Control of Swiss Needle Cast on Douglas-Fir Christmas Trees with Aerial Applications of Chlorothalonil

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ABSTRACT

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The effectiveness of helicopter applications of chlorothalonil in controlling Swiss needle cast on sheared Douglas-fir Christmas trees was compared with backpack mist-blower applications in four plantations in western Washington. Chlorothalonil (Bravo 500F, 500 g a.i./L) was applied at 2.35, 4.7, and 9.4 L/ha by mist blower and 4.7 and 9.4 L/ha by helicopter. Aerial and mist-blower applications were applied in the equivalent of 93.5 and 374 L of water per hectare, respectively. Applications were made on 4 or 5 June and/or 30 June. A single early mist-blower application at all rates tested provided effective disease control. Single early aerial applications of chlorothalonil at 4.7 or 9.4 L/ha also provided effective disease control. Aerial applications of chlorothalonil at 9.4 L/ha, however, provided significantly better disease control than the 4.7-L/ha rate on needles near the middle and bottom portions of larger trees. There was no difference in disease control on needles from smaller trees or needles from the top portions of larger trees. Aerial or mist-blower applications on 30 June did not provide significant disease control. Timely aerial application of chlorothalonil can provide an effective, convenient, and rapid means of controlling Swiss needle cast.

Control of Swiss needle cast, caused by *Phaeocryptopus gaeumannii* (Rohde) Petr., on Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) Christmas trees depends upon application of protectant fungicides during infection periods that occur shortly after budbreak during early shoot elongation (1,3,6–8, 12,13,16). Effective disease control has been obtained in western Washington and Oregon by using backpack sprayers to make a single application of various registered fungicides at this time (1,6). Use of backpack and/or ground-driven spray equipment has serious limitations in some Christmas tree plantations, however.

Aerial applications of copper fungicides for control of Swiss needle cast have been evaluated on Douglas-fir in forest plantations but have not provided effective disease control (7). Aerial applications, if effective on Christmas trees, would provide a convenient and rapid means of covering large acreages of trees during the 4- to 6-wk period in which infection occurs (1). This paper compares the effectiveness of aerial applications of chlorothalonil with applications made by a mist blower in controlling Swiss needle cast.

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MATERIALS AND METHODS

Four plantations of sheared Douglas-fir Christmas trees were used in this study, two plantations in Thurston County and two in Lewis County, WA. Trees were planted on 1.7-m centers in all four plantations. Tree heights in three of the plantations were about 1.8–2.0 m and trees in the fourth plantation were about 1.2–1.4 m at the time of applications.

Randomized plots were established in each plantation. Aerial application plots within individual plantations were equal in size but plots varied from 0.4 to 1 ha among plantations, depending on the size of the plantation. A helicopter with a 11-m-wide boom and 24 hollow-cone disk-spray nozzles was used to apply chlorothalonil (Bravo 500F, 500 g a.i./L) at 4.7 and 9.4 L in the equivalent of 93.5 L of water per hectare. Applications were made by making several passes about 15.2 m wide over each plot until the total area being treated was covered.

Three replicates of each treatment were arranged in a randomized complete block design within each plantation. Five trees were randomly selected in each plot to monitor disease control. These trees were separated from trees in adjacent plots by a minimum distance of 36.6 m. Mist-blower application plots were established in a randomized complete block design with three blocks adjacent to each aerial application plot.

A backpack mist blower (Solo Port 70, Solo Kleinmotoren GmbH, West Germany) was used to apply chlorothalonil at 2.35, 4.7, and 9.4 L in the equivalent of 374 L of water per hectare. Each treatment was applied to a set of five trees within each block. Sets of treated trees were separated from each other by a minimum of one row of untreated trees. A set of five untreated trees within each block served as checks for the aerial and mist-blower application plots. Applications were made on 4 or 5 June and/or 30 June 1981.

Disease control samples were collected on 22 March 1982. To determine if aerial applications would give adequate control on the entire tree, four terminal shoots were collected from lateral branches in each quadrant near the top, middle, and bottom of each tree. Samples were only collected near the middle portion of each tree in the mist-blower plots. The 20 samples (per sample site) from each set of five trees were placed in a single plastic bag. Samples were stored at 5 C. Incidence of needles with pseudothecia was determined by removing all needles from the shoots in each bag and examining 20 randomly selected needles for the presence of pseudothecia, using a dissecting microscope. Needles were classified as infected if one or more pseudothecia were present.

