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CONTINUED STUDIES ON THE USE OF REDUCED DOSES:

PART I. WINTER WHEAT AND WINTER BARLEY IN SCOTLAND

PART II. WINTER BARLEY IN SOUTH-WEST ENGLAND

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PART I. WINTER WHEAT AND WINTER BARLEY IN SCOTLAND

by

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PART II. WINTER BARLEY IN SOUTH-WEST ENGLAND

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The report describes the work from a single year of experimental work only, a factor which should be borne in mind in the interpretation of data.

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PART I. WINTER WHEAT AND WINTER BARLEY IN SCOTLAND

Summary

Four trials were carried out, two each on winter barley and winter wheat. Each trial evaluated a series of fungicide programmes using different fungicide doses at standard timings on two contrasting varieties. A prototype Integrated Disease Risk (IDR) Strategy was evaluated in the winter barley trials.

Both winter barley trials were sown late and yields were modest but contrasting disease epidemics occurred. At the SAC Edinburgh site disease developed only after GS 49. Despite the limited and late disease epidemic yield responses up to 1.0 t/ha (cv. Willow) and 1.4 t/ha (Pastoral) resulted. On the Rhynchosporium-susceptible variety (Willow), a single application of 3/4 dose at GS 31 was the most cost effective treatment although two 1/2 doses at GS 31 and 39 was similar. On Pastoral (a mildew susceptible variety), a two spray programme at GS 31 and 39 of 1/4 doses was most cost effective. At the SAC-Aberdeen site infection was first recorded at GS 31 and developed thereafter. Yield responses up to 0.87 t/ha (Willow) and 1.36 t/ha (Pastoral) were recorded. The most cost effective responses on Willow was two 1/2 doses at GS 31 and 39. On Pastoral, a three spray programme of 1/4 doses at GS 30, 31 and 39 was the most cost effective. The IDR strategy proved to be effective only in one trial. In part this could be attributed to the use of severity rather than incidence of disease as one criteria in deciding dose. It also lacked sensitivity, failing to recognise that responses were likely even at low disease levels.

Yield responses on wheat were large with the Septoria tritici susceptible cultivar Riband (up to 3.2 t/ha) but much smaller on Apollo (up to 1.05 t/ha). Timing and dose were shown to be crucial in control of S tritici. At both sites, delaying the GS 32 application to GS 33 improved disease control and yield. Using quarter doses proved ineffective in disease control. Three half doses at GS 33, 39 and 59 were highly cost effective at both sites. At the Aberdeen site reducing the GS 33 dose or increasing the GS 39 dose gave similar margins. On the cultivar Apollo at the SAC Edinburgh site where mildew development was limited, a two spray programme at GS 32 and 59 of 1/4 doses was most effective. At the Aberdeen site where mildew arrived later but developed to a greater extent a single application of a half dose at GS 39 or two half dose applications at GS 39 and 59 were most cost effective. Acceptable mildew control was achieved by reduced doses but like S tritici treatment early in disease development was crucial.

Using reduced fungicide doses on winter cereals requires a higher level of management and technical expertise. In order to use the minimum fungicide dose timing is crucial, yet management of all crop inputs (as well as farm management) involves a continuous series of compromises. Sub-optimal fungicide timing is a factor all growers and those who advise growers have to face. Any decision support system needs to be flexible, permitting the dose to vary with changing circumstances.

Strategies such IDR which has been developed on wheat have the potential to give guidance on dose. There is scope for refinement to encompass other factors that might influence dose. One of these factors is yield potential. The trials on winter barley demonstrated how this factor is important.

To fully implement a decision support system like IDR, more information is required on dose response curves and the interaction of fungicide dose and disease resistance of cultivars. Experimentation on this and evaluation of fungicide programmes comprises the appropriate fungicide dose projects on winter wheat and winter barley initiated in October 1993.

Introduction

This project, which was funded for one year, was intended to bridge the gap between the end of an initial project on reduced fungicide doses (Fisher *et al*, 1994) and the start of two major projects on appropriate fungicide doses for winter barley and winter wheat (0051/1/92 & 0052/1/92)

Work by SAC on reduced fungicide doses in the initial project focused largely on spring barley, where most success was achieved. Trials on winter wheat and to a lesser extent winter barley were less successful. In the winter cereals the complexity was much greater with more diseases and potential times of application.

Knowing the outline protocols for the two major projects on appropriate fungicide doses to be initiated in October 1993, the trials set up in this project were designed to a) examine some of the factors that would be part of the future projects to ensure the final protocols would be as effective as possible, and b) produce further data on the use of reduced fungicide doses to enhance our current knowledge. In particular, with the winter barley trials an initial attempt to develop an Integrated Disease Risk Strategy (IDR) was made. This broadly followed the principles laid down by Dr Neil Paveley for IDR on wheat. It was felt that only if a parallel IDR strategy was developed for winter barley would growers be able to utilise the results of this and future work to the full.

Trials

Four trials were set up, two on winter barley and two on winter wheat. In each trial, programmes of fungicides were tested on two varieties. These were Pastoral and Willow winter barley and Riband and Apollo wheat. These varieties were chosen because of susceptibility to one major disease and presence on the 1993 recommended list.

a) Winter barley

The two major timings for fungicide application on winter barley are the first node stage (GS 31) and the flag leaf stage (GS 39-49). In Scotland, evidence from previous trials (Wale, 1987) has shown that, particularly where crops are sown at the optimum timing, fungicide treatment at GS 30, three to four weeks prior to the first node stage could also be cost effective. The action of this early treatment appeared to be a reduction in inoculum such that subsequent fungicide treatments achieved much better control of disease (and the dose could be reduced in consequence) as well as giving a yield response in its own right. In Scotland many growers are already applying herbicides or chlormequat (for tiller manipulation) or micronutrients at this timing so the fungicide would not be applied specially.

Where crops were sown late and yield potential was lower, trials showed that this timing was rarely cost effective. The disease pressure was usually less anyway (Wale, 1987). However, all these conclusions were made on trials where full fungicide doses were used and it was considered justifiable to examine fungicide application at GS 30 when reduced doses were used at this and later timings irrespective of sowing date.

Pastoral was selected because it is the most widely grown winter barley variety in the UK and because it is particularly susceptible to mildew. Willow, by contrast, is resistant to mildew but susceptible to Rhynchosporium. The disease resistance ratings of the two varieties are given below.

Variety	Disease resistance rating to Mildew	Rhynchosporium	Net blotch	Brown rust
Pastoral	3	7	8	6
Willow	8	4	8	8

Source: UK Recommended lists for cereals 1993; NIAB, SAC, DANI

The treatments applied were identical for each variety and are given in Table 1. However, as Willow was primarily susceptible to Rhynchosporium the fungicide used for this variety was propiconazole (Tilt/Radar). The moderate resistance to Rhynchosporium in addition to the susceptibility to mildew of Pastoral meant that a triazole + morpholine mixture was required for this variety. Accordingly propiconazole (Tilt/Radar) + fenpropimorph (Aura/Corbel) was used.

IDR strategy. Tables were constructed for each growth stage for use by the field trials officers at Aberdeen and Edinburgh. It was felt important that if IDR was to succeed the interpretation of the strategy should be done by staff other than those who constructed the system. In other words, any strategy should be sufficiently straightforward that growers can apply it without recourse to advisers or consultants.

The tables utilised the four components of IDR as developed by Neil Paveley; disease resistance rating, inoculum, weather and crop responsiveness to fungicides at any given growth stage. Rather than use a formula such as produced by Neil Paveley it was felt that IDR presented in table form would be more user friendly. These tables are given in Appendix 1.

Table 1. Fungicide programmes for winter barley trials (Pastoral and Willow)

Codes	GS 30	GS 31	GS 39/49
A	-	-	-
B	-	1/4	-
C	-	1/2	-
D	-	3/4	-
E	-	1	-
F	-	1/4	1/4
G	-	1/2	1/2
H	-	3/4	3/4
J	-	1	1
K	1/4	1/4	1/4
L	1/2	1/2	1/2
M	3/4	3/4	3/4
N	-	1/2 S*	1/2 S*
P	IDR		
R	1/4	1/2	1/2

Fungicides:	Willow	Tilt (propiconazole) 1 = 0.5 l/ha 3/4 = 0.375 l/ha 1/2 - 0.25 l/ha 1/4 = 0.125 l/ha
	Pastoral	Tilt (propiconazole) + Aura (fenpropimorph) 1 = 0.5 + 1.0 l/ha 3/4 = 0.375 + 0.75 l/ha 1/2 = 0.25 + 0.5 l/ha 1/4 = 0.125 + 0.25 l/ha

*Sanction (flusilazole) was substituted for Tilt in this treatment
1/2 = 0.2 l/ha (Willow)
1/2 = 0.2 + 0.5 (Aura) l/ha (Pastoral)

IDR treatments

SAC-Edinburgh	GS 30	GS 31	GS 39-49
Willow	0	0	1/2
Pastoral	0	0	1/2
SAC-Aberdeen	GS 30	GS 30	GS 39-49
Willow	1/4	3/4	3/4
Pastoral	1/4	1/2	1/2

b) **Winter wheat**

ADAS trials have shown that foliar disease infection of the top three leaves results in significant yield loss. Thus potential timings for fungicides to minimise yield loss are at GS 32 (when the third top leaf is emerging), at GS 33 (when the second top leaf is emerging) and at GS 39 (when the flag leaf is fully formed). Additionally, fungicide treatment of the ear can restrict yield loss by preventing ear infection and, co-incidentally provide further treatment of the top three leaves.

Unlike the winter barley trials, it was considered necessary to develop separate fungicide programmes for Riband and Apollo. The programmes for each variety are shown in Table 2.

With Riband, which is susceptible to Septoria spp, the variety is very responsive to fungicide treatment and several assumptions were made in constructing the programmes.

1 Most growers adopt a two or three spray programme.
2 The flag leaf (GS 39) fungicide treatment is most important in England and Wales but in Scotland both the flag leaf and ear treatments are highly cost effective. The ear treatment is more important in the north of the country because of the longer ripening phase.
3 The maximum accumulated dose would be two full doses (except for a standard three spray full dose programme).
4 Spray programmes adopted should have commercial reality but allow comparisons between programmes.

By contrast, the variety Apollo which is susceptible to mildew, is less responsive to fungicide treatment. Accordingly different assumptions were made for this variety.

1 Most growers are unlikely to apply more than two fungicide treatments on this variety.
2 Growers are likely to apply sprays at conventional timings.
3 The maximum accumulated dose would be one full dose (except for a standard three spray full dose programme).
4 Spray programmes adopted should have commercial reality but allow comparisons between programmes.
5 Optimum time for mildew control is unknown but observations from other trials suggest control early in the epidemic allows reduced doses to be used most effectively.

The fungicide selected was chosen to control the principal disease to which each variety was susceptible. Thus Folicur (tebuconazole) was used with Riband and Patrol (fenpropidin) was used with Apollo.

Variety	Disease resistance rating to:			
	Mildew	S. tritici	S. nodorum	Yellow rust
Apollo	3	7	5	4
Riband	7	3	4	4

Source: UK Recommended lists for cereals 1993; NIAB, SAC, DANI

Table 2. Fungicide programmes for winter wheat trials

a) Riband

GS	GS 32	33	39	59	accumulated
leaf emerging (ed)	3	2	1	ear	fungicide dose
Code					
A	-	-	-	-	0
B	1/4	-	1/4	1/4	3/4
C	-	1/4	1/4	1/4	3/4
D	1/4	1/4	1/4	1/4	1
E	-	-	1/2	1/2	1
F	1/2	-	1/2	1/2	1 1/2
G	-	1/2	1/2	1/2	1 1/2
H	1/2	1/2	1/2	1/2	2
J	1/4	-	1/2	1/2	1 1/4
K	-	1/4	1/2	1/2	1 1/4
L	1/2	-	3/4	1/2	1 3/4
M	-	1/2	3/4	1/2	1 3/4
N	1/2	-	3/4	3/4	2
P	1	-	1	1	3

Fungicide: Folicur (tebuconazole)
1 = 1.0 l/ha
3/4 = 0.75 l/ha
1/2 = 0.5 l/ha
1/4 = 0.25 l/ha

b) **Apollo**

Code	GS 32	39	59	Accumulated
Leaf emerging(ed)	3	1	ear	fungicide dose
Code				
A	-	-	-	0
B	-	1/4	-	1/4
C	1/4	1/4	-	1/2
D	1/4	-	1/4	1/2
E	-	1/4	1/4	1/2
F	-	1/2	-	1/2
G	1/2	1/2	-	1
H	1/2	-	1/2	1
J	-	1/2	1/2	1
K	-	3/4	-	3/4
L	1/4	3/4	-	1
M	1/4	-	3/4	1
N	-	1	-	1
P	1	1	1	3

Fungicide: Patrol (fenpropidin)
1 = 1.0 l/ha
3/4 = 0.75 l/ha
1/2 = 0.5 l/ha
1/4 = 0.25 l/ha

If Eyespot was detected on more than 20% tillers at GS 30 on either variety, Sportak 45 would have been applied at this time. However at neither site was Eyespot a signficant disease.

Summary of Results

Detailed site reports for each site are given in Appendix 2.

Winter barley

Both trials were similar in that they were sown relatively late and yields were modest as a result. They were contrasting in their disease patterns.

At the SAC-Edinburgh site, disease developed late. Even at GS49 (first awns visible), disease infection was limited. It developed only to a modest level thereafter with differences between treatments only detectable at GS71 (grain watery ripe). The main disease on Willow was Rhynchosporium and on Pastoral it was mildew. Despite this late development, yield responses of up to 1.0 t/ha (Willow) and 1.4 t/ha (Pastoral) were recorded. The data are summarised in Table 3.

Table 3. Summary disease and yield data for reduced fungicide dose trial at SAC-Edinburgh

Code	Treatment (GS)			Willow		Pastoral	
	30	31	39/49	Rhyncho %	Yield t/ha	Mildew %	Yield t/ha
A	-	-	-	9.7	6.28	7.0	6.34
B	-	1/4	-	11.0	6.44	4.0	7.00
C	-	1/2	-	6.3	6.63	1.7	6.84
D	-	3/4	-	9.7	6.86	3.4	7.10
E	-	1	-	2.7	6.76	4.0	7.00
F	-	1/4	1/4	7.0	6.73	0.7	7.35
G	-	1/2	1/2	3.3	6.93	0.1	7.17
H	-	3/4	3/4	1.3	6.98	0.1	7.37
J	-	1	1	1.4	7.09	0.1	7.35
K	1/4	1/4	1/4	3.3	6.73	0.4	7.26
L	1/2	1/2	1/2	2.7	6.91	0.1	7.33
M	3/4	3/4	3/4	1.1	7.28	0.1	7.74
N	-	1/2S	1/2S	1.4	7.09	0.1	7.70
P	IDR	IDR	IDR	5.0	6.76	1.0	7.04
R	1/4	1/2	1/2	1.7	7.00	0.1	7.57
sed				2.93	0.119	2.03	0.265

Disease assessments as overall infection of top three leaves at GS 71

On the variety Willow, two spray programmes gave better control of Rhynchosporium at 3/4 and full doses than one spray programmes. The two spray programme at half dose was apparently less effective at disease control but gave an equivalent yield. There were, however, no significant differences between the two spray programmes. The addition of a fungicide application at GS 30 tended to improve disease control but appeared to improve yield only when applied at 3/4 dose. The IDR treatment (a single half dose application at GS 39) resulted in disease control and yield similar to a single half dose applied at GS 31. At the low disease pressure in this variety the substitution of Sanction for Tilt did not improve yield significantly.

Pastoral was more responsive to fungicide treatment. In general, two spray programmes improved disease control and yield over a single application but never significantly. The addition of a third application at GS 30 was again only apparently effective at 3/4 dose. The single spray at half dose in the IDR treatment at GS 39 was not significantly different from a single application at GS 31. In contrast to Willow, the substitution of Sanction for Tilt on this more responsive variety resulted in a significant yield response.

At the SAC-Aberdeen site, both mildew and Rhynchosporium were recorded at low levels at GS 31 (first node stage). Rhynchosporium was the predominant disease on Willow but both diseases developed on Pastoral. It was evident that Rhynchosporium was more difficult to control than mildew. By the early milk stage (GS 73), infection of the flag and second top leaves of both varieties was relatively severe. Yield responses up to 0.87 t/ha (Willow) and 1.37 t/ha (Pastoral) were recorded. The data for the SAC-Aberdeen trial are summarised in Table 4.

Table 4. Summary disease and yield data for reduced fungicide dose trial at SAC-Aberdeen

Code	Treatment (GS)			Willow		Pastoral		
	30	31	39/49	Rhyncho %	Yield t/ha	Rhyncho %	Mildew %	Yield t/ha
A	-	-	-	28.8	5.41	7.6	21.3	5.74
B	-	1/4	-	27.2	5.73	9.8	22.3	5.79
C	-	1/2	-	20.9	5.69	8.9	10.8	5.88
D	-	3/4	-	24.0	5.34	11.0	13.0	6.05
E	-	1	-	23.3	5.81	4.3	14.3	6.34
F	-	1/4	1/4	23.7	5.94	3.2	16.0	6.09
G	-	1/2	1/2	13.2	6.11	3.2	14.3	6.39
H	-	3/4	3/4	6.4	5.82	0.9	13.2	7.10
J	-	1	1	7.7	6.03	1.3	9.5	6.49
K	1/4	1/4	1/4	24.5	5.71	2.9	11.3	6.86
L	1/2	1/2	1/2	7.1	6.09	1.6	6.5	6.55
M	3/4	3/4	3/4	5.5	5.77	1.4	6.0	6.56
N	-	1/2S	1/2S	6.2	6.28	3.2	9.1	6.33
P	IDR	IDR	IDR	11.9	5.89	1.4	8.9	6.32
R	1/4	1/2	1/2	12.2	5.92	2.6	10.2	6.60
sed				4.40	0.286	2.09	4.40	0.286

Disease assessments of second top leaf at GS 73

Comparing one and two spray programmes, significant reductions in Rhynchosporium on the variety Willow only resulted from two sprays at 3/4 or full dose. Single sprays at any dose and two or three spray programmes at quarter dose were particularly ineffective at reducing Rhynchosporium. Three spray programmes tended to improve disease control over two sprays (except at 1/4 dose) but there were no significant differences between the yields of two and three spray programmes. Indeed there were few significant increases in yield over the untreated control.

On Pastoral, a single full dose and all two or three spray programmes significantly reduced disease over the untreated control. The best control of both diseases came with the two and three spray programmes but there was no clear trend between number of applications, dose, disease control and yield.

The substitution of Sanction for Tilt at the SAC-Aberdeen site did not result in a significant response in either disease control or yield.

IDR. In all four trials IDR did not prove effective at identifying the best disease control or yield response.

Winter wheat

At both SAC-Edinburgh and SAC-Aberdeen sites yield responses to fungicide treatment on the variety Riband were high (up to 3.2 and 2.46 t/ha respectively). At both sites Septoria tritici was the predominant disease and other foliar and stem base diseases were at low levels or absent. Both trials demonstrated how responsive Riband is and how crucial control of S. tritici is.

At both sites, rainfall was well above average and in consequence disease pressure was high. It was evident that, provided a three spray programme was applied, yields, not significantly different from a three spray full dose programme, could be achieved by using a total dose equivalent to 1.5 - 2.0 full doses. This is a reflection of the relative importance of the second top leaf (leaf 2) and the continuous disease pressure during the season. Quarter doses of fungicide proved of little value in this high disease pressure season, although a four spray quarter dose programme restricted S. tritici infection. However, after the final application the persistence of quarter doses proved inadequate. With a three spray half dose programme (GS 33, 39 & 59) increasing the dose at GS 39 or 59 had a small but non-significant effect on yield.

The importance of correct timing was demonstrated in the trials. It was evident in both that a delay of the GS 32 application to GS 33 improved disease control and yield in every instance.

A summary of the yield and disease for Riband at both sites is shown in Table 5.

In contrast to Riband, the variety Apollo was not as responsive to fungicide treatment. This might suggest that this variety is tolerant of infection by mildew. At the SAC-Edinburgh site, there were no significant differences in yield between any of the treatments despite high levels of mildew. At SAC-Aberdeen, significant differences in yield were detected but this was attributed in part to infection by S. tritici (despite application at GS39 of a protectant fungicide specific to S. tritici).

At SAC-Edinburgh, a single full or three quarter fungicide dose at GS 39 gave effective mildew control, in contrast to a single quarter or half dose. However, a two spray application of quarter doses at GS 32 & 39 was also successful. As mildew infection was established in May, at the time of the first spray, the application of fungicide even at quarter dose had some effect on suppressing mildew. At SAC-Aberdeen the control of mildew was less clear cut with only a single full dose at GS 39 or a full dose three spray programme effecting a significant reduction in mildew by the watery ripe stage. There was no obvious indication in this trial that an early application at GS 32 was beneficial but mildew infection was limited at this time and only developed to any extent after the flag leaf emerged stage.

These trials suggest that eradicating mildew on this variety is not cost effective.

The yield and disease results from the two trials are summarised in Table 6.

Table 5. Summary of disease and yields for the variety Riband at SAC-Edinburgh and SAC-Aberdeen

Code	Treatments				SAC-Edinburgh		SAC-Aberdeen	
					Yield	S. tritici	Yield	S. tritici
	GS32	GS33	GS39	GS59	t/ha	leaf 1 GS75	t/ha	leaf 1 GS77
A	-	-	-	-	6.30	52.3	4.15	79.1
B	1/4	-	1/4	1/4	8.17	12.0	4.99	36.9
C	-	1/4	1/4	1/4	8.45	7.3	5.30	38.3
D	1/4	1/4	1/4	1/4	8.64	5.7	5.50	17.8
E	-	-	1/2	1/2	8.42	7.7	5.53	20.3
F	1/2	-	1/2	1/2	8.72	3.4	5.96	13.2
G	-	1/2	1/2	1/2	9.30	6.7	6.49	14.7
H	1/2	1/2	1/2	1/2	9.46	1.7	6.33	20.7
J	1/4	-	1/2	1/2	8.89	0.7	6.01	29.0
K	-	1/4	1/2	1/2	9.12	1.4	6.48	19.6
L	1/2	-	3/4	1/2	9.05	4.0	6.37	11.4
M	-	1/2	3/4	1/2	9.21	0.7	6.61	5.5
N	1/2	-	3/4	3/4	9.36	3.3	6.55	7.8
P	1	-	1	1	9.50	3.7	6.57	11.7
sed					0.287	7.64	0.269	5.43

Table 6. Summary of disease and yields for the variety Apollo at SAC-Edinburgh and SAC-Aberdeen

Code	Treatment			SAC-Edinburgh		SAC-Aberdeen	
				Yield	Mildew	Yield	Mildew
	GS 32	GS 39	GS 59	t/ha	leaf 2 GS 71	t/ha	leaf 2 GS71
A	-	-	-	7.63	8.0	4.30	14.1
B	-	1/4	-	7.66	1.1	4.55	8.8
C	1/4	1/4	-	7.48	5.3	4.89	9.9
D	1/4	-	1/4	8.00	3.3	4.70	12.0
E	-	1/4	1/4	7.59	0.1	4.74	13.2
F	-	1/2	-	7.90	3.0	4.90	12.6
G	1/2	1/2	-	7.84	1.0	4.99	5.5
H	1/2	-	1/2	7.93	2.3	4.72	9.0
J	-	1/2	1/2	7.93	0.1	5.16	6.1
K	-	1/2	-	7.64	2.3	5.10	12.3
L	1/4	3/4	-	7.82	2.3	4.91	5.5
M	1/4	-	3/4	7.76	1.7	4.90	11.7
N	-	1	-	8.02	0.1	4.98	4.8
P	1	1	1	8.25	0	5.35	2.8
sed				0.287	1.19	0.269	4.39

Cost benefit analysis

Using 1994 prices for fungicides and a value of £5/ha for cost of each application (assumes applied by grower) values for margin/cost have been calculated for each of the four trials. Margin/cost (m/c) is taken as the value of the extra yield as a result of fungicide treatment less the cost of fungicide and application. In the tables below the m/c has been calculated at four prices for grain, £100, £95, £90 and £85. These are chosen to reflect the move to world prices as a result of the current CAP policy. The mean yield from each treatment has been used in the analysis and no statistical analysis attempted. In order to do this it would be necessary to determine gross margins for each plot and then analyse in the same way as yields. Clearly, because of the variability in yield data, caution is necessary when interpreting the financial data presented here, but several points can be drawn from the analysis.

