# Characteristics of Scald Susceptibility and Development on Cortland Apples in New England

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Postharvest development of scald is a severe threat for certain cultivars of apples. Cortland is particularly susceptible, so much so that growers would likely have discontinued production except for the discovery that scald could be controlled by treatment with diphenylamine (DPA). Even today, however, Cortland fruit stored long-term carry a significant risk of scald development.

In the Spring 1998 issue of *FruitNotes*, we reported on the success we have had in predicting scald susceptibility of New England Delicious apples, using equations based on harvest date, preharvest temperature, and harvest starch score of the fruit. At the same time that we have been studying scald prediction for Delicious, we have also been attempting to develop a similar prediction system for Cortland. For reasons we are unable to explain, we have failed in these efforts with Cortland. However, during our experiments we have learned much about scald development on this cultivar, and here we report some of these findings that

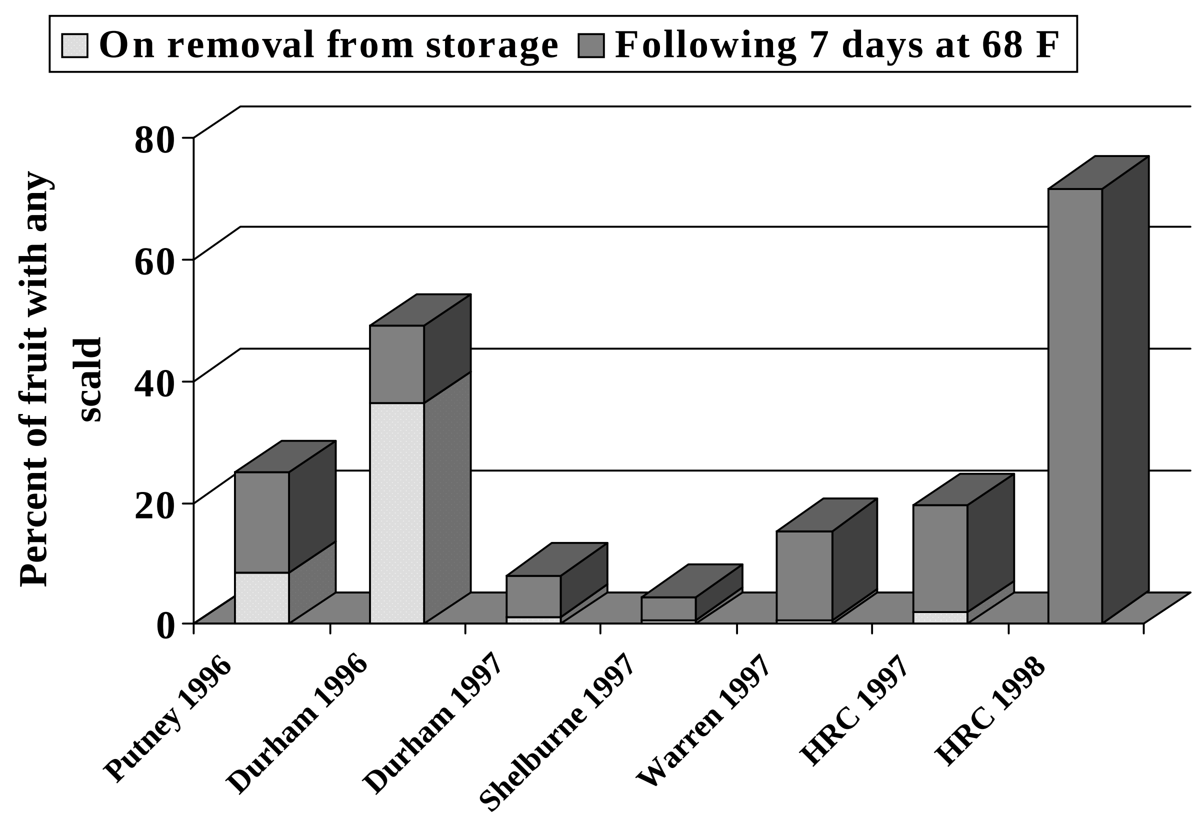



Figure 1. Scald development following 20 weeks of 32°F air storage of Cortland apples (harvest dates vary).

