http://ipm.osu.edu/fruit/index.html

THE OHIO STATE UNIVERSITY Newsletter Extension

Fruit ICM News

Volume 7, No. 8
March 6, 2003

In This Issue:

Calendar

March 12: Ohio Fruit Growers Society Board Meeting, Johnny Appleseed Heritage Center, Mifflin, OH, 9:30 am. (For map to JAHC: http://www.jahci.org)

March 28-29: Berry School, video sites include OSU Learning Center, South, Piketon, OH; 244 Kottman Hall, OSU Columbus Campus; and OARDC Wooster, 1680 Madison Ave. Contact Sandy Kuhns at 1-800-297-2072 (Ohio only) or 740-289-4591 or e-mail kuhn.37@osu.edu

April 2: North-Central Ohio Fruit Crops Breakfast; Vanson's Restaurant, Monroeville, OH, 8:00 a.m. Breakfast from the menu, program at 8:45 a.m. Guest presenter, Dr. Celeste Welty, Ohio State University Extension Entomology, will discuss codling moth management for Ohio apple growers.

June 25: Ohio Fruit Growers Society Summer Tour, Glen Hill Orchard, 17156 Glen Road, Mt Vernon, OH. More details to follow later.

The following articles are made available through Web research funding provided by the Ohio Fruit Growers Society. Look for future articles on Gala stem-end cracking, 1-MCP, and other grower-suggested subjects. More suggestions are welcomed.

Orchard Groundcover Management: Long-term Impacts on Fruit Trees, Soil Fertility, and Water Quality

Source: Ian A. Merwin, Department of Horticulture, Cornell University, Ithaca, NY, 14853; 2002-03 Proceedings of the New England Fruit Meetings

Summary:

Nitrogen (N) fertilizers can increase tree fruit yields, but if applied in excess they also may contaminate water resources. We are studying the availability, uptake, recycling, and losses of N in a New York apple orchard, using a naturally occurring non-radioactive nitrogen isotope ($_{15}$N) to trace N dynamics year-round under different soil and groundcover management systems (GMSs). Our goal is to identify factors that sustain tree growth and yield, maximizing N uptake and minimizing N losses.

We have amassed three years of continuous data at the test orchard and are just beginning the comprehensive data analysis. Some preliminary conclusions are that hardwood bark mulch and mowed turfgrass reduced N losses and improved soil quality substantially. Early summer was the critical time for N uptake by trees, and N leaching was relatively low (less than 5 ppm nitrate-N) in all GMSs.

Annual post-emergence glyphosate application in May and July, that permitted substantial weed regrowth and soil groundcover from August to May each year, was the best GMS from the fruit yield perspective, followed closely by the mulch treatment.

Year-round weed-free tree rows maintained by residual herbicides treatment - the industry standard in much of North America -ranked second to last in terms of fruit yield and tree growth after 10 years of observations. Bark mulch increased soil organic matter, supported excellent fruit yields, and did not result in leaching losses of N, despite the nitrogen and organic matter additions it provided to soil.

Research Objectives

- Determine the effects of different groundcover management systems (mowed turfgrass, hardwood bark mulch, and pre- and post-emergence herbicides) on apple tree growth and productivity, and nitrogen release, uptake, retention, and recycling in a northeastern apple orchard.
- Integrate and synchronize groundcover vegetation management in relation to critical periods of fruit tree N demand and leaching losses, manage the groundcovers to prevent erosion, and retain excess N during periods of low crop demand, so as to minimize N losses from orchards.

