Indiana Pine Wilt Nematode Survey

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Introduction

The pine wilt nematode (or pinewood nematode, same common name) (*Bursaphelenchus lignicolus* Maymiya and Kiyohara [Nematode: Tylenchida: Apelenchoididae]) is a serious disease to black pine (*Pinus thunbergiana* Franco) and red pine (*P. densiflora* Sieb. and Zucc.) in Japan. As these pines are economically and aesthecially important in Japan, the scattered wilting and mortality to the forests and landscapes started research that proved *B. lignicolus* to be the causal agent (2). The research also found a long-horn beetle (*Monochamus alternatus*) to be the vector (3).

Dying pines, for which no cause of mortality could be found, have occurred in the United States. In Missouri in 1979, a sample from a wilting Austrian pine (*P. nigra* Arnold) was submitted to the Department of Plant Pathology at the University of Missouri. On the suggestion of a visiting Japanese professor of plant pathology, wood samples were soaked in water. Nematodes emerged from the wood and were identified as the pine wilt nematode (*B. lignicolus*). This was the first report of the nematode (*B. lignicolus*) in the United States. *B. lignicolus* also has been reported in France (1).

With this first report, it was questioned as to how widespread the pine wilt nematode (*B. lignicolus*) is in the United States. Also, it was questioned whether the pine wilt nematode (*B. lignicolus*) is in the United States. Also, it was questioned whether the pine wilt nematode (*B. lignicolus*) was introduced into the United States from Japan or vice-versa.

To help answer these questions, a survey of the state was started by the Department of Natural Resources, Division of Forestry to determine the host range and distribution of the pine wilt nematode (*B. lignicolus*). This paper describes the survey and reports the results to date.

Methods and Materials

Foresters in the Division of Forestry were asked to conduct the survey. They were given a training program and hand book on how to conduct the survey. When a forester observed a dying or dead pine tree, he would take increment core, wood chips, or branch sample and submit the sample to the forest pest specialist for determination of the pine wilt nematode (*B. lignicolus*). Information collected by the forester on the sampled tree included, county, township, range, section, species of tree, age, DBH, height, location, description of site and adjacent trees, presence of bark beetles in the tree and submission of specimens, if possible, estimate of time since tree death, and any stress factors on the tree. The Division of Entomology also conducted the survey through their field entomologists. The entomologists submitted samples and similar information as did the foresters to the forest pest specialist or to the state entomologist.

Samples submitted to the forest specialist and state entomologist were soaked

in water for 12 to 24 hours to extract nematodes. Nematodes collected were submitted to the U.S.D.A., Animal and Plant Health Inspection Service for identification and confirmation of the pine wilt nematode (*B. lignicolus*).

Results of the survey are reported to the foresters, entomologists, and U.S. Forest Service.

Results

The pine wilt nematode (*B. lignicolus*) has been identified, to date, from 23 counties and confirmed by a nematologist from 14 of the 23 counties (Table 1). The survey to date has received samples from 48 counties. Eight pine species, Northern white cedar (*Thuja occidentalis*) and Eastern hemlock (*Tsuga canadensis*) have been sampled. Eastern white pine (*P. strobus*) is the only pine of the eight species not having pine wilt nematode (*B. lignicolus*) identified from it in Indiana (Table 1). The survey has sampled 185 trees from the 48 counties. The number of trees sampled by species are follows: pines - scotch (*P. sylvestris*), 114; red (*P. resinosa*), 25; eastern white (*P. strobus*), 6; Virginia (*P. virginiana*), 3; mugho (*P. mugo*), 4; shortleaf (*P. echinata*), 2; jack (*P. banksiana*), 11; Austrian (*P. nigra*), 7; and *Pinus* species, 11. Northern white cedar (*T. occidentalis*), 1. eastern hemlock (*T. canadensis*), 1.