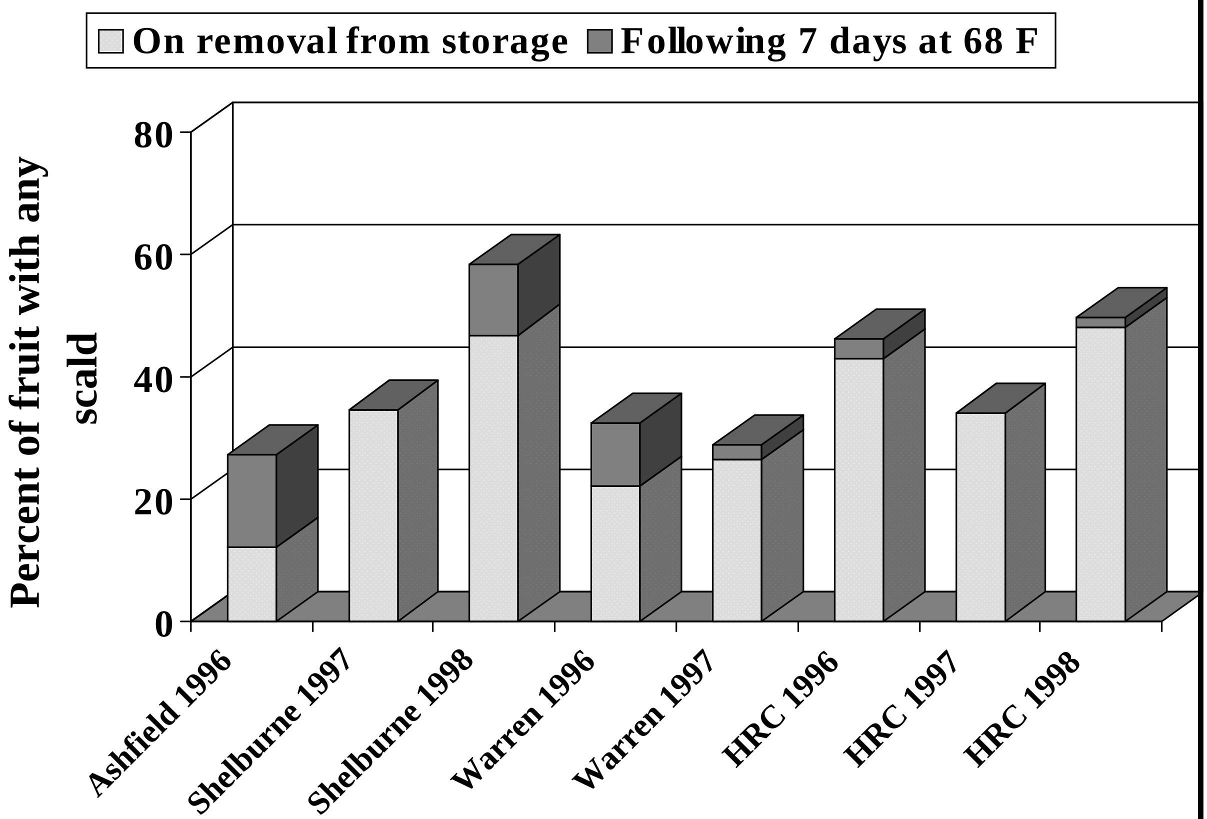



Figure 2. Scald development following 25 weeks of 32°F air storage of Delicious apples (harvest dates vary).

lead us to a set of conclusions about the current state of knowledge regarding scald development and control for New England-grown Cortland apples.

In our studies, we collected Cortland apples from 1985 through 1998 at the Horticultural Research Center (HRC), Belchertown, MA. In addition, samples were collected from other sites: Shelburne and Warren, MA (1997), Putney, VT (1996), Durham, NH (1995, 1996, and 1997), Storrs, CT (1995), and Monmouth, ME (1996). Each sampling site provided at least two harvests per year indicated. Fruit were stored at 32°F in air for 20 weeks, and then kept at 68°F for one week, after which scald development was evaluated. (In some years, scald was evaluated both at removal from storage and again after one week at 68°F.) All fruit were standard Cortland, i.e. no red sports were used. Fruit were not treated with DPA.

Cortland and Delicious differ in a very important way in the manner in which they develop scald. Figure 1 shows the presence of scald immediately upon removal from storage and then again after one week at room temperature. In most cases, little or no scald was present when the Cortlands were removed from storage, but it was present, sometimes extensively, after the fruit had been warmed. In contrast, Figure 2 illustrates the performance of Delicious. On these fruit, most scald was present at removal from storage, with only slight increases at room temperature. This means that Cortlands are very deceptive. They may look scald-free at the time of packing but become badly scalded once they warm up. Delicious, on the other hand, do not present this problem. A trip to the supermarket can be instructive. Rarely will you find a scalded Delicious on display, but scalded Cortlands are a common occurrence. Scalded Delicious usually can be removed during packing, but many Cortlands scald after packing.

For a scald prediction system to be of value, you must have considerable variation in scald development on samples. You can see in Figure 1 that this was the case in our experiments. Some samples developed hardly any scald while others developed a great deal of it. What are the sources of scald variation in Cortland?

In Figure 3 you see year-to-year variation in scald

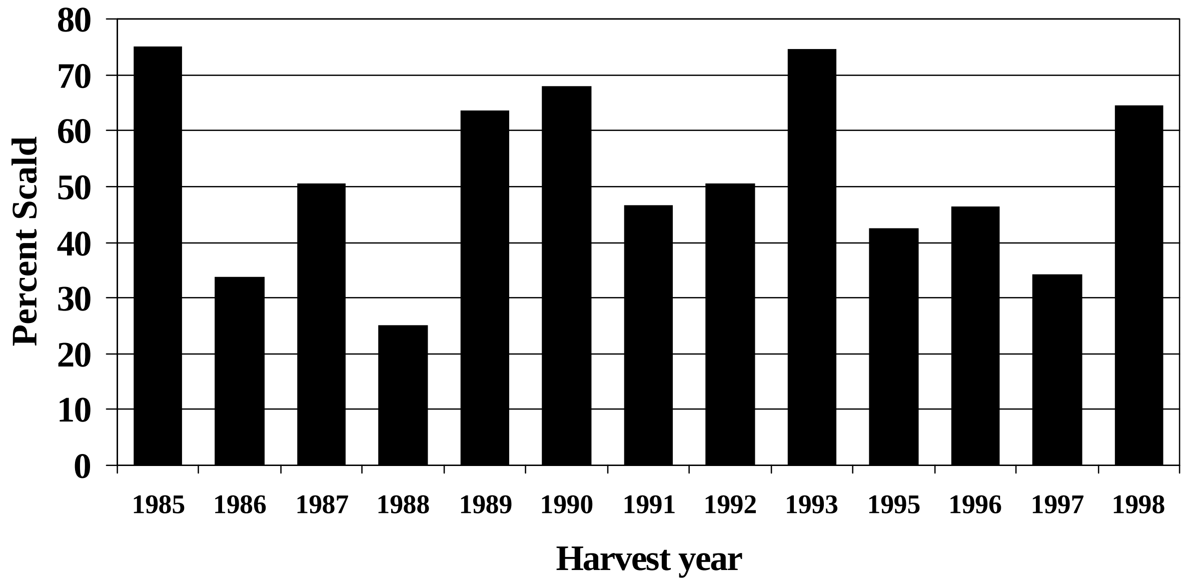



Figure 3. Year-to-year variation in mean scald development on HRC-grown Cortland apples (means corrected to account for differences in harvest dates each year).

susceptibility of Cortland apples from the HRC in Belchertown, MA. Scald always occurred, but it was much worse in some years (e.g. 1985 and 1993) than in others (e.g. 1988 and 1997). Thus, some years were "bad scald years" while others were not, although no year was scald-free.

