PINUS DAMPING-OFF INVESTIGATIONS IN SOUTHERN QUEENSLAND

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SUMMARY

The organisms associated with damping off in *Pinus* nurseries in southern Queensland were investigated. The potential pathogenicity of a number of *Pythium*, *Phytophthora*, *Rhizoctonia* and *Fusarium* species to *Pinus* seedlings was checked in greenhouse inoculation tests.

A damping-off control experiment showed that soil drenches of captan, thiram and copper oxychloride will control the disease in seedlings of slash pine (*Pinus elliottii* var. *elliottii*).

I. INTRODUCTION

Damping-off is a common and sometimes serious problem in *Pinus* nurseries in Queensland. Prior to 1958 little was known of the pathogens responsible for the disease in this State. Since 1958 the major Forestry Department nurseries in southern districts have been surveyed and a large number of isolations performed from infected plants and adjacent soil. For the most part these isolations were from plantings of slash pine (*Pinus elliottii* var. *elliottii* Engelm.) and radiata pine (*Pinus radiata* D. Don). This paper reports the results of pathogenicity tests carried out with suspected pathogens isolated during these nursery investigations. A damping-off control experiment was also conducted at Beerwah in 1960 and the results of this experiment are outlined.

II. SUSPECTED PATHOGENS ASSOCIATED WITH *PINUS* DAMPING-OFF

Isolations were carried out in two ways. In one, pieces of infected stem and/or root tissue were well washed in tap water and then sterile water, dried between sheets of sterile blotting paper and plated on water agar. Alternatively, infected roots and adhering soil were placed in apples, using the modification of Tucker's apple technique described by Campbell (1949). Pieces of the rotting apple tissue were subsequently plated onto potato dextrose agar.

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Of the fungi consistently isolated from infected seedlings, species of *Phytophthora, Rhizoctonia, Pythium* and *Fusarium* were selected for pathogenicity testing. Organisms belonging to these genera have been implicated in damping-off of conifer seedlings by numerous workers. The potential pathogens which were isolated are listed in Table 1.

TABLE 1

SUSPECTED PATHOGENS ISOLATED FROM SLASH AND RADIATA PINES, 1958–1961

Fungus	Host Plant	Localities
Pythium debaryanum	Slash pine	Beerburrum, Tuan, Beerwah
P. debaryanum	Radiata pine	Emu Vale
P. helicoides	Slash pine	Beerwah, Toolara
P. ultimum	Slash pine	Passchendaele, Beerwah
P. ultimum	Radiata pine	Passchendaele, Pechey, Emu Vale
P. spinosum	Slash pine	Beerburrum, Beerwah
P. splendens	Slash pine	Beerburrum
Pythium sp. 1*	Radiata pine	Emu Vale
Phytophthora cinnamomi	Slash pine	Beerburrum, Toolara, Passchendaele, Rocklea
P. cinnamomi	Radiata pine	Passchendaele, Emu Vale
Rhizoctonia solani	Slash pine	Beerburrum, Tuan, Beerwah
R. solani	Radiata pine	Yarraman
Fusarium oxysporum	Slash pine	Beerwah, Beerburrum, Tuan
F. oxysporum	Radiata pine	Pechey, Passchendaele
F. solani	Slash pine	Beerwah, Beerburrum, Tuan
F. solani	Radiata pine	Pechey, Passchendaele

* Did not produce fruiting bodies which would enable identification; resembled *Pythium vexans* in cultural characteristics.

III. PATHOGENICITY TESTS

The organisms listed in Table 1 were tested for pathogenicity in a number of greenhouse inoculation experiments from 1959 to 1961. In each case the inoculum was produced on cornmeal-sand medium which was fragmented before application to the soil. Both slash and radiata pines were inoculated in each experiment.

The pine seeds were planted in rows 2 in. apart in seed-boxes of steamed soil. When emergence commenced the inoculum was dug into the soil between the rows of plants. It was found in preliminary work that if the inoculum was applied prior to planting some of the organisms drastically curtailed emergence. However, as pine seed germinates over an extended period, inoculation at early germination still tended to reduce emergence in some cases. Stand counts were therefore made as well as counts of diseased seedlings.

