

NEMATODE MANAGEMENT

Revised in consultation with Dr. John Halbrecht, The Pennsylvania State University, Biglerville, PA

Nematode management in fruit orchards begins before planting and must continue each year throughout the life of the orchard. Once a nematode problem becomes serious, it is often difficult to reestablish control. Seriously affected trees may never recover full productivity.

Identifying Nematode Problems: The Critical First Step

Nematode damage is often difficult to detect. Common symptoms, such as poor yields, unthrifty growth, and increased tree mortality, may not immediately suggest nematode damage and may not be obvious until after extensive losses occur. Dagger nematode transmits tomato ringspot virus which causes stem pitting in peaches and union necrosis and decline in apples. The presence of damaging levels of nematodes can be detected only by proper laboratory techniques. Routine sampling of soil and roots on a regular basis, and especially before planting young trees or whenever nematode damage is suspected, is recommended.

Nematode samples must be collected properly, delivered promptly, and handled correctly in order for a reliable diagnosis to be made. Nematodes in a soil or root sample can be killed by warm temperatures, freezing, or drying. **Samples must be collected so that they are representative of the area being collected.** Faulty sample collection or handling can result in a misleading diagnosis and expensive nematode management mistakes.

WHEN, WHERE, AND HOW TO SAMPLE

When. Soil and root samples can be taken and reliably processed as needed, whenever the soil is not frozen. For best results, collect samples in fall or early spring before planting a site. For established orchards, collect samples during late summer or early fall. Keep samples cool and submit them to the Nematode Laboratory as soon as possible.

Where. A sample should consist of 10 or more subsamples representative of the area being sampled. When sampling individual trees, collect subsamples from around the dripline and toward the trunk. From problem areas, soil and root samples should be collected from symptomatic plants at the margin of the affected area. Since plant parasitic nematodes feed only on living plant tissues, dead or dying trees should be avoided.

For larger orchard blocks, collect a subsample from inside the drip line of at least 20 trees throughout the block. Blocks should be no larger than five acres. Collect separate samples for areas with different soil types, different cropping histories, or different management objectives.

How. Subsamples should be taken with a soil sampling tube. A trowel or narrow-bladed shovel may also be used. Take subsamples at a 2 to 12-inch depth, collecting as many feeder roots as possible. Combine at least 10-20 subsamples from the area being sampled in a clean pail or bag, mix thoroughly, and place 1 to 2 pints in a plastic bag to make the sample.

Caution! Put samples in an ice chest or refrigerate until submission. Do not allow samples to dry as the nematodes will die before the sample arrives in the laboratory. Temperatures above 95°F will also kill many nematodes.

SUBMIT SAMPLES TO THE NEMATODE LAB PROMPTLY!

Submit with the samples a letter or a nematode assay report form which includes the following information:

- a. date sample was collected
- b. crop from which sample was collected
- c. crop to be planted (if different from above)
- d. names and addresses of the grower and the person submitting the sample
- e. description of plant symptoms
- f. a brief history of the affected area
- g. previous pesticide usage and other relevant comments

Contact your county extension agent for appropriate forms, sample bags, and instructions.

Predictive assays will be processed for a cost of \$11.00 per sample by Virginia Tech. There is no charge for diagnostic assays. Send samples to: Nematode Assay Lab, 115 Price Hall, Virginia Tech, Blacksburg, VA 24061-0331. In West Virginia, send diagnostic samples to Nematology Lab, 401 Brooks Hall, P.O. Box 6057, Morgantown, WV 26506.

Recommended Nematode Management Practices in Orchards

Tree fruit orchards planted on new sites and receiving good care usually remain vigorous and productive for 20 years or more. Failure to control nematode diseases can substantially reduce orchard vigor, productivity, and life span. No single practice will eliminate nematode problems from any particular site. Rather, all of the practices listed below should be followed to maintain healthy productive trees.

NEW AND REPLANT ORCHARD SITES

New orchard sites are generally preferred for orchard establishment, especially for stone fruits. Nematode problems are not encountered frequently although it is a good idea to collect soil samples to be sure. If high nematode densities occur, treatment is recommended.

Orchard replant problems are more common than problems on new sites. Many different factors, including nematodes, contribute to orchard replant problems and the relative importance of any one factor varies from site to site. The potential for damage on replant sites, as well as new sites with serious nematode infestations, can be reduced by:

1. thorough removal of all tree root residues to reduce population density of nematodes and other soil-borne pathogens,
2. subsoiling and deep plowing to rework the soil profile and improve internal drainage,
3. rotating to field crops for at least two years to reduce pathogen populations, help eradicate weeds, and increase soil organic matter,
4. liming and fertilizing to adjust soil pH and nutrient levels for optimum tree growth and fruit production,
5. if needed, improving air and water drainage through the site, and
6. submitting a follow-up soil sample in the fall before tree planting to determine nematode population densities and the need for soil fumigation.

