5.0 RESULTS

5.1 Powdery mildew experiments

5.1.1 Disease control

Dose-response curves describing the activity of fungicides against powdery mildew, derived from over-assessment means, are shown in Figure 5.1. The parameter estimates given in Table 5.1 describe the curves quantitatively. The R^2 values suggest that the exponential dose-response function provided a good description of the data. Exceptions to this were cases where the level of control did not differ across the range of doses between quarter and full.

The data shown represent a range of situations, from treatments which were applied shortly after infections had become established, to those applied to well established infections at the limit of eradicant activity. These provide a strong test of product activity, that is representative of the activity that might be expected in commercial use, where spray timing is often compromised by adverse weather.

None of the products offered outstanding control, underlining the need for early treatment, usually as part of a spray programme, to ensure adequate control on the upper leaves. However, the strong experimental test reported here, achieved the desired effect of identifying differences between the active ingredients.

The very high levels of activity seen from the morpholine fungicides (e.g. Corbel and Patrol) when they were first released, appears to have been eroded. The newer triazole materials (e.g. Alto, Folicur and Opus) are now giving equivalent levels of control.

The novel active ingredients in Unix, Neon and the strobilurin/morpholine mixture Ensign, gave good control. The relatively poor performance of Fortress may reflect the eradicant nature of the data set. Data from associated projects suggest that the protectant effect of this active ingredient can be good and long lasting, when it is applied early in the expansion of the upper canopy.

Table 5.1 Cross-site parameter estimates for fitted dose response curves - mildew area, eradicant.

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Alto	2.2	4.4	-2.74	6.51	2.4	99.4
Opus	2.5	4.0	-1.36	6.51	3.5	95.7
Corbel	3.8	2.7	<-20.00	6.51	3.8	-50.0
Folicur	2.6	3.9	-5.12	6.51	2.6	63.8
Patrol	1.6	4.9	-2.61	6.51	2.0	95.9
Unix	2.2	4.3	-4.93	6.51	2.3	49.3
Amistar	3.8	2.7	-3.83	6.51	3.8	-4.1
Ensign	1.8	4.7	-11.71	6.51	1.8	52.8
Fortress	4.1	2.5	<-20.00	6.51	4.0	-50.0
Opus team	2.8	3.7	-3.86	6.51	2.9	94.6
Amistar+Corbel	2.5	4.0	-3.1	6.51	2.6	46.5
Neon	2.0	4.5	<-20.00	6.51	2.0	-50.0
Sanction	-0.6	7.2	-0.58	6.51	3.4	47.7
Tilt	4.7	1.8	-3.66	6.51	4.8	17.3

5.1.2 Green leaf area

The green leaf area dose-response curves shown in Figure 5.2 (parameter estimates in Table 5.2) were generally mirror images of the disease dose-responses. There was no evidence that higher doses were required to increase green leaf area, than were required to obtain adequate disease control.

Some of the increase in green area arose from the control of low levels of non-target diseases. So those products with broad spectrum activity, such as Opus, showed greater green leaf area benefits than those with only specific powdery mildew activity.

Table 5.2 Cross site parameter estimates for fitted dose response curves - green leaf area, eradicant.

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Alto	76.1	-23.0	-2.22	53.03	73.6	96.4
Opus	78.6	-25.6	-3.13	53.03	77.5	67.5
Corbel	54.4	-1.3	-17.83	53.03	54.4	-50.0
Folicur	32.1	21.0	0.95	53.03	86.5	99.9
Patrol	68.6	-15.6	-0.84	53.03	62.5	47.3
Unix	72.5	-19.5	-1.87	53.03	69.5	72.5
Amistar	65.9	-12.9	-10.09	53.03	66.0	-45.7
Ensign	68.2	-15.2	-5.3	53.03	68.2	-2.5
Fortress	Data not fitted					
Opus team	75.5	-22.5	-2.18	53.03	73.0	98.5
Amistar+Corbel	75.3	-22.3	-1.66	53.03	71.1	83.0
Neon	-2172.8	2225.9	0.01	53.03	71.4	66.8
Sanction	63.0	-9.9	-5.68	53.03	62.9	-28.8
Tilt	57.2	-4.2	<-20.00	53.03	57.2	-50.0

5.1.3 Grain yield

Grain yield data (Figure 5.3; Table 5.3) reflect a combination of eradicant and protectant activity on different leaf layers within the crop canopy. Full yield potential for a disease susceptible and responsive variety such as Buster, is unlikely to have been realised with a single spray application. Nevertheless, full dose treatments gave fitted yields up to 8.1 tonnes per hectare.