Symptoms produced by inoculation were typical of damping-off in pine seedlings. The first noticeable effect was a wilting of the plant followed by a collapse of the stem (Figure 1). A soft rotting of the primary root and lower stem was evident on removal from the soil. The symptoms produced by the various fungi did not differ greatly, although *Rhizoctonia solani* sometimes produced a browning of the affected tissues as compared with the watersoaked appearance of those infected with *Phytophthora cinnamomi* or the species of *Pythium.*

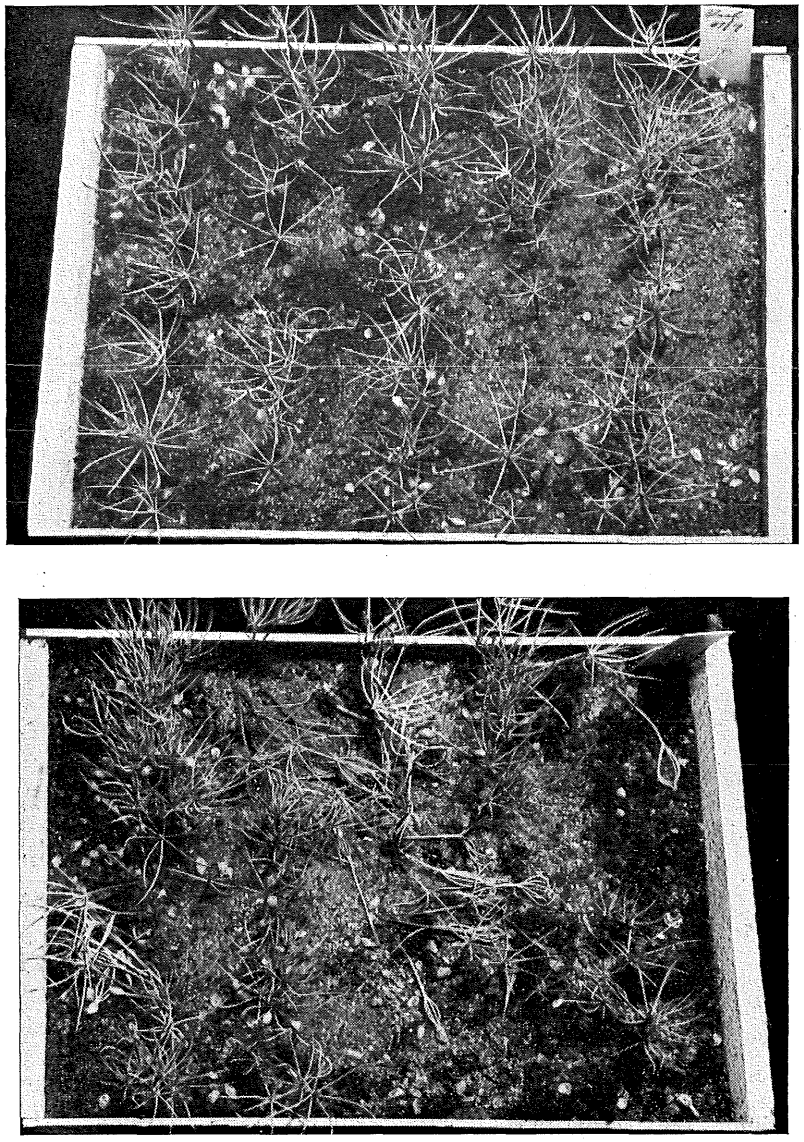

Fig. 1.—Slash pine seedlings inoculated with *Pythium splendens.* Uninoculated seedlings above.

Fig. 2.—Reduction in stand of slash pine seedlings as a result of preplanting soil inoculation with *Fusarium oxysporum*. Uninoculated seedlings above.

The appropriate fungi were readily re-isolated from the infected seedlings.

Table 2 summarizes the results of the pathogenicity tests.

TABLE 2

RESULTS OF PINUS DAMPING-OFF PATHOGENICITY TESTS, 1959–1961

Fungus	Year of Tests	Slash Pine	Radiata Pine
Pythium debaryanum	1959	Severe*	Severe*
P. helicoides	1959	Nil	Moderate*
P. ultimum	1959	Slight	Severe
P. spinosum	1961	Nil	Nil
P. splendens	1961	Severe	
Pythium sp. 1	1959	Slight	Severe
Phytophthora cinnamomi	1959	Slight	Severe
Rhizoctonia solani	1959	Moderate	Severe
Fusarium oxysporum	1959, 1960	+ Slight-moderate	+ Slight-moderate
F. solani	1959, 1960	+ Slight-moderate	+ Slight-moderate

*Slight ≡ less than 10% of plants infected.
Moderate ≡ 10–30% infected.
Severe ≡ more than 30% infected.
+ Variable pathogenicity.

Radiata pine was more susceptible than slash pine to infection with several of the fungi under these experimental conditions. *Pythium debaryanum, P. ultimum, Pythium* sp., *Rhizoctonia solani* and *Phytophthora cinnamomi* were severely pathogenic to radiata seedlings. *Pythium debaryanum* and *P. splendens* by these standards were the only severe pathogens of slash pine. *Pythium spinosum* did not infect seedlings of either host in three tests. *Fusarium oxysporum* and *F. solani* caused some damping-off of both pines, although results were variable in different tests with different isolates. However, both the Fusaria caused more pre-emergence damping-off than the Phycomycetes or *Rhizoctonia solani.* In experiments where the Fusaria were applied to the steamed soil prior to planting they reduced emergence of slash pine by 60-70 per cent. (Figure 2).