In Figure 4, you see orchard-to-orchard variation in Cortland scald development in New England. No particular pattern is evident, except that 1997 seems to have produced less scald than 1995 or 1996. Even this difference may be confounded by the fact that the 1997 samples were harvested on average 3 days later than the 1996 samples, but with an average starch score of 3.6 in 1997 vs 3.8 in 1996 (i.e. fruit were harvested slightly later, but slightly less ripe in 1997) . That the fruit from Monmouth, ME did not develop more scald than they did seems remarkable, since those samples were exposed to less cool weather (8 days of sub50$^o$F before harvest for ME vs overall mean of 17 days) than were any other group of samples, had the lowest starch scores (ME mean of 2.5 vs overall mean of 3.9 ), and were among the earliest harvested (ME mean of September 27 vs. overall mean of October 3). All those factors generally are considered "scald enhancing."

Time of harvest is a major factor in scald susceptibility of apples, and it is certainly a factor for Cortland. Figure 5 presents a composite of scald development on all of our samples, across years and sites, based on harvest date of the fruit. Cortlands picked before September 21 were extremely scald susceptible, while those picked after October 20 developed almost no scald, regardless of year or growing site. Between these extremes, susceptibility gradually fell as harvest date was later. However, delaying harvest until fruit have low susceptibility clearly is not desirable. Not only do they become excessively soft, but they also become susceptible to senescent breakdown, which occurred in 30% of fruit harvested after October 15.

Since there is so much variation in Cortland scald susceptibility, an effective method of predicting poststorage scald development at the time of harvest could be very useful in guiding strategies to control scald, e.g. whether or not to apply DPA, and , if so, what concentration to use. However, none of the equations we have created to relate preharvest conditions, such as we described for Delicious in the Spring 1998 issue of *FruitNotes*, have given reliable results in separating lots of fruit by their relative scald susceptibility. In Figure 6 are presented 10 years of results from the HRC, comparing percent scald "predicted" (in hindsight) from harvest date, starch score, and number of preharvest sub 50$^o$F days to

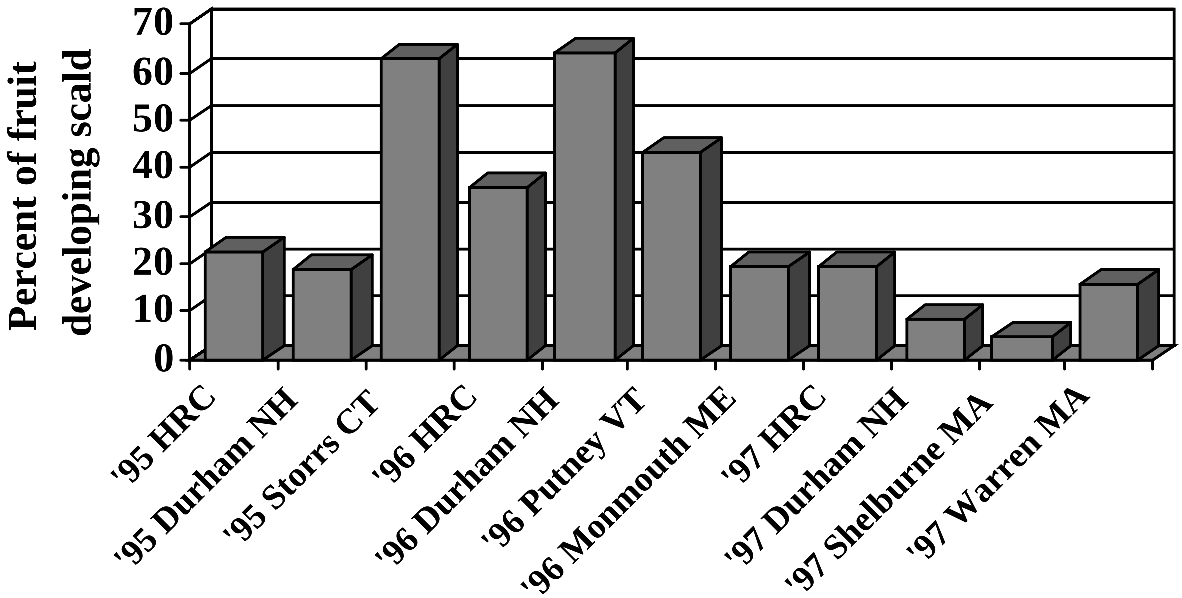



Figure 4. Orchard-to-orchard variation in scald susceptibility of Cortland apples in 1995, 1996, and 1997.