Overall, the yield data reflect the finding that powdery mildew is less injurious to yield that either the rusts or septoria diseases. Given the modest severity of mildew, the yield responses favoured broad-spectrum products, such as Opus, that were better able to control low levels of more deleterious diseases. For those product which gave the larger yield increases, estimates of the a parameter were close to or the same as (subject to rounding), estimates for $a+be^k$, suggesting that the yield had plateaued by the full dose, and was approaching he plateau by three-quarters of a dose (Table 5.3). However, there was some evidence that the yield dose-responses for the strobilurin treatments (e.g. Amistar and Ensign) were still on an upward trend for yield at the full dose, despite their disease dose-responses plateauing at a lower dose.

Table 5.3 Cross-site parameter estimates for fitted dose response curves - yield, combined eradicant/protectant.

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Alto	7.4	-2.1	-3.71	5.31	7.4	94.5
Opus	8.0	-2.7	-4.32	5.31	8.0	80.8
Corbel	6.0	-0.7	-2.61	5.31	6.0	83.3
Folicur	7.5	-2.2	-3.35	5.31	7.4	75.1
Patrol	6.5	-1.2	-1.77	5.31	6.3	95.2
Unix	5.3	0.04	2.83	5.31	5.9	86.2
Amistar	8.3	-3.0	-1.76	5.31	7.8	98.8
Ensign	8.0	-2.7	-2.41	5.31	7.8	85.0
Fortress	4.7	0.6	0.18	5.31	5.4	24.8
Opus team	8.2	-2.8	-4.19	5.31	8.1	78.2
Amistar+Corbel	8.5	-3.2	-1.77	5.31	8.0	95.4
Neon	6.6	-1.3	-3.40	5.31	6.6	81.2
Sanction	7.6	-2.3	-1.39	5.31	7.0	99.1
Tilt	7.3	-2.0	-1.91	5.31	7.0	91.2

5.1.4 Grain quality

Dose-response curves for specific weight (Figure 5.4; Table 5.4) mirrored grain yield, with those treatments and doses most effective at improving yield, giving most benefit to grain quality. The majority of the yield increase from treatment was explained by increases in grain weight.

Table 5.4 Cross site parameter estimates for fitted dose response curves - specific weight, combined eradicant/protectant.

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Alto	71.3	-4.5	-5.31	66.8	71.3	90.4
Opus	72.5	-5.7	-5.25	66.8	72.4	65.3
Corbel	86.8	-20.0	-0.13	66.8	69.2	87.1
Folicur	71.6	-4.8	-4.24	66.8	71.6	42.6
Patrol	71.9	-5.1	-0.83	66.8	69.7	97.3
Unix	66.8	0	22.92	66.8	67.9	69.9
Amistar	73.7	-6.9	-1.77	66.8	72.5	94.4
Ensign	72.7	-5.9	-1.73	66.8	71.6	97.6
Fortress	66.8	0.01	3.65	66.8	67.2	-12.8
Opus team	73.1	-6.3	-3.59	66.8	72.9	58.2
Amistar+Corbel	73.5	-6.7	-1.55	66.8	72.1	93.1
Neon	69.6	-2.8	-2.20	66.8	69.3	97.6
Sanction	75.6	-5.8	-1.43	66.8	71.2	99.0
Tilt	73.1	-6.3	-1.11	66.8	71.0	93.2

Figure 5.1 Dose-response curves for powdery mildew - overall means.

