

## The Occurrence and Prevalence of Oak Wilt in Indiana<sup>1</sup>

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The oaks are the most numerous species of trees in Indiana and are commercially the most important. Seventeen species are listed as native to Indiana by Deam (3). There are 4.1 million acres of forests and approximately 1,000 sawmills in the state. The production of native grown lumber in 1949 was 183 million board feet and the oaks made up about 45% of this production. Two-thirds of the lumber was produced in southern Indiana. Oak species comprised 1,422,000,000 cubic feet of sound wood in commercial forest land in Indiana in 1950 (4).

Oak wilt, caused by *Ceratocystis fagacearum* (Bretz) Hunt, was first reported in Indiana near Gary in 1949 by Cummins (2) and later by Carter and Kuny (1). Surveys conducted by Stearns and Crowder (6) throughout the state from 1952-1956 established the general distribution of the disease. In 1955, Schuder (5) reported the occurrence of oak wilt in 39 of the 92 counties of the state. These investigations established that oak wilt is widespread and destructive in the northwestern and north-central counties of the state, while infection centers in the southern part of the state are scattered and generally not as large as those in the northern areas.

In order to evaluate the significance of oak wilt in the commercially important southern areas of Indiana, the following phases of the epidemiology were studied.

1. The comparative incidence of oak wilt in southern and northern Indiana and the prevalence of this disease among the various oak species.
2. The relative rates of spread of oak wilt in selected infection loci in the northern and southern areas of the state.
3. The occurrence and prevalence of the ascigerous stage of *C. fagacearum* and associated known insect vectors as an indication of potential long distance spread of oak wilt.

### Surveys and Selection of Observation Areas

Road surveys were made throughout the state during 1957 of the distribution of oak wilt and to locate areas of infection where studies could be made of (1) the comparative rates of spread of this disease within infection loci and (2) the incidence and time of development of mycelial mats and pads (ascigerous stage) of the pathogen. Areas were selected that differed in size, dominant oak species, topography and soil. Difficulty was encountered in the northwestern counties of the state because in many locations the disease had killed most of the red-black oak species.

The initial size of each observation area was established by measuring the area occupied by trees killed prior to 1957. The red-black

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and white oak groups per acre were determined by counts in three 1/10 acre plots, selected at random. An Edscoep 6" Field Range Finder was used to measure the plots and the population counts represent the mean of 3 samplings.

An infection locus is defined as an area of active infection occurring beyond the range of natural root grafts (50 ft. or more) from any other area of infection. Frequently, there were several infection loci within one observation area.

All trees exhibiting oak wilt symptoms were sampled, using a Swedish increment hammer, and the stem increments were placed in petri

