CONTROL OF EYESPOT LODGING IN WHEAT WITH SYSTEMIC FUNGICIDES

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Summary

Thirteen systemic fungicides have been assessed for the prevention of lodging in wheat crops affected by eyespot (*Cercosporella herpotrichoides* Fron). A single foliar spray application of several materials, benomyl, thiabendazole, thiophanate-methyl and mecarbinizid has given good control of lodging in eyespot-infected crops. Other materials gave little control at the rates and times applied. Two fungicides, benomyl and thiabendazole, were evaluated at two times of application and gave better results when applied at a late growth stage (jointing) than when applied at an early stage (tillering). Seed treatment with benomyl was ineffective.

INTRODUCTION

THE EFFECT of various cultural methods on the control of eyespot (*Cercosporella herpotrichoides* Fron) in wheat has been reported (Blair, 1954; Manning, 1967; Witchalls and Hawke, 1970). Low seeding rates, good drainage, effective weed control, and efficient burning of stubble or its destruction by ploughing immediately after harvest are all factors which help to minimize the effects of this disease. Where successive wheat crops are grown, however, eyespot can still be a problem in spite of good management practices.

The use of chlormequat on wheat crops infected by eyespot has reduced lodging with a corresponding yield increase (Witchalls, 1970). This chemical does not control the disease but, by shortening and strengthening internodes, enables the wheat plant to withstand the stresses that cause lodging.

Benomyl, a systemic fungicide, when applied as a spray to infected crops, has prevented lodging (Witchalls and Close, 1971). This investigation examines further the use of benomyl as a foliar spray applied at different rates and stages of growth, as well as evaluating several other fungicides for eyespot control.

EXPERIMENTAL

All trials were in a randomized block design with plots 40 m × 1.22 m (seven drill coulter rows 17.5 cm apart) except for Trials A and B which were 12 m long. The systemic fungicides were applied at different growth stages (as measured by the Feekes scale, Large, 1954) in 225 l/ha of water. In the seed treatment benomyl was applied to the wheat at a rate of 2.49 g/kg of seed in the form of a slurry.

The wheat varieties sown were Hilgendorf 61 in Trials A, B, D, E and F, Aotea in Trial C and Aotea and three New Zealand Department of

The effect of time of fungicide application on eyespot lodging. Standing plot in centre sprayed late (Feekes 7-8) with benomyl (0.14 kg) with the two plots on immediate left sprayed early (Feekes 3-4) with thiabendazole (0.67 kg) and benomyl (0.28 kg), respectively. The plot on the immediate right is untreated and the next plot sprayed early with benomyl (0.14 kg).

Scientific and Industrial Research (DSIR) recent selections in Trial G. Seeding rates were 145 to 170 kg/ha for Trials A, B, C and G and 240 to 270 kg/ha for Trials D, E and F.

All trials were on areas where severe eyespot infection could be expected and were either third, fourth or fifth successive crops. Trials B, D, E and F had eyespot-infected straw spread over the trial area at drilling and 375 kg/ha of nitrogen applied before tillering, so as to induce a uniform and high incidence of disease over the trial area.

All trials received 250 to 375 kg/ha of basal superphosphate and were sprayed for weed control.

Lodging and yield measurements were made as follows:

(a) Lodging was assessed visually on a 0 to 10 scale (0 = no lodging, 10 = 100% lodging) and by counting lodged tillers in fifteen 1 m or 0.91 m row lengths in each plot.

(b) Yield: The plots were direct headed by a commercial harvester and yield weights corrected to 15% moisture. A low harvesting height was used so as to head some of the lodged tillers.

RESULTS

For Trials A and B, lodging assessments only are in Table 1; yield was not measured. In each trial lodging was severe with some treatments completely lodged. The most effective treatments were benomyl, thiabendazole, mecarbinizid and the thiophanate compounds.

Yield and lodging assessments for Trials C, D, E and F are in Tables 2, 3 and 4. In Trial C the seed treatment with benomyl and the foliar spray treatments of triarimol and ethirimol were ineffective. In this trial as well as Trials D, E and F the spray applications of benomyl at Feekes 3 to 4 (F3-4) were not as effective as the later application at Feekes 7 to 8 (F7-8). This was particularly so in Trial E with Hilgendorf 61 where severe eyespot occurred and the early spray treatments lodged

TABLE 1: TRIALS A AND B

Effects of various systemic fungicides, applied as sprays, on eyespot lodging in Hilgendorf 61 wheat at Waimatuku

