MORLEY RESEARCH CENTRE

Interaction between fungicide spray timing, rust development and yield of winter rye, 1996

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Summary

A range of conazole fungicides was applied at various timings either alone or with the addition of Corbel (fenpropimorph at 375 g ai/ha) to a crop of Amando winter rye. Programmes of fungicides were also evaluated. Brown rust developed slowly at first but eventually became severe. The seed dressings Baytan and Sibutol were compared but appeared to give no control of brown rust when it developed in the late spring. There was little difference between the conazoles except that by 3 July disease control on the lower leaves was better following Folicur or Opus than it was following Alto 100SL. The addition of half dose Corbel improved the performance of the conazoles. Although none of the treatments gave complete control of rust, green leaf area was considerably increased and yield improvements of over 1.0 t/ha were recorded.

Object

To assess the impact of spray timing on disease control and yield and evaluate the comparative activity of fungicides on brown rust of rye.

Method

A range of conazole fungicides (Table 1) was applied at various timings and in various programmes, alone or in mixture with fenpropimorh, to a crop of Amando in a randomised block with three replicates. These foliar programmes were compared to plots receiving only the standard seed treatment (Sibutol) or Baytan.

Three replicates were sown on 29 September 1995 at a rate of 350 seeds per m^2, on a loamy sand site at New Found Farm, Colney. Plants were counted on 1 November. The trial received normal farm inputs of nitrogen and growth regulator and was harvested on 5 August 1996. No lodging was recorded.

*Not for publication without consent of the Director of Morley Research Centre. This report deals primarily with only one year's work, so any conclusions given are provisional.

Fungicides were applied to appropriate plots on 22 April (GS 31), 5 May (GS 33), 14 May (GS 39) and 30 May (GS 57). All foliar fungicide applications were applied in 200 l/ha water using 11003 nozzles on a 4 m boom. Assessments of brown rust (*Puccinia recondita*) and mildew (*Erysiphe graminis)* were made on leaves 3, 4 & 5 separately on 16 May. Brown rust on leaf 5 was recorded on 31 May and brown rust and green leaf area were recorded separately on leaves 1 to 4 on 3 July. Plot layout and experiment method followed Morley standard operating procedures. Details of active ingredients and doses are provided in Table 2.

Table 1. *Details of treatments applied with target application growth stages (and actual)*

Seed treatment only
Untreated (Sibutol)
Baytan
Two sprays - GS 30 + 32 (GS 31 + 33)
Alto 100SL
Opus
Folicur
Corbel + Alto 100SL
Corbel + Opus
Corbel + Folicur
Timing of Folicur
GS 30 + 39 (GS 31 + 39)
GS 30 + 55 (GS 31 + 57)
GS 32 + 39 (GS 33 + 39)
GS 33 + 55 (GS 33 + 57)
GS 39 + 55 (GS 39 + 57)
Full programmes
Baytan + Folicur GS 32 + 39 (GS 33 + 39)
Opus GS 30 + 32 + 39 (GS 31 + 33 + 39)
NAS F 183 GS 30 + 32 + 39 (GS 31 + 33 + 39)
Folicur GS 30 + 32 + 39 (GS 31 + 33 + 39)
NAS F 185 GS 30 + 32 + 39 (GS 31 + 33 + 39)
NAS F 186 GS 30 + 32 + 39 (GS 31 + 33 + 39)
NAS F 187 GS 30 + 32 + 39 (GS 31 + 33 + 39)

Table 2. *Active ingredients and doses of commercially available products*

Product	Active ingredient (g ai/l)	Dose of product applied (l/ha)
Seed treatments		
Sibutol	bitertanol (375) + fuberidazole (23)	
Baytan	fuberidazole (22.5) + triadimenol (187.5)	
Foliar treatments		
Alto 100SL	cyproconazole (100)	0.8
Corbel	fenpropimorph (750)	0.5
Folicur	tebuconazole (250)	1.0
Opus	epoxiconazole (125)	1.0

Results and discussion

Foliar disease and persistence of green leaf area

Brown rust was very slow in establishing in the cold spring of 1996 compared to other recent seasons, but by 16 May was present at low levels on leaves 3 (0.02%), 4 (0.27%) and 5 (1.40%) on untreated plots. Baytan did not have a residual effect sufficient to reduce disease at this time but most foliar treatments had prevented brown rust from establishing on leaf 3. All treatments that started before GS 39 resulted in significant control of rust with the Folicur at GS 31 and 39 giving complete control on all three leaves. Leaves 4 and 5 were also significantly cleaner than the seed treated plots except where the start of a Folicur programme was delayed until flag leaf emergence (GS 39).