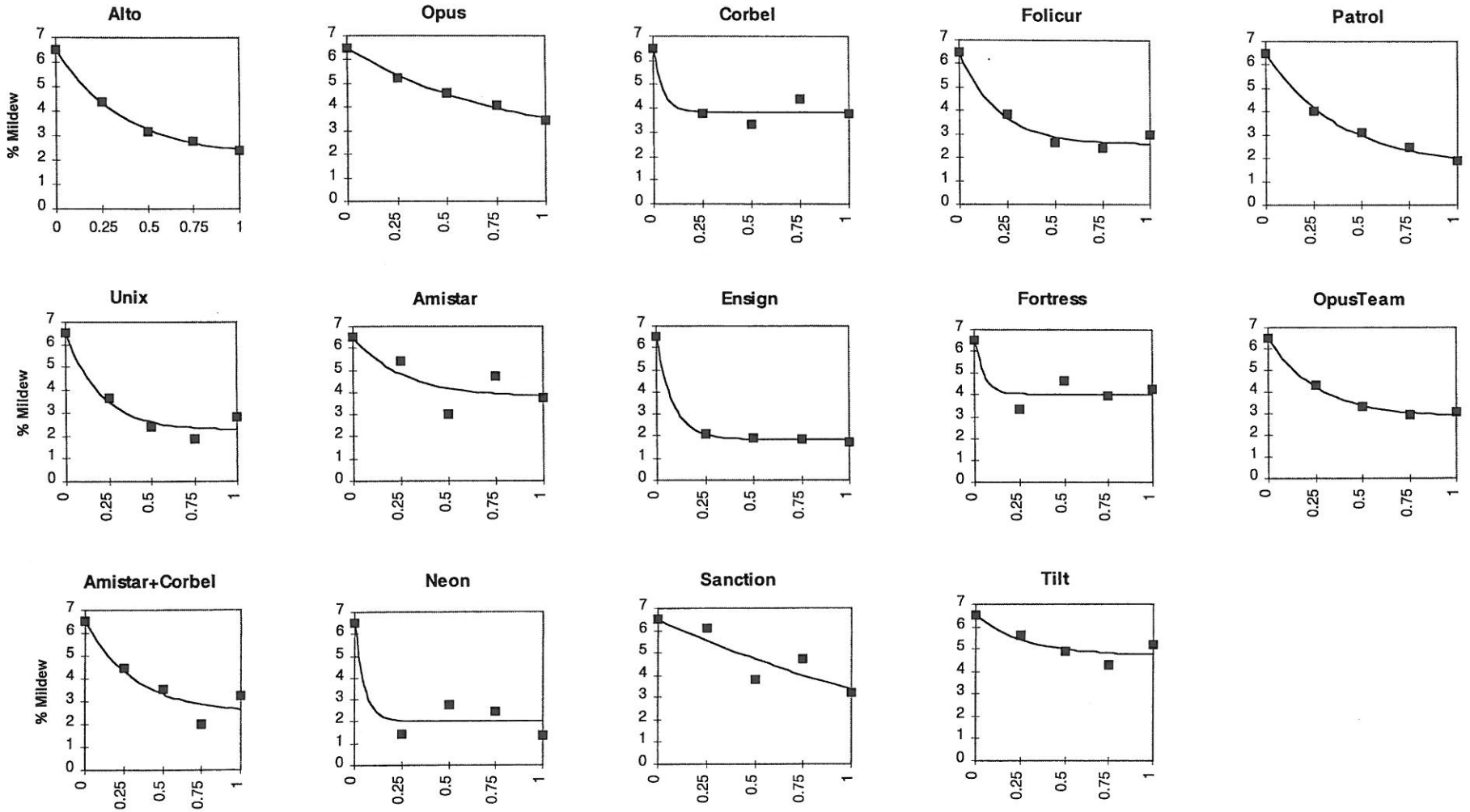


Figure 5.2 Dose-response curves for green leaf area in powdery mildew experiments - overall means

