Michigan State University
Cooperative Extension Service
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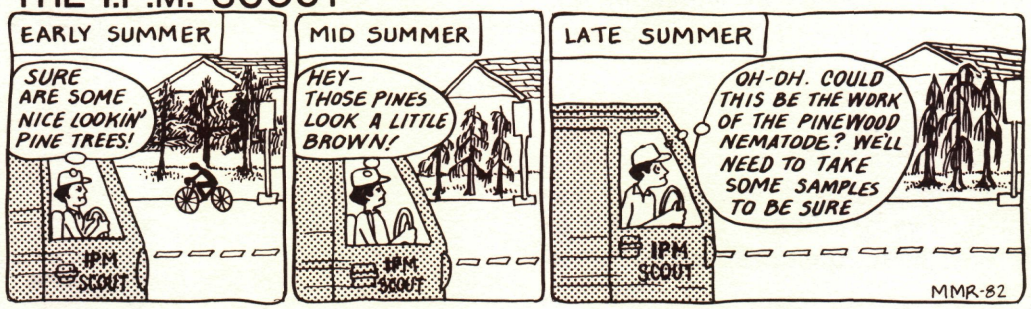
PINE WILT &

THE PINEWOOD NEMATODE

THE I.P.M. SCOUT [2]



Years ago, you planted pine trees. You watered, fertilized, trimmed, and admired them as they grew. This summer, however, you noticed a change. The usual green faded and in a short time the tree was totally brown.

The cause? Possibly the pine wilt disease. In the past, the cause of pine wilt, or sudden death, was attributed to blue-stain fungi, bark beetles, stress, drought, rodents, or poor soil. In 1979, however, the pinewood nematode was found to cause pine wilt. Insects, usually long-horn beetles, transmit (vector) this nematode.

PINEWOOD NEMATODE

Since the discovery of the pinewood nematode (Bursaphelenchus xylophilus) in the U.S., it has been found in 34 states associated with 20 pine and 7 non-pine species. Exotic

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[1] *Susan L. Battenfield and George W. Bird; Departmental Science Editor and Professor, respectively; Department of Entomology, Michigan State University, East Lansing, MI 48824. Illustrations by Marian Mahler Reiter and Lana Tackett.*

[2] *Integrated pest management (IPM) is "A strategy of ecological management of crop pests using a variety of techniques including predators and parasites, genetically resistant hosts, natural environmental modifications and, when necessary and appropriate, chemical pesticides." Scouting is an important part of IPM. The IPM Scout cartoon series was designed to provide information about IPM procedures.*

pines, especially Scotch, Austrian, and Japanese species, are very susceptible to the pine wilt disease. Pines grown in urban or plantation settings appear to be particularly susceptible. The pinewood nematode is believed to be native to the U.S. Therefore, the threat to U.S. pine forests may not be great. However, it could be a problem in ornamental and Christmas tree plantings. Although the pine wilt disease is present in Michigan, the extent of occurrence is not known. Some states south of Michigan have experienced heavy damage from the disease.

INSECT VECTOR

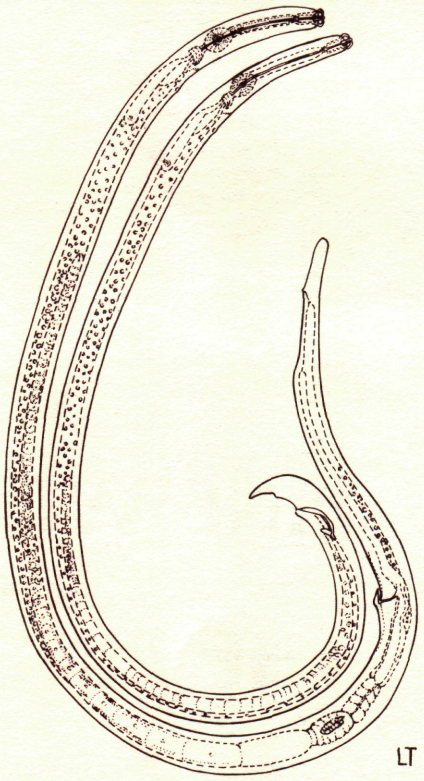
Although the sawyer beetle, (Monochamus carolinensis) appears to be the primary vector for the pinewood nematode in the U.S., the nematode has been found in other sawyer beetle species and in several other wood-boring beetles.