Winter barley

At SAC-Edinburgh, the treatment that produced the highest m/c value for each variety was treatment N, where Sanction was substituted for Tilt. The use of a more effective triazole fungicide produced a greater yield response at little extra cost. This result shows the importance of selecting the most effective fungicide per pound spent.

Comparing treatments other than N, on the variety Willow all treatment programmes resulted in positive m/c's even at the lowest grain price. Three treatments (D,G,M) gave the highest and comparable responses (within £5) but were very different, being a one, two and three spray programme respectively. This is not surprising for the extra yield achieved by applying extra fungicide balanced the extra cost. That a range of programmes produce similar m/c's is reassuring in that several approaches to disease control can be equally good. However, it must be borne in mind that reponses were low in this trial. Further trials are needed to evaluate whether a similar situation occurs where responses are high.

On the variety Pastoral, yield responses were generally higher than for Willow and one treatment, other than N, stood out as the most profitable (F). With this variety a two spray programme of full doses (J) was unprofitable at grain prices below £95/t.

The winter barley trials at SAC-Aberdeen also had relatively small yield responses and many treatments resulted in negative m/c's. On Willow, treatment N (Sanction substituted for Tilt) was the most profitable again. Treatments F and G (two spray programmes of quarter and half doses respectively) were the most profitable of the Tilt programmes. With Pastoral, where disease was present at GS30 and reached high levels of infection, the most profitable treatments were either a two spray three quarter dose programme or a three spray quarter dose programme. This result supports the contention that for profitability, where reduced doses are going to be used and disease pressure is high, a low dose treatment before the main spray timings (GS31 & 39) can have a beneficial effect, although in disease control this effect was not apparent.

In trials where yield responses are low the use of several applications of high (3/4, full) doses means that the yield for break-even is much higher. Thus if it can be decided with certainty that yield potential is low and thus responses will be low, the use of low dose programmes (using quarter and half doses) seems more likely to produce a better m/c. In low response situations it would appear that irrespective of disease pressure, a high degree of disease control may not be required. There still remains a judgement, which must be based on disease/cultivar/weather about when sprays should be applied. With the treatments that proved most profitable on the two winter barley trials, inspection of the disease data for these treatments in relation to less successful ones does not reveal any clear pattern that indicates why they were successful. Thus apart from the general conclusion that crops expected to produce low yields and responses require low fungicide dose inputs, these winter barley trials have not given a clear lead on how to judge dose based on disease severity.

Table 7. Analysis of margin over cost for winter barley trials at four grain prices

SAC-Edinburgh - Willow

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(6.28)	0	0	0	0
B	0.16	5.37	4.57	3.77	2.97
C	0.35	18.75	17.00	15.25	13.50
D	0.58	36.12	33.22	30.32	27.42
E	0.48	20.50	18.10	15.70	13.30
F	0.45	23.75	21.50	19.25	17.00
G	0.65	32.50	29.25	26.00	22.75
H	0.70	26.25	22.75	19.25	15.75
J	0.81	26.00	21.95	17.9	13.85
K	0.45	13.12	10.87	8.62	6.37
L	0.63	14.25	11.10	7.95	4.80
M	1.00	34.36	29.36	24.36	19.36
N	0.81	47.80	43.75	39.70	36.65
P	0.48	31.75	29.35	26.95	24.55
R	0.72	28.87	25.27	21.67	18.07

SAC Edinburgh - Pastoral

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(6.34)	0	0	0	0
B	0.66	49.87	46.57	43.27	39.97
C	0.50	22.75	20.25	17.75	15.25
D	0.76	37.62	33.82	30.02	26.22
E	0.66	16.50	13.20	9.9	6.60
F	1.01	68.75	63.70	58.65	53.60
G	0.83	28.50	24.35	20.20	16.05
H	1.03	26.25	21.10	15.95	10.80
J	1.01	2.0	-3.05	-8.10	-13.15
K	0.92	43.62	39.02	34.42	29.82
L	0.99	17.25	12.30	7.35	2.4
M	1.40	24.87	17.87	10.87	3.87
N	1.36	80.8	74.00	67.20	60.40
P	0.70	42.75	39.25	35.75	32.25
R	1.23	52.37	46.22	40.07	33.92

Calculations based on :

Tilt £22.5 /0.5 litres
Sanction £23.2 /0.4 litres
Aura/Corbel £22.0 /1.0 litres
Application £5.0 /ha

SAC-Aberdeen - Willow

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(5.41)	0	0	0	0
B	0.32	21.37	19.77	18.17	16.57
C	0.27	11.05	9.69	8.32	6.96
D	-0.07	-29.18	-28.82	-28.45	-28.09
E	0.40	12.70	10.69	8.68	6.67
F	0.53	31.95	29.29	26.63	23.97
G	0.70	37.50	34.00	30.50	27.00
H	0.41	-3.25	-5.28	-7.30	-9.33
J	0.62	6.80	3.71	0.62	-2.47
K	0.29	-2.58	-4.05	-5.51	-6.98
L	0.68	18.95	15.57	12.18	8.80
M	0.36	-29.64	-31.44	-33.24	-35.04
N	0.87	53.40	49.07	44.74	40.41
P	0.48	-6.28	-8.69	-11.09	-13.50
R	0.51	7.97	5.42	2.86	0.31

SAC-Aberdeen - Pastoral

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(5.74)	0	0	0	0
B	0.05	-11.43	-11.67	-11.90	-12.14
C	0.14	-13.05	-13.76	-14.47	-15.18
D	0.31	-7.68	-9.22	-10.75	-12.29
E	0.60	10.40	7.41	4.41	1.42
F	0.35	2.55	0.81	-0.93	-2.67
G	0.65	10.50	7.25	4.00	0.75
H	1.36	59.35	52.55	45.74	38.94
J	0.75	-24.50	-28.23	-31.95	-35.68
K	1.12	63.72	58.12	52.51	46.91
L	0.81	-0.95	-4.99	-9.03	-13.07
M	0.82	-33.43	-37.52	-41.60	-45.69
N	0.59	3.5	0.57	-2.37	-5.31
P	0.58	-12.83	-15.72	-18.61	-21.50
R	0.86	15.07	10.79	6.50	2.22

Calculations based on :

Tilt £22.5 /0.5 litres
Sanction £23.2 /0.4 litres
Aura/Corbel £22.0 /1.0 litres
Application £5.0 /ha

Winter wheat

At the SAC-Edinburgh site, only three treatments resulted in positive m/c's on the variety Apollo. The best two of these both included a quarter dose application at GS32. However, since there were no significant differences between treatment yields, firm conclusions are not really possible.

All treatments gave positive m/c's for Apollo at the SAC-Aberdeen site. Two of the three treatments that were profitable at the SAC-Edinburgh site were two of the top four profitable treatments at SAC-Aberdeen (F, N). However, there were no clear patterns of fungicide use that resulted in profitability. It was also not possible to relate profitability to the level of mildew infection. This may be because the degree of infection by Septoria tritici complicated the picture when a mildew specific fungicide was used. The results support the contention that where responses are likely to be low, reduced doses are most appropriate.

On the variety Riband where yield responses at both sites were mostly above 1.3 t/ha and frequently greater than 2.0t/ha, all treatments resulted in very large m/c's. The top four responses at Edinburgh were G,H,K,N whilst at Aberdeen they were G,K,M,N. Thus there was a good degree of agreement between both sites. Profitability followed the amount of yield response to a large extent, which in turn appeared to be related to disease control. However, this was only true where programmes using reduced doses were concerned. The full dose three spray programmes whilst giving the highest or second highest yield response proved too costly to give the best m/c.

The cost benefit analysis confirms the yield analysis, that effective disease control and yield loss can be achieved on a highly susceptible variety even under high disease pressure by using doses less than a full dose.

Cost benefit analysis - final comments

In these trials, only a few of the many fungicide treatment combinations could be evaluated. Conclusions are thus limited to those treatments tested. It is possible that untested treatments would be the most effective. Intensive trials such as those considered for experiment 3 in the subsequent projects on 'appropriate fungicide doses for winter barley and winter wheat' using different statistical approaches and allowing interpolation from the treatments tested to untested ones are likely to provide more conclusive results than those presented here. These trials do show that where responses are large, useful data can be gathered from trials such as those on Riband reported here. However, where yield responses are small, trials must be accurately done to minimise variation in yield and disease assessments in order to detect significant effects.

Table 8. Analysis of margin over cost for winter wheat trials at four grain prices

SAC-Edinburgh - Apollo

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(7.63)	0	0	0	0
B	0.03	-7.5	- 7.7	-7.8	-8.0
C	-0.15	-36.0	-35.3	-34.5	-33.8
D	0.37	16.0	14.2	12.3	10.5
E	-0.04	-25.0	-24.8	-24.6	-24.4
F	0.27	11.0	9.7	8.3	7.0
G	0.21	-11.0	-12.1	-13.1	-14.2
H	0.30	-2.0	-3.5	-5.0	-6.5
J	0.30	-2.0	-3.5	-5.0	-6.5
K	0.01	-20.5	-20.6	-20.6	-20.7
L	0.19	-13.0	-14.0	-14.9	-15.9
M	0.13	-19.0	-19.7	-20.3	-21.0
N	0.39	12.0	10.1	8.1	6.2
P	0.62	-19.0	-22.1	-25.2	-28.3

SAC-Edinburgh - Riband

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(6.3)	0	0	0	0
B	1.87	148.8	139.4	130.1	120.7
C	2.15	176.8	166.0	155.3	144.5
D	2.34	183.0	171.3	159.6	147.9
E	2.12	171.0	160.4	149.8	139.2
F	2.42	180.5	168.4	156.3	144.2
G	3.00	238.5	223.5	208.5	193.5
H	3.16	234.0	218.2	202.3	186.6
J	2.59	205.3	192.3	179.4	166.4
K	2.82	228.3	214.2	200.1	186.0
L	2.75	205.8	192.0	178.3	164.5
M	2.91	221.8	207.2	192.7	178.1
N	3.06	229.0	213.7	198.4	183.1
P	3.20	212.0	196.0	180.0	164.0

Calculations based on:

Patrol £22.0 /1.0 litres
Folicur £31.0 /1.0 litres
Application £5.0 /ha

SAC-Aberdeen - Apollo

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(4.299)	0	0	0	0
B	0.249	14.4	13.2	11.9	10.7
C	0.589	37.9	35.0	32.0	29.1
D	0.403	19.3	17.3	15.3	13.3
E	0.443	23.3	21.1	18.9	16.7
F	0.600	44.0	41.0	38.0	35.0
G	0.691	37.1	33.6	30.2	26.7
H	0.422	10.2	8.1	6.0	3.9
J	0.859	53.9	49.6	45.3	41.0
K	0.797	58.2	54.2	50.2	46.2
L	0.613	29.3	26.2	23.2	20.1
M	0.599	27.9	24.9	21.9	18.9
N	0.681	41.1	37.7	34.3	30.9
P	1.053	24.3	19.0	13.8	8.5

SAC-Aberdeen - Riband

Code	(Yield) Response	Margin / Cost (£) @ 100/t	95/t	90/t	85/t
A	(4.147)	0	0	0	0
B	0.838	45.6	41.4	37.2	33.0
C	1.157	77.5	71.7	65.9	60.1
D	1.357	84.7	77.9	71.1	64.3
E	1.379	96.9	90.0	83.1	76.2
F	1.810	119.5	110.5	101.4	92.4
G	2.344	172.9	161.2	149.5	137.7
H	2.181	136.1	125.2	114.3	103.4
J	1.866	132.9	123.5	114.2	104.9
K	2.331	179.4	167.7	156.0	144.4
L	2.224	153.2	142.0	130.9	119.8
M	2.466	177.4	165.0	152.7	140.4
N	2.406	163.6	151.6	139.5	127.5
P	2.424	134.4	122.3	110.2	98.0

Calculations based on:

Patrol £22.0 /1.0 litres
Folicur £31.0 /1.0 litres
Application £5.0 /ha

Discussion

When considering the use of reduced doses of fungicides, a different approach is required for winter cereals and spring cereals. For the latter where the disease spectrum is limited and the time scale short, the 'threshold' approach developed by SAC is highly appropriate. Provided growers can inspect crops regularly, timing of application and dose can be easily linked. Since mildew is the dominant disease, 'what you see is what you have'.

With winter cereals the same is true of mildew and the rust diseases but there are also diseases with long latent periods - Septoria spp and Rhynchosporium secalis. At the time a grower is making a decision to apply a fungicide it can be difficult to know exactly the degree of infection that is being tackled and therefore the most appropriate dose.

The use of reduced doses on winter cereals requires a higher level of management and technical expertise. In terms of management there are practical considerations to bear in mind including how long it will take to apply a treatment across the whole acreage, whether fungicide applications can be accommodated with other crop protection or micronutrient applications, and what priority is put on the fungicide application in relation to the plethora of other tasks on the farms.

The timing of fungicide application is important when using appropriate doses. Where timing is sub-optimal then the dose applied may be inappropriate and efficient control not achieved. In a similar way growers, quite naturally, want to make as few passes with a sprayer through a crop as possible. In doing this fungicides may not be applied at the most optimal time. Consideration of this fact must be borne in mind when deciding on fungicide dose. (It is a common failing of plant pathologists researching disease control to forget the other elements of crop protection and nutrition). Whole farm management is a continuous series of compromises. The secret is to weigh up all the tasks and assign priorities on a damage limiting basis. Thus where disease control is concerned, sub-optimal fungicide timing is a potential farm hazard.

It is clear from this situation that **flexibility** is a key factor in the use of reduced doses. Hence the term 'appropriate dose' has been coined. This means that if an appropriate dose suitable for a particular timing is chosen and for various reasons spraying is delayed a new appropriate dose needs to be calculated to accommodate the changed risk. Growers (and advisers) will quite naturally build in a small degree of leeway into any appropriate dose to cope with unforeseen delays or unappreciated disease. This is quite reasonable and given the variability of any biological systems, researchers should not expect that growers will ever apply exactly the right dose all the time.

Technical expertise is another skill that growers or advisers must have in order to use appropriate doses effectively. There remain, however, a large number of serious gaps in our knowledge for which 'experience' or 'gut feelings' are currently substituted. These gaps are being plugged but the process is slow. An example of one gap is the comparative effectiveness of fungicides below the full dose. Dose response curves are needed for all fungicides relative to known standards. These need to be determined for both protective and curative situations. Only with this information can objective decisions be made on dose. At the moment, experience is the main basis of judging which dose will provide sufficient control in any situation. The investigation of dose response curves is one experiment of the HGCA projects on appropriate fungicide doses of winter barley and winter wheat that started in October 1993.

Dose response curves provide a summary view of a particular situation. For example, if plants are sprayed just prior to a single episode of attack by a pathogen then the prophylactic effect of dose can be evaluated in a simple way. If plants are sprayed just prior to a continuous series of infection events then the effect of dose may or may not be different. Effectiveness of a fungicide will, in part, be related to the persistence of a fungicide in leaf tissue. This is not an easy or cheap thing to measure. In the absence of such information, interpretation of dose response curves will require care.

A knowledge of epidemiology of pathogens, of identification skills (with or without diagnostic aids), of crop growth, physiology and sensitivity to infection, of pathogen races in a locality and their relation to disease resistance ratings of varieties are all required for using appropriate doses.

When analysing the cost of fungicide treatment, one factor influencing the use of appropriate doses is yield potential. In Scotland, and no doubt elsewhere in the UK, there is an optimum drilling period for each winter cereal. After this period yields fall away and whatever is done to a crop the yield potential cannot be retrieved. With lower potential the inputs, including fungicide, need to be trimmed accordingly. Yield potential is, however, a very difficult thing to judge. Nevertheless, there are indications of yield potential - past farm history, sowing date, degree of severity of winter being three.

Taking winter barley, the optimum period for sowing winter barley is mid-to-the-end of September in north east Scotland. As drilling proceeds through October yield potential falls away (Walker, 1991). Earlier sowings have good yield potential but exact a penalty by way of autumn disease. In the two trials in this project, autumn conditions were poor and sowing dates sub-optimal. Yields were consequently well below normal expectation for the sites.

The yield responses expressed as a percentage of the untreated control, were less than those expected for each variety (c.f. SAC cereal recommended list of 1993) and with a lower untreated yields the actual responses were considerably less. It is not surprising, therefore, that the most cost effective responses use doses well below the full three spray programmes.

Site & Sowing date	Willow Yields		Pastoral Yields	
	Untreated	Highest	Untreated	Highest
SAC Edinburgh 9 October	6.28	7.28	6.34	7.57
SAC Aberdeen 7 October	5.41	6.28	5.74	7.10

On winter cereals, particularly winter wheat, researchers have identified the principal growth stages when fungicide applications should be considered. Taking winter wheat, for foliar disease control these are GS 32 (when the 3rd top leaf is emerging), GS 33 (2nd top leaf emerging), GS 37-39 (flag leaf emerging to emerged) and GS 59+ (ear emergence onwards). Eyespot control can still be achieved at GS 32 although it may be achievable at any time from late tillering to GS 33. Prior to GS 32 application of fungicide is less critical for foliar diseases such as Septoria spp as the leaves unfurled at this time have a very small contribution to yield. It is also recognised that use of fungicide 'to reduce the inoculum' of Septoria spp is largely ineffective as the degree of control would have to be very high indeed to limit the potential for spread to the top three leaves later. Only with mildew and yellow or brown rust is justification for fungicide applications prior to GS 32 unambiguous. As mildew is a difficult disease to control, even with morpholines, use of a fungicide early in the epidemic could ensure that disease progress is limited and efficient control possible. Yellow and brown rust are diseases with the potential for 'explosive' development and control at the time when they are first seen is important to prevent disease development. Application of low doses (as low as a quarter) at this early stage in disease development can control disease. (Paveley & Lockley, 1993).

The attitude of growers and some advisers to these timings is sometimes ambivalent. For example, a traditional timing for disease control has been GS 31. At this timing, as well as fungicides, chlormequat, micronutrients and even herbicides can be used. Where a grower wants to apply a single dose of chlormequat, GS 30-31 is optimal. GS 31 is also the latest time for correcting or preventing deficiencies (copper, manganese, sulphur) for optimal effect. And GS 31 is the latest time for a number of herbicides. For those growers looking to minimise passes with a sprayer through a crop, GS 31 is a more logical timing than GS 32. The fact that none of the three, crucial, top leaves have emerged at GS 31 and the time span between GS 31 and GS 37-39 means that those growers adopting this timing for the first fungicide application may need to use near full doses of fungicide at GS 37-39 to eradicate infection of the top three leaves should it occur between the two timings. The problem for the grower is that whilst mildew and rust infections are visible, Septoria sp., particularly S.tritici, have a long latent period and the grower is not able to predict easily the degree of infection. It is in this situation where decision support aids such as diagnostics, the Long Ashton Splashmeter and local weather information is so important.

The importance of timing and not leaving too long an interval between the 'stem extension' application and the flag leaf application on susceptible varieties (particularly if using reduced doses) is shown in the two wheat trials of this project. Under persistent pressure from S.tritici there was an increase in yield by delaying the GS 32 application to GS 33 in every instance. It seems unlikely at the moment that growers would have been inclined to spray at two growth stages so close together or indeed would have the information to have judged that such an action would have been beneficial. However, in the slow growth of the crop in 1993 at both sites, the time interval was a surprising 17-18 days during which time it was quite reasonable to have expected infection of the second and third top leaves. The difference in yield between treatments receiving a GS 32 and GS 33 application is probably entirely accounted for by the infection of the unprotected second top leaf before the flag leaf application was made.

Given these findings it is possible that dedicated growers would consider a 'drip feed' protective approach to disease control with applications at GS 32, 33, 39 and 59 but using low doses to continually top up the control on successively emerging leaves and the ear. Such an approach gave good yield responses and one of the highest margins over cost especially at the SAC-Edinburgh trial but it requires an intensive management approach.

On winter barley, growers have adopted standard timings. These timings have been adopted for reasons of disease control and husbandry. For example, a flag leaf application can be tank-mixed with a growth regulator and the reasons for a GS 31 application are similar to those described for wheat. Certainly trials have shown that these timings are highly cost effective; but recent MAFF trials investigating yield responses to different fungicide doses at different timings have shown that these standard timings are not necessarily the best (N. Paveley, personal communication). It is possible that better timings can be judged on disease development but given disease control is only one element of crop protection, it seems that growers may be reluctant to change from the standard timings.

With winter barley, similar problems exist in relation to knowing the time or extent of infection of disease. Once again it is rain-splashed diseases that give the greatest difficulty. Rhynchosporium, for example, has a latent period of 10-21 days depending on temperature. In the same way that growers have problems knowing whether Septoria spp. have infected, so growers can only use broad rainfall criteria for Rhynchosporium on barley. A difference to wheat is that the flag leaf of most barley varieties is relatively small and its contribution to yield is presumably lower. Knowledge of the epidemiology of Rhynchosporium and host-disease relationships of winter barley remain less advanced than the study of Septoria tritici and its relationship to yield loss in wheat.

In the two winter barley trials reported here, Rhynchosporium featured strongly in both, although the severity of infection was much greater at the SAC-Aberdeen site. The most cost effective treatments varied but often included quarter or half dose combinations.

By contrast, in the winter wheat trials using the variety Riband, that resulted in large yield responses, use of quarter doses was generally much less effective than doses of half or greater. These wheat trials do show, however, that given good timing, doses in the half to three quarter range were highly cost effective despite intense disease pressure. This conclusion confirms the findings of Wale & Oxley (1992) for susceptible and responsive varieties (work based on HGCA-funded trials).

Another conclusion that can be drawn from the SAC-Edinburgh winter barley trial is that even when the disease epidemic develops late in crop growth and is limited, significant yield responses can still be achieved using fungicide programmes. This supports the contention that even low levels of infection result in yield loss.

Varieties vary in their degree of responsiveness to fungicide treatment. The degree of responsiveness can be determined from variety recommended lists by comparing treated with untreated yields. Varieties like Riband winter wheat and Pastoral winter barley give particularly large yield responses almost every year primarily because they are highly susceptible to Septoria tritici and mildew. There can be little hesitation by growers to apply fungicides at standard timings to these varieties. Variety recommended lists do not and cannot indicate, however, if the degree of yield response is related to the degree of infection. This is because infections are often mixed and epidemics develop differently on different trials. However, closer examination of variety trial data might reveal characteristics of some varieties in their reaction to individual diseases that could save fungicide use. Such an instance could be the interaction of the wheat variety Apollo and mildew. Despite moderate infection in the two trials reported here there is a suggestion that either the variety is tolerant of mildew infection or the disease has a much lesser effect on yield than mildew on barley. The consequence of such a finding, if confirmed, would be that the degree of control required on such varieties would not need to be so great and fungicide inputs could be reduced with greater confidence.