Methods and Approach

Many orchards are located on well-drained upland sites near rivers and lakes, where nitrate and phosphate contamination of surface and groundwater is a potential problem. Nitrogen (N) pollution of water resources can affect ecosystems and human health, but it can be reduced by increasing the efficiency of nutrient, crop, and soil management. We are studying the impacts of alternative groundcover management systems (GMSs) on the nutrient status of apple trees, and the mineralization, uptake, retention, and losses of N in an orchard agroecosystem. Four GMSs have been maintained continuously since 1992 in the tree-rows of a commercial orchard near Cayuga Lake in upstate New York:

- A mowed, red fescue turfgrass (MwSod)
- A hardwood bark-chip mulch (ChpMulch)
- A conventional pre-emergence residual herbicides treatment (PreHrb) that keeps soil weed-free all year
- May and July post-emergence herbicide treatments (PostHrb) that permit weed re-growth and sparse soil cover from August to May.

We are using $_{15}$N enriched, stable isotopic fertilizer to trace the movement of N throughout the test orchard. A small amount (0.5 g of 99% enriched K_{15} NO_3) of fertilizer was applied on May 10, 1999 beneath the drip-lines of 24 trees (2 trees per GMS replicate plot). In subsequent years, we used different trees for all treatments and added a split application treatment, applying 0.5 g of 99% enriched $K_{15} NO_3$ to 24 trees (two trees per GMS plot) on May 3, 2000, and 0.17 g in three split application to another 24 trees in mid May, July and September.

We are collecting biweekly samples of root-zone soil, drainage and suction lysimeter ground water, shoots, leaves, and fruit from trees, and groundcover vegetation from each plot during each growing season. We are then analyzing their total N content, atom-percent $_{15}N$ proportion, and total carbon by mass spectroscopy. The $_{15}N$ tracer enables us to determine the uptake efficiency and biological pathways of N under each GMS, and since the quantity of N is relatively small compared to typical N fertilizer programs in orchards, our observations reflect the intrinsic efficiency and dynamics of N cycling and uptake in fruit trees adapted to low N supply. All other orchard studies involving N isotope tracers have applied large quantities of N to trees that had regularly received such fertilizer applications.

Our data will thus provide some very different information about orchard N dynamics under low-input conditions typical of many orchards on high fertility soils in the cool humid climate of the Northeast. Collectively, these data represent the most comprehensive information to date on the year-round dynamics of N in a representative commercial orchard under different soil management systems.

Results to Date

We collected more than 10,000 tree, soil, water, and fruit samples during the three years of this study, and have almost completed sample processing and analysis at the time of this report. Fruit yields per tree have been affected significantly by the GMSs, ranking PostHrb equal to ChpMulch and greater than PreHrb, which was greater than MwSod, and ranging from 110 down to 55 kg per tree from 1999-2001 (Figure 1). (Charts, i.e. Figures are available at http://www.massfruitgrowers.org/nefrtmtg/proc--2002-03/a06.pdf).

Nitrogen has been a significant factor in these effects, with substantial differences in soil, leaf, shoot, and groundwater N each year. Soil N and carbon content were greatest in the mulch treatment, averaging twofold greater than in the other GMSs (Figure 2). Leaf N content and fertilizer $_{15}N$ uptake efficiency of trees have been consistently lowest in Mowed Sod plots, and usually higher in the two herbicide treatments.

Tree uptake of soil N was very rapid during the early summer (May and June), and then declined steadily during the rest of the growing season. Unlike previous studies of N-saturated trees, the uptake of soil-applied N was almost instantaneous, and it accumulated within days in flowering spurs and leaflets of these low-N adapted trees. Leaf N was remobilized into shoot tissues during Oct. and Nov. each year, moved rapidly into other storage tissues after leaf drop (late November and early December), and then increased greatly in the shoots during early March the following year. Similar trends have been observed for fruit N content.

The N content and atom-percent $_{15}N$ (representing the uptake efficiency of applied N) in grass and herbaceous weed groundcover vegetation has differed strikingly from that in our fruit trees. The N content of grass and weeds averaged two to three times greater than in fruit tree tissues, and the efficiency of fertilizer $_{15}N$ uptake has been similarly greater in groundcovers than in trees. These observations demonstrate the weak competitive ability of fruit trees relative to groundcovers for soil N supply, and the potential for taking advantage of retention and recycling of N by orchard groundcovers, to reduce off-site N losses. The challenge is to minimize groundcover competition for N during the vitally important early summer months, and then utilize their high affinity for N to keep N in the orchard during the rest of the year.

