9.0 RESULTS

9.1 Powdery mildew

Significant epidemics of powdery mildew occurred in experiments 1 and 3.

Untreated severities varied between 2% on the resistant variety Hereward and 7% on the susceptible Genesis.

The fitted exponential dose-response curves, with common k values across varieties, provided a good description of the data (see R^2 values in Table 9.2), and a parameter values were all small (typically around 1%), suggesting that control was broadly proportional across the range of untreated severities tested.

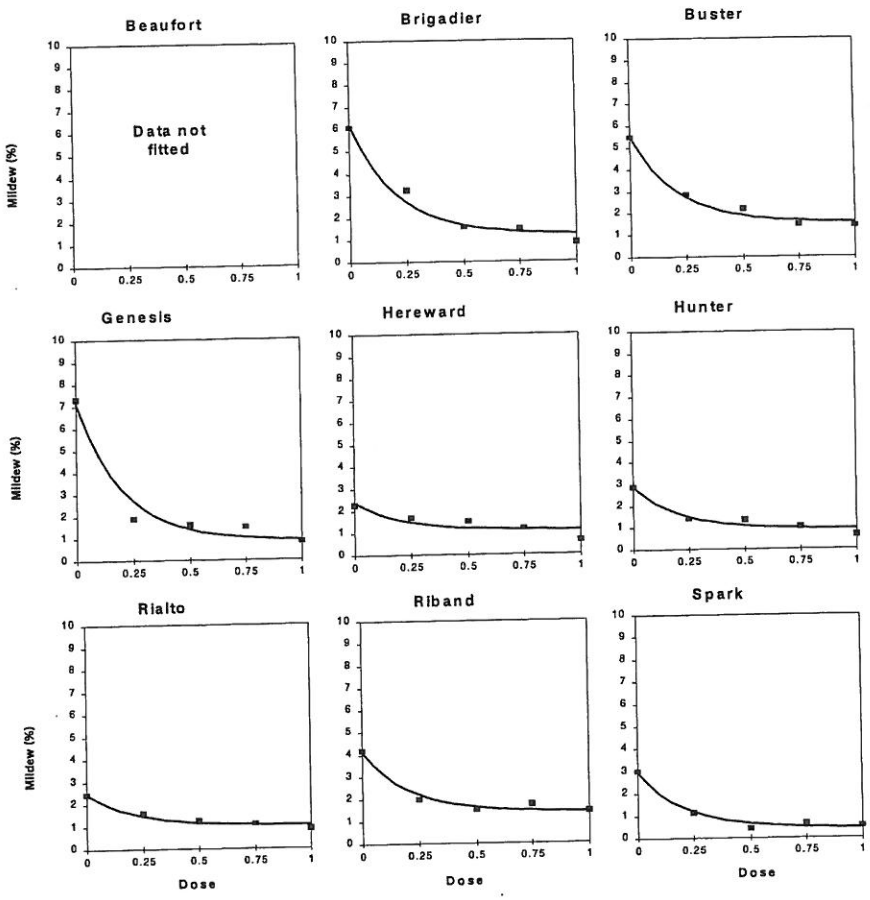
A quarter dose of the tebuconazole + fenpropidin mixture was required to suppress disease on Genesis to the level of untreated Hereward.

9.1.1 Disease control

Table 9.1 Parameter estimates for dose response curves - powdery mildew

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Beaufort	Data not fitted					
Brigadier	1.2	5.0	-4.85	6.2	1.3	94.3
Buster	1.5	4.0	-4.85	5.5	1.6	96.8
Genesis	0.9	6.3	-4.85	7.1	0.9	93.1
Hereward	1.1	1.3	-4.85	2.4	1.1	50.3
Hunter	0.9	2.0	-4.85	2.9	0.9	88.7
Rialto	1.0	1.5	-4.85	2.5	1.0	91.9
Riband	1.4	2.7	-4.85	4.1	1.4	94.2
Spark	0.4	2.5	-4.85	3.0	0.4	96.6

Figure 9.1 Dose-response curves for powdery mildew.



