

SUSCEPTIBILITY OF FARM SHELTER CYPRESSES TO THREE FUNGI ASSOCIATED WITH CYPRESS CANKER DISEASE

R. M. BERESFORD and R. I. MULHOLLAND

Plant Diseases Division, DSIR,
Lincoln Research Centre, Private Bag, Christchurch

(Received for publication 13 August 1981; revision 6 April 1982)

ABSTRACT

Trees in a trial plantation containing eight cypress varieties were examined for cypress canker disease. Three fungi were associated with the disease - *Seiridium cardinale* (Wagener) Sutton & Gibson, *S. unicorne* (Cke & Ell.) Sutton, and *Pestalotiopsis funerea* (Desm.) Steyaert which occurred mainly in combination with one of the other two fungi. The percentage of trees from which cypress canker fungi were isolated differed with the variety: × *Cupressocyparis leylandii* (Jacks. & Dall.) Dall. clone Haggerston Grey 18%; clone Naylor's Blue 0%; clone Leighton Green 17%; clone Green Spire 8%; *Cupressus macrocarpa* Hartw. 22%; *Cupressus torulosa* D. Don 0%; *Cupressus arizonica* Greene 9%; NZ FRI clone 850-329 (probably *C. arizonica* × *C. torulosa*) 8%.

An inoculation trial showed that *S. cardinale* consistently caused more damage on all varieties than *S. unicorne*, while *P. funerea* was a weak pathogen of secondary importance. Differences in susceptibility to *S. cardinale* were detected: the four × *Cupressocyparis leylandii* clones and *Cupressus macrocarpa* were the most susceptible; *C. arizonica*, *C. torulosa*, and FRI 850-329 showed some resistance. No differences in susceptibility were detected to *S. unicorne* or *P. funerea*.

INTRODUCTION

Cypress canker disease, a problem in farm shelter plantings of *Cupressus macrocarpa* and *Chamaecyparis lawsoniana* (A. murr.) Parl., was first recorded in New Zealand by Birch (1933). Hybrid cypresses are being evaluated as alternatives to these species, and an important aspect of their performance is resistance to cypress canker. The present study was made to determine the susceptibility of eight cypress varieties to three species of fungi commonly associated with the disease.

Cypress Canker Fungi

Birch (1933) recorded *Seiridium cardinale* (syn. *Coryneum cardinale* Wagener) as the cause of cypress canker in New Zealand. However, later workers (e.g., Fuller & Newhook 1954; Weston 1957; Newhook 1962; Gilmour 1966) have attributed the disease to *S. unicorne* (syn. *Monochaetia unicornis* (Cke & Ell.) Saccardo, *Cryptostictis cupressi* Guba). Some authors (e.g., Dingley 1969; Swart 1973) consider these two

species to be morphological variants of a single species, but this has not been proved conclusively because perfect states have not yet been identified for both *Seiridium* species. *Leptotypha cupressi* (Natrass, Booth & Sutton) Swart (syn. *Rhynchosphaeria cupressi* Natrass, Booth & Sutton) has been described as the perfect state of *S. unicornae*; however, the only record of a perfect state associated with *S. cardinale* is an unverifiable record by Hansen (1956) of a *Leptosphaeria* sp. The present paper, following Sutton (1975), maintains *S. unicornae* and *S. cardinale* as two distinct species.

A third fungus, *Pestalotiopsis funerea*, has also been associated with seedling diseases and gummosis of conifers in New Zealand (Birch 1933).

MATERIALS AND METHODS

This study was made in a farm shelter trial plantation on DSIR land near Lincoln, Canterbury, which contained the following 5- to 6-year-old cypresses:

Four clones of \times *Cupressocyparis leylandii* from Forest Research Institute (FRI) Rotorua:

Haggerston Grey (Clone 2)

Naylors Blue (Clone 10)

Leighton Green (Clone 11)

Green Spire (Clone 1)

Cupressus macrocarpa from seed, FRI Rangiora

Cupressus torulosa from cuttings, FRI Rangiora

Cupressus arizonica from seed, FRI Rotorua

NZ FRI Clone 850-329 (probably a hybrid of *C. arizonica* and *C. torulosa*) from cuttings, FRI Rotorua

Occurrence of canker fungi in the plantation

Of 250 trees examined, isolations were attempted from 45 trees showing gummosis and other canker symptoms. Discoloured tissue, cut from between the cork cambium and the wood, was surface sterilised for 2 minutes in 1% sodium hypochlorite, then plated on to potato dextrose agar. The fungi isolated were identified when they began to sporulate 2-4 weeks later.

Susceptibility of cypresses to the three fungi

The following fungal isolates were used to inoculate 12 disease-free trees of each cypress variety in late September 1980; *S. cardinale* and *S. unicornae* from \times *Cupressocyparis leylandii*, Lincoln, isolated in August 1980; *P. funerea* from \times *C. leylandii*, Marton, isolated in April 1980.

