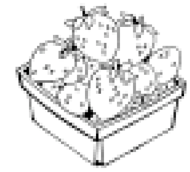
Ohio
Fruit ICM News



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In This Issue

Calendar

April 5: Ohio Apple Marketing Program (OAMP) Allocations Meeting, Dutch Heritage, Bellville, OH, 2:00 to 6:00 p.m. OAMP will allocate funds for the 2005/2006 promotions season. Contact Tom Sachs at 614-246-8290 or e-mail Tsachs@ofbf.org or Kathy Lutz at 614-246-8292 or e-mail growohio@ofbf.org.

June 28: Ohio Fruit Growers Society Board Meeting, Burnham Orchards, Berlin Heights, OH, 6:30 to 8:00 p.m. Contact Tom Sachs at 614-246-8290 or e-mail Tsachs@ofbf.org or Kathy Lutz at 614-246-8292 or e-mail growohio@ofbf.org.

June 28: Ohio Apple Marketing Program Board Meeting, Burnham Orchards, Berlin Heights, OH, 8:00 to 9:30 p.m. Contact Tom Sachs at 614-246-8290 or e-mail Tsachs@ofbf.org or Kathy Lutz at 614-246-8292 or e-mail growohio@ofbf.org.

June 29: Ohio Fruit Growers Society Summer Tour, Burnham Orchards, Berlin Heights, OH, 8:00 a.m. to 3:00 p.m. Contact Tom Sachs at 614-246-8290 or e-mail Tsachs@ofbf.org or Kathy Lutz at 614-246-8292 or e-mail growohio@ofbf.org.

Start Management Early for Optimal Control of Fruit Tree Bacterial Diseases

Source: George Sundin, MSU Plant Pathology, Fruit Crop Advisory, Volume 19, No. 1, March 30, 2004

Three important bacterial diseases of fruit trees occur yearly in Michigan and have the potential to cause significant losses if disease-favorable weather conditions occur. These diseases are bacterial canker of sweet and tart cherry caused by *Pseudomonas syringae,* bacterial spot of peach caused by *Xanthomonas campestris pv. pruni*, and fire blight of apple and pear caused by *Erwinia amylovora*.

For each of these diseases, effective management practices should include efforts to reduce the primary disease inoculum. Primary inoculum refers to the bacteria that cause the initial infections in a growing season. After primary infection, bacterial populations in orchards can skyrocket, and significant losses can occur. Therefore, limiting primary infection by starting control practices early is a critical first step in a season-long control program.

The predominant location of overwintering bacterial inoculum for these diseases can be found in the accompanying table:

Bacterial Canker	Dormant buds, cankers
Bacterial Spot	Twig cankers, terminal buds
Fire Blight	Cankers

On sweet cherry, bacterial canker infections are initiated during bloom and are associated with frost injury or extended periods of cool, wet weather. The critical factor for disease incidence is the occurrence of

large surface populations of *Pseudomonas syringae* on individual blossoms. These bacteria grow on blossoms
without causing symptoms, so it is impossible to determine their presence without processing blossoms in a laboratory.

We sampled 46 sweet cherry orchards in Michigan in 2003 and found high numbers of *P. syringae* on blossoms in every orchard sampled. These results indicate that orchards are at risk for bacterial canker infection if a frost event occurs during bloom, as happened in much of Michigan in 2002.

Fire blight infections leading to blossom blight are also initiated during bloom. Bacterial colonization and infection of open flowers lowers yield and initiates systemic infections of trees that can lead to rootstock blight and death of younger trees planted on susceptible rootstocks. The occurrence of shoot blight (wilting and dieback of actively growing shoots) is also typically higher in orchards where blossom infections have occurred.

Bacterial spot infections occur after petal fall; however, bacterial inoculum begins to build up in orchards during bloom. Leaves become susceptible to bacterial spot infection after they have elongated. Fruit are most susceptible to infection between shuck split and pit hardening.