Fungicides (all applied Feekes 7-8)	*Rate (kg/ha)*	*Lodging Index (0-10% Scale)*
1970-1—Trial A:		(mean of 3 reps.)
benomyl	0.28	0.8
thiabendazole	0.63	2.0
thiophanate	0.84	3.2
thiophanate-methyl	0.39	5.0
triarimol	0.09	5.3
triarimol	0.05	8.0
fuberidazole	0.49	7.0
dichlozoline	0.34	8.0
chloraniformethan	0.14	8.6
ethirimol	0.91	8.6
tridemorph	0.34	9.3
Untreated		9.0
1971-2—Trial B:		(mean of 6 reps.)
benomyl	0.28	2.3
mecarbinizid	1.08	1.1
thiophanate-methyl	0.87	3.2
triarimol	0.18	9.0
biformylchlorazin	0.55	10.0
Shell WL 24479	2.07	10.0
Untreated		10.0

TABLE 2: TRIAL C

Effect of benomyl applied as a seed treatment, or as a spray at two rates and times of application, and of ethirimol and triarimol sprays on eyespot lodging and yield of Aotea wheat, Browns, 1971-2.

Treatment (kg/ha)	*Applied Growth Stage*	*% Lodged Tillers**	*Yield (kg/ha)*
benomyl 0.14	F3-4	9.9 bcBC	2630 bcdBCD
benomyl 0.28	F3-4	5.0 cC	2930 abcABC
benomyl 0.14	F8	1.2 dD	3420 aA
benomyl 0.28	F8	0.3 eE	3140 abAB
benomyl seed treatment†		27.2 aA	2260 cCD
triarimol 0.023	F8	15.7 abAB	2390 cdBCD
ethirimol 0.45	F8	23.1 aAB	2480 cdBCD
Untreated		18.2 abAB	2400 cdBCD
CV %		33	16.1

*Lodged tillers were counted in a sample of 5 rows, each 0.9 m long, 3 samples per plot, 5 plots per treatment. The percentages were calculated on basis of 404 tillers (total number of tillers per sample), being the mean of total tillers in 12 samples in the benomyl 0.28 at F8 plots.

†Applied as a slurry to the seed at 2.49 g/kg, seed then sown at 146 kg/ha.

TABLE 3: TRIAL E

Effect of benomyl and thiabendazole sprays on severe eyespot lodging in Hilgendorf 61 wheat—Waimatuku—1971-2

Treatment (kg/ha)	*Applied Growth Stage*	*Lodging Index* (0-10)*	*% Lodged Tillers†*
benomyl 0.14	F3-4	10.0	100
benomyl 0.28	F3-4	9.3	100
benomyl 0.14	F7-8	1.3	2.8
benomyl 0.28	F7-8	1.0	2.5
thiabendazole 0.67	F3-4	10.0	100
thiabendazole 1.34	F3-4	10.0	100
thiabendazole 0.67	F7-8	2.0	3.5
thiabendazole 1.34	F7-8	1.0	2.0
Untreated		10.0	100

*Mean of six replicates.
†15 one metre lengths of row examined per plot, six plots per treatment.

TABLE 4: TRIALS D, E AND F

Effect of benomyl and thiabendazole sprays on yield of Hilgendorf 61 wheat affected by eyespot—1971-2 (Trial D, South Hillend; Trial E, Waimatuku; Trial F, Browns)

Treatment (kg/ha)	*Applied Growth Stage*	*Trials* D*	*E†*	*F*
benomyl 0.14	F3-4	3740 abcAB	1470	3730 bC
benomyl 0.28	F3-4	3920 abAB	2210	3990 bABC
benomyl 0.14	F7-8	3930 abAB	3940	4730 aAB
benomyl 0.28	F7-8	4030 aA	4210	4790 aA
thiabendazole 0.67	F3-4	3520 cB	1310	3780 bBC
thiabendazole 1.34	F3-4	3910 abAB	1880	3850 bABC
thiabendazole 0.67	F7-8	3960 abAB	3840	4380 abABC
thiabendazole 1.34	F7-8	3960 abAB	4090	4130 abABC
Untreated		3630 bcAB	990	3740 bC

*Lodging assessments for Trial E are in Table 3, there was minimal lodging in Trial D, and only moderate lodging in Trial F.
†No statistical analysis because of the big difference in standard error between the early and late spray treatments.

completely. Thiabendazole at the rates used gave a similar result to benomyl in Trials D, E and F.

In Table 5 a cultivar variation in response to nitrogen and benomyl is evident with Kopara most responsive to both treatments. This was considered to be due to the higher susceptibility of this cultivar to eyespot.

