2.5% O_2 + 2.5% CO_2) and the low O_2 regimes, but only at 0°C. Within a specific CA regime, apples treated with 1-MCP were 0.5 to 1 kg firmer than comparable apples after mid- or long-term storage (120 or 240 days, respectively). Lowering the O_2 and the presence of CO_2 did not consistently improve firmness, as many apples treated with 1-MCP exhibited the highest firmness regardless of gas concentrations during storage. Firmness of certain cultivars in specific CA regimes was influenced by 1-MCP, gas concentrations, and

storage temperature. Ethylene, CO_2, and volatile production were generally lower in apples treated with 1-MCP, held at lower temperatures, and in lower O_2 with CO_2, although there were some interactions of these factors. Overall, 1-MCP reduced the incidence of superficial scald, but increased core browning and CO_2 injury, and interacted with the CA regimes to influence internal browning.

ILOS + ULO as a Practical Technology for Apple Scald Prevention - *M.P. Fadanelli et al., Fruit Control Equipments, Italy*

Intial low oxygen stress (ILOS) followed by ultra-low oxygen (ULO) regimes has been applied for many years on small quantities of red Delicious apples in Italy. In 2001 and 2002, ILOS (15 days at 0.5% O_2) + ULO (0.9-1% O_2, 1-1.2% CO_2, at 0.8-1.2^oC) was applied to commercial CA storage rooms of red Delicious apples. Overall, fruit were generally firmer from the ILOS + ULO treatment than from the standard ULO regime. However, there was slightly more superficial scald development in apples from ILOS + ULO than in those drenched with DPA and held in ULO. The use of ILOS provides good scald control for mid-term storage (23-26 weeks), but difficulties arise with longer storage times (>28 weeks).

Does Acoustic Firmness Relate to Sensory Perception of Apple Texture? - *D.S. Johnson and C.J. Dover, United Kingdom*

Apple samples covering a wide range in texture were produced by storage in different regimes and by using two varieties (Cox's Orange Pippin' and Gala). Acoustic firmness and penetrometer measurements were conducted on the fruit, while a trained panel carried out the sensory assessments. In Cox, the penetrometer measurements showed a general decline with increasing fruit size and with increasing storage O_2 concentration. A decline in acoustic firmness with increasing fruit size and O_2 concentration was observed, although with an apparent reduced sensitivity compared to the penetrometer measure. The sensory assessment of crispness showed a similar overall trend with O_2 concentration, but without a consistent of fruit size. For Gala apples, similar trends with storage atmospheres for sensory crispness and penetrometer measurements were observed, although there was a clear trend of declining values with increasing fruit size for the penetrometer that was not evident for sensory crispness. There appeared to be little effect of storage atmosphere or fruit size on the acoustic firmness index for Gala. When data for the two varieties was combined, there was a good relationship between penetrometer readings and scores for sensory crispness for values below ~ 13 lb, but poorer above 13 lb. The relationship between acoustic firmness and sensory crispness was poor, as was that between acoustic firmness and penetrometer readings particularly between 13-15.5 lb.

SmartFresh™ Receives Temporary Registration in Canada

Dr. Jennifer DeEll, Fresh Market Quality Program Lead, OMAF, Simcoe

The following information was circulated by the PMRA last month: "New Product for the Canadian apple Industry. The active ingredient 1-methylcyclopropene (1-MCP) and SmartFresh technology, its associated end-use product, are eligible for temporary registration under Section 17 of the Pest Control Products Regulations. SmartFresh is used on apples immediately after harvesting to delay ripening, thereby maintaining fruit flesh firmness and extending the storage life of apples destined for immediate sale or storage. By extending the storage life of apples, it is expected that this product will increase the competitiveness of the Canadian apple industry in international markets. SmartFresh is applied to air-tight apple storage areas without the applicator or others being present. Risks to workers and consumers of apples, as well as to the environment, are low."

This temporary registration is until December 2005, at which time additional efficacy data will be required. Research needed to generate the necessary data will commence this fall, both on commercial and small-scale basis.

For more information on the use of SmartFresh technology, please join us at the Apple Storage Clinic to be held at the Simcoe Horticultural Station on August 24th, 2004. Representatives from AgroFresh Inc. will be present and will discuss the Canadian set-up and procedures. Further details of the clinic can be found at the end of this newsletter, under Announcements.

ANNOUNCEMENTS

Unpasteurized Apple Cider/Juice Food Safety Workshop

The Ontario Ministry of Agriculture and Food is in the process of preparing a workshop for Apple Cider/Juice Producers.
Date and Location: August 17, 2004 - Eckhard and Fiona Lutz, Lutz Orchards, R. R. #1, Troy

Time: 10:00 am to 3:00 pm (9:30 Registration)

Registration: $10.00 at the door (to cover lunch)

Topics to be discussed include:

- Results of the OMAF 2003 Cider Study
- Impact of the Juice HACCP Rule on US Cider Producers (Bob Tritten, MSU)
- Nutrition Labeling Update (Canadian Food Inspection Agency)
- Patulin Update - Orchard Management Tips to reduce moulds (OMAF)
- Pasteurization - operation review and product sampling (Eckhard Lutz + Goodnature Rep)

Additional information will be mailed to cider producers prior to the workshop. If you have any questions, please contact John Henderson, Food Inspection Branch at (613) 475-5175.

Apple Storage Clinic

Tuesday, August 24th, 2004
Horticultural Experiment Station Auditorium, Simcoe, Ontario

Cost $45, lunch included

Registration and coffee at 9 a.m., clinic starts at **9:30 sharp!**

Sponsored by: Apple Marketers' Association of Ontario and OMAF

Topics and speakers include:

- **Thermofogging**: New Technology for Postharvest Chemical Applications (Dr. Peter Sanderson, Pace International),
- **Management of Storage Decays** (Dr. Deena Errampalli, AAFC, Vineland),
- **Challenges in the Storage of Honeycrisp in Michigan** (Dr. Randy Beaudry, Michigan State University)
- **Handling and Storage of Honeycrisp in Ontario** (Dr. Jennifer DeEll, OMAF, Simcoe),
- **SmartFresh (1-MCP) Technology and the Canadian Program** (Dr. Nate Reed and Doug Warrington, AgroFresh),
- **Scientific and Commercial Experiences with 1-MCP/SmartFresh** (Dr. Randy Beaudry, Michigan State University),
- **Commercial and Small-Scale Trials with 1-MCP in Ontario** (Dr. Jennifer DeEll, OMAF, Simcoe),
- **Apple Stress and Storage Recommendations for Ontario** (Dr. Dennis Murr, University of Guelph).

New Factsheet Available

Patulin - A Chemical Concern for Apple Producers and Processors, by Sandra Jones. Order No. 04-043, June 2004.