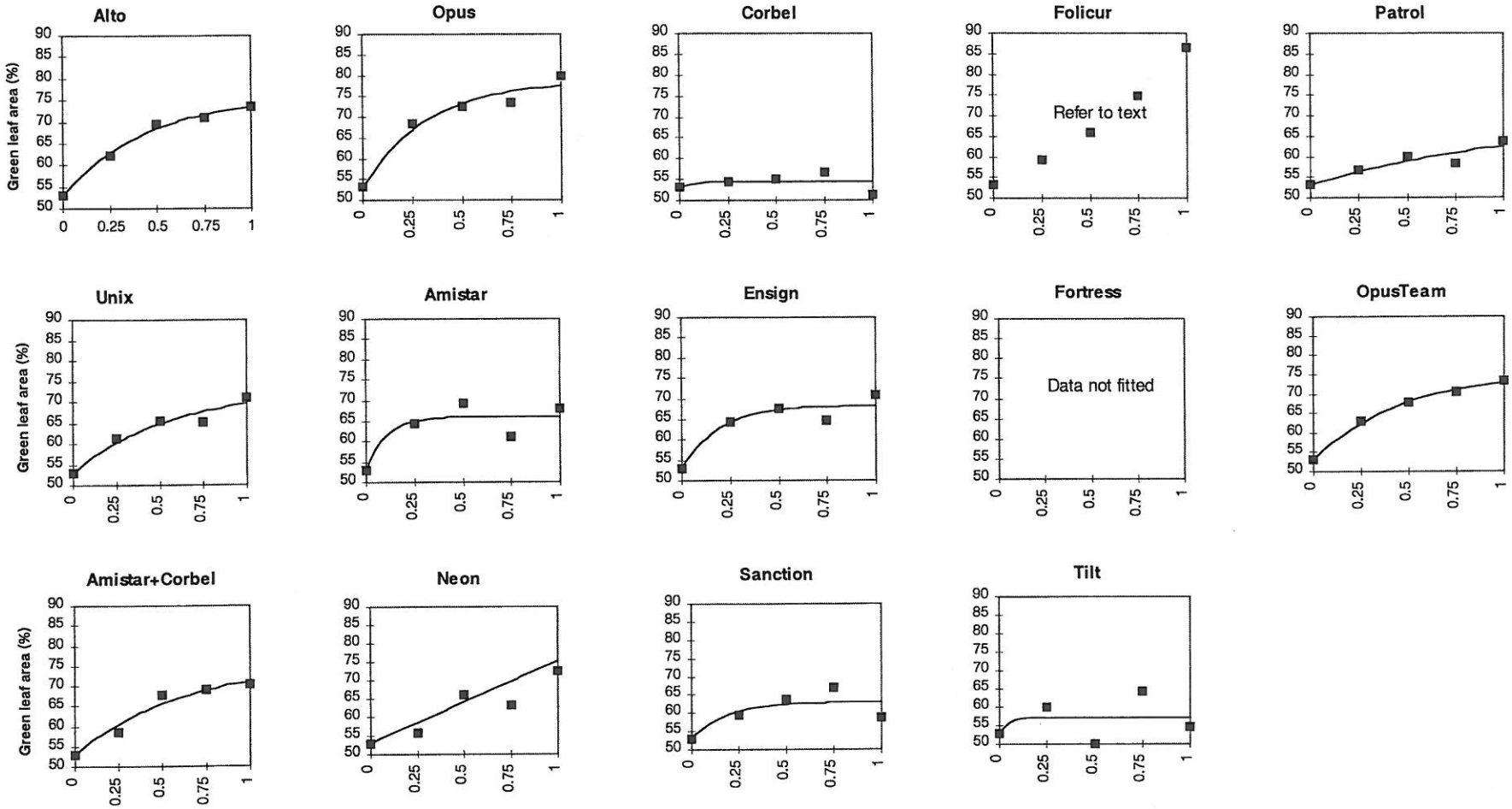


Figure 5.3 Dose-response curves for grain yield in powdery mildew experiments - overall means