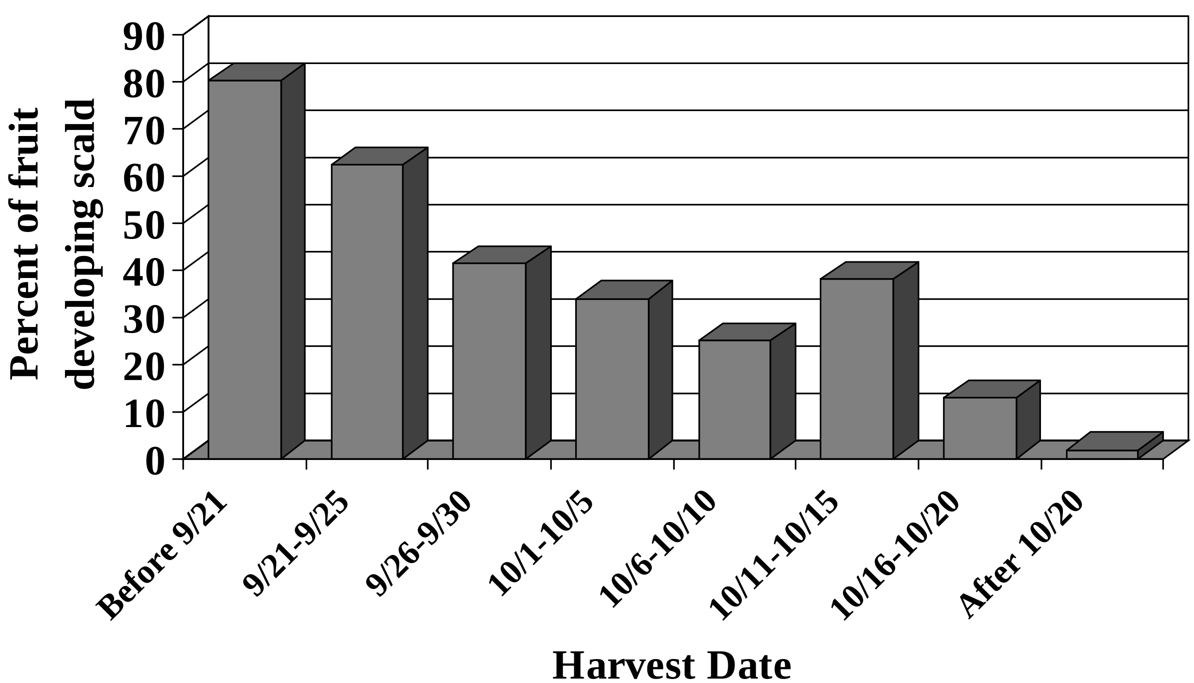
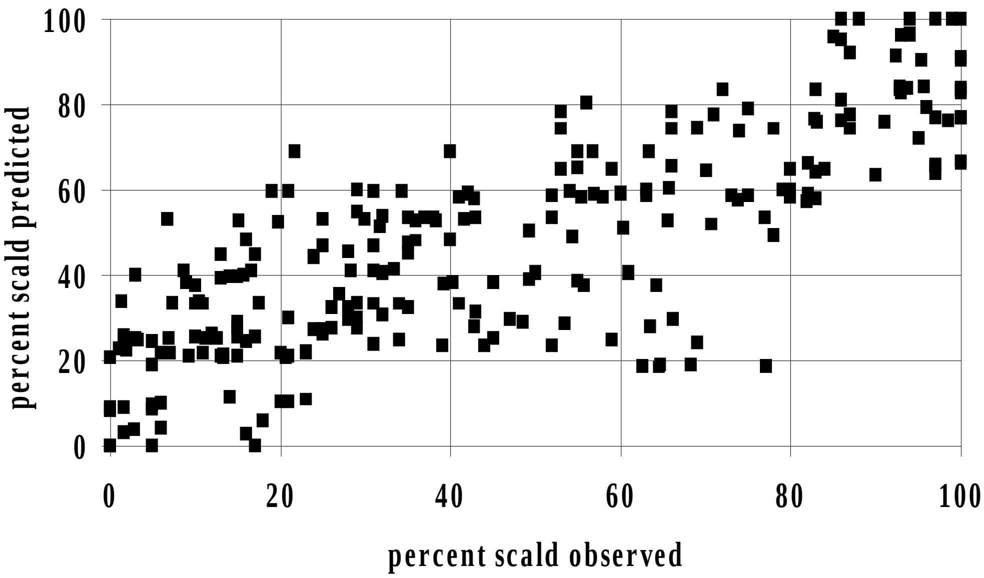



Figure 5. Effect of harvest date on poststorage scald development on NE-grown Cortland apples; 506 samples, 1985-98.




% scald = 116.8 - 1.43*(harvest date where 9/1=1) - 1.20*(n of preharvest days<50) - 1.58*(harvest starch)

Figure 6. HRC generated equation showing predicted vs. actual scald on HRC Cortland apples 1988-1997.

actual percent scald observed. While the trend of the data seems encouraging, the reliability of the predictions is not acceptable. Furthermore, this equation gave much worse results when applied to fruit harvested from other orchards in new England. We are continuing to pursue an effective predictive system, but as of now, we have not produced a tool in which we have confidence.

Based on nearly 15 years of experiments with Cortland, we draw the following conclusions about scald susceptibility of this cultivar in New England:

1. Scald susceptibility varies enormously from site to site, and also from year to year within a site. Because your fruit did or did not scald last year is not a reliable index of what they will do this year.
2. Susceptibility declines as fruit mature and, to some extent, as they experience increasing exposure to temperature below 50°F before harvest. However, delaying harvest to obtain scald resistance can result in soft fruit that develop senescent breakdown.
3. We still cannot predict scald development on Cortland.
4. At this time DPA is the only reliable method of controlling scald on Cortland. Unlike with Delicious, we have not been able to predict the concentrations needed to control Cortland scald.
5. Because Cortlands are scald-free at removal from storage does not mean they will remain scald-free when they warm to room temperature. Most scald symptoms develop after storage of this cultivar. Effective scald control treatment at harvest time is your best assurance that Cortlands will remain scald-free during their shelf life.

