# Fruit Notes

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# Fruit Notes

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Cover: Super Spindle (2.5'x10', planted 2000) Braeburn/M.9 in 2013 at Rutgers Snyder Research & Extension Farm, Pittstown, NJ. Win Cowgill photo.

# Maximizing SmartFresh™ Utilization for Farm Markets

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The adoption of SmartFresh™ technology in our retail farm markets has been slow. However, the use of this technology in the form of SmartTabs can provide significant advantages for growers who sell their fruit directly from the farm. Fruit intended for sale in farm markets is often harvested at a more advanced stage of maturity, allowing it to develop a flavor and aroma profile typical of the cultivar that consumers who purchase fruit from farm markets expect. Apples sold in our farm markets are often exposed to high temperatures in the retail market, causing the fruit to ripen quickly, limiting their shelf life and consumer appeal. This article discusses how SmartFresh™ technology can be used to enhance the quality of apple fruit sold in this type of retail farm market.

## *The Quality Challenge in Farm Markets*

Fruit destined for sales in retail markets is harvested at a more advanced stage of maturity compared to fruit harvested for long term storage. Fruit harvested for wholesale markets may be kept for many months in cold storage or controlled-atmosphere storage before it is packed and shipped. In contrast, the fruit harvested for direct farm market sales is often held in regular cold storage for shorter periods before sale. Once fruit are removed from cold storage, they may be held continuously at ambient temperatures in the market until they are sold. Fruit in these markets may be exposed to temperatures above 70° F, particularly during the months of August and September. Such high temperatures cause the fruit to ripen quickly, hastening the rates of fruit softening and loss of fruit acidity, and limiting the shelf life of fruit after sale.

Consumers who purchase fruit from retail farm markets are likely to have different sensory expectations compared to those who purchase fruit from a local supermarket. Most growers who sell fruit from farm markets readily acknowledge this point, and seek to deliver a product that fully meets these expectations. Customers who come to your farm market are looking to purchase fruit that have been allowed to ripen on the tree, developing a more complete flavor/aroma profile before it is harvested. They are expecting an apple that it is not only fresher, but also tastes better than a store-bought apple, because that extra time on the tree has allowed the fruit to develop a flavor profile that is typical of the cultivar. The dilemma, however, is that while late harvested fruit will develop a more favorable flavor profile, they also exhibit reduced firmness and acidity compared to fruit harvested at an earlier stage of maturity (Figure 1). Unmet consumer expectations for firmness and flavor will result in low customer satisfaction, and a reduction in repeat sales. SmartFresh™ (1-MCP), however, delays fruit softening and maintains fruit acidity, but can also reduce the development of volatile esters and alcohols that contribute to the characteristic flavor of a particular cultivar. The stage of fruit maturity at the time of harvest will have a pronounced effect

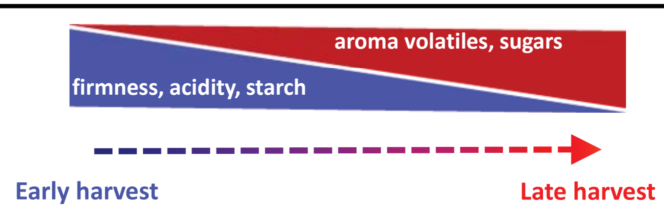


Figure 1. Firmness and 'flavor', which can be considered as the combined sensory effect of sweetness, acidity, starch content, and volatile aroma compounds, are critical components of overall consumer acceptance. Arguably, firmness and flavor are more critical to consumer acceptance of apples sold in farm markets compared to grocery stores. It is important to time the harvest so that the balance between firmness and flavor in the fruit will match consumer expectations. Tools like SmartFresh SmartTabs can be used to maintain this balance from the time of harvest until the time of consumption.

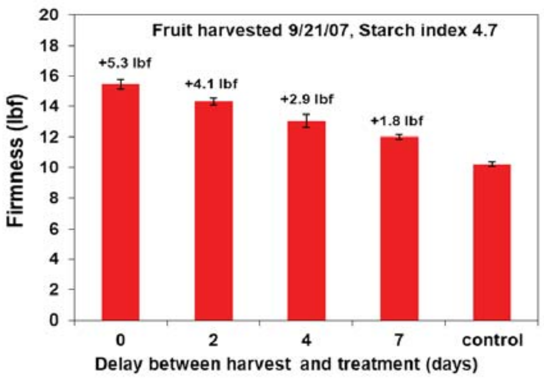


Figure 2. Effects of delay between harvest and SmartFresh application on firmness of Law Rome after 40 days at 32° F followed by 7 days at room temperature. Values above each bar indicate increase in firmness compared to untreated control.

on the quality perception of SmartFresh-treated fruit sold in retail farm markets, with fruit harvested at a more advanced stage of maturity more likely to have developed a desirable flavor profile.

## *Treat Fruit as Soon As Possible after Harvest*

Variety specific guidelines for SmartFresh treatment are published by Agro-Fresh Inc. These guidelines list the recommended maturity parameters (flesh firmness and starch index) and a maximum interval between harvest and treatment for each variety. At NCSU we have examined how the delay between harvest and treatment affects fruit firmness after short-term cold storage for the cultivars Law Rome (Figure 2), Golden Delicious, and Gala. We found a consistent decline in the effectiveness of SmartFresh, measured as the firmness after 40 days in cold storage followed by 7 days at room temperature, for Law Rome and Golden Delicious, but not for Gala, as the delay between harvest and treatment increased from 0 to 7 days. This decrease in efficacy was more dramatic for Law Rome than for Golden Delicious. The maturity of fruit harvested for sale in farm markets may be more advanced than those recommended in commercial practice. When fruit maturity is advanced, it becomes more important to treat the fruit immediately after harvest.

## *SmartFresh Maintains Firmness of Fruit Kept at Ambient Conditions*

We placed samples of untreated and SmartFresh-treated fruit of the cultivars Gingergold, Gala, and Golden Delicious into three different farm markets in the southeast and monitored firmness for up to 4 weeks (Figure 3). Under the high ambient temperatures (often greater than 75° F) that prevailed in these markets, the firmness of untreated fruit rapidly declined to levels that most consumers would find unacceptable (less than 12 lb.), whereas treated fruit maintained their harvest firmness for up to 4 weeks (Figure 3). We do not advocate the use of SmartFresh to maintain firmness of fruit held continuously under high temperatures for several weeks, but these data show that a consumer will still enjoy a crunchy apple even the fruit is "abused" by

