EFFECTS OF DISEASE RESISTANCE AND FUNGICIDE TREATMENTS ON SCALD AND YIELD IN FOUR BARLEY CULTIVARS

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ABSTRACT

New Zealand barley cultivars differ in resistance to leaf scald, caused by *Rhynchosporium secalis.* Four cultivars (one highly resistant, two moderately resistant and one susceptible) were selected for evaluation in a field trial under differing fungicide regimes. Fungicide applications were used to encourage no epidemic (early + late fungicide applications), an early epidemic (late applications only), a late epidemic (early applications only) or a full epidemic (no applications). Disease severity was assessed six times. The resistant cultivar, Dash, was virtually free of scald at all assessment dates. Disease progressed rapidly in untreated plots of the susceptible cultivar, Optic, from the first appearance of scald (13 August) until all leaves were fully diseased (mid-November). Fungicide applications reduced scald severity in Optic, but did not eliminate the disease. The two moderately resistant cultivars had intermediate disease levels. Yields reflected relative disease severity, with the greatest yield differences between full and no disease control being recorded in Optic. Control of the late epidemic increased yield to a much greater extent than the early epidemic.

Keywords: *Rhynchosporium secalis*, partial resistance, disease severity.

INTRODUCTION

Scald, caused by *Rhynchosporium secalis* (Oud.) J. J. Davis, is a common disease of barley (*Hordeum vulgare* L.) in New Zealand. In a survey, Arnst and Fenwick (1973) found 30% of New Zealand barley crops were infected with *R. secalis*. In the Wairarapa district of the North Island this figure has reached 90% (Cromey *et al.* 1980), with individual crop yield losses estimated to be as high as 44% (Sheridan and Grbavac 1977).

Disease resistance can provide a cost-effective means of controlling diseases such as scald, but resistance is often race-specific, and therefore may quickly be overcome. For instance, Cromey (1987) identified four races of *R. secalis* in New Zealand which overcame the resistance of several local cultivars. The pathogenic variation of *R. secalis* in New Zealand presents a risk to the use of resistance based on single genes in barley cultivars. Smaller, quantitative levels of resistance reduced yield losses caused by *R. secalis* (Rowling and Jones 1976). Such resistance can also be race-specific (Habgood 1976), but provides an additional strategy in breeding for potentially durable resistance to *R. secalis*. New Zealand barley cultivars range from highly resistant to highly susceptible to scald, with several cultivars showing intermediate levels of resistance (Cromey *et al.* 1999). The research presented here sought to determine the effects of disease resistance and fungicide treatments on scald severity and grain yield.

MATERIALS AND METHODS

A field trial was sown at the Crop & Food Research farm at Lincoln, Canterbury on 4 May 1999 using a split plot design with four replicates. Fungicide treatments were applied to main plots and sub-plots (10 m x 1.5 m) of four cultivars, Optic (susceptible), Dash (resistant), Valetta and Regatta (both partially resistant), were sown within each of four fungicide treatments. The fungicide treatments were: full fungicide (fungicides applied 20 Aug, 15 Sep, 28 Sep, 19 Oct); early fungicide (fungicides applied 20 Aug, 15 Sep); late fungicide (fungicides applied (28 Sep, 19 Oct); and no fungicide (no fungicides applied). Fungicide (187.5 g/ha tebuconazole as Folicur 430) was applied using a motorised back-pack sprayer with a hand-held boom fitted with XR TeeJet Nozzles (Spraying System Co. XR11002-VP) calibrated to apply 200 litres/ha.

Percentage leaf area affected by scald and other diseases on the top three fully expanded leaves of 20 tillers per plot was assessed on six dates. Due to bird damage in the trial, 100 undamaged ears were collected per plot and threshed. The resulting grain was weighed and thousand grain weights determined. Tiller counts were made in each plot to estimate plot yields. Yields and thousand grain weights were adjusted to 14% moisture.

Data were analysed using analysis of variance. Disease severity scores for Dash were removed from the analysis on dates where scald was not recorded. The level of variability between main-plots was similar to that within main-plots, so the analysis was repeated as if the trial was a completely randomised block design, ignoring the split plot structure.

RESULTS

Scald was the predominant disease in the trial, although low levels of net blotch, caused by *Drechslera teres* Sacc. Shoemaker, were also recorded. Slight scald infection was recorded on 20 August, when the first fungicide application was made (Table 1). Severity was higher (P<0.05) in cv. Optic than in the other three cultivars. Scald severity remained greater (P<0.05) in cv. Optic than in the other cultivars at all assessment dates. Apart from traces of scald at the first assessment date, cv. Dash was not affected by the disease. The cultivars Regatta and Valetta had intermediate scald levels, with slightly greater severity recorded on Valetta than on Regatta.

TABLE 1: Mean percent leaf area affected by scald on the top three fully expanded leaves of barley cultivars to which four different fungicide treatments were applied.

