

# NEW YORK FRUIT QUARTERLY

## Editorial

### The Future of the New York Fruit Extension Team

One of the great strengths of the New York State fruit industry is the Cooperative Extension System made up of field specialists and on-campus faculty. Over the last 30 years, we have had the benefit of specialized field extension agents who have helped the fruit industry much more than general agriculture agents could have. Our system is viewed as the model system by the rest of the world. Our field extension specialists have national and international recognition as the best field extension team around. However, the current system is under severe budgetary pressure at both the county extension association and the college level and is probably not sustainable in its current funding format. The fruit extension system needs careful and thoughtful deliberation by the fruit industry and the college to develop a plan for the next five years.

It appears to me that there are two possible courses of action:

- 1) Downsize the fruit extension team as funds are lost at the county and college level;
- 2) Develop new innovative funding sources to support the team.

The first option would seriously weaken the technical support system Cornell and the county extension associations provide the fruit industry. It is exactly what has been happening in many other parts of the world. Extension systems in New Zealand, the UK, and Holland were dramatically downsized over the last 15 years and, in those three countries, the public extension systems disappeared. Public extension specialists were replaced in part with private consulting companies which work with the larger growers but, for many of the other growers, there has been a significant void in the support they receive. The kinds of events our growers have come to rely on such as annual pruning demonstrations, winter fruit schools, spring thinning meetings, on-farm research and demonstration plots, summer field tours, preharvest meetings, trouble shooting visits and proactive education programs have disappeared in those countries. Growers there look at our system with envy and tell us "don't let your extension system disappear."

The second option of developing new innovative funding sources to support our field extension system offers a much better future for the New York fruit industry. Currently, the funding that county extension associations provide is the backbone of our field extension system. First, we must continually support them within the political system of each county to maintain as much of the county funding as possible. Without the counties, the whole system would collapse. However, the continual budget pressure county extension associations are facing means that over the long term they will only be able to fund a smaller portion of the cost of the extension system than they do now. This budget gap is where the industry needs to focus its collective efforts.

What possible sources of funding might the industry pursue to meet this budget gap? The first option is greater state funding. An effort needs to be pursued by the organizations representing the growers: the New York State Horticultural Association, the NY Farm Bureau, the NY Apple Association, the NY Berry Growers Association, the NY Summer Fruits Growers, the NY Pear Growers, and the NY Wine and Grape Growers. What is the state willing to invest in the extension support system to keep New York fruit growers competitive and profitable? Relatively small amount of state dollars will help stabilize the current system.

A second source of funds is the industry itself. What are growers willing to pay to keep the outstanding system we currently have? What are the fruit processors in the state willing to pay? What are the fresh packers and shippers willing to pay? What are the New York state retailers willing to pay to keep the excellent extension support system in place to keep New York growers on the cutting edge of fruit production?

A multi-source funding system of county extension associations, Cornell University, the State of New York and the fruit industry itself ought to be developed. If properly implemented, it will stabilize the fruit extension system in New York and strengthen the New York fruit industry. Let's work together to get it done.

Terence Robinson  
Chair of the Cornell Fruit Program Work Team

## CONTENTS

### Modified Atmosphere Packaging Maintains Sweet Cherry Quality After Harvest

Jim M. Wargo, Olga I. Padilla-Zakour, and Kawaljit S. Tandon.....5

### Fresh Market Sweet Cherry Varieties for Eastern North America

Bob Andersen, Gregory Lang and James Nugent.....11

### Susceptibility of New Apple Cultivars to Common Apple Diseases

Dave Rosenberger .....17

### Susceptibility of New Apple Cultivars to Various Arthropod Pests

Dick Straub ..... 25



FRONT COVER: Hydrocooling and special plastic bags that give modified storage atmosphere can help extend the storage life of fresh sweet cherries for four weeks. Photos by Jim Wargo.

BACK COVER: Lapins sweet cherries that were stored in modified atmosphere packages for four weeks had green stems and better fruit quality than conventionally stored cherries. Photos by Jim Wargo.

Background photos on front and back covers by Communications Services, NYSAES, Geneva, NY.

## NEW YORK FRUIT QUARTERLY

VOLUME 11 • NUMBER 2 • SUMMER 2003

This publication is a joint effort of the New York State Horticultural Society, Cornell University's New York State Agricultural Experiment Station at Geneva, and the New York State Apple Research and Development Program.



Editors:

Terence Robinson and Steve Hoying  
Dept. of Horticultural Sciences  
New York State Agricultural Experiment Station  
Geneva, New York 14456-0462  
Telephone: 315-787-2227  
Fax: 315-787-2216

Subscriptions: \$20/year. Contact Karen Wilson,  
NYSHS, PO Box 462, Geneva, NY 14456  
or call: 315-787-2404

Advertising: Warren Smith: 845-255-1442  
Production: Communications Services,  
NYSAES, Geneva

# Modified Atmosphere Packaging Maintains Sweet Cherry Quality After Harvest

Jim M. Wargo<sup>1</sup>, Olga I. Padilla-Zakour<sup>2</sup>, and Kawaljit S. Tandon<sup>2</sup>

<sup>1</sup>Cornell Cooperative Extension's Lake Ontario Fruit Team

<sup>2</sup>Dept. of Food Science and Technology, NYSAES, Cornell University, Geneva, NY

Sweet cherries can be highly profitable for growers in the Northeastern United States due to the strong demand for locally grown quality products. A major limitation is their short shelf life even under ideal cold storage conditions. Over-production in any given year and gluts in the market restrict the growers' ability to competitively sell fresh cherries compared to other crops with extended storage capacity. In many cases, cherries must be sold at low prices to expedite movement and prevent complete losses that can occur once the fruit falls out of condition. In the worst case scenario, the cherries are discarded after the

grower has incurred all production costs including harvesting and packing. Growers in New York are at a disadvantage compared to their Western United States counterparts because the cherry varieties produced here typically have shorter storage potential and shelf life. Clearly, any method to preserve postharvest quality would help New York cherry growers compete in wholesale and high end retail markets.

Postharvest practices such as proper handling and cooling, notably hydrocooling, are essential to maintaining sweet cherry quality after harvest. The most important factors which help

Sweet cherry growers in New York are at a disadvantage compared to their Western US counterparts because the cherry varieties produced here typically have shorter storage potential and shelf life. Modified atmosphere packaging (MAP) appears to offer cherry growers a tool for maintaining quality during storage and marketing. Our work shows that MAP maintains fruit color and intensity, preserves green stem color, maintains fruit firmness, prevents water loss and shriveling, and keeps cherries in excellent condition during four weeks of storage.

minimize water loss and prolong shelf life of cherries are careful control of temperature and humidity.

In recent years, sweet cherry quality has been extended by the use of Modified Atmosphere Packaging (MAP), especially in the large production areas in the Western United States. Storing fruit in semi-permeable polyethylene bags can lower respiration rates and maintain quality by altering the oxygen and carbon dioxide concentration inside the bags. The atmosphere is changed as the fruit consumes the oxygen through respiration and gives off carbon dioxide as a by-product. This is similar to storing apples in a controlled atmosphere room, except the bags are gas permeable and the process is passive. MA bags can also prevent water loss and fruit shriveling by maintaining a high relative humidity environment. One of the most important attributes of MAP is that it can preserve green stem color and fruit firmness, both critical attributes for marketing cherries

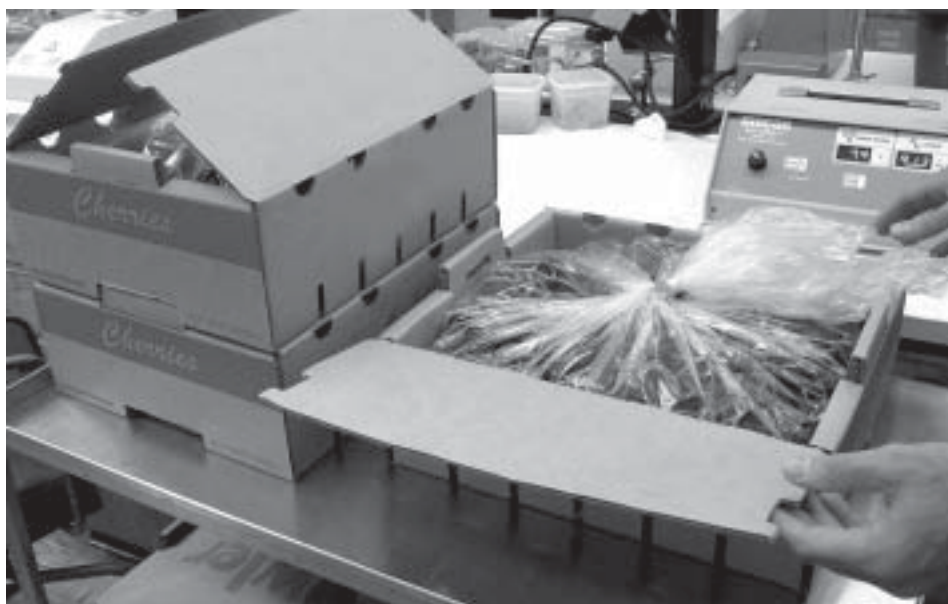


Figure 1. Lapins cherries were put in modified atmosphere bags and placed in cardboard boxes, similar to the way cherries are packed loose fill in boxes.



Figure 2. Gas measurements were taken weekly to determine the oxygen and carbon dioxide concentrations in the bags.

in retail stores. The success of MAP depends on the physical properties of the film which determine permeability to oxygen and carbon dioxide, and the respiration rate of the product which is partially dependent on harvest date, maturity, variety, temperature and other factors. Incorrect use of MAP could result in anaerobic (low oxygen) conditions leading to product spoilage.

We conducted two studies to investigate the potential for MAP to maintain quality and prolong shelf life of Hedelfingen and Lapins sweet cherries. The trials used two different MA films to evaluate possible differences depending on gas permeability. Hedelfingen is a popular sweet cherry variety commonly grown in New York State. The trial with Lapins was done in collaboration with a commercial farm in Wayne County, NY. There has been no prior documented research with MAP on sweet cherries in New York.