The development of a decision support system such as IDR has to confront a range of situations and be flexible enough to cope with them all. The four elements of an IDR strategy as proposed by Neil Paveley are:

Disease resistance rating
Level of inoculum
Environmental factors
Crop sensitivity

Integrated together they can provide an objective way of deciding the most appropriate dose. Currently IDR is being developed for wheat. The system has the advantage of being flexible so that if circumstances change - a spray timing is missed for example - a recalculation can be done to re-adjust the dose. That such a balancing is necessary was shown in the trials reported here. Where a low dose (quarter) was used for the first application in the winter wheat Riband trials, increasing the dose of the second application could, to some extent make up for the inadequacy of the first.

IDR as proposed above retains a few inherent problems and these need to be addressed before it can be unleashed on farmers. For example, the level of inoculum can be difficult to quantify. It may be adequate to use percentage of plants infected for diseases, such as mildew or the rusts, but with rain driven disease such as S.tritici, extensive pycnidia on dead leaves can make accurate quantification very difficult. It is argued that inoculum is far less important than the weather factors for rain driven diseases and in the IDR equation the greater importance of rainfall is utilised. But a conversion has to be made for growers who have no access to local weather data - and for rainfall, heavy showers can be very restricted across a region to specific localities.

Disease resistance ratings for IDR are taken from the HGCA-funded UK recommended cereal varieties list. Ratings are indicators of disease risk and describe the likely severity of infection when conditions favour disease development and compatible races of a pathogen are present. The rating is a mean result of several years trials and cannot indicate in a single figure that the rating is declining due to a built up of compatible races. Thus if new or unexpected races develop, the IDR equation can be unfairly disadvantaged.

As yet the weather factors that favour diseases are only known broadly. More specific information on how diseases develop in relation to weather parameters is needed to improve the accuracy of this part of the IDR equation.

The final part considered by IDR is crop sensitivity. To a large extent the response of winter cereals to fungicides at specific growth stages is known. It will vary according to the time and form of epidemic of the various diseases but broadly it is sufficiently well established. Work has been initiated under MAFF funding to integrate a knowledge of crop physiology with crop sensitivity.

There still remain areas that affect the success of an IDR strategy that require incorporation. For example, the degree of response will depend on the crop potential and the dose must be related to the actual response rather than likely percent response. The dose that the IDR equation comes up with must accommodate the relative effectiveness of fungicides. Relative effectiveness is a complicated factor in itself as it will vary according to whether a fungicide is used curatively or protectively. Knowledge of the relative persistence of fungicide residues will also help in ascertaining doses of succeeding applications in a programme of fungicides. Concerns of insensitivity of fungal pathogens by fungicides must be considered. It is for this reason that SAC advisory policy continues to be to use mixtures of fungicides (for example triazole + morpholines) wherever possible.

Given the complexities of an IDR strategy it is not surprising that a first attempt to test one out on winter barley in this project met with only limited success. In the SAC-Edinburgh trials where disease pressure was low the cost effectiveness was reasonably good. If there was a failing in this initial attempt, it was that IDR failed to recognise that responses were likely even at low inoculum levels.

At SAC-Aberdeen IDR gave one of the poorest returns. In part this was due to the inoculum levels being pitched too high. Inoculum was estimated in overall percent leaf area infected terms. In the first place this is very difficult to determine accurately especially by unskilled assessors. Secondly, the categories of infection selected were extremely high which tended to underestimate the dose at any particular timing. In this first version, too, little consideration of the effect of weather parameters on disease epidemiology was made.

Initial testing of an IDR strategy has not been wasted, for knowing the failings of this prototype strategy, major modifications have been made to another version which will be evaluated in the 'Appropriate fungicide doses for winter barley' project which was initiated in October 1993. In the revised version, inoculum is assessed as percent plants or percent main tillers with infection of a critical leaf layer. Such an assessment does not require highly skilled staff - except for the skill of identification. Weather parameters have been introduced for each disease, although these are based on limited data in the scientific literature.

One of the disadvantages of small plot trials such as those described in this project is that, by necessity, they contain plots of untreated controls. These plots can supply continuous inoculum to neighbouring plots and the whole trial. Account can be and is made of this in trial design but the fact remains that the disease pressure on treated plots is probably much greater than if the treatment had been applied on a field scale.

Whilst this is described as a disadvantage from a trial point of view it can be considered an advantage when attempting to relate trial results to the field. If a fungicide programme is successful under the disease pressure conditions in a trial situation then it should be equally or more effective in the field where disease pressure should be lower.

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APPENDIX 1

INTEGRATED DISEASE RISK STRATEGY

FOR WINTER BARLEY

AN INITIAL TABULATION

The doses indicated (1/4, 1/2, 3/4, 1) relate to one quarter, one half, three quarters and full dose of the fungicide or fungicide mixture specified for a variety.

GROWTH STAGE 30 (3-4 WEEKS BEFORE GS 31)

Mildew

Disease resistance	Disease level - % of total leaf area Trace - 1%	2-5%	5-20%	>20%
1-3	1/4	1/4	1/4	1/4
4-5	0	1/4	1/4	1/4
6-7	0	0	1/4	1/4
8-9	0	0	0	1/4

Rhynchosporium

Disease resistance	Disease level - % of total leaf area							
	Trace - 1%		2-5%		5-20%		>20%	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	in last 3 wks		in last 3 weeks		in last 3 weeks		in last 3 weeks	
1-3	0	1/4	1/4	1/2	1/4	1/2	1/2	3/4
4-5	0	0	1/4	1/4	1/4	1/2	1/2	1/2
6-7	0	0	0	1/4	1/4	1/2	1/4	1/2
8-9	0	0	0	0	0	1/4	1/4	1/4

Net Blotch

Disease resistance	Disease level - % of total leaf area 0-1%	2-5%	5-20%	>20%
1-3	1/4	1/4	1/2	1/2
4-5	0	0	1/4	1/4
6-7	0	0	0	1/4
8-9	0	0	0	1/4

Brown Rust

Disease resistance	Disease level - % of total leaf area 0-1%	2-5%	5-10%	>10%
1-3	0	1/4	1/2	1/2
4-5	0	0	1/4	1/2
6-7	0	0	0	1/4
8-9	0	0	0	1/4

Determine the appropriate dose for each disease and use the highest dose. Assume no fungicide if disease absent

GROWTH STAGE 31

Mildew

Disease resistance	Disease level - % total leaf area Trace -1%	2-5	6-20	>20
1-3	1/4	1/2	1/2	3/4
4-5	1/4	1/2	1/2	3/4
6-7	1/4	1/4	1/2	1/2
8-9	0	1/4	1/2	1/2

Rhynchosporium

Disease resistance	Disease level - % of total leaf area Trace-1%		2-5 %		6-20 %		>20%	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	in last 3 weeks		in last 3 weeks		in last 3 weeks		in last 3 weeks	
1-3	1/4	1/4	1/2	1/2	3/4	1	1	1
4-5	1/4	1/4	1/2	1/2	3/4	3/4	1	1
6-7	0	1/4	1/4	1/2	1/2	3/4	3/4	1
8-9	0	0	1/4	1/2	1/2	1/2	3/4	3/4

Net Blotch

Disease resistance	Disease level - % of total leaf area Trace 1%	2-5 %	6-20 %	>20 %
1-3	1/4	1/2	3/4	1
4-5	1/4	1/2	1/2	3/4
6-7	0	1/4	1/2	3/4
8-9	0	1/4	1/2	3/4

Brown Rust

Disease resistance	Disease level - % of total leaf area Trace 1%	2-5 %	6-20 %	>20 %
1-3	1/4	1/2	1	1
4-5	1/4	1/2	3/4	1
6-7	0	1/4	1/2	3/4
8-9	0	1/4	1/2	3/4

* Determine the appropriate dose for each disease and use the highest dose
* Assume no fungicide if disease absent
* If eyespot >20% tillers contact project leader

GROWTH STAGE 39-49 HGCA WB APPROPRIATE DOSE TRIAL

Mildew

	Disease level - 1% of total leaf area			
Disease resistance	Trace 1%	2-5%	6-20%	>20%
1-3	1/4	1/2	1/2	3/4
4-5	1/4	1/2	1/2	3/4
6-7	1/4	1/4	1/2	1/2
8-9	0	1/4	1/2	1/2

Rhynchosporium

	Disease level - % of total leaf area							
Disease resistance	Trace 1%		2-5%		6-20%		>20%	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	in last 3 weeks		in last 3 weeks		in last 3 wks		in last 3 weeks	
1-3	1/4	1/4	1/2	1/2	3/4	1	1	1
4-5	1/4	1/4	1/2	1/2	3/4	3/4	1	1
6-7	0	1/4	1/4	1/2	1/2	3/4	3/4	1
8-9	0	0	1/4	1/2	1/2	1/2	3/4	3/4

Net Blotch

	Disease level - % of total leaf area			
Disease resistance	Trace 1%	2-5%	6-20 %	>20%
1-3	1/4	1/2	3/4	1
4-5	1/4	1/2	1/2	3/4
6-7	0	1/4	1/2	3/4
8-9	0	1/4	1/2	3/4

Brown Rust

	Disease level - % of total leaf area			
Disease resistance	Trace 1%	2-5%	6-20 %	>20%
1-3	1/4	1/2	3/4	1
4-5	1/4	1/2	3/4	3/4
6-7	1/4	1/4	1/2	3/4
8-9	0	1/4	1/2	3/4

* Determine the apropriate dose for each disease and use the highest dose

* Assume no fungicide if disease absent

APPENDIX 2

Site reports for SAC-Edinburgh written by Dr S Oxley
Site reports for SAC-Aberdeen written by Dr S Wale

Winter Barley Reduced Fungicide Dose Trial
SAC Edinburgh

Site Details

Site:	Hayknowes, Bush Estate Midlothian
Grid Ref	NT 248 650
Soil series:	MacMerry
Soil texture:	Sandy clay loam
Soil pH:	5.7 (4 t/ha lime applied after analysis)
Previous cropping	
1992	Winter barley
1991	Winter Wheat
1990	Winter Wheat
1989	Potatoes
Variety: Willow	
	Pastoral
Date sown:	9 October 1992
Date harvested	21 August 1993
Seed rate	190 Kg/ha
Plot size	22 x 2 metres
Autumn fertilizer	0:60:60 N:P:K in Kg/ha 15 October 1992
Nitrogen top dressing	50 Kg/ha 9 March 1993 Gs13 21
	50 Kg/ha 1 April 1993 GS14 22
	70 Kg/ha 29 April 1993 GS30 - 31
Herbicide:	Panther 2 l/ha 21 October 1992 GS 05
Fungicides	28 April 1993 GS 30 - 31
	6 May 1993 GS 31
	28 May 1993 Managed plot P GS39
	1 June 1993 GS 45-51
Other sprays	Cutonic manganese 10 l/ha 28 April 1993 GS30 - 31
	Terpal 1.5 l/ha 12 MAy 1993 GS 37

Treatments

Code	GS30 Pseudostem erect 28 April 1993	GS31 First node 6 May 1993	GS39-45 Flag leaf emerged to boot stage 1 June 1993
A	0	0	0
B	0	0.25	0
C	0	0.5	0
D	0	0.75	0
E	0	1.0	0
F	0	0.25	0.25
G	0	0.5	0.5
H	0	0.75	0.75
J	0	1.0	1.0
K	0.25	0.25	0.25
L	0.5	0.5	0.5
M	0.75	0.75	0.75
N	0	0.5S	0.5S
P	IDR*	IDR*	IDR*
R	0.25	0.5	0.5

Cultivars: Willow
Pastoral

Treatment codes Willow:	1.0	Tilt 0.5 l/ha
	0.75	Tilt 0.375 l/ha
	0.5	Tilt 0.25 l/ha
	0.25	Tilt 0.125 l/ha
	0.5S	Sanction 0.2 l/ha
Treatment codes Pastoral	1.0	Tilt 0.5 + Corbel 1.0 l/ha
	0.75	Tilt 0.375 + Corbel 0.75 l/ha
	0.5	Tilt 0.25 + Corbel 0.5 l/ha
	0.25	Tilt 0.125 + Corbel 0.25 l/ha
	0.5S	Sanction 0.2 + Corbel 0.5 l/ha

IDR* - Integrated Disease Risk programme
Disease levels were low throughout the season. Willow received 0.25 l/ha Tilt and Pastoral received 0.25 l/ha Tilt + 0.5 l/ha Corbel on 28 May 1993 at Growth Stage 39.

Results

Yields Willow (Crop harvested 21 August 1993)

Code	Yield tonnes/ha	Thousand grain wt g	Specific weight kg/hl
A	6.28	49.6	70.1
B	6.44	50.1	70.4
C	6.63	51.2	70.4
D	6.86	52.4	70.9
E	6.76	52.1	70.6
F	6.73	51.1	70.6
G	6.93	51.4	70.9
H	6.98	52.7	71.2
J	7.09	53.4	71.5
K	6.73	51.8	70.8
L	6.91	54.1	71.2
M	7.28	53.8	71.3
N	7.09	53.1	71.4
P	6.76	52.5	70.9
R	7.00	52.6	71.1
SED	0.119	0.973	0.179

Yields Pastoral (Harvested 21 August 1993)

Code	Yield tonnes/ha	Thousand grain wt g	Specific weight kg/hl
A	6.34	50.6	66.0
B	7.00	51.4	68.0
C	6.84	51.3	68.4
D	7.10	52.4	68.3
E	7.00	52.6	68.3
F	7.35	50.0	68.3
G	7.17	51.7	69.1
H	7.37	53.8	68.5
J	7.35	52.8	69.1
K	7.26	53.0	68.5
L	7.33	54.3	69.1
M	7.74	53.8	69.1
N	7.70	54.5	68.9
P	7.04	51.2	68.1
R	7.57	53.8	68.6
SED	0.265	1.61	0.44

24 May 1993 - Willow - GS49 (First Awns Visible)

Code	% Mildew	% Rhynchosporium
A	0.4	4.0
B	0	1.4
C	0	3.3
D	0	2.0
E	0	1.7
F	0	1.7
G	0	4.0
H	0	2.3
J	0	1.0
K	0	2.7
L	0	0.7
M	0	1.7
N	0	2.4
P	0.4	2.7
R	0	1.7
SED	0.15	1.57

24 May 1993 - Pastoral - GS49 (First Awns Visible)

Code	% Mildew	% Rhynchosporium
A	1.7	2.7
B	0	1.0
C	0	0.8
D	0	1.7
E	0	1.0
F	0	1.4
G	0	1.4
H	0	0.1
J	0	0.3
K	0.1	0.1
L	0	0.4
M	0	0
N	0	0.4
P	1.0	2.0
R	0	0.3
SED	0.38	0.74

8 June 1993 - Willow - GS 65 (Crop Flowering) mean assessment of top three leaves

Code	% Mildew	% Rhynchosporium
A	0.1	3.7
B	0	0.1
C	0	0.7
D	0	2.7
E	0	0.3
F	0.1	2.0
G	0.1	2.0
H	0	2.3
J	0	2.0
K	0	2.0
L	0	0.1
M	0	0
N	0.3	2.7
P	0	4.3
R	0	1.7
SED	0.12	1.57

8 June 1993 - Pastoral - GS 65 (Crop Flowering) mean assessment of top three leaves

Code	% Mildew	% Rhynchosporium
A	0.7	3.3
B	0.1	0.1
C	0.1	0.1
D	0.1	0.3
E	0	0.4
F	0.1	0.3
G	0.1	0.7
H	0	0
J	0	0.7
K	0.1	0.1
L	0	0
M	0	0
N	0	0
P	0	1.7
R	0	0
SED	0.23	1.29

28 June 1993 - Willow - GS71 (Watery ripe)

Code	% Mildew	% Rhynchosporium
A	0	9.7
B	0	11.0
C	0	6.3
D	0	9.7
E	0	2.7
F	0	7.0
G	0	3.3
H	0	1.3
J	0	1.4
K	0	3.3
L	0	2.7
M	0	1.1
N	0	1.4
P	0	5.0
R	0	1.7
SED	0	2.93

28 June 1993 - Pastoral - GS71(Watery ripe)

Code	% Mildew	% Rhynchosporium
A	7.0	0.7
B	4.0	1.3
C	1.7	0.4
D	3.4	1.0
E	4.0	0.1
F	0.7	0.7
G	0.1	0.7
H	0.1	0.1
J	0.1	0.1
K	0.4	0.3
L	0.1	0.1
M	0.1	0
N	0.1	0.1
P	1.0	0.4
R	0.1	0.1
SED	2.03	0.47

Comments

Levels of disease were low in all treatments throughout the season. Differences were only seen as late as watery ripe stage when specific fungicide treatments for disease control would be too late. Mildew was more common on Pastoral and Rhynchosporium more common on Willow.

Willow

The single quarter dose programme B was the only one not to yield significantly more than the untreated control. When treatment M was compared with the others (M = highest dose of fungicide applied three times), the only treatments which had similar yields were J and N. J was a two spray programme at full dose rates, and M was two half doses of Sanction. Sanction is generally a better triazole then Tilt for winter barley. The IDR treatments was not a success. The main reason would be that the IDR depended upon disease thresholds being met before fungicides were applied. This is the wrong approach with Rhynchosporium where a protective spray programmes would work better.

Pastoral

All treatments yielded significantly more than the untreated control. When treatments were compared with M (3 sprays of 3/4 dose of fungicide), all the single spray programmes yielded significantly less, and also the IDR programme. The IDR programme was triggered by disease thresholds, and in this particular trial where no thresholds were met (due to low disease levels), it performed poorly.

In future studies, IDR programmes should take more account of potential problems which may occur late in the season, and also accept that varieties respond well to fungicide in the absence of disease. The low doses were not tested to the full in a season where disease levels were unusually low.

Controlling diseases with low doses in winter barley follows the pattern seen in winter wheat more than spring barley in that there are more diseases to consider over a longer period of time. This means that taking decisions to cut dose rates means increasing the risk because the greatest variable - the weather cannot be forecast accurately at the time of fungicide application.

WINTER BARLEY REDUCED FUNGICIDE DOSE TRIAL
SAC ABERDEEN 1992/3

Site Details

Site	Mansion Field, Tillycorthie Farm, Udny Station, Grampian
Grid reference	NJ 908 235
Varieties	Willow and Pastoral
Sowing date	7 October 1992
Soil type	Sandy cly loam, freely drained
Soil series	Tarves Association
Other site details	Slight slope westerly direction, 100 m above sea level
Previous crop	1991/2 Winter barley
Cultivations	Ploughed, power harrowed, crumbler, sown with Oyjard drill, Cambridge rolled
Seed rate	Willow: 248 kg/ha Pastoral: 240 kg/ha
Row width	13 cm
Seed bed fertiliser	18: 90: 90: NPK kg/ha
Nitrogen topdressing	18 February 1993 60 kg N/ha 19 March 1993 140 kg N/ha
Micronutrient applications	None
Growth regulator applicatons	None
Herbicide	10 March 1993 Panther 2 l/ha
Plot dimensions at sowing	1.78 x 20.1m
Date of harvest	16 August 1993
Trial design	Split plot with varieties as main plots Treatments in randomised block design, three replicate as sub plots

Fungicide application details

Date	13 April 1993	12 May 1993	9 June 1993
Growth stage	30	32/33	49
Wind speed (km/hr)	0-8	8-15	0-10
Wind direction	S	N	E
Cloud cover	7/8	8/8	7/8
Temperature (^{O}C)	8.2	8.1	14.6
Comment	Crop and ground damp	crop dry, ground dry	-

Spraying equipment

Date	All dates
Sprayer type	AZO propane driven
Nozzles & No's.	SD 11002 (4)
Water Volume	198 l/ha
Pressure (bars)	2.5
Forward speed	4 km/hr
Boom width	2 m

Treatments

Code	GS 30 Pseudostem erect 13 April 1993	GS 32/33 First node Second node 12 May 1993	GS 49 In boot 7 June 1993
	Dose applied		
A	0	0	0
B	0	0.25	0
C	0	0.5	0
D	0	0.75	0
E	0	1.0	0
F	0	0.25	0.25
G	0	0.5	0.5
H	0	0.75	0.75
J	0	1.0	1.0
K	0.25	0.25	0.25
L	0.5	0.5	0.5
M	0.75	0.75	0.75
N	0	0.5S	0.5S
P	IDR	IDR	IDR
R	0.25	0.5	0.5

Cultivars: Willow, Pastoral

Treatment doses - Willow:	1.0	Tilt 0.5 l/ha
	0.75	Tilt 0.375 l/ha
	0.5	Tilt 0.25 l/ha
	0.25	Tilt 0.125 l/ha
	0.5S	Sanction 0.2 l/ha
Treatment doses - Pastoral	1.0	Tilt 0.5 + Corbel 1.0 l/ha
	0.75	Tilt 0.375 + Corbel 0.75 l/ha
	0.5	Tilt 0.25 + Corbel 0.5 l/ha
	0.25	Tilt 0.125 + Corbel 0.25 l/ha
	0.5S	Sanction 0.2 + Corbel 0.5 l/ha

IDR - Integrated Disease Risk programme

Variety (code)	GS 30 13 April 1993	GS 32/33 12 May 1993	GS 49 7 June 1993
Willow (P)	0.25	0.75	0.75
Pastoral (P)	0.25	0.5	0.5

Yield, thousand grain weight and specific weight

a) Willow

Code	Yield (t/ha @ 15% mc)	Thousand grain weight (g)#	Specific weight (kg/ha)##	Leaning + (%)
A	5.412	41.9	657.9	76.7
B	5.732	42.0	662.5	81.7
C	5.685	43.9	673.8	83.3
D	5.339	43.5	670.3	81.7
E	5.814	44.4	674.9	80.0
F	5.944	45.8	674.7	70.0
G	6.112	45.4	681.2	80.0
H	5.817	46.5	689.5	53.3
J	6.030	48.5	669.6	56.7
K	5.705	44.0	676.9	66.7
L	6.089	47.0	691.3	58.3
M	5.772	45.4	688.1	56.7
N	6.278	47.7	687.6	70.0
P	5.893	46.2	685.8	65.0
R	5.923	44.6	680.3	73.3
SED (56 df)	0.2855	1.31	7.54	10.63
CV%	5.7			
	***	***	***	ns

\# after cleaning - expressed at 15% mc
\## after cleaning
\+ at harvest

b) Pastoral

Code	Yield (t/ha @ 15% mc)	Thousand grain weight (g)#	Specific weight (kg/ha)##	Leaning + (%)
A	5.741	45.0	635.5	25.0
B	5.788	44.8	640.9	28.3
C	5.883	46.0	641.6	18.3
D	6.048	47.0	653.8	26.7
E	6.340	47.8	643.3	31.7
F	6.089	48.3	654.6	30.0
G	6.391	48.8	658.7	30.0
H	7.102	50.3	659.9	45.0
J	6.486	50.4	667.6	18.3
K	6.862	49.2	652.9	26.7
L	6.549	49.0	665.0	36.7
M	6.558	48.4	663.6	41.7
N	6.328	49.3	653.2	36.7
P	6.319	50.1	666.1	21.7
R	6.598	49.0	651.4	23.3
SED (56 df)	0.2855 ***	1.31 ***	7.54 ***	10.63 ns

after cleaning - expressed at 15% mc
after cleaning
\+ at harvest

Disease

All foliar disease expressed as % leaf area infected

1) 7 April 1993 - GS 21-23

Leaf	6		7		8	
	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
Pastoral	0.0	0.0	0.2	0.03	0.7	2.3
Willow	0.0	0.0	0.02	0.2	0.4	1.7