The best method for lowering initial populations of plant pathogenic bacteria in orchards is to use an early application of copper to cover trees with a "blanket" of copper. Entire trees should be sprayed, not just alternate rows. High rates of copper can be used (~ 2.0 to 2.5 lbs metallic copper per acre), with timings immediately prior to the trees breaking dormancy. Be sure that the correct rate of copper is used and that sprayers are properly calibrated. Any formulation of copper should be effective in disease control (copper sulfate, cupric hydroxide, copper oxychloride, etc.). The goal of this management practice is to have copper available to protect the plant tissue from bacterial colonization as the tissue develops, thus lowering initial inoculum levels.

Beware of phytotoxicity! Between bud break and bloom on sweet cherry, copper can be used at about 25 percent rate. On peaches, cut the rate in half after bud break. Both sweet cherry and peach are highly susceptible to leaf injury caused by copper. Copper phytotoxicity can also occur on apple, with the predominant copper problem on apple being increased fruit russeting. Although phytotoxicity is a potential problem, if used wisely, copper bactericides applied early will effectively begin the 2004 disease management season and lower primary bacterial disease inoculum.

Pest Phenology

Coming Events	**Degree Day Accum.** Base 50°F
Pear psylla adults active	0 - 49
Pear psylla 1st oviposition	1 - 72
Redbanded leaf roller 1st catch	5 - 251
Green fruitworm 1st catch	9 - 101
Spotted tentiform leafminer 1st catch	17 - 251
Tarnished plant bug active	34 - 299

Thanks to *Scaffolds Fruit Journal* (Art Agnello)

Degree Day Accumulations for Ohio Sites

March 30, 2004

Ohio Location	**Degree Day Accumulations Base 50°**	
	Actual	**Normal**
Akron-Canton	4	32
Cincinnati	43	73
Cleveland	4	32
Columbus	30	48
Dayton	17	46
Fremont	4	20
Kingsville	2	21
Mansfield	5	32
Norwalk	5	25
Piketon	45	84
Toledo	7	22
Wooster	16	28
Youngstown	5	26

Peach Flower Buds

Source: Diane Miller, OSU Horticulturist

The reports from central and northern Ohio indicate there are a lot of dead peach buds out there. If you want to get an idea if there are differences in mortality among varieties, cut a few branches and put in vases and wait a few days. Looking at the weather data around the state, it appears that damage occurred December 20, 21, and/or 25. Weather from mid-October through mid-December was very mild around the state, not the slow, steady decline in temperatures that is desired for good hardening-off. Piketon, in Ohio's southern banana belt, did not have the below zero (F) temperatures (1, 11, 6) that central Ohio (-1, -2, -5) and northern Ohio (-2, -2, -8) had on these three dates. Kingsville, with temperatures moderated by Lake Erie, recorded 8, 5 and 0.

If the buds are completely dead they will fall off without opening. If this happens it was because the vascular connections between the shoot and the flower were damaged by cold temperature. Since these connections are damaged, the buds can't take up water and just shrivel and fall off.

Under better autumn hardening off conditions, these connections would have become drier, higher in sugar content, and able to withstand these marginally cold temperatures. These are temperatures the buds likely would have survived in late January.

I cut shoots at Wooster and put them in vases for a few days and then looked at flower bud survival. The only variety we have is Red Haven. Almost all the buds swelled but when I looked at flower bud survival using the microscope, most of the buds had dead flower parts – the inner core of the bud where the flower parts were contained was brown. However, some of them appeared undamaged. I didn't do an exact count, but will estimate that for every 3 or 4 buds with dead flowers there was 1 with live flowers. There was no apparent pattern to where the live buds were located up and down the shoots. You can examine your swollen peach buds using a magnifying glass and cutting them with a single edge razor blade. A brown or black clump in the upper center of a swollen bud indicates dead flower parts.

I don't think there will be wood damage and the trees likely will leaf out fine – without reduced numbers of flowers.

As the spring progresses, please keep track of variety differences in the field. There are a lot of new peach varieties planted around the state that we really don't know a lot about. If there are some that come through with live flower buds that will be good to know – so please keep an eye out this spring and make some detailed observations on peach variety performance that can be shared with others via this newsletter forum. Email your observations to me at miller.87@osu.edu.

