

SUSCEPTIBILITY OF NEW ZEALAND WHEAT CULTIVARS TO SHARP EYESPOT

M.G. CROMEY, R.C. BUTLER, C.A. MUNRO and S.C. SHORTER

Crop & Food Research, Private Bag 4704, Christchurch, New Zealand

Corresponding author: cromeym@crop.cri.nz

ABSTRACT

The susceptibility of 12 New Zealand wheat cultivars to sharp eyespot (caused by *Rhizoctonia cerealis*) was examined in three autumn-sown field trials in the 2004-05 growing season. Moderate to high disease incidence was recorded in two of the trials, and low levels occurred in the third. While disease incidence was high in at least some plots of most cultivars, low incidence was recorded in all plots of two cultivars, and all but two plots of two other cultivars. These trials provide evidence that at least 2 of the 12 cultivars have useful levels of resistance to sharp eyespot, and that several cultivars are highly susceptible. Ranking of the more susceptible cultivars varied between locations. Further work is required to determine whether this is due to genetic interactions between hosts and pathogens or whether relative susceptibility of cultivars to sharp eyespot can be affected by environment.

INTRODUCTION

Sharp eyespot of wheat (*Triticum aestivum*), caused by *Rhizoctonia cerealis* van der Hoeven, is common in New Zealand wheat crops (Cromeey et al. 2002). The disease was recorded in 43% of surveyed South Island wheat crops in the 1998/99 growing season, and incidence in infected crops ranged from 2 to 88% from 1996 to 2000 (Cromeey et al. 2002). Severe sharp eyespot of mature tillers may result in small, shrivelled grain, lodging and premature ripening (Clarkson & Cook 1983). While sharp eyespot is not a major yield-limiting disease of wheat in New Zealand, it can reduce yields considerably under local conditions conducive to its establishment, with losses in individual crops calculated as high as 18% (Cromeey et al. 2002). Yield loss has been shown to be related to disease incidence, and was considered to be negligible when the incidence was below 10% (Cromeey et al. 2002). In England and Wales, severe infection has been shown to reduce yields by an average of 26% (Clarkson & Cook 1983).

There is little information on cultivar resistance to sharp eyespot (Wiese 1987). Use of resistant cultivars, or at least the avoidance of highly susceptible cultivars, may be useful strategies to minimise yield losses from sharp eyespot. Field experiments comparing commercial wheat cultivars where plots were inoculated with *R. cerealis* were carried out over a number of years in the late 1970s and early 1980s at the Plant Breeding Institute, Cambridge, England (Hollins & Scott 1983b). Differences in sharp eyespot infection were found between cultivars in each year. While some cultivars were always relatively heavily or lightly infected, the ranking order of cultivars was not always consistent. Clulow & Wale (1984) conducted a similar trial with some of the same cultivars and, while there were again significant differences between cultivars, there was some inconsistency with the results of Hollins & Scott (1983b). More recently, cultivar resistance in wheat to sharp eyespot has been examined in China. Variation in resistance between cultivars was identified, with cultivars ranging from highly resistant to highly susceptible, although only 4–7% of all wheat lines tested, and as few as 1.7% commercial cultivars, were resistant (He et al. 1998; Shi et al. 2000).

The series of trials reported in this paper provide preliminary information on whether current New Zealand wheat cultivars differ in resistance to sharp eyespot. The possible need for artificial inoculation of future cultivar evaluation trials is evaluated.

MATERIALS AND METHODS

Assessments of sharp eyespot were carried out in three cultivar field trials. Two trials were located at Chertsey, Canterbury, at the Foundation for Arable Research (FAR) field site. These two trials were in adjacent blocks, one of which was irrigated. Both trials were sown on 22 April 2004 in randomised complete block designs with 4 replicates, and consisted of 12 wheat cultivars in plots each consisting of 9 rows, 8 m long. Sharp eyespot incidence in each plot was assessed *in situ* on 4 January 2005 at the soft dough stage of grain development. The percentage of tillers with distinct sharp eyespot lesions on leaf sheaths was assessed by counting tillers (infected and healthy) in 0.5 m lengths of row (avoiding the outer two rows) in each of four positions in each plot.