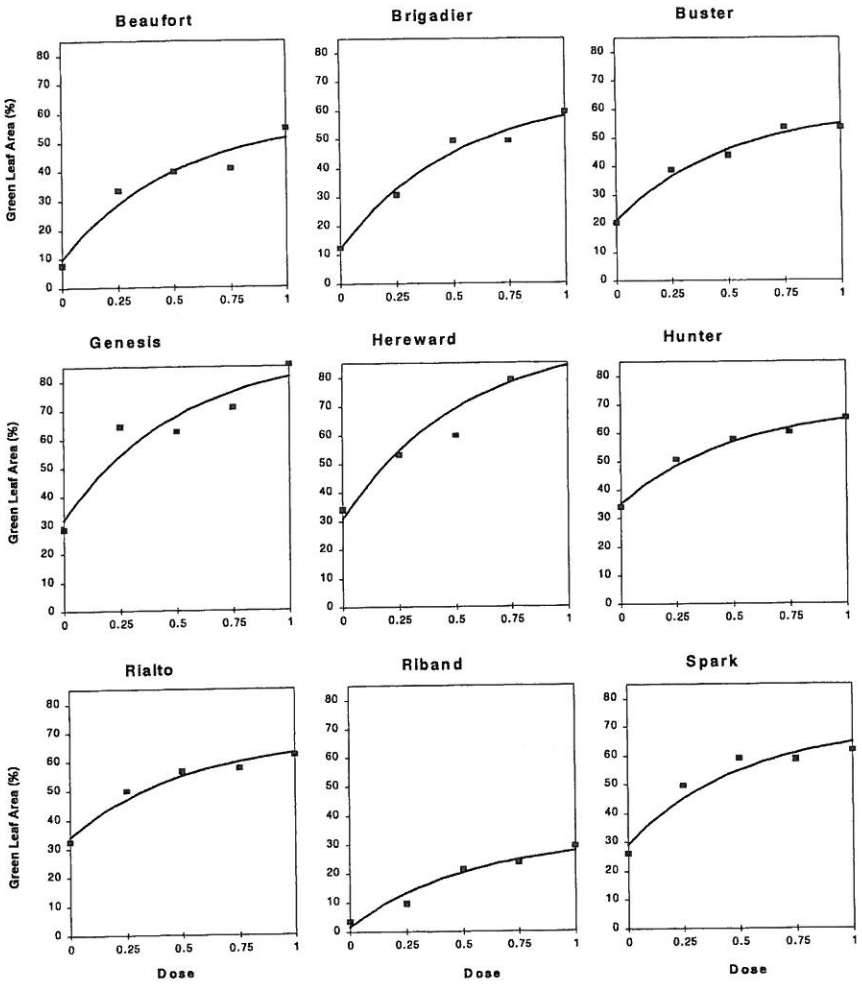
9.1.2 Green leaf area

Green leaf area responses to fungicide treatment were larger than could be accounted for by the control of powdery mildew, and were found to relate predominantly to the control of non-target diseases.

Table 9.2 Parameter estimates for green leaf area dose response curves.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Beaufort	58.4	-48.5	-1.95	9.9	51.4	87.2
Brigadier	65.5	-53.2	-1.95	12.3	57.9	94.4
Buster	60.6	-39.2	-1.95	21.4	55.0	95.8
Genesis	89.7	-57.7	-1.95	32.0	81.4	77.8
Hereward	92.7	-62.0	-1.95	30.6	83.8	84.5
Hunter	69.8	-34.5	-1.95	35.3	64.9	96.9
Rialto	67.5	-33.3	-1.95	34.2	62.8	93.3
Riband	31.8	-30.1	-1.95	1.8	27.6	90.3
Spark	70.5	-41.1	-1.95	29.3	64.6	86.1

Figure 9.2 Dose-response curves for green leaf area.



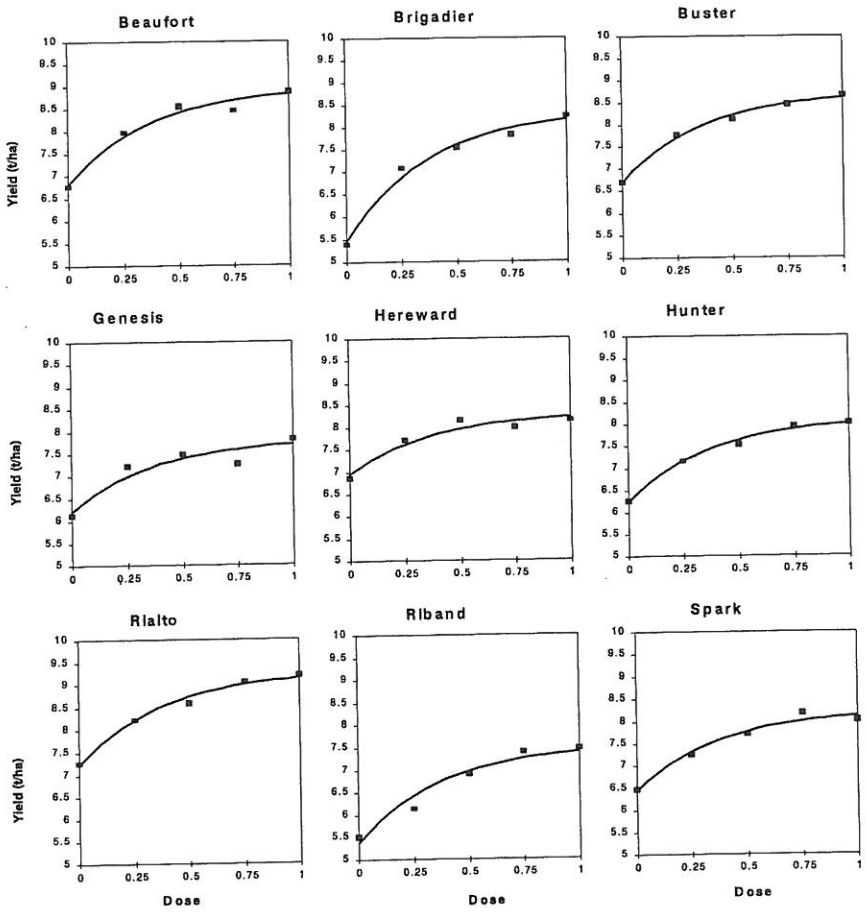
9.1.3 Grain yield

Grain yield related more to the retention of green leaf area than to the control of powdery mildew (Figure 9.3; Table 9.3).