## Materials and Methods

Sweet cherries var. Hedelfingen were obtained from the New York State Agricultural Experiment Station in Geneva, courtesy of Dr. R. Andersen and Dr. T. Robinson's programs. The cherries were hydrocooled with chlorinated water within three hours of harvest. The treatments compared regular air storage with modified atmosphere storage in low-density polyethylene bags (LDPE). Each treatment replicate contained 10 lbs. of cherries that were graded by hand to exclude



Figure 3. Lapins control cherries (left) got darker after four weeks of storage and stems turned brown. Cherries in LifeSpan 208 bags (right) maintained green stems and fruit color was similar to that at harvest.



Figure 4. Cracking was a problem in LifeSpan 204 and 208 bags in the Hedelfingen trial. This problem can be minimized by ensuring the fruit are not wet at the time of packing.

cracks and defects. For MAP storage, cherries were placed in two different kinds of microperforated, polyethylene bags with different oxygen transmission rates (OTR): LifeSpan L204 and LifeSpan L208 (Amcor Ltd). The modified atmosphere (MA) bags selected for the trial are presently available for commercial use on cherries. The bags were closed tightly using plastic sealing clips, and then placed in small plastic crates. All the samples were placed in a storage chamber maintained at 38°F and 90 percent relative humidity. The study was designed for a four-week storage period; with evaluations performed every seven days.

In the second trial, Lapins cherries were harvested at Fowler Farms Inc., hydrocooled and left in cold storage overnight before packing using the two LifeSpan bags L204 and L208. The bags

were filled with 19-20 lbs. of cherries and sealed tightly. The cherries were then transported to Geneva where they were stored for four weeks and evaluated after that time.

Various parameters were measured, including: oxygen and carbon dioxide concentrations in the bags, firmness, color, acidity, pH, soluble solids, weight loss, and stem color. Each week, the amount of decayed and cracked cherries was recorded.

## Hedelfingen Trial Results

The Oxygen ( $O_2$ ) concentration in LifeSpan L204 bags quickly dropped from 21 percent to 7 percent after two days under MA conditions. Between the 3<sup>rd</sup> day and 28<sup>th</sup> day in storage,  $O_2$  concentration fluctuated between 3.8 percent and 4.8 percent, well above the level that could induce low oxygen injury. The  $O_2$  concentration in L208 bags decreased, but not nearly as much as in the L204 bags. In the L208 bags,  $O_2$  dropped to 14 percent by day two, and tended to fluctuate between 14.5 percent and 15.7 percent from 7 to 28 days in storage. The higher  $O_2$  concentration indicates a higher permeability of L208 bags compared to L204 bags. The  $CO_2$  concentrations in both L204 and L208 bags increased initially over time, and then tended to stabilize after five days in MAP. L204 bags were able to achieve

TABLE 1

Mean concentration of O <sub>2</sub> and CO <sub>2</sub> in the headspace of MAP bags containing sweet cherries and stored at 38°F for 4 weeks.				
Hedelfinger	L204		L208	
	% O <sub>2</sub>	% CO <sub>2</sub>	% O <sub>2</sub>	% CO <sub>2</sub>
Initial	19	1.1	19	1.6
Week 2	3.9	8.5	15	5.9
Week 4	4.6	7.4	15	5.9
Lapins				
Week 4	10	8.1	10	8.0

higher CO<sub>2</sub> levels compared to L208. Carbon dioxide concentration fluctuated between 6.5 percent and 8.5 percent between 7 and 28 days in storage in L204 bags. In L208 bags, CO<sub>2</sub> fluctuated between 4.9 percent and 6.0 percent from day 7 to 28 (Table 1).

The physical appearance of the control cherries was darker in color after four weeks (lower Lightness color value), whereas the MAP cherries maintained a lighter appearance (Table 2). Brightness, as measured by chroma, showed a significant decrease over time in control cherries. A less pronounced decrease was observed in both the MAP treatments, and by the end of the four-week storage period, MAP cherries still had a bright shiny appearance. Hue angle decreased for the control cherries, which means red color increased over the storage period. Hue angle did not change for either of the MAP treatments suggesting color was maintained similar to harvest. Overall, MAP had a positive effect on preventing the cherries from getting a dull or over mature appearance. At the end of the experiment, the cherries still appeared in marketable condition.

A slight increase in pH was observed for all three treatments during storage. Consequently, titratable acidity (TA) declined over time for all the treatments as well. By the end of the four-week storage period, TA declined most in the L208 bags, whereas TA was similar in the L204 and control cherries. Decrease in acidity is one of the factors that cause loss of flavor during storage, a common occurrence in sweet cherries. It appears MAP will not prevent acidity loss, however, it has been shown to maintain volatile flavor components in other studies. The soluble solids content of control cherries increased over time, which can be attributed to water loss from the fruit resulting in the concentration of sugars. The soluble solids content for the MAP treatments increased in some weeks but not in others, and there was no clear trend over time. Considering that

TABLE 2

Quality changes for control and MA stored Hedelfingen cherries over 4 weeks at 38°F.				
Quality Attributes	Week 2		Week 4	
	Control	MAP	Control	MAP
Fruit color	bright	bright	dull	bright
Stem color	< 50% green	> 75% green	< 25% green	> 75% green
Soluble solids	1% increase	constant	16% increase	constant
Acidity	slight decrease	slight decrease	slight decrease	slight decrease
Firmness	constant	constant	constant	constant
% cracked + decayed	4	12	9	10
% water loss	8	0.5	13	0.5
Eating and marketing quality	acceptable	acceptable	marginal	acceptable

TABLE 3

Quality changes for control and MA stored Lapins cherries over 4 weeks at 38°F.			
Quality Attributes	Week 4		
	Control	L204	L208
Fruit color	less bright	bright	bright
Stem color	> 50% green	100% green	100% green
Soluble solids	10% decrease	10% decrease	10% decrease
Acidity	slight decrease	slight decrease	slight decrease
Firmness	6% increase	constant	13% decrease
% cracked	0	0.2	0.3
% decayed	4.7	2.6	1.4
% water loss	6	0	0
Eating and marketing quality	marginal	acceptable	acceptable

MAP minimized water loss from the cherries, it is unlikely that soluble solids would increase in storage.

There were no differences in firmness among treatments and it tended to remain fairly constant over time. Control cherries maintained their firmness over the duration of the experiment, which was most likely the result of water loss giving the cherries an elastic texture that resisted penetration by our firmness measuring device. Other researchers have reported this phenomenon as well. No loss in firmness was observed in L204 or L208 cherries throughout the four-week storage period.

Major differences were seen in stem color change among treatments. After two weeks in storage, stem color of control cherries had deteriorated noticeably, and by the end of four weeks, all the cherries had brown shriveled stems. Green stem color was maintained in both MAP treatments, and, after four weeks of storage, the majority of the stems were still green,

healthy, and hydrated. This finding is consistent with reports by other researchers and commercial users of MAP. Maintaining green stem color appears to be one of the major benefits of MAP.

Water loss was greatly reduced by both MA bags regardless of gas permeability. Control cherries lost 13 percent of their weight over the four-week storage period, which was evidenced by noticeable shriveling even under high relative humidity (90 percent). Both the MAP treatments lost only 1 percent of their weight over that same time. Shriveling is a common problem in sweet cherries in storage due to their ability to easily lose water through the skin. MAP appears to be one method to help resolve this issue.

Cracking was significantly higher in both MAP treatments compared to the control on each evaluation date. There was no clear trend in cracking over time, but on certain evaluation dates, cracking was as high as 14 percent in the MA bags. The increase in cracking with MAP was most

likely caused by not allowing sufficient drying of the cherries after hydrocooling and then packing wet cherries into the bags. Decay was similar among all treatments during the first two weeks of storage and remained relatively low. During the third and fourth week evaluations both MAP treatments had more decay than control cherries. The increase in decay over time for MAP treatments was apparently due to the higher amount of cracked cherries in MA bags, making the fruit more susceptible to invasion by spoilage microorganisms. Other researchers also found increased cracking and mold growth in MAP bags due to high humidity and water condensation in the bags. In commercial practice, it is likely this problem can be avoided by ensuring that the cherries are properly cooled and dry at the time of packing.

### Lapins Trial Results

There appeared to be little difference in atmospheric composition between L204 and L208 in the Lapins trial. After two weeks in storage the O<sub>2</sub> concentration in L204 bags was reduced to 8.4 percent, and crept up to 10.4 percent by week four. Carbon dioxide in L204 was stable at 8.0 percent to 8.4 percent between weeks two and four. Oxygen concentration in L208 bags was 9.8 percent after two weeks and rose to 10.3 percent by the fourth week of storage. Carbon dioxide fluctuated between 8.0 percent and 9.0 percent between weeks two and four (Table 1).

Control cherries became darker and redder in storage (Table 3). They also lost their bright and shiny appearance by week four. Cherries in the L204 and L208 bags did not get darker, but they did increase in redness, and maintained their shiny luster after four weeks in storage.

The pH of cherries in all treatments increased, and titratable acidity decreased after four weeks in storage regardless of treatment. Soluble solids decreased after four weeks in storage and was not affected by treatment. Control cherries and L204 bagged cherries maintained their firmness after four weeks in storage similar to firmness levels at harvest. The L208 bagged cherries experienced a slight reduction in firmness. Stem color of control cherries showed considerable browning after four weeks in storage. The MAP cherries did not experience any stem browning showing stems as green as when they were packed in the bags.

Control cherries lost a significant amount of water in storage, about 6 percent of their total weight after four weeks.

The two MAP treatments did not lose any water in storage over the four-week period. The control cherries had shriveled skin whereas the MAP cherries were still turgid and firm. Cracking was not a significant problem with the MAP treatments in this trial and it was less than 0.5 percent after four weeks in storage. This is probably due to packing the cherries after allowing sufficient drying time after hydrocooling. The control cherries did not crack either, but they had significantly more decay than the two MAP treatments. Control cherries had 4.7 percent decay compared to 2.6 percent in L204 bags and 1.4 percent in L208 bags. The lesser amount of decay with MAP in this trial was probably a result of having fewer cracked cherries.

### Conclusions

Modified atmosphere packaging appears to offer cherry growers a tool for maintaining quality during storage and marketing. In this trial, MAP treatments maintained fruit color and intensity, preserved green stem color, maintained fruit firmness, prevented water loss and shriveling, and kept cherries in excellent condition during four weeks of storage. On the downside, we observed increased cracking and decay with MAP on Hedelfingen, and MAP failed to maintain fruit acidity. It is likely that the cracking and decay issues can be resolved by ensuring that the cherries are dry at the time they are packed into the bags.