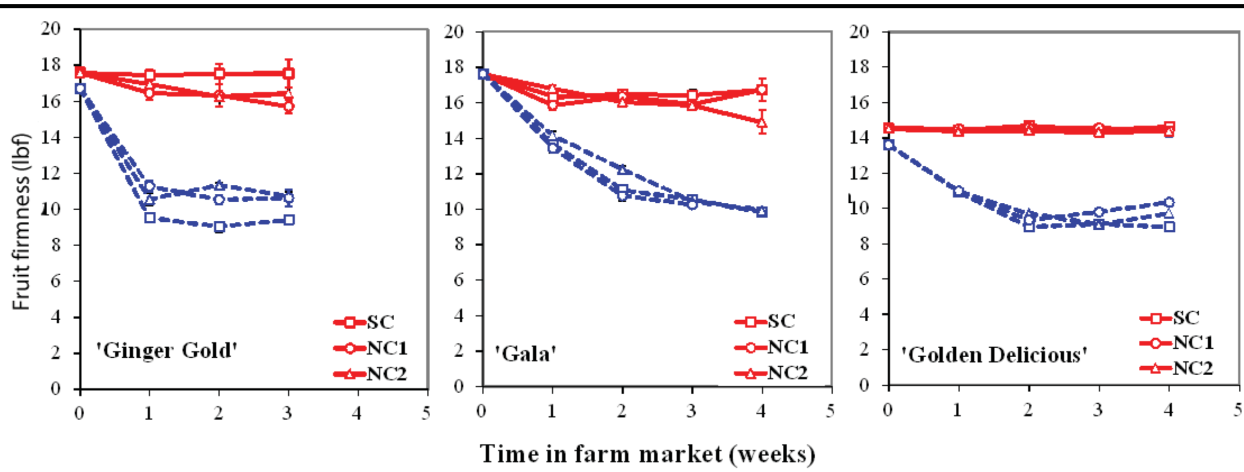


Figure 3. Effects of SmartFresh on firmness of Ginger Gold, Gala, and Golden Delicious apples kept continuously at ambient conditions in three farm markets (SC, NC1, NC2). Red lines represent SmartFresh™ treated fruit, and blue lines represent untreated fruit.

**Hot Tip**

The treatment tent or room must me airtight in order to keep the concentration of 1-MCP (the active ingredient in SmartFresh) at an effective level during the 24-hour treatment period. Any leaks will result in concentrations falling below an effective level, and the product will not be as effective. How do you know if you have a leak? A trick we use in our research experiments is to include a few tomatoes at the breaker stage of maturity in the tent with the apples and leave a few more tomatoes at the same stage of maturity outside the tent. After treatment we place both treated and untreated tomatoes beside each other in a warm spot for a few days. The treated tomatoes remain green while the untreated tomatoes quickly turn red within a day or two. This method provides a quick confirmation treatment efficacy.


not storing it at ideal temperatures. What is remarkable about these data is that treated Golden Delicious fruit did not exhibit any softening over a 4-week period at ambient temperatures. These data also indicate that SmartFresh can maintain fruit quality in situations where fruit are stored at temperatures that are higher than ideal, perhaps due to cold storage rooms that are not running at optimum temperatures. After several weeks at the ambient temperatures and relative humidity levels in these markets, we saw some fruit rots developing in the fruit, and observed that SmartFresh reduced, but did not eliminate, the incidence of rots. If you are going to hold SmartFresh™ treated fruit for prolonged periods at ambient temperatures then you may need to consider a postharvest fungicide treatment to reduce the incidence of fruit rots.

## *A Question of Scale*

Rooms for treating fruit with SmartFresh have

Figure 4. The Adjustable Apple Tent (http://theblimpworks.com/ ) has a four bin footprint and can treat 4, 8, or 12 bins of fruit at a time. The tent is raised or lowered to minimize dead space and maintain the concentration of active ingredient at an effective level for the duration of the 24-hour treatment period. It is easily sealed around the base with a water bladder.

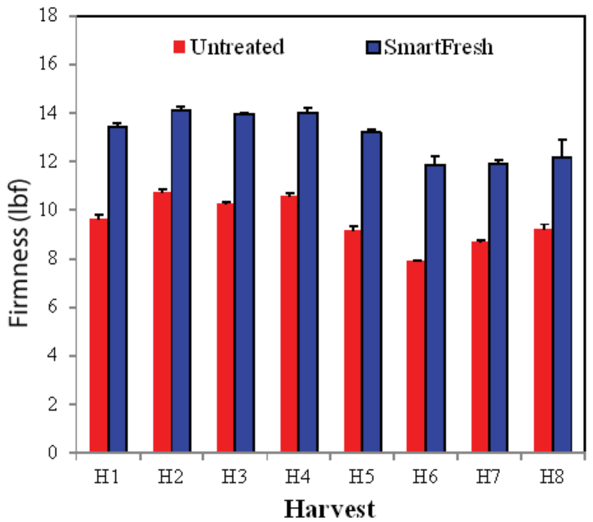

Figure 5. Effects of SmartFresh treatment at different harvest dates (H1-H8) on the firmness of Golden Delicious apple fruit after 8 weeks in cold storage. Fruit at the final harvest date (H8) had a starch index of 7.8 (maximum index is 8) and 80 percent of the fruit with an internal ethylene concentration greater than 1 ppm, indicating that maturity had progressed beyond the climacteric point.

typically been large, with capacities anywhere from 50-500 bins if fruit at a time. Many growers are not able to fill a room that size within one or two days after harvest. Growers can either build their own airtight chamber for SmartFresh treatment, or purchase a purpose-built unit. In our research we have used a two-bin capacity pallet tent where a 4 mil polyethylene pallet cover (64” × 56” × 108”) is placed over a frame made from ¾” PVC pipe (60” × 50” × 70” H). To keep the pallet tent airtight we place it on a linoluem base and use duct tape to seal the pallet cover to the linoleum. Working with a local company (The Blimp Works, Statesville, NC; http://theblimpworks.com/), we have developed an Adjustable Apple Tent that has a capacity for treating 4, 8, or 12 bins of fruit at a time (Figure 4). A battery-operated fan is placed inside these tents to ensure good air circulation during the 24-hour treatment period.

## *Does the Fruit Need to be Cold Prior to Treatment?*

We investigated the effect of fruit core temperature on the efficacy of SmartFresh on Golden Delicious in 2012. Fruit were harvested from the same trees on the same day, either early in the morning when the core temperature was coolest (approx. 60°F) or during the hottest part of the day when the fruit core temperature was around 95°F. Fruit harvested in the morning were cooled immediately. Fruit from the afternoon harvest were either treated in a pallet tent at ambient temperatures in a packhouse, or in a second pallet tent in a cooler together with the fruit that had been harvested and cooled that morning. Fruit harvested in the morning were already cool prior to treatment, with core temperatures around 40°F; whereas, fruit harvested in the afternoon still had the field heat at the beginning of the treatment period, but cooled slowly during treatment, with core temperatures starting at 95°F and finishing at 40°F after the 24-hour treatment interval. A third fruit sample had fruit core temperatures ranging from 77-86°F during the 24-hour treatment period. What we found was that SmartFresh was equally as effective regardless of fruit core temperature during the treatment period. We cannot claim that this is true of all cultivars, but for Golden Delicious, fruit temperature does not influence SmartFresh effectiveness.

## *Mature Fruit Respond to SmartFresh*

In research with Golden Delicious and Gala, we found that fruit harvested at a very advanced stage of maturity responded positively to SmartFresh treatment on the day of harvest by exhibiting reduced softening and ethylene production after short-term cold storage (see Figure 5 for firmness of treated and untreated Golden Delicious fruit after 8 weeks in storage). Golden Delicious fruit harvested with a starch index of 7.8 (using the Cornell 1-8 starch rating system) and more than 80 percent of the fruit climacteric i.e., with an internal ethylene concentration greater than 1 part per million, still exhibited acceptable firmness (12.2 lb) after 8 weeks storage at 34° F, whereas the firmness of untreated fruit harvested at the same time was only 9.2 lb. Similarly, Gala fruit that were harvested with a starch index of 7.6 and 100 percent of the fruit climacteric exhibited a firmness of 13.6 lb after 8 weeks storage; whereas, the firmness of untreated fruit from the same harvest dropped to 10.9 lb.