Losses of N in surface runoff and subsurface leachate from the drainage sampling system have been greater in the PostHrb and PreHrb than in the other GMSs, but relatively low in all the treatments (Figures 3 and 4). Averaged by season, concentrations of nitrate-N in drainage from this orchard typically ranged from undetectable (< 0.1 ppm) to 5 ppm throughout the year. Surprisingly, nitrate-N losses during the irrigation season (May to October) were actually somewhat greater than during the dormant season.

Recent growing seasons have been variable--unusually hot and dry during 1999, wet and cool during 2000, and intermittently dry during 2001. Our data therefore cover the range of expected growing conditions in central New York, and suggest that nitrate leaching from orchards with sod drive-lanes receiving low inputs of N fertilizers may be minimal, considerably less than reported for other crops such as corn or potatoes, and comparable to undisturbed forest reservoir watersheds.

The soil at our site is a silty-clay loam, averaging 4.5% organic matter content, and mineralizes about 80 kg N per year without any fertilizer additions. This amount of soil N is probably sufficient to meet the needs of mature, bearing trees. The $_{15}$N fertilizer applied to trees growing in turfgrass plots was almost entirely captured by grass instead of trees during early and mid-summer, while in the bare soil of residual pre-emergence herbicide plots, much of the $_{15}$N tracer appeared in leaves of the fruit trees. Leaf N content of trees in all GMSs was adequate, so we considered the elevated tree N uptake in herbicide plots as superfluous and not essential for optimal fruit quality and yields. However, the best cumulative fruit yields were in the post-emergence herbicide and mulch treatments, and the lowest were in grass plots.

Soil temperature and moisture fluctuated substantially among the GMSs during 1999, which was an abnormally hot and dry year in upstate N.Y. Generally, root-zone temperatures were 2 to 4 degrees C warmer under the two herbicide systems compared with grass and mulch plots, and then cooled more rapidly beneath the herbicide treatments in late Fall.

During drought conditions, we irrigated the orchard regularly with micro-sprinklers covering the entire treated tree-row area. Despite this irrigation, there were marked differences in soil water content among GMSs. Soil under the grass was usually drier, and under the mulch it was often wetter during early and mid summer, while soil in herbicide plots was usually more saturated later in the growing season and early this winter. These observations may have important implications for nutrient availability and drainage or runoff losses from the orchard.

The final phase of this project will involve integration of practices such as N fertilizer form or timing, and deferring or modifying weed suppression and other GMS treatments during critical periods when fruit tree uptake is not sufficient to retain N within this orchard. We will also develop nutrient budgets for each GMS system, quantifying the amounts and movements of N in each major component of the tree/crop/groundcover/soil/water system. This will enable growers in comparable orchards to adjust their fertilizer programs so that only the amount actually lost from the orchard each year is added in fertilizer form--a strategy that should reduce or eliminate leaching of N from the agro-ecosystem. Results of this study will be made available to growers, students, extension staff and crop consultants, and disseminated in commercial fruit production recommendations and extension bulletins. We hope this project will help sustain fruit growing and conserve our vital soil and water resources in the Northeast.

Again, the following Figures (charts) are available at: http://www.massfruitgrowers.org/nefrtmtg/proc--

2002-03/a06.pdf.

Figure 1. Yearly and cumulative fruit yields in a New York apple orchard during eight years under four different groundcover management systems.

Figure 2. Soil nitrogen content (percent dry weight basis) during the growing season of 2000, after ten years of four different groundcover management systems in a New York orchard.

Figure 3. Nitrate-N leachate concentrations averaged by month, in drainage tiles under four different groundcover management systems in a New York orchard during the year 2000.

Figure 4. Nitrate-N concentrations in surface runoff water from four different groundcover management systems in a New York orchard during the growing season of 2000.