Table 3. *Mildew on 16 May (GS 43-51) and brown rust on 31 May (GS 59)*

Treatment	Infection (%) Mildew, leaf 4	Mildew, leaf 5	B. rust, leaf 5
Seed treatment only			
Untreated	0.77	3.33	3.33
Baytan	0.95	2.38	4.33
Two sprays - GS 31 + 33			
Alto 100SL	0.02	0.07	0.27
Opus	0.03	0.13	0.60
Folicur	0.00	0.05	0.13
Corbel + Alto 100SL	0.00	0.03	0.07
Corbel + Opus	0.02	0.03	0.07
Corbel + Folicur	0.00	0.02	0.03
Timing of Folicur			
GS 31 + 39	0.00	0.00	0.20
GS 31 + 57	0.02	0.02	0.33
GS 33 + 39	0.03	0.57	1.77
GS 33 + 57	0.52	1.02	1.07
GS 39 + 57	0.70	3.83	3.00
Full programmes			
Baytan + Folicur GS 33 + 39	0.05	0.58	0.57
Opus GS 31 + 33 + 39	0.02	0.02	0.20
NAS F 183 GS 31 + 33 + 39	0.00	0.05	0.23
Folicur GS 31 + 33 + 39	0.00	0.02	0.10
NAS F 185 GS 31 + 33 + 39	0.00	0.03	0.10
NAS F 186 GS 31 + 33 + 39	0.00	0.02	0.07
NAS F 187 GS 31 + 33 + 39	0.00	0.02	0.33
LSD	0.513	1.100	1.016
SE per plot (38 df)	0.310	0.666	0.615
CV(%)	199.1	109.2	73.2

At a later assessment (31 May) all 2-spray treatments and full programmes reduced mildew (leaves 4 & 5) together with brown rust on leaf 5 (Table 3). At this time, the earlier start date (GS 31) for Folicur was most effective with the programme starting at GS 39 providing significantly poorer control of both mildew and rust on leaf 5.

Table 4. *Brown rust on 3 July (GS 75)*

Treatment	Infection (%) Leaf 1	Leaf 2	Leaf 3	Leaf 4
Seed treatment only				
Untreated	14.2	29.7	49.3	56.3
Baytan	14.7	29.7	49.0	60.8
Two sprays - GS 31 + 33				
Alto 100SL	5.6	12.4	16.5	17.4
Opus	4.7	10.6	12.5	11.0
Folicur	7.1	9.8	10.5	5.5
Corbel + Alto 100SL	4.7	9.0	8.3	5.9
Corbel + Opus	5.4	10.8	9.8	8.9
Corbel + Folicur	4.5	7.9	5.2	3.2
Timing of Folicur				
GS 31 + 39	3.2	4.2	5.4	7.3
GS 31 + 57	0.8	3.2	5.8	9.5
GS 33 + 39	2.9	5.3	6.8	10.0
GS 33 + 57	1.6	3.3	6.1	11.8
GS 39 + 57	0.9	2.7	6.1	17.4
Full programmes				
Baytan + Folicur GS 33 + 39	7.3	9.5	13.5	20.1
Opus GS 31 + 33 + 39	2.7	5.4	7.6	8.4
NAS F 183 GS 31 + 33 + 39	2.4	3.6	4.6	6.4
Folicur GS 31 + 33 + 39	2.8	4.9	5.6	6.9
NAS F 185 GS 31 + 33 + 39	3.8	8.6	8.6	6.3
NAS F 186 GS 31 + 33 + 39	2.8	5.2	5.8	4.5
NAS F 187 GS 31 + 33 + 39	4.4	5.5	6.1	6.8
LSD	3.81	4.74	5.39	5.60
SE per plot (38 df)	2.30	2.87	3.26	3.39
CV(%)	47.7	31.7	26.8	23.8