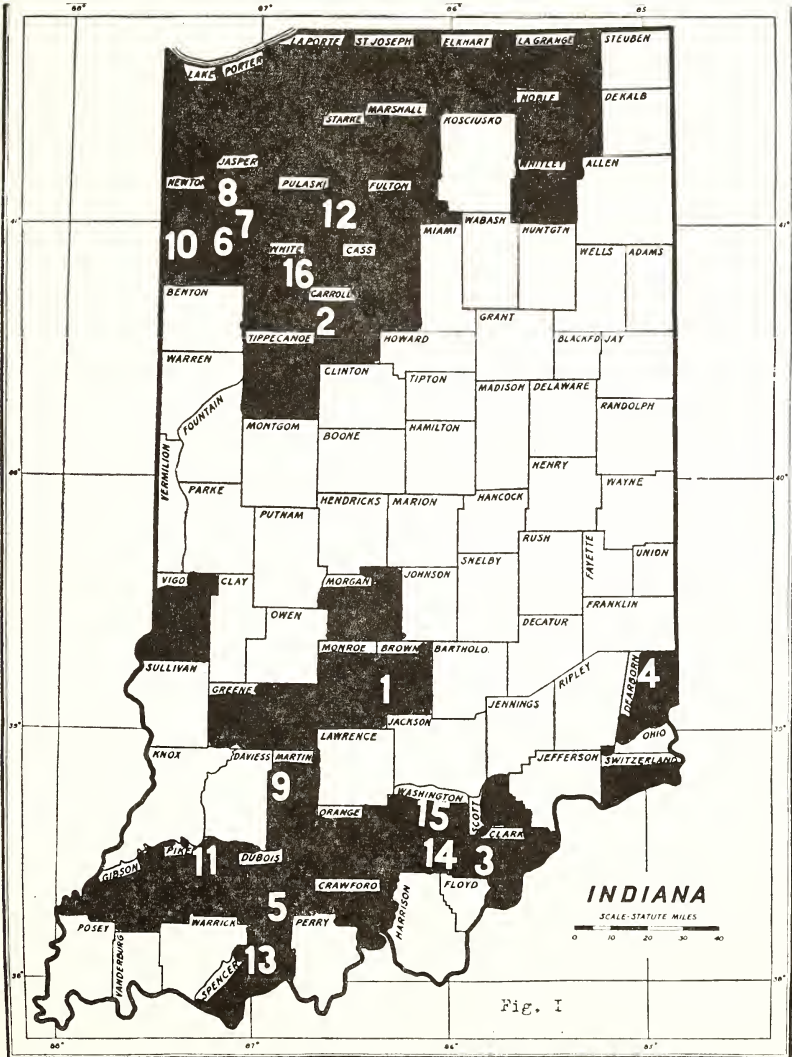


Fig. 1. Distribution of oak wilt in Indiana by counties to September, 1957, and location of 16 oak wilt observation plots.

dishes containing acidified potato dextrose agar (pH 4.0-5.0) and observed for the presence of the pathogen. Each tree sampled was marked and the date of sampling and species recorded.

The present known distribution of oak wilt in Indiana, by counties, and the 16 observation areas used in the studies of the rate of spread of this disease are shown in fig. 1. Oak wilt is reported for the first time in Clark, Gibson, Orange, Pike, Spencer, and Switzerland counties, all located in the southern part of the state. The disease has now been reported from 45 counties in the state of which 35 have been confirmed by culturing the pathogen.

During 1957, the oak wilt pathogen *C. fagacearum* was isolated from the following oak species: *Quercus palustris*, 78 trees; *Q. velutina*, 26 trees; *Q. rubra*, 32 trees; *Q. ellipsoidales*, 6 trees; *Q. imbricaria*, 1 tree; and *Q. alba*, 1 tree. It will be noted that oak wilt occurs predominately in the red-black oak group and is rarely found among the white oak species in Indiana.

#### Comparison of Rates of Spread of Oak Wilt in Northern and Southern Indiana

The comparative rates of spread of oak wilt in northern and southern Indiana were considered by 2 methods. (1) The number of trees infected during the period June 1, 1957, to July 1, 1958, in an area 50 ft. wide around each infection locus was compared to the total population of oak of each group within this area. By this means the actual incidence of oak wilt could be determined. (2) A ratio was made between the potential area of new infection resulting from trees infected during 1957-58 and the total area of the infection locus. Each infected tree on or near the perimeter of the infection locus became the center of a new area of potential infection with a radius of 50 ft. It was assumed that all oaks within the 50 ft. radius of the newly infected tree would eventually become infected via natural root grafts.

TABLE 1

A comparison of the percentage of oaks infected by oak wilt and the areas of potential new infection as a percent of the total area in 16 observation plots in northern and southern Indiana from June 1, 1957, to July 1, 1958.

Observation Area and Loci	Red-Black Oaks/Acre	White Oaks/Acre	% Oaks Infected	% of Areas of Potential New Infection
<b>Northern Indiana</b>				
2—Carroll Co.				
locus—a	140	...	5.0	78.8
" —b	140	...	7.0	97.1
" —c	140	...	5.5	62.7
6—Jasper Co.	200	30	6.3	30.9
7—Jasper Co.	170	...	4.3	35.7
8—Jasper Co.				
locus—a	140	40	2.7	77.2
" —b	140	40	16.0	97.6
10—Newton Co.	180	10	1.9	27.7

(Table 1 (cont'd.))