Table 9.3 Parameter estimates for yield dose response curves.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Beaufort	9.0	-2.2	-2.67	6.8	8.8	93.6
Brigadier	8.4	-2.9	-2.67	5.5	8.2	97.0
Buster	8.7	-2.0	-2.67	6.7	8.6	98.8
Genesis	7.8	-1.6	-2.67	6.2	7.7	77.6
Hereward	8.3	-1.4	-2.67	7.0	8.2	86.2
Hunter	8.1	-1.9	-2.67	6.2	8.0	98.6
Rialto	9.3	-2.1	-2.67	7.2	9.1	97.7
Riband	7.5	-2.2	-2.67	5.4	7.4	90.1
Spark	8.2	-1.8	-2.67	6.5	8.1	94.3

Figure 9.3 Dose-response curves for grain yield.



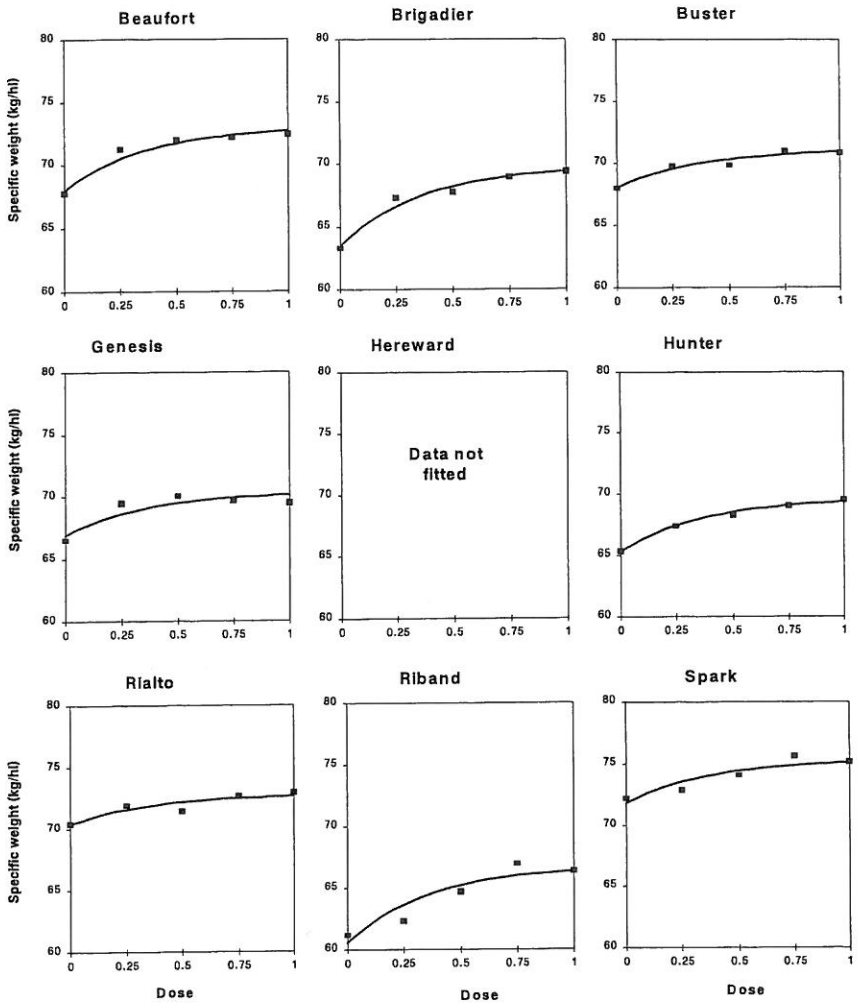
9.1.4 Grain quality

Specific weight responses to fungicide treatment were closely related to yield responses (Figure 9.4; Table 9.4).

Table 9.4 Parameter estimates for dose response curves - specific weight

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Beaufort	73.0	-5.0	-2.72	68.0	72.7	90.0
Brigadier	69.8	-6.3	-2.72	63.5	69.4	94.0
Buster	71.1	-3.1	-2.72	68.0	70.9	87.6
Genesis	70.3	-3.4	-2.72	66.9	70.1	57.3
Hereward	Data not fitted					
Hunter	69.6	-4.3	-2.72	65.3	69.3	98.8
Rialto	72.8	-2.4	-2.72	70.4	72.6	62.9
Riband	66.8	-6.2	-2.72	60.6	66.4	75.2
Spark	75.3	-3.5	-2.72	71.8	75.1	69.4

Figure 9.4 Dose-response curves for grain specific weight.



