CONTROL OF TERMINAL CROOK DISEASE IN RADIATA PINE SEEDLINGS

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SUMMARY

In nursery trials, prochloraz applied weekly at a rate of 0.45 kg/ha or fortnightly at 0.675 kg/ha, was as effective as the currently recommended treatment of weekly applications of 2 kg dichlofluanid in a 1% oil emulsion, for controlling Terminal Crook disease of radiata pine (*Pinus radiata* D. Don) seedlings caused by *Colletotrichum acutatum*.

INTRODUCTION

Terminal Crook disease is a disease of radiata pine seedlings caused by the fungus *Colletotrichum acutatum* Simms f. sp. *pineae* (Dingley and Gilmour 1972). The disease is of major concern in some forest nurseries, causing the terminals of infected seedlings to grow over in a crozier-shaped malformation. This inhibits seedling growth until a lateral bud develops into a terminal shoot. Seedlings affected early in the growing season often fail to reach a plantable size. Control of Terminal Crook disease contributes significantly to the cost of raising pine seedlings in infected nurseries.

The current control recommendation of weekly applications of 2 kg dichlofluanid plus 10 litres of an all-purpose emulsifiable spray oil and 33 ml surfactant in 1000 litres/ha water, has provided good disease control (Vanner and Ray 1977). As an alternative to the current treatment, the efficacy of several fungicides in controlling Terminal Crook disease was evaluated in a glasshouse trial. The most promising fungicide was then evaluated at different rates and application intervals, with and without a spray additive, in nursery plot trials.

METHODS

Glasshouse pot trial

Radiata pine seed was sown in 170-mm-square pots in a glasshouse in mid October 1987.

Each fungicide tested (Table 1) was applied to five pots, each containing three seedlings, on 1 March 1988. Each pot was sprayed with 4 ml fungicide using an air-aspirated nozzle mounted above the pot. This resulted in an application rate equivalent to 188 litres/ha. The fungicide concentrations (Table 1) were chosen to give application rates similar to those generally used for controlling other diseases.

Twenty-four hours after spraying, all seedlings, including the untreated controls, were inoculated by spraying with a suspension of *C. acutatum* spores in distilled water (2.75×10^6 /ml) at a rate of 5 ml per seedling.

Immediately after inoculation, pots were randomly placed in a humidity chamber constructed of clear plastic film, in the glass house. Seedling foliage was lightly misted with water, morning and evening for 3 days after inoculation. Seedlings were assessed for disease symptoms on 21 March 1988, 20 days after inoculation.

Data were analysed using analysis of variance. Significant differences between treatments and the dichlofluanid treatment were determined using an LSD test.

Nursery trials

Nursery trials were conducted in the Forest Research Institute nursery, Rotorua. Prior to the formation of the nursery beds, sterilized oat seed, inoculated with *C. acutatum*, was scattered evenly over the trial area.

Two trials were undertaken. Radiata pine seed was sown on 31 October 1988 for one trial and on 12 December 1988 for a second trial. Seeds were sown in rows, 15

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seeds/m, with each nursery bed containing eight rows of seed. Treatment plots 3 m long were laid out in a fully randomised block design, with a minimum of four replicates. The treatments used are listed in Tables 2 and 3, respectively. Spray applications were made at a rate of 500 litres/ha using a shielded nursery plot sprayer fitted with two 730116 (Spraying Systems) nozzles. In both trials the first fungicide spray applications were made 2 weeks after seedling emergence.

In the first trial emergence occurred during a long period of very wet weather, conditions highly conducive to disease development. The first spray was applied on 30 November 1988 despite impending rain. As rain commenced before spraying had been completed, a second application was made on the next fine day, 3 days later. Disease levels in the unsprayed control reached sufficiently high levels to warrant assessment of the trial 3 weeks after emergence.

The second trial was first sprayed on 10 January 1989 and both weekly and fortnightly applications continued for a further 11 weeks. The trial was assessed 14 weeks after seedling emergence.

Assessments were made by counting the percentage of seedlings exhibiting disease symptoms (crooking of the terminals) in each plot. To avoid edge effects, only the seedlings in the central 2 m of the six middle rows of each plot were assessed.

Data were analysed using analysis of variance after square root transformation and significant differences between treatments were detected using an LSD test.

RESULTS AND DISCUSSION

Glasshouse trial

The dichlofluanid plus oil treatment gave good disease control (Table 1) despite being applied at half the rate recommended for field application. Of the four fungicides which were not significantly different to dichlofluanid, but significantly better than the unsprayed treatment, prochloraz showed the best activity against the disease and was considered worthy of further evaluation in a nursery trial.