Most growers wait as long as possible to prune their peaches, and this year pruning decisions should be based upon cropping potential. Rich Marini recommends that when at least 20% of flower buds remain alive, trees should be pruned normally because only 10% of a full bloom is necessary to set a commercial crop. When less than 20% of the flower buds are alive, pruning should be modified to retain most of the fruiting shoots – just taking off water sprouts that increase tree height and shade the tree center. If there are no flower buds alive, trees should be pruned to get healthy growth for next year's crop.

Managing Apple Scab Resistance to Fungicides

Source: Wolfram Koeller & Dave Rosenberger, Plant Pathology, Geneva and Highland, Scaffolds Fruit Journal, Volume 14, No. 2, March 28, 2005

The fungus responsible for apple scab has developed or will develop resistance to all known scab fungicides that have post-infection activity. Unfortunately, nobody can really predict at what time and in which orchard a sudden outbreak of resistance will cause a control failure. Over the past three years, we have developed a simplified test that measures the sensitivities of orchards to all of our post-infection options.

We found that most of our orchards in New York are resistant to at least one of the post-infection classes, but we also found that the nature and magnitude of resistance is very different from orchard to orchard:

Table 1. Sensitivities of apple scab fungus in NY orchards based on assays done in 13 commercial and 2 research orchards.

Key: + = sensitive
+/- = use with caution
- = resistant

Orchard	Dodine	SI's	Strobilurins	AP's
1	+	+/-	+	+
2	-	-	+	+/-
3	+	-	+	+/-
4	+	-	+	+/-
5	-	-	+/-	-
6	+	+	+	+/-
7	+	+/-	+	+/-
8	-	-	+	+/-
9	+	-	+	+
10	+	+	+	+/-
11	+	+/-	+	+/-
12	+	-	+	+
13	-	-	+/-	+/-
14	+/-	-	+	+/-
15	+	-	+	+

If growers could determine resistance levels within their orchards, then they could select post-infection fungicides that are still effective while avoiding those that are no longer working. Only this knowledge of orchard sensitivities would permit the continued beneficial use of post-infection materials without risking crop losses. The question of how this knowledge could be gained will be addressed at the end of this article.

Scab fungicides with post-infection activity must be viewed as classes with similar modes of action rather than as individual products, because fungicides within a given mode of action class will be cross-resistant to all other products in the same class. We will review the current status of resistance for the various classes of post-infection fungicides before we will discuss the management options we have.

Dodine:

Dodine was introduced 45 years ago under the trade name CYPREX and continues to be available as SYLLIT. In sensitive orchards, dodine provided and still provides both protectant and post-infection activities. Widespread cases of dodine resistance, which nullified both the post-infection advantage and the protectant activities, emerged in the early 1970s, after 60 dodine applications had been made in total. This total number of 60 dodine sprays could be applied over 10 years with six applications per season, or over 30 years with only two applications made.

In our most recent survey of New York orchards we found that only four (31%) of 13 commercial orchards were dodine-resistant, while nine orchards were sensitive or only slightly shifted toward resistance. In sensitive or slightly shifted orchards, dodine could still be used whenever post-infection control of scab is needed.

Can we apply the "60 sprays in total" rule to estimate the level of dodine resistance in a given orchard? In principle we could, but there are serious pitfalls. We found that once an orchard became resistant to dodine, it remained resistant, even after the orchard had been replanted, presumably because the scab population persisted in adjacent orchards or wild trees during the replanting phase. Considering that resistance to dodine could have been established 30+ years ago, it might be very difficult to estimate the total number of dodine sprays a given orchard or surrounding orchards had received since 1960. Direct measurements of dodine sensitivities appear to be the better choice in deciding whether Syllit would be an active post-infection option in a given orchard.

Benzimidazoles:

The benzimidazole fungicides were introduced in the early 1970s, after resistance to dodine had been established in many orchards and prior to the introduction of the SI fungicides. Benomyl (BENLATE), the first benzimidazole product on the market, is no longer available, leaving thiophanate-methyl (TOPSIN M, METHYL-T) as the current representative of this class. Resistance to the benzimidazoles developed fast, in many orchards after only 20 sprays were made in total.