2a) Willow - 29 April 1993 - GS 31

Leaf	4		5		6	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	-	-	-	-	-	-
H	-	-	-	-	-	-
J	-	-	-	-	-	-
K	0.0	0.0	0.0	4.2	1.3	6.8
L	0.1	0.1	0.0	2.9	1.1	3.7
M	0.0	0.2	0.0	1.8	0.4	5.7
N	-	-	-	-	-	-
P	0.0	0.0	0.0	3.7	0.5	10.2
R	0.0	<0.1	<0.1	3.4	1.0	11.7
SED (16df)	-	0.07	-	0.94	0.83	2.68
	ns	ns	ns	ns	ns	ns

2b) Pastoral - 29 April 1993 - GS 31

Leaf	4		5		6	
	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	-	-	-	-	-	-
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	-	-	-	-	-	-
H	-	-	-	-	-	-
J	-	-	-	-	-	-
K	0.0	0.0	0.4	1.8	2.0	0.5
L	0.0	0.0	0.2	0.9	1.2	0.9
M	0.0	0.0	0.1	0.4	0.8	0.6
N	-	-	-	-	-	-
P	0.0	0.0	0.2	0.8	3.2	2.1
R	0.0	0.0	0.3	0.7	1.8	0.7
SED (16df)	-	-	0.19	0.94	0.83	2.68
			ns	ns	ns	ns

3a) Willow - 14 May 1993 - GS 33

Leaf	2		3		4	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	0.0	0.1	1.2	3.4	1.7	10.5
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	-	-	-	-	-	-
H	-	-	-	-	-	-
J	-	-	-	-	-	-
K	0.0	<0.1	1.2	3.5	2.8	14.0
L	0.0	0.0	1.4	1.4	0.7	7.9
M	0.0	0.3	0.6	5.6	2.0	16.4
N	-	-	-	-	-	-
P	0.0	0.0	1.4	2.0	1.4	8.8
R	-	-	-	-	-	-
SED (16df)	-	-	1.54 ns	1.77 ns	3.82 ns	4.39 ns

3b) Pastoral - 14 May 1993 - GS 33

Leaf	2		3		4	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	0.1	0.0	2.0	1.2	5.5	7.2
B	-	-	-	-	-	-
C	-	-	-	-	-	-
D	-	-	-	-	-	-
E	-	-	-	-	-	-
F	-	-	-	-	-	-
G	-	-	-	-	-	-
H	-	-	-	-	-	-
J	-	-	-	-	-	-
K	0.0	0.0	4.9	1.2	10.2	5.0
L	<0.1	0.0	1.0	1.8	1.9	7.5
M	<0.1	0.1	1.8	0.9	2.1	3.0
N	-	-	-	-	-	-
P	0.1	0.1	3.6	1.4	7.4	5.2
R	-	-	-	-	-	-
SED (16df)	-	-	1.54 ns	1.77 ns	3.82 ns	4.39 ns

4a) <u>Willow - 7 June 1993 - GS 51</u>

Leaf	1		2		3	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	0.0	1.3	1.6	7.3	4.2	12.2
B	0.4	1.4	1.4	6.2	3.9	12.5
C	0.1	1.4	1.1	4.3	5.6	10.0
D	>0.1	0.5	1.2	6.1	2.5	6.8
E	>0.1	0.8	1.2	6.4	2.6	11.1
F	0.0	0.7	2.0	5.2	3.7	11.1
G	0.0	0.8	1.4	6.5	4.0	13.1
H	0.2	0.7	1.4	3.9	3.6	9.6
J	0.0	0.8	1.0	4.7	2.7	9.9
K	>0.1	0.4	2.3	4.0	5.3	8.6
L	0.2	0.1	2.2	3.8	6.5	5.2
M	>0.1	0.7	2.5	3.8	5.1	6.2
N	0.2	1.2	1.5	6.3	4.7	10.0
P	0.1	0.4	1.6	6.4	4.4	10.9
R	0.1	0.6	1.4	3.3	5.0	7.3
SED (56df)	-	0.78	0.74	1.71	1.89	2.29
	ns	ns	ns	ns	*	*

4b) Pastoral -7 June 1993 - GS 51

Leaf	1		2		3	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	0.3	1.6	3.8	3.2	7.0	8.8
B	0.1	1.4	3.6	4.3	5.4	9.3
C	0.2	0.4	4.0	2.8	8.9	6.1
D	0.3	0.7	2.0	3.1	5.2	7.6
E	0.1	0.3	1.3	1.6	3.3	4.9
F	0.2	0.6	2.6	2.4	9.6	5.4
G	0.2	0.6	2.2	3.4	5.3	9.1
H	0.2	1.4	2.5	3.5	5.4	9.7
J	0.2	0.4	2.0	1.7	3.3	6.3
K	0.1	0.9	2.4	3.2	9.6	7.3
L	0.3	0.3	2.4	3.7	3.6	7.8
M	0.6	0.4	2.8	2.5	5.8	3.8
N	0.1	0.5	2.4	1.8	2.6	4.7
P	0.2	0.3	2.1	1.7	7.0	4.9
R	0.2	0.6	2.4	2.4	5.0	6.1
SED (56df)	-	0.781	0.74	1.71	1.90	2.29
	ns	ns	ns	ns	*	*

5a) <u>Willow - 22 June 1993 - GS 59</u>

Leaf	1		2		3	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	0.0	5.9	0.3	14.4	0.5	11.4
B	0.0	11.9	0.3	20.1	0.0	12.0
C	0.1	9.5	0.4	10.4	0.1	10.6
D	0.0	3.4	0.4	9.1	0.4	10.2
E	0.1	5.3	0.2	10.6	0.1	8.3
F	0.0	3.6	0.3	11.3	0.5	11.3
G	0.1	1.9	0.5	10.5	0.7	14.9
H	0.1	1.4	0.2	4.8	0.6	8.0
J	0.0	0.6	0.2	4.6	0.1	5.8
K	0.0	2.2	0.3	7.8	0.4	6.9
L	0.1	0.8	0.3	2.5	0.5	4.6
M	0.0	0.9	0.2	2.9	0.2	3.3
N	0.1	1.8	0.2	8.1	0.4	4.9
P	0.0	0.4	0.4	3.1	0.1	4.8
R	0.1	1.7	0.6	7.1	0.3	5.1
SED (56df)	1.11	2.44	3.41	4.10	4.31	6.59
	ns	**	ns	***	ns	ns

5b) Pastoral - 22 June 1993 - GS 55

Leaf	1		2		3	
Code	Mildew	Rhyncho	Mildew	Rhyncho	Mildew	Rhyncho
A	1.5	1.4	13.9	14.6	5.2	5.6
B	1.2	2.2	3.6	14.2	2.3	22.6
C	4.7	2.6	8.8	16.5	15.4	27.7
D	0.5	1.6	6.3	8.9	9.3	7.1
E	0.2	0.4	1.8	6.8	1.2	11.7
F	0.4	0.4	2.6	7.8	5.2	3.8
G	0.3	0.9	0.8	13.1	1.2	20.4
H	0.2	0.9	0.5	7.9	0.5	7.5
J	0.2	0.4	0.7	4.5	1.2	13.2
K	0.5	0.8	3.4	8.5	1.4	6.1
L	0.1	1.5	0.6	8.5	1.1	15.1
M	0.3	0.2	0.5	4.5	0.4	13.5
N	0.1	0.3	0.9	4.0	0.8	9.3
P	0.2	0.4	0.8	6.6	0.9	18.9
R	0.2	0.4	1.5	10.4	3.9	14.6
SED (56df)	1.11	2.44	3.41	4.10	4.31	6.59
	ns	**	ns	***	ns	ms

6a) Willow - 5 July 1993 - GS 73

Leaf	1		2	
Code	Mildew	Rhyncho	Mildew	Rhyncho
A	0.9	27.9	2.1	28.8
B	1.1	21.5	2.3	27.2
C	1.0	14.9	2.6	20.9
D	1.2	18.0	1.8	24.0
E	1.0	21.9	2.5	23.3
F	0.6	13.0	2.1	23.7
G	0.2	4.8	1.4	13.2
H	0.1	3.2	1.2	6.4
J	0.1	1.1	0.8	7.7
K	0.4	14.2	1.2	24.5
L	0.3	4.6	1.6	7.1
M	0.2	0.8	1.7	5.5
N	0.3	0.4	1.7	6.2
P	<0.1	2.3	1.0	11.9
R	0.1	2.8	1.4	12.2
SED (56df)	1.78 ***	3.40 ***	2.09 ***	4.40 ***

6b) Pastoral - 5 July 1993 - GS 73

Leaf	1		2	
Code	Mildew	Rhyncho	Mildew	Rhyncho
A	8.0	12.1	7.6	21.3
B	11.8	9.0	9.8	22.3
C	8.8	6.3	8.9	10.8
D	9.7	5.1	11.0	13.0
E	4.6	6.5	4.3	14.3
F	1.4	3.1	3.2	16.0
G	0.5	2.4	3.2	14.3
H	0.2	1.8	0.9	13.2
J	0.2	0.6	1.3	9.5
K	0.7	2.2	2.9	11.3
L	0.2	0.2	1.6	6.5
M	0.3	0.4	1.4	6.0
N	0.4	1.4	3.2	9.1
P	0.4	0.8	1.4	8.9
R	0.3	0.8	2.6	10.2
SED (56df)	1.78	3.40	2.09	4.40
	***	***	***	***

7) Sharp Eyespot - 21 July 1993 - GS83

Treatment A

	% plants in each category of sharp eyespot infection			
	Nil	Slight	Moderate	Severe
Pastoral	10.7	60.0	26.7	2.6
Willow	8.1	58.1	29.7	4.1

Green leaf area

20 July 1993 - GS 83

	Pastoral		Willow	
Code	Leaf 1	2	1	2
A	19.2	0.4	0.9	0.0
B	18.6	0.3	1.0	0.0
C	16.1	1.1	0.2	0.0
D	23.6	0.3	2.7	1.3
E	30.2	7.5	0.0	0.0
F	41.3	3.8	6.0	0.4
G	51.2	19.3	7.8	3.2
H	56.7	12.5	11.7	1.5
J	61.0	10.8	16.3	0.8
K	60.1	10.2	7.8	1.0
L	62.4	18.8	3.6	0.0
M	60.9	20.2	17.3	2.7
N	63.9	25.5	40.2	3.6
P	61.2	12.4	18.8	0.5
Q	43.9	5.3	12.4	3.2
SED (56 df)	10.9	7.38	10.9	7.38
	***	ns	***	ns

Comments

In what proved to be the most difficult season experienced in north-east Scotland for may years, the trial was not sown until 7 October 1992, two to three weeks later than the optimum sowing date. The trial went into the winter at the three leaf stage. Whilst not particularly cold, the winter was wetter than average.

Nonetheless the trial emerged from winter relatively unscathed but continued to develop slowly with the first node stage some two weeks later than normal. Below normal temperatures persisted and rainfall was well above average. Rain fall on 66 out of 122 days from 1 April to 31 July (see figure).

A consequence of the continued wet weather was that Rhynchosporium was the dominant disease on both Willow and Pastoral. Conditions were unfavourable for mildew and on Pastoral which is very susceptible to this disease it never developed to any major extent.

The late sowing and cool wet summer resulted in yields much below average for the farm (five year average 6.7 t/ha). With the variety Willow yields ranged from 5.339 to 6.278 t/ha and with Pastoral from 5.741 to 6.558 t/ha.

Willow: Rhynchosporium was absent going into winter and only became apparent on the majority of plants in early April. Progress on untreated plots was slow during a relatively dry April but the epidemic increased rapidly during May and June, culminating in 28 and 29% infection of the flag and second top leaf in the untreated plots by GS 73. Progress curves on successive leaves of the untreated plots are shown in the figure below.

Mildew only reached 2 to 5% on leaf 3 by early June otherwise it rarely exceeded 2%. There were no apparent or consistent differences in yield between treatments.

The effect of GS 30 applications (treatments K, L, M, P, R) were not particularly apparent one month afterwards. After the GS 31 treatments were applied there were only slight indications that the GS 30 treatments had assisted the GS 31 treatments to restrict disease development. Only after the GS 49 treatments were applied were clear trends apparent that those treatments receiving a GS 30 treatment had lower levels of infection.

At this time also the benefits of an additional fungicide at GS 49 over an application at GS 31 because apparent (compare treatments F, G, H and J with B, C, D, E on 22 June and 5 July).

A summary of the yield responses for each timing is given in the table below.

Yield response (t/ha) to:

Dose	GS 31 treatment	Additional GS 49 treatment	Additional GS 30 treatment	Total response to GS 30, 31 & 49
0.25	0.320	0.212	-0.239	0.293
0.5	0.273	0.427	-0.023	0.677
0.75	-0.073	0.478	-0.045	0.360
1	0.402	0.216		(0.618)
Mean	0.231	0.333	-0.102	

Apart from the anomalous result for 0.75 dose, there was little difference in response at any dose. All additional treatments at GS 49 gave a positive yield response. This would accord with the knowledge that Rhynchosporium affects yield primarily by reducing 1000 grain weight and protection of the top three leaves against infection by Rhynchosporium minimises yield loss.

Substitution of a triazole known to have a better effect against Rhynchosporium (flusilazole, treatment N) resulted in the highest yield although this was not significantly different from any other treatment except A, C & D.

With this variety, provided a two spray programme at GS 31 and 49 was applied, the effect of dose applied did not appear to have a major effect. Although there were indications that a GS 30 treatment did help to limit subsequent disease development after further treatments were applied, no extra yield resulted.

All two and three spray treatments increased 1000 grain weight and specific weight significantly over the untreated. Like yield, there were few significant differences between fungicide treatments where these two quality parameters were concerned.

Pastoral: Like Willow, disease was absent entering the winter and only low levels had formed by early April. Thereafter Rhynchosporium was the predominant disease increasing during May and June but to a lesser extent than Willow, reflecting a higher disease resistance rating. By GS 73 in early July there was 12 and 21% on the flag and second top leaves respectively. Disease progress for Rhynchosporium on successive leaves of untreated plots are shown in the figure below.

Mildew was more evident on Pastoral than Willow reaching 5-10% on the third top fully expanded leaf at GS 33 in mid-May and persisting around this level on the third top leaf until mid-June. In general those treatments receiving a single application at GS 31 of 0.75 dose or less exhibited most infection. This pattern persisted at the last assessments on the flag and second top leaf at GS 73. Mildew rarely exceeded 10% infection.

As with Willow, the effect of a GS 30 application (treatments K, L, M, P and R) was not apparent until the last two assessments. Single applications at GS 31 were much less effective than two or three spray treatments in reducing infection by mildew or Rhynchosporium.

A summary of the yield responses for each timing is given in the table below.

Yield responses (t/ha) to:

Dose	GS 31 treatment	Additional GS 49 treatment	Additional GS 30 treatment	Total response to GS 30, 31 & 49
0.25	0.047	0.301	0.773	1.121
0.5	0.142	0.508	0.158	0.808
0.75	0.307	1.054	-0.544	0.817
1	0.599	0.146		(0.745)
Mean	0.274	0.512	0.097	

Yield responses to a single GS 31 application increased with dose applied. An additional treatment at GS 49 had the effect of evening out responses, a trend which continued with a further GS 30 treatment. Implicit in this result was that the early (GS 30) treatment proved more effective the lower the dose used.

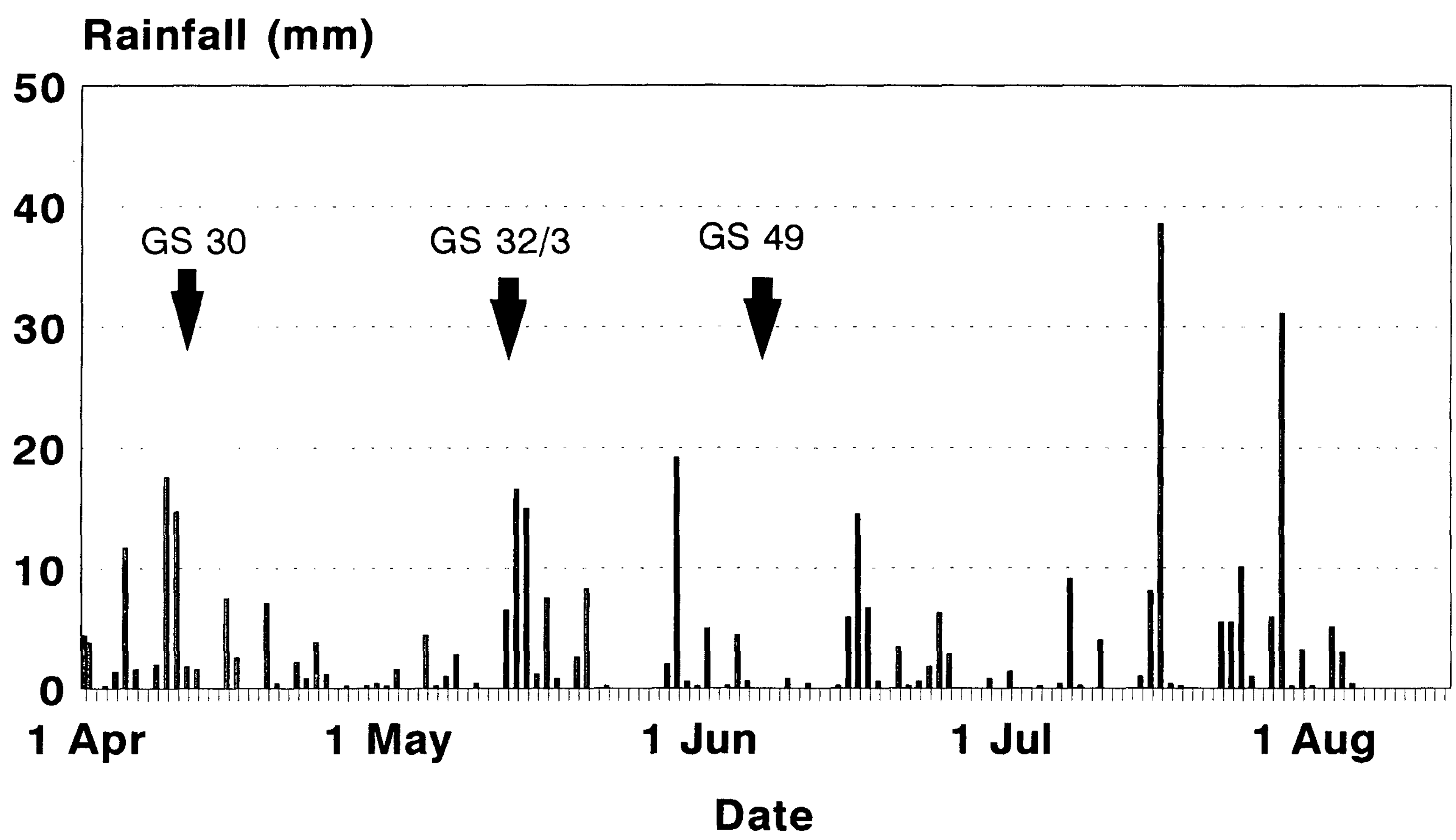
Substitution of a triazole more effective against Rhynchosporium (flusilozole - treatment N) gave no improvement in yield. This was presumably due to a morpholine + triazole mixture being used which together provided better control of Rhynchosporium than was the case when just triazoles were applied with Willow.

Two and three spray fungicide programmes significantly improved 1000 grain weight and specific weight over untreated controls. Single spray treatments whilst increasing these parameters, mostly did not give a significant effect.

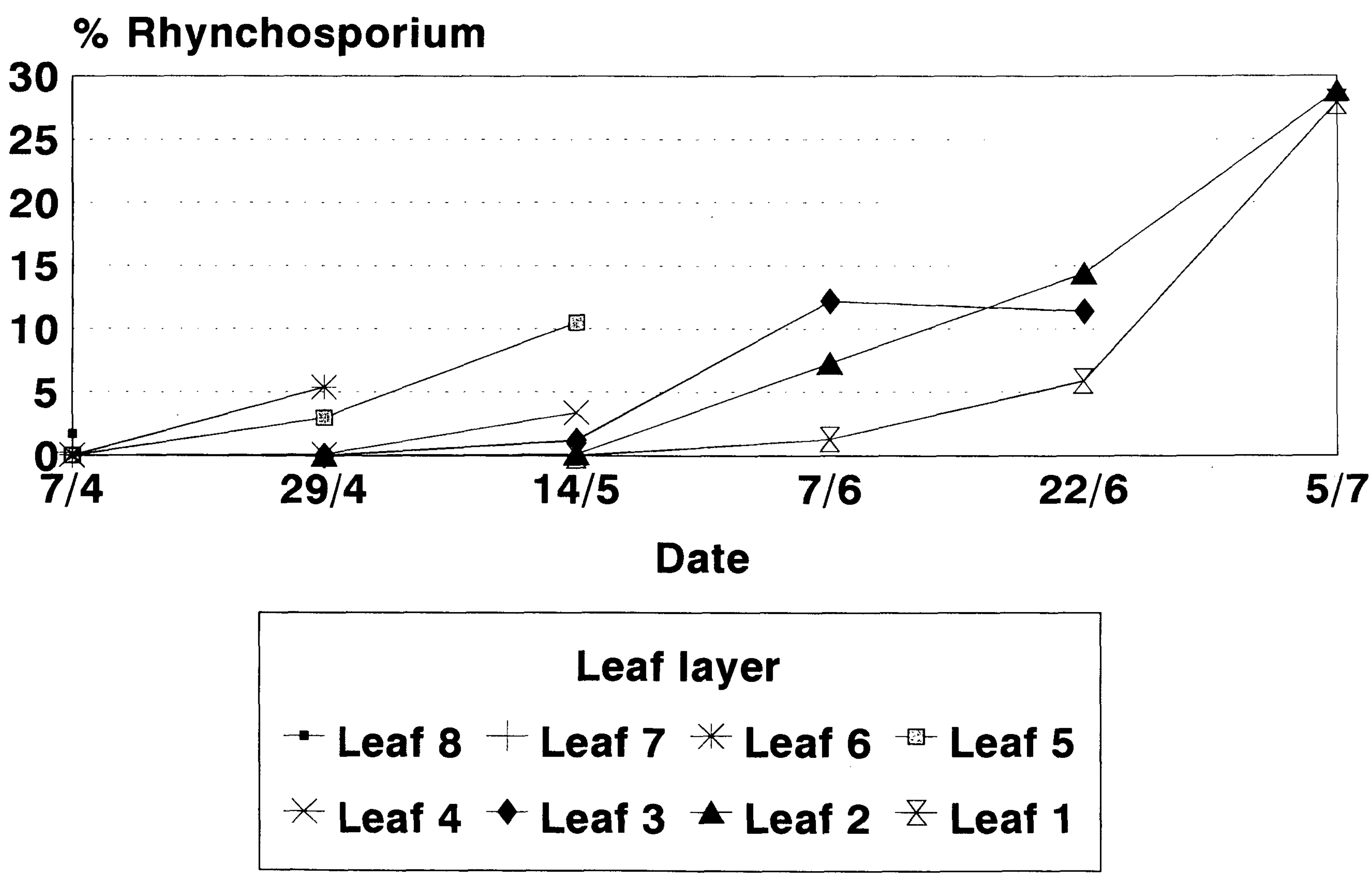
IDR: The IDR programme for Willow resulted in a yield not significantly different to the best fungicide treatment (using the same triazole ie. excluding treatment N). However, the results indicate that a GS 30 treatment was unnecessary and this was not ascertained from the tables.

