EFFECT OF SEED TREATMENT ON APHANOMYCES ROOT ROT OF PEAS

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ABSTRACT

Field trials to test the effectiveness of fungicidal seed treatments against *Aphanomyces euteiches* in soils with moderate and high disease severity indices (DSI), were carried out in two seasons.

In a soil of DSI = 100 the fungicides Dowco 444 (pyroxyfur), Previcur (Propamocarb), Ridomil (metalaxyl), fenaminosulf plus benomyl (f + b), and benomyl plus captan (b + c) had no effect on germination, disease severity at the 12-14 node and flat pod stages, or seed yield of Whero or Partridge 73 peas.

Fenaminosulf plus benomyl slightly reduced disease severity on Rovar and Small Sieve Freezer peas at the 11-13 node stage. Propamocarb effected a similar slight reduction in disease severity on Rovar peas only.

In a soil of DSI = 55, propamocarb, f + b and Tachigaren (hydroxyisoxazole) were used to treat seed of Whero and Partridge 73 peas sown in autumn and spring. F + b slightly reduced disease severity of autumn-sown peas at the 12 node stage but none of the treatments affected disease severity at a later stage, plant fresh or dry weight, or seed yield.

None of the chemicals tested gave effective control of *Aphanomyces euteiches.* Avoidance remains the only method of control for this disease.

Additional Key Words: fungicides, disease index, yield

INTRODUCTION

Cropping farmers in mid-Canterbury, where approximately 15,000 ha of field peas are grown annually, had reported recurring pea crop "failure" in some seasons throughout the 1970's. Severe crop loss was experienced in 1976, 1978 and 1979 (Table 1). Those seasons were characterised by greater than average spring rainfall which is known to favour Aphanomyces root rot (Papavizas and Ayers, 1974).

TABLE 1: Monthly rainfall (mm) deviations from normal (1941-1970) over six cropping seasons. Data from Highbank Power Station, 5 km from the trial sites. Area of pea crop not threshed in Canterbury statistical area.

		YEAR					
Month	Mean	1976	1977	1978	1979	1980	1981
Aug.	74	+ 12	− 11	+ 24	+ 21	+ 7	+ 25
Sept.	66	+ 55	+ 53	+ 159	− 68	− 21	− 34
Oct.	86	+ 23	− 38	+ 24	+ 105	− 35	+ 13
Nov.	97	− 59	− 52	− 44	− 42	+ 43	− 50
Dec.	94	+ 66	+ 18	+ 34	+ 3	− 20	-53
Jan.	89	+ 5	− 31	− 41	—	− 42	− 62
Area not harvested (Ha)		288	154	730	706	—	—

Common root rot of peas caused by *Aphanomyces euteiches* Drechsler was first identified in New Zealand by Manning and Menzies (1980) in a soil sample from Rakaia and subsequently was found to be widespread in Mid-Canterbury by survey (Jermyn and Arnst, unpublished data) and by indexing soil samples sent to the Plant Health Diagnostic Station, Lincoln, for testing.

A. euteiches is one of the most destructive pea pathogens known and is of major economic importance in the pea growing areas of the United States and elsewhere (Papavizas and Ayers, 1974).

Despite extensive chemical testing in the U.S.A. there are no reports of effective chemical control of Aphanomyces root rot, although Kotova and Tsvetkova (1980) found some benefit from use of hydroxyisoxazole. There is an urgent need for some means of control of this disease in Canterbury and the objective of this work was to identify effective chemical control agents for Aphanomyces root rot of peas so that scientists and advisors could provide farmers with factual information on disease control.

MATERIALS AND METHODS

Site

The sites for the two seasons were 1km apart on deep fertile Lyndhurst silt loam 5km east of Methven. This soil type predominates in the field pea growing area of Mid-Canterbury. The 1980 experiment was conducted on a soil with a disease severity index (DSI) of 100 while the 1981 site had a DSI of 55. This change was made because farmers had been advised to avoid planting peas in soil with DSI greater than 70 and that soils with DSI between 50 and 70 were potentially risky. Thus, a chemical treatment was more likely to be used in soils within the lower index range.

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Environment

Climatic data are presented in Table 1. Rainfall during the period of the experiments was less than average in 1980, except in November, and substantially less than average in 1981 when one of the most extreme droughts on record was experienced.