Fruit that are harvested at more advanced stages of maturity for immediate sale or short-term storage will have developed a more favorable flavor/aroma profile compared with fruit harvested at an earlier stage of maturity for long-term storage. While there are many individual chemical compounds that contribute to the aroma volatiles in apples, a small group dominates to create the overall varietal impact characteristic of Gala. SmartFresh treatment can reduce levels of the dominant aroma compounds in Gala (2-methylbutyl acetate, butyl acetate, hexyl acetate, and butanol). The potential for SmartFresh to suppress development of aroma volatiles should provide a note of caution for its use on fruit that are harvested at an early stage of maturity. Such fruit may not develop an acceptable flavor/aroma profile. In contrast, fruit that are harvested at a more advanced stage of maturity, such as those destined for short term storage and sale in direct farm markets, can benefit greatly from SmartFresh treatment. The apples will have developed a more favorable flavor profile on the tree, and treatment with SmartFresh immediately after harvest will ensure minimal loss of firmness and fruit acidity both in storage and during the stressful conditions that may develop in the market or in the hands of the consumer.

Many retail growers in North Carolina have found that SmartFresh is a very effective tool to help them maintain the quality of their fruit. This technology helps them to sell more fresh fruit by providing customers with higher quality fruit over a longer selling season in addition to extending the market window of tree-ripened fruit. Growers who also make their own cider comment that SmartFresh-treated apples have a significantly greater juice yield that pays for the cost of treatment, which is approximately $0.90/bushel.

# Third-leaf Results from the 2010 NC-140 Apple Rootstock Trial in Massachusetts and New Jersey

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As part of the 2010 NC-140 Apple Rootstock Trial, replicated plantings were established in New Jersey (Rutgers Snyder Research & Extension Farm, Pittstown) and Massachusetts (UMass Cold Spring Orchard Research & Education Center, Belchertown). Descriptions of the trials were included in Horticultural News (Summer, 2010, Volume 90, Number 3) and Fruit Notes (Summer, 2010, Volume 75, Number 3).

Both trials include 31 rootstocks with Honeycrisp as the scion variety and are trained as tall spindles. Thirteen Cornell-Geneva rootstocks are in the trial, including four that have been named (G.11, G.41, G.202, and G.935). The trial has nine Budagovsky rootstocks, two of which are named (B.9 and B.10). Three Malling rootstocks (M.9 NAKBT337, M.9 Pajam 2, and M.26 EMLA) are included as controls.

Both plantings have done quite well, and the data presented here are those collected through the third growing season (2012) (Table 1). The third season was the first yield season. Please note that the trees in Massachusetts yielded fruit but data were not collected, because the trees were inadvertently harvested prior to yield measurement.

The effects of rootstock on tree size were similar in Massachusetts and New Jersey, but trees in New Jersey have grown more in their first three seasons. It is clear that a few rootstocks produce trees

Table 1. Trunk cross-sectional area, cumulative root sucker number, yield, and fruit size in 2012 of Honeycrisp apple trees on various rootstocks in the 2010 NC-140 Honeycrisp Apple Rootstock Trial in Massachusetts and New Jersey.[z]

| | UMass Cold Spring Orchard, Belchertown, MA | | Rutgers Snyder Farm, Pittstown, NJ | | | |
|---|---|---|---|---|---|---|
| Rootstock | Trunk cross-sectional area (2012, cm$^2$) | Cumulative root suckers (2010-12, no.) | Trunk cross-sectional area (2012, cm$^2$) | Cumulative root suckers (2010-12, no.) | Yield per tree (2012, kg) | Average fruit size (2012, g) |
| B.9 | 3.2 f | 2.2 ab | 4.0 hi | 1.0 bc | 5.1 cde | 266 ab |
| B.10 | 5.8 cdef | 0.0 b | 6.6 gh | 0.3 bc | 8.8 abcd | 285 a |
| B.7-3-150 | 6.8 bcde | 0.4 ab | 12.2 cde | 0.6 bc | 9.4 abc | 289 a |
| B.7-20-21 | 8.7 bc | 0.5 ab | 15.4 b | 0.1 bc | 9.0 abcd | 266 ab |
| B.64-194 | 8.8 bc | 0.0 b | 13.5 bcd | 0.1 bc | 7.6 abcde | 284 a |
| B.67-5-32 | 8.4 bcd | 0.1 ab | 11.9 de | 0.6 bc | 5.4 cde | 277 ab |
| B.70-6-8 | 8.7 bc | 0.4 ab | 11.1 defg | 0.0 c | 9.7 abc | 273 ab |
| B.70-20-20 | 15.7 a | 1.4 ab | 26.3 a | 0.9 bc | 4.4 de | 273 ab |
| B.71-7-22 | 1.2 f | 1.0 ab | 1.5 i | 0.3 bc | 0.8 e | 164 b |
| G.11 | 4.7 ef | 2.7 ab | 7.2 gh | 0.7 bc | 9.8 abc | 290 a |
| G.41N | 4.6 ef | 0.2 ab | 7.3 gh | 0.1 bc | 6.5 abcde | 290 a |
| G.41TC | 4.3 ef | 2.5 ab | 7.1 gh | 0.3 bc | 5.0 cde | 302 a |
| G.202N | 10.1 b | 8.2 a | 15.1 b | 1.9 bc | 5.1 cde | 284 a |
| G.202TC | 7.3 bcde | 3.7 ab | 8.6 fg | 1.6 bc | 8.4 abcd | 282 a |
| G.935N | 7.5 bcde | 2.1 ab | 9.7 efg | 1.3 bc | 6.8 abcde | 271 ab |
| G.935TC | 5.5 cdef | 6.4 ab | 10.6 defg | 2.8 ab | 6.5 abcde | 277 ab |
| CG.2034 | 3.8 ef | 0.5 ab | 5.7 hi | 0.0 c | 7.2 abcde | 298 a |
| CG.3001 | 11.3 ab | 0.0 b | 11.4 defg | 0.3 bc | 9.1 abcd | 316 a |
| CG.4003 | 4.0 ef | 0.7 ab | 6.7 gh | 0.0 c | 8.7 abcd | 298 a |
| CG.4004 | 8.0 bcde | 5.5 ab | 13.3 bcde | 0.8 bc | 6.5 abcde | 292 a |
| CG.4013 | 6.3 bcdef | 0.2 ab | 10.3 defg | 0.3 bc | 5.2 cde | 285 a |
| CG.4214 | 6.3 bcdef | 2.9 ab | 9.8 efg | 0.4 bc | 5.5 bcde | 307 a |
| CG.4814 | 7.0 bcde | 5.9 ab | 12.8 bcde | 3.0 ab | 6.8 abcde | 273 ab |
| CG.5087 | 6.1 bcdef | 2.9 ab | 12.8 bcde | 0.7 bc | 4.2 de | 323 a |
| CG.5222 | 8.6 bcd | 5.7 ab | 11.7 defg | 1.8 bc | 7.6 abcde | 259 ab |
| Supp.3 | 4.5 ef | 0.5 ab | 7.7 fg | 0.1 bc | 5.5 bcde | 232 ab |
| PiAu 9-90 | 9.5 b | 0.0 b | 16.3 b | 0.1 bc | 6.6 abcde | 250 ab |
| PiAu 51-11 | 9.0 bc | 0.6 ab | 14.6 bc | 0.4 bc | 5.2 cde | 311 a |
| M.9 NAKBT337 | 5.5 cdef | 3.8 ab | 8.0 fg | 2.8 ab | 11.0 a | 307 a |
| M.9 Pajam 2 | 5.1 def | 6.3 ab | 8.3 fg | 5.3 a | 10.3 ab | 299 a |
| M.26 EMLA | 5.2 cdef | 2.3 ab | 8.7 fg | 1.0 bc | 5.8 bcde | 328 a |

[z] Within columns, means not followed by a common letter are significantly different at odds of 19 to 1.

that are much too large for the tall spindle system: B.70-20-20, PiAu 9-90, B.7-20-21, G.202, PiAu 51-11, and possibly others (Table 1).