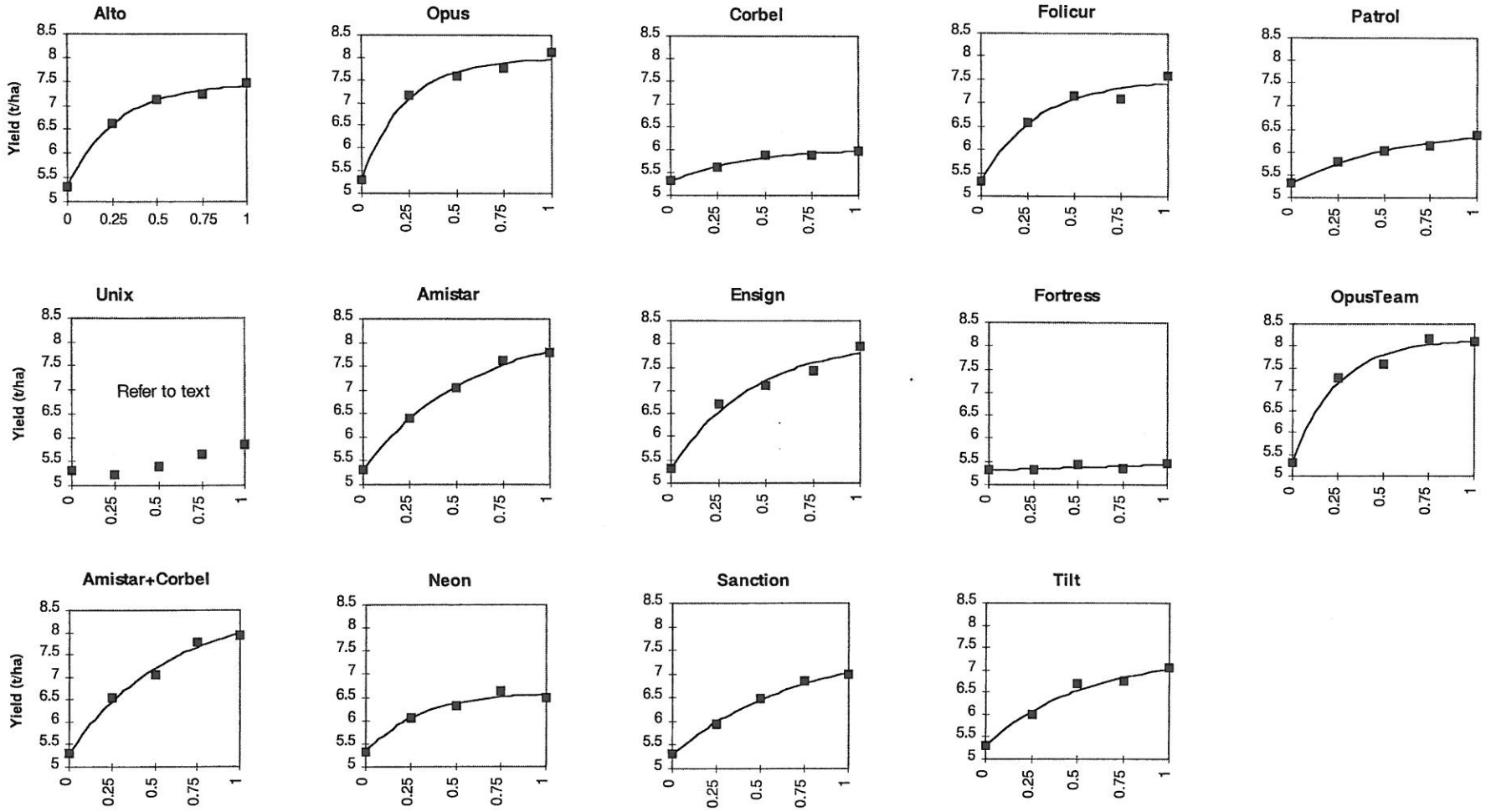