Maintaining a safe atmosphere in which O<sub>2</sub> does not get too low or CO<sub>2</sub> does not get too high is critical for the successful use of MAP. In the Hedelfingen trial, different atmospheric compositions were achieved within the two types of bags; the L204 bag was much tighter than L208 resulting in greater reduction of O<sub>2</sub> and higher levels of CO<sub>2</sub>. However, both bags maintained quality similarly regardless of O<sub>2</sub> and CO<sub>2</sub> levels. In the Lapins trial, there were similar atmospheres in both bags and quality was also similar. In both trials, L204 and L208 bags maintained atmospheres that were considered "safe", however the atmosphere in the bags is highly dependent on temperature. At low temperatures, the respiration rate of the fruit is lower and therefore less oxygen is used. At warmer temperature respiration rate increases and the oxygen in the bag can be depleted leading to fruit injury. This could be particularly important during transportation and delivery if the fruit is allowed to warm up. If this is perceived to be a potential problem then the bags

should be opened or punctured prior to shipment.

Growers who are interested in using MAP on sweet cherries should consider experimenting on a small scale at first. The L204 bags appear to provide a more ideal atmosphere with some varieties, however they are also more likely to result in low oxygen damage if the cold chain cannot be maintained. Since L208 bags provided similar benefits at higher oxygen concentration, they might be a safer option. A good way to start might be to try both MA bags on small quantities of several varieties.

Certain rules must be followed to have successful results with MAP. It is important to harvest cherries before they are too mature since best results occur with cherries harvested in the early to mid maturity stage. MAP will not be a rescue treatment for over-mature fruit that is past its prime. It is critical to remove the damaged, cracked or decayed cherries at the time of packing since these cherries will not respond to MAP. If hydrocooling is used to remove field heat, make sure to allow sufficient drying time in the cooler before packing since this will minimize cracking and decay problems. The sooner the fruit is packed in MA bags after harvest, the better the results since quality only deteriorates after harvest. Also, it is important to be aware of the danger of fruit injury caused by too low oxygen under warm conditions. The bottom line is that MAP can be an effective tool if all the other things are done correctly, but it will not make poor quality fruit better. Similar to the storage of most commodities, you need to put good fruit in to get good fruit out.

### Acknowledgements

This research was supported with funding by USDA Fund for Rural America/CSREES Agreement No. 99-36200-8703, the New York State Agricultural Experiment Station and Cornell Cooperative Extension. We thank Robert Andersen, Terence Robinson and Fowler Farms Inc. for providing the cherries, and Tom Gibson for laboratory support.

---

*Jim Wargo is a postharvest specialist with CCE's Lake Ontario Fruit Program. Olga Padilla-Zakour is an assistant professor of food processing in the department of food science and technology at the Experiment Station in Geneva. Kawaljit Tandon is a postdoctoral associate in the the department of food science and technology at the Experiment Station in Geneva.*

---

# Fresh Market Sweet Cherry Varieties for Eastern North America

Bob Andersen<sup>1</sup>, Gregory Lang<sup>2</sup>  
and James Nugent<sup>2</sup>

<sup>1</sup>Department of Horticultural Sciences, NYSAES, Cornell University, Geneva, NY

<sup>2</sup>Department of Horticulture, Michigan State University, East Lansing MI

Only a minor component of sweet cherry production in Eastern North America has been for fresh markets, and the region's processing infrastructure and specialized processing markets will continue to drive the bulk of eastern cherry production. However, the increasing success of farm markets for local produce, the recognition of high value specialty market niches, and the proximity to many areas of high population in the Midwest and Northeast, bode well for many eastern growers interested in modest-scale fresh market sweet cherry production. The advent of hybrid clonal rootstocks that promote early returns, high productivity, and small tree stature may dramatically improve the economics for diversifying existing fruit-growing operations with fresh market sweet cherries. Also, some varieties have the potential for dual-purpose production, being suitable for fresh or processing markets, depending on cultural practices and/or annual production conditions.

New rootstocks such as the Gisela series (Gisela® 5, 6, or 12), Tabel® Edabriz, Weiroot 158, and others currently in regional research trials, can reduce the time to first commercial crop by half, which is a strong incentive for testing and adopting new varieties for diversified market opportunities. The ability to better control tree stature and tremendously improve labor efficiency on these rootstocks is a major consideration for both pick-your-own operations and even for commercial hand-harvest. Furthermore, it can reduce the cost for some previously unthinkable protective cropping options like installation of bird nets or rain covers.

The strong rootstock effect on productivity is a two-edged sword: for shy-bearing varieties, rootstock alone can make the difference between profit and loss. However, on very productive varieties (particularly many of the new self-fertile varieties), excessive crop loads can lead rapidly to poor fruit quality and even tree decline or death. Other good news/bad news situations have also been noted. In Michigan's disastrous spring of 2002, sweet cherry trees on Gisela rootstocks not only had much higher flower numbers per tree than on Mazzard or Mahaleb, but in some locations, significantly more of those flowers survived the widespread frost damage compared to other rootstocks. However, where conditions subsequently were brutal for flower infection by bacterial canker, those trees with higher flower numbers suffered proportionally higher infection sites as well.

As is often the case in life, new and exciting opportunities may also bring unforeseen additional challenges. While the exciting traits and cautionary caveats noted below are the culmination of our experiences to date, there is no doubt that much will yet be learned about these varieties as research trials and grower experimentation progress through the varying growing conditions of future seasons.

In this article, we will report our observations and data on sweet cherries for fresh market production, based on two decades of collaborative variety testing that has been supported by the Michigan Cherry Committee, Cornell University's Geneva Experiment Station, and Michigan State University's Northwest Horticultural Research Station. Some new varieties, for which we have limited exper-

Although sweet cherry production in Eastern North America is small, the advent of new improved sweet cherry varieties and clonal rootstocks that promote early returns may dramatically improve the economics for diversifying existing fruit-growing operations with fresh market sweet cherries.

Our observations on sweet cherry varieties for fresh market production reported in this article are based on two decades of collaborative work between Cornell University and Michigan State University.

ience but which may have potential based on research from the fresh market cherry production regions of the Pacific Northwest, are also discussed to stimulate grower experimentation within their own orchard.

## Fresh Market Sweet Cherry Characteristics

Fresh market sweet cherries are expected to be visually attractive, generally with a glossy-skinned appearance and deep mahogany red color (or yellow skin with reddish blush, in the case of yellow-fleshed varieties like 'Rainier'). The flesh should be firm, juicy, and with an intense sweetness, often balanced by a palate-refreshing hint of acidity. Historically, bright red fruit or yellow fruit lacking a reddish blush have been shunned as an indication of insufficient ripeness and lack of flavor intensity. Eating properly tree-ripened sweet cherries is a delectable summer sensation that is rivaled by few other fruits, and accordingly, such fresh cherries often command handsome prices

and willing repeat purchases. Pick-your-own sweet cherry operations often have special notices or “hotlines” to alert their best customers when fresh sweet cherries will be at their peak.

For such prized fruit, potential defects like rain-induced fruit cracking are critical production issues. Fruits are most susceptible to cracking during the final three weeks of maturation and ripening. While specialized cultural practices, such as plastic row covers or calcium applications by overtree sprinklers, often can reduce the incidence of fruit cracking, varieties differ significantly in cracking susceptibility. Even when fruit are not visibly cracked following rainfall, microscopic cracks may develop that can greatly reduce fresh market shelf-life due to increased susceptibility to attack by fungal pathogens. Consequently, for Eastern North America, varieties with reduced cracking susceptibility provide an important trait for enhancing profits due to improved fruit quality and market supply consistency. The same benefits hold true for key varietal traits such as winter hardiness, spring frost sensitivity, spring frost avoidance by late bloom, and susceptibility to endemic diseases.

The varieties below are discussed in order of ripening, within each of the categories presented (red sweet cherries for commercial or experimental fresh market production, and yellow blush cherries for experimental fresh market production). It must be noted that relative bloom times, and subsequent ripening times, can vary quite significantly from year to year, depending on late winter and early spring temperatures.

### Commercial Fresh Market Red Sweet Cherries

**Cavalier™ (Rynbrandt cv.)** - Early ripening, high quality, firm, medium-sized dark red fruit. Low productivity on vigorous rootstocks, but a good match for precocious, productive, vigor-controlling clonal rootstocks. Bacterial canker tolerance and winter hardiness are both good, as is resistance to cracking. Self-infertile, in Pollen Group IV (S<sup>2</sup>S<sup>3</sup>), with an early bloom season; multiple pollenizers are recommended to boost productivity.

**Sam** - Early- to mid-season ripening, moderately large, very dark red to black fruit, with poor flavor until fully ripe and dark. The fruit are borne in relatively tight clusters, which favors brown rot incidence. Winter hardiness and resistance to bacterial canker, as well as fruit resistance to rain-cracking, are among the best.

Should only be grown for fresh market if fruit can ripen fully. Self-infertile, in Pollen Group XIII (S<sup>2</sup>S<sup>4</sup>), with a mid- to late-bloom season.

**Kristin** - Early- to mid-season ripening, moderately large, firm dark red, flavorful fruit. Winter hardiness is excellent, and fruit have moderate to good resistance to rain-cracking. Self-infertile, in Pollen Group III (S<sup>3</sup>S<sup>4</sup>), with a mid bloom season.

**Benton™ (Columbia)** - Fruit are dark mahogany red, firm, with large size, very good flavor, and a mid-season ripening time. Consumer taste panels in Washington state picked ‘Benton’ over ‘Bing’ in three of four years, and performance has been rated consistently high in trials in New York as well as Europe. Resistance to cracking is fairly good. Self-fertile, with a mid- to late-bloom season.

**Ulster** - Fruit are dark red, moderately large, with good quality and a mid-season ripening time. Winter hardiness is good, though fruit are moderately susceptible to rain-cracking. Self-infertile, in Pollen Group III (S<sup>3</sup>S<sup>4</sup>), with a mid bloom season.