9.2 *S. nodorum* experiments

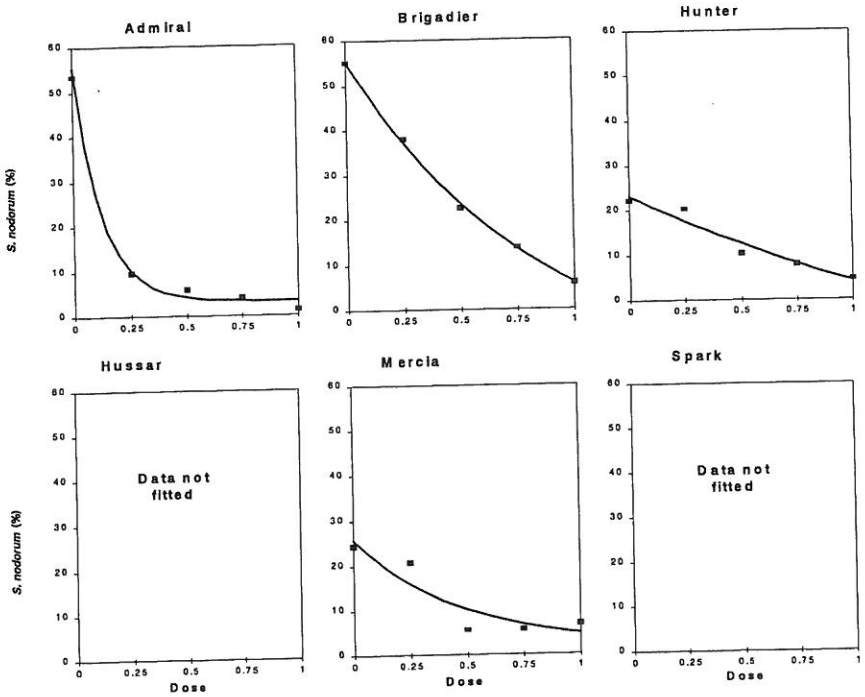
9.2.1 Disease control

The dose-response curves for *S. nodorum* in Figure 9.5 were derived from assessments of leaves 2 and 3 in 1997 at GS 69 (34 days after treatment). Admiral and Brigadier were the most susceptible varieties to *S. nodorum* and Spark was the most resistant. Mercia Hunter and Hussar were intermediate, although Hussar proved to be susceptible to *S. tritici.* Half dose Folicur was sufficient to control *S. nodorum* on Admiral but not on Brigadier where a full dose was required. Lowest levels of *S. nodorum* were recorded on Hussar and Spark, and data from these varieties could not be represented by fitted dose-response curves.

Table 9.5 Parameter estimates for fitted dose-response curves - foliar *S. nodorum* severity.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Admiral	3.2	52.1	-8.07	55.3	3.2	99.2
Brigadier	-16.6	71.9	-1.16	55.3	5.9	99.8
Hunter	-27.7	50.9	-0.47	23.2	4.1	89.8
Hussar	Data not fitted					
Mercia	1.9	23.8	-2.13	25.7	4.7	68.8
Spark	Data not fitted					

Figure 9.5 Dose-response curves for foliar *S. nodorum* severity.



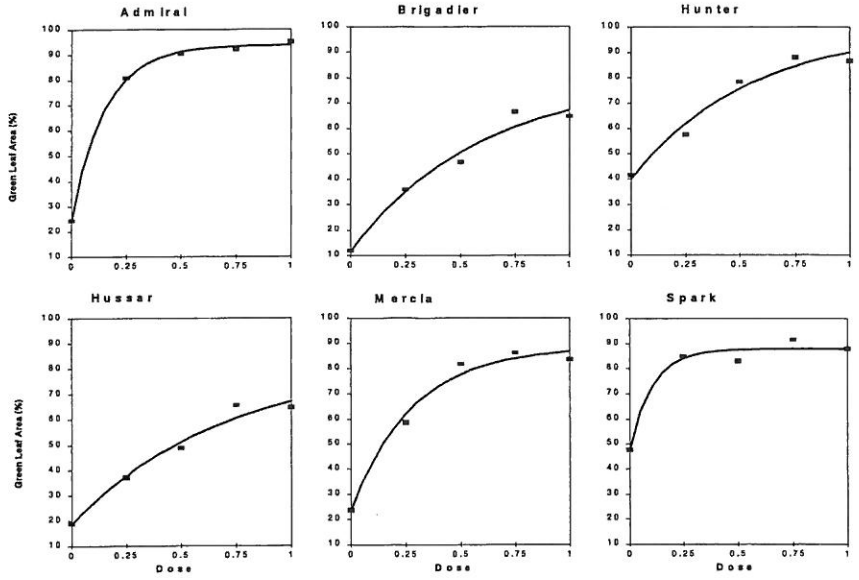
9.2.2 Green leaf area

The dose-response curves for green leaf area, based on an average green leaf area of leaves 2 and 3 at GS 69 in 1997, (Figure 9.6) show high levels of green leaf area in Admiral when at least half dose Folicur was applied, but in Brigadier, even at full dose, green leaf area was not particularly high, although *S. nodorum* had been well controlled. This is due to Brigadier being susceptible to *S. tritici* which was less well controlled by the application of Folicur. Similar differences are seen between the curves for Hussar and Spark - both varieties had low levels of *S. nodorum*, but high levels of *S. tritici* on Hussar reduced its green leaf area.

Table 9.6 Parameter estimates for fitted dose-response curves - green leaf area.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Admiral	93.8	-69.6	-6.55	24.2	93.7	99.8
Brigadier	79.7	-68.0	-1.69	11.7	67.2	94.2
Hunter	99.7	-59.7	-1.82	40.0	90.0	93.7
Hussar	82.2	-63.8	-1.44	18.4	67.1	95.5
Mercia	88.4	-64.9	-3.60	23.4	86.6	97.0
Spark	87.9	-40.2	-9.49	47.7	87.9	95.0

Figure 9.6 Dose-response curves for green leaf area.



