Fungicides for strategic and tactical control of wheat leaf diseases in central-west NSW

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Key Points

- H45 proved far more susceptible to stripe rust than Diamondbird in 2004.
- With the dry conditions of 2004, when yields were higher (2-3 t/ha) stripe rust infection significantly decreased yield in H45 by 1*6%-17%*. Grain quality effects were also recorded at the site with the highest level of infection.
- Jockey® seed treatment provided some residual control of stripe rust at two out of the three sites.
- Foliar fungicides proved very effective at reducing stripe rust infection.
- Only the combination of seed applied + foliar fungicide resulted in a significantly higher yield and quality than the nil treatment with H45 wheat.
- Yellow leaf spot had no effect on yield or quality of the susceptible variety Diamondbird.

Background

The aim of these trials was to assess the potential for yield and quality responses from controlling Stripe Rust and Yellow Leaf Spot (YLS) in central-western (CW) NSW.

Stripe rust has emerged as a serious disease for farmers in CW NSW since 2003. Trial data from south-eastern NSW has shown that stripe rust can cause significant yield and quality losses in susceptible wheat varieties. However there is little local trial data to indicate the potential yield and quality consequences of stripe rust. CW NSW has less reliable spring weather conditions than south-eastern NSW, which is needed both for severe stripe mst development and high grain yield potentials.

These trials follow on from CWFS trials at Wirrinya in 2003. With the dry conditions of 2003, these earlier trials showed no significant grain yield or quality response from fungicide applications for the control of stripe rust (Motley and Rice, 2004).

The trials in 2004 also allowed the opportunity to assess the potential for controlling YLS with fungicides at one site (Goonumbla). This was due to the presence of significant levels of retained wheat stubble from the previous crop in 2003 that provided a source of infection for the 2004 crop.

Methods

Three trial sites at Gunning Gap, Wirrinya and Goonumbla (Alectown) were sown as randomised blocks with 3 replicates. Crop rotation histories varied between the sites. In 2003 (previous crop year) the Gunning Gap and Goonumbla sites were sown to wheat, while the Wirrinya site was pasture/fallow. All soils were red soils with a sandy loam surface and heavier clay subsoil. Analyses of the top soil (0-10 cm) showed: pHc_a 5.8 at Gunning Gap, 4.6 at Wirrinya and 5.4 at Goonumbla and CEC (meq/100g) 6.5 at Gunning Gap, 8.0 at Wirrinya, 7.9 at Goonumbla. Drought has severely limited crop production at the sites for the past 4 years. In general there has been little to no subsoil moisture at sowing, with the occurrence of late sowing rains and dry springs.

The varieties H45 (very susceptible to stripe rust; well suited to this climate) and Diamondbird (an older variety with some acid soil tolerance and moderately susceptible to stripe rust) were both sown at a seeding rate of 60kg/ha with 100kg/ha of DAP (18N; 20P). Sowing was into moisture after sowing rains (late May to mid June). Post emergent herbicides: Tristar® and Jaguar® were applied as required. Fungicides were applied at crop growth stages Z45 and at Z70 (Tables 1 and 2). The foliar fungicides were applied with a hand held boom at a walk speed of 5km/hr and water rate of 200L/ha. Detailed assessments of stripe rust were made at Z70. Detailed assessments of YLS were made at Z13 and Z70. Table 2 provides further information on the exact dates and timing of operations and assessments.

Table 1: Fungicide rates and indicative costs.

Actives used	Products names	Application Method	Rate /100 kg seed	Rate (/ha)	Adjuvant	Indicative Cost $/L	$/ha*
Fluquinconazole	Jockey	seed dressing	450 mL	n/a		$75	$20.25
Fluquinconazole + Tebuconazole	Jockey + Folicur, Orius	seed dressing +	450 mL	145 mL	n/a +	$75	$33.35
		foliar fungicide	n/a	1,000 mL		$8	$8.00
Triadimefon 125EC	Bayleton, Turret, Triad	foliar fungicide	n/a	145 mL	1%oil	$8	$13.10
Tebuconazole 430SC	Folicur, Orius	foliar fungicide	n/a	290 mL	Nil	0	$24.70
Tebuconazole 430SC	Folicur, Orius	foliar fungicide	n/a	250 mL	+ 1 % oil	$8	$11.25
Propiconazole 250EC	Tilt, Bumper	foliar fungicide	n/a	500 mL	+ 1%oil	0	$22.50
Propiconazole 250EC	Tilt, Bumper	foliar fungicide			Nil	$4	
		foliar fungicide			Nil	5	
*cost includes adjuvant							

Table 2: Diary of trial management activity (2004).

