63. Pine Wilt Disease

Jerry W. Riffle and Frederick J. Crowe

The pine wood nematode, *Bursaphelenchus xylophilus*, causes a disease of pines called pine wilt. This nematode is unusual, compared to other plant-parasitic nematodes, because it is a pathogen in above-ground parts of trees, is transmitted by insects, and does not enter the soil. *B. xylophilus* was first reported in the United States in 1931 in logs of longleaf pine. However, it was not recognized as a potential pathogen of pines in this country until 1979 when it was found associated with dying Scots and Austrian pines in Columbia, Missouri.

Hosts and Distribution

Twenty-two species of *Pinus*, one species of *Abies* and *Pseudotsuga*, and two each of *Larix*, *Picea*, and *Cedrus* are known hosts of the pine wood nematode in the United States. The ability of this nematode to kill native North American pines growing in forests has not been established, but evidence suggests that it can kill exotic pines such as Scots, Austrian, and Japanese black pines in the United States, particularly on off-site, high-stress locations. Most pine mortality has occurred in landscape plantings, but the nematode also has caused mortality in windbreaks, Christmas tree, and recreational plantings. Scots pine, an important landscape and popular Christmas tree species, is the most commonly reported host. In the Great Plains, *B. xylophilus* has been found on Scots, Japanese black, Austrian, eastern white, and loblolly pines. Greenhouse inoculation tests show that the five species most susceptible to *B. xylophilus* are jack, shortleaf, Monterey, sugar, and Scots pines.

Nationally, *B. xylophilus* has been found in 34 States, including all states in the Great Plains except North Dakota. However, typical symptoms of pine wilt have not been observed throughout the geographical range of *B. xylophilus*. The nematode can reproduce on fungi associated with dead, stressed, and live pines, and thus can be found in pines killed by other agents. The widespread distribution and host range of this nematode suggest it is endemic to the United States.

Symptoms and Signs

The first symptom of pine wilt is a marked reduction in flow of oleoresin that occurs before external symptoms are apparent. Transpiration from foliage decreases, then stops 3 to 4 weeks after infection. Foliage rapidly yellows and browns as sapwood moisture decreases (fig. 63–1). Needles show definite wilt only in long, soft needled species such as white pine. Foliar symptoms may progress uniformly through the tree or branch by branch, largely depending on the size of the tree and the season of death. Trees may die from midsummer to late fall or from late winter to late spring. The rapid death contrasts with the slow decline caused by pathogenic fungi such as *Diplodia pinea*, or by unfavorable environmental conditions.

Disease Cycle

The biology of *B. xylophilus* and basic information on the disease cycle have been determined by scientists in Japan where pine wilt has been a serious problem for many years. The cerambycid beetle *Monochamus alternatus* is the principal vector that transmits *B. xylophilus* to native Japanese pines. Adult beetles infested with *B. xylophilus* emerge from dead pines in May and June, fly to healthy pine trees, and begin maturation feeding on phloem of young pine shoots (fig. 63–2). Immature nematodes leave the tracheae of the beetle, enter feeding wounds, molt to the adult stage, mate, and reproduce rapidly in the resin canals of the pine host during the

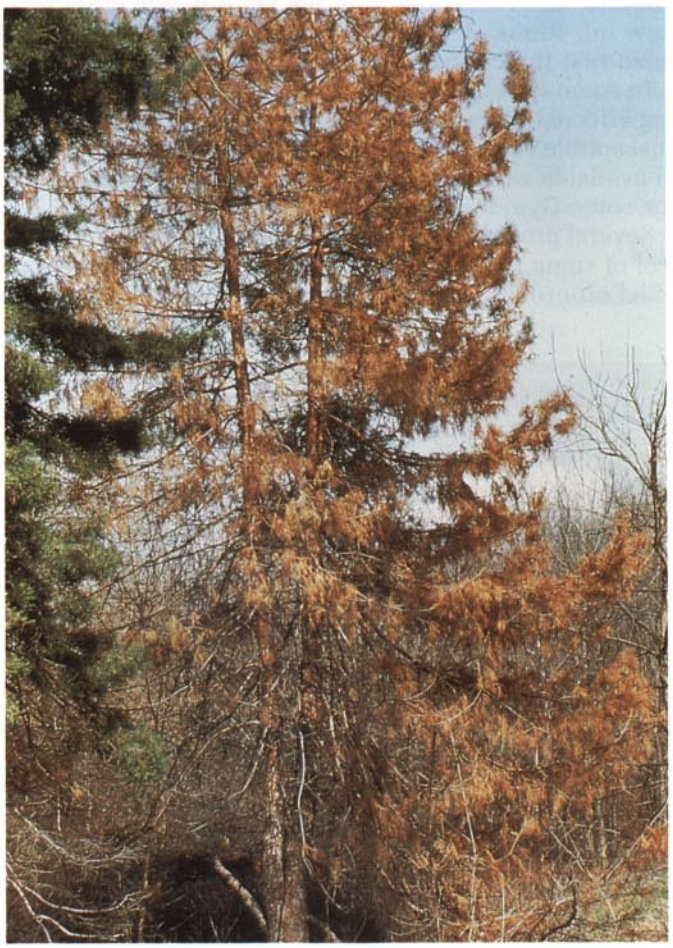


Figure 63–1. Scots pine tree showing brown foliage symptoms of pine wilt disease.