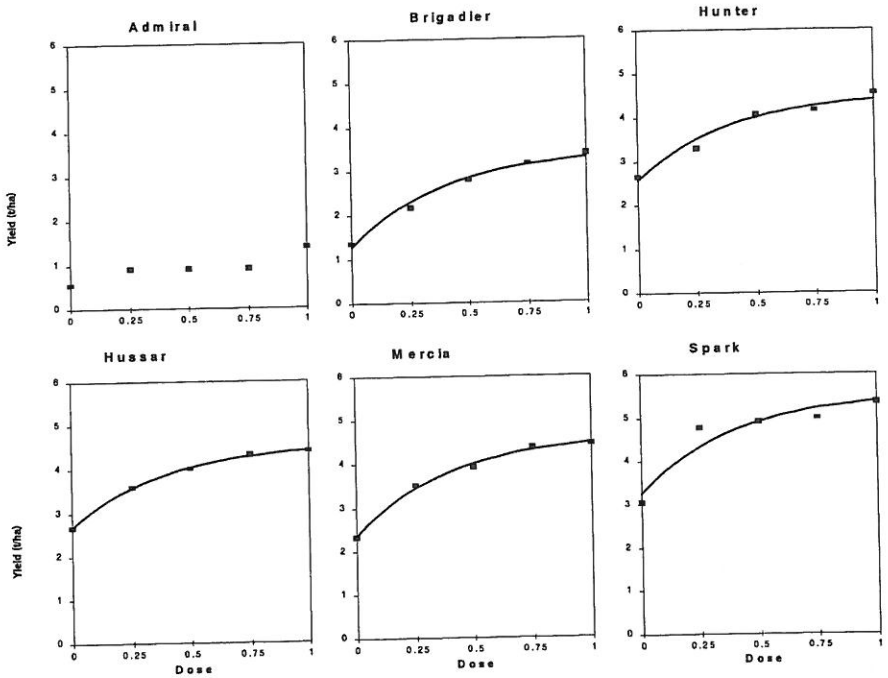
9.2.3 Grain yield

Yields of all varieties were low, particularly Admiral and Brigadier. Single doses of fungicide in 1996 and 1997 could not cope with the disease epidemics, and even the two-spray treatments in 1998 struggled to control the severe epidemics of *S. nodorum, S. tritici* and *Fusarium* ear blight. The data in Table 9.7 and Figure 9.7 are from the experiment in 1997. The data for Admiral could not be fitted, but this variety was severely affected by glume blotch, which the fungicide applied at GS 39 did not control and this phase of the *S. nodorum* epidemic was largely responsible for reducing the yield of Admiral to less than 1 tonne/ha. The shape of the dose-response curves for each of the other varieties was remarkably similar and yield increased in each case up to a full dose of fungicide, although the increment from three-quarter dose to full dose was small. Fitted yield increases from full dose fungicide ($(a+be^k)$-(a+b)) ranged from 151% for Brigadier to 63% for Hussar and 69% for the most resistant variety, Spark.

Table 9.7 Parameter estimates for fitted dose-response curves - grain yield.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Admiral	Data not fitted					
Brigadier	3.5	-2.2	-2.57	1.3	3.3	97.1
Hunter	4.5	-2.0	-2.57	2.5	4.4	92.2
Hussar	4.6	-1.9	-2.57	2.7	4.4	99.5
Mercia	4.6	-2.3	-2.57	2.3	4.5	98.9
Spark	5.5	-2.3	-2.57	3.2	5.4	83.0

Figure 9.7 Dose-response curves for grain yield.



9.2.4 Glume blotch on the ear

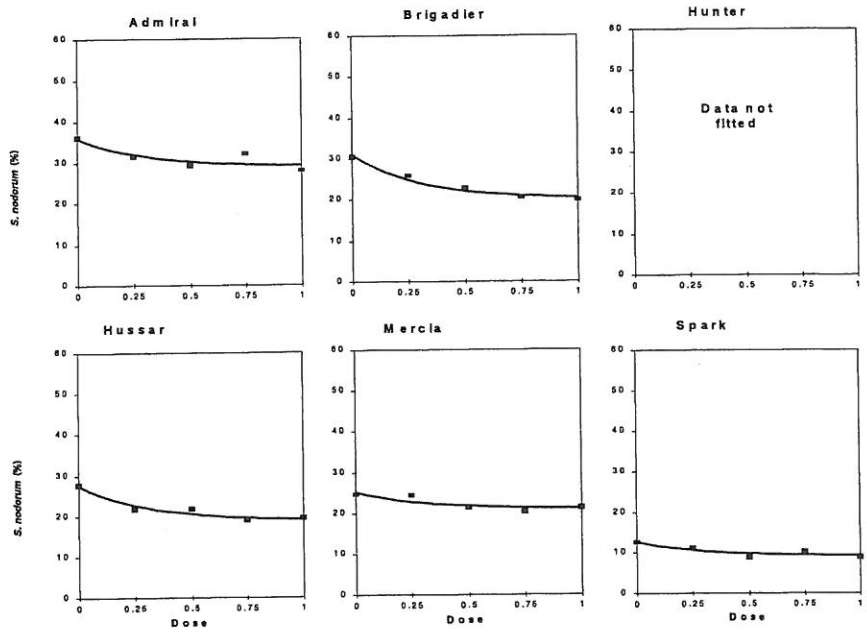
Glume blotch developed in each of the three years of the experiment. In 1996 and 1997, it was most severe on Admiral and Brigadier, but in 1998, highest levels of the disease were recorded on Hussar and Mercia. Substantial infection of *Fusarium* ear blight also occurred in 1998, and this may have been responsible for this apparent shift in susceptibility. If Admiral and Brigadier were more susceptible to ear blight, the *Fusarium* symptoms could mask glume blotch. Over the three years, Admiral proved to be most susceptible to glume blotch, followed by Brigadier, Hussar, Mercia and Spark. Data for Hunter could not be fitted, but that variety was generally as susceptible as Hussar. The data shown in Figure 9.8 and Table 9.8 are cross-season means from all three years, as it was considered unlikely that the early dose in 1998 would have materially affected glume blotch severity. Dose-response curves were

fairly shallow for all varieties, but this is not surprising in view of the fact that fungicide was not applied to ears except in 1998.