IV. DAMPING-OFF CONTROL EXPERIMENT

An experiment was conducted at Beerwah Forest Nursery in 1960 to compare chemical soil treatments for their effects on emergence and damping-off incidence. A seed treatment was also included. The area was planted with slash pine seed at the rate of 16 per foot in rows 8 in. apart. Each plot consisted of three rows 4 ft long. A buffer area 20 in. wide was left around each plot. The layout was a 6 x 5 randomized block design, the six treatments being:—

(*a*) Captan (50 per cent. active ingredient); 1 oz to 40 sq. ft.
(*b*) Thiram (80 per cent. active ingredient); 1 oz to 40 sq. ft.
(*c*) Copper oxychloride (50 per cent. copper); 1 oz to 16 sq. ft.
(*d*) Captan + P.C.N.B. (50 per cent. active ingredient); 1 oz of each to 40 sq. ft.
(*e*) Thiram seed dressing (50 per cent. active ingredient).
(*f*) Control (untreated).

Apart from the seed dressing, the treatments were applied as soil drenches as soon as damping-off was noticed. This was 10 days after first germination. They were applied at the specified rate in one half-gallon of water per plot as the soil was moist at the time. A second application of the drenches was made three weeks later, and as the soil was fairly dry at this stage the chemicals were applied in one gallon of water per plot.

Damping-off counts were made on each week day and the diseased plants were removed as they were counted. Rainfall and humidity were low during the experiment and the beds were lightly watered twice daily in an endeavour to promote disease development. Seed germination was prolonged and consequently new infections occurred over a period of 8 weeks. Isolations from diseased seedlings yielded *Rhizoctonia solani, Pythium debaryanum* and *P. spinosum.*

A summary of the results is given in Table 3.

TABLE 3

RESULTS OF PINUS DAMPING-OFF CONTROL EXPERIMENT, 1960

Summary—mean values

Treatment	Percentage Diseased	Total No. of Plants
A. Captan	13·9	117
B. Thiram	14·6	113
C. Copper oxychloride ..	15·4	117
D. Captan + P.C.N.B. ..	15·5	105
E. Thiram Seed Dust ..	28·7	103
F. Control	34·0	110
s.e. and necessary differences for significance	7·01, 9·3, 12·6 A, B, C, D >> E, F	4·8 No significant differences

The drenches of captan, thiram, copper oxychloride, and captan + P.C.N.B. all significantly reduced damping-off. Although *Rhizoctonia solani* was one of the pathogens present, the addition of P.C.N.B., which is considered to be particularly effective against this organism, did not give better control than captan alone. None of the treatments including thiram seed dust increased emergence in this experiment. Phytotoxicity was not observed with any treatment. As germination and damping-off incidence were prolonged and frequent watering was carried out during the experiment, the degree of control may have been improved by additional applications of the drenches.

V. DISCUSSION

The types of organisms which are commonly associated with damping-off of conifers have been discussed by Vaartaja and Cram (1956). These workers and Vaartaja, Cram, and Morgan (1961) have pointed out the difficulties associated with testing for pathogenicity with such organisms. Laboratory and

greenhouse tests with seedlings raised in various sterilized media in fact give an estimate of the "potential" pathogenicity of the isolates. Tests in undisturbed seedbed soil may appear more realistic in theory but are fraught with difficulty because of the varied effects of soil flora and physical environment.

In the present study, pathogenicity tests were carried out in steamed soil in the greenhouse. Several organisms, including *Pythium debaryanum, P. ultimum, P. splendens,* an unidentified species of *Pythium, Phytophthora cinnamomi* and *Rhizoctonia solani* were shown to have a high potential pathogenicity. This, coupled with their frequency of isolation from diseased seedlings, suggests that they are important pathogens in Queensland forest nurseries.

Fusarium oxysporum and *F. solani* were frequently isolated from diseased seedlings but did not appear to have a great capacity for pathogenicity after seedling emergence. However, they caused more pre-emergence damping-off than the other organisms in steamed soil.

A nursery damping-off experiment illustrated that timely drenching of young plantings with captan, thiram or copper oxychloride will control the disease. Captan and thiram have proved effective in general forest nursery practice provided they are applied thoroughly to young seedlings at the first onset of symptoms. However, they have not been particularly effective when applied to larger seedlings suffering from rotting of the root tips as a result of *Pythium* or *Phytophthora* infection. Failure of such wettable powder preparations to penetrate sufficiently into the soil may be a problem here. Water-soluble fungicides may be more effective in such circumstances.

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