DISEASE SYMPTOMS

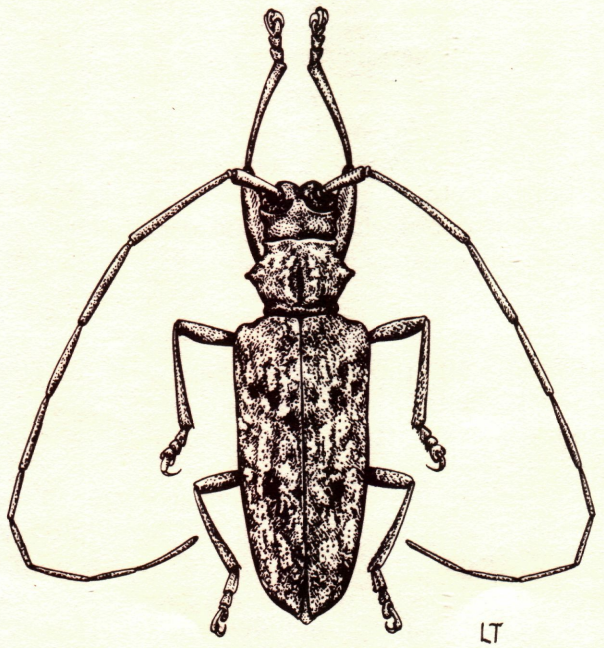
The most noticeable symptom of pine wilt is the rapid death of a tree, usually in 2-3 months. The first symptom is a stop in resin flow, which can be detected by wounding the tree. If a tree becomes infected in the fall, the first symptom may be either "flagging" or an absence of candle growth in the spring. Flags are dead (brown or red-brown) branches. As symptoms of possible pinewood nematode infection, flags are found in the upper crown; if they are below the middle of a tree, they are most likely caused by some other problem.

In late summer and early fall, the disease progresses rapidly. Visual symptoms are changes in needle color from green to light gray-brown, followed by yellowish-green and yellowish brown, until (approximately two months after the needles first change color) the needles are light chocolate or reddish brown. In longer or soft-needled pines, the needles droop as if they lack adequate moisture.