With Pastoral the yield from the IDR programme was significantly lower than the best treatment, but not significantly different from other two and three spray fungicide treatments. IDR in this instance identified that a GS 30 treatment was cost effective.

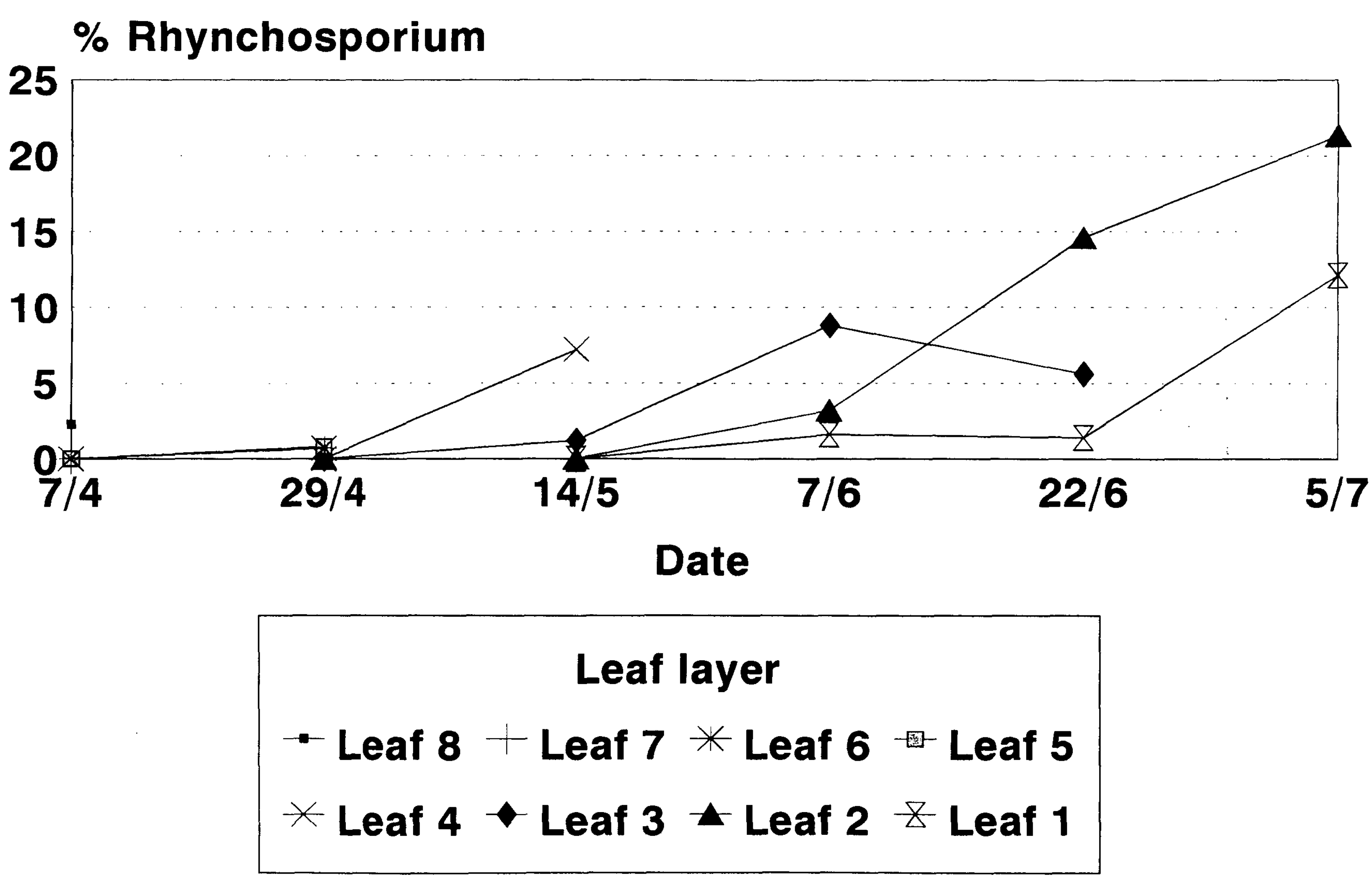
HGCA REDUCED FUNGICIDE DOSE TRIAL
WINTER BARLEY TRIAL - SAC-ABERDEEN
Recorded by Delta T weather station



HGCA REDUCED FUNGICIDE DOSE TRIAL
Progress of Rhynchosporium on untreated plots
Cv. Willow



HGCA REDUCED FUNGICIDE DOSE TRIAL
Progress of Rhynchosporium on untreated plots
Cv. Pastoral



Winter Wheat Reduced Fungicide Dose Trial
SAC Edinburgh

Site Details

Site:	Crosshall Farm Greenlaw, Berwickshire
OS Number	NT 764 424
Soil series:	Whitsome
Soil Type:	Sandy clay loam
pH	6.3
Available nutrients	
Phosphorus	Mod
Potassium	Mod
Magnesium	Mod
Sulphur	Mod
Previous cropping	
1992	Peas
1991	Winter Wheat
1990	Winter Wheat
1989	Grass
Cultivars:	Riband
	Apollo
Date sown:	8 October 1992
Date Harvested	18 September 1993
Plot size	2x 22 metres
Autumn fertiliser	0:60:60 N:P:K in Kg/ha 13 October 1992
Nitrogen top dressing	
	50 kg/ha 23 February 1993 GS21
	50 kg/ha 26 March 1993 GS 15,22
	50 kg/ha 15 April 1993 GS25-30
Herbicide	Ally 20g/ha 14 April 1993 GS25
	Duplosan 2 l/ha 14 April 1993 GS 25
Other sprays:	Draza 5kg/ha 9 October 1992
	Cutonic manganese 28 April 1993 GS31

Treatments

Fungicide treatments on cultivar Riband - Fungicide = Tebuconazole (trade name Folicur). Full dose = 1 litre per hectare.

Code	GS32 Second node 7 May	GS33 Third node 19 May	GS39 Flag leaf emerged 7 June	GS59 Ear emerged 24 June	Total fungicide dose
A	0	0	0	0	0
B	0.25	0	0.25	0.25	0.75
C	0	0.25	0.25	0.25	0.75
D	0.25	0.25	0.25	0.25	1.0
E	0	0	0.5	0.5	1.0
F	0.5	0	0.5	0.5	1.5
G	0	0.5	0.5	0,5	1.5
H	0.5	0.5	0.5	0.5	2.0
J	0.25	0	0.5	0.5	1.25
K	0	0.25	0.5	0.5	1.25
L	0.5	0	0.75	0.5	1.75
M	0	0.5	0.75	0.5	1.75
N	0.5	0	0.75	0.75	2.0
P	1.0	0	1.0	1.0	3.0

Fungicide treatments on cultivar Apollo - Fungicide = Fenpropidin (Trade name Patrol). Full dose = 1 litre per hectare.

Code	GS32 Second node 7 May	GS33 Third node 19 May	GS39 Flag leaf emerged 7 June	GS59 Ear emerged 24 June	Total fungicide dose
A	0	0	0	0	0
B	0	0	0.25	0	0.25
C	0.25	0	0.25	0	0.5
D	0.25	0	0	0.25	0.5
E	0	0	0.25	0.25	0.5
F	0	0	0.5	0	0.5
G	0.5	0	0.5	0	1.0
H	0.5	0	0	0.5	1.0
J	0	0	0.5	0.5	1.0
K	0	0	0.75	0	0.75
L	0.25	0	0.75	0	1.0
M	0.25	0	0	0.75	1.0
N	0	0	1.0	0	1.0
P	1.0	0	1.0	1.0	3.0

(Numbers in table represent dose rate at stated crop growth stage)

Comments on the cultivar Riband (Septoria tritici control)

Riband is a variety which responds well to fungicide, and which is susceptible to Septoria tritici and Septoria tritici was the predominant disease on this variety. Mildew, brown rust and yellow rust were either present at very low levels or absent. All treatments yielded significantly more than the untreated control A. The full dose programme (P) yielded 3.2 tonnes more than the untreated and was the highest yielding treatment. Assuming the value of the grain to be £100 per tonne, and Folicur to cost £28 per litre, the benefit of each fungicide programme minus fungicide costs is as follows:

Code	Yield Tonnes/ha	Value of grain minus fungicide cost	Ranking
A	6.30	£630	14
B	8.17	£795	13
C	8.45	£823	11
D	8.64	£834	9
E	8.42	£812	12
F	8.72	£827	10
G	9.30	£885	2
H	9.46	£886	1
J	8.89	£852	8
K	9.12	£875	4
L	9.05	£853	7
M	9.21	£869	5
N	9.36	£876	3
P	9.50	£860	6
SED	0.287		

Seven treatments yielded significantly lower than the full dose three spray programme P. They were A, B, C, D, E, F and J. All these treatments comprised fungicide programmes using up to 1.5 doses of Folicur, and all seven ranked lower in profitability than P the full dose three spray programme. The other treatments were not significantly different from the full dose three spray programme (G, H, K, L M and N), and with the exception of treatment K, all of these comprised 1.75 doses of Folicur or more. Treatment K comprised 1.5 doses of fungicide. The most profitable programmes were H, G and N. These comprise three or four sprays with a combined fungicide use of 2 or 1.5 full doses of Folicur.

On 20 May, Septoria tritici levels were high on leaf 6, and there were no differences between treatments. There were also no differences in disease levels on leaf 5. The treatments were unlikely to have had any great influence on leaf 6 because the Septoria would have been well established at the time of spraying on 7 May. These leaves will have very little effect on influencing the crop yield. .

On 4 June there were no differences in disease levels on leaf 5 and Septoria tritici was starting to appear on leaf 4 and on 14 June, significant differences in Septoria tritici were seen on leaf 3 and leaf 4. All treatments had significantly less Septoria tritici on leaf three compared to the untreated control. Treatments with the higher levels of disease on leaf 4 include the treatments which received no fungicide at GS32 and only a quarter dose at GS33 (C, G but not K) and also the treatment which received a quarter dose at GS32 only (B and E) which had not received a fungicide until GS39 on 7 June. It is likely that leaf 4 was infected several times and not just on 25 April and the quarter dose applied once either at GS32 or GS33 was insufficient to protect the leaf throughout the period from 25 April until symptoms were seen on 4 June. Treatments D and H had received a treatment at GS32 and GS33 (quarter and half dose respectively) and appeared to be successful in reducing the level of disease.

On 21 June, disease was seen on the second leaf at low levels. On the third leaf, all treatments except E had significantly less disease then the untreated. E had not received a treatment until the flag leaf had emerged, and the half dose applied then was probably too low to eradicate the disease already developing inside the leaf (205 day degrees after the first infection by Septoria tritici)

On 29 June, E remained the only treatment to have similar levels of disease on leaf three compared to the untreated control. All treatments had significantly less disease on leaf two compared to the untreated.

On 1st July, B, E and J had similar levels of disease on the third leaf to the untreated control. Only treatment E had a similar level of disease on leaf two compared to the untreated control.

On 13 July at watery ripe stage, Septoria tritici was developing on the flag leaf on the untreated control. All treatments had significantly less disease on leaf two compared to the untreated, and also on leaf three. When comparing the treatments with the three spray full dose programme P, five treatments had significantly more disease (A, B, D, F and J).

On 27 July at milky ripe, all treatments had more green leaf area on the flag leaf compared to the untreated, but green leaf area was more variable on leaf two. By 3 August at late milky ripe, the untreated control had no green leaf area, and all other treatments except E had similar amounts of green leaf compared to the three spray full dose programme P. On leaf two, treatments A, B, D, E, J and K had less green leaf area than P. Treatment K did however result in one of the better yields at harvest, and this may be explained by the low level of Septoria tritici on the flag leaf at this time.

If we take 10% Septoria tritici on the flag leaf on 3 August as an arbitrary number and look at the treatments above and below the line, A, B, C, D, E, F G, and J all have the higher disease levels, and H, K, L, M, N and P have lower levels.

Treatments with the higher disease level generally yielded the least with the exception of G (which had 11% Septoria and was on the borderline). All the treatments in the lower disease group resulted in the better yields demonstrating how important it is to protect the flag leaf from disease.

On 27 July, all treatments had significantly lower levels of Septoria tritici on the flag leaf than the untreated. Disease levels were significantly lower on leaf two in treatments F,G,H,K,L,M and N than the untreated control. Surprisingly the three spray full dose programme did not. The other treatments which had high levels were the quarter dose programmes and the half dose programme which started at flag leaf emergence.

In this trial, stem base disease were not a serious problem, and this is probably reflected in the low levels of white heads.

The table below summarises the emergence of leaves 1 to 4, the time of the first infection period with Septoria tritici and the time taken for symptoms to develop. The leaves would have been continually under attack from Septoria tritici this season, and this makes it difficult to analyse disease development. The four spray programmes were successful at keeping disease levels low throughout the season D and H but D (quarter doses) was insufficient to protect the crop over the later stages of ripening. (It would be less persistent than other programmes which gave higher doses later in the season e.g. L to P). Treatment E has generally been poor to control Septoria tritici on leaves 1 to 4. This treatment received the first spray at flag leaf emergence, and demonstrates the need to control disease earlier than flag leaf emergence on a susceptible variety like Riband to allow the crop to realise its full potential with a fungicide applied to the flag leaf.

• • **Date**	Leaf 4 Date	Leaf 4 Day Degree	Leaf 3 Date	Leaf 3 Day Degree	Leaf 2 Date	Leaf 2 Day Degree	Leaf 1 Date	Leaf 1 Day Degree
Leaf Emerges	21 April	0	19 May	0	27 May	0	4 June	0
Spray	-	-	-	-	-	-	7 June	0
Infection	25 April	0	19 May	0	29 May	0	11 June	0
Spray	7 May	135	7 June	205	7 June	116	24 June	158
Spray	19 May	271			24 June	326	-	-
Symptom on leaf	4 June	386	14 June	299	29 June	424	13 July	425
Days to infection	40 days	386	24 days	299	30 days	424	32 days	425

Infection was taken to have occurred when 5 mm or more rainfall had fallen in one day.

Comments on the cultivar Apollo (Mildew control)

Apollo is a variety susceptible to mildew, and despite high levels of the disease in some treatments, there were no significant differences in yields between any of the treatments. This is not unusual with Apollo, and it may lead to the question that some cultivars may be tolerant to mildew (i.e. show no yield penalty related to disease). It is worth noting that despite high levels of mildew in some treatments, green leaf area was not affected by disease. The yield may be related more to green leaf area retention then by severity of mildew. The trial does demonstrate an important point that eradicating mildew is not always cost effective.

Mildew was established in the crop on 20 May, and none of the early treatments appear to have had an effect at this time. By 14 June, the flag leaf spray had also been applied, and differences in mildew levels were seen on leaf 4 between those treatments which had been sprayed twice (C, D,G, H, L, M and P) and the others which were first sprayed on the 7 June. The differences are surprising considering most treatments received a quarter dose of fenpropidin on 7 May which would have had a short persistence. By 21 June, differences were less obvious and the only treatment to have very low disease levels was the full dose programme P.

On 1 July, levels of mildew were lower on leaf three on treatments which had received a spray on the flag leaf on 7 June. Treatments which were sprayed earlier (but not on 7 June) had more mildew on leaf 3 (treatments D, H and M). On 13 July all treatments had been applied, and they all had significantly less mildew on leaf three compared to the untreated control. The full dose three spray programme was the only one to have no mildew on the top three leaves. A quarter or half dose applied to the flag leaf on 7 June was insufficient to control mildew on the upper leaves, but two sprays of a quarter or half dose was successful. A single three quarter dose or full dose was also successful.

Results

Yield of cultivar Riband

Code	Yield Tonnes/ha	Thousand Grain weight - g	Specific weight kg/hl
A	6.30	34.4	62.8
B	8.17	40.3	65.9
C	8.45	40.4	65.4
D	8.64	42.5	65.9
E	8.42	42.7	66.7
F	8.72	44.0	66.3
G	9.30	44.6	66.9
H	9.46	44.1	66.5
J	8.89	42.4	66.3
K	9.12	43.3	66.4
L	9.05	43.9	66.8
M	9.21	44.4	67.0
N	9.36	45.9	66.2
P	9.50	45.2	66.9
SED	0.287	1.78	0.609

Yield of cultivar Apollo

Code	Yield Tonnes/ha	Thousand Grain weight - g	Specific weight kg/hl
A	7.63	40.5	66.5
B	7.66	39.5	67.3
C	7.48	40.0	66.7
D	8.00	40.6	67.6
E	7.59	40.1	67.5
F	7.90	40.1	67.6
G	7.84	41.9	68.2
H	7.93	40.1	66.5
J	7.93	41.8	67.7
K	7.64	40.9	68.1
L	7.82	40.1	67.8
M	7.76	41.1	68.1
N	8.02	41.5	67.7
P	8.25	41.7	67.8
SED	0.287	1.178	0.609

20 May 1993 - GS33 - Riband

(Leaf numbering assumes flag leaf =1, leaf below = 2 etc. Unfurled leaf = leaf 3.)

Code	% Septoria tritici leaf 5	% Septoria tritici leaf 6	% Mildew leaf 6	Crop height (1-10 scale
A	14.0	70.0	0	5.7
B	9.7	50.0	0	5.7
C	12.7	66.7	0	6.0
D	20.0	90.0	0	5.7
E	16.3	90.0	0	5.3
F	8.3	63.3	0	6.0
G	13.3	60.0	0	6.0
H	9.3	70.0	0	6.0
J	16.0	76.7	0	6.0
K	15.7	50.0	0	5.7
L	16.0	73.3	0	5.7
M	8.3	53.3	0	6.0
N	14.3	63.3	0	6.0
P	22.7	93.3	0	5.7
SED	4.66	11.22	1.62	1.32

20 May 1993 - GS33 - Apollo

Leaf numbering assumes flag leaf =1, leaf below = 2 etc. Unfurled leaf = leaf 3.

Code	% Septoria tritici leaf 5	% Septoria tritici leaf 6	% Mildew leaf 6	Crop height (1-10 scale
A	0.1	0	4.0	4.4
B	0.1	0	3.4	4.7
C	0.1	0	2.4	4.7
D	0.1	0	0.1	6.7
E	0.1	0	4.3	4.7
F	0.1	0	3.3	4.3
G	0	0	2.0	4.0
H	0.1	0	2.0	4.0
J	0.4	0	3.7	4.7
K	0	0	3.4	6.3
L	0	0	2.4	4.7
M	0.1	0	2.3	4.7
N	0	0	2.7	4.7
P	0	0	2.0	5.0
SED	4.66	11.22	1.62	1.32

4 June 1993 - GS39 - Riband

Code	% Septoria tritici leaf 4	% Septoria tritici leaf 5	% Mildew leaf 4	% mildew leaf 5	Crop height 1 to 10 scale
A	0.1	20.0	0	0	6.0
B	0	18.3	0	0	6.3
C	1.0	25.0	0	0	6.0
D	1.3	30.0	0	0	6.7
E	1.0	28.3	0	0	6.0
F	0	16.7	0	0	5.7
G	0	16.7	0	0	6.0
H	0.1	14.0	0	0	6.3
J	0	16.0	0	0	6.3
K	1.7	31.0	0	0	6.3
L	0	9.0	0	0	6.3
M	0	8.3	0	0	6.3
N	0	11.7	0	0	6.3
P	0.1	16.0	0	0	6.0
SED	0.55	6.21	0.89	3.09	0.34

4 June 1993 - GS39 - Apollo

Code	% Septoria tritici leaf 4	% Septoria tritici leaf 5	% Mildew leaf 4	% mildew leaf 5	Crop height 1 to 10 scale
A	0	2.3	0.1	3.0	7.3
B	0	8.3	0.7	6.0	7.3
C	0	3.0	0.3	4.0	6.7
D	0	2.0	0	0.7	7.7
E	0	5.7	3.0	11.7	7.3
F	0	4.7	2.3	9.3	6.7
G	0	4.3	0	0.3	7.3
H	0	5.7	2.3	6.7	7.3
J	0	5.7	0.1	3.7	7.3
K	0	5.7	2.7	11.3	7.0
L	0	4.3	0.7	1.0	7.3
M	0	5.0	0	0.1	7.0
N	0	4.7	1.3	3.4	7.3
P	0	6.3	0.1	1.3	7.3
SED	0.55	6.21	0.89	3.09	0.34

14 June 1993 - GS55 - Riband

(crop wet so mildew difficult to score accurately)

Code	% Septoria tritici leaf 3	% Septoria tritici leaf 4	% Mildew leaf 3	% Mildew leaf 4
A	4.0	31.7	0	0
B	0.4	20.0	0	0
C	1.3	21.7	0	0
D	0.1	6.3	0	0
E	1.3	18.3	0	0
F	0	5.0	0	0
G	0.1	16.0	0	0
H	0	8.7	0	0
J	1.0	20.0	0	0
K	1.7	9.7	0	0
L	0.1	7.0	0	0
M	0.1	12.7	0	0
N	0.7	10.0	0	0
P	0.3	13.0	0	0
SED	0.68	5.36	1.26	4.83

14 June 1993 - GS55 - Apollo

crop wet so mildew difficult to score accurately

Code	% Septoria tritici leaf 3	% Septoria tritici leaf 4	% Mildew leaf 3	% Mildew leaf 4
A	0.1	9.7	0.7	11.7
B	0.1	11.7	0.7	12.7
C	0	11.7	0.7	4.0
D	0	13.3	0.1	4.0
E	0	7.3	2.0	19.0
F	0	14.0	3.4	14.0
G	0.1	15.7	0.3	5.0
H	0	9.7	1.0	3.4
J	0	5.7	2.7	10.7
K	0	8.3	1.7	9.0
L	0	13.3	0.1	1.7
M	0	6.3	0.7	5.0
N	0	13.3	2.0	8.7
P	0	14.0	0	3.3
SED	0.68	5.36	1.26	4.83

21 June 1993 - GS55 - 57 - Riband

Leaf 4 dead in many treatments making assessment difficult

Code	% S tritici leaf 2	% S tritici leaf 3	% S tritici leaf 4	% Mildew leaf 2	% Mildew leaf 3	% Mildew leaf 4
A	0.7	41.7	30	0	0	0
B	0.7	22.3	30	0	0	0
C	2.7	28.3	0	0	0	0
D	0.3	9.4	1.7	0	0	0
E	0.1	35.0	26.7	0	0	0
F	0.1	16.7	2.3	0	0	0
G	2.3	20.0	0	0	0	0
H	0	3.3	10.0	0	0	0
J	1.4	21.7	0	0	0	0
K	0.1	14.0	33.3	0	0	0
L	0.3	15.0	0	0	0	0
M	0.1	5.0	1.7	0	0	0
N	0.1	11.7	5.0	0	0	0
P	0.1	14.3	5.0	0	0	0
SED	0.73	6.46	16.73	0.21	1.61	4.08

21 June 1993 - GS55 - 57 - Apollo

Code	% S tritici leaf 2	% S tritici leaf 3	% S tritici leaf 3	% Mildew leaf 2	% Mildew leaf 3	% Mildew leaf 4
A	0	0.1	23.3	0.7	3.4	14.7
B	0	0.1	20.0	0.3	5.0	10.0
C	0	0	15.7	0	1.7	6.4
D	0	1.7	16.7	0	0.4	5.7
E	0	0.1	11.7	0	2.3	12.3
F	0	0.1	10.0	0.3	1.0	5.7
G	0	0.7	16.7	0	0.1	1.0
H	0	0.3	11.7	0	0.7	4.0
J	0	0.1	20.0	0.1	3.3	10.3
K	0	0	6.0	0	0.7	7.0
L	0	0.3	13.3	0	0.1	3.7
M	0	0.7	16.7	0.1	2.0	9.0
N	0	3.3	18.3	0.1	1.7	7.3
P	0	0	11.7	0	0.1	0.7
SED	0.73	6.46	16.73	0.21	1.61	4.08