Table 9.8 Parameter estimates for fitted dose-response curves - glume blotch severity.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Admiral	28.9	6.9	-3.303	35.8	29.1	51.0
Brigadier	20.0	11.2	-3.303	31.2	20.4	94.3
Hunter	Data not fitted					
Hussar	18.9	8.7	-3.303	27.6	19.2	86.4
Mercia	21.0	4.2	-3.303	25.2	21.1	52.1
Spark	9.1	3.6	-3.303	12.7	9.2	63.1

Figure 9.8 Dose-response curves for glume blotch severity on the ear



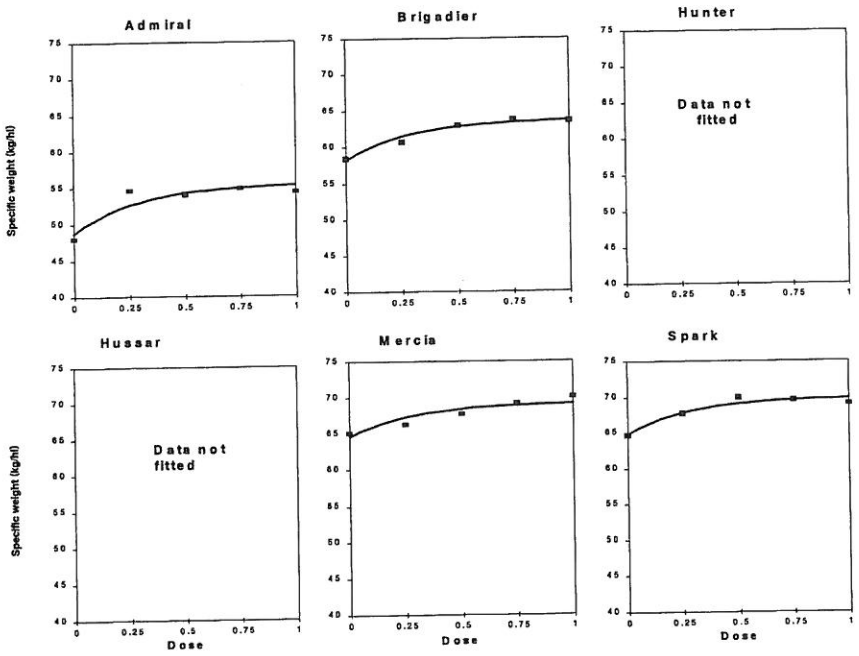
9.2.5 Grain quality

The data shown in Figure 9.9 and Table 9.9 are from 1997 only, to allow direct comparison with the foliar disease, green leaf area and grain yield data. The dose-response curves for specific weight of grain generally reflected those for yield and were again of similar shape for each variety (although the data for Hussar and Hunter could not be fitted). The specific weights for Admiral were considerably lower than those for other varieties, even Brigadier and reflect the severity of glume blotch on Admiral.

Table 9.9 Parameter estimates for fitted dose-response curves - specific weight.

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Admiral	55.5	-6.7	-3.43	48.8	55.2	68.2
Brigadier	63.8	-5.6	-3.43	58.2	63.6	92.8
Hunter	Data not fitted					
Hussar	Data not fitted					
Mercia	69.2	-4.6	-3.43	64.6	69.1	65.8
Spark	69.9	-5.1	-3.43	64.8	69.8	82.1

Figure 9.9 Dose-response curves for grain specific weight.



9.3 Brown rust experiments

9.3.1 Disease control

A significant epidemic of brown rust occurred in experiment 4.

A statistically significant interaction was detected between the eradicant/protectant category of the assessment data and variety, suggesting that eradicant and protectant data should be interpreted separately. In practical terms, however, the differences in interpretation between the two categories are minor.

Considering the protectant data first. The level of disease resistance in Hunter and Abbot, and to a lesser extent Rialto, reduced untreated disease to such low levels that dose-response curves could not be fitted.