Cultivar	Treatment	20 Aug[1]	14 Sept	15 Oct	26 Oct	4 Nov	15 Nov
Dash	Full fung.	–	0.0	0.0	0.0	0.0	0.0
	Late fung.	–	0.0	0.0	0.0	0.0	0.0
	Early fung.	–	0.0	0.0	0.0	0.0	0.0
	No fung.	0.5	0.0	0.0	0.0	0.0	0.0
Regatta	Full fung.	–	0.3	1.3	2.3	3.5	16.5
	Late fung.	–	1.6	1.7	5.8	6.1	11.5
	Early fung.	–	0.4	2.2	16.0	21.3	47.0
	No fung.	1.1	5.0	6.3	24.9	29.3	44.0
Regatta	Full fung.	–	0.6	2.0	5.6	3.7	11.3
	Late fung.	–	1.5	3.3	10.7	6.1	24.5
	Early fung.	–	0.5	2.0	17.5	22.1	49.0
	No fung.	1.0	1.5	11.3	36.4	48.7	68.5
Regatta	Full fung.	–	6.0	10.3	31.9	29.1	65.5
	Late fung.	–	18.9	15.9	51.5	58.6	65.0
	Early fung.	–	10.2	45.3	79.3	90.8	97.5
	No fung.	4.6	28.3	43.5	66.8	87.0	92.1
LSD (P<0.05)	df=32	1.7 (df=21)	7.1	6.1	12.1	10.3	13.0
LSD (P<0.05)	df=32 to compare with Dash		5.0	4.3	8.6	7.3	9.2

[1]Assessment immediately prior to first application of fungicides.

Scald severity in untreated plots increased during the course of the experiment, rapidly becoming severe in cv. Optic. Late fungicide applications reduced scald severity to low levels dramatically in cvs Regatta and Valetta until the final assessment, but provided only partial control in cv. Optic.

Early fungicide applications reduced disease levels in cv. Optic at the 14 September assessment, but with ongoing crop growth this effect was no longer seen on the upper three leaves of plants by the 15 October assessment, a month after these plots received their final fungicide application.

Yields and grain weights were affected by fungicide treatment (Table 2). The full fungicide treatment increased (P< 0.05) yields and grain weights compared with the nil fungicide treatment for Optic and Valetta, the two most susceptible cultivars. The same trend was observed in the more resistant Dash and Regatta, but differences were not statistically significant (P>0.05). There is little evidence that yields from plots which received early fungicide applications alone were different (P>0.05) from untreated plots.

TABLE 2: Mean yields and grain weights of four barley cultivars which received different fungicide treatments.

	Yield (t/ha)				Grain weight (mg)			
	Full fung.	Late fung.	Early fung.	No fung.	Full fung.	Late fung.	Early fung.	No fung.
Dash	5.2	5.1	4.4	4.5	35	35	31	32
Regatta	5.2	4.9	4.4	4.7	39	39	38	37
Valetta	4.8	4.3	4.3	3.9	33	32	30	28
Optic	4.6	3.9	3.6	3.4	35	29	31	28
LSD (P<0.05) (df=43)	0.9				4.1			

Even with the partial levels of scald control achieved, full-fungicide-treated plots of Optic yielded 35% more, and had grain weights 25% greater than untreated Optic plots (Table 3). Yield and grain weight increased by 16 and 9% respectively in Dash, where virtually no disease was recorded.

TABLE 3: Yields and grain weights (as percentage of nil fungicide treatment) for four barley cultivars which received different fungicide treatments.

	Yield (t/ha)				Grain weight (mg)			
	Full fung.	Late fung.	Early fung.	No fung.	Full fung.	Late fung.	Early fung.	No fung.
Dash	116	113	98	100	109	109	97	100
Regatta	111	104	94	100	105	105	102	100
Valetta	123	110	110	100	118	114	107	100
Optic	135	115	106	100	125	104	111	100

DISCUSSION

Results presented here confirm previous research (Cromey *et al.* 1999) that New Zealand barley cultivars differ in resistance to scald. Amongst the resistant cultivars, those with resistance characteristics like Dash have a high level of resistance and are seldom infected in the field. Other cultivars, such as Regatta and Valetta, have partial resistance, and disease severity will vary according to inoculum and environment, as well as fungicide applications.

It proved difficult to control scald with fungicides in the highly susceptible cultivar Optic under the high inoculum in the trial. The trial was autumn-sown, and disease in such situations is usually severe, but it can also be severe in second or subsequent spring barley crops (Cromey *et al.* 1999) and in wet years. For instance, the intermittent rain during the 1999/2000 summer led to late outbreaks of scald in some Canterbury spring barley crops (M. Cromey, unpubl. data). The 35% yield increase in fungicide-treated cv. Optic, even with the partial control achieved with fungicides, demonstrates the potential of scald to reduce yields in New Zealand barley crops.

The value of partial resistance to scald was demonstrated by the relatively low disease levels in Regatta and Valetta. Final disease severity was reduced (full fungicide compared with nil-fungicide) by 29% in the highly susceptible cv. Optic, compared with 63% and 84% for Regatta and Valetta respectively. Disease control with fungicides was therefore relatively better in partially resistant cultivars than in the susceptible cultivar. Cost-effective control in such cultivars will require the optimisation of the number and timing of applications.

Very low disease levels were recorded in cv. Dash even in nil-fungicide plots. The yield increase in this cultivar in plots that received late fungicide applications (late or early + late treatments) compared with those that did not (nil fungicide or early fungicide only), reinforces the importance to grain yield of retaining the photosynthetic area of upper leaves. No other diseases were observed in Dash, but yield increases in response to fungicide may be due to control of minor pathogens.

Infected host residue is the principal source of primary inoculum of *R. secalis* (Davis and Fitt 1992). The development of scald epidemics in plots that received only early fungicide applications suggests that sufficient inoculum is available to cause a late epidemic if conditions are suitable, even where early disease control has been applied. Interplot interference may have exacerbated this in the trial situation, and partial resistance will be more effective in a field situation where there is no inoculum from adjacent diseased plots. Integrated scald control should combine cultivar resistance with appropriate crop rotations and fungicide applications where necessary. Highly susceptible cultivars should be avoided where second year or subsequent barley crops are grown.

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