We wish to express sincere thanks to the following people who contributed greatly to this work by providing samples of fruit for study: Mr. Joseph Sincuk, HRC, Belchertown, MA, Mr. Dana Clark, Clark Orchards, Ashfield, MA, Mr. Evan Darrow, Green Mountain Orchards, Putney, VT, Mr. Timothy Smith, Apex Orchards, Shelburne, MA, Mr. Mark Tuttle & Mr. Robert Tuttle, Breezelands Orchards, Warren, MA, Professor William G. Lord, University of New Hampshire, Dr. James Schupp, University of Maine (now at Cornell University's Hudson Valley Laboratory), and Dr. David Kollas, University of Connecticut. Without their help this study could not have been done.

# Effects of Planting Density and IPM Level on Apple Fruit Quality

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Many New England apple growers have replanted their orchards with dwarf at densities of 400 to 1000 trees per acre. At the same time, growers have been advancing their efforts to reduce pesticide inputs on their land by employing bio-intensive IPM methods to manage flyspeck disease, plum curculio, pest mites, and apple maggot fly, which together account for almost all pesticide use from about June 10 to harvest. The tree fruit research and extension team at the University of Massachusetts and eight growers have been integrating these horticultural and pest-management practices for the last 2 years.

Just before commercial harvest in 1997, 100 fruit were examined from each of the 48 blocks for symptoms of disease and arthropod damage. As in other experiments of this 3-year study, there were six blocks per orchard and eight orchards. At each orchard there were two high-density blocks, two medium-density blocks, and two low-density blocks. Half of the blocks were managed according to third-level IPM strategies, and half were managed with traditional first-level IPM. The blocks were McIntosh, with an occasional row of Cortland or similar cultivar, and were seven rows by seven trees or as close to this as possible. The feat of selecting and mapping the 48 blocks in eight orchards across the state was considerable and could not have been done without a very supportive and proactive grower community.

A sub-sample of 20 fruit were selected from each group of 100 for fruit quality evaluations. The 20 were weighed. The percent red color was determined. Firmness was assessed with an Effigi penetrometer, and juice was collected from this process. The percent soluble solids was assessed in the juice with a hand refractometer.

Fruit quality was not affected in 1997 by planting density or IPM level. We hoped that fruit produced

Table 1. Fruit quality (1997) and crop density (1998) of apples from blocks of different planting densities and IPM levels in eight Massachusetts orchards.*

| Treatment | Fruit weight (g) | Soluble solids (%) | Red color (%) | Firmness (lbs.) |
|---|---|---|---|---|
| *Planting density* | | | | |
| Low | 145 a | 10.6 a | 60 a | 18.0 a |
| Medium | 135 a | 10.4 a | 66 a | 18.9 a |
| High | 135 a | 10.4 a | 67 a | 18.5 a |
| *IPM level* | | | | |
| First | 139 a | 10.4 a | 63 a | 18.5 a |
| Third | 139 a | 10.5 a | 66 a | 18.7 a |

* Means within column and treatment type not followed by the same letter are significantly different at odds of 19 to 1.

under bio-intensive "third-level IPM" would be as colorful, sweet, large, firm, and as plentiful as fruit produced with more chemically based IPM practices, and this is what we found. We were surprised, however, that there were no differences due to planting density, because other studies have shown high density apple blocks produced larger, more colorful and more plentiful (yield per acre) fruit than blocks with larger less densely planted trees. For 1999, we plan to study these factors more comprehensively. We will increase the number of apples, branches, and trees that are examined.

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# Evaluation of Flint and Sorvran, Two New Strobilurine Fungicides, Against Apple Diseases

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For the first time in many years, the agricultural chemical industry is releasing new types of fungicides for control of apple diseases. One new class of fungicides, the strobilurines, is particularly interesting. The first registered versions of these on apples are Flint® (trifloxystrobin) and Sovran® (kresoxim-methyl). The original discovery of this class of chemistry was in a forest mushroom, *Strobilurus tenacelius*. In a natural setting, the mushroom produces a chemical called strobilurine to fight off other fungi that may be trying to feed off the forest debris, or off the mushroom itself. Strobilurine A is a natural fungicide. Several companies have synthesized versions of chemicals similar to Strobilurine A, collectively called strobilurines, and are completing evaluation and registration of them.

These fungicides offer some interesting opportunities for apple growers. They are very effective against scab and flyspeck, the two key fungal diseases of apple in New England. In addition, they have a very clean bill of health on the environmental front, with low toxicity to mammals, bees, birds, and earthworms. While toxic to fish and other aquatic organisms, strobilurines are broken down very quickly, and tests show that under normal use patterns, they will not reach water before they break down.

It will also be important to use them wisely, since it will be relatively easy for pathogens to develop resistance to them. Indications are that the resistance that develops will be "all or nothing." That is, if resistance develops, it will come on with little warning, probably leaving significant disease in the wake.

The manufacturers recognize the potential for resistance and attempted to address the problem by limiting the total number of applications that can be made in a year, the amount of material that may be applied in a year, and the number of consecutive sprays of strobilurines that may be applied. There are differences between the two labels in these respects. The Flint label uses a more cautious approach. For Sovran, the manufacturer "recommends" no more than three applications in a row. The Flint label states "use a maximum of two consecutive applications." The Sovran label says "do not make more than six applications per season". The Flint label carries a five application limit. The Sovran label states that Sovran should not be used as the last fungicide application of the season, while Flint does not have that restriction on the label.