RESULTS

Although incidence of infected needles in the untreated check plots varied from 18.7 to 70.6% between the four plantations, the effectiveness of helicopter and mist-blower applications in controlling Swiss needle cast was similar in all the plantations. Thus, the data from the four plantations were combined and each plantation was considered a block for statistical analysis.

A single helicopter application of chlorothalonil at the proper time and rate effectively controlled the disease. Trees receiving an early application at 4.7 or 9.4 L/ha had significantly less disease than those receiving no spray (Figs. 1 and 2); however, trees sprayed about 1 mo later, although they had less disease than the controls, had significantly more disease than those sprayed earlier (Figs. 1 and 2). There was no significant difference in disease control on trees that received both an early and late aerial application compared with trees that received an early application only.

On unsprayed trees, more disease was present in the middle and lower portions of the trees compared with the tops (Fig.

1). The rate of chlorothalonil influenced disease control at these various positions. Early application of 9.4 L/ha provided significantly better disease control than the 4.7-L/ha rate on needles near the middle and bottom portions of the trees; however, there was no significant difference in the level of control between the two rates on needles from the tops of the trees (Fig. 1). An exception to this occurred in the plantation with the smaller (1.2-m) trees, which also had the lowest incidence of disease (18.7% infected needles compared with 70.6, 50.6, and 32.8% for the other three plantations). In this plantation, there was no significant difference between the control obtained with the low and high rates on needles from the middle (1.7 vs. 0%) and bottom (1.7 vs. 0%) portions of the trees. Overall, when the data from all the aerial application plots in each plantation were combined, the 9.4-L/ha rate provided significantly better disease control than the 4.7-L/ha rate when applied early (Fig. 2).

A single application of chlorothalonil applied by a backpack mist blower also provided effective disease control (Fig. 3). There was no significant difference in the disease control on needles in the middle portions of the trees when the 2.35, 4.7, or 9.4 L/ha rates were used. As with the aerial applications, the late spray gave some control but significantly less than the early spray. Also, there was no difference in disease control on trees receiving a single early application and those receiving both an early and late application.

DISCUSSION

Aerial applications of chlorothalonil can provide as effective control of Swiss needle cast on sheared Douglas-fir Christmas trees as ground applications. The level of control is dependent on application timing, rate of material applied, and tree size (age).

During 1981, applications on 4 or 5 June (early in the infection period) provided significantly better disease control than applications made on 30 June. Studies in 1980 and 1981 indicated infection occurred during the early part of June (1,6) so it would not be expected that the late application (30 June) would provide adequate control. There also was no advantage for an early and late spray compared with an early application only.

In order to achieve adequate control by helicopter, it appears that high rates of chlorothalonil (9.4 L/ha) are required compared with rates giving equivalent control with a ground application (2.35–4.7 L/ha). In larger trees, which had a higher incidence of infected needles, the high rate was necessary to give acceptable control on needles in the middle and bottom portions of the trees. Only when the trees were smaller and/or when the disease pressure was reduced (top portions of larger trees) did the lower rate provide good control. In contrast, the lower rates applied by backpack mist blower in the larger diseased trees provided good control.

Thus, it would appear that the reduced level of control on needles in the middle and bottom portions of the larger trees obtained from helicopter applications of chlorothalonil at 4.7 L/ha occurred because of insufficient fungicide residue being deposited on these needles. Previous work with early chlorothalonil applications prior to needle and shoot extension provides indirect evidence that given sufficient initial residues, redistribution of these residues can result in good disease control (1).

We have not found any indication in the literature that aerial applications of fungicides have proven effective in controlling Swiss needle cast on Douglas-fir. Hood (7) found that aerial applications of copper fungicides to Douglas-fir trees in a forest plantation were not effective in controlling Swiss needle cast. Aerial applications of copper fungicides are effective in controlling *Dothistroma* needle blight on Monterey pine (*Pinus radiata* D. Don) (4,5). Aerial applications of fungicides known to be effective when applied by ground (10,14,15,17) have provided effective control of Lophodermium and Rhizophaera needle casts in Christmas tree plantations (D. D.