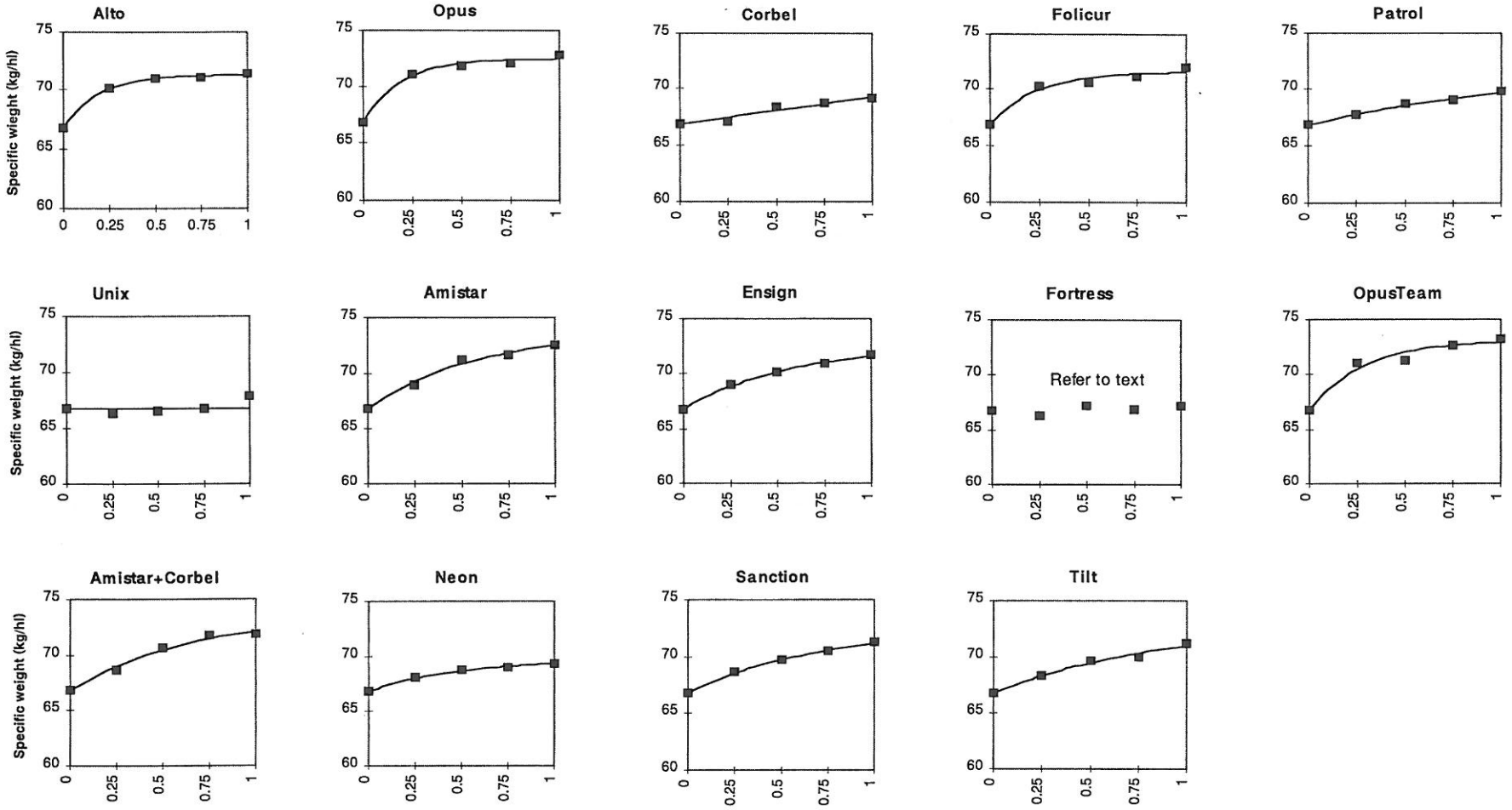