Yield in New Jersey varied only by a few kg per tree. Notably, M.9 resulted in the highest yields per tree, but not signifcantly higher than trees on about two thirds of the other rootstocks. Likewise, average fruit size did not vary much from tree to tree. One rootstock, however, appeared to reduce fruit size. B.71-7-22 resulted in the smallest fruit. Interestingly, it also resulted in the smallest tree with the lowest yields.

Obviously, these are very early results from this trial, but they point out those rootstocks at the extremes. We will periodically publish results from this trial over its projected 10 years.

The 2010 NC-140 Apple Rootstock Trial at Rutgers Snyder Farm in New Jersey.

# He's Only Mostly Dead! Managing Brood II of the 17-year Cicada in the Hudson Valley

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The first two weeks of June 2013 were quite a challenge for fruit growers experiencing Brood II of the 17-year cicada, *Magicicada septendecim*. Populations were variable throughout the Hudson Valley with a very strong edge effect in blocks bordering woodlands and concentrated emergence within apple blocks heavily infested in 1996. The first appearance of adults was observed on the May 27, 2013, with the onset of mate calling or 'singing' on the June 2. Egg-laying slits in pencil size branches occurred the following day. Winds from a June 8 storm front began to break limbs that once bore fruit but were damaged from cicada oviposition.

Figure 1. The 17-year cicada in a moribund state.

Tree fruit producers with high-pressure cicada blocks made at least one application of an insecticide to reduce egg-laying damage to branches during the first week in June. Yet growers have had a difficult time discerning how effective these treatments really are. In most first- and second-cover treatments used against PC and codling moth, the cicada can still be found in trees shortly after applications. Some treatments induce a knock down effect lasting only a few hours before the insect is back on its feet, climbing up the trunk and limbs to cause trouble. This 'mostly dead' effect or moribund state, has been observed

Figure 2. A 17-year cicada adult on a Surround-treated leaf.

in larger insects including the brown marmorated stink bug. The moribund effect can last for a few days before the insects either succumb to the toxic effects of the insecticide or revive and go back to 'business as usual'. During this 'down time' they are vulnerable to predation by mammals and other insects, such as foraging ants.

Materials in the carbamate class, such as Lannate (methomyl), and the pyethroid class, including Asana (esfenvalarate), Danitol (fenpropathrin) or Warrior (lambda-cyhalothrin), have proven to be quite effective against the cicada, often providing high mortality on contact. Given the body mass of the insect, these materials appear to have very short residual toxicity against the migrating adults and emerging nymph. With short residual toxicity, repellency becomes an important mode of action, found to be an effective component of the pyrethroid chemistry.

Of these insecticides, it appears two of the pyrethroids are capable of maintaining low ovipositional damage to trees to reduce limb breakage and fruit loss. In studies conducted by Chris Bergh in Winchester, Virginia, three dilute applications were made at 6-8-day intervals to young trees beginning May 28. Near the end of the egg-laying season, Asana applied at the high-labeled rate of 14.5 oz./acre and Danitol applied at 21.0 oz./acre provided significantly better ovipositional deterrence to the 17-year cicada than did the highest labeled rates of Actara, Calypso, Avaunt 30WG, and Aza-Direct 1.20%. Lannate, Warrior, and Assail, although numerically better, were not significantly different then the best treatments in reducing egg-laying slits, while Danitol provided complete control of limb breakage (Table 1 & 2).

In plots to which we have applied the organic control measures of Surround WP at 50 lbs./acre and highest labeled rate of Pyganic to control plum curculio, we continue to see the presence of the cicada with oviposition into treated wood (Figure 1). In conventionally treated plots employing Imidan and Lannate at the full labeled rates, we have seen re-infestation 3 days post application, also with continued egg-laying to treated wood.

Although pyrthroids have a tainted history of mite flare-up from the disruption of predatory arthropods and

Table 1. Effects of various insecticides on the number 17-year cicada oviposition slits.

| Treatment | Rate Per acre | Mean number of cicada oviposition slits/branch May 27 | June 3 | June 10 | June 17 |
|---|---|---|---|---|---|
| Actara 25WG | 5.5 oz | 9.9a | 21.1a | 26.7a | 30.2abc |
| Asana XL | 14.5 fl oz | 1.3b | 2.6b | 3.4c | 3.5e |
| Assail 70WP | 3.4 oz | 2.1b | 15.6ab | 21.9ab | 19.3bcde |
| Avaunt 30WG | 6.0 oz | 9.7a | 21.1a | 31.1a | 38.4a |
| AzaDirect 1.20% | 1.0 qt | 4.6ab | 16.4ab | 27.4a | 34.3ab |
| Calypso 480SC | 8.0 fl oz | 5.1ab | 15.1ab | 21.1ab | 27.1abcd |
| Danitol 2.4EC | 21.0 fl oz | 1.2b | 1.8b | 2.1c | 2.1e |
| Lannate LV | 3.0 pt | 1.4b | 4.9b | 9.3bc | 11.1de |
| Warrior 1CS | 5.1 fl oz | 1.2b | 7.6ab | 11.1bc | 13.3cde |
| Untreated check | | 7.9ab | 21.3a | 28.4a | 32.6ab |

Means within columns not followed by a common letter are significantly different at odds of 19 to 1.

significant loss of efficacy at higher temperatures, they are relatively 'user friendly' with low mammalian toxicity and broad-spectrum activity to help combat the tree-fruit pest complex, and so, maintain an important role in the toolbox during these days of plague-like emergences of the 17-year cicada and looming presence of the invasive brown marmorated stink bug.

Modified and printed with permission from *Scaffolds Fruit Journal* (Volume 22, Number 12, June 10, 2013)

Table 2. Effects of various insecticides on the incidence of 17-year cicada damage.

| Treatment | Rate per acre | Mean no. flagged shoots/tree (June 24) | Mean no. fallen shoots/tree (June 24) |
|---|---|---|---|
| Actara 25WG | 5.5 oz | 8.3ab | 1.75a |
| Asana XL | 14.5 fl oz | 0.3e | 0.50ab |
| Assail 70WP | 3.4 oz | 3.0cde | 0.25ab |
| Avaunt 30WG | 6.0 oz | 9.0a | 1.75a |
| AzaDirect 1.20% | 1.0 qt | 4.8abcd | 0.75ab |
| Calypso 480SC | 8.0 fl oz | 4.5bcde | 0.75ab |
| Danitol 2.4EC | 21.0 fl oz | 1.0de | 0.0b |
| Lannate LV | 3.0 pt | 5.0abcd | 0.75ab |
| Warrior 1CS | 5.1 fl oz | 4.5bcde | 0.50ab |
| Untreated check | | 7.3abc | 1.25ab |

Means within columns not followed by a common letter are significantly different at odds of 19 to 1.