**Sylvia** - Fruit are dark red, large and firm, with good flavor and a mid- to late-season ripening time. Bacterial canker tolerance is good, and the tree has a lower

vigor than normal, even on vigorous rootstocks. Tolerance to rain-cracking has varied widely, from excellent tolerance in some locations to excessive cracking on young trees at other locations. Self-infertile, in Pollen Group IX (S<sup>1</sup>S<sup>4</sup>), with a late bloom season.

**Attika® (Kordia)** - Fruit are large, very firm, heart-shaped and mahogany red with a very long stem, have excellent flavor, and a mid- to late-ripening time. Winter hardiness is good, with moderate to good tolerance of rain, but the flowers are more frost-sensitive than other varieties. Self-infertile, in Pollen Group VI (S<sup>3</sup>S<sup>6</sup>), with a mid- to late-bloom season.

**Regina** - Good quality, mahogany red fruit, having large size, good firmness, a mild flavor, and a late ripening time. Cold hardy and well-adapted to the growing conditions of Eastern North America, with good tolerance of rain and low susceptibility to cherry leaf spot. Productivity is low to moderate, making this a good candidate for matching to new clonal rootstocks that impart higher productivity. Self-infertile, in Pollen Group II (S<sup>1</sup>S<sup>3</sup>), with a late bloom season; multiple pollenizers are recommended to boost productivity.

**Sweetheart** - Very good quality, bright red, firm fruit having moderate to large size, good flavor, and very late ripening. A very grower-friendly tree, with a spreading tree form and precocious, heavy cropping on all rootstocks. Reports on winter hardiness and bacterial canker susceptibility have been variable, and fruit are moderately susceptible to cracking. Self-fertile, with an early- to mid-bloom season (though bloom date has varied widely in northwest Michigan).

**Hudson** - Good quality, mahogany red, firm fruit having moderate to large size, good flavor, and very late ripening. Very good winter hardiness and tolerance to bacterial canker, as well as good resistance to fruit cracking. Productivity is quite delayed, suggesting better potential with a clonal rootstock to impart precocity and productivity. Self-infertile, in Pollen Group IX (S<sup>1</sup>S<sup>4</sup>), with a late bloom season.

### Experimental Fresh Market Red Sweet Cherries

The varieties in this category are dominated by new varieties released from the Agriculture Canada breeding program at Summerland (British Columbia), the Washington State University breeding program at Prosser (Washington), and the Cornell University breeding program (Geneva) plus several older eastern varieties that may find renewed utilization if matched with the new clonal rootstocks like the Giselas. Many of the western variety releases exhibit remarkable fruit size and quality, but tree performance and survival under the harsher conditions typically found in Eastern North America has yet to be documented thoroughly enough for significant commercial plantings.

**Chelan**<sup>TM</sup> - Moderately good quality, dark mahogany red, firm fruit having moderate to large size and early season ripening. For best flavor, fruit must be allowed to ripen fully. Productivity is very good, resistance to cracking is fairly good, and trees are resistant to powdery mildew. Self-infertile, in Pollen Group V (S<sup>3</sup>S<sup>9</sup>), with an early bloom season.

**Index**<sup>TM</sup> - Good quality, mahogany red, firm fruit having large size, very good flavor, and an early- to mid-ripening time. Bacterial canker tolerance is similar to that of 'Ulster' and 'Kristin', and susceptibility to rain-induced fruit cracking is moderate. Self-fertile, with an early bloom season.

**Glacier**<sup>TM</sup> - Impressively large fruit size, dark mahogany red with very good flavor but less firmness than other fresh market varieties; ripens mid-season. 'Glacier' could be an outstanding fruit for local fresh markets and may be a good candidate for matching with precocious, size-controlling rootstocks. Moderately susceptible to rain-cracking. Self-fertile, with a mid- to late- bloom season.

**Nelson** - Fruit quality is moderately good (in terms of size and firmness) with very good flavor, ripening mid-season with the highest cracking resistance of any cherry tested thus far in Northwest Michigan. Trees exhibit low susceptibility to bacterial canker as well. Previous sources of 'Nelson' have been virus-infected, but when virus-free trees are available (virus elimination and certification currently underway), this variety is worthy of further test for fresh markets. Self-infertile, in Pollen Group XIII (S<sup>2</sup>S<sup>4</sup>), with a mid- to slightly-late-bloom season.

**BlackGold**<sup>TM</sup> - Fruit are moderately large, dark red and heart-shaped, ripen in mid-season, and moderately tolerant of rain. Cold hardy and well-adapted to the growing conditions of Eastern North America. Self-fertile, with mid- to late-bloom season.

**Schmidt** - Fruit quality is moderately good (in terms of size and firmness) with very good flavor, ripening mid-season with very good resistance to rain-induced fruit cracking. The traditional drawback with 'Schmidt' is low productivity, but the potential for matching with a new clonal rootstock to impart higher productivity is worthy of further test. Self-infertile, in Pollen Group XIII (S<sup>2</sup>S<sup>4</sup>), with a mid- to slightly-late-bloom season.

**Summit** - Impressively large, bright red, heart-shaped fruit size, with good flavor but less firmness than other fresh market varieties. Ripens mid-season, but often is picked earlier, especially by pick-your-own customers due to remarkable size. Moderately susceptible to rain-cracking, and tree winter-hardiness may be marginal in some years, but impressive fruit size is worth a trial. Self-infertile, in Pollen Group I (S<sup>1</sup>S<sup>2</sup>), with a mid- to late-bloom season.

**Selah**<sup>TM</sup> (**Liberty Bell**) - A dark red to mahogany, round fruit having impressively large fruit size, excellent flavor, and a mid- to late-season ripening time. Fruit are borne in loose clusters and have average susceptibility to rain-induced cracking. Superior size and cropping habit to 'Lapins' under western conditions, but little

performance data yet available in Eastern North America. Self-fertile, with an early- to mid-bloom season.

**Skeena**<sup>TM</sup> - A dark red to mahogany, impressively large and attractive high quality fruit, having good flavor and ripening in the mid- to late season. Superior to 'Lapins' for both fruit traits and tree growth (spreading and precocious) under western conditions, with moderate tolerance to rain, but little performance data yet available in Eastern North America. Self-fertile, with a mid-bloom season.

Not recommended for fresh market due to suspect fruit quality, rain-induced cracking, or tree adaptability: Bing, Brooks, Hartland, Hedelfingen, Lambert, Lapins, Royalton, Star, Valera, Van, Vic, Windsor.

### Experimental Fresh Market Blushed Yellow Cherries

This is a niche category for special markets, one for which discerning consumers are willing to pay extra for a premium cherry that is more difficult to grow well. This market was created by legendary fruit variety pioneer, Grady Auvil of Washington State, who began pruning and training his yellow-fleshed 'Rainier' cherries for the fresh market rather than for canning. By reducing his yields and improving light distribution through the canopy, he was able to consistently harvest very large, very firm fruit of very high sweetness (often 25° Brix or more), with an attractive red blush to the yellow skin. 'Rainier' has subsequently become the highest-priced fresh market variety, but it is also the most difficult to grow well, as the yellow flesh reveals every inadvertent bruise from wind, harvest, or packing as unattractive brown marks (which are usually present in mahogany-fleshed fruit, but not nearly as noticeable).

**Rainier** - Excellent quality fruit having the drawback of marginal adaptation for eastern growing conditions. In the Great Lakes, winter cold damage (particularly in young trees) and its associated disease problems, such as bacterial canker, can be a challenge for maintaining tree health, and in some orchards, 'Rainier' fruits have been noted to be particularly susceptible to *Alternaria* infection. The fruit ripen in mid-season and are low- to moderately-susceptible to rain-induced cracking. Self-infertile, in Pollen Group IX (S<sup>1</sup>S<sup>4</sup>), with an early- to mid-bloom season.

**Emperor Francis** - A very nice quality, firm fruit having the drawback of only medium size, yet perhaps the blush vari-

ety best adapted (thus far) to the growing conditions of Eastern North America. Good tree survival of cold winters and endemic diseases, with better resistance to fruit cracking than 'Rainier'. The fruit ripen mid-season, slightly after 'Rainier' and 'WhiteGold'. Self-infertile, in Pollen Group III (S<sup>3</sup>S<sup>4</sup>), with an early- to mid-bloom season.

**WhiteGold®** - A nice quality fruit of moderate to large size, ripening mid-season. Cold hardy and well-adapted to the growing conditions of Eastern North America, with a very low susceptibility to cherry leaf spot. Fruit are moderately tolerant of rain. Self-fertile, with a mid- to late-bloom season.

**Vega** - Very attractive fruit appearance, rivaling that of 'Rainier' and ripening about a week earlier, but having the drawbacks of higher susceptibility to rain-induced fruit cracking, rather low productivity, and reports of insufficient sweetness to offset its acidity (which is significantly higher than 'Rainier'). A potential candidate for growers interested in matching with size-controlling precocious rootstocks to increase productivity and provide external protection from rain-cracking. Self-infertile, in Pollen Group IV (S<sup>2</sup>S<sup>3</sup>), with an early bloom season.

**Stardust®** - Excellent fruit quality, with size, flavor, and firmness rivaling that of 'Rainier' but ripening significantly later. Limited reports in eastern North America suggest good winter hardiness and adaptability to Great Lakes conditions. Self-fertile, with a late bloom season.

Not recommended for fresh market due to fruit quality or adaptation: Gold, Napoleon (Royal Ann), Sue.

## Summary

The advent of new sweet cherry varieties having excellent fruit qualities and new rootstocks that confer important advantages for potential fresh market production are only two cornerstones for Eastern North American growers considering possible diversification of their orchard operations. Profitable production for fresh markets requires more intensive orchard management, a more thorough understanding of relationships between tree growth and reproduction, and a greater investment in hands-on labor. Such topics deserve further exposition in future articles.