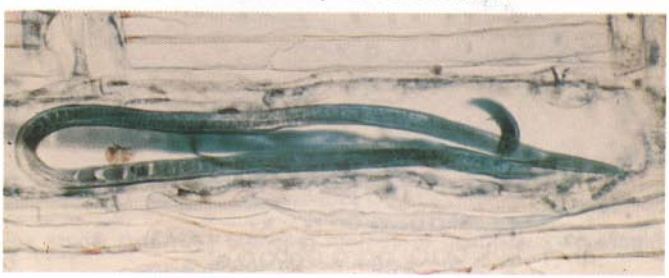
propagation phase of the life cycle (fig. 63–3). Under optimum conditions, growth of nematodes from eggs to adults is completed in 5 days. Within 4 to 5 weeks, infected pines exhibit reduced oleoresin flow and transpiration, and large numbers of nematodes are present throughout trees as wilting and yellowing of foliage become noticeable.

Trees die within 3 months after becoming infected. Nematodes continue to reproduce for several months on fungi, principally the blue stain fungi, that invade the dead trees. Nematode development then converts to a dispersal phase as the wood dries. During this phase, the nematodes molt from second-stage propagative larvae to third-stage dispersal larvae. These larvae contain high levels of lipids, are resistant to adverse environmental conditions, and do not feed. During early spring these larvae molt from the dispersal stage to the fourth larval stage, called dauer larvae. Cerambycid beetles are attracted to dying trees and oviposit in them. The cerambycid larvae, known as pine sawyers,bore into the wood, overwinter, and pupate in the spring. Dauer larvae of *B. xylophilus* enter adult beetles prior to their emergence. These beetles transmit the nematodes to healthy trees when they begin maturation feeding.

The development of pine wilt differs in the United States. *B. xylophilus* is carried by *Monochamus carolinensis, M. mutator,* M. *notatus, M. obtusus, M. scutellatus,*and *M. titillator* in the eastern United States. The principal vector in pine wilt appears to be *M. carolinensis* (fig. 63–4). Investigations in Minnesota, Wisconsin, and Iowa have shown that *B. xylophilus* is transmitted to dying trees and cut timber of native pine species by *M. carolinensis, M. scutellatus,* and *M. mutator* during oviposition. Thus *B. xylophilus* may be present in conifers dying as a result of any cause. This pattern of attack may explain the association of *B. xylophilus* with trees in the north-central region that are stressed by various pathogens and insects, but lack typical symptoms of pine wilt.

Figure 63–2. Maturation feeding by *M. alternatus* on Japanese black pine.

Figure 63–3. Longitudinal section of pine wood showing pinewood nematodes in pine resin canals.



Damage

Pine wilt poses a potential threat to susceptible species of pines, especially to Scots pines, growing on poor sites. Pine wilt is not a significant problem in native pine forests.

Control

Control measures are not justified in forest situations. In established landscapes, windbreaks, and Christmas tree plantings, destroy recently infected trees by cutting and burning to eliminate the breeding habitat of beetle vectors and to kill larvae and pupae of vectors before they emerge. Control known pathogens and insect pests of pines to avoid stressing trees and attracting vectors that could transmit nematodes to stressed trees during oviposition. In high value areas, keep trees well pruned of dead and diseased branches.

Selected References

Kondo, Eizo; Foudin, Arnold; Linit, Marc; Smith, Mike; Bolla, Robert; Winter, Rudy; Dropkin, Victor. Pine wilt disease—nematological, entomological, and biochemical investigations. Publication SR 282. Columbia: University of Missouri Agricultural Experiment Station; 1982. 56 p.

Malek, Richard B.; Appleby, James E. Epidemiology of pine wilt in Illinois. Plant Disease. 68: 180–186; 1984.

Wingfield, M. J.; Blanchette, R. A.; Nicholls, T. H. Is the pine wood nematode an important pathogen in the United States? Journal of Forestry. 82: 232–235; 1984.

Figure 63–4. *Monochamus carolinensis* is the principal vector of the pinewood nematode in the United States.