At the very least, the label recommendations and limits should be followed strictly. A conservative approach would be a four application per season limit, with a maximum of two consecutive applications. All strobilurins have the same mode of action, so the limit of four applications per season would apply to the total number of Sovran and Flint sprays. Because strobilurines work well on fruit scab and other diseases, there is no compelling reason to tank-mix them with a broad-spectrum protectant as there is with the sterol inhibitor fungicides. Rather, the manufacturers have chosen to recommend alternating pairs of applications. Pairs of applications made 7 to 10 days apart sounds similar to the "back-to-back" applications recommended for the SI fungicides such as Rubigan and Nova. However, the important point with the strobilurines is to use a different class of fungicide after making two strobilurine applications in order to reduce the chances that resistance will develop. There certainly are a number of unanswered questions about the best way to manage resistance, but that probably argues for taking a relatively cautious approach to using the strobilurines.

Both products exhibit excellent post-infection efficacy, similar to the 4-day activity of the SI fungicides. As you might expect with this sort of post-infection efficacy, the strobilurines are somewhat systemic. The strobilurines show some protectant activity, probably on the order of 3 to 6 days. Therefore, recommended intervals between applications are 7 to

Table 1. Effects of sterol inhibitors, mancozeb, and a cyprodinil/trifloxystrobin treatment on the incidence of scab in mature McIntosh, Belchertown, MA, 1998.

| | | Scab incidence (%) | | | |
|---|---|---|---|---|---|
| Primary scab season fungicides (per 100 gal.) | Summer fungicides (per 100 gal.) | Terminals | Clusters | Fruit | Fruit (harvest) |
| Nova 40W+ Dithane 75DF (1.7oz. + 1 lb.) | Captan 50W (1 lb.) | 0.4 c | 0.0 c | 0.6 b | 1.8 b |
| Rubigan 1.6 EC+ Dithane 75DF (2.7 oz. + 1 lb.) | Captan 50W (1 lb.) | 1.1 c | 0.8 c | 1.2 b | 1.6 b |
| Dithane 75DF (1 lb.) | Captan 50W (1 lb.) | 14.0 b | 11.7 b | 2.5 b | 1.0 b |
| Vangard 75WG [pink, bloom]; Flint 50WG [petal fall, 1st cov.] (1.7 oz.; 0.75 oz.) | Flint 50WG+ Captan (2.25 oz. + 1 lb.) | 2.0 c | 0.4 c | 1.2 b | 3.2 b |
| Untreated control | | 57.0 a | 59.9 a | 23.7 a | 50.0 a |

* Means within columns not followed by the same letter are significantly different at odds of 19 to 1.

Table 2. Effects of cyprodonil and trifloxystrobin on incidence of scab in mature McIntosh, Belchertown, MA , 1999.

| | | Scab incidence (%) | | | |
|---|---|---|---|---|---|
| Primary scab season fungicides (per 100 gal.) | Summer fungicides (per 100 gal.) | Terminals | Clusters | Fruit | Fruit (harvest) |
| Vangard 75WG (1.7 oz.) 2 applications; then Vangard 75WG (1.7 oz.) plus Dithane 75 DF (1 lb.) through petal fall | Flint 50 WG (0.7 oz.) 10 days after pf; 14 - 21 days | 6 b | 9 c | 1 b | 2 b |
| Vangard 75WG (1.7 oz.) 2 applications; then Vangard 75WG (1.7 oz.) plus Dithane 75 DF (1 lb) through petal fall | Flint 50 WG (0.7 oz.) 21 days after pf; 21 - 28 days | 4 b | 5 bc | 0 b | 1 b |
| Flint 50 WG (0.7 oz.) | Captan 50W (1 lb.) | 0 b | 0 c | 0 b | 0 b |
| Untreated control | | 31 a | 20 a | 4 a | 4 a |

* Means within columns not followed by the same letter are significantly different at odds of 19 to 1.

10 days.

We have tested Flint for the last two years in scab trials, and looked at Sovran in a flyspeck trial this past year. In addition, several other researchers have run tests of one or both of these fungicides in recent years. We show some of the results of our trials here. The scab trials were done at the Horticultural Research Center in Belchertown, with an airblast sprayer. The fungicides were applied on schedules that would normally be used in a growers orchard. However, the manufacturer of Flint wanted to include another new fungicide, Vangard (cyprodonil) in the tests. Vangard represents another new class of fungicide chemistry, but appears to be of limited value to apple growers.

In Table 1 includes 1998 results. It shows that the Flint treatment performed as well as standard Rubigan or Nova plus Dithane treatments against fruit and foliar scab. While the percentages were slightly different, the differences were not significant. By comparison, a low rate of Dithane (1 lb. / 100 gal.) did a relatively poor job of controlling early foliar scab. However, by the end of the summer, following three applications of captan on all treatments, fruit in the Dithane treatment were comparable to those in the other fungicide treatments.

In the 1998 test (Table 2), Vangard performed well when used in combination with the strobilurine. However, the 1999 test suggested that Vangard may not be carrying much of the load in Flint/Vangard combinations. While the differences generally were not significant, there was no scab where Flint was used alone, but 4 to 5 % foliar scab in treatments where Vangard was used in the early season. Scab on fruit at harvest was similar. While this test is not conclusive, data from the Hudson Valley Lab (Rosenberger et al., 1998) showed clearly that Vangard did not control scab as well as Flint when both were used on a 10-day spray interval during the exceptionally wet 1998 season. (Table 3).

