



Parasitic nematodes may damage roots of apple trees, especially those that are newly planted. The lesion *Pratylenchus penetrans* and dagger (*Xiphinema mericanum*) parasitic nematodes are two serious pests commonly found in New England orchard soils. Lesion nematodes primarily feed within newly formed feeder

roots of fruit trees. Dagger nematodes feed along root surfaces and serve as vectors for transmitting tomato ringspot virus. Tomato Ringspot Virus is the causal agent of Apple Union Necrosis and Decline disease (AUND). Lesion nematodes are more likely to build up to a damaging level in sandy and loamy soils than in the heavier clay soils. However, as a virus vector, dagger nematodes can be a significant problem even on heavier soils.

Parasitic nematodes most often cause economically important problems when old orchard sites are replanted. On replant sites, nematodes, along with other soil-borne pathogens (i.e., fungi, bacteria) and abiotic factors, combine to reduce new tree growth, delay tree development, and reduce yield. This disease complex is referred to as apple replant disease. The symptoms of apple replant disease include stunting, yellowing of leaves, discolored and necrotic feeder roots, and death of the tree in severe cases. Typically, affected trees are scattered throughout the orchard and can show large variations in symptom severity. Orchards affected by replant disease never reach their full production potential.

To determine if a nematicide treatment is necessary, soil nematode levels should be properly diagnosed. This can be done at the University of Massachusetts (contact Dr. Daniel Cooley or Dr. Robert Wick, Dept. of Microbiology) or at the Connecticut Agricultural Experiment Station (contact Dr. James LaMondia, Dept. of Plant Pathology and Ecology). If potentially damaging levels of nematodes are present, then some form of pre-plant treatment should be used to reduce the population. This can either be fumigation, or a longer-term land preparation process that does not use fumigants.

PRE-PLANT FUMIGATION. There are a number of problems associated with using fumigants. Fumigation is generally expensive, costing between \$750 to \$1,500 per acre and often requires hiring a custom applicator. *Chemical fumigants are highly toxic.* There are four

primary materials registered for use in apple orchards: sodium methyldithiocarbamate (Vapam), 1, 3-dichloropropene (Telone II), 1, 3-dichloropropene/chloropicrin (Telone C-17) and dazomet (Basamid).

Injecting fumigants can be difficult in rocky New England soils, reducing the effectiveness of these materials. Also, sodium methyldithiocarbamate is not generally effective for deeply rooted trees. Aside from these problems, effective fumigation can quickly knock down nematode populations, as well as some soil fungi and weeds, and boost tree growth.

In general, fumigants should not be applied to wet, cold (<50°F) soil, as they will not work well in these conditions. Fumigants work best when soils are slightly moist and warm, conditions that occur in August through early October. Prior to fumigation, soil should be worked to a good friable condition, free of plant residue (particularly tree roots), and large clods of soil. This may require a year or two of cover cropping in addition to using heavy equipment to remove roots. Details of the fumigation process will depend on the applicator and material. Consult the label for specific application instructions. The range of organisms affected varies by the material used.

RECOMMENDED NON-FUMIGANT, PRE-PLANT NEMATODE TREATMENT.

Many of the benefits of fumigation can be obtained by carefully renovating a replant site over several years. This is a longer-term approach. A suggested outline is as follows:

Four years before replanting

1. Stop all use of persistent herbicides such as simazine in orchards that are to be replanted.
2. Prioritize blocks, determining which are most in need of replanting, and which can wait. (A rule of thumb is to replant 5 to 10 percent of your orchard annually.)

Fall, Three Years Before Planting

1. Remove old trees and roots. Use deep plowing to expose additional roots and large rocks for removal. Analyze top 18 inches for pH and basic fertility needs.
2. Apply lime to adjust soil pH to 6.5
3. Plant barley, oats or rye as a cover crop to reduce winter erosion.

Spring, Two Years Before Planting

1. 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. Incorporate these minerals as the winter cover crop is plowed or disked under.
2. Plant Sudex (sorghum x sudan grass hybrid variety of *Sorghum bicolor*) at 20–25 pounds of seed per acre. This cover crop will rapidly produce biomass, and root penetration will improve soil tilth. Sudex also

appears to suppress nematodes.

Mid-July through Late-August

3. Mow down Sudex in mid- to late-July and add an additional 75–100 pounds ammonium sulfate per acre 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.
4. 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.
5. In late August, approximately two weeks after plowing down the Sudex plant residues, plant rapeseed (var. Dwarf Essex) at 8–10 pounds of seed per acre. Rapeseed produces chemicals that are toxic to plant-parasitic nematodes and provides organic matter to soil. Rapeseed may be more consistently effective against dagger (*Xiphinema* spp.) nematodes than lesion (*Pratylenchus* spp.) or root-knot (*Meloidogyne*) nematodes. Lesion nematodes may best be controlled with a second crop of Sudex, which will winter kill. Root-knot may best be controlled by a grain crop such as winter wheat or rye.

Mid-Late April, One Year Before Planting

1. 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, as nematicidal chemicals in the rapeseed need to be incorporated into the soil quickly or they are lost.
2. Two weeks after plowing down the first rapeseed or other rotational crop, broadcast 50–75 pounds of ammonium sulfate per acre and plant a second crop of Dwarf Essex rapeseed at 8 to 10 pounds of seed per acre.

August-September Before Planting

3. Collect and submit soil samples in early August for analysis of pH and basic fertility levels so that results can be available by early September.
4. In mid-August, mow down the second rotational crop and plow down the residue immediately.
5. In early September, approximately two weeks after plowing down the second rotational crop, broadcast any lime needed to readjust the soil pH to 6.5. Add 15 to 20 pounds of actual nitrogen (do not use ammonium sulfate) per acre and other nutrients needed for fruit crop production and plow or disk these materials in deeply.

6. Plant 20 pounds of certified Kentucky-31 tall fescue seed and 10 pounds of winter oats per acre. (Use only certified Kentucky-31 seed for uniformity and maximum performance and 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

1. 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.
2. Leave the killed sod in place and plant trees through the sod with a tree planter where possible, or a suitable auger if necessary. 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.

POST-PLANT NEMATICIDES

Where soil analysis shows high populations of parasitic nematodes in a young orchard, a post-plant application of a nematicide may be justified.

Nemacur 3: (Nonbearing and bearing apple, cherry and peach trees). Apply as a band treatment, 1.7 to 2.5 gallons of Nemacur 3 in not less than 10 gallons of water per acre. Must be incorporated immediately either mechanically or with sufficient irrigation (not to exceed the depth of the root zone). Center the treated band on the tree row using a band width of 50% of the row spacing and covering the feeder root system of the plant. Control of nematodes is best obtained when there is adequate rainfall or irrigation after application.

On newly planted, nonbearing trees, make the first application when the trees have recovered from planting shock and have initiated new growth. Do not apply more than 2.5 gallons per acre per year. Special precaution: On bearing trees, do not apply within 72 days of harvest of apples or within 45 days of harvest of peaches or cherries. Do not feed cover crop grown in treated area to livestock. Do not add oil or surfactant to the spray mixture.

Vydate L: (Non-bearing apple, cherry, pear and peach trees). Use as a foliar treatment, as per label directions. Apply on a 2 to 3-week schedule for 4 applications. Apply first spray at first full leaf. Special precaution: Do not treat planting stock by root dip nor apply foliar sprays to trees under water stress or if they are not actively growing. ‘Non-bearing’ trees are trees that will not bear fruit within 12 months after application.