Figure 5.4 Dose-response curves for specific grain weight in powdery mildew experiments - overall means



5.2 *S. nodorum* experiments

5.2.1 Disease control

Severe epidemics of *S. nodorum* were encountered in each of the three years. However, it proved difficult to obtain data on *S. nodorum* alone, as *S. tritici* also developed, and pycnidia of both fungi were often found occurring together within a single lesion. Occasionally, as in 1997 when a dry April delayed the development of *S. tritici*, it was possible to differentiate between the two pathogens at the earlier disease assessment.

The curves in Figure 5.5 are means for leaves 1 and 2 assessed at GS 69 (34 days after treatment) and reflect both curative and protectant activity of the fungicides. The least effective fungicides were Bravo and Ensign, both lacking eradicant activity. Amistar was slightly more effective, but again lacked good eradicant activity. The most effective fungicides were those containing epoxiconazole or metconazole (Opus and Caramba). The additional strobilurin in Landmark did not improve disease control. Unix also showed good activity against *S. nodorum* and its high negative k value (Table 5.5) indicates good activity at a low dose, although it must be noted that the full dose used in this experiment was the maximum recommended dose, 1.0 kg/ha. The positive k value for Sanction indicates that the dose-response curve did not fit the normal pattern.

Table 5.5 Parameter estimates for fitted dose response curves - *S. nodorum* (leaf)

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Opus	-3.1	20.3	-1.8	17.19	0.3	88.0
Bravo	0.5	16.7	-1.3	17.19	5.2	99.2
Folicur	2.5	14.6	-6.0	17.19	2.6	-14.9
Sanction	18.0	-0.8	2.7	17.19	5.4	19.9
Unix	1.9	15.2	-8.9	17.19	1.9	30.3
Amistar	4.8	12.4	-2.3	17.19	6.0	-20.6
Ensign	1.6	15.6	-0.9	17.19	8.1	60.4
Caramba	0.6	16.6	-3.7	17.19	1.1	97.0
Landmark	0.9	16.3	-3.0	17.19	1.7	88.0

5.2.2 Green leaf area

The green leaf area curves in Figure 5.6, taken from the same assessments as the disease severity data shown above, generally reflect disease control. Opus, Caramba and Landmark gave the greatest green leaf area as assessed at GS 69. There was some benefit from the strobilurin in Landmark at lower doses, but at full dose, Opus alone was equally effective. Bravo gave a relatively high green leaf area at full dose due to its ability to control *S. tritici*. Unix and Ensign, on the other hand, were less effective

in maintaining green leaf area due to their lack of activity against *S. tritici*. Again, the data for Sanction could not be fitted with a logical dose-response curve.

Table 5.6 Parameter estimates for fitted dose response curves - Green leaf area for *S. nodorum*

Product	Parameter estimates					
	a	b	k	a + b	$a + be^k$	Mean R^2 adjusted
Opus	96.9	-31.7	-3.4	65.19	95.8	69.0
Bravo	94.5	-30.0	-2.0	65.19	90.3	99.7
Folicur	92.3	-27.1	-6.3	65.19	92.2	14.8
Sanction	33.1	32.1	0.4	65.19	82.9	-7.2
Unix	87.4	-22.2	-6.9	65.19	87.4	54.3
Amistar	90.0	-24.8	-2.5	65.19	87.9	74.3
Ensign	84.8	-19.6	-3.5	65.19	84.2	62.3
Caramba	96.4	-31.2	-3.2	65.19	95.2	83.8
Landmark	94.3	-29.1	-4.8	65.19	94.0	93.0

5.2.3 Glume blotch on the ear

Glume blotch occurred in each of the three years of the experiment, but fungicides only controlled the disease in 1996 and 1998. In 1997, heavy rainfall after ear emergence was sufficient to transport *S. nodorum* spores from lower leaves to ears, which were not emerged when fungicides were applied. In 1996, June rainfall was much lower and glume blotch infection probably relied on spore transfer from upper leaves. In 1998, June rainfall was high, but ears were protected by fungicides applied at GS 59. The dose-response curves for glume blotch in Figure 5.7 therefore reflect both direct protectant activity of the fungicides and indirect protectant activity by their ability to suppress inoculum on upper leaves. Opus gave good control of glume blotch at half dose and the addition of the strobilurin fungicide in Landmark improved control at a quarter dose. Both of the other strobilurin fungicides (Amistar and Ensign) were also effective at a quarter dose. Alto and Tilt gave poor control of glume blotch.