

PHYTOPATHOLOGICAL NOTES

A Numerical Index for Rating Trees with Oak Wilt

Robert L. Anderson and Oscar H. Calvert

Former Research Assistant and Associate Professor, respectively, Department of Plant Pathology, University of Missouri, Columbia 65201.

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A quantitative disease index was developed for rating trees with oak wilt incited by *Ceratocystis fagacearum* (Bretz) Hunt. The utility of this index was demonstrated using trees exhibiting various stages of the disease. The index is the product of the percentage of the individual plant showing various types of leaf symptoms times a numerical value assigned to each type of leaf symptom in ascending order of occurrence.

Oak wilt-infected trees usually show a progression of symptoms from wilted leaves to defoliation. The symptoms rarely develop uniformly over the trees, and it is difficult to compare the relative extent of disease development among many plants. The index is useful for rating single trees and for obtaining averages for several trees. To obtain the disease index from a symptom rating and per cent of tree affected, notes are taken as follows. After considerable observation, we found that most infected trees fell naturally into three classes according to the distribution of symptoms. Trees

in class I were divided into an upper 10% zone (A) and a lower 90% zone (B), each with characteristic symptoms; in class II, into an upper 50% zone (A) and a lower 50% zone (B); and in class III, the entire tree or 100% zone. The degree of symptom development of the leaves was classified into four categories: 1 = leaves wilting; 2 = leaves partially dead; 3 = leaves dead and brown; and 4 = leaves fallen. The zone percentage multiplied by the number assigned to the symptom category equaled the index for the zone. For intermediate zone indexes, we assigned averaged values as shown in Table 1, which gives all possible combinations. To obtain the disease index for each tree, the index for zone A is added to the index for zone B. For example, a tree of class I expressing all 4 symptoms in zone A, for an index of 33, and expressing symptom 1 in zone B, for an index of 90, has a disease index of 123 (33 + 90).

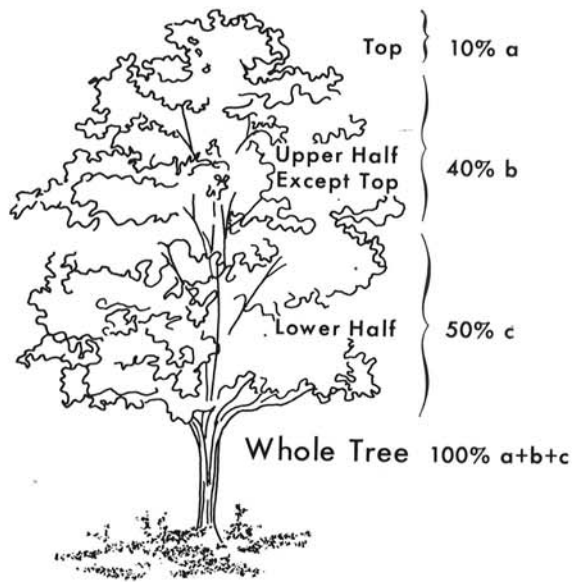
This method of calculating a disease index permits the observer to follow the progression of disease in an individual tree during the season as well as to make comparisons between plots and among replicates.

Table 2 presents indexes for 20 five-tree plots inoculated on two dates with four single strains of *C. fagacearum* and the six possible paired combinations (half and half mixtures of equal numbers of endospores) of each of the four strains. The tree plots were established in the Sinkin Experimental Forest in Missouri, and were observed four times at 21, 35, 48, and 62 days after inoculations. We make three conclusions from the data: (i) Observations of the test trees indi-

TABLE 1. Reference table of disease index values for rating *Quercus coccinea* trees with oak wilt in the Sinkin Experimental Forest