The number of benzimidazole-resistant orchards in New York has probably increased over the past two decades because many growers have applied a benzimidazole plus captan mixture during summer to control black rot, sooty blotch, and flyspeck. In many years, the end of the primary scab season and the start of the summer program overlap, and benzimidazole-resistant individuals of the scab fungus have been kept under continuous selection pressure even though the benzimidazole applications were not aimed at scab.

The current product labels for the thiophanate-methyl fungicides continue to list apple scab as one of the target diseases, but the labels also state that the products are to be used in a mixture with another unrelated fungicide. Can we reintroduce thiophanate-methyl for the management of scab? The most likely answer is no, because a large percentage of our orchards in New York contain benzimidazole-resistant scab at a high level. The post-infection activities formerly provided by the benzimdazole (such as thiophanate-methyl) will be negligible. In such orchards, only the mixture product (usually captan) will be active against scab. It follows that a thiophanate-methyl/captan mixture used in the early part of the season will rarely improve scab control beyond the level achieved with captan alone.

SI's:

The SI fungicides fenarimol (RUBIGAN) and myclobutanil (NOVA) were introduced in 1987, with triflumizole (PROCURE) following 10 years later. At the time the SI fungicides were introduced, they had excellent post-infection activity against scab. They provided good control of scab even when the start of the scab program was delayed. In clean orchards, the SI's allowed growers for many years to skip the first green tip and 1/2-inch green applications, both of which are important when scab is managed only with protectant fungicides.

From the time the SI's were introduced, they were recommended to be used in mixtures with a low dose of a protectant fungicide. The protectant fungicide most often applied was and still is mancozeb at the low 3 lb/A rate. The rationale behind this early mixture recommendation was to improve the protection of developing fruits and to introduce an anti-resistance component to the equation. The mixture strategy did indeed provide extra protection against fruit scab, but it has not prevented orchards from becoming resistant to the SI"s.

In 2003 and 2004, we measured the SI sensitivities in 13 commercial orchards across New York. We found that eight orchards (62%) were SI-resistant and only two orchards (15%) remained at a sensitive stage. Three orchards (23%) were approaching SI resistance. The percentage of SI-resistant orchards we found was somewhat inflated by our selection of test orchards. Four of the growers had experienced scab problems after they had used SI's for many years. We verified that these problems were caused by SI resistance. At present we estimate that at least one-third of our New York orchards have reached the stage of SI resistance, with many more orchards approaching the level of resistance expected to result in control failures in the near future.

Whenever an orchard becomes SI-resistant, mancozeb in combination will carry the full burden of scab control, in particular on fruits. Two aspects relating to this full burden of control are of practical importance. In many seasons, mancozeb at the low mixture rate of 3 lbs per acre will not be sufficient whenever post-infection control is expected but no longer provided by the SI. Second, scab development might even be slightly stimulated in the presence of an SI in resistant orchards. If true, this slight stimulation would put mancozeb as the only remaining active component under additional pressure.

Predicting when an orchard will become of SI-resistant turned out to be difficult. We found that fewer than 20 SI applications in total can lead to resistance in some orchards, whereas in other orchards SI's are still effective after 60 applications. With this level of uncertainty, it is almost impossible to guess whether SI's remain effective in a given orchard. The status of SI resistance can be determined only by testing populations from an orchard in question.

Strobilurins:

The strobilurins kresoxim-methyl (SOVRAN) and trifloxystrobin (FLINT) were introduced in 1999, with the first full-season use in 2000. In our risk studies prior to commercial product introductions, we predicted that strobilurin resistance would develop with certainty, and maybe as quickly as for the benzimidazole fungicides before. Our predictions were confirmed in Europe, where the strobilurins were introduced earlier than in the U.S. In some orchards in Europe, strobilurin resistance developed after only 25 strobilurin applications in total. Fortunately, we have not yet found such strobilurin-resistant orchards in New York, probably because very few apple growers have applied 25 strobilurin sprays.