Preplant Site Preparations: What Works and What Doesn't in Northeast Orchards?

Source: Ian A. Merwin and Rachel Byard, Dept. of Horticulture, Cornell University, Ithaca, NY; Terence L. Robinson and Steven Carpenter, Dept. of Horticultural Science, New York State Agricultural Exp. Station, Geneva, NY; Stephen A. Hoying, Kevin A. Iungermann, and Michael Fargione, Cornell Cooperative Extension; *2002-03 Proceedings of the New England Fruit Meetings*

Summary

As New York growers renovate old orchards, apple replant disease (ARD) has become a major problem. Past research at Cornell has shown that ARD problems occur at more than half the farms statewide. Chemical soil fumigation sometimes controls ARD, but fumigation responses have been variable and may be linked with environmental problems. Other possible control tactics for ARD include preplant cover crops of marigolds, Brassicas (mustards) and certain Sudan grass varieties, correction of soil compaction, nutrient and pH problems, and disease resistant rootstocks.

Six years ago, we began a project to test and develop comprehensive strategies for diagnosing and controlling orchard replant problems. With funding support from NY apple growers, we have been testing methods for predicting the severity of ARD, and biological or chemical strategies for controlling ARD, at selected commercial apple orchards in the state's major fruit-growing regions. Soils from 17 orchards were sampled during 1996 to 1998 for nematode populations and nutrient status, and growth of apple seedlings or grafted rootstocks was compared in fumigated, pasteurized, and untreated field soil. At the same time, six or seven preplant soil treatments were evaluated at each orchard:

- No treatment (Control)
- Brassica/Sudan grass cover crops (B/S)
- Lime and fertilizer amendments(L/F)
- Lime and fertilizer plus Brassica/Sudan grass(LFB/S)
- Lime and fertilizer plus Vapam fumigation (LFV)
- Vapam soil drench
- Telone C-17 soil fumigation

The following year apple trees were planted into each preplant treatment, and since then we have measured tree growth, fruit yields, and nutrient uptake each year. The preplant bioassays indicated ARD

problems at two-thirds of these orchards -- seedlings or grafted trees grew much better in pasteurized or fumigated soil. Nematode populations were below damage thresholds at most sites.

In subsequent years, tree responses to the preplant treatments have been inconsistent from farm to farm. Fruit yields varied up to five-fold among the orchards. At a few sites, trees responded positively to fumigation, while at others the best growth and yields occurred in fertilizer/cover crop treatments, or there was no significant response to any preplant treatment.

The initial diagnostic bioassays over-predicted substantially the subsequent tree growth responses to soil fumigation in most orchards. As we finish tree growth and fruit yield measurements at these sites, the results indicate that preplant soil fumigation, fertilizer amendments, and pest-suppressive cover crops will not guarantee good growth and early yields of apple trees unless growers can also manage successfully all the other factors that sometimes limit replant establishment and success.

Introduction:

When fruit growers renovate and replant apple orchards, the new trees often grow poorly and fail to meet expectations for early yields or profitability. This problem is sometimes called apple replant disease (ARD) and has been the subject of extensive research in New York, Washington, and Europe. Abiotic problems such as soil nutrient depletion, compaction or acidification, and phytotoxic residues of arsenic or old roots have been associated with ARD. Biotic problems such as parasitic nematodes or fungal and bacterial pathogens of tree roots have also been implicated.

European fruit growers consider ARD a major threat, and have relied upon a greenhouse bioassay comparing seedling growth in untreated vs. steam-pasteurized or fumigated soil, to diagnose ARD problems. In this bioassay a 50% increase in seedling growth in treated soils is considered the action threshold for recommending soil fumigation before replanting. In the past decade we have tested soils from 50 orchards in the Lake Ontario, Lake Champlain, Hudson Valley, and Long Island regions with this diagnostic bioassay, and about two-thirds appeared to have serious ARD problems.