Soil fumigation is recommended if nematode densities exceed damaging levels, if the site has a history of other soil-borne diseases, and/or if highly susceptible cultivars are to be planted. The success of soil fumigant treatments depends on soil type, temperature, and moisture. Do not apply soil fumigants when soil temperature at a 12-inch depth is below 50°F or to wet saturated soils because the fumigant cannot volatilize and disperse adequately through the soil profile. Higher fumigant rates should be applied in heavier clay soils, soils with high organic matter, or where other soil-borne pathogens and weeds must be controlled. Many nematode problems can be controlled by treating a 12 to 14 foot band over the row. Where more serious problems occur or reinfestation from untreated areas is likely, a broadcast treatment to the entire area is recommended. The nematicides listed (see Table 24) are divided between nematicidal fumigants, broad-spectrum fumigants, and nonfumigant nematicides. Nematicidal fumigants act primarily against nematodes. Where control of other soil-borne disease and weeds is required, broad-spectrum soil fumigants should be used. In rocky ground or where fumigation is difficult, nonfumigant nematicides provide some nematode control, but do not control weeds or other diseases.

POST-PLANT NEMATODE CONTROL

After planting, nematode control options are limited to nonfumigant nematicides. They should generally be applied in a band from one foot beyond the dripline of the tree to the trunk. Broadcast applications are also registered. Application through drip irrigation systems are registered for some products.

Since these nematicides are not fumigants, they must dissolve in the soil water and contact the nematode before control will occur. Therefore, soil incorporation is needed for effective control. Mechanical incorporation to a depth of 2 to 4 inches or sprinkler irrigation with 1 to 2 inches of water should be applied immediately after nematicide application. Oxamyl (Vydate L), and fenamiphos (Nemacur 3) may be applied to nonbearing orchards: Only fenamiphos (Nemacur 3) is registered for bearing trees. Annual applications of nonfumigant nematicides may be needed to achieve good control. Registered uses for Nemacur 3 will be withdrawn as of May 31, 2007.

SPOT TREATMENT

Spot treatment of replant sites offers promise for nematode and disease control. Several pieces of equipment are currently available depending on the material to be used. After removing dead or diseased trees and as many roots as possible, make a shallow basin (10 by 10 feet) over the planting site and apply 0.8 lb metam sodium (e.g. 3/4 qt of Vapam HL) per 100 square feet while filling the basin with enough water to penetrate the entire root zone, up to six feet if possible.

Caution: Pesticide registrations may change. Always read and follow directions on the label.

Table 24. Nematicidal pesticides for use in deciduous fruit orchards.

Active ingredient	Trade Name	Rate per treated acre ^a
1,3 dichloropropene ^d	Telone II	27-35 gal
Broad Spectrum Fumigants (for control of nematodes, other soil-borne diseases, and weeds)		
1, 3 dichloropropene + chloropicrin	Telone C-17	32-42 gal
	Telone C-35	39-50 gal
metam-sodium ^e	Vapam HL	50-75 gal
dazomet+ 98%	Basamid	222-450 lb
Nonfumigant Nematicides: Nonbearing trees		
fenamiphos ^g	Nemacur 3	1 2/3-2 1/2 gal ^b
oxamyl (foliar spray)	Vydate L	2-4 pt ^c
oxamyl (pre-plant, soil incorporated)	Vydate L	3-4 gal ^f
Bearing trees		
fenamiphos ^g	Nemacur 3	1 2/3 - 2 1/2 gal ^b (soil spray) 1-2 gal/A/yr (via drip irrigation)

^a Use the higher rates in heavier soils, soils with high organic matter content, or where deeper penetration of fumigants is desired.

^b For use on peach, nectarine, apple and cherry. Apply in a band beneath the drip line of the tree. Also may be applied in 1-4 applications per year via low pressure irrigation systems. Consult the label for rates and application directions.

^c Apply 2 to 4 pints per 100 gallons of water as a foliar spray. Start when trees reach full leaf and apply at 2 to 3 week intervals up to four applications per season. Treatment will also control some insects. For use on nonbearing apples, cherries, peaches, or pears.

^d Telone EC is labeled for application through drip irrigation lines at 9-24 gal/A; however, tarping is required.

^e Metam sodium is available in a variety of formulations such as Nemasol (3.18 lb/gal), or as Nemasol 42% or Sectagon 42 (4.26 lb/gal). Adjust rates according to label directions.)

^f Apply within 24 hours of planting and thoroughly incorporate to a depth of 4-8 inches immediately after application.

^g Bayer will discontinue sale of Nemacur 3 as of May 2007, and all distributors will discontinue sale of the product by May 2008. Existing stocks can continue until depleted.