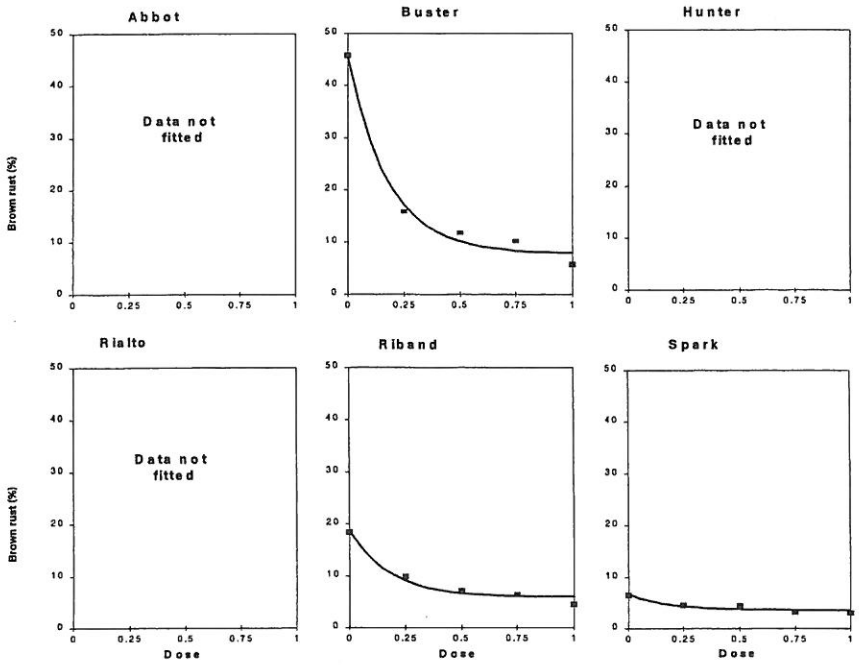
Substantial differences were obtained in the severity of symptoms on the other varieties, under severe disease pressure, with Buster, Riband and Spark having untreated severities of 45%, 18% and 6% respectively (Figure 9.10; Table 9.10). The a parameters for these varieties were within a relatively narrow range of low values and a constant k fitted all the varieties well, despite the differences in resistance. - indicating that proportional control was similar on all varieties.

The partial resistance of Spark was equivalent to a full dose treatment of a tebuconazole + fenpropidin mixture on Buster and the resistance of Abbot, Hunter and Rialto was more effective still.

Table 9.10 Parameter estimates for protectant dose response curves - brown rust

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Abbot	Data not fitted					
Buster	7.7	37.9	-5.55	45.6	7.9	97.7
Hunter	Data not fitted					
Rialto	Data not fitted					
Riband	5.9	12.8	-5.55	18.6	5.9	95.1
Spark	3.6	3.1	-5.55	6.6	3.6	71.1

Figure 9.10 Protectant dose-response curves for brown rust.



Considering the eradicant data; response curves were fitted to all varieties except Abbot, where major gene resistance excluded disease completely. Untreated

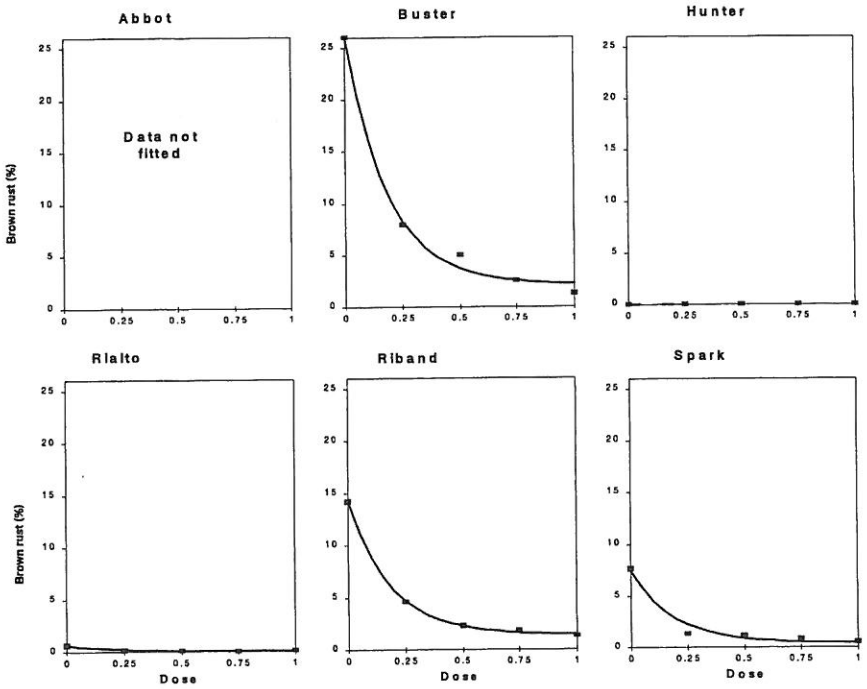
severities of 26%, 14%, 7%, 0.6% and <0.1% were recorded on Buster, Riband, Spark, Rialto and Hunter respectively (Figure 9.11; Table 9.11).

Low levels of disease were achievable on successively more resistant varieties with successively lower doses.

Table 9.11 Parameter estimates for eradicant dose response curves - brown rust

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Abbot	Data not fitted					
Buster	2.1	23.9	-5.40	26.0	2.2	98.7
Hunter	0.0	0.0	-5.40	0.0	0.0	84.1
Rialto	0.0	0.6	-5.40	0.6	0.0	92.4
Riband	1.4	12.9	-5.40	14.3	1.4	99.9
Spark	0.4	7.0	-5.40	7.4	0.4	93.7

Figure 9.11 Eradicant dose-response curves for brown rust.



9.3.2 Green leaf area

Green leaf area retention in response to fungicide treatment was largely a result of brown rust control, with a small additional effect from control of non-target diseases - most clearly seen on Abbot (Figures 9.12/13; Tables 9.12/13.