Cultivars

Maple peas, a generic term for round, yellow-cotyledoned peas with a mottled brown testa, have been grown in mid-Canterbury since the 1930's for export to the United Kingdom. Partridge 73 is a wilt resistant selection from Tasmanian Partridge and it is the most commonly grown maple pea cultivar.

Whero is a more determinate, larger seeded maple pea cultivar released in 1977. It may be grown successfully when spring-sown. A blue field pea, Rovar, and a garden pea cultivar, Small Sieve Freezer (SSF) were included in 1980 to assess the reaction of a wider range of cultivars.

Chemicals

In 1980, the fungicides pyroxyfur (Dowco 444, sample code XRM 4408), propamocarb (pro), metalaxyl (met), and mixtures of fenaminosulf plus benomyl, (f + b) and benomyl plus captan, (b + c) were used as seed dressings. In 1981, the treatments used were propamocarb, fenaminosulf plus benomyl and hydroxyisoxazole (hyd).

Seed lots for each treatment were treated with the fungicides in a rotating drum. Fungicides in the wettable powder form were added to 10ml water prior to application to the seed lots. The seed was dried in trays then divided up into replicate plot quantities.

Common Name	**Trade Name**	**Rates**
benomyl/captan	Benlate	2.5 g/kg of 50% ai. WP
	Orthocide	2.5 g/kg of 50% ai. WP
benomyl/ fenaminosulf	Benlate	2.5 g/kg of 50% ai. WP
	Bayer 5072	0.28 g/kg of 70% ai. WP
pyroxyfur	Dowco 444	3.2 ml/kg of 75% ai. EC
metalaxyl	Ridomil	1.43 g/kg of 25% ai. WP
propamocarb	Previcur	6 ml/kg of 70% ai. EC
hydroxyisoxazole	Tachigaren	5 g/kg of 70% ai. WP

Experimental

The layout for the experiments in 1980 was a randomised complete block with four replicates and in 1981 a split design with six replicates. Plot size was 15m^2, drilled at 100 seeds/m^2 with a 9-coulter Ojyord cone seeder. The planting dates for the first experiment were 22.8.80 (Partridge 73 and Whero) and 9.10.80 (Rovar and Small Sieve Freezer). Plant counts were made six weeks after each sowing. Plant samples of Partridge 73 and Whero were taken on 29 October and 2 December and 2 December and 5 January 1981 from the plots of Rovar and SSF.

To sample each plot, five plants were dug out by hand trowel from five randomly selected positions within the plot to provide 25 plants. These plants were root washed and individually scored for root rot symptoms according to the scale of Sherwood and Hagedorn (1958).

At maturity, all remaining plants from each plot were pulled and threshed in a stationary thresher. The harvest dates were 26.1.81 (Whero) and 10.2.81 for the other three cultivars.

The 1981 experiment was split into autumn (12.6.81) and spring (22.9.81) sowings of Partridge 73 and Whero. Plot size and populations were as described for the previous experiment.

Autumn-sown plots were sampled on 5 November and spring-sown plots were sampled on 1 December. Plant samples were scored as described. After scoring, roots were removed and the 25 plants from each plot were bulked, weighed, dried for 16 hours at 70C, cooled and reweighed.

Plots were direct headed at maturity with a Wintersteiger plot harvester. Harvest dates were 23 January 1982 (autumn-sown plots) and 1 February (spring-sown plots).

On each sampling occasion isolation and identification of the pathogen was made from randomly selected plants.

RESULTS

1980 Experiment

None of the chemicals significantly affected plant establishment (plants/m^2) which was satisfactory for Partridge 73 (107) and Whero (104) but was lower than planned for Rovar (80) and SSF (65). The SSF seed was four years old and had reduced germination.

There was no effect of chemicals on the DSI of Partridge 73 or Whero at either sampling time (Table 2). Nine weeks after planting (pre-flowering) the level of infection in both cultivars was slight to moderate (mean DSI = 54) and there was a significant difference between cultivars of 5 DSI points. At 14 weeks, (post-flowering) infection had progressed to a moderate (DSI = 67) level and there was no significant difference between cultivars.