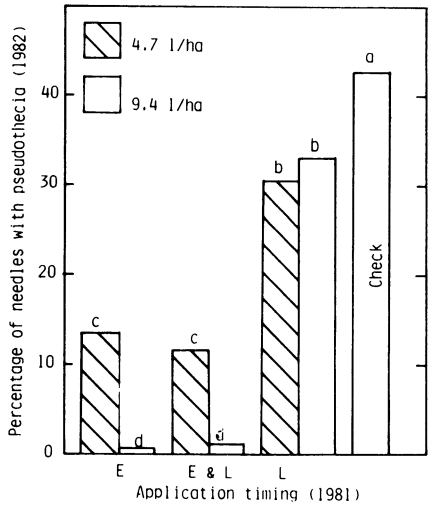

Fig. 2. Influence of rates and application timing on the overall control of Swiss needle cast with aerial applications of chlorothalonil. Application dates were (E) 4–5 June and (L) 30 June. Bars with the same letters are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

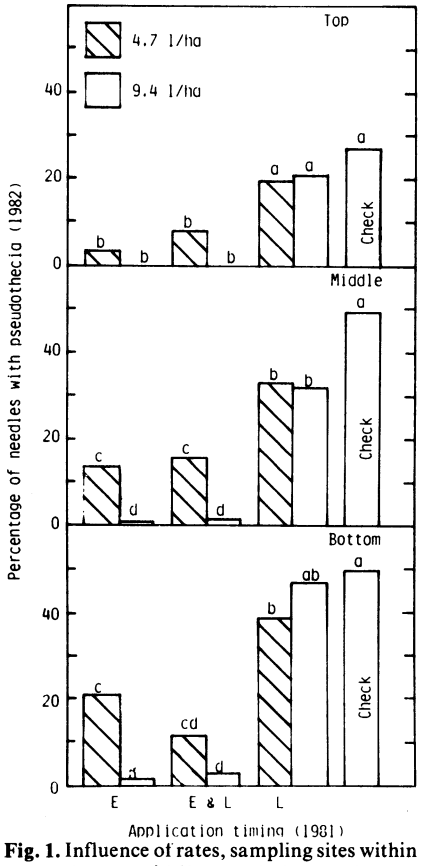

Fig. 1. Influence of rates, sampling sites within trees (top, middle, and bottom) and application timing on the control of Swiss needle cast with aerial applications of chlorothalonil. Application dates were (E) 4–5 June and (L) 30 June. Bars for given sample sites with the same letters are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

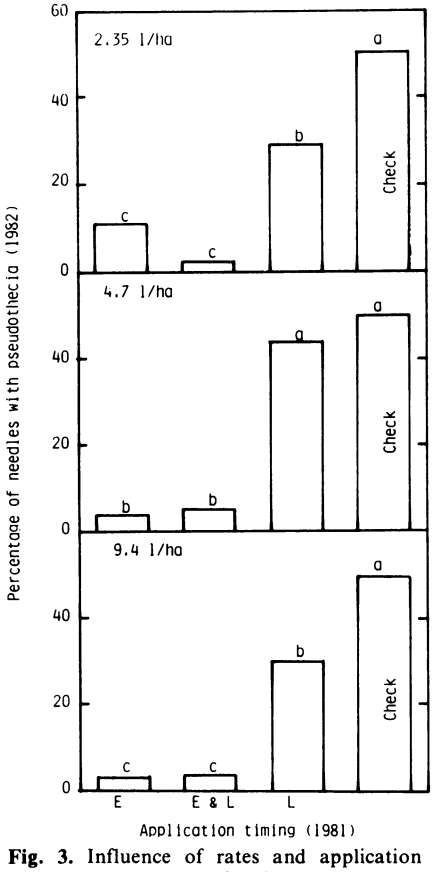

Fig. 3. Influence of rates and application timing on the control of Swiss needle cast on needles from the middle portions of trees with backpack mist-blower applications of chlorothalonil. Application dates were (E) 4–5 June and (L) 30 June. Bars for given rates with the same letters are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Skilling, *personal communication*).