Broad-spectrum preplant soil fumigants such as methyl bromide, 1,3-dichloropropene plus chloropicrin (Telone C-17), or metam sodium (Vapam) provide temporary suppression of soilborne pathogens and weeds, and have dramatically increased growth and yields of replant trees in many regions. With fewer options and increasing costs for chemical controls, there is renewed interest in using preplant cover crops as biocontrols to suppress nematodes and/or other ARD pathogens.

In previous studies of NY orchards, cover crops of marigolds (*Tagetes patula*), Sudan grass (*Sorghum sudanense*), and 'Saia' oats (*Avena sativa*) reduced ARD, but results varied greatly from one site to another. In Europe, growers have used oilseed mustards (*Brassica nigra* and *B. juncea*) as cover crops to suppress soilborne pathogens and improve tree growth. Recent research by Dr. Rosemary Loria and others in the Dept. of Plant Pathology at Cornell University identified two mustard cultivars - 'Forge' and 'Cutlass' - with high concentrations of allylisothiocyanates that could suppress fungi or nematodes when grown as a cover crop and incorporated into the soil.

Past research by Dr. Warren Stiles suggested that depletion of essential soil mineral nutrients, and soil acidification from long-term sulfur or nitrogen applications, could also limit the growth of replanted apple trees. There is not much information available on the interactions between previous groundcovers or cropping history, soilborne plant pathogens, and nutritional deficiencies in NY orchards. We therefore included fertilizer treatments with the other factors tested in this project.

The economic impacts of ARD have not been studied much in NY, but we do know that when poor tree establishment delays and reduces yields in high-density plantings, substantial economic losses can result. Economic studies demonstrate that orchards with serious ARD problems are likely to be unprofitable (Geldart, 1994; White and DeMarree, 1992).

Considering all these factors, replant problems definitely pose a serious threat to sustainable and profitable apple production. Developing and validating a comprehensive system of ARD diagnosis and control is therefore a priority for the NY fruit industry. Hence, our main objectives in this project were to:

- Assess the extent and severity of ARD in NY State with bioassays using apple seedlings and grafted rootstocks to test the potential benefits of soil pasteurization and/or fumigation.
- Evaluate growth and yield of apple trees planted following Vapam or Telone C-17 soil fumigation, Mustard/Sudan grass cover crops, and soil pH and fertility amendments.
- Compare the field performance of apple trees in fumigated orchard plots with the results of preplant diagnostic bioassays, to determine the reliability of these bioassays for NY orchards.
- Develop extension recommendations for preplant soil treatments and adjustment of orchard tree spacing, based on validated soil bioassays and on-farm economic responses to ARD controls.
- Conduct extension programs including orchard field tours, winter meetings, and workshops. Upon completion of the research, write a comprehensive bulletin explaining the causes and extent of replant problems, and appropriate diagnostic and control strategies for NY state.

Research Methods:

Each year, five to seven orchards were selected within the state's major fruit growing regions. Soil was sampled extensively at each orchard and analyzed for parasitic nematodes, essential plant nutrients, and physical/chemical properties. Experimental objectives and designs were discussed with participating growers and regional extension specialists. The following preplant treatments were selected:

- No preplant soil treatments (Control)
- Soil amendments with lime and fertilizers according to Cornell recommendations as determined for each site by Dr. Warren Stiles (LF);
- Soil-drench with Vapam at 100 gallons per treated acre, or shank injection of Telone C-17 at 35 gallons per treated acre
- Preplant cover crops of Brassica (*B. juncea* cv. Forge) seeded in June, then tilled under and reseeded with Sudan grass (cv. Trudan-8) in late July, which was then tilled down in September (B/S)
- Lime/fertilizer amendments plus treatment with Vapam (LFV)
- Lime and fertilizers plus the Brassica/Sudan grass cover crops (LFB/S).