29 June 1993 - crop flowering - Riband

Code	% Septoria tritici leaf 2	% Septoria tritici leaf 3	% Mildew leaf 2	% Mildew leaf 3
A	3.7	36.7	0	0
B	1.7	25.7	0	0
C	0.3	11.7	0	0
D	0.1	9.7	0	0
E	1.7	28.3	0	0
F	0.1	15.7	0	0
G	0.1	9.7	0	0
H	0	6.7	0	0
J	0.7	21.7	0	0
K	0.1	14.0	0	0
L	0.7	11.7	0	0
M	0	5.7	0	0
N	0.1	17.7	0	0
P	0	6.0	0	0
SED	0.44	5.37	0.58	3.10

29 June 1993 - crop flowering - Apollo

Code	% Septoria tritici leaf 2	% Septoria tritici leaf 3	% Mildew leaf 2	% Mildew leaf 3
A	0	13.3	2.0	13.0
B	0	11.7	1.3	11.0
C	0	15.0	0.7	8.0
D	0	8.0	0.7	10.7
E	0.1	14.0	0.7	11.3
F	0	23.3	2.0	14.7
G	0	14.0	0.3	5.3
H	0.1	14.0	0.7	6.3
J	0	10.0	1.4	6.7
K	0	12.3	0	4.3
L	0.1	15.0	0.3	4.0
M	0	16.7	1.0	14.0
N	0	10.7	0.1	7.0
P	0	11.3	0	1.0
SED	0.44	5.37	0.58	3.10

1 July 1993 - Mid flowering - Riband

Code	% Septoria tritici leaf 2	% Septoria tritici leaf 3	% Mildew leaf 2	% Mildew leaf 3
A	2.3	33.3	0	0
B	1.0	20.3	0	0
C	0	14.7	0	0
D	0	9.0	0	0
E	2.7	25.0	0	0
F	0.3	12.3	0	0
G	0	6.3	0	0
H	0	4.0	0	0
J	0.1	22.7	0	0
K	0.3	11.7	0	0
L	0	10.0	0	0
M	0	8.0	0	0
N	0.3	9.3	0	0
P	0.3	11.3	0	0
SED	0.46	4.70	1.65	4.32

1 July 1993 - Mid flowering - Apollo

Code	% Septoria tritici leaf 2	% Septoria tritici leaf 3	% Mildew leaf 2	% Mildew leaf 3
A	0	15.7	5.0	21.7
B	0	21.7	6.3	17.0
C	0	10.7	0.3	5.3
D	0	13.3	3.7	16.7
E	0	10.0	0.7	12.7
F	0	19.3	0.7	6.7
G	0	13.3	0.1	4.3
H	0	12.3	3.4	16.0
J	0.1	18.3	1.0	10.3
K	0	12.3	0.1	6.3
L	0	14.0	0	2.0
M	0	18.3	2.7	15.0
N	0	12.3	0.1	4.3
P	0	15.0	0	1.7
SED	0.46	4.70	1.65	4.32

13 July 1993 - Watery ripe - Riband

Code	% S tritici leaf 1	% S tritici leaf 2	% Se tritici leaf 3	% Mildew leaf 1	% Mildew leaf 2	% Mildew leaf 3
A	6.3	21.7	90.0	0	0	0
B	0	4.7	30.0	0	0	0
C	0	1.0	12.3	0	0	0
D	0	4.0	25.0	0	0	0
E	0	3.3	18.3	0	0	0
F	0	2.0	20.0	0	0	0
G	0	0.4	14.3	0	0	0
H	0	0	5.0	0	0	0
J	0	2.0	22.3	0	0	0
K	0	0.7	8.3	0	0	0
L	0	0.7	10.7	0	0	0
M	0	1.3	13.0	0	0	0
N	0	1.3	14.7	0	0	0
P	0	0.1	6.0	0	0	0
SED	1.16	1.69	6.67	0.14	1.19	3.83

13 July 1993 - Watery ripe - Apollo

Code	% S tritici leaf 1	% S tritici leaf 2	% S tritici leaf 3	% Mildew leaf 1	% Mildew leaf 2	% Mildew leaf 3
A	0	4.7	23.3	1.0	8.0	30.0
B	0	1.7	18.3	0	1.1	10.7
C	0	0.7	23.3	0	5.3	14.3
D	0	0.4	20.0	0.1	3.3	15.0
E	0	1.7	14.0	0	0.1	5.7
F	0	3.7	21.7	0	3.0	12.7
G	0	2.0	12.3	0	1.0	6.7
H	0	2.7	25.0	0	2.3	15.3
J	0	1.4	22.3	0	0.1	7.0
K	0	1.7	7.3	0	2.3	3.7
L	0	2.0	9.0	0	2.3	9.0
M	0	1.7	16.7	0.1	1.7	8.3
N	0	1.0	11.7	0	0.1	9.0
P	0	3.3	18.3	0	0	0
SED	1.16	1.69	6.67	0.14	1.19	3.83

27 July 1993 - Milky ripe - Riband

Code	% Septoria tritici leaf 1	% Septoria tritici leaf 2	% Mildew leaf 1	% Mildew leaf 2	% Green leaf area leaf 1	% Green leaf area leaf 2	% White heads
A	52.3	68.3	0	0	38	17	0.7
B	12.0	53.3	0	0	75	33	0.1
C	7.3	46.7	0	0	82	30	0.1
D	5.7	40.0	0	0	85	40	0.1
E	7.7	61.7	0	0	77	30	0.4
F	3.4	35.0	0	0	86	52	0.4
G	6.7	35.0	0	0	80	52	0.4
H	1.7	25.0	0	0	92	55	0.1
J	0.7	43.3	0	0	95	42	0.7
K	1.4	22.7	0	0	92	52	0.1
L	4.0	30.0	0	0	88	52	0.1
M	0.7	31.7	0	0	90	57	0.4
N	3.3	28.3	0	0	88	53	0.4
P	3.7	51.7	0	0	83	33	0.1
SED	7.64	16.33	1.56	6.10	10.1	13.3	0.39

27 July 1993 - Milky ripe - Apollo

Code	% Septoria tritici leaf 1	% Septoria tritici leaf 2	% Mildew leaf 1	% Mildew leaf 2	% Green leaf area leaf 1	% Green leaf area leaf 2	% White heads
A	2.3	41.7	5.0	8.3	80	28	0.1
B	15.0	53.3	0.7	5.0	63	25	0.4
C	5.7	56.7	1.7	0	80	27	0.7
D	3.0	31.0	0.1	20.3	85	30	0.4
E	5.7	50.0	0	2.3	83	37	0.1
F	8.0	30.0	0	8.3	82	28	0.4
G	0.4	61.7	2.3	1.0	82	20	0.1
H	6.3	43.3	0	0	72	27	0.7
J	2.0	28.3	0	0	85	27	0.7
K	8.7	36.7	0	0	73	40	0.4
L	3.0	43.3	0	0	87	33	0.4
M	4.0	51.7	1.0	0	83	27	0.4
N	2.4	35.0	0	0	83	48	0.4
P	2.0	28.3	0	0	87	47	0.1
SED	7.64	16.33	1.56	6.10	10.1	13.3	0.39

3 August 1993 - Late milky ripe - Riband

Code	% Septoria tritici leaf 1	% Septoria tritici leaf 2	% Mildew leaf 1	% Mildew leaf 2	% Green leaf area leaf 1	% Green leaf area leaf 2	% White heads
A	16.7	26.7	0	0	0	0	2.3
B	18.3	55.0	0	0	68	30	2.0
C	21.7	53.3	0	0	77	38	2.3
D	12.3	38.3	0	0	63	33	2.0
E	15.0	60.0	0	0	60	22	2.3
F	20.0	40.0	0	0	70	43	2.3
G	11.0	48.3	0	0	77	40	2.3
H	4.3	55.0	0	0	78	37	2.7
J	11.7	66.7	0	0	70	30	2.7
K	4.0	68.3	0	0	78	20	2.0
L	1.7	28.3	0	0	83	53	2.7
M	5.0	30.0	0	0	82	48	2.7
N	4.3	41.7	0	0	73	50	2.0
P	2.4	26.7	0	0	83	60	2.7
SED	7.34	16.97	2.45	1.34	10.9	13.4	0.58

3 August 1993 - Late milky ripe - Apollo

Code	% Septoria tritici leaf 1	% Septoria tritici leaf 2	% Mildew leaf 1	% Mildew leaf 2	% Green leaf area leaf 1	% Green leaf area leaf 2	% White heads
A	16.7	70.0	1.7	3.3	60	20	2.0
B	11.7	83.3	8.3	1.7	62	13	3.0
C	13.3	85.0	0.1	0	55	12	3.7
D	22.7	53.3	0.1	1.7	48	12	2.3
E	14.3	76.7	0.1	0.7	70	8	3.7
F	13.3	60.0	0.1	1.7	55	23	2.7
G	16.7	80.0	0	0.1	57	17	2.3
H	23.3	60.0	0	3.4	67	23	2.7
J	18.3	63.3	0	0	57	30	2.7
K	14.0	63.3	0.1	0.1	77	20	3.0
L	23.3	76.7	3.3	3.3	60	17	2.3
M	10.0	60.0	0	0.1	72	17	3.7
N	15.0	51.7	0	0	60	37	3.3
P	20.0	70.0	0	0.7	63	28	2.3
SED	7.34	16.97	2.45	1.34	10.9	13.4	0.58

3 August 1993 - Late milky ripe

Code	Riband % Brown rust leaf 1	% Brown rust leaf 2	Code	Apollo % Brown rust leaf 1	% Brown rust leaf 2
A	0	0	A	0	0
B	0	0	B	0	0.7
C	0	0	C	0	0
D	0	0	D	1.7	5.0
E	0	0	E	0	0
F	0	0	F	0	0
G	0	0	G	0.1	0.1
H	0	0	H	0	0.1
J	0	0	J	1.7	0
K	0	0	K	0	0
L	0	0	L	0	0
M	0	0	M	0	1.7
N	0	0	N	0	0
P	0	0	P	0	0
SED	0.61	1.39	SED	0.61	1.39

17 August 1993

Code	Riband % Whiteheads	Code	Apollo % Whiteheads
A	33.3	A	30.0
B	30.0	B	28.3
C	28.3	C	28.3
D	30.0	D	30.0
E	30.0	E	28.3
F	43.3	F	31.7
G	36.7	G	28.3
H	40.0	H	30.0
J	31.7	J	26.7
K	31.7	K	28.3
L	31.7	L	28.3
M	35.0	M	26.7
N	38.3	N	28.3
P	35.0	P	28.3
SED	4.15	SED	4.15

HGCA WINTER WHEAT REDUCED FUNGICIDE DOSE TRIAL
SAC ABERDEEN

Trial details:

Site:	Tillycorthie farm, Udny. Grampian
Field:	16/17/18 Square field
Grid ref:	NJ 909 235
Site manager:	Dr S Wale SAC-Aberdeen 581 King Street Aberdeen AB9 1UD Tel: 0224 480291
Site details:	100 m above sea level 5^{o} dip to east
Soil type & drainage:	Sandy clay loam, freely drained
Soil series:	Tarves
Soil association	Tarves
Soil analysis:	P. moderate, K. high, Mg. high, pH. 6.2
Previous cropping:	1992: Winter oilseed rape 1991: Winter oilseed rape 1990: Winter barley
Disposal of previous Crop residue:	Chopped and incorporated
Cultivations:	Ploughed, power harrowed plus crumbler, Oyjord drill
Cultivars:	Apollo and Riband
Sowing date:	8 November 1992
Seed rates:	Apollo: 241 kg/ha Riband 318 kg/ha
Seed treatment:	Single purpose, non mercurial seed dressing
Row width:	13 cm
Herbicide:	29 April 1993 45g/ha Harmony M + 0.75 l/ha Oxytril
Growth regulation:	29 April 1993 2.5 l/ha Cycocel
Seedbed/fertiliser:	Nil
Top dressings:	17 February 1993 16 March 1993 27 April 1993
Plot dimension at sowing:	20 x 1.78 m
Plot dimension at harvest:	20 x 2.1 m
Date of harvest:	19 October 1993
Layout:	Randomised block

Treatments

Apollo

Code	Target Actual Datel	GS32 GS32 (28.5.93)	GS39 GS45 (28.6.93)	GS59 GS62 (14.7.93)
A		-	-	-
B		-	1/4	-
C		1/4	1/4	-
D		1/4	-	1/4
E		-	1/4	1/4
F		-	1/2	-
G		1/2	1/2	-
H		1/2	-	1/2
J		-	1/2	1/2
K		-	3/4	-
L		1/4	3/4	-
M		1/4	-	3/4
N		-	1	-
P		1	1	1

Fungicide: Patrol - full dose = 1.0 litres/ha
Dynene applied to control Septoria at GS 39.

Riband

Code	Target Actual Date	GS32 GS32 (28.5.93)	GS33 GS33 (8.6.93)	GS39 GS39 (25.6.93)	GS59 GS62 (14.7.93)
A		-	-	-	-
B		1/4	-	1/4	1/4
C		-	1/4	1/4	1/4
D		1/4	1/4	1/4	1/4
E		-	-	1/2	1/2
F		1/2	-	1/2	1/2
G		-	1/2	1/2	1/2
H		1/2	1/2	1/2	1/2
J		1/4	-	1/2	1/2
K		-	1/4	1/2	1/2
L		1/2	-	3/4	1/2
M		-	1/2	3/4	1/2
N		1/2	-	3/4	3/4
P		1	-	1	1

Fungicide: Folicur - full dose = 1.0 litres/ha

Application details:

Date	28.5.93	8.6.93	25.6.93	28.6.93	14.7.93
GS	32	33	43	45	62
Wind speed (km/hr)	5	7-14	0-4	4-8	4-6
Wind direction	SE	SE	SSW	S	ESE
Temperature (^{o}C)	14.3	21.3	10.8	19.8	16.1
Cloud cover	6/8	5/8	8/8	1/8	8/8
Comments	Crop & Ground dry	Crop & Ground dry	Crop & Ground Dry at first. Spitting with rain for last 40 mins. Tilth B-J m Riband sprayed	Crop & Ground damp. Tilth K-N Riband overspray Apollo	Crop & Ground dry

Spraying equipment (all dates):

Sprayer	AZO propane sprayer
Nozzle	Lurmark SD 11002
Water volume (l/ha)	194
Pressure (bars)	2.5
Forward speed (km/hr)	4
Boom width (m)	2.0

Disease

1) 28 May 1993 - GS 32

	Apollo		Riband	
	% Leaf area	infection	% Leaf area	infection
	S.tritici	Mildew	S.tritici	Mildew
leaf 3*	0.0	0.0	0.0	0.0
leaf 4	0.0	0.0	0.0	0.0
leaf 5	0.0	0.0	0.0	0.0
leaf 6	trace	0.0	2.8	0.0

* Topmost fully expanded leaf
No yellow rust present

2a) Apollo - 9 June 1993 - GS 33

Treatment	Leaf 2		Leaf 3		Leaf 4		Mean	
Code	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	0.0	tr	0.3	0.3	1.3	2.8	0.5	1.1
B	-	-	-	-	-	-	-	-
C	0.0	tr	tr	0.7	1.6	3.5	0.5	1.4
D	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-
G	tr	0.3	1.1	1.4	5.4	3.1	2.2	1.6
H	-	-	-	-	-	-	-	-
J	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	-
P	0.0	0.0	0.3	0.8	1.5	3.0	0.6	1.3
s.e.d.	-	-	-	-	1.96	1.23	-	-
d.f.					6	6		
					n.s.	n.s.		

* Leaf 1 = Flag leaf
No yellow rust present

2b) Riband - 9 June 1993 - GS 33

Treatment	Leaf 2		Leaf 3		Leaf 4		Mean	
Code	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	tr	0.0	1.5	0.6	9.8	2.8	3.4	1.1
B	0.5	0.0	1.4	0.6	4.0	1.0	2.0	0.5
C	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-
F	tr	0.1	1.5	0.4	3.4	0.8	1.6	0.4
G	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	-
J	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	-
P	tr	tr	0.9	0.5	5.9	1.6	2.3	0.7
s.e.d.	-	-	-	-	2.40	-	0.71	0.15
d.f.					6	-	6	6
					n.s.		n.s.	*

Leaf 1 = Flag leaf
No yellow rust present

3a) Apollo - 22 June 1993 - GS 41

Treatment	Leaf 1		Leaf 2		Leaf 3		Mean	
Code	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	0.0	tr	tr	tr	tr	0.2	tr	0.1
B	-	-	-	-	-	-	-	-
C	0.0	0.0	0.0	tr	tr	tr	tr	tr
D	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-
G	0.0	0.0	0.0	tr	tr	tr	tr	tr
H	-	-	-	-	-	-	-	-
J	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	-
P	0.0	tr	tr	tr	tr	0.0	tr	tr

* Leaf 1 = Flag leaf
No yellow rust present

4a) <u>Apollo - 14 July 1993 - GS 62</u>

Treatment	Leaf 1		Leaf 2		Leaf 3		Mean	
Code	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	0.1	3.2	0.9	4.3	4.6	12.1	1.9	6.5
B	0.3	2.5	2.4	4.3	4.1	5.6	1.7	4.1
C	0.2	0.9	2.3	1.5	4.5	1.5	2.3	1.3
D	0.1	1.4	1.6	4.0	3.7	4.0	1.8	3.1
E	-	-	-	-	-	-	-	-
F	tr	0.6	1.0	3.6	2.8	6.3	1.3	3.5
G	0.1	0.5	1.9	1.9	4.6	2.9	2.2	1.7
H	0.1	1.0	1.5	2.3	6.3	2.6	2.7	2.0
J	-	-	-	-	-	-	-	-
K	0.2	0.4	1.2	1.1	4.6	1.2	2.0	0.9
L	0.4	0.6	1.5	1.8	3.5	2.1	1.8	1.5
M	-	-	-	-	-	-	-	-
N	0.1	1.5	0.9	2.9	5.1	5.0	2.0	3.1
P	0.1	0.2	1.1	0.9	3.1	0.7	1.4	0.6
s.e.d.	-	0.75	0.93	1.33 20	1.31	3.56	-	-
df		20	20		19	19		
		*	n.s.	n.s.	n.s.	n.s.		

* Leaf 1 = Flag leaf
No yellow rust present

3b) Riband - 22 June 1993 - GS 41

Treatment Code	Leaf 1 S.tritici	Leaf 1 Mildew	Leaf 2 S.tritici	Leaf 2 Mildew	Leaf 3 S. tritici	Leaf 3 Mildew	Mean S.tritici	Mean Mildew
A	tr	0.0	tr	tr	2.1	tr	0.7	tr
B	0.0	0.0	tr	tr	0.6	tr	0.2	tr
C	0.0	0.0	tr	tr	2.7	tr	0.9	tr
D	0.0	0.0	0.1	0.0	1.1	tr	0.4	tr
E	-	-	-	-	-	-	-	-
F	0.0	tr	tr	tr	0.5	tr	0.2	tr
G	tr	tr	tr	tr	1.2	tr	0.4	tr
H	0.0	0.0	tr	0.0	0.5	0.0	0.2	tr
J	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	-	-
L	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	-
P	0.0	0.0	tr	tr	0.5	tr	0.2	tr
s.e.d.					0.97			
d.f.					14			
					n.s.			

* Leaf 1 = Flag leaf
No yellow rust present

4b) Riband - 14 July 1993 - GS 62

Treatment Code	Leaf 1		Leaf 2		Leaf 3		Mean	
	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	5.0	0.2	2.9	0.2	20.6	0.1	9.5	0.2
B	5.2	0.1	6.1	0.3	14.5	0.2	8.6	0.2
C	0.9	0.2	0.2	0.1	2.8	0.2	1.3	0.2
D	1.5	0.3	0.3	0.3	4.7	0.1	2.2	0.4
E	0.2	0.2	1.5	0.3	9.6	0.2	3.8	0.2
F	0.9	0.2	1.0	0.2	7.4	0.5	3.1	0.2
G	0.5	0.0	0.3	0.6	5.2	0.1	2.0	0.2
H	0.4	0.1	0.2	0.2	2.8	0.1	1.1	0.1
J	2.4	tr	3.5	0.2	12.1	0.4	6.0	0.2
K	0.4	0.1	0.4	0.1	8.0	0.2	3.0	0.2
L	1.0	0.2	1.6	0.3	5.4	0.4	2.6	0.5
M	0.8	0.1	0.1	0.2	3.0	0.0	1.3	0.1
N	0.4	0.0	0.8	0.1	7.4	0.2	2.9	0.2
P	0.7	tr	1.4	0.1	4.9	tr	2.3	tr
s.e.d.	2.16	-	1.56	-	3.37	-	2.11	-
df	26		26		26		26	
	n.s.		*		***		**	

* Leaf 1 = Flag leaf
(**) trace of yellow rust on leaf 2
(***) trace of yellow rust on leaf 3

5a) Apollo - 26 July 1993 - GS 71

Treatment Code	Leaf 1 S. tritici	Leaf 1 Mildew	Leaf 2 S.tritici	Leaf 2 Mildew	Leaf 3 S. tritici	Leaf 3 Mildew	Mean S.tritici	Mean Mildew
A	0.8	3.4	9.1	14.1	18.4	20.3	4.6	8.7
B	0.7	3.6	6.0	8.8	24.0	8.7	3.3	6.2
C	0.6	2.6	5.4	9.9	12.8	24.1	3.0	5.7
D	1.0	5.1	3.1	12.0	12.7	22.0	2.9	9.0
E	1.2	3.8	10.1	13.2	21.2	19.4	5.6	8.5
F	0.6	3.5	4.5	12.6	13.2	23.1	2.6	8.1
G	0.3	3.7	3.5	5.5	11.7	14.7	1.9	4.6
H	0.5	4.3	4.0	9.0	16.7	17.5	2.2	6.7
J	0.6	2.2	6.7	6.1	20.5	13.4	3.7	4.2
K	0.6	3.8	4.9	12.3	12.8	14.1	2.7	8.0
L	0.8	2.4	4.2	5.5	15.6	10.6	2.5	4.0
M	0.5	6.2	5.5	11.7	21.1	15.0	3.0	8.9
N	0.1	1.3	2.5	4.8	11.7	7.5	1.3	3.0
P	0.4	1.1	2.9	2.8	10.0	2.9	1.7	2.0
s.e.d.	-	-	1.971	4.39	6.30	6.96	1.07	2.63
d.f.			24	24	24	24	26	26
			*	n.s.	n.s.	n.s.	*	n.s.