For further information on sweet cherry varieties (including pollination charts), and periodic updates on cherry rootstocks and cultural practices, the fol-

lowing websites may be useful and/or provide additional relevant internet links: **Michigan State University** <[www.hrt.msu.edu/faculty/list\\_langg.htm](http://www.hrt.msu.edu/faculty/list_langg.htm)>, **MSU Northwest Horticultural Research Station** <[www.maes.msu.edu/nwmihort/](http://www.maes.msu.edu/nwmihort/)>, **Cornell University** <[www.nysaes.cornell.edu/hort/faculty/andersen/](http://www.nysaes.cornell.edu/hort/faculty/andersen/)>, **Washington State University** <[www.fruit.prosser.wsu.edu/chervar.htm](http://www.fruit.prosser.wsu.edu/chervar.htm)>, **Summerland Research Centre** <[http://res2.agr.ca/parc-crapac/english/2summerland/horticulture/kappel/variety\\_descriptions.htm](http://res2.agr.ca/parc-crapac/english/2summerland/horticulture/kappel/variety_descriptions.htm)>.

*Bob Andersen is a research and extension professor of horticulture at Cornell University's New York State Agricultural Experiment Station, Geneva, NY, specializing in stone fruit breeding and variety evaluation. Greg Lang is an associate professor in the department of horticulture at Michigan State University who specializes in cherry culture and physiology. Jim Nugent, a specialist in cherry production, is the superintendent of Michigan State University's Northwest Horticultural Research Station in Travers City, MI.*

---

# Susceptibility of New Apple Cultivars to Common Apple Diseases

**Dave Rosenberger**

Department of Plant Pathology, NYSAES, and Cornell's Hudson Valley Laboratory, Highland, NY.

This work was supported in part by Federal Formula Funds from the United States Department of Agriculture

The Multistate Research Project, NE-103, was initiated in 1995 to coordinate multi-disciplinary evaluations of new apple cultivars at multiple locations throughout the United States and Canada. Regional research projects such as NE-183 are organized under the auspices of the USDA and are funded using a portion of the Federal Formula Funds that are allocated to land-grant universities each year. The purpose of multistate research programs such as the NE-183 project is to enable cooperation among the State Agricultural Experiment Stations (SAES) in partnership with the Co-operative State Research, Education, and Extension Service (CSREES) of the U.S. Department of Agriculture, to tackle complex problems that are beyond the scope of a single state experiment station.

Currently, 68 scientists from 21 states and three Canadian provinces are listed as participants in the NE-183 multistate project. In the spring of 1995, a series of uniform plantings containing 21 new cultivars and selections was established at 28 locations from Missouri to Maine and from New York to Washington State. In 1999, a second round of uniform plantings of 22 additional cultivars/selections was established at 29 locations. Some of the plantings are being used to assess horticultural qualities of the new cultivars whereas other plantings are being used to evaluate susceptibility to diseases, insects, and mites.

At Cornell's Hudson Valley Lab in Highland, the new apple varieties in both the 1995 (Planting #1) and 1999 (Planting #2) trials are being evaluated for susceptibility to diseases and arthropod

pests. Not all pests can be monitored in the same year because severe infestations of one pest can make it impossible to monitor for other pests in that same year. To simplify management of these plantings, disease data has been collected during the early years of the plantings whereas evaluations for insect damage were generally delayed until the trees were older.

This paper presents some of the results of disease evaluations conducted at the Hudson Valley Lab since 1996. Background information on the cultivars has not been included in this paper but is accessible at the NE-183 web site, <http://www.ne183.org/cultivars/cultivars.html>. Horticultural characteristics for some of these cultivars have also been summarized in a previous *N.Y. Fruit Quarterly* article (Brown and Maloney, 2002).

## Experimental Design

Both the 1995 and the 1999 plantings contained five single-tree replicates for each cultivar or selection being evaluated. Within each planting, cultivars were planted in a randomized, complete-block design. Trees evaluated for this report were all on M.9 rootstock and were trained as vertical axe trees. Trees were tied to steel conduit posts, and posts were connected with a single high-tensile wire. Trees were planted approximately 7 ft. apart within the row, and herbicides were used to control weeds and grass beneath trees. Tree rows in the 1995 planting were 20 ft. apart whereas in the 1999 planting they were only 12 ft. apart. Both plantings

Knowing what to expect from new apple cultivars can help in planning pest control strategies for orchards that contain these cultivars. Although susceptibility to insects and diseases is usually not a limiting factor in cultivar selection, cultivars that are highly susceptible to particular pests may require extra applications of pesticide each year, and the costs associated with those applications should be considered before trees are planted.

had trickle irrigation. Golden Delicious (Gibson strain), McIntosh (Pioneer strain in 1995; Rogers strain in 1999), and Mutsu were used as standard cultivars in both plantings, and Cortland was included in the 1999 planting as a known standard for mildew susceptibility.

## Disease Evaluations and Data Analysis

No early-season fungicides were applied to the test plots in years when trees were evaluated for apple scab, powdery mildew, or rust diseases. Incidence of various diseases was determined by counting the number of leaves with disease on a specified number of terminals per tree or by evaluating up to 100 fruit per tree. Where similar data were collected for more than one year, a statistical procedure known as repeated measures analysis was used to determine means for the entire multi-year data sets. In all of the data tables, numbers followed by the same small letters do not differ significantly. The arc-sine transformation was used for statistical analyses to determine mean separations, but arithmetic means are shown in the tables.

Because of the transformation used for statistical analyses and the rounding of means to whole numbers, cultivars with the identical means in the data tables sometimes fall into different statistical groupings. Also, the rankings of means may differ slightly from the ranking based on statistical groupings as designated by small letters that follow the means, as occurs, for example, for NJ90, Delblush, and Ambrosia in Table 2.

**Apple scab:** Only Orin developed as much leaf scab as McIntosh when cultivars were compared over three years in Planting #1 (Table 1). In 1997, the only year that susceptibility to fruit scab was evaluated, McIntosh, Orin, Cameo, Sunrise, Shizuka, Gala, and Golden Supreme all had similar levels of fruit scab. Trees were too young to carry fruit in 1996, and many trees carried no fruit in 1998 because of the severe scab infection that was allowed to develop in 1997.

Pristine, Enterprise, GoldRush, and NY75414-1 are all considered scab-resistant cultivars. The trace of leaf scab reported for these cultivars resulted either from misidentified lesions or from a trace of scab caused by fungal strains that are not completely controlled by the Vf gene for resistance. The scab lesions reported for these cultivars were not examined in the lab to verify that the lesions actually represented apple scab

In Planting #2, only Cortland was as susceptible to leaf scab as McIntosh (Table 2). Rankings for susceptibility to fruit scab varied considerably between 2001 and 2002. In 2002, only NJ 90 and Hampshire developed as much fruit scab as McIntosh. In this planting, Coop 39, Scarlet O'Hara, CQR 10T17, NY 79507-72, CQR 12T50, NY 65707-19, NY 79507-49, and Sundance are considered scab-resistant cultivars. Scab lesions recorded for these cultivars are subject to the same uncertainties as noted for scab-resistant cultivars in Planting #1.

**Powdery mildew:** None of the cultivars in either planting proved totally resistant to mildew (Tables 3 & 4). However, the more resistant cultivars are likely to develop less mildew in commercial plantings than they did in these randomized plantings

**TABLE 1**

**Apple scab incidence in NE-183 Planting #1, Highland, NY.**

Variety	Percent terminal leaves with scab over three years 1996-1997-1998*		% fruit with scab at harvest in 1997	
McIntosh (Pioneer) .....	46	i**	88	h i
Orin .....	48	i	87	h i
Ginger Gold .....	31	h	53	d e
Golden Delicious .....	30	g h	64	e f g
Cameo .....	29	g h	84	g h i
Sunrise .....	29	g h	70	e f g h
Braeburn .....	29	g h	84	g h i
Shizuka .....	27	f g h	93	i
Mutsu .....	26	f g h	63	d e f g
Fuji (BC #2) .....	26	f g h	57	d e
SunCrisp .....	25	f g h	55	d e
Gala (Fulford) .....	25	f g h	72	e f g h
Yataka .....	23	f g	26	b c
Arlet .....	23	f g	62	d e f
Creston .....	20	e f	54	d e
Fortune .....	20	e f	60	d e f
Senshu .....	15	d e	41	c d
Golden Supreme .....	15	d e	73	e f g h
Honeycrisp .....	12	d	no data	
Sansa .....	7	c	0 a	
Gala Supreme .....	2	b	11	b
Pristine .....	<1	a	0 a	
NY75414-1 .....	<1	a	0 a	
Enterprise .....	<1	a	0 a	
GoldRush .....	<1	a	0 a	

\* All leaves on 5, 15 and 10 terminals per tree were evaluated on the 2 Aug 1996, 14 July 1997 and 11 June 1998 respectively.

\*\*Numbers within columns followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

**TABLE 2**

**Apple scab incidence in NE-183 Planting #2, Highland, NY.**

Cultivar	Percent terminal leaves with scab over three years (1999-2000-2001)*		% fruit with scab**	
			2001	2002
McIntosh (Rogers) .....	30	j	17	e f 56 f
Cortland .....	30	i j	9	c d e no data
Hampshire .....	28	h i	13	d e f 39 e f
Chinook .....	25	g h	30	g 30 d e
NJ 90 .....	24	g h	24	f g 48 f
Delblush .....	24	f g	17	d e f 8 c
Ambrosia .....	23	g h	30	g 34 e
Zestar .....	17	e f	0 a	6 b c
Mutsu .....	16	e	15	d e f 0 a
Jubilee Fuji .....	14	d e	1 a	14 c
Golden Delicious .....	11	c d	4 a b c	1 b
Corail (Pinova) .....	9	c	0 a	3 a b
Runkel .....	7	c	6 b c d	15 c d
NJ 109 .....	3	b	3 a b c	2 a b
BC 8S-26-50 .....	1	b	0 a	8 c
Coop 39 .....	<1	a	3 a b c	0 a
Scarlet O'Hara .....	<1	a	2 a b	0 a
CQR 10T17 .....	<1	a	2 a	<1 a b
NY 79507-72 .....	1 a b		0 a	0 a
CQR 12T50 .....	<1	a	0 a	0 a
NY 65707-19 .....	<1	a	0 a	0 a
NY 79507-49 .....	<1	a	0 a	0 a
Sundance .....	0	a	0 a	0 a

\* Presence of scab was evaluated on five terminals/tree on 24 June 1999 and on 10 terminals/tree on 24 July 2000, and 13 June 2002. Numbers within columns followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

\*\* Fruit were harvested near maturity using different dates for different cultivars in 2001, but all cultivars were harvested 24 Jul 2002 because severe rust and scab infections were causing fruit to drop from some trees.