Successful disease control from aerial applications reported in this paper can be attributed to several factors: Only current-season needles need protection and only for a relatively short period of time. Older needles are considered relatively resistant to infection (9), thus penetration of the fungicide into the interior portion of the trees is not required. Apparently, the flowable formulation of chlorothalonil has enough residual and redistribution properties so that adequate protection can be achieved during the time new susceptible growth occurs in the spring. It is not known if aerial applications of wettable powder formulations of chlorothalonil or other registered fungicides such as mancozeb or benomyl would provide effective disease control.

Swiss needle cast occurs on most sheared Douglas-fir Christmas trees produced in western Washington and Oregon (11). At harvest, the presence of symptomless Swiss needle cast-infected needles significantly reduces the post-harvest quality of these trees (2). Because producing a quality Christmas tree generally requires retention of needles for at least 3 yr, Swiss needle cast should be controlled the last 3 yr before harvest. Aerial and ground application of chlorothalonil provides an effective means of obtaining this control.

Determining the importance of Swiss needle cast in commercial Douglas-fir timber stands has not been feasible to date because of the difficulty in obtaining disease control under field conditions (7). The effective control provided by aerial applications of chlorothalonil provides a tool to assess the importance of this disease in young forest plantations.

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LITERATURE CITED

1. Chastagner, G. A., and Byther, R. S. 1983. Infection period of Douglas-fir needles by *Phaeocryptopus gaeumannii* in western Washington. Plant Disease 67:In press.
2. Chastagner, G. A., Byther, R. S., and Michaels, E. 1982. Dehydration and needle loss on cut Douglas-fir Christmas trees with Swiss needle-cast. (Abst.) Phytopathology 72:965.
3. Ford, K. F. 1973. The etiology, distribution and impact of Swiss needle cast on Douglas-fir in Michigan. Thesis, University of Michigan, Ann Arbor. 32 pp.
4. Gibson, I. A. S. 1965. Recent research into Dothiostroma blight of pines in Kenya. Agric. Vet. Chem. 6:39-42.
5. Gilmour, J. W., and Noorderhaven, A. 1973. Control of *Dothistroma* needle blight by low volume aerial application of copper fungicides. N.Z. J. For. Sci. 3:120-136.
6. Hadfield, J., and Douglass, B. S. 1982. Protection of Douglas-fir Christmas trees from Swiss needle-cast in Oregon. Am. Christmas Tree J. (May): 31-33.
7. Hood, I. A. 1973. *Phaeocryptopus* infection of Douglas-fir foliage. Page 50 in: Report for 1973, Rotorua. N.Z. For. Res. Inst.
8. Hood, I. A. 1978. Results of fungicidal trials against *Phaeocryptopus gaeumannii*. Pages 136-137 in: A review of Douglas-fir in New Zealand. FRI Symp. 15. N.Z. For. Serv. For. Res. Inst. 455 pp.
9. Hood, I. A., and Kershaw, D. J. 1975. Distribution and infection period of *Phaeocryptopus gaeumannii* in New Zealand. N.Z. J. For. Sci. 5:201-208.
10. Merrill, W., and Kistler, B. R. 1976. Seasonal development and control of *Lophodermium pinastri* in Pennsylvania. Plant Dis. Rep. 60:652-655.
11. Michaels, E., and Chastagner, G. A. 1982. Distribution and severity of Swiss needle-cast in Douglas-fir Christmas tree plantations. (Abstr.) Phytopathology 72:965.
12. Morton, H. L. 1975. Biology and control of Swiss needle cast. (Abstr.) Proc. Am. Phytopathol. Soc. 2:30.
13. Morton, H. L., and Miller, R. 1976. Fungicidal control of Swiss needle cast on Douglas-fir. (Abstr.) Proc. Am. Phytopathol. Soc. 3:214.
14. Powell, C. C., and Leben, C. 1973. Epidemiology and control of *Lophodermium* needlecast of Scotch pine in Ohio. Plant Dis. Rep. 57:515-517.
15. Skilling, D. D. 1974. Control of *Lophodermium* needlecast in Scotch pine Christmas tree plantations. Plant Dis. Rep. 58:853-856.
16. Skilling, D. D. 1981. Control of Swiss needle cast in Douglas-fir. Am. Christmas Tree J., 25(3):34-37.
17. Skilling, D. D., and Waddell, C. D. 1975. Control of *Rhizosphaera* needlecast in blue spruce Christmas tree plantations. Plant Dis. Rep. 59:841-843.