Observation Area and Loci	Red-Black Oaks/Acre	White Oaks/Acre	% Oaks Infected	% of Areas of Potential New Infection
12—Pulaski Co.				
locus—a	220	90	7.3	47.3
“ —b	220	90	4.6	41.2
“ —c	220	90	1.2	41.5
“ —d	220	90	1.9	65.7
“ —e	220	90	1.4	68.8
“ —f	220	90	5.6	56.5
16—White Co.				
locus—a	180	...	4.3	77.5
“ —b	180	...	18.8	Only 1 oak died prior to 1957
Mean			6.02	62.6a
<b>Southern Indiana</b>				
1—Brown Co.	2108	50	6.0	85.7
3—Clark Co.	30	60	22.2	96.6
4—Dearborn Co.				
locus—a	270	...	1.2	95.5
“ —b	270	...	2.8	92.6
5—Dubois Co.	60	50	9.1	Only 1 oak died prior to 1957
9—Martin Co.	No oaks died prior to 1957			
11—Pike Co.	70	120	2.4	38.1
13—Spencer Co.	30	240	5.6	Only 1 oak died prior to 1957
14—Washington Co.	200	80	5.4	72.8
15—Washington Co.				
locus—a	200	...	3.3	24.5
“ —b	200	...	2.1	55.3
Mean			6.01	70.1a

a Not significantly different at 5% level.

The results of these studies are presented in table 1. It will be noted that the actual rate of spread of oak wilt is relatively slow, based upon total oak populations in the various infection loci. However, the increase in potential area of new infection is much greater. These results indicate that there is no significant difference in either the actual rate of spread of oak wilt or the potential rate of spread of this disease in the northern and southern parts of Indiana.

#### Occurrence and Prevalence of the Ascigerous Stage of *C. fagacearum* and Associated Known Insect Vectors

The overland or long distance spread of oak wilt is apparently due to the dissemination of inoculum by various insect vectors. Observations were made during Sept.-Oct., 1957, and April-May, 1958, of trees killed by oak wilt during 1957 to determine the presence and prevalence

of the ascigerous stage (mycelial mats and pads) of *C. fagacearum*. This spore stage occurs only on recently killed trees and can be detected by cracks in the bark caused by pressure exerted by the mycelial pad produced by the pathogen. Insect collections were made from the area of the spore-producing surfaces.

The first observation of the ascigerous stage of *C. fagacearum* in Indiana was made near Parr, in Jasper County, on May 1, 1957. Subsequent studies in selected observation areas revealed that this spore stage occurred on 12.2% of the trees killed during the previous growing season. Mycelial mats and pads occurred on 8.7% of the trees observed in the northern areas and 29.2% in the southern areas of the state.

Insect collections were made in May, September and October, 1957, throughout the state. These collections included species from the following: Order *Coleoptera* fam. *Buprestidae*, *Staphylenidae*, *Colydiidae*, *Histeridae*, *Ostomatidae*, *Orthoperidae*, *Mycetopagidae*, *Cucurijidae*, *Cerambycidae*, *Nitidulidae* and *Scolytidae*; Order *Diptera* fam. *Lonchaeidae*; Order *Hymenoptera* Fam. *Braconidae* and *Siricidae*. Included were numerous species reported by other investigators to be known vectors of the oak wilt pathogen, principally in the order *Coleoptera* fam. *Nitidulidae* and *Scolytidae*.

### Summary and Conclusions

1. These studies confirm earlier reports that oak wilt is at present more widespread and destructive in the north-western and north-central counties of Indiana than in other parts of the state. However, the disease is more prevalent in southern counties than previously reported. In addition, oak wilt occurs predominately among the red-black oak group and is rarely found infecting members of the white oak group. The reason for this is not apparent, since the disease is known to infect both groups in other regions.

2. The rate of spread of oak wilt in Indiana is comparatively slow, when considered on the basis of total oak populations. It should be emphasized, however, that the potential spread is much greater. This conclusion is based upon the fact that all of the oaks of the same group within a 50 ft. radius of an infected tree may eventually become infected through naturally occurring root grafts.

The results presented also indicate that there is no significant difference in either the actual or potential rates of spread of oak wilt in northern and southern areas. Presumably, the explanation for the lower incidence of this disease in southern Indiana, at present, is that the pathogen was introduced into this area at a later time. There are 2 distinct areas of infection in the state (fig. 1) with a section through the central region where oak wilt has not been reported to occur. It is suggested that oak wilt may have been introduced into southern Indiana from contiguous infection centers in Kentucky and Ohio that are of more recent origin than the areas in the northern part of the state.

3. The importance of the ascigerous stage of *C. fagacearum* in the long distance spread of oak wilt in Indiana is not known. These

studies show that this spore stage of the pathogen is found throughout the state wherever oak wilt has been reported and that insect vectors known to disseminate this inoculum are also present.

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