As temperatures rose in June, brown rust developed very rapidly resulting in high levels being recorded on 3 July (GS 75). At this time all foliar treatments had reduced rust infection with Opus and Folicur providing significantly better control than Alto 100SL on the lowest leaf, but not on the upper leaves (Table 4). The addition of Corbel to the conazoles improved the control of brown rust on the lower leaves and was statistically significant with Alto 100SL (leaves 3 & 4).

Table 5. *Green leaf area on 3 July (% leaf area)*

Treatment	Leaf 2	Leaf 3	Leaf 4
Seed treatment only			
Untreated	52.7	33.5	19.0
Baytan	52.7	30.9	15.0
Two sprays - GS 31 + 33			
Alto 100SL	75.5	68.5	54.3
Opus	76.4	71.4	50.1
Folicur	77.9	70.6	45.6
Corbel + Alto 100SL	78.4	75.4	50.6
Corbel + Opus	74.3	71.9	54.3
Corbel + Folicur	74.4	71.6	45.5
Timing of Folicur			
GS 31 + 39	79.2	70.6	45.9
GS 31 + 57	81.8	73.9	52.5
GS 33 + 39	75.4	76.6	53.7
GS 33 + 57	77.2	74.4	50.1
GS 39 + 57	82.5	75.4	44.1
Full programmes			
Baytan + Folicur GS 33 + 39	75.8	70.3	45.7
Opus GS 31 + 33 + 39	78.1	74.8	46.6
NAS F 183 GS 31 + 33 + 39	82.5	80.0	51.9
Folicur GS 31 + 33 + 39	74.9	73.5	54.3
NAS F 185 GS 31 + 33 + 39	79.1	73.7	51.9
NAS F 186 GS 31 + 33 + 39	77.8	76.4	50.2
NAS F 187 GS 31 + 33 + 39	76.5	75.5	58.7
LSD	5.41	7.12	13.26
SE per plot (38 df)	3.27	4.31	8.02
CV(%)	4.4	6.2	17.1

At this stage the timing of 2-spray programmes of Folicur did not result in significant differences in infection although, as might be expected, there was the tendency for programmes starting at GS 31 to give better control of disease on the lower leaves and for the upper leaves to be cleaner when at GS 57 treatment had been applied.

The full programmes performed equally well except for that which started with Baytan. No reason is apparent to account for two sprays after Baytan resulting in more rust than the same two sprays alone. None of the programmes resulted in any signs of crop damage.

All foliar treatments resulted in a considerable increase in green leaf area on each of leaves 2, 3 and 4 on 3 July (Table 5). There were no significant differences between comparable groups of treatments except that the full programme starting with Baytan was less effective than the best three foliar spray treatment in controlling brown rust on leaves 2 and 3.

The only assessments that failed to provide statistically significant results are the mildew on leaf 3 on 16 May (all values less than 1%) and green leaf area on the top leaf on 3 July (all values between 52% and 65%). These data are not presented as tables of results.

Grain yield and quality

While the site suffered from the exceptionally dry season which accentuated small soil variations, significant yield differences were recorded (Table 6). Mixtures of Corbel with either Alto 100SL or with Opus gave yields significantly above either treatment that received only seed dressing. The conazoles alone generally performed less well than the mixtures.

In the evaluation of Folicur timing the treatments that included a GS 55 application resulted in the best yields except where the programmes did not start until GS 39. This reflects the low levels of disease early in the season and the severity later in the season. In the full programmes there was a tendency for the coded products to outperform the standard Folicur and Opus treatments.