After obtaining 500 kg of composite soil samples throughout each test orchard, plots were blocked out and the first treatments applied in May when the Brassica cover crop was planted. In mid-July, the Brassica was chopped, tilled down, and Sudan grass was seeded. In September, the Sudan grass was chopped and incorporated, the macro/micronutrient fertilizers and lime were applied and worked into the soil, and the Vapam and Telone C-17 were applied. After preplant treatments were completed, the sites were fallowed during winter, and four to six trees were planted into each treatment replicate by growers in April of the following year.

Concurrently with establishing the preplant treatments at each orchard, we also conducted a series of apple seedling and grafted rootstock ARD diagnostic bioassays at a greenhouse and outdoor nursery in

Ithaca, NY, using the soil sampled from each site. Nematode identification and counts were performed in the initial soil samples, and again on a second set of samples taken from the Brassica/Sudan grass and untreated control plots in early October. Dormant bare-root 'Gala' or 'Jonagold' trees were obtained from commercial nurseries on M.9 and M.26 rootstocks, using the varieties and rootstocks that each participating grower intended to plant.

Grafted trees were grown in ten 20-liter pots of soil from each farm, in an outdoor nursery. There were five pots of pasteurized or Vapam treated soil and five pots of untreated field soil from each orchard. At planting, trees were headed to 1-m height, lateral branches were removed, and drip irrigation was provided with granular N-P-K fertilizer applications every two weeks. In late October we measured and weighed all new lateral and central leader growth of each potted tree.

When trees were planted at each test orchard the year after preplant treatments (i.e. in April or May, 1997-1999), we measured tree caliper 40 cm above the graft union. As trees subsequently grew and came into production, we measured trunk caliper and counted and weighed fruit samples from the center two trees in every plot annually at each orchard -- with timely assistance from the growers and local cooperative extension specialists.

Results & Discussion:

Preplant diagnostic bioassays: For most of the tested soils, there was a substantial increase in grafted tree growth after soil pasteurization or fumigation (Figure1; Photo 1). (Figures and Photos are available at: http://www.massfruitgrowers.org/nefrtmtg/proc--2002-03/a06.pdf).

However, a few soils each year showed negligible tree-growth responses, or even negative responses, to bioassay soil treatments. In the seedling greenhouse bioassay tests for these same soils, somewhat different results were obtained (Fig. 2). In some bioassays we included both steam pasteurization and Vapam treatments, and observed that soil pasteurization was often more effective than Vapam treatment for improving seedling growth, but the structure of several soils (usually sandy loams) was damaged by steam pasteurization. In gravelly loam soils of Washington, Vapam has been effective in controlling ARD; it may be less effective in NY soil types, or higher than labeled rates may be required for Vapam to control ARD in our soils.

Averaged for all 17 soils tested in three years of bioassays, the growth responses of seedlings and grafted trees to pasteurization or fumigation treatments were remarkably similar. Apple seedling biomass ratios in pasteurized vs. untreated field soil in greenhouse tests averaged 1.48 (range of 0.6 to 3.2); the ratios for seedlings in Vapam vs. untreated soil averaged 1.43 (range of 0.7 to 3.3); and the ratios for grafted trees grown outdoors in 5-gallon pots of pasteurized vs. untreated soil averaged 1.46 (range of 0.5 to 3.5). In other words, despite the different soil types and site histories, growth of apple seedlings and grafted trees in preplant bioassays was increased an average of 43 to 48% by steam pasteurization or Vapam treatments.

Preplant soil treatments at test orchards: Soil types at the 17 farms included sandy loams, gravelly loams, silt loams, and clay loams. Weather conditions during preplant treatments and the first 2 to 4 years of replant tree establishment were also variable -- including droughts, floods, and hailstorms. Across this range of growing conditions, the cover crops of Brassica and Sudan grass established reasonably well (Photo. 2), providing sufficient biomass for soil improvement and pathogen suppression at most sites.