Activity		Gunning Gap	Wirrinya		Goonumbla
Sowing		29-May	16-Jun		9-Jun
PE herbicide early	11	-Aug Tristar + Jaguar	11-Aug Tristar +	Jaguar	11-Aug Tristar + Jaguar
PE herbicide late	1	-Sep Tristar	.		_
Z13 (3 leaf) assessment		-	-		14-Jul
Z45 (mid boot) fungicide application		14-Sep	17-Sep		23-Sep
Z70 (late flower) fungicide application		14-Oct	16-Oct		20-Oct
Z70 (late flower) assessment		18-Oct	19-Oct		22-Oct
Harvest		16-Dec	18-Dec		17-Dec

Results and discussion

*Seasonal conditions **and** disease development*

Stripe rust was first detected in the Goonumbla trial site in mid September (Z40 - early booting) and in the Wirrinya trial site in late September (Z55 - head emergence). Stripe rust was not observed in the Gunning Gap trial site until early October (Z65 - mid flower). Good rainfall in late September / early October promoted rapid development of the stripe rust infection at both the Wirrinya and Goonumbla sites through early and mid October. Seasonal conditions at the Gunning Gap site were not as conducive for the development of stripe rust. Dry and warm conditions in late October early November at all three sites slowed the development of the stripe rust and reduced grain yield potentials. The Wirrinya site had the highest levels of stripe rust.

Goonumbla site was the only site with large quantities of retained wheat stubble, and therefore high infection levels of YLS. As such it was the only site where detailed YLS infection and control measurements were taken. YLS developed very early at Goonumbla site, with rapid development of infections on the young crop leaves. A comparison between the water limited yield potentials (Table 3; using the French and Schultz model) and the actual yield achieved (Table 5) suggests that the yields at all sites did not meet the water limited yield potential. With the late sowing this is not surprising.

Table 3: 2004 rainfall at Gunning Gap, Wirrinya and Goonumbla.

	Rainfall (mm)																	Water limited yield potential[A]
	Monthly Rainfall														Annual	Fallow	Growing season	
	No	Dec	Jan	Feb	Mar	Apr I	M	'	Jul	Au	Se	Oct	No	Dec	Total	(Nov-Mar)	(Apr to Oct)	t/ha
Gunning Gap	29	32	58	26	23	0	2	49	12	29	31	62	5	105	428	167	212	**3,1**
Wirrinya	0	14	72	66	4.5	**6**	1	63	21	25	31	54	29	95	482	163	210	**3.0**
Goonumbla	26	34	61	45	21	4	4	52	27	52	44	38	31	82	503	191	259	**4.3**

[A]water limited yield potential (t/ha) = ((Nov to Feb) X 30% + (Mar) X 50%)mm + (Growing season rainfall -110)mm) X 20(kg grain/mm) /1000

Stripe rust incidence and % stripe rust leaf area infection

A strong relationship was found between stripe rust incidence (% of leaves infected) and % stripe rust leaf area infection on the flag leaf (Figure 1). This relationship was found to be similar at each site, despite differences in the magnitude of infection. Figure 1 indicated that beyond an incidence of 60% of flag leaves infected with stripe rust, the % of leaf area infected with stripe rust increase rapidly. Figure 1, also suggests that 100% stripe rust incidence correlates with about 10% leaf area infection. Stripe rust incidence is suggested to be a good disease monitoring measurement when stripe rust levels are low; however, leaf area infection becomes the preferred measurement when stripe rust levels are high. The relationship depicted in Graph 1 appears to fit in closely with that described in the extension literature (Murray *et al,* 2005). Stripe rust incidence was found to have less statistical variability than % stripe rust area infection in these experiments, and thus was the most useful for determining significant differences between control treatments.

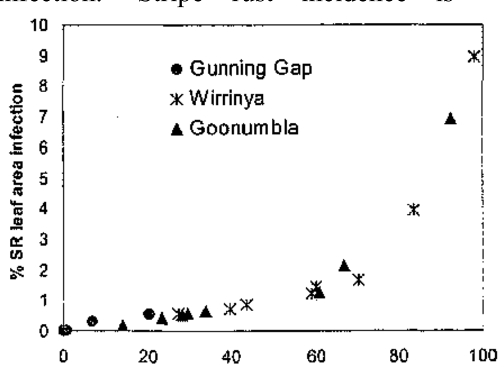

Figure 1: Relationship between stripe rust incidence and % stripe rust leaf area infection (flag leaf only) - combined results from 3 trial sites for the wheat variety H45 in 2004.