TABLE 3

## Powdery mildew incidence in NE-183 Planting #1, Highland, NY

Cultivar	Percent terminal leaves with mildew over three years 1996-1997-1998							
Ginger Gold	44							l
GoldRush	32							k
SunCrisp	26						j	k
Gala (Fulford)	23					i	j	
Braeburn	21			g	h	i	j	
Mutsu	21					h	i	j
Shizuka	20	e	f	g	h	i	j	
BC 8M 15-10	19			f	g	h	i	j
Orin	18	e	f	g	h	i	j	
Carousel	17	e	f	g	h	i	j	
Golden Delicious	17	e	f	g	h	i	j	
Sunrise	17	d	e	f	g	h		
Honeycrisp	17	e	f	g	h	i		
McIntosh (Pioneer)	15	d	e	f	g	h		
Golden Supreme	15	d	e	f	g	h		
Sansa	14	d	e	f	g			
Fortune	13	d	e	f				
Arlet	11	c	d	e				
Pristine	9	b	c	d				
Senshu	8	a	b	c				
Fuji (BC #2)	7	a	b	c				
Enterprise	6	a	b					
NY 75414-1	5	a	b					
Yataka	4	a						
Gala Supreme	4	a						

\* Ratings were made by evaluating all leaves on five terminals per tree on 28 June 1996 and the eight youngest leaves on 15 terminal per tree on 3 July 1997 and on 10 terminal per tree on 11 June 1998. Numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

TABLE 4

## Powdery mildew incidence in NE-183 Planting #2, Highland, NY

Variety	Percent terminals leaves with mildew during two years (2000 & 2002)*							
Delblush	53							j
Coop 39	47						i	j
CQR 10T17	47						i	j
Cortland	44					h	i	j
Chinook	42					h	i	
Sundance	36					g	h	
Golden Delicious	36					g	h	
NJ 90	32			f	g			
Mutsu	31			f	g			
Scarlett O'Hara	30			f	g			
Corail (Pinova)	29			e	f	g		
Ambrosia	28			d	e	f	g	
BC 8S-26-50	27	c	d	e	f	g		
NJ 109	24	c	d	e	f			
Runkel	23	c	d	e	f			
NY 65707-19	21	b	c	d				
Hampshire	19	b	c	d	e			
McIntosh (Rogers)	19	b	c	d				
NY 79507-49	18	b	c	d				
CQR 12T50	18	b	c					
NY 79507-72	16	a	b					
Zestar	14	a	b					
Jubilee Fuji	10	a						

\* The eight youngest leaves on 10 terminal shoots per tree were evaluated for powdery mildew on 30 June 2000 and 24 June 2002. Numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

where they were constantly exposed to large amounts of inoculum produced by the adjacent susceptible cultivars.

**Rust diseases:** Three different rust diseases caused by *Gymnosporangium* species are common on apples in southern New York. Cedar apple rust (CAR), caused by *G. juniperi-virginianae*, infects both leaves and fruit of susceptible cultivars. Leaf infections are far more common than fruit infections for CAR. Hawthorn rust caused by *G. globosum* only infects leaves and is generally less abundant than CAR. Quince rust (*G. clavipes*) infects fruit but does not cause leaf lesions.

On infected leaves, the early symptoms of CAR and hawthorn rust are so similar that the two species cannot be easily differentiated. Therefore, rust evaluations completed during early-summer produced leaf ratings that represented a combination of CAR and hawthorn rust infections. By mid-August, the two species of rust can be differentiated based on the appearance of aecia that form on the bottom sides of infected leaves. Aecia produce the aeciospores that can infect only cedar trees, thereby completing the rust disease cycle. Lesions caused by *G. juniperi-virginianae*, the CAR fungus, develop short aecial tubes that split apart and roll back whereas aecial tubes of *G. globosum* are longer, split open unevenly, and often appear tangled.

In Planting #1, Shizuka, Mutsu, GoldRush, BC8M 15-10, and Golden Delicious all had rust lesions on at least 20 percent of terminal leaves over two years (Table 5). By comparison, NY75414-1, Gala Supreme, Golden Supreme, McIntosh, Fortune, Sunrise, SunCrisp, Enterprise and Sansa all had less than 3 percent of leaves with rust lesions. Susceptibility to quince rust could not be determined for Planting #1 because little quince rust developed in any of the plots during the years when there was sufficient fruit to evaluate.

More detailed data on rust susceptibility was collected in Planting #2. Trees in this planting were surrounded by scattered cedar trees that provided inoculum. The severity of rust infections in this planting was enhanced by spring weather conditions during 2001 and 2002 that favored rust infection. All of the cultivars in Planting #2 were susceptible to rust diseases, with 25-64 percent of terminals leaves affected (Table 6, right-hand column).

The type of rust symptoms that developed in Planting #2 varied among

cultivars. Mutsu, CQR 12T50, and Scarlet O'Hara all had at least 40 percent of leaves with more than 20 lesions per leaf in 2000 and 2001. Of these, 93-99 percent of infected leaves developed aecia typical of CAR lesions (Table 6). By comparison, the last 11 cultivars listed Table 6 had less than 4 percent of leaves with >20 rust lesions per leaf, but eight of these cultivars had more than 10 percent of leaves with >20 leaf spot lesions. Rust-induced leaf spot lesions frequently develop on leaves when CAR spores begin germinating, kill a few leaf cells, then stop growing because of an incompatible host reaction. The killed cells are frequently invaded by other secondary pathogens such as *Alternaria*, *Botryosphaeria*, or *Phomopsis*, and these secondary invaders cause a leaf spot disease that can be nearly as devastating as rust infections.

The 12 cultivars listed in the top half of Table 6 were highly susceptible to cedar apple rust but had relatively few leaves with severe leaf spot (>20 lesions/leaf). The remaining cultivars tended to have a higher incidence of leaf spot, and they usually had more leaves with aecia of hawthorn rust than with aecia of CAR.

**TABLE 5**

Incidence of rust lesions on leaves (cedar apple rust and hawthorn rust) in NE-183 Planting #1, Highland, NY.

Cultivar	Percent terminal leaves with rust (1996 & 1997)	
Shizuka	28	k
Mutsu	28	k
GoldRush	24	j k
BC 8M 15-10	21	i j
Golden Delicious	20	h i j
Ginger Gold	18	g h i
Carousel	17	f g h i
Arlet	17	f g h
Fuji (BC #2)	14	e f g
Senshu	14	e f g
Orin	14	d e f g
Braeburn	14	d e f
Yataka	13	e f g
Pristine	13	d e f
Honeycrisp	11	d e
Gala (Fulford)	9	d
Sansa	2	c
Enterprise	2	b c
SunCrisp	1	b c
Sunrise	1	a b c
Fortune	1	a b c
McIntosh (Pioneer)	<1	a b c
Golden Supreme	<1	a b c
Gala Supreme	<1	a b
NY 75414-1	0	a

\*Ratings are from all leaves on 5 terminals per tree on 2 Aug. 1996 and all leaves on 15 terminals per tree on 14 July 1997. Numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

**TABLE 6**

Incidence of apple rust diseases, rust-induced leaf spot, and rust aecia in NE-183 Planting #2, Highland, NY.

Cultivar	Percent terminal leaves in 2001 & 2002 that had >20 lesions per leaf <sup>1</sup>		% infected leaves in Aug 2002 showing <sup>2</sup>			Mean percent terminal leaves affected by rust (including leaves with leaf spot) for 2001 & 2002				
	rust lesions	leaf spot	cedar apple rust aecia	hawthorn rust aecia	hawthorn rust aecia					
Mutsu	47	h <sup>3</sup>	1.1	b	c <sup>3</sup>	99	1	4	64	j <sup>3</sup>
CQR 12T50	40	g	0.5	a	b	99	1	6	53	g h i
Scarlet O'Hara	40	g	0.6	a	b	93	8	1	54	h i
Chinook	36	f	0.4	a	b	100	0	5	52	f g h i
CQR 10T17	36	f	1.2	b	c	100	0	10	49	e f g h
Coop 39	32	e	0.2	a		88	13	3	49	d e f g h
Golden Delicious	32	e	0.3	a	b	100	0	4	48	d e f g
Corail (Pinova)	32	e	0.8	a	b c	69	31	0	57	i j
Ambrosia	31	d e	1.0	a	b c	99	1	3	49	e f g h
BC 8S-26-50	31	d e	0.3	a	b	79	20	10	48	d e f g h
NJ 109	28	c d	0.1	a		90	10	1	46	d e f
Jubilee Fuji	26	c	0.5	a	b	36	59	5	48	d e f g h
Runkel	3	b	6.1		d	19	53	29	38	b c
Cortland	2	a b	4.1		d	1	80	18	43	c d e
NY 79507-72	0	a	2.8		c	8	21	71	25	a
NJ 90	0	a	5.2		d	6	65	31	34	b
Delblush	<1	a	7.0		d e	6	40	55	42	c d
McIntosh (Rogers)	0	a	10.2		e f	0	95	5	46	d e f
Hampshire	<1	a	12.2		f g	15	64	24	43	c d e
NY 79507-49	0	a	13.0		f g	14	57	30	45	c d e
Sundance	0	a	13.2		g h	32	47	21	46	d e f
Zestar	0	a	15.0		h	0	80	20	48	d e f g h
NY 65707-19	0	a	22.5		i	11	50	39	52	f g h i

<sup>1</sup>All leaves on 5 terminals per tree were evaluated for disease in 2001 and 2002. Missing leaves (empty nodes) were not included in the counts.

<sup>2</sup> Twenty leaves with yellow-orange lesions were collected from each tree in four reps and examined under a dissecting scope for aecial development 21-23 Aug 2002.

<sup>3</sup> Numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

The cultivars with the greatest resistance to foliar rust infections appear in the middle of Table 6. NY79507-72 was the most resistant with only 25 percent of leaves affected by rust and only 2.8 percent of leaves with > 20 lesions.

All of the cutlivars in Planting #2 were susceptible to quince rust, but the incidence of infection ranged from a low of 13 percent for Sundance to a high of 69 percent for Zestar.