Class and % of tree affected	Numerical degree of symptom development ^a and index values			
Class I	Zone A		<i>upper 10% of tree</i>	
	(10)	(1) = 10		
	(10)	(1-2) = 15	(2) = 20	
	(10)	(1-3) = 24	(2-3) = 27	(3) = 30
	(10)	(1-4) = 33	(2-4) = 36	(3-4) = 38
				(4) = 40
	Zone B		<i>lower 90% of tree</i>	
	(90)	(1) = 90	(2) = 180	
	(90)	(1-2) = 135	(2-3) = 240	(3) = 270
	(90)	(1-3) = 210	(2-4) = 315	(3-4) = 338
(90)	(1-4) = 293		(4) = 360	
Class II	Zone A		<i>upper 50% of tree</i>	
	(50)	(1) = 50	(2) = 100	
	(50)	(1-2) = 75	(2-3) = 133	(3) = 150
	(50)	(1-3) = 116	(2-4) = 175	(3-4) = 187
	(50)	(1-4) = 163		(4) = 200
	Zone B		<i>lower 50% of tree</i>	
	(50)	(1) = 50	(2) = 100	
	(50)	(1-2) = 75	(2-3) = 133	(3) = 150
	(50)	(1-3) = 116	(2-4) = 175	(3-4) = 187
	(50)	(1-4) = 163		(4) = 200
Class III	No zones		<i>100% of tree</i>	
	(100)	(1) = 100	(2) = 200	
	(100)	(1-2) = 150	(2-3) = 267	(3) = 300
	(100)	(1-3) = 233	(2-4) = 350	(3-4) = 375
	(100)	(1-4) = 325		(4) = 400

^a 1 = Leaves wilting; 2 = leaves partially dead; 3 = leaves dead and brown; 4 = leaves fallen from tree, multiplied by per cent of tree affected equals index values.



cated insignificant variations in the pathogenicity of three of the four fungal strains, and the indexes were relatively lower whenever the B gray strain was used alone or in a mixture for the inoculum; (ii) there was a marked and progressive increase of the disease indexes from the first observation, made 21 days after inoculation, to the last made 62 days after inoculation; and (iii) the indexes for 21 and 35 days after inoculation were not so high for the June as for the May inoculations, as shown by t-tests, but for observations made 48 and 62 days after inoculation, there were no apparent differences.

Plant pathologists frequently need to determine the relative extent or rapidity of wilt development. In a diseased plant we may note that individual leaves display a variety of symptoms ranging from slight departure from the healthy condition to complete death. Equally important is the distribution of symptoms. A plant with one dead leaf and no other symptoms differs from a plant with no dead leaves but many wilted ones. Our index combines both of these parameters, and was quickly and easily calculated. In addition, we found

TABLE 2. Average disease indexes of wilt at different observation dates of *Quercus coccinea* inoculated with *Ceratomyces fagacearum*

Inoculation date	Days after inoculation with endoconidia			
	21 days	35 days	48 days	62 days
Average disease index combining 4 single strains and 6 paired strains				
May	227 ^a	315	328	335
June	156 ^{**b}	260 ^{**b}	301	332
Average disease index combining both inoculation dates				
Single strains				
A albino	182 ^c	299	325	325
B albino	192	284	343	361
A gray	159	270	292	329
B gray	107 ^{**b}	200 ^{**b}	218 ^{**b}	241 ^{**b}
Paired strains				
A albino + B albino	270	342	351	353
B albino + A gray	247	304	340	360
A albino + A gray	229	319	340	341
B albino + B gray	171 ^{**b}	278	301	328
A gray + B gray	153 ^{**b}	278	290	305
A albino + B gray	128 ^{**b}	229 ^{**b}	286	314

^a Average of 50 trees.

^b ** = Significant at the .01 level (t-test for paired values within each observation period).

^c Average of 10 trees.

this index a good measure to indicate differences in disease among trees infected with *C. fagacearum*.

We believe the described index may be valuable for use with other plant diseases where leaf wilting occurs. By determining the percentage of the plant associated with a given set of symptoms and assigning numbers to the successive variations in symptoms, a table such as Table 2 can be calculated for a given disease. With such tables, quantitative estimations of disease development can be made.