Do we have to be concerned? The answer is yes. In our most recent orchard survey we found initial sensitivity shifts toward strobilurin resistance in 11 of the 13 orchards we tested. These initial shifts do not discourage the use of strobilurins, but they show that the strobilurin resistance clock is ticking. In orchards with initial shifts toward resistance, the strobilurins will continue to provide excellent protective forward control of scab, but their "kick-back" activities will be shorter than promised in their product labels. Reliance on the up to 96 hour kick-back window allowed in product labels will be risky in the majority of orchards in New York. Rather, a 48 hour post-infection window appears to set the limit of reliable post-infection control to be expected in the 2005 season.

Are anti-resistance strategies in place for the strobilurins? The answer is "sort of". The current labels for SOVRAN and FLINT restrict the number of strobilurin applications allowed per season to a total of four. This strategy would delay the development of resistance to six years in orchards where all four allowed applications were made during the primary scab season. (Four sprays per year times 6 years = 24 sprays, a number that triggered resistance in Europe.) Can we do more? Perhaps we can. We have good evidence that using the strobilurins primarily as protectant fungicides, applying them no more than 48 hours after infection when post-infection activity is needed, and using them at their highest label rates will slow the development of resistance beyond the "25 sprays in total" that triggered resistance in Europe and more recently in Chile.

Anilinopyrimidins (AP's):

The first AP fungicide, cyprodinil (VANGARD), was introduced in 1999. The NY registration of the second AP, pyrimethanil (SCALA), is pending and may be approved in time for the 2005 scab season. The AP's only control scab (not mildew or rust diseases), but they provide post-infection activity against scab on leaves.

They are not very effective in protecting fruits from scab, and this weakness is reflected in their product labels. The use of AP's as solo fungicides is restricted to pre-bloom applications, and mixtures with another scab fungicide are advised for applications for bloom and later.

Multi-year trials in one of our Geneva experimental test orchards indicated that the scab performances of AP's when used according to their labels were comparable to mancozeb applied at the low 3 lb/A mixture rate. The failure of the AP's to out-perform the more economical mancozeb treatments was related to the SI-resistant status of our test orchard. We found that many SI-resistant individuals of the scab fungus had also lower sensitivities to the AP's. Our recent survey of New York orchards has confirmed this partial interdependence of SI and AP sensitivities of orchards.

We recommend that in SI-resistant orchards, the AP's should always be mixed with another scab fungicide, even in pre-bloom applications. In SI-sensitive orchards (and even in some resistant orchards), the AP's will provide good post-infection control of scab on cluster leaves if applied within 48 hours after the start of an infection period. However, the residual effect of this post-infection control appears to wear off quickly, and pre-bloom applications of AP's should always be followed up with another class of scab fungicides.

Where do we go from here?

Starting with dodine, resistance of the scab fungus to post-infection fungicides has been with us for 35 years. Looking at the current picture, we must concede that the way fungicide resistance has been managed in the past was not overly successful. Basically, we used risky fungicides until they failed, and after they failed, we replaced them with the next class of fungicides coming along, only to initiate another round of resistance. This "burn them up until they fail" concept has its (much too) obvious limitations: action is taken only after scab control failures have occurred.

Unfortunately, such control failures translate into serious crop losses that most growers can hardly afford given today's narrow profit margins.

Where do we stand with regard to the post-infection management of scab? As discussed above: SYLLIT could still be used in many orchards, but the question of "where" is not easily answered without a sensitivity test. For scab control, TOPSIN M or METHYL-T will be inactive in most orchards. The heydays of the SI's are over. The strobilurins are good alternatives, but their kick-back action is eroding, and the resistance clock is ticking. The AP's are not foolproof in post-infection applications. Are there any new classes of scab fungicide on the horizon? To the best of our knowledge, the answer is "no". This is bad news, because we will have to live with what we've got for the next 10 years.

What are our options? One option is to stop depending on post-infection fungicides and to manage scab with the old protectants (mancozeb and captan) that never had and never will have problems with resistance. Unfortunately, this is easier said than done. Protectant fungicides are unforgiving, and poor scab control can be expected whenever a protective spray is missed. Reasons for such missed sprays are all too obvious. The orchard floor might be too soggy to spray at green tip, or five days of rain may be followed by two days of strong winds. In those situations, it will be critical to know which post-infection fungicides are still working in a given orchard.