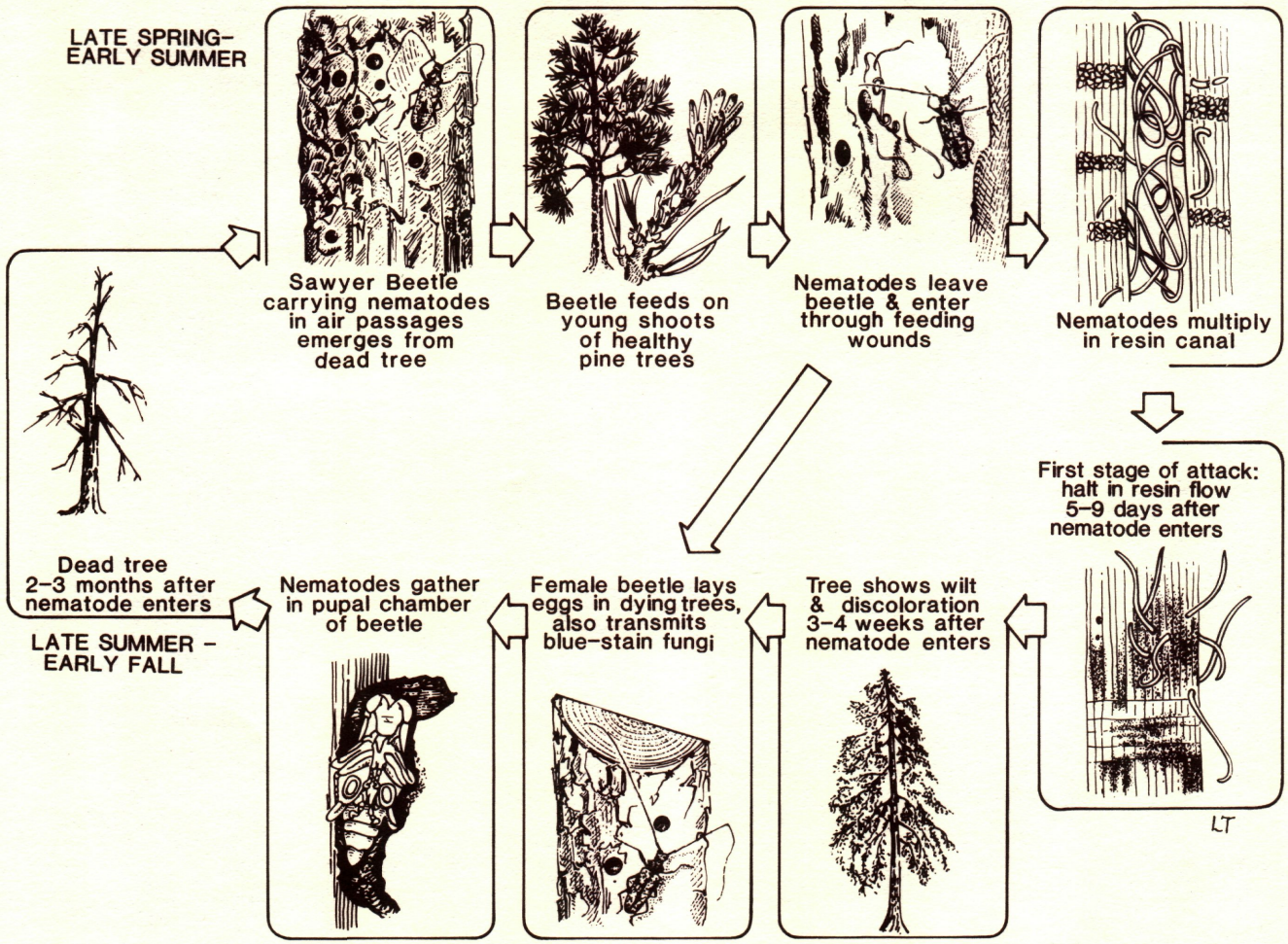
Symptoms usually appear in mid to late summer, with trees dying in late summer or early fall. The age and resistance of trees may contribute to how long it takes a tree to succumb to pine wilt. Old, large trees may take a year to die. Disease-tolerant species (like Ponderosa and Lodgepole) may show flagging or localized infections for a year or more before dying. In some cases, death may be from a combination of pests.