TABLE 2: Disease severity index (DSI) of four pea cultivars seed-treated with fungicides. Scores taken at 9 and 14 weeks after planting in a soil of DSI = 100 in 1980/81.

Cultivars	Treatments						
9 wks	Dow	Pro	Met	f + b	b + c	Untr.	Mean
Part.	48.5	47	61.2	46	53	54.2	51.7
Whero	56.2	55.7	57	53.5	58.2	0.7	56.9
Rovar	92.5	82.7	95	86.5	93	93.2	90.5
SSF	88.2	84.7	90.7	74.5	89.5	85.5	85.5
14 Wks							
Part.	66.5	66.7	68.7	62.7	66.2	61.7	65.5
Whero	63.2	63.7	70.2	65.7	71	78	68.7
Rovar	94	93.5	93.7	89.2	93.2	93.5	93
SSF	94	91.5	94	94.2	94.7	96	94.1

Sign. levels
Dates 1%
Dates. Rep. Cultivar 1%
Treatments 5% Rovar and SSF at 9 weeks.

Seed yield of both cultivars was low but Partridge 73 significantly outyielded Whero (Table 3). The low yield was thought to be due largely to a heavy infestation of wild oats (*Avenua fatua*) and several broadleaf weed species. The comparatively low yield of Whero reflected the inability of this more determinate cultivar to smother weeds.

In spite of the moderate level of infection in these two cultivars, there appeared to be no adverse effects on the aerial parts of the plants.

TABLE 3: Yield (t/ha) of four pea cultivars seed-treated with fungicide planted into a soil of DSI = 100 in 1980/81.

Cultivars	Treatment						
	Dow	Pro	Met	f+b	b+c	Untr.	Mean
Part.	1.65	1.40	1.61	1.61	1.21	1.54	1.50
Whero	1.27	1.38	1.18	1.20	1.09	0.91	1.17
Rovar	0.83	0.84	0.78	0.89	0.90	0.71	0.83
SSF	0.86	0.87	0.67	0.89	0.76	0.57	0.77

By contrast, the later planted Rovar and SSF plants had developed a severe infection level after nine weeks. There were small, but statistically significant, differences among treatment means and between cultivars (Table 2). Propamocarb and fenaminosulf plus benomyl (f+b) reduced DSI slightly in SSF and propamocarb also slightly reduced DSI in Rovar. At this stage, the plants of both cultivars appeared stunted, weak and showed wilting on the lowest 2-3 nodes.

At 14 weeks, the DSI had increased slightly and there were no longer any differences between treatments and cultivars. All plots were distinctly diseased, exhibiting what farmers described as "typical" pea failure symptoms seen in previous seasons. Rovar significantly outyielded SSF (Table 3) but the yield of both cultivars was very low. Weed infestation was less severe than in the Partridge 73 and Whero plots.

1981 Experiment

The experiment was repeated with modification primarily to test and compare the effectiveness of hydroxyisoxazole under local conditions. The results are presented in Table 4.

In autumn-sown plants, root rot infection had reached an index of 46 by the first sampling date. The DSI of Partridge 73 was significantly reduced by 27% with f+b treatment and by 9% with hydroxyisoxazole and propamocarb. While f+b significantly reduced the DSI of Whero by 19% propamcarb raised it by 9%. There was a small but significant difference of 5 DSI points between cultivars, Whero being the higher.

At this stage, plant dry weight was not significantly affected by treatment. Whero was slightly heavier than Partridge 73. From about the 5-node stage until the sampling date, the farmer on whose property the trial was conducted, was consistently able to identify autumn-sown plots treated with f+b on the basis of plant vigour. This difference was not detectable later in the season.

TABLE 4: Disease severity index and total dry weight (gms) of 25 plants of two pea cultivars treated with fungicides and planted in autumn and spring into a soil of DSI = 55 in 1981/82.