**Fire blight:** Streptomycin sprays were used to protect trees in the Hudson Valley plantings from fire blight, and no blight symptoms developed in any of the trees at this location. However, natural fire blight epidemics developed in NE-183 plantings in several other states. In the 1995 plantings, Arlet, Braeburn, Cameo, Creston, Fortune, Gala Supreme, Ginger Gold, Golden Delicious, Golden Supreme, GoldRush, Honeycrisp, NY 75415-1, Pristine, Sansa, Shizuka, Suncrisp, and Sunrise have all been severely damaged by fire blight in one or two locations. Ambrosia, Autumn Gold, Coop 29, Coop 30, Delblush, Golden Delicious, Hampshire, Jubilee Fuji, NJ 109, NJ 90, NY.75907-72, and Zestar all suffered more than 50 percent mortality from fire blight at one location. Many of

**TABLE 7**  
Quince rust incidence in NE-183 Planting #2, Highland, NY.

Variety	Percent fruit with quince rust in 2001 & 2002*
Zestar .....	69 i
Cortland .....	60 h i
Coop 39 .....	60 h i
Jubilee Fuji .....	59 g h i
CQR 12T50 .....	57 f g h i
McIntosh (Rogers) .....	54 e f g h i
NJ 109 .....	52 d e f g h i
NY 79507-72 .....	52 d e f g h
NJ 90 .....	50 d e f g h i
Delblush .....	49 d e f g h
BC 8S-26-50 .....	45 c d e f g
NY 65707-19 .....	43 c d e f g h
Mutsu .....	41 c d e f g h
Golden Delicious .....	41 c d e f g
Chinook .....	41 c d e f
Ambrosia .....	39 b c d e
NY 79507-49 .....	39 b c d e f
CQR 10T17 .....	35 b c d e
Scarlet O'Hara .....	34 b c d e
Corail (Pinova) .....	32 a b c d
Runkle .....	28 a b c
Hampshire .....	25 a b
Sundance .....	13 a

\* In 2001 the mean number of fruit evaluated was 34.0 and ranged from 1 to 150 fruit per tree with three trees having no fruit for evaluation. In 2002 the mean number of fruit evaluated was 30.7 and ranged from 1 to 100 fruit per tree with 13 individual trees having no fruit for evaluation. Numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ).

the trees killed by fire blight died from rootstock blight after the M.9 rootstocks became infected.

### Significance of Differences in Susceptibility

Most apple growers decide which apple cultivars to plant based on their perceptions of whether or not the apples from those cultivars can be marketed at a profit. Susceptibility to insects and diseases is usually not a limiting factor in cultivar selection, although organic producers may avoid highly-susceptible cultivars. Cultivars that are highly susceptible to particular pests may require extra applica-

tions of pesticide each year, and the costs associated with those applications should be considered before trees are planted. For example, Ginger Gold trees frequently require one or two additional mildewcide sprays per year as compared to less susceptible cultivars such as McIntosh whereas McIntosh may require more sprays to control apple scab. Knowing what to expect from new cultivars can help in planning pest control strategies for orchards that contain these cultivars.

### Literature Cited

Brown, S., and K. Maloney. 2002. Apple cultivars: a Geneva perspective. N. Y. Fruit Quarterly 10(2):21-27.

*Dave Rosenberger is research and extension professor of plant pathology and superintendent of Cornell University's Hudson Valley Laboratory in Highland, NY. He specializes in pre- and post-harvest diseases of apple.*

# Susceptibility of New Apple Cultivars to Various Arthropod Pests

**Dick Straub**

Department of Entomology, NYSAES and Cornell's Hudson Valley Laboratory, Highland, NY

Although apple cultivars are generally not developed with the intended goal of resistance or tolerance to particular arthropod infestations, nonetheless, our research shows that varieties differ in various unidentified resistance or susceptibility factors. Cultivars that are highly susceptible to particular pests will probably require extra applications of pesticide each year, while some relatively pest tolerant cultivars may require less attention.

This research is supported in part by the New York Apple Research and Development Program.

The NE-103 Multistate Research Project was initiated in 1995 to coordinate multi-disciplinary evaluations of new apple cultivars at multiple locations throughout the United States and Canada. Regional research projects such as NE-183 are organized under the auspices of the USDA and are funded using a portion of the Federal Formula Funds that are allocated to land-grant universities each year. Currently, 68 scientists from 21 states and three Canadian provinces are listed as participants

in the NE-183 multistate project. Two separate plantings were established during 1995 and 1999 at Cornell's Hudson Valley Lab in Highland to study susceptibility to native diseases and arthropod pests. More detailed background regarding this project, the cultivars, and particulars about the Highland plantings, can be found in previous *Fruit Quarterly* articles (Brown and Maloney, 2002; Rosenberger, 2003). Thus far, data on arthropod pests have been taken only from the 1995 planting and the results are reported here.

## Experimental Design

The 1995 planting contained five-single tree replicates for each cultivar/selection that was tested. Within each planting, cultivars were planted in a randomized, complete-block design. Trees evaluated for this report were on either M.9 or Mark rootstock and were trained as vertical axe trees. Trees were tied to steel conduit posts, and posts were connected with a single high-tensile wire. Trees were planted approximately 7 ft x 20 ft and trickle irrigated. Herbicides were used to control vegetation beneath the trees.

## Evaluations and Data Analysis

No insecticides or miticides were applied to the test plots during the years when trees were evaluated for arthropods. Regular fungicide applications were employed to maintain disease-free trees. Incidence of infestation by arthropods was determined by various methods during 1999 and 2001. Foliar damage by phytophagous mites was assessed by sampling 25 leaves from each plot. Leaves were removed to the laboratory where they were brushed with a mite-brushing machine, and the mites and eggs examined using a binocular scope. Mites monitored were European red mite, *Panony-*

**TABLE 1**

Incidence of phytophagous mites<sup>1</sup> in NE-183 planting#1 that was established at the Hudson Valley Laboratory during 1995.

Variety	No. European red mite per leaf	No. two spotted spider mite per leaf	Combined no./leaf
Braeburn/M.9	1.6 a b c d e f	5.6 a	7.2
Senshu	0.5 c d e f	6.0 a	6.5
Ginger Gold	1.3 e f	3.3 a	4.6
Golden Del./M.9	0.8 d e f	3.3 a	4.1
Cameo	0.6 c d e f	3.5 a	4.1
NY 75414-1	0.7 d e f	3.2 a	3.9
Fortune	0.3 a b c d	3.4 a	3.7
Shizuka	0.2 a b c	3.5 a	3.7
McIntosh (Pioneer)	0.2 a b c	3.5 a	3.7
Yataka/M.9	0.3 a b c d	3.3 a	3.6
Fuji (BC #2)	0.2 a b c	2.9 a	3.1
Enterprise	0.1 a b	2.8 a	2.9
Creston	0.7 d e f	1.8 a	2.5
Honeycrisp	0.1 a b	2.3 a	2.4
SunCrisp	0.0 a	2.4 a	2.4
GoldRush	0.1 a b	2.2 a	2.3
Golden Supreme	0.3 a b c d	2.0 a	2.3
Sansa	0.1 a b	1.9 a	2.0
Pristine	0.4 b c d e	1.5 a	1.9
Sunrise	0.4 b c d e	1.2 a	1.6
Gala Supreme	0.2 a b c	1.5 a	1.7
Orin	0.1 a b	1.3 a	1.4
Arlet	0.1 a b	0.4 a	0.5

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by  $\log_{10}(X+1)$  prior to analysis.

<sup>1</sup>Twenty-five leaves per tree were sampled in five reps on 29 June, 1999. June threshold is 2.5 mites/leaf.

*chyus ulmi* (Koch), and two spotted spider mite, *Tetranychus urticae* (Koch).

Damage to fruit by insects was assessed by randomly selecting 25 fruit at harvest maturity (13 August) that were examined for external damage by each pest; subsequently, fruits were dissected to detect internal damage. All entries could not be evaluated for fruit damage during 2001 because fruit loads were low or nonexistent due to the biennial characteristic of some cultivars—those included Creston, Fuji Red Sport, Fulford Gala and Sansa. Insects monitored included apple maggot, *Rhagoletis pomonella* (Walsh); plum curculio, *Conotrachelus nenuphar* (Herbst); codling moth, *Cydia pomonella* (Linnaeus); and oblique banded leafroller, *Choristoneura rosaceana* (Harris). Although damage from European apple sawfly, San Jose scale, a leafhopper complex, an aphid complex and a plant bug complex was evident, it was not consistent or serious among entries, and those data are therefore not presented.

Significance of differences among cultivars was determined by Fisher's Protected LSD. In all data tables, columnar numbers followed by the same letter do not differ significantly ( $P \leq 0.05$ ). Where appropriate, the arcsine or log transformation was used prior to analysis to stabilize variance, but arithmetic means are shown in the tables.

**Phytophagous mites:** Relative to all cultivars, Braeburn and Ginger Gold were notably more susceptible to European red mite (Table 1), but no cultivar exceeded the June threshold of 2.5 mites/leaf. For two spotted spider mite however, approximately half of the cultivars exceeded the June threshold, with Braeburn/M.9 and Senshu being the most susceptible. Based on all categories, Pristine, Sunrise, Gala Supreme, Orin and Arlet appeared to be the most resistant to infestation by both species combined. Arlet was unique in that infestation by both species was sufficiently low to perhaps preclude the use of chemical management.

**Plum curculio:** Entries that sustained less than 5 percent damage from plum curculio are considered to be tolerant—approximately 38 percent of the cultivars were in this category (Table 2). Very noteworthy for tolerance were Arlet, Enterprise and Mutsu. Cultivars that were very susceptible to curculio were Cameo, Braeburn/Mark, Yataka/M.9 and SunCrisp.