Orchard Site Bio-Renovation Program

Dr. Paul Steiner, University of Maryland, College Park Maryland (Deceased)

Few registered chemicals for soil fumigation remain for treating old orchard sites to reduce plant parasitic nematode populations and various soil-borne fungi. Simply leaving the land fallow for several years is often not enough to return the site to its full productive potential. If broad leaf weeds are not excluded during the fallow period, the site may continue to harbor the tomato ringspot virus. Most grain, corn and forage crops that might be grown in the interim between orchard contribute little to the reduction of many parasitic nematode species that attack fruit trees and can be at high levels in old orchard soils. Finally, old orchard soils often have persistent residues of herbicides, are low in organic matter, have problems with soil compaction and internal drainage.

Given the high cost of establishing a modern, high density orchard and our limited ability to treat the soil effectively after the trees are planted, it is important to prepare the soil for these intensively cropped sites carefully. All of the elements of the pre-plant site conditioning program outlined here are based on research in the mid-Atlantic region over the last decade. What is new is that these elements have now been combined into a cohesive two-year program aimed at establishing a soil ecosystem that will support the long term productivity needed in fruit orchards.

FALL, THREE YEARS BEFORE PLANTING

Remove old trees and roots. Rip soil thoroughly to expose additional roots and large rocks for removal. Submit soil samples from top 18 inches for pH and basic fertility determinations.

Apply lime to adjust soil pH to 6.5 and incorporate by deep plowing. If more than 1,500 pounds of total oxides per acre are required, apply half before plowing and incorporate the remaining half after plowing by disking.

Plant barley, oats or rye as cover crop to reduce winter erosion.

TWO YEARS BEFORE PLANTING

Mid-April to Early May

Broadcast 50 pounds of actual nitrogen per acre along with the required amounts of phosphorus and potassium needed for forage crops based on soil test results and incorporate these materials as the winter cover crop is plowed or disked under.

Plant Sudex (sorghum x sudan grass hybrid variety of *Sorghum bicolor*) at 20-25 pounds of seed per acre. *Note:* Sudex is the crop of choice because it produces a large amount of biomass quickly and the roots will penetrate four to six feet deep. This additional organic matter should also help reduce the availability of toxic herbicide residues in the previous orchard soil.

Mid-July through Late-August

Mow down Sudex in mid- to late-July and add an additional 75-100 pounds per acre of ammonium sulfate to support regrowth of the Sudex crop and to begin the nutritional plan for the following rapeseed crop. In mid-August, an additional mowing with a flail mower may be necessary to reduce the bulk of plant residue before plowing it down thoroughly.

Incorporate 50-75 pounds of ammonium sulfate per acre by disking. *Note:* The additional sulfur added during this season may acidify the soil slightly, but the additional availability of sulfur should increase the amount of toxic materials produced in the following rapeseed crop.

In late August, approximately two weeks after plowing down the Sudex plant residues, plant rapeseed (var. 'Dwarf Essex') at 8 to 10 pounds of seed per acre. *Note:* In addition to adding more organic matter to the soil, rapeseed produces chemicals that are toxic to plant-parasitic nematodes. Test show that two successive plantings of rapeseed will reduce nematode populations equivalent to an application of Telone-II.

ONE YEAR BEFORE PLANTING

Mid- to Late-April

Mow rapeseed using a flail mower and plow down the residue immediately. Never mow down more area than can be plowed under within two hours. *Note:* Mowing injures the plants and initiates a process releasing nematicidal chemicals into the soil. Failure to incorporate mowed plant material into the soil quickly, allows much of these available toxicants to escape by volatilization.

Two weeks after plowing down the first rapeseed crop, broadcast 50-75 pounds of ammonium sulfate and plant a second crop of 'Dwarf Essex' rapeseed at 8 to 10 pounds of seed per acre.

August -September

Collect and submit soil samples in early August for pH and basic fertility levels so that results can be available by early September.

In mid-August, mow down the second rapeseed crop and plow down the residue immediately as done previously.

In early September, approximately two weeks after plowing down the second rapeseed crop, broadcast any lime needed to readjust the soil pH to 6.5 along with 15 to 20 pounds of actual nitrogen (do not use ammonium sulfate) per acre along with other nutrients needed for fruit crop production and plow or disc these materials in deeply.

Plant 20 pounds of *certified* Kentucky-31 tall fescue seed and 10 pounds of winter oats per acre. *Note:* Use only certified Kentucky-31 seed for uniformity and maximum performance and then only seed lots that are "endophyte-infested". Bargain seed lots marked K-31 often are not true to variety and endophyte free seed may not suppress nematode populations as intended.

SPRING, YEAR OF PLANTING

Two weeks prior to planting trees, apply glyphosate (Roundup) herbicide as a directed spray to kill the K-31 sod cover in four foot wide strips marking the planting rows. Where possible locate the new tree rows in the row spaces from the previous orchard. Leave the killed sod in place and plant trees through the sod with a tree planter where possible or a suitable auger if necessary. *Note:* Killed sod does not compete with the new trees, traps more rain than bare ground and reduces soil loss through erosion. In addition, by not disturbing the soil, fewer weed seeds are exposed for germination.