Tests for flyspeck control in Belchertown have been less conclusive. This year, the dry weather and the low inoculum in Belchertown made it unlikely that

Table 3. Effects of cyprodonil and trifloxystrobin on incidence of scab in mature Jerseymac, Highland, NY, 1998 (Adapted from Rosenberger et al., 1998).

| Fungicide (per 100 gal.) | Scab Incidence (%) | | |
|---|---|---|---|
| | Terminals | Clusters | Fruit (harvest) |
| Vangard 75WG (1.68 oz. ) 2 applications; then Flint 50 WG (0.75 oz.) 2 applications; then Flint 50 WG (0.75 oz.) plus Captan 50W (12 oz.). | 3.2 b | 30.1 b | 54.3 b |
| Flint 50 WG (0.75 oz.) | 0.1 c | 2.0 c | 19.2 c |
| Flint 50 WG (0.5 oz.) | 0.6 c | 3.4 c | 26.6 bc |
| Untreated control | 67.5 a | 97.5 a | 100.0 a |

* Means within columns not followed by the same letter are significantly different at odds of 19 to 1.

we would get flyspeck. Therefore, we did a single-application test in a block of Liberty trees at the University of Rhode Island East Farm in Kingston. By the time the application was made on July 29, flyspeck was already evident in the test block. Test trees received no fungicides for the season except for the application that was part of this test. Flint and Sovran were compared to Benlate plus captan and to calcium chloride. The results are shown in Table 4 and Figure 1.

Strobilurines performed as well as or better than the best standard treatment, Benlate plus Captan, in a single application. The difference between Flint and Sovran may be due to a rate effect, as it has been suggested that Sovran should be used at twice the Flint rate for equivalent activity. The single application of calcium chloride did not significantly reduce flyspeck at harvest, but did appear to slow the epidemic. It also appears that the effect of the strobilurines lasted for approximately 3 weeks, at which point the rate of flyspeck–symptom appearance in both strobilurine treatments and the Benlate/captan treatment were similar. The early effect meant that at harvest, Flint was still significantly better than Benlate/captan in terms of flyspeck control.

Table 4. Flyspeck severity in apples treated with a single fungicide application on July 29, 1999, Kingston, RI.

| Treatment | Flyspeck* |
|---|---|
| Check | 2.73 a |
| Calcium chloride 80% 10 lbs. / acre | 2.46 a |
| Benlate 50 WP 9 oz. / acre plus captan 50W 3 lbs. / acre | 1.64 b |
| Sovran 3.2 oz. / acre | 1.41 bc |
| Flint 2 oz. / acre | 1.14 c |

*Rating for each fruit: 0=clean; 1=<10%; 2=10-40%; 3=>40%, Means not followed by the same letter are significantly different at odds of 19 to 1.

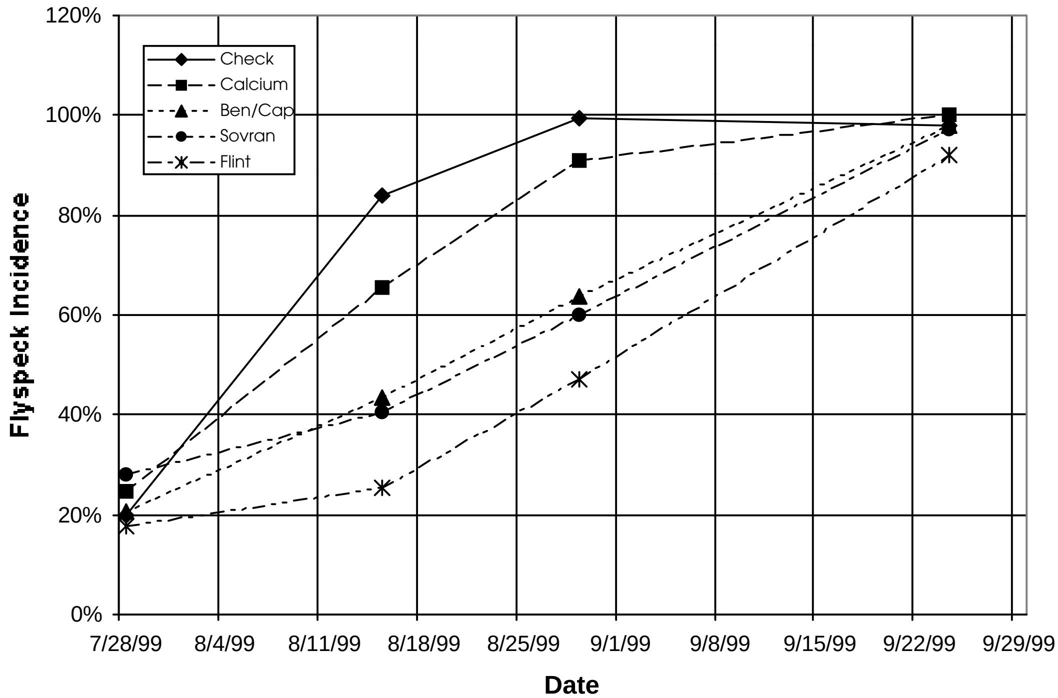


Figure 1. Percentages of fruit showing flyspeck symptoms following sprays with calcium chloride and three different fungicide treatments, Kingston, RI, 1999.

The strobilurines may represent a real opportunity to improve our summer-disease managment. So far, no interactions with mite management have appeared. Residue problems with the strobilurines, as compared to Benlate or captan, might be expected to be minimal. Rather than focusing the strobilurines on scab, it might be useful to reserve at least a couple of applications for flyspeck.

So, should Flint or Sovran be purchased for the 2000 growing season? Both materials have performed very well against scab and flyspeck, so the limiting factor will probably be price. The chemical companies are aware of this, and will probably price the strobilurines to be competitive with the combined cost of an SI plus protectant. Captan or mancozeb alone probably will be cheaper. If price is an issue and growers cut strobilurine rates below the label minimums, then control may not be very good, especially without a protectant to act as a back-up.