TABLE 1: *Distribution of Pine wilt nematode, Bursaphelenchus lignicolus, in Indiana by county and host as of October, 1980.*

COUNTY	HOST
Boone[1]	*Pinus mugo*
Clark	*P.* spp.
Fulton	*P. sylvestris*
Grant[1]	*P. sylvestris*
Hamilton[1]	*P. sylvestris*
Harrison	*P. sylvestris, P. virginiana*
Hendricks[1]	*P. sylvestris*
Jasper[1]	*P. banksiana*
Jennings	*P. sylvestris, P. echinata, P. banksiana*
Johnson[1]	*P. sylvestris, P. resinosa*
Lake	*P. resinosa*
Lawrence	*P. sylvestris*
Marion	*P. nigra, P. sylvestris*
Martin	*P. sylvestris*
Orange	*P. virginiana, P. resinosa*
Perry	*P. sylvestris*
Pike	*P. sylvestris*
Porter	*P. sylvestris*
Pulaski	*P. sylvestris*
Putnam[1]	*P. sylvestris*
St. Joseph[1]	*P. sylvestris*
Shelby[1]	*P. resinosa*
Tippecanoe	*P. sylvestris*

[1]The nematodes found are identified as pine wilt nematode, but not confirmed by a nematologist.

Of these trees sampled, the number identified with pine wilt nematode (*B. lignicolus*) are as follows: pines - scotch (*P. sylvestris*), 24 (15 confirmed); red (*P. resinosa*), 4 (2 confirmed); Virginia (*P. virginiana*) (1 confirmed); mugho (*P. mugo*), 1 (not confirmed); shortleaf (*P. echinata*), 1 (1 confirmed); jack (*P. banksiana*), 2 (1 confirmed); Austrian (*P. nigra*), 1 (1 confirmed); and *Pinus* species, 1 (1 confirmed).

An additional 30 samples have nematodes collected from them, but not identified at this time.

No collection of pine wilt nematode (*B. lignicolus*) from an insect has been made. Nematodes were collected from under the elytra of a pine engraver (*Ips* spp.) but they were not the pine wilt nematode (*B. lignicolus*). *Ips* bark beetles, cerambycid larvae, and weevil larvae were reported from 38.9 percent of the trees sampled (Table 2). 25.7 percent of the samples having pine wilt nematode (*B. lignicolus*) had one of the above insects infesting the tree. Excluding the 30 samples the samples without pine wilt nematode (*B. lignicolus*) had 25 percent with one of the above insects infesting the tree. 12.8 percent of the samples with another nematode species present had one of the above insects infesting the tree. 12.1 percent of the samples without any nematodes had one of the above insects infesting the tree. 70 percent of the 30 samples to be identified have one of the above insects infesting the tree.

TABLE 2: *Number and percent of samples with or without bark beetles by presence or absence of nematodes.*

Bark beetles	P W N Positive		Other Nematodes Present		No Nematodes Present		Total	
Yes	#	%	#	%	#	%	#	%
Yes	9	25.7	41	63.1	22	25.9	72	38.9
No	8	22.8	16	24.6	35	41.1	59	31.9
No Report	18	51.4	8	12.3	28	15.1	54	29.2
Total	35	100.0	65	100.0	85	100.0	185	100.0
		18.9		35.1		45.9		100.0

No significant stress factors were reported for the trees sampled. Trees sampled ranged from one year dead to alive and averaged 6 months dead. No time after death was common for recovery of nematodes or the pine wilt nematode (*B. lignicolus*). Three trees with pine wilt nematode (*B. lignicolus*) were alive when sampled with the other trees ranging from 1 week to 1 year dead. These three trees did not have bark beetles attacking them. However, two of the trees were scotch pine (*P. sylvestris*) and found to be infested by Northern pine weevil (*Pissodes approximatus*). Trees not identified with the pine wilt nematode (*B. lignicolus*) ranged from alive to one year dead when sampled.