Nursery trials

In the first nursery trial, applications of prochloraz at 0.45 and 0.675 kg/ha gave significantly better control of Terminal Crook disease than 2 kg dichlofluanid plus 1% emulsifiable spray oil (Table 2), despite the rapid development of the disease.

TABLE 1: Effectiveness of fungicides in controlling Terminal Crook disease: glasshouse pot trial.

Fungicide	Trade name and formulation	Concentration g ai/litre	Diseased seedlings 21 days after treatment (%)
dichlofluanid*	Euparen 50W	5.0	13 a
prochloraz	Sportak 45EC	2.25	20 ab
fenpropimorph	Corbel 75EC	3.75	40 abc
bitertanol	Baycor 50W	1.25	47 abcd
penconazole			
+ mancozeb	Topas MZ 62W	0.17 + 6.0	47 abcd
triadimenol	Bayfidan 25EC	1.25	53 bcde
myclobutanil	Systhane 40W	0.40	57 cde
nitrothal-isopropyl	Pallitop** 48W	1.68	60 cde
propiconazole	Tilt 25EC	0.625	60 cde
flusilazol	Nustar 20WDG	0.20	67 cde
fenarimol	Rubigan 12FL	0.30	73 de
unsprayed control			83 e

* Plus an all-purpose spray oil at 10 ml/litre

** Contains 3% metiram

Treatments joined by a common letter do not differ significantly at the 5% level.

TABLE 2: Effectiveness of fungicide treatments in controlling Terminal Crook disease: nursery trial 1.

Treatment	Fungicide application rate (kg ai/ha)	Diseased seedlings 3 weeks after emergence (%)*
unsprayed		58.4 a
dichlofluanid†	2.0	50.3 a
prochloraz	0.225	49.4 a
prochloraz	0.45	33.7 b
prochloraz	0.675	21.7 b

* Treatments joined by a common letter do not differ significantly at the 5% level.

† Plus an all-purpose spray oil and a surfactant added at a rate of 1% and 0.0033%, respectively.

In the second trial, a small number of diseased seedlings were noted 13 days after the initial spray application but high numbers were not present until March. Weekly applications of prochloraz at 0.45 and 0.675 kg/ha and fortnightly applications at 0.675 kg/ha did not give significantly better disease control than that provided by the use of dichlofluanid and oil (Table 3). Even at the higher rate, the use of prochloraz could reduce chemical costs by as much as 75% per application if current price differentials are maintained. It is suggested that prochloraz may have been more effective in the first trial, under conditions which favoured an explosive development of Terminal Crook disease, due to its reported eradicant action (Birchmore *et al* 1977).

TABLE 3: Effectiveness of fungicide treatments in controlling Terminal Crook disease: nursery trial 2. Disease assessments made 14 weeks after emergence.

Treatment	Fungicide application rate (kg ai/ha)	Additive	Additive concentration	Application interval	Diseased seedlings (%)*
unsprayed					60.0 a
prochloraz	0.45	Sprayfast	0.1%	Fortnightly	36.0 ab
prochloraz	0.675	Sprayfast	0.1%	Fortnightly	25.9 bc
prochloraz	0.45			Fortnightly	24.9 bcd
dichlofluanid	2.0	Sprayfast	0.1%	Weekly	16.8 bcde
prochloraz	0.675			Fortnightly	14.8 cde
dichlofluanid	2.0	All-purpose spraying oil†	1.0%	Weekly	11.3 cde
prochloraz	0.45			Weekly	9.3 de
prochloraz	0.675			Weekly	6.0 e
prochloraz	0.675	Sprayfast	0.1%	Weekly	4.9 e

* Treatments joined by a common letter do not differ significantly at the 5% level.

† Plus 0.0033% surfactant.

The recommendation that dichlofluanid and oil be applied at weekly intervals is a major drawback to its use, particularly in large nurseries. In the second trial, fortnightly applications of prochloraz at 0.675 kg/ha were as effective as weekly applications of dichlofluanid plus oil. Major economies in the use of nursery resources can be achieved if the interval between spray applications could be increased from 1 to 2 weeks. The rate at which the disease developed in the first trial, however, indicates that under severe conditions it would be prudent to spray more regularly than fortnightly.

The spray additive Sprayfast has been reported to improve the efficacy both of glyphosate applied just prior to rainfall and of mancozeb in controlling potato blight

(McLean 1988). Sprayfast did not enhance the effectiveness of either prochloraz applied as an emulsifiable concentrate, or dichlofluanid applied as a wettable powder, in controlling a disease which spreads rapidly under wet conditions.

CONCLUSIONS

The fungicide prochloraz is an effective alternative to dichlofluanid plus oil in controlling Terminal Crook disease in forest nurseries.

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