For each variety, except Naylors Blue and FRI 850-329, four trees in each of three replicate plots were inoculated. For the latter two varieties, six trees in each of two replicate plots were inoculated. On each tree there were inoculation points for the three fungi and a control, each on a separate branch. Inoculations were made in the axils of side shoots 10-20 cm from the tips of lateral branches which had just begun

the new season's growth. A shallow wound was made with the tip of a sterile scalpel dipped in a spore suspension containing 10^6 spores/ml. Surfactant (100 $\mu\text{g}/\text{ml}$ alkaryl-polyglycol ether 'Citowett') was used in the suspension to ensure spores penetrated the wound. Controls were treated in the same manner, except that no spores were present. The inoculum was obtained from 4- to 6-week-old agar cultures, and inoculation points were marked on the trees with coloured spray paint.

A 0–4 scale was used to index the severity of disease 12 weeks after inoculation:

- 0 = symptoms similar to the control
- 1 = discoloration of the cambium immediately around the wound, with or without gummosis
- 2 = discoloration extending away from the wound, cracking of the bark, usually with gummosis
- 3 = a large sunken canker with swelling of the shoot distal to the inoculation point, acervuli of the fungus often present on the bark, much gummosis
- 4 = as for 3, with death of the side shoot.

In addition to these inoculations, six further isolates of *P. funerea* from trees in the trial plantation were tested for pathogenicity on Leighton Green.

RESULTS

Occurrence of Canker Fungi in the Plantation

Of 250 trees inspected, 45 with suspected canker were sampled (Table 1). From many of the trees with suspected canker, no canker-causing fungi were isolated. This was because gummosis, which for the purpose of the isolations was used as an indication of canker, can also result from mechanical injury and is not in itself a reliable symptom of the disease.

Eleven percent of the trees were infected, but there were large differences between varieties, with *C. macrocarpa*, Haggerston Grey clone, and Leighton Green clone showing the highest levels. Naylor's Blue clone and *C. torulosa* were free of infection.

All three fungi previously recorded in New Zealand were present in the plantation, although there was a predominance of *S. cardinale*. *Pestalotiopsis funerea* was isolated mainly in combination with one or other of the *Seiridium* species, and on two trees both *Seiridium* species were associated with a single canker.

Susceptibility of Cypress Varieties to the Three Fungi

Results of the inoculation tests were analysed using the method of McCullagh (1980) for ordinal data. For *S. cardinale*, there was a significant effect due to fitting varieties (chi-squared with 7 degrees of freedom = 49.53). There was no significant effect for *S. unicornae* or *P. funerea*. Analyses of variance were also carried out on the data, and these also showed that there were significant varietal differences in disease scores as a response to inoculation with *S. cardinale*, but not to inoculation with *S. unicornae* or *P. funerea*. Although analysis of variance is only approximate for this type

TABLE 1—Fungi isolated from cypress trees in a farm shelter trial plantation at Lincoln

Variety	No. trees examined	No. with suspected canker	Trees from which fungi were isolated		<i>S. cardinale</i>	<i>S. unicorne</i>	<i>P. funerea</i>
			(No.)	(%)			
× <i>Cupressocyparis leylandii</i> :							
Haggerston Grey	33	9	6	18	5	—	2
Naylor's Blue	21	0	0	0	—	—	—
Leighton Green	53	18	9	17	8	1	1
Green Spire	36	3	3	8	2	—	1
<i>Cupressus macrocarpa</i>	27	7	6	22	5	2	2
<i>C. torulosa</i>	33	0	0	0	—	—	—
<i>C. arizonica</i>	35	5	3	9	3	—	—
FRI 850-329	12	3	1	8	—	1	—
TOTALS	250	45	28	11	23	4	6

of data, the mean disease indices and standard errors in Table 2 demonstrate that *C. macrocarpa* and the four \times *Cupressocyparis leylandii* clones were more severely affected by *S. cardinale* than *Cupressus arizonica*, *C. torulosa*, and FRI 850-329 which all showed some resistance. *Seiridium unicorne* produced less severe symptoms, and no significant differences in susceptibility to this fungus were detected. *Pestalotiopsis funerea* was a weak pathogen and caused little more damage than did the wounding in the controls. This was confirmed by inoculations with six other isolates of *P. funerea* which all gave similarly low disease indices.

TABLE 2—Disease severity in cypresses inoculated with fungi associated with cypress canker disease

Variety	Mean disease indices*		
	<i>S. cardinale</i>	<i>S. unicorne</i>	<i>P. funerea</i>
Cupressus macrocarpa	3.33	1.19	0.36
\times Cupressocyparis leylandii Haggerston Grey	3.17	2.03	0.25
Naylors Blue	3.16	2.08	0.58
Leighton Green	3.08	1.50	0.33
Green Spire	3.00	2.36	0.33
FRI 850-329	1.92	1.56	0.75
Cupressus torulosa	1.42	1.17	0.25
C. arizonica	0.93	0.75	0.33
Standard error	0.30	0.27	0.15

* Disease index scale 0-4, see Materials and Methods

DISCUSSION

Based on the inoculation results, the four \times *Cupressocyparis leylandii* clones tested are as susceptible to cypress canker disease as *Cupressus macrocarpa*, which has a reputation for high susceptibility. The hybrid clone FRI 850-329 appears to have a useful level of resistance to *S. cardinale*, but is possibly not as resistant as *C. arizonica* or *C. torulosa*.