The third (irrigated) trial, sown on 20 May 2004, was located at the Crop & Food Research farm at Lincoln, Canterbury. This trial consisted of three sub-trials, each with three replicates in a randomised complete block design. The trials consisted of 54 cultivars, but only the 12 cultivars that were in the Chertsey trials were assessed for sharp eyespot incidence. Each plot was two rows, 1 m long. Plots were assessed for sharp eyespot infection on 12–14 January 2005, at the mid dough stage of grain development.

All data from these assessments were analysed by ANOVA, using this primarily as an exploratory tool rather than an exact analysis. The results were checked against an equivalent non-parametric analysis (Friedman's non-parametric ANOVA) and were found to be consistent.

RESULTS

Sharp eyespot was detected at moderate to high levels in two of the three trials assessed (Table 1). These two trials had similar sharp eyespot incidence, with a mean of 8.8% of tillers infected at the May-sown Lincoln trial and 10.9% tillers affected at the April-sown irrigated Chertsey trial. Incidence was low (mean of 1.2%) in the April-sown dryland trial at Chertsey, which was adjacent to the irrigated Chertsey trial.

TABLE 1: Mean and median incidence of sharp eyespot on tillers of 12 wheat cultivars in three field trials.

Cultivar	Mean % tillers with sharp eyespot			Median % tillers with sharp eyespot ¹	% plots with >15% tillers infected ¹	% plots with >30% tillers infected ¹
	Lincoln	Chertsey irrigated	Chertsey dryland			
Regency	0.3	0.6	0.0	0.0	0.0	0.0
Centaur	2.9	4.7	2.1	2.8	0.0	0.0
Weston	3.9	9.4	0.6	3.8	7.7	0.0
Solstice	6.8	10.6	0.0	5.7	30.8	0.0
Pennant	7.1	6.3	0.6	7.0	7.7	0.0
Macro	8.5	4.4	1.6	2.6	15.4	0.0
Alberic	8.7	20.9	3.8	7.7	30.8	23.1
Option	9.3	5.6	2.2	5.0	30.8	0.0
Claire	10.0	23.4	0.6	9.7	46.2	15.4
Tanker	10.8	16.9	1.3	6.5	23.1	7.7
Savannah	12.0	18.8	0.0	15.5	53.8	7.7
Equinox	24.8	9.1	1.9	20.0	61.5	30.8
LSD (P<0.05)	7.4	14.1	3.5			
(df)	(88)	(33)	(33)			

¹Combined for the Lincoln and the Chertsey irrigated trials.

one trial and median incidences across two trials of over 7.5%. Tanker may also be at particular risk of sharp eyespot, with incidence of over 30% in one plot.

Cultivar ranking was not always consistent between trials, as reported in studies in the United Kingdom (Hollins & Scott 1983b; Clulow & Wale 1984). This was particularly obvious in some of the more susceptible cultivars. For instance Equinox was by far the most heavily infected cultivar in the Lincoln trial, but had only intermediate incidence in the Chertsey irrigated trial. Conversely, Claire and Alberic were the most heavily infected cultivars in the Chertsey irrigated trial, but were only the fourth and sixth most infected cultivars at Lincoln. This lack of consistency could be due to genetic (host-pathogen) or environmental interactions and warrants investigation. Firstly, it is possible that some cultivars are more susceptible to some *R. cerealis* populations than to others, reflecting a gene-for-gene interaction.

It is also possible that relative cultivar resistance can be affected by environment. It is known that sowing date and soil moisture and temperature can affect sharp eyespot severity (Wiese 1987) and it is possible that such factors could differentially affect disease development amongst cultivars. Until these causes of variation between trials are resolved, it will be important to conduct cultivar testing at a range of sites over time to accurately assess relative cultivar resistance. The high level of sharp eyespot in some cultivars in some trials indicates that they have the potential to be heavily infected. Conversely, those cultivars that have low disease levels in all trials can reasonably be claimed to be resistant to the disease, although confirmation in further trials will be desirable.