Strobilurines are good antisporulants. That is, they prevent active scab from producing large numbers of viable conidia that can cause more infections. They will do a good job stopping or slowing an epidemic. However, more than 96 hrs after the start of an infection, it is unlikely that strobilurines will stop symptom development. With the SI fungicides, applications a few days beyond the 96-hour post-infection recommendation would usually stop symptom development, or limit it to yellow spotting. This will probably not be the case with the strobilurines. In addition, post-infection use will hurry the process to resistance development.

Another factor to consider is what might be called "new product caution." With any new product, unforeseen circumstances may yield unexpected performance problems. While the strobilurines look great, it might be prudent to use them on a limited basis for a year or two. A lot will be learned about the strobilurines as commercial growers begin to use them. In short, use them where the price and timing fits your needs, but do not abuse them by cutting rates, or applying extra applications.

# Ottawa 3: A Summary of Twenty Years of Trial

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This article is the second in a series summarizing the data collected in Massachusetts on specific apple rootstocks over a number of years. Ottawa 3 (O.3) is the focus of this installment. The Ottawa series of rootstocks dates back to the 1950's and 1960's. They were selected at the Ottawa Research Station. O.3 resulted from a cross of Robin (a hardy crab apple) and M.9. It is more resistant to collar rot than M.26 and somewhat less resistant than M.9. It is sensitive to fireblight. Propagation has been a problem, but Traas Nurseries in Canada have been relatively successful with tissue culturing of O.3, providing most rootstock liners for nurseries producing finished trees on O.3.

In Massachusetts, the first planting including O.3

Table 1. Characteristics of trees of various cultivars on O.3 in comparison to M.9 and M.26. These data were extracted from several replicated trials, and represent conditions through the end of the 1999 growing season for Golden Delicious, Empire, Rome, and Gala, through 1994 for McIntosh, and through 1993 for Delicious. Fruit size is the average over all fruiting years for each trial.

| Tree age (years) | Cultivar | Rootstock | Trunk cross-sectional area ($in^2$) | Cumulative yield per tree (bu) | Cumulative yield efficiency (lbs/$in^2$ TCA) | Fruit size (no./42-lb box) |
|---|---|---|---|---|---|---|
| 14 | Delicious | M.26 EMLA | 12.7 | 27 | 94 | 91 |
| | | M.9 EMLA | 5.2 | 18 | 143 | 86 |
| | | O.3 | 8.8 | 23 | 110 | 88 |
| 10 | McIntosh | M.26 EMLA | 10.2 | 13 | 57 | 115 |
| | | O.3 | 6.9 | 13 | 77 | 115 |
| | Golden Delicious | M.26 EMLA | 8.4 | 9 | 45 | 97 |
| | | M.9 EMLA | 6.5 | 8 | 48 | 101 |
| | | O.3 | 8.0 | 12 | 62 | 95 |
| | Empire | M.26 EMLA | 10.9 | 8 | 34 | 108 |
| | | M.9 EMLA | 4.9 | 10 | 80 | 99 |
| | | O.3 | 7.3 | 10 | 63 | 102 |
| | Rome | M.26 EMLA | 9.7 | 12 | 55 | 73 |
| | | M.9 EMLA | 9.6 | 13 | 58 | 74 |
| | | O.3 | 8.9 | 12 | 58 | 80 |
| 6 | Gala | M.26 EMLA | 7.0 | 5 | 31 | 107 |
| | | M.9 EMLA | 5.0 | 4 | 35 | 102 |
| | | O.3 | 4.5 | 5 | 47 | 110 |

was part of an NC-140-coordinated trial established in 1980. This trial included 9 rootstocks with Starkspur Supreme Delicious as the scion cultivar. Since then, additional trials including O.3 were established in 1985, 1990, and 1994 with Summerland Red McIntosh, Smoothee Golden Delicious, Nicobel Jonagold, Empire, and Law Rome as scion cultivars. This article will provide information from all of these plantings, extracting data from each experiment to compare O.3 with M.9 and/or M.26. These data are given in Table 1.

In general, O.3 produced a tree that was intermediate to those on M.9 EMLA and M.26 EMLA rootstocks. Exceptions include scions Rome and Gala, where trees on O.3 were similar in size to those on M.9 EMLA.

Relative to M.26, O.3 yielded somewhat less per tree with Delicious and McIntosh, somewhat more with Golden Delicious and Empire, and similar to M.26 with Rome and Gala. With the exception of Rome, trees on O.3 generally yielded more than those on M.9. In all cases, trees on O.3 were more yield efficient than those on M.26 EMLA. They also were more efficient than trees on M.9 with Gala and Golden Delicious as scions. The practical result of these differences is that O.3 will generally produce a tree that is between M.26 and O.3 in size but will yield more per acre, when appropriately spaced in the field, than trees on M.26.

O.3, M.9, and M.26 all resulted in good fruit size, and there were no consistent differences among the three rootstocks. Overall, average fruit size in these studies averaged about 200 g (96 count), attesting to the fact that these dwarfing rootstocks regularly result in large fruit, even with a lack of irrigation, as was the case in all of the trials.

O.3 was compared with eight other rootstocks (including M.9 EMLA and M.26 EMLA) at 27 sites throughout the U.S. and Canada as part of a cooperative NC-140 trial. After 10 years, trees on O.3 were intermediate in size and yield per tree to those on M.9 EMLA and M.26 EMLA. Trees on O.3 and M.9 EMLA were similarly efficient and significantly more efficient than those on M.26 EMLA.

The data from Massachusetts and from the NC-140 trial suggest that O.3 is a good rootsock, one that is worthy of grower trial. Some studies have grown O.3 unsupported, but in many cases, trees on O.3 lean at the trunk. Therefore, some form of support likely will be beneficial.

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