	Treatment				
DSI	Hyd	f+b	Pro	Untr	Mean
Autumn					
Cultivars					
Part.	44.3	35.5.	44.3	48.7	43.2
Whero	51.7	40.2	53.8	49.5	48.8
Sign. Levels					
Cultivars		1%			
Treatments		1%			
C.V.%	10.8				
Spring					
Part.	74.7	72.3	74.3	74.2	73.9
Whero	76.7	74.7	75.3	74.2	72.5
Sign. Levels					
C.V.%	4.4				
Dry Wt					
Autumn					
Part.	46.7	61.3	52.3	51.5	53.0
Whero	57.7	65.2	57.3	5.85	59.7
Sign. Levels					
Cultivars		5%			
C.V.%	19.3				
Spring					
Part.	45.0	37.3	34.7	41.5	39.6
Whero	48.7	50.8	52.2	39.7	47.8
Sign. Levels					
Cultivars		1%			
Treatments		1%			
C.V.%	15.2				

Seedlings treated with f+b had noticeably less infection with *Septoria pisi* leaf spot when recorded at the 4-5 node stage but no sampling was carried out for this disease.

Disease severity index reached a level of 77 (moderate) in spring-sown plots when sampled on 1 December but there were no significant differences between chemicals or cultivars. Infection level was extremely uniform. Plant fresh weight was not affected by chemicals but Whero plants were slightly heavier ($p = 0.05$) than Partridge 73. Plant dry weight differed ($p = 0.01$) between cultivars and there was an interaction between chemicals and cultivars. Whero plants from all treatments and Partridge 73 plants treated with hydroxyisoxazole were heavier ($p = 0.01$) than untreated plants and Partridge 73 plants treated with f+b and propamocarb.

There was no significant yield difference between cultivars or among treatments sown in Autumn (Table 5). Mean yield of the spring-sown plots was 1.5 tonnes/ha, half that of the autumn-sown plots. Again there were no significant differences in yield due to treatments but Whero out-yielded Partridge 73 by 0.5 t/ha, confirming its superiority for spring planting. However, it is not common practice to plant Partridge 73 as late as 22 September.

The low yield from the spring planting was due predominantly to the severe drought (see Table 1), reflecting reduced pea yields in nearby crops in disease-free soil.

TABLE 5: Yield (t/ha) of two pea cultivars treated with fungicide and sown into a soil of DSI = 55 in 1981/82.

	Treatment				
	Hyd	f+b	Pro	Untr	Mean
Autumn					
Part.	3.00	3.08	2.92	3.11	3.03
Whero	2.78	3.21	3.16	3.35	3.12
Sign. Levels					
C.V.%	12.8				
Spring					
Part.	1.25	1.24	1.31	1.28	1.27
Whero	1.88	1.72	1.80	1.72	1.78
Sign. Levels					
Cultivars		1%			
C.V.%	9.9				

DISCUSSION AND CONCLUSION

Because both seasons were dry and generally not conducive to the development of root rot, the results must be interpreted with caution except for comparisons among treatments.

The fungicide mixture of fenaminosulf plus benomyl gave a small, but significant, reduction in DSI on Rovar and SSF peas spring-sown into a high DSI (100) soil. This also occurred in autumn-sown Partridge 73 and Whero peas in a slightly infected soil (DSI = 55). This effect was noted when the plants were in the pre-flowering stage (12-15 nodes). The effect did not persist. Yield was not affected by any fungicide treatment in either year.

These results confirm previous reports of no effective control agents from extensive chemical testing against Aphanomyces root rot in the United States (Papavizas and Ayers, 1974). The strongly phytotoxic effect of propamocarb reported by Kotova and Tsvetkova (1980) was not seen in these experiments.

In both years, DSI of autumn or early spring-sown peas was lower and yield was higher than later sown peas. It may be tempting to conclude that early sowing affords some protection from, or tolerance of Aphanomyces root rot. However, without comparable sowing date experiments in disease free soils, it is not valid to draw this conclusion from the results presented.

Whero appears marginally (3-5%) more susceptible to Aphanomyces than Partridge 73, at least in the pre-flowering stage. The yield figures from the two seasons demonstrate an advantage and a disadvantage of the more determinate growth habit of Whero compared with Partridge 73. In 1980/81, Whero failed to suppress a heavy weed infestation, but in the spring planting of 1981/82, produced a higher yield than Partridge 73 under severe drought conditions.

Control of Aphanomyces root rot in New Zealand parallels previous experience elsewhere. Without resistant cultivars or effective chemicals, avoidance remains the only safe method of control. An effective soil indexing service is available to farmers through the Ministry of Agriculture and Fisheries and should be used to minimise crop loss.

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