# Cicada Notes

**Dean Polk and Atanas Atanassov**
***New Jersey Agricultural Experiment Station, Rutgers University***

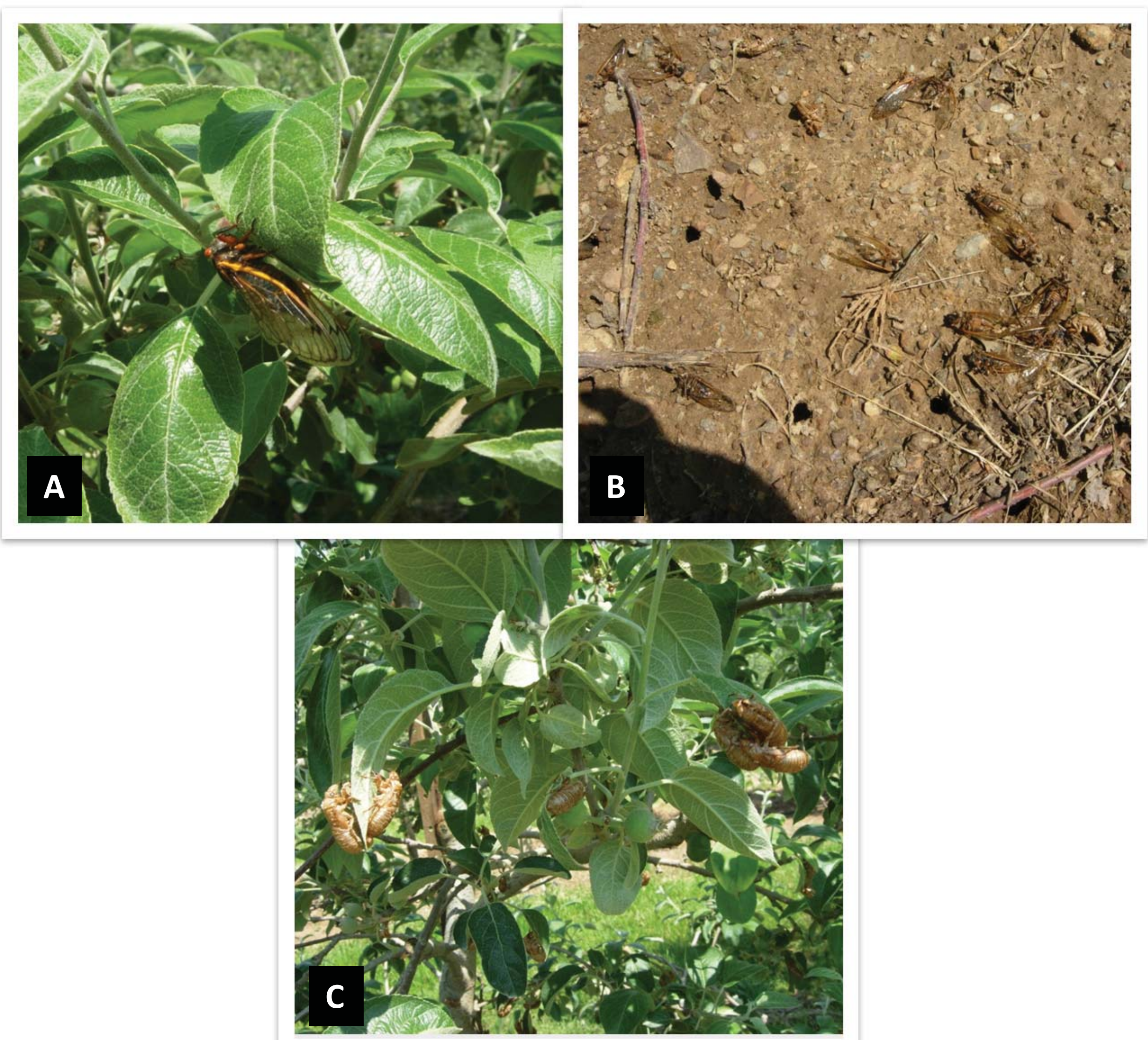
The first of 17-year periodical cicadas emerged in apple and peach orchards on a farm in Morris County on May 24, 2013. Appearance was pretty spontaneous and in the next 2 days adult numbers were very high.

The grower sprayed on May 26 with a generic lambda-cyhalothrin (a pyrethroid insecticide - Grizzly, 5 oz/acre).

Counts taken on May 31 indicated about a 99% kill. Only single adults (A) were seen in the canopy or flying around trees. All other cicadas were dead on the ground (B). No eggs had been laid, since the treatment came soon after emergence. Many cast skins remained are on the ground, trunks, or leaves (C).

The orchard is partially surrounded by woods, which may have provided an additional non-sprayed host habitat. The cicada's most common habitat is woods/forests. Additional treatments may be needed in some cases, especially along border rows.

*Photo credits: Atanas Atanassov.*



# Not Understanding Phytotoxicity Can Damage Your Bottom Line

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**Dave Rosenberger**
*New York Agricultural Experiment Station, Cornell University*

Phytotoxicity or spray injury occurs relatively infrequently. Pesticide safety, extensive field testing and research ensure that agricultural chemicals are safe for application to a crop when applied properly and according to the label. Devastating effects, however, can result from phytotoxicity, because a problematic application is often made to an entire field or even a farm before there is any knowledge that a problem exists.

Phytotoxicity, therefore, can have a tremendous financial impact on farm finances. The economic impact if you injure or kill a perennial crop like wine grapes can be even larger (more on this example later).

Phytotoxic effects can show a wide range of symptoms. However a key diagnostic feature is uniformity. The pattern of symptom development typically follows the application method. For example, an eight row boom sprayer would give a distinctly different pattern than spot applications of an herbicide.

## *Diagnosis*

Phytotoxicity can show up as spotting on leaves and fruit, unusual growth patterns, blighting leaves or flowers, stunted growth, reduced root growth, as well as complete plant death. Symptoms often develop within a few days of an application, although in some cases phytotoxicity may take much longer to develop. We have seen Roundup injury express itself 1-2 years after the application was made (in apple, it is absorbed by the plant, stored in the roots and travels up to the foliage the following spring where it is expressed as injury to the leaves). It is essential to diagnose phytotoxicity properly and make sure that the same mistakes are not made again. The most telling symptom of phytotoxicity is uniform distribution or a pattern that can be attributed to application methodology. For example, is the entire field affected or is damage limited to the end of the row? Once this has been established, research should be conducted to determine and confirm the cause.

There are various factors that can sometimes mimic phytotoxicity. For example a frost event can cause uniform damage to one part of a field or just the bottom halves of fruit trees. Soil pH, salt injury, or fertilizer burns are other possible factors that might mimic phytotoxicity. Information on the climatic conditions and soil factors are critical in making a diagnosis.

## *Types of Pesticides*

Pesticides are toxins that kill or inhibit the target organism. They are generally considered selective toxins and, when used as prescribed by the label, will not harm the crop. It is important to note that some pesticides (such as captan and chlorothalonil) are biocidal and will kill any cell into which they gain entry. They are selective, because they are formulated so that the target organisms will ingest them and non-target organisms will not. These surface acting pesticides do not enter the plant cells. Other pesticides target a certain biochemical pathway that is unique to the target organism(s). Often these types of pesticides maybe systemic and be translocated in the plant tissues.