The second option would be to test the sensitivity of orchards to post-infection options not yet inactive because of resistance, and then to design a program around the still active options. The expected benefits of this approach are two-fold: We would stop using post-infection fungicides before they fail, and we would prolong the useful lifetime of all still active post-infection fungicides by using more than one class over a growing season.

Why would using more than one class prolong their lifetime? The question is answered best by repeating the simple "60 sprays in total" example for dodine. The 60 dodine sprays could be spread over 10 years with six applications per season, or over 30 years when only used twice. When we measure the useful lifetime of post-infection fungicides in years, it is clear that the rule that "the less we use them, the longer they will last" will work. This rule will ensure availability of post-infection fungicides over a longer period of time than would be the case if we continue the extensive use of a single compound until it is worn out.

Who would do the sensitivity tests to find out where orchards stand? We are gearing up to offer this diagnostic test service for the 2005 season on a limited scale, for an $800 fee. Growers interested in this service should contact Wolfram Koeller at wk11@cornell.edu or 315-787-2375.

Considering "Replant"ing?

Source: Juliet Carroll, IPM, & Bill Turechek, [formerly] Plant Pathology, Geneva, Cornell University

Replant is a disorder that is characterized by poor growth in young, newly planted trees, and can occur wherever fruit trees are grown in continuous rotation. Growth reduction is typically severe and trees rarely catch up to those that were unaffected. Many factors have been cited as contributing to replant, including: soil-born pathogenic fungi and nematodes and their interaction with each other and with soil type and drainage characteristics; soil factors such as organic matter content; nutrient imbalances; and ethylene produced by decomposing roots.

Trees suffering from replant disease show slow and uneven growth within the first three years of planting, including reduced shoot growth, early cessation of shoot growth, and severe stunting. Moreover, fruit production can be delayed 2-3 years, and yields thereafter are diminished. The root systems of affected trees are fibrous, poorly developed, and are often in a state of decay with darkened or discolored necrotic lesions. In some orchards, trees can grow through the symptoms if replant pressure is not severe and the trees are well nourished. In severe cases, the trees decline rapidly and die. The symptoms of replant are often indistinguishable from other diseases that cause general decline or poor growth.

A number of fungi and nematodes have been implicated in replant disorders of tree fruit, leading to conclusions that replant is caused by a complex of organisms and their interactions.

The following fungi have been consistently isolated from apple replant soils: *Cylindrocarpon destructans*, *Phytophtora cactorum*, *Pythium* spp., *Rhizoctonia solani* and *Fusarium tricinctum*. There have been mixed reports of the importance of nematodes in apple replant, though the root lesion nematode, *Pratylenchus penetrans*, is most often associated with it.

Fungi associated with stone fruit replant include *Thielaviopsis basicola*, *Pythium* spp., *Cylindrocarpon* spp., *Phytophthora* spp., *Fusarium* spp., *Armillaria mellea*, *Clitocybe tabescens*, and *Peniophora sacarta*. Nematodes found associated with stone fruit replant include *Pratylenchus* spp., *Macroposthonia* spp. (ring nematodes), *Meloidogyne* spp. (root-knot nematodes), and occasionally *Xiphinema* spp. (dagger nematodes).

Because soil factors are implicated in replant disorders, it is very important to consider soil pre-plant preparation as the keystone for managing replant. These steps include removal of tree roots, improving soil tilth, incorporation of organic matter, cover crops, crop rotation, soil analysis and correction of deficiencies in pH and nutrient levels, and soil fumigation.

The orchard tree roots that remain in the ground after orchard removal have been implicated in replant by generating ethylene as they decay, providing a food source for nematodes, and serving as a reservoir for plant pathogenic fungi. Therefore, part of the preplant preparation should include removing as much of the old tree root systems as possible, while preventing soil erosion. The addition of organic matter to soil, including peat and cover crops (Sudan grass, canola, marigold, etc.) to improve the organic matter content of the soil, has been shown to reduce replant risk. Including a fallow period or rotation to another crop is perhaps the best measure to prevent replant disorders.

Additional preplant practices that have been shown to reduce replant include subsoiling or excavation to improve soil-drainage and aeration, and planting new trees in the drive alley or digging holes the autumn prior to planting to expose the causal organisms to harsh conditions.