Table 6. *Grain yield and specific weight at 85% dm*

Treatment	Grain yield (t/ha)	Specific weight (kg/hl)
Seed treatment only		
Untreated	4.26	72.5
Baytan	4.03	71.4
Two sprays - GS 31 + 33		
Alto 100SL	4.61	71.4
Opus	4.36	71.0
Folicur	4.65	70.5
Corbel + Alto 100SL	4.87	69.5
Corbel + Opus	5.01	69.2
Corbel + Folicur	4.48	69.9
Timing of Folicur		
GS 31 + 39	4.29	70.2
GS 31 + 57	4.92	70.9
GS 33 + 39	4.83	69.1
GS 33 + 57	4.80	68.1
GS 39 + 57	4.49	71.0
Full programmes		
Baytan + Folicur GS 33 + 39	4.88	68.9
Opus GS 31 + 33 + 39	4.88	70.3
NAS F 183 GS 31 + 33 + 39	5.47	68.0
Folicur GS 31 + 33 + 39	4.62	69.1
NAS F 185 GS 31 + 33 + 39	4.95	69.0
NAS F 186 GS 31 + 33 + 39	5.25	69.0
NAS F 187 GS 31 + 33 + 39	5.24	66.7
LSD	0.513	NS
SE per plot (30 df)	0.308	2.07
CV(%)	6.5	3.0

Conclusions

Although the rust was slower than usual in establishing in the cool spring it eventually became very severe and was not completely controlled by any of the programmes tested. Baytan did not contribute to control in this trial and programmes including late sprays (GS 57) were required to give the best disease control although the start of treatment could not

be delayed to flag leaf emergence. The addition of Corbel improved disease control and yield.

This trial confirms the difficulty in controlling brown rust of rye and further work is required. This should include new chemistry where it may contribute activity.

Acknowledgements

The assistance of many colleagues is greatly appreciated. This experiment was funded by Morley Research Centre.

Appendix

The following information is presented as an appendix which is available on request.

Field details
Method
Experiment diary
Results
Table 1 - Brown rust, 16 May.

Field details

Site	New Found Farm, Colney
Field reference	Block 2
Crop	Rye
Variety	Amando
Previous crop	1995 Spring barley 1994 Sugar beet 1993 Rye 1992 Spring barley
Soil type	Loamy sand (Burlingham series)

Soil analysis	pH	P	K	Mg
26 January 1994	8.0	2.0	1.0	0.0

Seed	C2 commercial stock

Nutrients applied	**Rate (kg/ha)**
17 March	42
22 April	103
Total N	**145**

Cultivations	September 1995

Applications to crop

Date	GS	Item (g ai/l)	Dose/ha
16 October 1995	11	Cyperkill (cypermethrin, 100)	250 ml
18 October		Avadex (tri-allate, 10% ww)	15 kg
15 November	12	Harlequin 500 SC (isoproturon, 450 + simazine, 50)	1.5 l
		+ Ardent (diflufenican, 40 + trifluralin, 400)	1.0 l
20 March 1996	24	Chlormequat 700 (chlormequat, 700)	1.75 l
		+ Mantec (elemental manganese, 310)	0.5 kg
7 May	37	Terpal (2-chloroethylphosphosphonic acid, 155	
		+ mepiquat chloride, 305)	1.25 l
		+ non ionic wetter	40 ml

Experiment diary

Date	Treatments applied or action
29 September 1995	Plots sown into ploughed and pressed soil using Oyjord plot drill to sow at 350 seeds/m^2. Seeds were sown at 3 cm depth into a fine friable tilth with a cloddy surface.
1 November	Plant counts on Baytan and Sibutol plots showed populations of 161 and 175 plants/m^2 respectively.
22 April 1996	First sprays applied at GS 31 (target GS 30)
5 May	Second sprays applied at GS 33 (target GS 32)
14 May	Third sprays applied at GS 39 (as target)
16 May	Mildew and brown rust assessed on leaves 3 to 5 (10 tillers/plot)
30 May	Final sprays applied at GS 57 (target GS 55)
31 May	Brown rust assessed on leaf 5 (whole plot score)
4 July	Brown rust and green leaf area assessed on leaves 1 to 4 (10 tillers/plot)
5 August	Trial harvested without lodging

Spray and assessment methods for cereal trials

Method

This is an abbreviated version of the standard operating procedures used at Morley Research Centre.