Pinewood Nematode



Sawyer Beetle



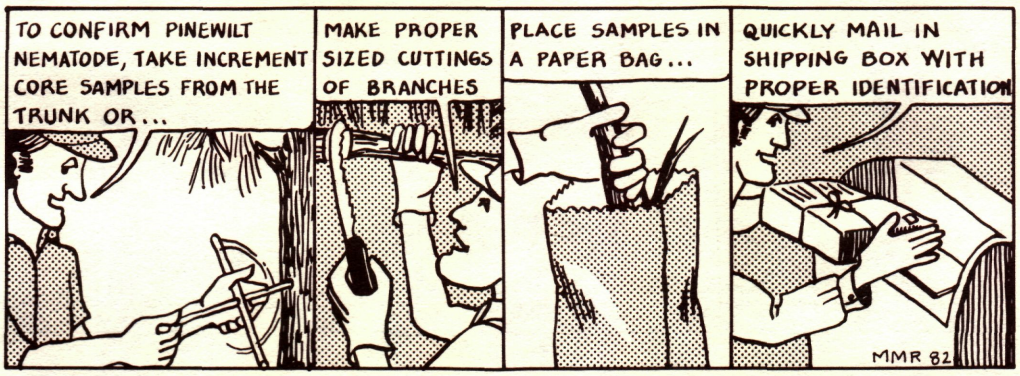
Pine Wilt Disease Cycle

DISEASE CYCLE

In early to mid-summer, adult sawyer beetles (Cerambycids) emerge from dead pine trees, with thousands of pinewood nematodes in their air passages (spiracles). In Missouri, as many as 79,000 nematodes have been found in a single beetle. The average number is about 18,000 nematodes per insect. The beetles fly to healthy pine trees and feed on growing branch tips. As they feed, the nematodes enter the tree, most likely through the feeding wound made by the beetle. All of the nematodes do not leave the beetle at any one feeding. One beetle, therefore, can infect several trees, or one tree in several locations. The nematodes invade the resin canals, cambial tissues, and cortex. The first symptom of the disease is a drop in resin levels. This generally happens 5 to 9 days after the nematode enters the tree.

The pinewood nematode has a very short life cycle. At optimal temperatures of 25 to 30°C, it completes a generation in four days. Mated female nematodes deposit up to 80 eggs. As the nematode population increases, the resin canal system of the tree is disrupted and the water transport system breaks down. Three to four weeks after the nematodes enter, a tree shows symptoms of pine wilt. Changes in needle color and wilting become visible. By late summer or early fall (5 to 6 weeks after the first sign of wilting) the tree dies.

The larvae of the pinewood nematode develop two ways. Larvae first develop along the reproductive pathway. When the beetle larvae begin to pupate, however, the nematodes change to the overwintering-dispersal pathway. These larvae are well adapted to survive nutrition, temperature, and moisture stress. When the beetle is pupating, these larvae (called Dauerlarvae) aggregate in the pupal chamber and enter the body of the beetle through the spiracles. The disease cycle is completed when the adult beetle emerges in late spring or early summer, feeds on healthy pines, and deposits nematode larvae.



PREDISPOSITION AGENTS

The pinewood nematode is not the sole cause of sudden death in pines. Continuing research indicates a complex of factors may be interacting to predispose the tree and cause pine wilt. In addition to the nematode and beetle, fungi, toxins, and bacteria have been implicated. Physical stress also seems to be involved in the disease cycle.

Several species of fungi have been found in trees that are dead or dying from pine wilt. Of these, the blue-stain fungi (Ceratocystis ips) seems to be the most important. Researchers feel that blue-stain enters a tree that has already succumbed to the pinewood nematode. Sawyer beetles may distribute the fungi when they enter a tree to lay eggs. The fungi colonize the cambium layer and spread inward. The fungi feed on frass produced by insect larvae; the pinewood nematode in turn, feeds on the fungi.

In Japan, pine wilt is a major problem in pine forests. Studies by Japanese scientists suggest that pine wilt may be associated with a toxin produced when a bacterium and the nematode are introduced into the pine tree at the same time. U.S. researchers have isolated toxins from diseased trees and found a toxin that also causes pine wilt and kills the tree. It is believed that the tree produces the toxin as a possible defense against the nematode.

Physical stress factors are crucial to disease development. Studies comparing watered to non-watered seedlings show a marked difference in resistance to the disease: 4% of the well-watered plants died, while 62% of the water-stressed seedlings died. Water-stress, therefore, may predispose trees to pine wilt.

Another route of infection could be using chips or pulp from pine wilt-diseased trees as mulch around healthy pines. The nematodes can move out of the mulch, through the ground and penetrate the pine tree's roots. Although this is probably rare, it is important when considering using pine chips or pulp as mulch.

PROBLEM DIAGNOSIS

Due to the suddenness of tree death, symptoms of the disease are relatively easy to detect. To confirm the specific cause of death, however, the presence of the pinewood nematode must be identified through a laboratory analysis. Accurate identification of the nematode from tree wood is done via microscopic examination. Wood samples for pinewood nematode diagnosis should be sent to a nematode laboratory such as the Nematode Diagnostic Laboratory, Department of Entomology, Michigan State University, East Lansing, MI 48824. Samples should consist of:

1) several wood cores taken at shoulder height with an increment borer, or pieces of wood taken with a saw or axe (wrap core samples in aluminum foil), and
2) two branch sections of 2 to 3 inches in diameter and 4 to 6 inches in length.