Sampled trees ranged in age from 6 to 120 years and averaged 27 years. Diameter ranged from 2 to 22 inches and averaged 8 inches. Height ranged from 3 to 80 feet and averaged 42 feet.

Discussion

The pine wilt nematode (*B. lignicolus*) is widespread in Indiana as indicated by being reported from 23 counties and seven pine species. The pine wilt nematode (*B. lignicolus*) is expected to be found in all Indiana counties and pine species eventually. The pine wilt nematode (*B. lignicolus*) is also widespread in the United States (Table 3) on seventeen pine species (Tabe 4) (4). This information helps to answer the questions of how widespread the nematode (*B. lignicolus*) is. Apparently the nematode (*B. lignicolus*) has been overlooked in the past because of lack of knowledge regarding it. The question still remains to be answered whether the nematode (*B. lignicolus*) came from Japan or was introduced into Japan.

The survey has not found any vectors; although the southern pine sawyer (*Monochamus titillator*) has been proven to be a vector in Iowa (5). The *Ips* bark

TABLE 3: *Distribution of Pine wilt nematode, Bursaphelenchus lignicolus, in the United States -October, 1980*[2].

Alabama	Missouri
Arkansas	Nebraska
California	New York
Florida	North Carolina
Illinois	Ohio
Indiana	Oklahoma
Iowa	Pennsylvania
Kansas	South Carolina
Kentucky	Tennessee
Louisiana	Texas
Maryland	Vermont
Michigan	Virginia
Minnesota	West Virginia
Mississippi	Wisconsin

[2]Personal Communication, Kathryn Robbins, Pathologist, U.S., Forest Service, St. Paul, Minnesota.

beetles may be vectors but it is unlikely as they do not enter the wood where it would be easier to contract the nematode (*B. lignicolus*). More insects need to be examined than have been examined by the survey to date for possible vectors.

The *Ips* bark beetles reported in sampled trees may be the actual killers of the trees. The summer of 1980 was hot and dry in Indiana which encourages a build-up of the *Ips* bark beetles. 18.9 percent of the trees sampled were found with pine wilt nematode (*B. lingnicolus*) and 25.7 percent of these trees were infested with *Ips* bark beetles. 34 percent of the trees without pine wilt nematode (*B. lignicolus*) were infested with *Ips* bark beetles. Thus, 52.9 percent of the trees had a determined cause of death with 14.0 percent attributed to pine wilt nematode (*B. lignicolus*), 4.9 percent to *Ips* bark beetles and pine wilt nematode (*B. lignicolus*), and 34 percent to *Ips* bark beetles. Also, the percent of those infested with *Ips* bark beetles increased in the late summer to 70 percent (26% of the last 37 trees sampled). Thus, *Ips* bark beetles may be the primary cause of mortality; but the relationship of the pine wilt nematode (*B. lignicolus*) and *Ips* bark beetles needs to be examined further.

TABLE 4: *Hosts of Pine wilt nematode, Bursaphelenchus lignicolus, in the United States - October, 1980*[3].

Jack pine	*Pinus banksiana*
Swiss Stone pine	*Pinus cembra*
Sand pine	*Pinus clausa*
Sierra Nevada lodgepole pine	*Pinus contorta* var. *murrayana*
Shortleaf pine	*Pinus echinata*
Slash pine	*Pinus elliottii*
Mugho pine	*Pinus mugo*
Austrian pine	*Pinus nigra*
Longleaf pine	*Pinus palustris*
Ponderosa pine	*Pinus ponderosa*
Monterey pine	*Pinus radiata*
Red pine	*Pinus resinosa*
Eastern white pine	*Pinus strobus*
Scotch pine	*Pinus sylvestris*
Loblolly pine	*Pinus taeda*
Japanese black pine	*Pinus thunbergiana*
Virginia pine	*Pinus virginiana*

[3]Personal communication, Kathryn Robbins, Pathologist, U.S. Forest Service, St. Paul, Minnesota.

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