As well as cultivar differences between trials, there were often large differences between plots of individual cultivars in the same trial. Such differences are probably due to the uneven distribution of soilborne inoculum within trials. It is a common practice to artificially inoculate sharp eyespot cultivar trials with one or more isolates of *R. cerealis*. While this will ensure that plants in each plot are exposed to pathogen inoculum, it does not ensure that they are exposed to the same level of inoculum. In the current trials, high disease incidence was recorded in some plots, in spite of reliance on natural inoculum. Adding inoculum equally to all plots may overwhelm the resistance of some cultivars in plots that already have a high level of natural inoculum. Further experiments comparing natural versus applied inoculum are planned in order to optimise assessment methods.

The other advantage of applying inoculum is that it ensures sufficient inoculum for disease expression. Two of the three trials had sufficient disease incidence to compare cultivars. The low-incidence dryland Chertsey trial was adjacent to the irrigated Chertsey trial and it is therefore more likely that soil moisture was responsible for differences in disease incidence than the levels of primary inoculum. However, inoculum differences cannot be ruled out, since the trials were adjacent, and irrigated/dryland treatments were not included within the trials for practical reasons.

Hollins & Scott (1983a) assessed seedling and adult plant resistance to sharp eyespot in glasshouse tests. They detected differences between cultivars at both growth stages, but results for seedlings and adult plants were not correlated. However, results for adult plants in the glasshouse were comparable to field scores of adult plants. This difference in ranking between seedling and adult stages demonstrated that growth stage is important when assessing resistance to sharp eyespot.

The present study has revealed considerable variation in sharp eyespot resistance between currently grown New Zealand commercial wheat cultivars. Because yield losses due to sharp eyespot have been demonstrated to be negligible when disease incidence is below 10% (Cromey et al. 2002), the most appropriate strategy for control of the disease is probably the avoidance of highly susceptible cultivars, especially in early autumn-sown crops amongst which disease incidence is usually greatest (M.G. Cromey, unpubl. data). Sharp eyespot susceptibility should therefore be considered by plant breeders during cultivar selection. While destructive sampling of plots will provide the most accurate differentiation of resistant and partially resistant cultivars, highly susceptible cultivars can easily be distinguished *in situ* during grainfill, as long as assessments are made in several plots and trials.

ACKNOWLEDGEMENTS

The Chertsey trials were managed by Mr Bede McCloy. The Foundation for Arable Research (FAR) funded the establishment and maintenance of all trials. Sharp eyespot resistance research undertaken in these trials was funded by the New Zealand Foundation for Research, Science and Technology.

REFERENCES

- Clarkson JDS, Cook RJ 1983. Effects of sharp eyespot on yield loss in winter wheat. *Plant Pathology* 32: 421-428.
- Clulow M, Wale SJ 1984. Resistance of cultivars of wheat, barley and oats to sharp eyespot. *Annals of Applied Biology* 104 (Supplement, Tests of Agrochemicals and Cultivars, 5): 104-105.
- Cromey MG, Butler RC, Boddington HJ, Moorhead AR 2002. Effects of sharp eyespot on yield of wheat (*Triticum aestivum*). *New Zealand Journal of Crop and Horticultural Science* 30: 9-17.
- He W, Song Y, Zhang Z 1998. Evaluation of resistance of wheat cultivars to sharp eyespot. *Crop Genetic Resources* 39: 30-31.
- Hollins TW, Scott PR 1983a. Sharp eyespot. Annual Report of the Plant Breeding Institute. Plant Breeding Institute, Cambridge, U.K. Pp. 99-100.
- Hollins TW, Scott PR 1983b. Resistance of wheat cultivars to sharp eyespot caused by *Rhizoctonia cerealis*. *Annals of Applied Biology* 102 (Suppl.): 126-127.
- Wiese MV 1987. Compendium of wheat diseases. Second edition. APS Press, St Paul, Minnesota.
- Shi J, Wang Y, Chen H 2000. Screening techniques and evaluation of wheat resistance to sharp eyespot caused by *Rhizoctonia cerealis*. *Acta Phytopylacica Sinica* 27: 107-112.