DISCUSSION

The susceptible variety Hilgendorf 61 was used in most trials (as a third or subsequent wheat crop) in order to ensure a uniform and high level of infection in the untreated plots and an excellent visual difference

TABLE 5: TRIAL G

The effect of benomyl and nitrogen on the yield of four New Zealand wheat cultivars—Waimatuku—1971-2

Cultivars	*Yield (kg/ha)* *Untreated*	*benomyl*	*Nitrogen*	*benomyl + Nitrogen*
Aotea	5440 cdeABC	5630 cdeABC	5080 deBC	5030 abcdABC
Kopara*	4600 eC	5800 bcdABC	5580 cdeABC	7010 aA
790.01	5740 cdeABC	6120 abcdABC	5670 cdeABC	6300 abcAB
1169.01	5670 cdeABC	6360 abcAB	—	5920 abA
CV % 8.1				

*Some lodging in the Kopara plots, minimal in the others.

between treatments. The value of this is well demonstrated in Trials A and B (Table 1) where those plots treated with chemicals with no activity against eyespot were either completely or severely lodged (more than 7 on the visual scale). This has proved to be a simple and rapid method of screening a number of chemicals (at the rates used) for their effectiveness against the eyespot disease. All of the benzimidazole compounds (except fuberidazole) were effective to varying degrees. None of the other systemic fungicides (representing a range of chemical groups) were effective. Trial A indicated that triarimol may have had some activity but this was not confirmed by Trial B.

In Trials D, E, and F with Hilgendorf 61, benomyl and thiabendazole at the rates used gave similar results but were not as effective when applied at Feekes 3-4 as when applied later at Feekes 7-8 (Tables 3 and 4). The results with benomyl contrast with those in Trial C on Aotea (Table 2) where benomyl (0.28 at Feekes 3-4) has significantly reduced lodging, and while there has been a yield increase this has not reached significance. This difference is probably due to the combined effect of the spray treatment at Feekes 3-4 together with the partial resistance of the variety Aotea. It is important to note in Trials C and E that the lower rate of benomyl at Feekes 7-8 has reduced lodging significantly and increased yield. Similarly, in Trial E the lower rate of thiabendazole has been effective though it should be noted that the rates of thiabendazole are almost five times the benomyl rates.

It is not clear how the fungicides move to the base of the plant when applied at the late stage of growth as the crop has canopied with the upper leaves shielding the plant base. Although upward translocation has been demonstrated (Peterson and Edginton, 1970), downward movement has not been described. It is probable that the fungicide is washed down the outside of the plant and absorbed by the basal leaf sheaths.

On commercial crops where a systemic fungicide has been used for eyespot control, it has usually been added to the weed spray and applied about Feekes growth stage 5 to 6. The above results suggest that, if weed sprays are applied earlier, at or before Feekes 3 to 4, a later application of fungicide would give improved eyespot control.

Seed treatment with benomyl (in Trial C) was not successful, possibly because of the low and diminishing chemical concentration in the root zone during the period the wheat plant was susceptible, and/or the lack of translocation to the basal leaf sheaths.

Where eyespot occurs and nitrogen is applied, the interaction between the fungicide treatment and nitrogen may be important. When used,

nitrogen stimulated crop growth and thus provided conditions suitable for eyespot development. Thus any yield benefit from nitrogen could be negated unless a fungicide was applied. While not conclusive, some of the data in Table 5 are indicative of this.

Some wheat cultivars are more susceptible to eyespot than others (Witchalls, 1970) and this is again demonstrated in Trial G (Table 5). In this trial benomyl delayed the maturity of all cultivars by a few days. This effect was not observed in the other trials (where Hilgendorf 61 was used) though it has been observed in the trial on Aotea reported by Witchalls and Close (1971).

Powdery mildew, *Erysiphe graminis* D.C. was present in the trials, with *Septoria* evident in one trial. The fungicides most likely checked these diseases for a period after they were applied but as there was only a very low incidence of these diseases no yield effects were likely. Benomyl and thiabendazole had no effect on take-all (*Gaeumannomyces graminis* (Sacc) Arx and Oliver) which occurred in another experiment.

Initial residue data from Chemistry Division, DSIR, has shown that benomyl levels in the grain are below the tolerance levels of 1 ppm. The other fungicides have not been tested for residue levels.

Further work on thiophanate-methyl and mecarbinizid at various rates is needed as these materials have given promising results.

In southern New Zealand, local weather conditions ensure that eyespot disease of wheat is an important and continuing problem. Because eyespot is likely to be more prevalent in second and subsequent crops, the susceptible cultivars Hilgendorf 61 and Kopara should be used only for first crops. For second and subsequent crops, farmers should select those varieties known to have some resistance to the disease (namely, Aotea), and maintain the cultural control practices known to reduce the severity of the disease. Effective fungicides (as spray treatments) are now also available to aid in the control of this important disease problem.

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