Chemical Control of Rhabdocline Needle Cast of Douglas-Fir

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ABSTRACT

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Rhabdocline needle cast of Douglas-fir Christmas trees was studied in Michigan in 1975–1976. Apothecia matured between 14 May and 4 June, with infected needles cast from 4 June until 17 July and later. Benomyl provided good disease control, ferbam and chlorothalonil were variable, whereas maneb and Bordeaux mixture were less effective. Fungicides were effective when applied by 4 June but were ineffective when applications were delayed until 26 June. Chlorothalonil application by mist blower was as effective as dip application. Disease control evaluations were equally reliable when made in the fall or spring.

Additional key words: epidemiology, *Pseudotsuga menziesii*

Rhabdocline needle case of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), caused by *Rhabdocline pseudotsugae* (Syd.), has been known in the United States since 1917 (7). The disease was later reported in New York (1) and Pennsylvania (6) and only recently has been reported in Minnesota, Wisconsin, and Michigan (3). Limited data have been presented on disease impact (3). Information on chemical control of the disease is limited to reports of the effectiveness of ferbam, lime sulfur (1), copper-lime (2), and some antibiotics (1,8,9). Brandt (1) reported that evaluations made in the spring are more reliable than those made in the fall because symptoms are more completely expressed in the spring.

The objective of this paper is to summarize our work on chemical control of the pathogen.

MATERIALS AND METHODS

The study was conducted during 1975–1976 in a commercial Douglas-fir plantation near Harbor Springs, MI. The stand comprised 16 ha of 15-yr-old, 6- to 10-ft-tall trees now at a density of 1,200 trees per hectare. The seed source was unknown.

Trees or branches that showed uniform, heavy natural infection, but on which buds were well formed for expansion the following year, were selected for each treatment within a single row. This was thought to minimize variation in disease resistance and bias in selecting branches for fungicidal evaluation. All trees and branches were tagged for their location and treatment. To evaluate treatments, terminal twigs were removed, allowing later evaluation of lateral twigs if needed. Disease was considered present when characteristic mottled spots or apothecia were found.

To evaluate host phenology and disease development, 15 scattered trees were selected for periodic evaluation. On each of four dates, a preselected 1-yr-old shoot from each tree was examined for apothecia, shoot elongation, and casting of 1-yr-old needles.

To study chemical control, the treatment design consisted of 10 trees per treatment, each with one preselected branch. In some cases, different fungicides were applied to different branches of a single tree by a dip treatment; however, when benomyl was applied using this technique, a separate tree was used for each dip treatment. Check branches were also selected on individual trees, and in some cases separate check trees were used. Controls were treatments with water plus an adjuvant and no treatment. The fungicides and rates (gram of formulated product per liter of water) were benomyl (50% WP; 5.1 g), Bordeaux mixture (12% copper; 8.0 g), chlorothalonil (60% F; 2.2 g), maneb (80% WP; 1.8 g), and ferbam (76% WP; 3.6 g). A spreader-sticker (Black Leaf) was added at a concentration of three drops per liter. In 1975, fungicides were applied three times by mist blower at 0.3 gal per tree at 3-wk intervals beginning 31 May. In 1976, they were applied by dipping foliage four times at 3-wk intervals beginning 14 May. Ferbam was substituted for Bordeaux mixture in 1976.

To test the comparative effectiveness of fall and spring disease control evaluations, eight fungicidal treatments were evaluated on the same trees in the fall of 1976 and the spring of 1977 by separate investigators.

The method of applying fungicides was compared because this differed between 1975 and 1976. Ten trees were treated with chlorothalonil. To avoid overlapping treatments, the left portion of each tree was treated by mist blower, whereas single branches on the right side of the trees were treated by dipping. Any "blow-through" of the fungicide did not affect the portion of the tree to be dipped but passed into a buffer area.

Four different dates were selected to cover the range of phenology of the plant and parasite. Chlorothalonil was applied in various combinations of frequency and dates. To test control with minimum effort and materials, three fungicides were applied to trees via a single application on different dates. Chlorothalonil, ferbam, and benomyl were applied to 10 trees on four dates by dipping. All needles on a single preselected shoot were examined on each tree. Temperature and relative humidity conditions necessarily varied at the time of fungicide application during the 2-yr, multiseason test period, but applications were made only on low wind and rainless days. In all cases, the water-fungicide suspensions were observed to dry on the foliage. The percentage of disease-free needles was determined and data analyzed by analysis of variance.