The pinewood nematode does not inhabit pine needles or bark and is rarely found in small twigs. Be sure to provide the nematode laboratory with the following information:

1) pine species,
2) estimated age,
3) planting type (plantation, urban, forest)
4) when symptoms first seen,
5) present color of tree,
6) extent of occurrence in planting,
7) sample date, and
8) name and address of owner.

If more than one tree is being sampled, indicate which samples belong to which tree. Most nematode laboratories have a supply of sample submission forms and mailing pack-

ages. (See Michigan State University Extension Bulletin E-800 "Nematode Detection," free, for more information about nematode sampling.)

MANAGEMENT STRATEGY

To manage the pinewood nematode and pine wilt disease, you need an appropriate strategy for each site. Removing and burning dead trees is essential. This reduces the reservoirs of pinewood nematodes and the beetles that spread the disease. Trees should be burned before the beetles emerge in early to mid-summer. Pruning flagged branches may help, though it may only postpone tree mortality.

Future management procedures may include (1) chopping and pulping, (2) cutting and fumigating for later use as firewood, (3) cutting and placing under plastic (this allows the sun to kill the nematodes and beetles) then using as firewood, or (4) treating the bark with pesticides.

When planting or replanting pines, avoid the more susceptible pines, such as Scotch and Austrian. Scotch is generally considered the most susceptible. Maintain pine plantings under optimal moisture and fertility, and control other pests that stress trees.

SIMILAR PROBLEMS

Because the pine wilt disease kills a tree quickly, it is relatively easy to diagnose. Many other diseases and pests, however, cause similar symptoms that can be confused with pine wilt.

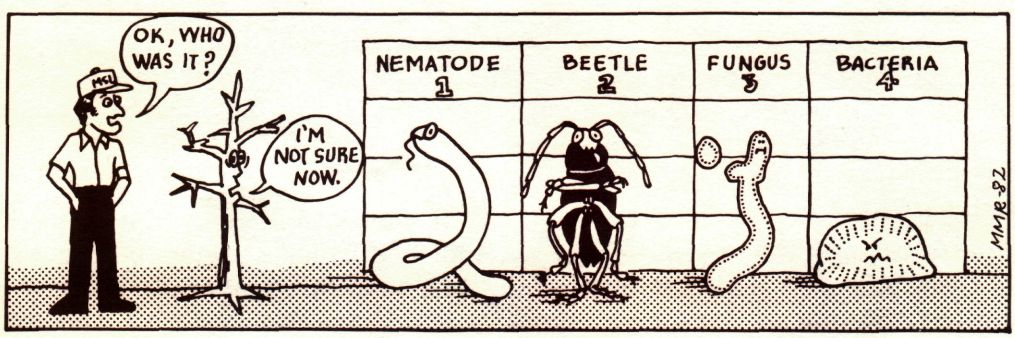
Damage by the pine root collar weevil is common in Michigan, especially in northwest lower peninsula. The weevils are found in the soil and look like small (less than half-inch long) grubs. The weevils usually feed on young trees. Damage begins slowly with needles turning yellow and ends two to three years later in death.

Armillarea root rot, also a common problem in pines in Michigan, usually occurs in trees less than ten years old that were planted in areas where hardwood trees had been planted. Symptoms are similar to pine wilt, although the tree does not die quickly.

Rodents feeding on small trees (up to five years old) can also create needle yellowing and tree death. Damage usually occurs where grassy vegetation is high around trees; it is easily spotted by toothmarks or girdling around the base of the tree.

Various pine needle blights caused by fungi can also be confused with the symptoms of pine wilt. In addition, severe drought, grass fires, lightning strike, and similar natural damage mimic pine wilt.

Because of the variety of factors that cause symptoms similar to pine wilt, it is important to note the progression of symptoms and to check for causes other than the pinewood nematode.



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