Table 9.12 Parameter estimates for green leaf area dose response curves - protectant assessments

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Abbot	Data not fitted					
Buster	77.5	-44.1	-3.03	33.5	75.4	86.4
Hunter	Data not fitted					
Rialto	77.5	-6.6	-3.03	70.9	77.2	67.9
Riband	77.5	-29.8	-3.03	47.7	76.1	83.0
Spark	Data not fitted					

Figure 9.12 Dose-response curves for green leaf area - protectant assessments.

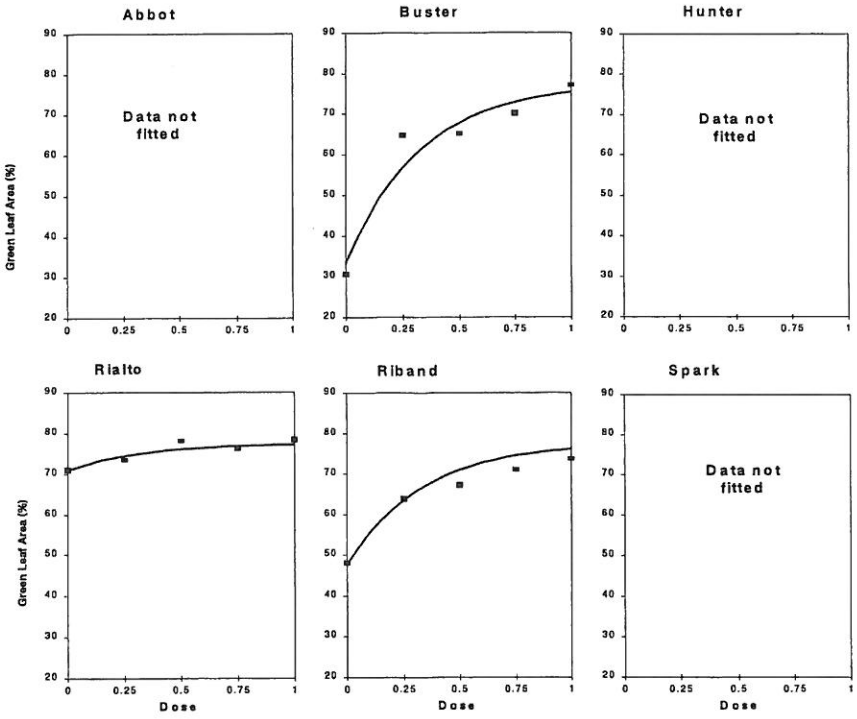
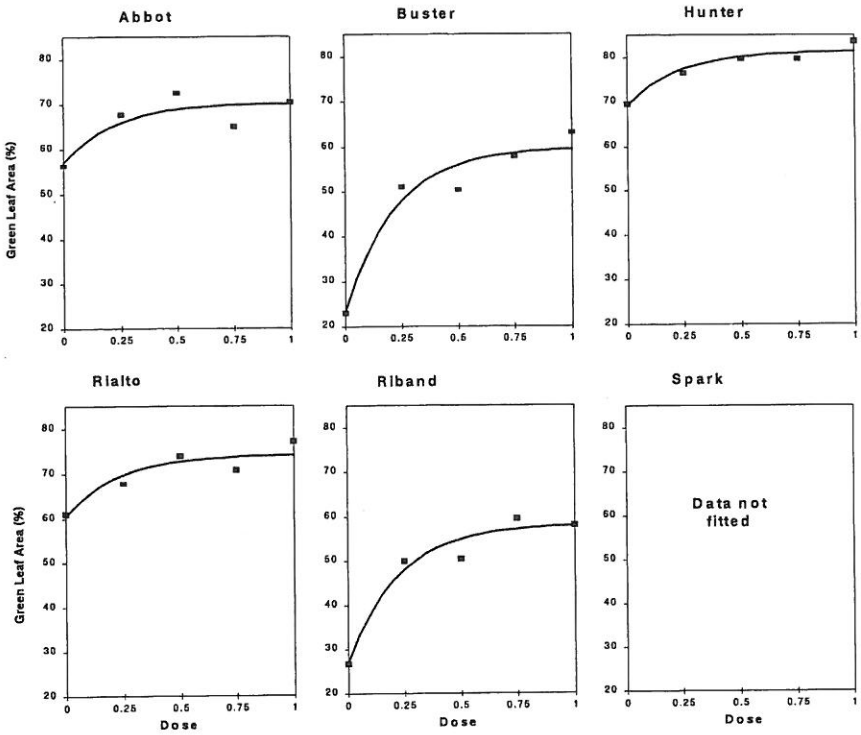


Table 9.13 Parameter estimates for green leaf area dose response curves - eradicant assessments

Variety	Parameter estimates					
	a	b	k	a + b	$a+be^k$	Mean R^2 adjusted
Abbot	70.3	-13.3	-4.47	57	70.1	50.7
Buster	59.9	-36.5	-4.47	23.4	59.5	88.8
Hunter	81.4	-12.3	-4.47	69.2	81.3	83.4
Rialto	74.1	-13.6	-4.47	60.5	74.0	67.9
Riband	58.3	-31.2	-4.47	27.1	57.9	91.7
Spark	Data not fitted					

Figure 9.13 Dose-response curves for green leaf area - eradicant assessments.



9.3.3 Yield and grain quality

Site variability precluded analysis of yield and grain quality data.