RESULTS

Phenology. New shoot elongation had not begun by 14 May, but it did on all trees by 4 June. Apothecia were evident

Table 1. Efficacy of five fungicides for control of Rhabdocline needle cast of Douglas-fir

Treatment	Disease-free needles (%)[z] 1975	1976
Benomyl	83 a[z]	92 a
Chlorothalonil	66 a	79 ab
Maneb	11 b	79 ab
Bordeaux mixture	2 b	···
Ferbam	···	78 ab
Check: no treatment	0 b	59 b
Check: adjuvant	···	64 b

[z]Values followed by a common letter are not significantly different ($P = 0.05$).

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Table 2. Effect of application date and time of evaluation on control of Rhabdocline needle cast of Douglas-fir using chlorothalonil, 1976

Application dates				Disease-free needles (%) when evaluated	
14 May	4 June	26 June	17 July	Fall	Spring
X	X	X	X	86 a[y]	83 a NS*[z]
...	X	X	X	88 a	86 a NS
X	X	X	...	94 a	83 a NS
X	X	...	...	92 a	93 a NS
X	...	...	...	92 a	...
...	...	...	X	63 b	60 b NS
...	...	X	X	44 b	43 b NS
Check: no treatment				40 b	50 b NS

[y]Values followed by a common letter are not significantly different ($P = 0.05$).
[z]*NS indicates nonsignificance ($P = 0.05$) between adjacent values.

Table 3. Efficacy of a single application of various fungicides for control of Rhabdocline needle cast of Douglas-fir, 1976

Treatment	Disease-free needles (%) when applied			
	14 May	4 June	26 June	17 July
Chlorothalonil	77 a[y]	86 a	56 a	57 a
Ferbam	56 a	91 a*[z]	47 a	65 a
Benomyl	78 a	94 a*	73 a	63 a
Check: no treatment	71 a	59 b	44 a	59 a

[y]Values in the same column followed by a common letter are not significantly different ($P = 0.05$).
[z]*Denotes values that are significantly different from all other values for the same fungicide on different dates.

on 1-yr-old needles on 13 of 15 and 15 of 15 trees by 14 May and 4 June, respectively. Apothecial maturation (swelling), development of an apothecial flap, and asci and ascospores were absent on 15 May but present on 15 of 15 trees by 4 June. One-year-old needles were cast beginning 4 June, with 5 of 15 and 10 of 15 trees casting needles by 26 June and 17 July, respectively.

Fungicides. Benomyl and chlorothalonil significantly reduced the amount of disease in 1975, which was a particularly severe disease year. However, only benomyl controlled the disease in 1976 (Table 1).

Fall and spring evaluations of disease control appeared to be equally reliable (Table 2). Also, there was no significant difference in the amount of disease control using the two application techniques; dipped and sprayed branches showed 85 and 78% disease-free needles, respectively.

Delaying the first application of chlorothalonil, ferbam, or benomyl until 26 June or later resulted in an increased disease level that was not significantly different from the untreated check (Tables 2 and 3). Applications with any of the three fungicides as early as 14 May gave ambivalent results. However, the first (Table 2) or a single (Table 3) application on 4 June generally gave significantly improved control over checks.

DISCUSSION

Field observations have shown Rhabdocline needle cast to be more prevalent than previously thought in the northern Lower Peninsula of Michigan. However, other investigations (3–5) throughout the state have shown the disease to be absent over the rest of the Lower Peninsula.

Phenological observations indicate that the apothecia form well in advance of needle elongation and bud burst but that they mature about the time when needles emerge from the elongated shoot. Infected, 1-yr-old needles are cast later in the summer after major periods of infection.

Three fungicides showed activity against Rhabdocline needle cast. Benomyl was consistently efficacious in three of three trials. Further interpretation of efficacy data must be done carefully. Chlorothalonil appeared effective in three of four tests and ferbam in one of two tests. Most reliability is placed on the 1975 tests (Table 1), where heavy natural infection increased severity and which showed acceptable control by chlorothalonil but ineffective control by maneb and Bordeaux mixture. In 1976, ferbam gave some control when tested by dipping but appeared ineffective when tested by spraying. Apparently the level of natural inoculum plays a considerable role in fungicide efficacy, but artificial inoculation techniques have not been developed.

Based on spray schedule experiments, disease control can be expected with applications of selected fungicides when the materials are applied at the time of shoot elongation (4 June in this locale). When applied as early as 14 May, the preformed needles may still be protected (Table 2). However, if the first or only application is delayed until 3 wk after shoot elongation and apothecial maturation (26 June), infection has probably taken place and disease expression is not reduced.

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