* Leaf 1 = Flag leaf
No yellow rust present

5b) Riband - 26 July 1993 - GS 71

Treatment Code	Leaf 1		Leaf 2		Leaf 3		Mean	
	S. tritici	Mildew	S.tritici	Mildew	S. tritici	Mildew	S.tritici	Mildew
A	11.7	0.2	31.6	0.8	51.0	0.1	21.7	0.5
B	4.3	0.2	11.3	0.5	tr	0.1	7.8	0.6
C	3.6	0.3	5.9	0.9	14.2	1.1	4.8	0.5
D	3.9	0.4	3.1	0.4	14.0	3.1	3.5	0.4
E	3.8	0.1	9.9	0.4	16.3	0.5	6.9	0.2
F	5.7	0.1	10.5	0.5	1.8	0.1	8.1	0.4
G	3.9	0.3	3.8	0.5	13.4	0.8	3.8	0.4
H	2.6	0.4	2.3	0.2	8.2	0.6	2.4	0.3
J	6.6	0.2	11.7	0.5	14.2	0.7	9.2	0.4
K	3.7	0.3	5.8	0.4	16.4	0.1	4.7	0.4
L	1.9	0.1	5.7	0.5	21.3	1.0	3.8	0.2
M	1.9	0.1	2.1	0.2	10.9	0.1	2.0	0.2
N	4.8	0.2	8.3	0.4	14.8	0.7	6.5	0.3
P	1.3	0.3	2.2	0.3	6.8	0.3	1.8	0.3
s.e.d.	2.196		2.930				2.339	
d.f.	26		26				26	
	*		***				***	

* Leaf = Flag leaf
1 many senescent leaves
2 mean of top two leaves

6a) Apollo - 9 August 1993 - GS 76

	Leaf 1* S.tritici	mildew	Leaf 2 S.tritici	mildew	Mean S.tritici	mildew
A	14.6	5.3	59.0	2.2	36.8	3.7
B	5.6	3.7	31.1	3.5	18.3	3.6
C	6.3	2.7	33.1	4.9	19.7	3.8
D	10.5	5.8	23.7	3.1	17.1	4.4
E	10.7	3.6	40.2	4.8	25.5	4.2
F	7.8	2.6	35.7	4.0	21.8	3.3
G	5.0	2.1	31.2	3.8	18.1	2.9
H	8.3	2.1	30.7	2.3	19.5	2.2
J	3.3	1.4	24.8	2.6	14.1	2.0
K	5.6	1.6	24.3	3.3	14.9	2.5
L	8.0	0.9	23.7	3.1	15.9	2.0
M	4.2	2.6	28.0	3.9	16.1	3.2
N	13.1	0.5	25.2	1.2	19.2	0.9
P	4.0	0.4	21.5	0.8	12.8	0.6
s.e.d.	4.08	1.95	8.20	1.98	4.97	1.71
d.f.	26	26	26	26	26	26
	n.s.	n.s.	*	n.s.	*	n.s.

*Leaf 1 = Flag leaf
No yellow rust present

6b) Riband - 9 August 1993 - GS77

Treatment Code	Leaf 1* S. trit	mildew	Leaf 2 S. trit	mildew	Leaf 3[1] S. trit	mildew	Mean [2] S. trit	mildew
A	79.1	0.2	87.5	0.2	59.8	tr	38.3	0.0
B	36.9	0.3	69.5	0.5	85.6	tr	53.2	0.2
C	38.3	0.9	46.9	0.2	60.8	tr	42.6	0.4
D	17.8	0.2	38.5	0.5	65.0	0.0	28.2	0.4
E	20.3	0.2	53.0	0.2	59.8	tr	36.6	0.1
F	13.2	0.5	39.5	tr	40.9	tr	26.3	0.2
G	14.7	0.2	26.0	0.7	48.4	0.4	20.4	0.5
H	20.7	0.2	33.1	0.0	57.1	tr	26.9	0.1
J	29.0	tr	50.5	tr	75.6	tr	39.7	0.2
K	19.6	0.4	42.5	tr	58.0	0.0	31.1	0.2
L	11.4	0.1	30.1	0.4	53.3	0.0	20.8	0.2
M	5.5	0.0	24.9	0.0	55.1	0.0	15.2	0.0
N	7.8	0.1	35.2	0.0	59.4	0.0	21.5	tr
P	11.7	0.0	24.1	0.2	58.4		17.9	0.1
s.e.d.	5.43		4.699				4.186	
d.f.	26		26				26	
	***		***				***	

* Leaf 1 = Flag leaf
1 Many senescent leaves
2 Mean of top two leaves

7) 12 August 1993 - GS 77

Treatment Code	Mean % infection on ears Apollo S. tritici	 Riband S. tritici
A	4.6	3.3
B	2.4	2.4
C	2.6	2.3
D	2.4	2.2
E	2.4	2.1
F	2.0	2.3
G	2.7	1.8
H	1.6	2.0
J	1.8	1.5
K	2.8	2.2
L	2.4	1.7
M	1.2	1.6
N	1.6	1.7
P	1.3	2.0
s.e.d.	0.87 (26 df)	0.61 (26df)
	n.s.	n.s.

Yield of grain

Treatment Code	Yield (t/ha @ 15% m.c.) Apollo	Riband
A	4.299	4.147
B	4.548	4.985
C	4.888	5.304
D	4.702	5.504
E	4.742	5.526
F	4.899	5.957
G	4.990	6.491
H	4.721	6.328
J	5.158	6.013
K	5.096	6.478
L	4.912	6.371
M	4.898	6.613
N	4.980	6.553
P	5.352	6.571
s.e.d.	0.2693	0.2693
d.f.	52	52
	***	***

% CV = 6.1
LSD = 0.541

Thousand grain weight and specific weight

Code	Apollo 1000 grain wt g	Specific wt kg/hl	Riband 1000 grain wt g	Specific wt kg/hl
A	38.9	526.2	31.5	525.7
B	42.2	560.5	35.5	548.7
C	42.4	568.9	37.6	548.8
D	40.9	543.5	38.2	557.7
E	42.1	579.2	37.2	572.8
F	42.1	560.7	39.0	571.3
G	42.3	552.8	40.7	539.4
H	41.8	556.6	40.2	568.1
J	43.4	575.6	39.5	563.3
K	42.4	560.5	40.6	565.5
L	42.0	581.3	41.7	560.0
M	43.2	559.2	41.5	549.0
N	42.5	557.8	41.9	569.3
P	43.8	584.2	42.0	560.5
s.e.d.	0.95	13.32	0.95	13.32
d.f.	52	52	52	52
	***	***	***	***

Summary disease data

Apollo

Mean % Septoria tritici infection

GS	33	41	62	71	76	77
	9.6.93	22.6.93	14.7.93	26.7.93	9.8.93*	12.8.93
Treatment						ear infection
Code						
A	0.5	tr	1.9	4.6	36.8	4.6
B	-	-	1.7	3.3	18.3	2.4
C	0.5	tr	2.3	3.0	19.7	2.6
D	-	-	1.8	2.9	17.1	2.4
E	-	-	-	5.6	25.5	2.4
F	-	-	1.3	2.6	21.8	2.0
G	2.2	tr	2.2	1.9	18.1	2.7
H	-	-	2.7	2.2	19.5	1.6
J	-	-	-	3.7	14.1	1.8
K	-	-	2.0	2.7	14.9	2.8
L	-	-	1.8	2.5	15.9	2.4
M	-	-	-	3.0	16.1	1.2
N	-	-	2.0	1.3	19.2	1.6
P	0.6	tr	1.4	1.7	12.8	1.3

Mean % Mildew infection

A	1.1	0.1	6.5	8.7	3.7
B	-	-	4.1	6.2	3.6
C	1.4	tr	1.3	5.7	3.8
D	-	-	3.1	9.0	4.4
E	-	-	-	8.5	4.2
F	-	-	3.5	8.1	3.3
G	1.6	tr	1.7	4.6	2.9
H	-	-	2.0	6.7	2.2
J	-	-	-	4.2	2.0
K	-	-	0.9	8.0	2.5
L	-	-	1.5	4.0	2.0
M	-	-	-	8.9	3.2
N	-	-	3.1	3.0	0.9
P	1.3	tr	0.6	2.0	0.6

* only the top two leaves were assessed

Riband

Mean % Septoria tritici infection

GS	33	41	62	71	76	77
	9.6.93	22.6.93	14.7.93	26.7.93	9.8.93*	12.8.93
Treatment Code						ear infection
A	3.4	0.7	9.5	21.7	83.3	3.3
B	2.0	0.2	8.6	7.8	53.2	2.4
C	-	0.9	1.3	4/8	42.6	2.3
D	-	0.4	2.2	3.5	28.2	2.2
E	-	-	3.8	6.9	36.6	2.1
F	1.6	0.2	3.1	8.1	26.3	2.3
G	-	0.4	2.0	3.8	20.4	1.8
H	-	0.2	1.1	2.4	26.9	2.0
J	-	-	6.0	9.2	39.7	1.5
K	-	-	3.0	4.7	31.1	2.2
L	-	-	2.6	3.8	20.8	1.7
M	-	-	1.3	2.0	15.2	1.6
N	-	-	2.9	6.5	21.5	1.7
P	2.3	0.2	2.3	1.8	17.9	2.0

Mean % Mildew infection

A	1.1	tr	0.2	0.5	0.0
B	-	tr	0.2	0.6	0.2
C	-	tr	0.2	0.5	0.4
D	-	tr	0.4	0.4	0.4
E	-	-	0.2	0.2	0.1
F	0.4	tr	0.2	0.4	0.2
G	-	tr	0.2	0.4	0.5
H	-	tr	0.1	0.3	0.1
J	-	-	0.2	0.4	0.2
K	-	-	0.2	0.4	0.2
L	-	-	0.5	0.2	0.2
M	-	-	-	8.9	3.2
N	-	-	01	0.2	0.0
P	0.7	tr	tr	0.3	0.1

* only the top two leaves were assessed

Comments

In north east Scotland the 1992/93 season proved extremely difficult for arable farmers. Continued wet conditions in the autumn of 1992 delayed drilling and the trial was not sown until 8 November. It emerged just after the new year and progressed slowly in the cold wet spring. The first node stage, normally occurring in early May, did not occur until nearly a fortnight later in 1993. The summer continued cool and wet and the normally slow ripening was extended further. The trial was eventually combined on 19 October 1993 but the moisture content of the grain even then was over 30%. The rainfall pattern for the period after April is shown in the figure below.

In terms of disease, the weather was not particularly conducive to mildew. However, it was entirely favourable for Septoria tritici.

On Apollo, mildew reached a maximum of 14% on leaf 2 of untreated plots by GS 71. Septoria tritici infection overtook that of mildew despite the variety being rated as more resistant to S.tritici than Riband and by GS 76 infection of the flag, second and third top leaves were 15, 59 and 37% respectively.

On Riband, once the flag leaf had formed, progress of Septoria tritici was rapid and by GS 77 infection of the top three leaves on untreated plots was 79, 88 and 60%. Mildew failed to exceed 1% infection on any of the top three leaves. Disease progress curves on successive leaf layers on the variety Riband is shown in the following figure.

In accordance with the inclement summer and slow ripening, yields were well below average. No lodging, grain shedding or sprouting occurred in this trial despite the late harvest.

Riband: All fungicide programmes significantly increased yield. The difference in yield between the untreated and highest yield was 2.466 t/ha. When the GS 32 treatment was delayed to GS 33 there was a consistent improvement in yield.

Dose	Extra yield (t/ha) in delaying GS 32 treatment to GS 33	treatment comparison
1/4	0.319	C-B
1/2	0.534	G-F
1/4	0.465	K-J
1/2	0.242	M-L
Mean	0.39	

Taking the three spray programme at full dose (treatment P) as a standard, the yields of treatment G, H, J, K, L, M and N were not significantly different. This demonstrated that doses down to a half of the standard could be used to give the same effect.

Given the rainfall pattern and pressure from disease, had the flag leaf treatment, targetted to be applied as soon as the flag leaf had emerged, been on time then the GS 33 treatment might not have been so effective. This application clearly coincided with a Septoria splash event. This was shown by the reduction in S.tritici on leaf 2 by those programmes with a GS 33 treatment

when compared to those with a GS 32 treatment. This effect was not as pronounced on leaf 3 or leaf 1.
At GS 77, the best fungicide programme achieved a 93% reduction in S. tritici compared to the untreated on leaf 1 and 72% reduction on leaf 2.

The response to a GS 32 and GS 33 treatment was little different when using 1/4 or 1/2 dose.

	Yield response (t/ha) when first application at:		Treatment Comparisons
Dose	GS 32	GS 33	
1/4	0.431	0.965	J-E, K-E
1/2	0.487	0.952	F-E, G-E

By increasing the dose at GS 39 from 1/2 to 3/4 (treatment M-G, L-F) an extra response between 0.122 and 0.414 t/ha was achieved. By contrast an increase in the dose applied to the ear was unnecessary (treatment N & L). There were clear indications that a dose as low as 1/4 at GS 39 and GS 59 was insufficient to cope with the pressure of disease.

Apollo: The majority of treatments resulted in a significant yield increase over the untreated control. Those treatments giving a significant yield increase were also not significantly different from each other. Thus yield responses similar to that from a full dose three spray programme were achieved with much lower doses applied once or twice.

As might be expected treatments using the lowest dose (1/4) frequently resulted in the least yield response, although a two spray 1/4 dose programme at GS 32 and GS 45 gave a yield not significantly different from other treatments using higher doses.

Of the single spray programmes applied at GS 43, the yield response over the untreated were:

Dose	Yield response (t/ha)
1/4	0.249
1/2	0.600
3/4	0.797
1	0.681

The full dose three spray programme (P) was the only treatment to maintain mildew levels below 3% on any leaf. Despite relatively high levels of mildew on leaf 3 of other treatments the extra yield by this treatment was relatively modest. It seems likely that the control of S.tritici contributed more to the yield response than any control of mildew

PART II. WINTER BARLEY IN SOUTH-WEST ENGLAND

SUMMARY

Two fungicides, propiconazole as Tilt and fenpropimorph as Corbel, were evaluated as single sprays at four different doses against foliar diseases in winter barley at three Westward Arable Centres trial sites in Devon and Cornwall.

At the Devon site, brown rust was significantly controlled in Pastoral for five weeks by all dose rates (full, ¾, ½, ¼) of both fungicides, with full recommended doses giving best control. This was reflected in yield increases of 26% for full dose propiconazole and 22% for fenpropimorph. All treatments significantly increased yields, but for both fungicides, use of full recommended doses produced significantly higher yields than lower doses.

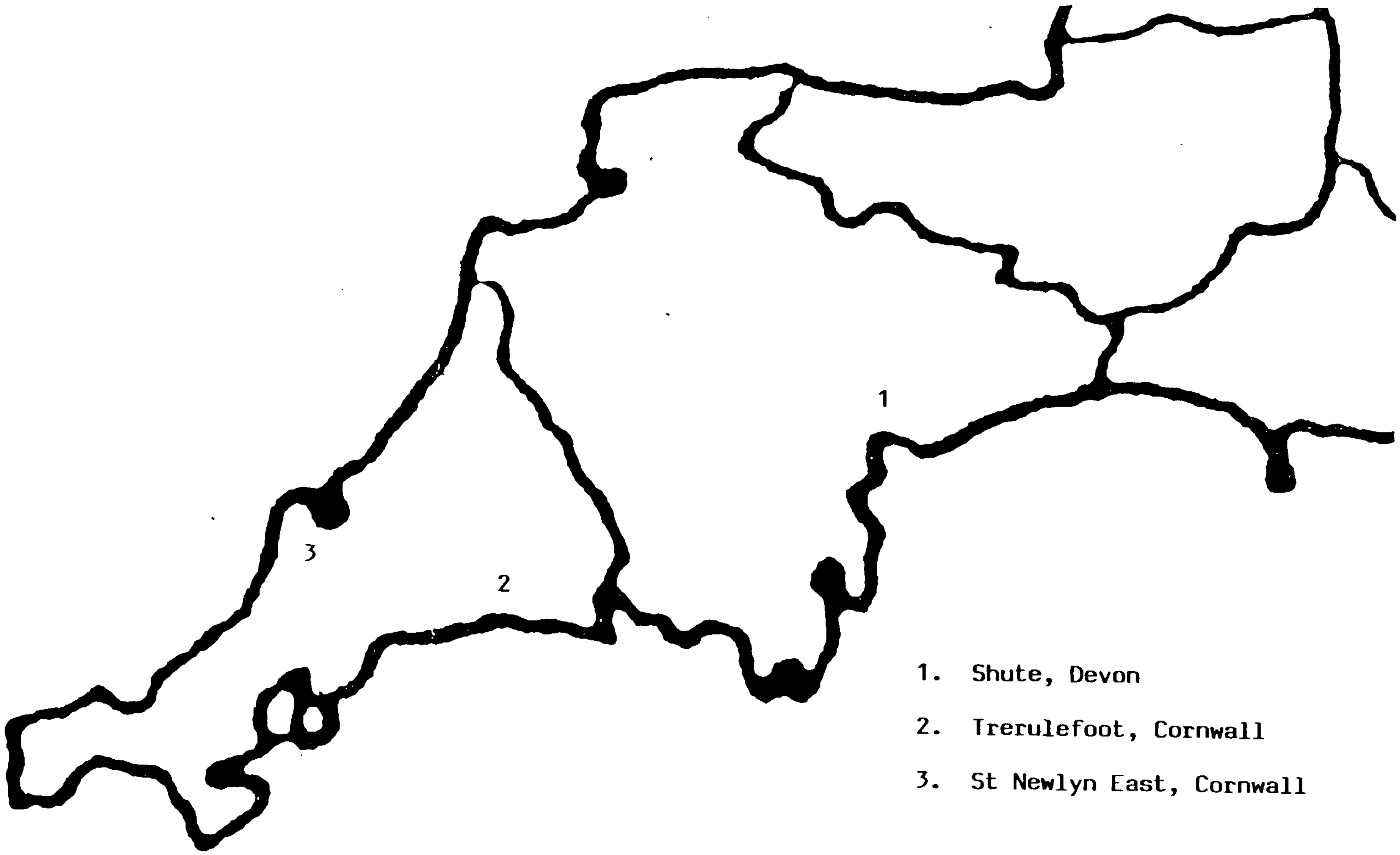
At Trerulefoot, East Cornwall, *Rhynchosporium* was significantly reduced on Halcyon by all treatments for seven weeks, with propiconazole at half recommended dose and above giving outstanding control - 7% compared with 34% on flag leaf. Although all treatments significantly improved yields, the superior control of *Rhynchosporium* with propiconazole was reflected in higher yields with this fungicide.

Net blotch was the major disease on Pastoral in West Cornwall and was well controlled for seven weeks by all doses of propiconazole. This resulted in significantly increased yields with half recommended dose of propiconazole and above.

INTRODUCTION

With the unique climate in Devon and Cornwall, foliar diseases are a constant annual threat to winter barley yields. The area is therefore well suited to undertake fungicide evaluation trials as well as dose response investigations. *Rhynchosporium* and net blotch are commonly found in Cornwall and the coastal areas of Devon, while brown rust is a persistent and serious disease in mid and east Devon.

Trials were done at three trial sites run by Westward Arable Centres Ltd in Devon and Cornwall - Shute (near Exeter) in Devon, Trerulefoot (near Saltash), East Cornwall, and St. Newlyn East (near Newquay) in West Cornwall - see map.



1. Shute, Devon
2. Trerulefoot, Cornwall
3. St Newlyn East, Cornwall

OBJECTIVES

To monitor foliar disease control in winter barley following the application of two fungicides (propiconazole as Tilt and fenpropimorph as Corbel) at a range of concentrations.

METHOD AND TREATMENTS

Plots were marked out in existing commercial crops, and single fungicide sprays applied at growth stage 37 (flag leaf visible). Planned sprays (GS 32-33) were delayed due to persistent wet weather.

The fungicides used were propiconazole as Tilt, and fenpropimorph as Corbel. Applications were full, ¾, ½, ¼ recommended dose of each fungicide (full dose of Tilt is 0.5 l/ha and Corbel 1.0 l/ha). The trials were laid out in randomised blocks of three replicates. Fungicide applications were made with a hand held precision sprayer, pressurised by carbon dioxide, and using a 2m boom.

Disease assessments were done at time of fungicide applications and on 10 tagged plants in each plot at approximately 21, 38 and 50 days after spraying. Plots were harvested using a Massey Ferguson Plot 8 Combine fitted with electronic weigh cells.

SITE DETAILS

Site	*Shute, Devon*	*Trerulefoot, East Cornwall*	*St. Newlyn East, West Cornwall*
Variety	Pastoral	Halcyon	Pastoral
Soil Type	Sandy Loam	Clay Loam	Silty Clay
Plot Area	$30m^2$	$36m^2$	$24m^2$
Spray Date	29 April (GS 37)	28 April (GS 37)	28 April (GS 37)
Assessment Dates	3 May (GS 37) 26 May (GS 57) 6 June (GS 71)	2 May (GS 37) 24 May (GS 57) 5 June (GS 65) 15 June (GS 71+)	1 May (GS 37) 21 May (GS 55) 4 June (GS 61) 17 June (GS 71+)
Harvest	30 July	31 July	1 August

For further site details - see Appendices I, II and III.

YIELDS - *Grain @ 85% DM t/ha*
(Actual yields and as % of untreated controls)

Treatment	Dose (l/ha)	Shute, Devon		Trerulefoot, Cornwall		St. Newlyn East, Cornwall	
		Yield	***%***	***Yield***	***%***	***Yield***	***%***
Control	-	3.22	100	4.35	100	3.96	100
fenpropimorph	1.0	3.92	122+	4.90	113+	4.29	108+
fenpropimorph	0.75	3.74	116+	4.85	112+	4.25	107+
fenpropimorph	0.5	3.66	114+	4.91	113+	4.14	105
fenpropimorph	0.25	3.56	110+	4.60	106+	4.07	103
propiconazole	0.5	4.04	126+	5.10	117+	4.63	117+
propiconazole	0.375	3.81	118+	5.08	117+	4.46	113+
propiconazole	0.25	3.66	114+	4.82	111+	4.36	110+
propiconazole	0.125	3.50	109+	4.68	108+	4.11	104
Mean		3.68		4.81		4.25	
LSD(5%)		0.186	5.8	0.218	5.0	0.229	5.8
CV%		2.9		2.6		3.1	
SE		0.062	1.9	0.073	1.7	0.076	1.9
Sign.		P<0.001		P<0.001		P<0.001	

At two sites, Shute and Trerulefoot, all fungicide treatments significantly increased yield. At all sites, highest yield was obtained with full recommended rate of propiconazole. At the two Cornwall sites, *Rhynchosporium* and net blotch were well controlled by propiconazole even at half rate. This was reflected in yield responses with half dose propiconazole giving similar grain yield to full dose fenpropimorph. Brown rust at the Devon site was well controlled by full dose of fenpropimorph and propiconazole. Yield responses reflected this with decreasing yield with both fungicides corresponding to inferior disease control. Cost benefit at all sites favoured full and ¾ dose propiconazole- see Appendix IV.

GRAIN QUALITY
A. *Screenings - % over 2.2mm*

Treatment and Dose	Site		
	Shute	***Trerulefoot***	***St. Newlyn East***
Untreated	81.4	93.1	90.1
fenpropimorph(1.0)	89.3	94.9	92.4
fenpropimorph (0.75)	87.5	95.0	92.6
fenpropimorph (0.5)	87.9	94.6	92.2
fenpropimorph (0.25)	85.9	94.7	91.4
propiconazole (0.5)	88.1	95.3	93.9
propiconazole (0.375)	88.5	95.6	93.5
propiconazole (0.25)	88.7	95.0	93.4
propiconazole (0.125)	85.3	94.9	91.4
Site Mean	87.0	94.8	92.3

B. *Specific Weight and Thousand grain weight*

Treatment	***Dose (l/ha)***	***Specific Wt (kg/hl)***			***Thousand grain wt(g at 85% DM)***		
		Shute	***Trerulefoot***	***St.Newlyn East***	***Shute***	***Trerulefoot***	***St.Newlyn East***
Untreated	-	59.6	64.9	57.8	34.3	34.1	37.4
fenpropimorph	1.0	59.6	65.3	60.0	36.8	36.2	37.3
fenpropimorph	0.75	59.4	65.3	57.2	37.3	37.7	38.8
fenpropimorph	0.5	59.2	65.1	59.2	36.2	37.9	38.5
fenpropimorph	0.25	58.6	66.2	57.8	35.4	36.4	38.2
propiconazole	0.5	60.4	65.1	61.2	37.9	39.0	41.7
propiconazole	0.375	59.6	63.2	59.0	38.2	39.2	39.6
propiconazole	0.25	59.6	63.6	59.2	35.9	37.0	38.0
propiconazole	0.125	58.6	63.2	*	36.7	37.2	39.3
Site Mean		59.4	64.8	58.9	36.5	37.2	38.8

*Missing value

Screenings, grain under 2.2 mm, were low at both Cornwall sites, but high at Shute, Devon, probably due to early senescence. There were no treatment differences at any of the sites although the untreated control gave highest screenings at all three sites.