Pre-plant soil fumigation, with sodium methyldithiocarbamate (Vapam) or chloropicrin plus 1,3-dichloropropene (Telone C-17), can be effective at minimizing losses due to replant. To get the most from preplant fumigation treatment, proper preparation of the site and soil is crucial and is outlined in the *2005 Cornell Pest Management Guidelines for Commercial Tree-Fruit Production* (pages 50-52).

Many of these steps are very similar to the ones that will reduce replant disorders alone. Consider fumigation, particularly where high populations of root lesion nematodes are found and you are replanting apple, or where high populations of dagger nematodes are found and you are replanting stone fruits.

Replant disorders undoubtedly represent a significant challenge to growers as they consider removal and replanting of their orchards. This can be especially challenging in years following serious weather-related damage to orchards, as occurred to cherry orchards in the ice storm of 2003 and apple orchards in the winter of 2003-04. A combination of preplant practices shows promise in reducing the risk of replant disorders in tree fruit. Adopt those best tailored to your orchard management practices.

For nematode testing: Fees are charged; contact the lab before submitting samples to find out how to properly collect and submit them. Some nematode analysis labs are listed below:

Cornell University
http://plantclinic.cornell.edu/
Karen Snover-CliftPlant Disease Diagnostic Clinic607-255-7850329 Plant Science Building, Dept. of Plant PathologyIthaca, NY 14853**Michigan State University**http://www.cips.msu.edu/diagnostics/services/MSU Diagnostic Services517-355-4536101 Center for Integrated Plant SystemsEast Lansing, MI 48824-1311

For soil analysis: Fees are charged; contact the lab before submitting samples to find out how to properly collect and submit them. **Cornell University**http://www.css.cornell.edu/soiltest/Soil Nutrient Analysis Lab607-255-4540Bradfield HallIthaca, NY 14853

Replant Bioassay

Source: Juliet Carroll, IPM, Geneva, & Ian Merwin, Horticulture, Ithaca, Cornell University

This procedure was developed in the Netherlands about 40 years ago and used by Ian Merwin, as outlined below:

Replant-tolerant apple rootstocks, CG30 and CG6210, should not be used for the bioassay.

- Collect enough soil to fill about ten, 5-gallon pots. Obtain soil from 6 to 10 (or more) random locations in the field to be planted. Collect samples from the edge of the grass lane and tree row. Scrape off the top inch of soil and collect soil into a bag or convenient clean container. If soil has been tilled, simply collect soil samples from random locations in a "V" or "W" transect across the field. Wherever residual herbicides have been used (for example Karmex, Simazine, or Solicam), avoid collecting soil from the herbicide strip that contains herbicide residue

- Thoroughly mix the soil and divide it into two equal parts. Leave one half untreated. Treat the other half by either heat pasteurizing it (35 minutes at 180°F) or fumigating it (follow pesticide label directions) or with whatever preplant soil treatments you plan to use. Dilute each soil (treated and untreated) with an equal part of sterile perlite (50:50), which can be obtained at a nursery supply. Fill ten, 5-gallon pots with each of the soil mixtures, and label them as treated or untreated. If not enough soil is available to fill 10 pots, use at least five pots of each treatment to ensure accurate bioassay results.
- In each pot, plant a small tree of the same rootstock/scion combination planned for the orchard planting. Head the trees back to uniform height, label each with a number, weigh them, and record their preplant weights. Plant them in the pots and grow them outside for one full growing season. During this time, water them as needed. After leaf-drop in the fall, lift the trees out of the pots, shake or hose the soil off of their roots, and examine their root systems for signs of disease, such as dead or rotten feeder roots. Weigh each tree and its roots. By calculating the average biomass of trees grown in the treated and untreated soil samples, you can obtain a "stunting index" by dividing the average weight of trees in untreated soil by the average weight in treated soil. Research in Europe indicates that when tree growth is 50% less in the untreated soil vs. the treated soil, the expenses of preplant soil treatments may be justified. If you want to use the trees from this bioassay, you can heal them in for the winter and plant them out the following spring.

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