In the inoculation tests, *S. cardinale* caused more damage than *S. unicorne* on all the cypress varieties tested. It is not known whether this is a difference in virulence between the fungal species, or whether isolates of each pathogen differ in their virulence.

The predominance of *S. cardinale* in the trial plantation is interesting in view of the reports of Fuller & Newhook (1954), Weston (1957), Newhook (1962), and Gilmour (1966) which suggest *S. unicorne* to be the main cause of cypress canker in New Zealand. A nation-wide survey of the disease is required to determine whether *S. cardinale* is more widespread than previously thought.

The occurrence of *P. funerea* mainly in combination with the other two fungi, and its weak pathogenicity in the inoculation tests are consistent with the view that it is

mainly a secondary invader of wounded or diseased tissue, and is not important in causing cypress canker disease (Gilmour 1966; Mordue 1976).

Isolations from the trial plantation showed that the incidence of cypress canker fungi, particularly *S. cardinale*, was higher in some varieties of cypress than in others. The differences in incidence, however, were not always related to the order of susceptibility to *S. cardinale* that was suggested by the inoculation results. It is likely that these differences arose from the introduction of disease with the nursery stock. It has been suggested that infected nursery stock and human agencies are important for long-range spread of cypress canker (Fuller & Newhook 1954; Booth & Gibson 1972; Sutton & Gibson 1972). This may be particularly true for *S. cardinale*, since no wind-borne ascospore phase has been consistently associated with this fungus. The conidia of *S. cardinale*, which are abundantly produced in acervuli on the bark of cankered areas, have been shown to be rainwater-dispersed (Wagener 1939). The same is true for *S. unicornae*, but for this fungus rain-splashed conidia are considered important only for build-up of disease within a tree or within adjacent trees in a shelterbelt. In *S. unicornae*, wind-borne ascospores from the ascomycete stage have been implicated in spread of the disease. Newhook (1962), however, indicated that in the Waikato district ascospores are infrequently produced compared with conidia, and that this difference accounts for the rapid local build-up of disease but its relatively slow spread over a distance.

Further study is required to assess the relative importance of ascospores and diseased nursery stock for long-range spread of *S. unicornae* and *S. cardinale*; and the search for the perfect state of *S. cardinale* must continue so that the taxonomy of the two *Seiridium* species can be clarified.

ACKNOWLEDGMENTS

The authors wish to thank Crop Research Division, DSIR, for the opportunity to carry out this work, and Miss Elizabeth Severson of Applied Mathematics Division, DSIR, for assistance with the statistical analyses.

REFERENCES

- BIRCH, T. T. C. 1933: Gummosis diseases of *Cupressus macrocarpa*. **New Zealand Journal of Forestry** 3: 108-13.
- BOOTH, C.; GIBSON, I. A. S. 1972: *Rhynchosphaeria cupressi*. **Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 325**.
- DINGLEY, J. M. 1969: Records of plant diseases in New Zealand. **DSIR Bulletin 192**.
- FULLER, C. E. K.; NEWHOOK, F. J. 1954: A report on cypress canker in New Zealand. **New Zealand Journal of Agriculture** 88: 211-20.
- GILMOUR, J. W. 1966: The pathology of forest trees in New Zealand: the fungal, bacterial and algal pathogens. **New Zealand Forest Service, Forest Research Institute, Technical Paper No. 48**.
- HANSEN, H. N. 1956: The perfect state of *Coryneum cardinale*. **Phytopathology** 46: 636-7.
- MCCULLAGH, P. 1980: Regression models for ordinal data. **Journal of the Royal Statistical Society series B** 42: 109-42.
- MORDUE, J. E. M. 1976: *Pestalotiopsis funerea*. **Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 514**.
- NEWHOOK, F. J. 1962: Cypress canker and root rot: Two serious fungus diseases of conifers. **New Zealand Journal of Agriculture** 104: 151-3.

- SUTTON, B. C. 1975: Coelomycetes v. *Coryneum*. **CMI Mycological Papers No. 138.**
- SUTTON, B. C.; GIBSON, I. A. S. 1972: *Seiridium cardinale*. **Commonwealth Mycological Institute Descriptions of Pathogenic Fungi and Bacteria No. 326.**
- SWART, H. J. 1973: The fungus causing cypress canker. **Transactions of the British Mycological Society 61: 71-82.**
- WAGENER, W. W. 1939: The canker of *Cupressus* induced by *Coryneum cardinale* n.sp. **Journal of Agricultural Research 58: 1-46.**
- WESTON, G. C. 1957: Exotic forest trees in New Zealand. **New Zealand Forest Service Bulletin No. 13.**