Persistent residues of simazine and other herbicides prevented good cover crop establishment at a few orchards. Also, it was difficult to incorporate cover crop residues thoroughly into the root-zone at farms where large rocks and/or drought-hardened soils prevented rototillers from penetrating deeply into the topsoil. Nematode populations were low at the outset in most orchards, and were not suppressed further by either cover crop treatment. In fact, lesion nematode (*Pratylenchus* spp.) populations actually increased on the Brassica cover crop.

Replant tree growth in test orchards: In contrast with the generally positive growth responses to soil fumigation or pasteurization in our preplant bioassays (Figs.1-2), tree growth after replanting each orchard was highly variable and did not respond consistently to soil treatments (Figs. 3A-C). There were few significant differences among treatments at each site, but the differences in growth among the 17 orchards were impressive. Trees in the Champlain Valley grew less on average in all treatments, compared with other regions of the state with longer growing seasons. The best overall growth and the most positive response to preplant fumigation and fertilizers were observed in one Long Island orchard. At four sites (Hudson Valley 1 and 2 [HV-1 and HV-2], Champlain Valley [CV], and Long Island [LI]) tree growth was increased by Vapam treatments with or without fertilizers. A combination of Brassica/Sudan grass cover crops and fertilizers promoted better tree growth at two Ontario region orchards. Where Vapam and Telone C-17 could be compared directly (Fig. 3-C 50 for the 1998 sites), neither was very effective in comparison with untreated control plots. In general, the responses to preplant soil treatments were not significant and would not have justified the expenses of fumigation or fertilizer applications at most of the test orchards.

Yield responses to preplant treatments: At five orchards (LI-1, HV-2, HV-3 and ON-2 and ON-5), trees cropped in the second or third leaf, with relatively good production in all treatments and a positive response to the Vapam, LFV or LFB/S relative to Control treatments (Figs. 4A-C). At orchard CV-3, on a sandy loam soil, the yield response to Telone-C17 was greater than to Vapam (Fig. 4-C). At the best yielding of the 1998 sites (HV-5) there was no significant response to any preplant treatment. In five of the best yielding orchards (LI-1, HV-1, HV-2, HV-5 and ON-2), the growers obtained well-feathered, large caliper trees and were able to irrigate when necessary.

Comparing preplant treatment responses over different soil types and years (Figs. 5A-B), the trends were also mixed, suggesting that preplant cover crop, fertilizer, or fumigation responses were not consistently affected by soil texture, organic matter, or water holding capacity.

There were many factors beyond the scope of our experimental treatments that probably limited growth and yield of replanted trees at test sites, and might have negated the potential benefits from preplant treatments. For example, weed control in the new plantings was often inadequate. Potato leafhopper infestations caused trees at several orchards to stop growth in mid-summer. There were severe drought periods in some non-irrigated plantings, and one orchard was flooded repeatedly during the first year. Many of the trees at one site had suffered winter injury at the nursery and had to be replaced after their first growing season. Trees obtained for planting at some orchards were low-grade and unfeathered. Meadow voles and fireblight severely damaged or killed trees at two orchards. The lower trunks of trees at one site were completely girdled by plastic baling twine used to tie-down branches. Any one of these problems would be serious enough to counteract the potential gains from preplant soil treatments for ARD.

The preplant diagnostic bioassays appeared not to predict reliably the subsequent replant tree responses to soil fumigation at most of these 17 orchards. However, it is also possible that the 45% average increase in bioassay tree or seedling growth observed following soil fumigation or pasteurization under optimal nursery and greenhouse conditions in the diagnostic bioassays was a valid indication of the potential benefits of controlling soil-borne pathogens when all other growing conditions were optimal for newly planted apple trees. Similarly, the excellent tree growth and impressive yields in the second or third leaf at 5 of the 17 test sites represents a realistic goal that should also be attainable for other New York apple growers under ideal conditions.

These are difficult times for the world apple industry, and growers everywhere are working hard to cut costs and survive in the fruit business. Under such circumstances, it is easy to understand how replanting orchards and meticulous care for non-bearing orchards may not be top priorities for fruit growers. Our research demonstrates that preplant soil treatments are not "cure-alls" for apple replant problems. Without close attention to all the essential details of orchard replant management, it appears that soil fumigation, fertilizer amendments, and disease-suppressive cover crops will not guarantee successful renovation of old apple orchards.