**Codling moth:** Pristine, Sunrise, McIntosh (Pioneer) and Braeburn/M.9 were remarkably resistant to infestation by codling moth (Table 3). NY 75414,

TABLE 2

Incidence of plum curculio damage<sup>1</sup> in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with ovipositional scars		
Cameo	31.5		i
Braeburn/Mark	28.4		h i
Yataka/M9	22.8		g h i
SunCrisp	20.6		g h i
Yataka/Mark	16.1		f g h i
Sunrise	13.0		e f g h
Fortune	11.4		d e f g
McIntosh (Pioneer)	11.4		d e f g
Gala Supreme	10.7	c	d e f g
Golden Del/Mark	10.6	c	d e f g
NY 75414-1	8.8	c	d e f g
Fuji (BC #2)	8.7	c	d e f g
Pristine	8.2	b c	d e f g
Golden Supreme	8.1	b c	d e f g
GoldRush	5.5	a b c	d e f
Ginger Gold	5.0	a b c	d e f
Braeburn/M.9	4.3	a b c	d e f
Honeycrisp	3.7	a b c	d e
Senshu	3.6	a b c	d e
Orin	2.3	a b c	d
Shizuka	1.9	a b c	d
Arlet	1.5	a b c	
Enterprise	0.7	a b	
Mutsu	0.2	a	

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

<sup>1</sup>Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

TABLE 3

Incidence of codling moth damage<sup>1</sup> in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with larval tunnels		
GoldRush	20.9		i
Yataka/Mark	17.5		h i
Gala Supreme	16.9		h i
Senshu	16.0		h i
Braeburn/Mark	15.9		h i
Arlet	15.0		g h i
Fuji (BC #2)	14.1		f g h i
Enterprise	14.0		f g h i
Mutsu	13.3		f g h i
Shizuka	12.7		f g h i
Golden Del/Mark	10.8		e f g h i
Fortune	10.4		e f g h i
SunCrisp	10.0		e f g h
Orin	9.5		d e f g h
Cameo	8.5		d e f g h
Golden Supreme	8.5		d e f g h
Ginger Gold	8.3		d e f g h
Yataka/M9	6.2		c d e f g
NY 75414-1	5.5		c d e f
Honeycrisp	4.4	b c	d e
Braeburn/M.9	2.8	a b c	d
McIntosh (Pioneer)	1.5	a b c	
Sunrise	0.5	a b	
Pristine	0.2	a	

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

<sup>1</sup>Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

**TABLE 4**

**Incidence of obliquebanded leafroller damage<sup>1</sup> in NE-183 planting #1 that was established in 1995.**

	Mean percentage of fruit with surface feeding		
Cameo	20.2		i
Sunrise	19.0		i
Pristine	17.2		h i
Golden Supreme	16.6		g h i
Honeycrisp	15.8		g h i
Fortune	12.0	f	g h i
Ginger Gold	8.5	e f	g h
Enterprise	7.6	d e f	g
Braeburn/Mark	7.5	d e f	g
Gala Supreme	5.7	c d e f	
Golden Del/Mark	5.5	c d e f	
SunCrisp	5.5	c d e f	
Mutsu	5.3	c d e f	
Yataka/M9	4.4	c d e f	
GoldRush	4.3	c d e	
Orin	4.3	c d e	
Senshu	3.9	b c d e	
NY 75414-1	3.1	b c d e	
Shizuka	3.1	b c d e	
Fuji (BC #2)	2.3	b c d	
Yataka/Mark	2.8	b c d e	
McIntosh (Pioneer)	1.5	a b c	
Braeburn/M.9	0.3	a b	
Arlet	0.0	a	

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

<sup>1</sup>Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

**TABLE 5**

**Incidence of apple maggot damage<sup>1</sup> in NE-183 planting #1 that was established in 1995.**

	Mean percentage of fruit with larval tunnels		
Arlet	99.3		k
Cameo	93.1		j k
Honeycrisp	90.9		i j
Braeburn/Mark	90.8		i j
Braeburn/M.9	89.7		h i j
Orin	78.5		g h i
Mutsu	78.4		g h i
Golden Supreme	75.3	f	g h
SunCrisp	69.6	e f	g
Shizuka	66.6	e f	g
Gala Supreme	65.9	e f	g
Ginger Gold	62.7	e f	g
Yataka/M.9	59.9	d e f	
Fortune	58.5	d e f	
Senshu	57.8	d e f	
Golden Del/Mark	55.8	d e	
Sunrise	40.6	c d	
Enterprise	35.9	c	
Yataka/Mark	35.2	c	
Fuji (BC #2)	32.9	c	
Pristine	32.3	c	
McIntosh (Pioneer)	26.9	b c	
GoldRush	13.0	a b	
NY 75414-1	11.5	a	

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

<sup>1</sup>Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

Honeycrisp and Yataka/M.9 appeared somewhat tolerant to infestation, while all others were susceptible to very susceptible (8.3 – 20.9 percent infested).

**Oblique banded leafroller:** Approximately 54 percent of the cultivars sustained less than 5 percent damage from the fruit feeding stage of OBLR—Arlet, Braeburn/M.9 and McIntosh were the most resistant to damage (Table 4). Remarkably susceptible to damage were Cameo, Sunrise, Pristine, Golden Supreme, Honey Crisp and Fortune.

**Apple maggot:** Infestation pressure from this pest was extreme during 2001—approximately 67 percent of the cultivars sustained greater than 50 percent infestation (Table 5). NY 75414, Goldrush and McIntosh (Pioneer) were less susceptible to apple maggot than other entries. All other entries were susceptible, with Arlet and Cameo being extremely so. Susceptibility to maggot infestation was apparently independent of fruit color or earliness of maturity. Generally, firm varieties are less susceptible to larval establishment than soft varieties but in these evaluations, firmness had no apparent effect.

### Relative Damage by All Insects

This summary (Table 6) includes the assessment of damage by all insects encountered, even though such data were not presented in the previous tables (e.g., leafhoppers, aphids, etc.). On the basis of percent clean fruit, only NY 75414-1 (60 percent clean) and McIntosh (39 percent clean) had a general tolerance to insect damage, displaying low relative damage in all categories.

### Significance of Differences in Susceptibility

Apple cultivars, including those included in this assessment, are generally not developed with the intended goal of resistance or tolerance to particular arthropod infestations. In most cases, genetic resistance to specific pests has not yet been discovered, or not yet bred into apple cultivars. Nonetheless, there appear to be various unidentified resistance or susceptibility factors that are inherent to some cultivars. Cultivars that are highly susceptible to particular pests may require extra applications of pesticide each year. If cultivar susceptibilities to pests were known prior to orchard establishment, growers could plan for the concomitant costs of pest control. For example, data presented here suggest that Braeburn or Senshu trees are likely to require

additional miticide sprays, compared to cultivars having minimal susceptibility to arthropods such as Orin or Arlet. In areas where infestations by internal leps are of concern, the selection of Pristine or Sunrise would be logical over Gold Rush or Yataka. If one were seeking a single cultivar that would require less attention to general damage by all insects, these results would suggest that NY 7541 should be selected.

### Literature Cited

- Brown, S., and K. Maloney. 2002. Apple cultivars: a Geneva perspective. *NY Fruit Quarterly* 10(2):21-27.
- Rosenberger, D. 2003. Susceptibility of New Apple Cultivars to Various Diseases and Arthropod Pests. N. Y. *Fruit Quarterly* 11(2):xx-xx.

*Richard Straub is research and extension professor of entomology at Cornell University's Hudson Valley Laboratory in Highland, NY. He specializes in fruit and vegetable insect management.*

**TABLE 6**

**Incidence of fruit undamaged by insects<sup>1</sup> in NE-183 planting #1 that was established in 1995.**

	Mean percentage of undamaged fruit	
Arlet	0.0	a
Braeburn/Mark	1.0	a b
Cameo	1.5	a b
Honeycrisp	2.8	b c
Mutsu	3.9	b c d
Braeburn/M.9	5.5	b c d e
Fortune	5.9	b c d e f
Orin	8.5	c d e f g
Senshu	8.5	c d e f g
Ginger Gold	8.6	c d e f g
Shizuka	10.3	d e f g
Golden Supreme	10.3	d e f g
Yataka/Mark	12.6	e f g h
Sunrise	14.1	e f g h
Gala Supreme	14.3	f g h
Fuji (BC#2)	16.3	g h i
SunCrisp	17.2	g h i
Pristine	18.0	g h i
Yataka/M.9	22.1	h i j
Enterprise	24.0	h i j
Golden Del/Mark	27.0	i j k
GoldRush	33.2	j k
McIntosh (Pioneer)	39.8	k
NY 75414-1	60.0	l

Means followed by the same letter are not significantly different ( $P < 0.05$ ; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

<sup>1</sup>Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.



## Join the New York State Horticultural Society

Become a part of our Society. Yearly membership includes HortSense Newsletter, Hort Flash Updates, and the New York Fruit Quarterly. **Join us today and support the NYSHS mission to educate, promote and protect the NY fruit industry! Fill out and mail the Membership Application below.**

### NYSHS Membership Dues

NY Fruit Growers (Individual membership)	\$95
Additional (Voluntary Contribution)	\$ _____
Industry Professionals	\$95
Academic Professionals	\$45
Out of State	\$45
<b>Fruit Industry Sponsors</b>	
NYSHS Supporter	<\$500
Bronze	\$500
Silver	\$1250
Gold	\$2500
Platinum	\$5000+

### Subscribe to the informative

**NEW YORK**  
**FRUIT QUARTERLY**

for \$20\* per year.



Please use the subscription form at right.

\*Membership in the NYS Horticultural Society includes a subscription to the New York Fruit Quarterly.

### New York State Horticultural Society Membership Application

Become a part of our Society. Yearly memberships include HortSense Newsletter, Hort Flash Update, and the New York Fruit Quarterly. **Join us today!**

Please Print

NAME \_\_\_\_\_  
 FIRM NAME \_\_\_\_\_  
 STREET ADDRESS \_\_\_\_\_  
 CITY \_\_\_\_\_ COUNTY \_\_\_\_\_  
 STATE \_\_\_\_\_ ZIP \_\_\_\_\_  
 PHONE \_\_\_\_\_ FAX \_\_\_\_\_ E-MAIL \_\_\_\_\_

### PLEASE FIND THE ENCLOSED DUES FOR THE FOLLOWING:

\$ \_\_\_\_\_ NYS Horticultural Society Membership Dues  
 \$ \_\_\_\_\_ \$20 per year NY Fruit Quarterly Subscription ONLY  
 \$ \_\_\_\_\_ TOTAL

PLEASE MAKE CHECK PAYABLE TO:  
 New York State Horticultural Society

MAIL TO: New York State Horticultural Society  
 PO Box 462 • Hedrick Hall  
 Geneva, NY 14456

Questions? Call the NYSHS office at 315-787-2404