Plot layout

Plots were sown at 400 seeds/m^2 with an Oyjord drill. The drilled plots were 12 m long and 1.56 m wide from outside row to outside row (14 rows at 12.0 cm spacing). Plots were separated by a buffer of the same size with a 54 cm gap between successive plots and buffers. This gave an effective plot width of 2.10 m, which was used for harvest yield calculations. Treatments were applied to the plot and to part of the buffer at each side. For harvest purposes, plot length was reduced to 9.1 m to match the track and tyre size of the farm equipment.

Overall treatments

Overall treatments such as fertiliser, insecticides, herbicides, and growth regulators were applied across all plots with farm machinery using wheelings, 24 m apart.

Spraying details

Treatments were applied using a CO_2 powered backpack sprayer, utilising 'Cornelius' vessels and a 4 m boom (eight nozzles at 0.5 m spacings) with Lurmark F110-03 nozzles at 2 bar pressure, to give 200 l/ha spray volume at 1.6 m/s forward speed.

Foliar disease, green leaf and ear colour

Foliar disease of a particular leaf or leaf layer was determined by the following method. A standard (based on the appropriate key from the ADAS manual of disease assessment keys, 1976) was agreed between two experienced assessors and plots were assessed by walking along the gap between the harvest area and the buffer, examining the plot from both sides. The crop was examined at intervals and an appropriate disease level was agreed at the end of each plot.

Foliar disease was determined by estimating the percentage leaf area infected with each disease on 10 individual tillers per plot (taken at random). Disease level was assessed on each leaf by one person whilst another recorded the appropriate values. The lowest leaf layer assessed was the layer on which the best treatment still had greater than 50% of the leaf area remaining green.

The green area was determined by estimating the percentage leaf area remaining green on 10 individual tillers per plot (taken at random). Green area was assessed on each leaf by one

person whilst another recorded the appropriate values.

Harvest details

Plots were harvested using a Claas Compact combine which was modified for plot work and used electronic weighing (Novatech M864 Loadmeter). Trials were harvested by replicate.

Post harvest determinations

Moisture content was determined using a Burrows digital moisture computer. A minimum of two samples were tested from each plot, with a tolerance of 0.2% required between samples.

The grain samples were pre-cleaned using a Rational sample cleaner to remove any chaff or straw before further assessments (specific weight or 1000 grain weight) were carried out.

Specific weight was determined using a Farm-Tec Easi-Lab chondrometer and electronic balance. A minimum of two samples were tested from each plot, with a tolerance of 2.0 g required between samples.

Table A1. *Brown rust on 16 May at GS 43-51 (% infection)*

Treatment	Infection (%)		
	Leaf 3	Leaf 4	Leaf 5
Seed treatment only			
Untreated	0.02	0.27	1.40
Baytan	0.05	0.30	1.67
Two sprays - GS 31 + 33			
Alto 100SL	0.00	0.00	0.15
Opus	0.00	0.03	0.08
Folicur	0.00	0.00	0.03
Corbel + Alto 100SL	0.00	0.00	0.02
Corbel + Opus	0.00	0.00	0.02
Corbel + Folicur	0.00	0.00	0.02
Timing of Folicur			
GS 31 + 39	0.00	0.00	0.00
GS 31 + 57	0.00	0.02	0.07
GS 33 + 39	0.00	0.10	0.37
GS 33 + 57	0.00	0.07	0.43
GS 39 + 57	0.02	0.13	1.00
Full programmes			
Baytan + Folicur GS 33 + 39	0.00	0.05	0.40
Opus GS 31 + 33 + 39	0.00	0.02	0.03
NAS F 183 GS 31 + 33 + 39	0.00	0.00	0.07
Folicur GS 31 + 33 + 39	0.00	0.00	0.03
NAS F 185 GS 31 + 33 + 39	0.00	0.00	0.03
NAS F 186 GS 31 + 33 + 39	0.00	0.00	0.03
NAS F 187 GS 31 + 33 + 39	0.00	0.00	0.03
LSD	0.015	0.115	0.594
SE per plot (38 df)	0.009	0.070	0.359
CV(%)	222.0	141.5%	122.1

LSD = least significant difference at 95% probability level