## *Causes of Phytotoxicity*

1. **Direct toxicity.** Certain pesticides are simply toxic to a particular crop species or variety. When a pesticide is applied to the crop with the goal of controlling a specific pest, weed or pathogen phytotoxic symptoms develop on the entire treated area. A classic example of this scenario is with the fungicide azoxystrobin (Abound, Quadris) on apple (see the example). In grapes, Concords as well as some other varieties are sensitive to a variety

of pesticides including Revus, Pristine, Flint, and sulfur. Many herbicides are selective in toxicity and may cause direct injury to a sensitive crop type.

2. **Overdose.** Pesticides are formulated to be applied at a specific rate or rate range. Overdosing can arise from poor sprayer calibration, lack of uniformity, or inaccurate rate calculations. In all cases, overdose levels may be large (i.e. 10 fold) and a variety of problems including phytotoxicity as well as excessive residues may develop. Sprayer calibration can be difficult with airblast sprayers that may reach one to many rows depending on wind conditions. Growers should calibrate and spray at the minimum row interval that is practical. Even if the spray can reach further, by spraying at a tight interval insures a more uniform and accurate application. Non-uniformity can be the result of overlapping sprays, poor guidance systems or calibration for a larger area than the sprayer is capable of reaching in a single swath. Systemic materials such as Ridomil will cause burning along the leaf margins when too high a rate is applied. This symptom develops because the material is translocated with the flow of water in a plant. Thus, the chemical is translocated and concentrated in the leaf margins and if an excessive rate is used chlorosis and burning will develop.
3. **Mixtures.** Most pesticides are marketed as a formulated product. For example there are granular formulations, wettable powders, and emulsifiable concentrates to name only a few. These formulations are specifically tailored for maximizing the effect of the individual pesticide. A convenient and economical method for controlling several pest problems at once is through the use of pesticide mixtures. Fungicides and insecticides are commonly used in combination for disease and insect control. Many problems can arise from inappropriate use of mixtures. Chemicals that are physically incompatible form an insoluble precipitate that clogs nozzles and sprayer lines. Other mixtures may be phytotoxic and result in a crop loss. Mixing formulations of diazinon or Danitol with Captan or Captec have caused crop injury in the past. Therefore, diazinon and Captan formulations should <u>not</u> be tank-mixed. This type of phytotoxicity results from either a direct interaction of the active ingredients or an interaction of the "inert" ingredients in one formulation that enhances the toxicity of the other one.
4. **Incompatible spray schedules.** A related topic to mixtures is incompatible spray schedules. In this case, use of one product, such as a crop oil, followed by another product, such as sulfur or captan, may cause phytoxicity. The pesticide labels will generally give a recommended interval to avoid problems.
5. **Excessive concentrations**. If a pesticide is applied at a specific rate to an agricultural field, it must be applied in a specific volume of water. Some pesticides are safe to the crop if applied at a high enough dilution. Also, the pH of the water used can affect both pesticide activity and phytotoxicity. An example of this situation occurred with some phosphite fungicides. These materials were found to be phytotoxic when used in less than 50gallons/acre of water if the pH of the water was less than 5.5.
6. **Climate and Phytotoxicity.** Pesticide applications should be made under "ideal" climate conditions. However, this is often impractical. Understanding the implications of various climate conditions can help minimize possible negative effects.
   a. Application during windy periods can lead to drift. This is particularly important when applying herbicides near sensitive crops. For example, Roundup applied to Roundup resistant crops may drift to sensitive neighbors. Also, herbicides applied to the ground may be carried into the sensitive canopy during windy conditions.
   b. Plants growing in cool overcast seasons are often more sensitive to phytotoxicity. It is likely that these plants have a more easily penetrated cuticle and are more sensitive to the biocidal chemicals.
   c. Temperature can greatly affect pesticide related phytotoxicity. Compounds such as sulfur, chlorothalonil and captan can become phytotoxic at high temperatures. A good rule of thumb is to avoid spraying when temperatures exceed 85$^{o}$F.

A third type of incompatibility arises when one component of the mixture reduces efficacy of the other component.

***When using mixtures there are several guidelines to follow:***

1. Read the label and follow the manufacturer directions. A section specifically addressing compatibility is usually included on the label. If you are in doubt contact the manufacturer, or a technical representative.
2. Obtain a compatibility chart and use it as a guideline only. Compatibility charts are frequently out of date because new pesticide formulations can alter compatibility. However, they provide useful baseline information.
3. Use a jar test to determine physical compatibility. Jar tests are conducted by mixing chemicals at approximately the same rate as specified on the labels. The volumes are scaled down to fit in a small (1 pint – 1 quart) container. Results are evaluated by observing the mixture for reactions such as formation of larger particles, the formation of layers or other changes that result in the formation of a precipitate (i.e. sludge at the bottom of the container).
4. Chemicals that are physically compatible may be phytotoxic**.**
   a. Note: Captan formulations and Oil are the most obvious, all EC fomulations (eg. Dianzinon, Danitol) have oil and should not be used on grapes (See the Example)
   b. Therefore, mixtures of new chemicals should always be tested on a small number of plants before being sprayed on a larger area. Phytotoxicity may appear as wilting, spotting, dieback or other abnormalities in plant growth. The appearance of phytotoxicity may be environmentally controlled. For example, high temperatures may cause more severe expression of phytotoxicity. Environmental variables can play a big role in causing mixtures as well as single component sprays to perform not as predicted.
5. Use of spray additives, such as spreaders, stickers, penatrants or activators can greatly complicate chemical compatibility in mixtures. Unless recommended by the manufacturer these additives should be avoided.
6. Use of Aircraft - For aircraft sprays, apply at least 5 gal/A of spray mix. Use a jar test to check for compatibility of pesticides.
   a. Mixtures provide an economical and efficient method for applying different classes of pesticides. Mixtures can provide enhanced activity through synergism and in some cases reduce the chance of resistance developing in the target population. Some chemical companies market pesticides premixed. Thus, appropriate use of mixtures **requires** preliminary research to determine the compatibility.

## Examples

***The Captan Conundrum: Scab Control vs. Phytotoxicity -- Dave Rosenberger***

Captan is a cornerstone fungicide for apples, because it is very effective against apple scab and also controls summer fruit rots. Captan has long been noted for its ability to prevent scab on fruit even when scab control on leaves is less than perfect. In fungicide tests in replicated plots where we purposely used lower than recommended rates, Captan 50W at 3 lbs/acre has usually provided better control of apple scab than mancozeb fungicides applied at the same rate.

Fungi do not become resistant to captan because it blocks multiple biochemical pathways (i.e., it is a multi-site inhibitor). Resistance to captan can occur only if fungi develop simultaneous mutations for all of the blocked pathways, something that has not happened in the 60 years since captan was introduced.

Captan kills spores that it contacts whereas many of our newer fungicides kill fungi or arrest fungal growth only after germ tubes emerge from the spores. As a result, when captan is applied in combinations with other fungicides in protectant sprays, captan usually does 90 to 99% of the work by killing spores on contact, thereby reducing selection pressure for fungicide resistance to the other product in the tank mix. We use tank mixes with other fungicides (dodine, benzimidazoles, DMIs, strobilurins, SDHIs) to expand the spectrum of disease control and/or to control/suppress the small amount of scab that may have escaped control from the last spray. Captan does not control powdery mildew or rust diseases, so tank mixes are needed to control those diseases even when captan alone might suffice for controlling apple scab.