Figure 1. Relative total new shoot biomass for 'Gala' apple on M.9 rootstocks after 6 months growth in 20-liter pots of Vapam treated and untreated field soil from seven NY orchards tested in 1997. Trends were similar in the 1996 and 1998 diagnostic bioassays.

Figure 2. Comparison of 'Northern Spy' seedling apple growth (total grams dry weight) after 80 days in a greenhouse, growing in 2-liter pots of pasteurized, Vapam treated, and untreated field soil collected from seven New York orchards in 1997.

Figures 3A-C. Cumulative tree growth in trunk cross-sectional area as of Fall 2000 for 17 NY orchards after different preplant soil treatments in 1996, 1997, 1998.

Figures 4 A-C. Cumulative fruit yields (kg harvested per tree) as of Fall 2001 at 17 New York orchards where different preplant treatments were applied 1996-1998, for control of apple replant disease.

Figures 5A-B. Apple tree growth (cm 2 of trunk cross-sectional area) following different preplant treatments in 1996 and 1997, grouped by orchard soil type.

Photo 1. A typical tree growth response of 'Gala' on M.9, grown outdoors for 6 months in a 20-liter pot of steam-pasteurized soil vs. untreated field soil from one of test orchards.

Photo 2. Treatment stands and randomization of preplant mustard (*Brassica juncea* cv. Forge) cover crop in a test orchard just before mowing and soil mixing cover crop residues in July.

Preliminary Monthly Climatological Data for Selected Ohio Locations, February, 2003

Weather Station Location	Monthly Precip	Normal Monthly Precip	Year-to-Date Precip	Normal Year-to-Date Precip	Avg High	Normal High	Avg Low	Normal Low	Mean Temp.	Normal Mean
Akron-Canton	1.90	2.28	3.70	4.77	30.3	36.8	16.1	19.8	23.2	28.3
Cincinnati	3.60	2.75	5.26	5.67	35.2	43.1	21.4	25.0	28.3	34.0
Cleveland	2.74	2.29	4.72	4.77	31.4	35.8	17.5	21.0	24.5	28.4
Columbus	2.96	2.20	4.61	4.73	33.8	40.5	20.0	23.5	26.9	32.0

Dayton	2.23	2.29	3.30	4.89	31.7	38.2	17.7	22.4	24.7	30.3
Fremont	1.37	2.04	2.13	4.39	30.9	35.1	12.9	17.7	21.9	26.7
Kingsville	2.00	1.80	3.12	3.80	30.9	33.6	13.7	17.4	22.3	25.5
Mansfield	1.96	2.17	3.28	4.80	30.0	35.9	15.1	18.6	22.6	27.3
Norwalk	2.31	1.73	3.83	3.63	30.8	35.6	17.4	18.9	24.1	27.3
Piketon	3.35	3.00	4.66	6.40	37.5	41.7	23.7	23.6	30.6	32.7
Toledo	1.87	1.88	3.16	3.81	32.0	35.1	15.7	18.9	23.9	27.0
Wooster	2.27	1.97	4.11	3.92	33.1	36.9	16.4	19.1	24.7	28.0
Youngstown	2.31	2.03	3.94	4.45	30.8	36.0	14.6	19.3	22.7	27.6

Temperatures in degrees F, Precipitation in inches

Table Created by Ted W. Gastier, OSU Extension from National Weather Service, OARDC & Local Data

---

The Ohio Fruit ICM News is edited by:

Ted W. Gastier
Extension Agent, Agriculture
Tree Fruit Team Coordinator
Ohio State University Extension Huron County
180 Milan Avenue
Norwalk, OH 44857
Phone: (419)668-8210
FAX: (419)663-4233
E-mail: gastier.1@osu.edu

| Back |