The specific weights at Trerulefoot were acceptable, those at the other two sites were poor. Thousand grain weights were poor at all three sites. None of the quality assessments were statistically analysed.

DISEASE ASSESSMENTS AND OBSERVATIONS

Site: *Shute, Devon, Brown Rust (% leaf area infected)*

Treatment	***Dose (l/ha)***	***% of rec.***	***At spraying***		***Spray + 21 days***			***Spray + 38 days***		
			L3	L4	L1	L2	L3	L1	L2	Awns
Control	-	-	2.8	7.5	8.1	23.0	31.0	31.5	59.3	40.0
fenpropimorph	1.0	100	1.6	6.0	2.0	7.3	17.0	11.8	25.3	11.7
fenpropimorph	0.75	75	2.3	8.4	1.3	6.7	15.4	12.3	28.8	15.0
fenpropimorph	0.5	50	1.5	7.9	3.5	14.2	26.8	16.7	36.5	18.3
fenpropimorph	0.25	25	1.7	7.2	3.8	12.5	23.7	17.3	45.7	26.7
propiconazole	0.5	100	2.2	7.6	1.4	7.5	15.2	11.2	27.2	15.0
propiconazole	0.375	75	1.9	7.0	2.1	9.8	21.0	14.5	34.2	18.3
propiconazole	0.25	50	1.6	6.1	3.0	11.8	22.4	14.7	38.7	15.0
propiconazole	0.125	25	2.1	8.0	4.3	14.3	23.3	18.8	47.7	21.7
Mean			2.0	7.3	3.3	11.9	21.8	16.5	38.2	20.2
LSD±			1.67	3.82	1.67	4.69	6.89	4.24	8.36	7.04
CV%			49.1	30.2	29.4	22.7	18.3	14.8	12.6	20.2
Sign.			NS	NS	$P<0.001$	$P<0.001$	$P<0.01$	$P<0.001$	$P<0.001$	$P<0.001$

At spraying (29 April), as well as brown rust there were considerable infections of mildew and some net blotch. After 21 days mildew was well controlled on leaf 3 by all fenpropimorph treatments, but only slightly reduced by full dose propiconazole. Mildew did not progress onto the top leaves and net blotch levels remained below 3% on leaf 3 when assessed 21 days after spraying, and was below 2% on leaf 2 when assessed after 38 days (GS 71). For full disease assessments during the season see Appendix V.

There was considerable infection on lower leaves with brown rust at spraying, 2% on leaf 3, and 7% on leaf 4. All concentrations of both fungicides gave significant control of brown rust for 21 days on the top three leaves. This difference continued until 38 days after spraying, including ear infections. Best control of brown rust was with full dose of either fenpropimorph or propiconazole with efficacy of both fungicides reduced with lowering of dose.

Site: *Trerulefoot, East Cornwall - Rhynchosporium (% leaf area infected)*

Treatment	*Dose (l/ha)*	*% of rec. dose*	*At spraying*		*Spray + 21 days*		*Spray + 38 days*		*Spray + 48 days*	
			L3	*L4*	*L2*	*L3*	*L1*	*L2*	*L1*	*GLA*
Control	-	-	2.1	13.7	11.5	40.2	5.2	24.3	34.3	4.2
fenpropimorph	1.0	100	2.1	13.3	2.9	16.5	1.0	11.7	9.8	41.0
fenpropimorph	0.75	75	3.5	15.3	4.9	19.5	1.2	15.3	10.5	36.2
fenpropimorph	0.5	50	2.2	14.7	5.1	20.6	1.5	14.2	9.7	28.3
fenpropimorph	0.25	25	2.6	15.2	4.9	23.7	2.4	12.1	15.0	15.0
propiconazole	0.5	100	2.8	17.0	1.1	7.9	0.5	5.1	6.0	54.7
propiconazole	0.375	75	1.9	15.6	1.6	11.1	0.6	6.3	7.7	48.2
propiconazole	0.25	50	2.7	16.3	2.5	11.6	0.5	7.5	7.0	42.8
propiconazole	0.125	25	2.6	15.8	4.2	17.3	1.7	16.4	9.8	32.0
Mean			2.5	15.2	4.3	18.7	1.6	12.6	12.2	33.6
LSD±			2.03	3.85	2.53	7.92	1.17	4.19	8.26	7.54
CV%			46.8	14.6	34.0	24.5	41.6	19.3	39.1	13.0
Sign.			NS	NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

Apart from *Rhynchosporium,* no other disease developed in this crop of Halcyon. There was an initial level of 2.5% *Rhynchosporium* on leaf 3 and 15% on leaf 4 when the trial was sprayed on 28 April. After 21 days all treatments significantly reduced disease progress on leaves 2 and 3, with propiconazole giving significantly superior disease control at all concentrations except the lowest dose (25% of recommended dose). This superiority of propiconazole was maintained for 38 days after spraying on leaves 1 (flag) and 2. By mid-June, 48 days after spraying, the crop was at GS 71 (grain watery ripe). While disease levels on flag leaf were still significantly reduced by all treatments, there were no significant differences between individual treatments. Green leaf area (GLA) at this time was significantly higher in all spray treatment with propiconazole being superior to fenpropimorph.

Site: *St. Newlyn East, West Cornwall - Net Blotch (% leaf area infected)*

Treatment	***Dose (l/ha)***	***% of rec. dose***	***At spraying***	***Spray + 21 days***	***Spray + 37 days***		***Spray + 50 days***		
			L4	***L3***	***L2***	***L3***	***L1***	***GLA 1***	***GLA 2***
Control	-	-	4.2	7.0	5.0	21.0	26.7	8.5	5.8
fenpropimorph	1.0	100	4.0	3.9	2.6	15.8	11.7	13.3	7.7
fenpropimorph	0.75	75	4.9	3.9	2.7	15.0	16.7	19.2	11.2
fenpropimorph	0.5	50	3.7	4.6	2.9	15.5	16.7	11.7	8.7
fenpropimorph	0.25	25	4.4	4.9	4.5	17.2	21.7	15.3	8.0
propiconazole	0.5	100	4.2	2.6	1.0	3.9	2.0	47.0	37.7
propiconazole	0.375	75	4.8	3.2	1.7	5.8	5.0	35.7	26.8
propiconazole	0.25	50	5.0	3.6	1.9	10.0	5.0	29.2	21.7
propiconazole	0.125	25	4.2	3.8	2.2	10.0	8.3	25.5	16.2
Mean			4.4	4.2	2.7	12.7	12.6	22.8	16.0
LSD±			1.23	1.89	1.16	4.37	4.96	8.92	4.65
CV%			16.2	26.3	24.6	19.9	22.7	22.6	16.8
Sign.			NS	P<0.01	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

For complete disease assessments during the season see Appendix VI.

When the plots were sprayed (29 April) there was a low incidence of brown rust and *Rhynchosporium* - less than 1% on leaf 4. Neither of these diseases became epidemic in the crop with brown rust only reaching 2.5% on leaf 3 and *Rhynchosporium* 1.5% on leaf 3 in the unsprayed plots by early June (GS 61). Three weeks after spraying, all treatments significantly contained net blotch, but disease development at that time was slow. When assessed 37 days after spraying, propiconazole was still giving significant control at half dose and above. The control with propiconazole was significantly superior to fenpropimorph at all doses, with full and three-quarter doses giving best control of net blotch. Green leaf area of both flag and second leaf (GLA1 and GLA2) with all propiconazole treatments were significantly higher than any of the fenpropimorph treatments and untreated control, when assessed 50 days after spraying. At that time, propiconazole at half-dose and above gave outstanding control of net blotch on the flag leaf; all treatments reduced disease severity at that time.

Stem base diseases at any of the sites were not present at significant levels.

CONCLUSIONS

Valuable information on doses and persistence of two fungicides against three major diseases in winter barley has been obtained from these preliminary trials at three WAC trial sites.

At Shute, Devon, brown rust was significantly controlled for over 5 weeks by all concentrations of both fungicides, with full doses of both fenpropimorph or propiconazole being equally effective, and giving best control. At Trerulefoot, East Cornwall, *Rhynchosporium* was significantly reduced by all treatment for 7 weeks, with propiconazole at concentrations of half recommended doses and above giving outstanding control.

At St. Newlyn East, West Cornwall, net blotch was well controlled by all treatments for 7 weeks, with propiconazole at all doses giving superior disease control.

At the two Cornwall sites, green leaf area was assessed due to the obvious differences late in the seasons. Due to very dry conditions in mid June, the Devon site senesced prematurely. Green leaf area at both Cornish sites was retained for longer with all spray programmes, with highest doses of propiconazole resulting in highest green leaf area 7 weeks after spraying.

The effect of these differences in disease levels on yields was illustrated at all three sites. The delay in development of brown rust at the Devon site by both fungicides resulted in significant yield differences with all doses, but decreasing with lower concentrations of both fungicides. Similarly, at the East Cornwall site, the delayed epidemic of *Rhynchosporium*, especially by propiconazole, resulted in significant yield and economic benefit. The excellent early control of net blotch by propiconazole in West Cornwall also resulted in significant yield benefit.

APPENDIX I

SITE DETAILS - DEVON

Site:	Shute Farm Shobrooke Crediton Devon	*Field:* *Grid ref:*	Common Close SS 883012
Soil type:	Sandy loam	*Aspect:*	91 m asl South facing and exposed
Previous cropping:	1992 W Wheat 1991 Peas 1990 W Barley	*Soil analysis:*	pH 6.5 P 2 K 1 Mg 1
Cultivations:	Ploughed and pressed Spring tilled x 1	*Drilled:*	5 October 1992
Variety:	Pastoral	*Seed treatment:*	Baytan
Seed rate:	180 kg/ha	*Row width:*	17 cm
Seed bed (kg/ha) fertiliser:	0:80:103	*Nitrogen topdressing:*	42 kg/ha 15 Feb 1993 75 kg/ha 22 Mar 1993 44 kg/ha 19 Apr 1993
Micronutrients:	None		
Herbicides:	Avadex granules (17.5 kg/ha) Panther (1 l/ha)	13 Oct 1992 14 Dec 1992	
Insecticides:	Cypermethrin (0.25 l/ha)	14 Dec 1992	
Growth regulator:	Chlormequat (0.65 l/ha)	14 Dec 1992	
Fungicides: (surrounding crop)	Punch C (0.45 l/ha) Solfa (8 kg/ha) Corbel (0.5 l/ha)	15 April 1993 15 April 1993 7 May 1993	
Harvested:	30 July 1993		

APPENDIX II

SITE DETAILS - EAST CORNWALL

Site:	Trerule Farm Trerulefoot Saltash Cornwall	*Field:* *Grid ref:*	Warren SX 325 585
Soil type:	Medium loam	*Aspect:*	80 m asl East facing slope, sheltered.
Previous cropping:	1992 W Oats 1991 W Wheat 1990 Peas	*Soil analysis:*	pH 7.2 P 3 K 3 Mg 2
Cultivations:	Ploughed and rolled Harrow x 2	*Drilled:*	7 October 1992
Variety:	Halcyon	*Seed treatment:*	Baytan
Seed rate:	157 kg/ha	*Row width:*	17 cm
Seed bed (kg/ha) fertiliser:	0:63:94	*Nitrogen topdressing:*	44 kg/ha 17 Feb 1993 88 kg/ha 2 Apr 1993

Micronutrients:	Sulphur (27 kg/ha)	17 Feb 1993
	SM6 (2-5 l/ha)	14 March 1993
Herbicides:	Trifluralin (2 l/ha)	8 Oct 1992
	Avenge 2 (3.3 l/ha)	5 Feb 1993
	Ally (7.5 g/ha)	16 Feb 1993
Insecticides:	None	
Growth regulator:	Chlormequat (1.25 l/ha)	16 Mar 1993
	Terpal (0.5 l/ha)	6 May 1993
Fungicides:	200 Plus (1 kg/ha)	14 Apr 1993 (surrounding crop)
	Punch C (0.5 l/ha)	6 May 1993
Harvested:	31 July 1993	

APPENDIX III

SITE DETAILS - WEST CORNWALL

Site:	Ventonarren Farm St Newlyn East Newquay Cornwall	*Field:*	Artillery Downs
		Grid ref:	SW 855 440
Soil type:	Medium loam	*Aspect:*	140 m asl Level field, exposed.
Previous cropping:	1992 S Oats 1991 W Barley 1990 W Barley	*Soil analysis:*	pH 5.9 (1 ton lime applied) P 0 K 1 Mg 2
Cultivations:	Ploughed and rolled Harrow x 2	*Drilled:*	9 October 1992
Variety:	Pastoral	*Seed treatment:*	"Dual purpose"
Seed rate:	157 kg/ha	*Row width:*	13 cm
Seed bed (kg/ha) fertiliser:	0:75:75	*Nitrogen topdressing:*	54 kg/ha 17 Feb 1993 88 kg/ha 2 Mar 1993 44 kg/ha 19 Apr 1993
Micronutrients:	None		
Herbicides:	Panther (1 l.ha) 13 Feb 1993 Optica (2 l/ha) 14 April 1993		
Insecticides:	Cypertox (0.25 l/ha) 13 Feb 1993		
Growth regulator:	None		
Fungicides: (surrounding crop)	Sportax Delta (1 l/ha) + Mistral (0.5 l/ha) 14 April 1993		
Harvested:	1 August 1993		

APPENDIX IV

COST BENEFIT - MARGIN OVER FUNGICIDE COSTS (£/ha)

Treatment	Dose	Shute, Devon *Pastoral*		Trerulefoot, East Cornwall *Halcyon*		St Newlyn East, West Cornwall *Pastoral*	
	(l.ha)	Value	Margin	Value	Margin	Value	Margin
Control	-	322		500		396	
Fenpropimorph	0.5	372	+30	564	+44	429	+13
Fenpropimorph	0.75	374	+37	558	+43	425	+14
Fenpropimorph	0.5	366	+34	565	+55	414	+8
Fenpropimorph	0.25	356	+29	529	+24	407	+6
Propiconazole	0.5	404	+48	587	+70	463	+50
Propiconazole	0.375	381	+46	584	+71	446	+37
Propiconazole	0.25	366	+35	554	+45	436	+31
Propiconazole	0.125	350	+24	538	+34	411	+11

Pastoral at £100/tonne propiconazole at £34/litre

Halcyon at £115/tonne fenpropimorph at £20/litre

APPENDIX V

DISEASE ASSESSMENTS - SHUTE, DEVON

GS37 3.5.93 - at spraying

Treatment	Dose	Mildew			Brown rust			Net blotch	
		L2	L3	L4	L2	L3	L4	L3	L4
Control		0.2	2.5	6.4	0.4	2.8	7.5	0.3	1.6
fenpropimorph	1.0	0.1	1.5	6.4	0.2	1.6	6.0	0.2	1.8
fenpropimorph	0.75	0.0	0.9	4.8	0.3	2.3	8.4	0.8	2.6
fenpropimorph	0.5	0.1	2.4	7.4	0.2	1.5	7.9	0.1	2.3
fenpropimorph	0.25	0.0	2.3	7.6	0.3	1.7	7.2	0.2	2.3
propiconazole	0.5	0.1	1.7	7.0	0.3	2.2	7.6	1.0	2.2
propiconazole	0.375	0.1	3.1	6.6	0.3	1.9	7.0	0.5	2.0
propiconazole	0.25	0.1	2.0	6.5	0.3	1.6	6.1	0.0	2.2
propiconazole	0.125	0.1	2.5	5.9	0.2	2.1	8.0	0.1	2.0
Mean		0.1	2.1	6.5	0.3	2.0	7.3	0.4	2.1
SE (var. mean)		0.070	0.335	1.092	0.102	0.557	1.275	0.218	0.257
LSD (var.mean) (P=0.05)		0.21	1.00	3.27	0.31	1.67	3.82	0.65	0.77
CV %		121.9	27.5	29.1	63.0	49.1	30.2	107.5	21.1

GS57 26.5.93 - spraying + 21 days

Treatment	Dose	Mildew			Brown rust			Net blotch		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
Control		0.8	21.0	32.1	8.1	23.0	31.0	0.3	1.7	0.9
fenpropimorph	1.0	0.0	0.2	1.5	2.0	7.3	17.0	0.1	1.0	1.1
fenpropimorph	0.75	0.0	0.0	0.7	1.3	6.7	15.4	0.2	0.6	2.1
fenpropimorph	0.5	0.0	0.2	1.9	3.5	14.2	26.8	0.2	1.9	3.0
fenpropimorph	0.25	0.0	1.6	8.3	3.8	12.5	23.7	0.2	0.8	1.2
propiconazole	0.5	0.0	3.2	15.2	1.4	7.6	15.2	0.0	0.1	0.2
propiconazole	0.375	0.0	6.5	18.8	2.1	9.8	21.0	0.0	0.2	0.6
propiconazole	0.25	0.4	8.1	20.1	3.0	11.8	22.4	0.0	0.1	0.6
propiconazole	0.125	0.2	12.8	26.8	4.3	14.3	23.3	0.0	0.3	0.5
Mean		0.2	6.0	13.9	3.3	11.9	21.8	0.1	0.8	1.1
SE (var. mean)		0.151	3.036	3.530	0.557	1.564	2.299	0.095	0.558	0.588
LSD (var.mean) (P=0.05)		0.45	9.10	10.58	1.67	4.69	6.89	0.28	1.67	1.76
CV %		160.7	88.3	43.9	29.4	22.7	18.3	138.7	127.9	90.1

GS71 6 June - spraying + 38 days

Treatment	Dose	Mildew		Brown rust			Net blotch	
		L1	L2	L1	L2	L3	L1	L2
Control		3.0	3.5	31.5	59.3	40.0	1.3	1.5
fenpropimorph	1.0	0.2	0.0	11.8	25.3	11.7	0.5	1.3
fenpropimorph	0.75	0.2	0.0	12.3	28.8	15.0	0.3	1.0
fenpropimorph	0.5	0.5	0.7	16.7	36.5	18.3	0.6	1.4
fenpropimorph	0.25	0.0	0.0	17.3	45.7	26.7	0.2	0.3
propiconazole	0.5	0.0	1.0	11.2	27.2	15.0	0.0	0.1
propiconazole	0.375	0.9	1.5	14.5	34.3	18.3	0.0	0.0
propiconazole	0.25	1.3	1.5	14.7	38.7	15.0	0.1	0.3
propiconazole	0.125	1.7	1.0	18.8	47.7	21.7	0.0	0.0
Mean		0.9	1.0	16.5	38.2	20.2	0.3	0.7
SE (var. mean)		0.627	1.116	1.414	2.787	2.349	0.206	0.407
LSD (var.mean) (P=0.05)		1.88	3.35	4.24	8.36	7.04	0.62	1.22
CV %		125.2	189.1	14.8	12.6	20.2	106.9	106.9

APPENDIX VI
DISEASE ASSESSMENTS - ST NEWLYN EAST, CORNWALL

GS37 29.4.93 - at spraying

Treatment	Dose	Brown rust		Rhynchos-porium	Net blotch	
		L3	L4	L4	L3	L4
Control		0.2	0.8	0.2	1.0	4.2
fenpropimorph	1.0	0.1	0.5	0.2	1.0	4.0
fenpropimorph	0.75	0.2	0.7	0.0	1.1	4.9
fenpropimorph	0.5	0.2	0.6	0.1	0.9	3.7
fenpropimorph	0.25	0.1	0.6	0.3	1.6	4.4
propiconazole	0.5	0.1	0.5	0.2	1.2	4.2
propiconazole	0.375	0.2	0.6	0.1	1.2	4.8
propiconazole	0.25	0.1	0.4	0.3	1.4	5.0
propiconazole	0.125	0.1	0.5	0.0	1.1	4.2
Mean		0.1	0.6	0.2	1.2	4.4
SE (var. mean)		0.071	0.090	0.140	0.191	0.409
LSD (var mean) (P=0.05)		0.21	0.27	0.42	0.57	1.23
CV %		85.6	26.9	152.0	28.5	16.2

GS55 21.5.93 - spraying + 21 days

Treatment	Dose	Brown Rust			Rhynchosporium			Net blotch		
		L1	L2	L3	L1	L2	L3	L1	L2	L3
Control		0.1	0.9	1.3	0.1	0.5	0.3	0.0	2.1	7.0
fenpropimorph	1.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	1.3	3.9
fenpropimorph	0.75	0.0	0.0	0.2	0.0	0.0	0.1	0.0	1.0	3.9
fenpropimorph	0.5	0.0	0.1	0.2	0.0	0.1	0.2	0.1	1.1	4.6
fenpropimorph	0.25	0.0	0.3	0.3	0.1	0.2	0.1	0.1	1.5	4.9
propiconazole	0.5	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.8	2.6
propiconazole	0.375	0.1	0.3	0.4	0.0	0.0	0.3	0.2	0.7	3.2
propiconazole	0.25	0.0	0.3	0.4	0.0	0.0	0.0	0.1	1.0	3.6
propiconazole	0.125	0.0	0.1	0.3	0.0	0.1	0.1	0.0	1.2	3.8
Mean		0.0	0.2	0.4	0.0	0.1	0.1	0.1	1.2	4.2
SE (var. mean)		0.029	0.146	0.167	0.032	0.090	0.106	0.072	0.126	0.631
LSD (var.mean) (P=0.05)		0.09	0.44	0.50	0.10	0.27	0.32	0.21	0.38	1.89
CV %		343.7	101.7	78.7	378.7	156.3	165.0	209.2	18.5	26.3

GS61 4.6.93 - spraying + 37 days

Treatment	Dose	Brown rust		Rhynchosporium		Net blotch		
		L2	L3	L2	L3	L1	L2	L3
Control		1.4	2.4	0.8	1.6	0.9	5.0	21.0
fenpropimorph	1.0	0.4	0.5	0.2	0.2	0.4	2.6	15.8
fenpropimorph	0.57	0.5	0.6	0.1	0.2	0.3	2.7	15.0
fenpropimorph	0.5	0.5	0.6	0.3	0.2	0.5	2.9	15.5
fenpropimorph	0.25	0.6	0.7	0.0	0.0	0.5	4.5	17.2
propiconazole	0.5	0.7	0.9	0.0	0.0	0.1	1.0	3.9
propiconazole	0.375	0.7	0.5	0.2	0.2	0.3	1.7	5.8
propiconazole	0.25	0.7	1.2	0.0	0.0	0.4	1.9	10.0
propiconazole	0.125	0.7	0.8	0.4	0.2	0.4	2.2	10.0
Mean		0.7	0.9	0.2	0.3	0.4	2.7	12.7
SE (var. mean)		0.150	0.271	0.110	0.148	0.157	0.388	1.457
LSD (var.mean) (P=0.05)		0.45	0.81	0.33	0.44	0.47	1.16	4.37
CV %		38.6	52.3	88.9	93.5	64.4	24.6	19.9