Unfortunately, captan also has a dark side: it is toxic to plant cells if it penetrates into leaf or fruit tissue. Spray oil and other spray adjuvants that act as penetrants allow captan to move through the protective wax cuticle on leaf surfaces. When that occurs, we see captan-induced leaf spotting, usually on the two or three leaves on each terminal that were just unfolding at the time trees were sprayed. It takes time for cuticular waxes to develop on new leaves, so young unfolding leaves are the most susceptible to spray injury. The leaf cells directly killed or injured by captan provide entry sites for other leaf spotting fungi such as *Phomopsis, Alternaria,* and *Botryosphaeria* than can enlarge the spots. It may take five or 10 days for the injury to become visible, and by that time the injured leaves may be 5 or 6 nodes below the growing point on terminal shoots.

Azoxystrobin damage to young apple can be severe enough to cause fruit drop. *Photo credit: Win Cowgill.*

Captan injury on apples usually appears during the three weeks after petal fall because during that time period terminal shoots are growing very rapidly (i.e., producing lots of new leaves), and spray mixtures used at petal fall and in first and second cover sprays commonly include insecticides, growth regulators, foliar nutrients, and spray adjuvants. Captan applied alone almost never causes leaf spotting on apples. Rather, it is the other products in the tank that sometimes enhance captan uptake and trigger the resultant phytotoxicity. Increasing the number of products that are included in a tank mixture increases the probabilities that the mixture will enhance captan absorption and result in injury to leaves.

***SENSITIVITY OF APPLE CULTIVARS TO AZOXYSTROBIN FUNGICIDE -- Norman Lalancette, Win Cowgill, Jeremy Compton, and Kathleen Foster***

Three Strobilurin fungicides became labled for growers in the late 1990's: azoxystrobin (Abound), kresoxim-methyl (Sovran), and trifloxystrobin (Flint). With respect to tree fruit crops, Abound is available for use on stone fruit, while both Sovran and Flint are labeled for pome fruit; all three are registered for use on grape as well as various other crops. Each of the three registered strobilurins has some

Azoxystrobin can damage leaves and in some cases completely defoliate trees. *Photo credit: Win Cowgill.*

Table 1. Apple cultivars and strains non-sensitive to azoxystrobin fungicide

| | | |
|---|---|---|
| Ark Black | Fuji, Red | Red Delicious, Superchief |
| Baldwin | Gingergold | Red Delicious, Sali |
| Ben Davis | Golden Delicious | Red Delicious, Radiant |
| Blushing Gold | Gold Rush | Red Delicious, Ace Spur |
| Cameo | Granny Smith | Red Delicious, Scarlet Spur |
| Carousel | Granspur | Red Delicious, Oregon Spur |
| Corodel | Idared | Rome, Red |
| Coromandel Red | Jerseyred | Smokehouse |
| Dorsett Gold | Jonagold | Spire, Crimson |
| Earligold | Jonathan | Spire, Emerald |
| Elstar | Jonica | Spire, Ultra |
| Empire | Macfree | Splendor |
| Empire Royal | Mapcle | Sundowner |
| Empress | Mutsu | Supreme Staymared |
| Enterprise | Nova Easygro | Winesap |
| Esophus Spitenburg | Priscilla | Winter Banana |
| Firmgold | Pristine | Yakata |
| Freedom | Red Delicious, Starks Orig. | Yellow Newtown |
| Fuji | Red Delicious, Red Chief | York Imperial |

Table 2. Apple cultivars and strains moderately sensitive to azoxystrobin fungicide

| | |
|---|---|
| Braeburn | Slight leaf curl, possible stunting; No necrosis or drop |
| Luster Elster | 2% leaf necrosis / browning |
| Red Delicious, Dulcet | 2% leaf necrosis / browning |
| Shamrock | 10% stippling |
| Suncrisp | 20% basil leaf drop on 2-year wood; uninjured 1-year wood; browned fruit |
| Sunrise | 10% leaf drop; 10% scorch |

Table 3. Apple cultivars and strains highly sensitive to azoxystrobin fungicide

| | | |
|---|---|---|
| Akane | Gala, Stark Ultra Red | Northwest Greening |
| Britemac | Gravenstein | Pink Lady |
| Cortland | Keepsake | Raritan |
| Cox Orange Pippin | Liberty | Red Cort |
| Fameuse | Macoun | Redfree |
| Gala | McIntosh, Millers | Red Haralson |
| Gala, Royal | McIntosh, Rodgers Red | Spartan |
| Gala, Imperial | McShay | Spire, Scarlett |
| Gala, Lydia’s Red | Mollies Delicious | Vista Bella |
| Gala, Scarlet | Northern Lights | Wealthy |
| Gala, Stark Galaxy | Northern Spy | William’s Pride |

In some cases, fruit stop growing as a result of azoxystrobin damage, and these fruit will drop. *Photo credit: Win Cowgill.*

level of phytotoxicity to another crop. For azoxystrobin, certain apple cultivars –particularly McIntosh – have been found to be particularly sensitive. This phenomenon complicates usage byorchardists who have both stone and pome fruit. Many growers in both NJ and Massachusetts have both.

Research in NJ in 1999-2000 evaluated 96 strains and varieties of apple to test sensitivity of apple to azoxystrobin. Tables 1, 2, 3 show the results.

## *Wine Grape Phytotoxicity to Captan 80WDG plus Danitol 2.4EC in NJ -- Win Cowgill and Dan Ward*

At the Rutgers Snyder Farm in 2010 Captan and Danitol was applied twice in midseason on standard IPM based pest control program maintenance program. The right weather conditions warm 80's and humid, created the perfect conditions for the oil in the Danitol to pull the captan into the plants killing some of the more sensitive grape cultivars in the variety trial. No warning is found on either label but they should not be combined together on wine grapes. See pictures and Table 4.

## *Literature Cited (in addition to labels)*


***2013 Commercial Grape Pest Control Information for New Jersey***- E283, Dan Ward, Brad Majek, Peter Oudemans, Douglas Pfeiffer, http://njaes.rutgers.edu/pubs/publication.asp?pid=e283.

**Sensitivity of Apple Cultivars of Azoxystrobin Fungicide**, Norman Lalancette, Win Cowgill, Jeremy Compton, and Kathleen Foster, Reprinted from Proceedings: 76th Cumberland – Shenandoah Fruit Workers Conference.

***2011 New York and Pennsylvania Pest Management Guidelines for Grapes***, http://ipmguidelines.org/grapes/.

Fungicides and insecticides with known phytotoxic reactions in grapes. The chemical compounds below are known to damage grapes. Grape varieties come from a diverse genetic background and differ widely in their susceptibility to the various phytotoxic compounds. If applying any of these chemicals to (or near) varieties of unknown susceptibility, apply to a small test area before spraying many vines.

| Compound | Varieties with Known Susceptibility[1] | Effect | Notes |
|---|---|---|---|
| Sulfur | Many red hybrids and some natives; Chambourcin, Chancellor, Concord, Cynthiana (Norton), De Chaunac, Ives, Maréchal Foch, Mouvèdre, Rougeon, Van Buren. | Leaf stippling, burning (necrosis), defoliation. | Sensitivity to sulfur is increased by high temperatures, intense sunlight, frost, or rain. Temperatures of 80-95° F during or immediately after application may cause damage in otherwise tolerant varieties. |
| Copper-fungicides | Many hybrids and some natives; Aurore, Catawba, Cayuga White, Chancellor, Chelois, Concord, De Chaunac, Delaware, Elvira, Gewürztraminer, León Millot, Maréchal Foch, Merlot, Niagara, Cynthiana (Norton), Pinot blanc, Pinot noir, Rosette, Rougeon, Seyval blanc. | Leaf "bronzing", burning, reduced vigor | Damage from copper-containing fungicides is increased under slow drying conditions. Cool or very humid conditions shortly after application may cause damage in otherwise tolerant varieties. |
| Paraffinic or Mineral oil (JMS Stylet Oil, Purespray Green) | All varieties. | Leaf burning, Removes waxy "bloom" from fruit. Oil applied near veraison may lower Brix values at harvest. | Use of Captan or Sulfur within two weeks after applying oil can result in severe vine damage and death. Do not use oil with copper when fruit are present. |
| Trifloxystrobin (Flint, in Adament) | Concord | Leaf burning. | |
| Pyraclostrobin (in Pristine) | Concord, Noiret, and related varieties such as, Fredonia, Niagara, Rougeon, Steuben, Worden | Leaf burning. | |
| Difenconazole (in Revus Top, Inspire Super, and Quadris Top) | Brianna, Canadice, Concord, Concord Seedless, Frontenac, Glenora, Noiret, Skujinsh 675, St. Croix, Thomcord | Leaf burning. | The Revus Top label cautions that: On V. labrusca, V. labrusca hybrids, and other non-viniferea (*sic*) hybrids where sensitivity is not known - the use of Revus Top by itself or in tank mixtures with materials that may increase uptake (adjuvants, foliar fertilizers) may result in leaf burning or other phytotoxic effects. |
| Carbaryl (Sevin XLR) | All varieties. | Leaf damage on tender foliage and growing tip. | Damage is typically seen when application is followed by high humidity or rain. |

[1] Not all varieties have been thoroughly tested with all chemicals. Use caution and be aware that varieties that are closely related to susceptible varieties may also be susceptible. Compiled by Dan Ward, Source E-*2013 Commercial Grape Pest Control for New Jersey*


Captan plus Dannitol injury on Marquis grapes. *Photo credit: Dan Ward.*

Captan plus Dannitol injury on grape leaves. *Photo credit: Dan Ward.*

***Wine Grape Production Guide for Eastern North America***, Tony Wolfe ed. NRAES- http://palspublishing.cals.cornell.edu/nra_order.taf?_function=detail&pr_id=178&_UserReference=0E03A.

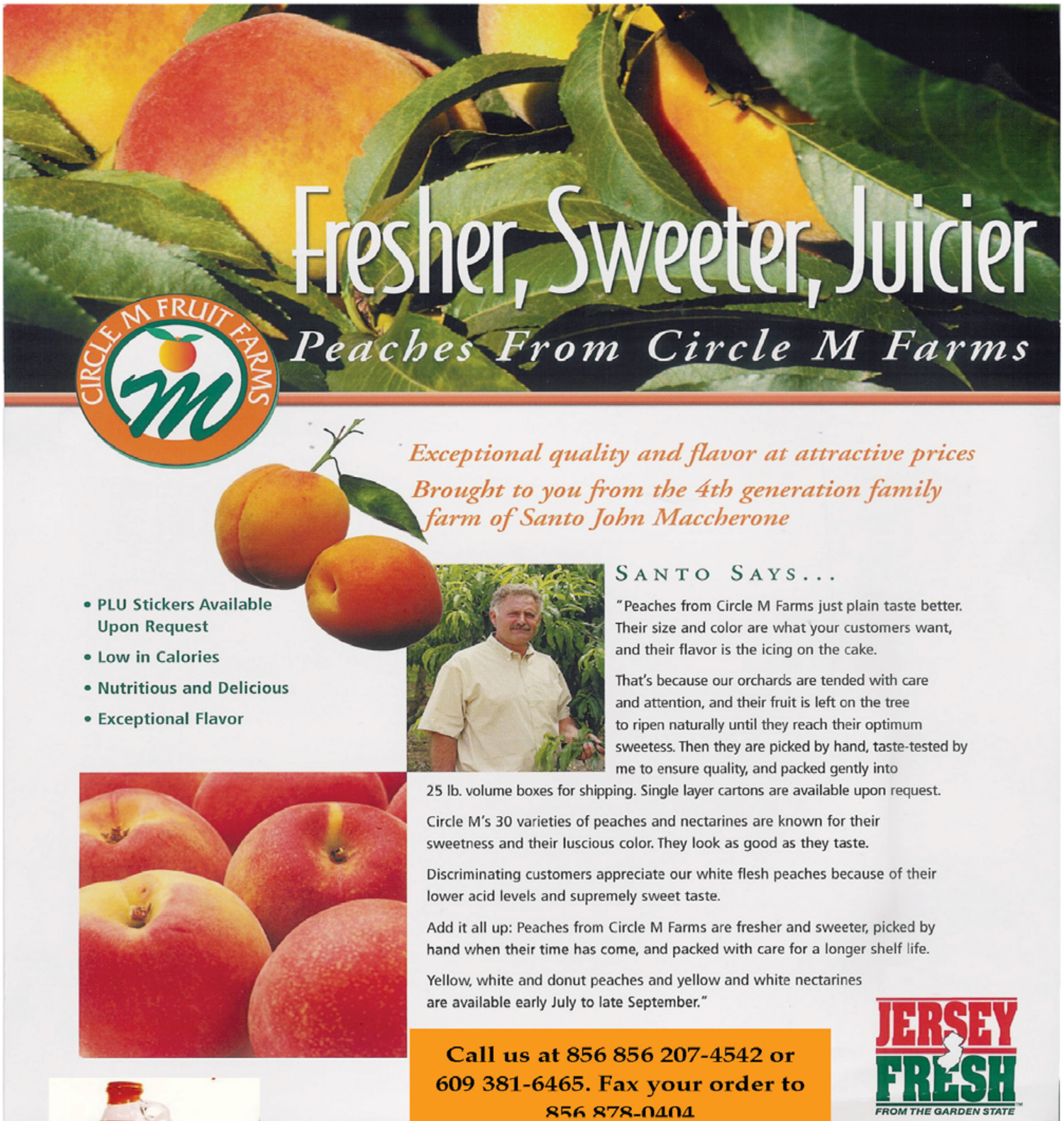
***Phytotoxicity in Tender Fruit and Grapes***, Ontario Ministry of Agriculture, Food, and Rural Affairs, http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2006/08hrt06a4.htm.

Photo credit: Dan Ward.

# Win Cowgill is Featured Speaker at June Twilight Meeting in Massachusetts

On June 11, 2013, Win Cowgill joined Duane Green (far left) and Jon Clements (far right) at Tougas Family Farm in Northborough, MA, to discuss the 2013 apple thinning season. *Photo credit: Wes Autio.*

At the June twilight meeting at Tougas Family Farm in Northborough, MA, André Tougas explains his approach to KGB cherries under a Haygrove Tunnel. *Photo credit: Win Cowgill.*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