Stripe ***rust control***

- *Variety effects*

H45 proved far more susceptible to stripe rust than Diamondbird at all three sites (Table 4). At the Wirrinya and Goonumbla sites the H45 nil treatments had stripe rust incidence levels of 98% and 92% respectively, being well above the suggested thresholds of 10-20% for a highly susceptible variety (Murray *et ah,* 2005). The level of stripe rust in the Diamondbird nil treatments all three sites was far less than H45 and equal to or below the suggested incidence threshold of 30-40% for a moderately susceptible variety (Murray *et ah,* 2005). However, despite the much higher levels of stripe rust in H45, it yielded equal to or higher than Diamondbird (Table 5) and had screenings equal to or lower than Diamondbird. When stripe rust was controlled at the Wirrinya and Goonumbla sites (with Jockey® + Tebuconazole) H45 yielded significantly better than Diamondbird.

At the low level stripe rust site at Gunning Gap, H45 yielded 3 times higher and had much lower screenings levels than Diamondbird regardless of stripe rust control treatment. This is thought to be attributed to the timing of severe dry seasonal conditions in late September (before the rain) coinciding with the flowering of Diamondbird. The quicker maturing H45 variety may have partially avoided these tough conditions at flowering. The only observed advantage of Diamondbird over H45 occurred at the Goonumbla site where protein was significantly higher.

Table 4: Pathology assessments of stripe rust and YLS in H45 and Diamondbird at 3 sites in 2004 (Nil fungicide treatments).

Variety (Nil fungicide treatment)	Gunning gap : SR Flag area %[A]	Incid-ence %[B]	Wirrinya SR Flag area %[A]	Incid-ence %[B]	Leaf area %[c]	Goonumbla Flag area %[A]m	SR Incid-ence %[B]	Leaf area %[c]	YLS Z13 area %[u]	Z70 area %[u]
H45	0.54	20	8.9	98	19.5	6.9	92	10.9	3.0	6.4
Diamondbird	0.01	1	0.5	31	0.2	0.2	15	0.1	50.0	38.3
Isd (p<0.05)	0.22	7	1.8	10	5.2	1.7	10	4.8	9.9	7.2

[A]flag area % = the % of flag leaf area covered with SR at Z70

[B]incidence% = the % of flag leaves with SR visibly present at Z70

[c]Leaf area % = the % of leaf area (all leaves) covered with SR at Z70

[D]YLS area % = the % of leaf area (all leaves) covered with YLS at Z30 or Z70

Table 5: Grain yield and quality results for H45 and Diamondbird at 3 sites in 2004 (Nil fungicide treatments).

Variety (Nil fungicide treatment)	Yield t/ha	Gunning Screen %	i gap Protein %	Weight kg/hL	Yield t/ha	Wirrinya Protein %	Screen %	Weight kg/hL	Yield t/ha	Goonu Screen %	mbla Protein %	Weight kg/hL
H45	1.49 100%	2.0	15.2	75.3	1.79 100%	11.8	13.4	70.6	3.27 100%	6.9	9.2	74.0
Diamondbird	0.52 35%	9.7	17.5	72.1	1.81 101%	10.0	14.7	73.8	3.11 95%	8.9	10.3	73.9
Isd (p<0.05)	0.14 10%	2.6	0.4	2.5	ns	ns	0.5	2.2	ns	2.6	0.7	2.4

- *Fungicide product effects*

Jockey® seed dressing provided significant stripe rust control at the Wirrinya and Goonumbla sites, but not at the Gunning Gap site (Table 6). This is thought to be because the Gunning Gap site was sown earlier and the stripe rust developed later than at the other sites. Jockey® is only registered for 6 weeks control and then 6 weeks protection of stripe rust. The results at the Wirrinya and Goonumbla sites suggest that when stripe rust infections occur early, this early control and protection may have beneficial effects lasting longer than 12 w

All of the foliar fungicides provided significant levels of stripe rust control at the 2 sites where stripe rust was a problem (i.e. Wirrinya and Goonumbla sites). Tebuconazole and propiconazole gave significantly better control of stripe rust than Jockey® alone or triadimefon. However, triadimefon gave significantly better stripe rust control than Jockey® alone at the Gunning Gap and Goonumbla, but not at the Wirrinya site.

The only treatment to result in a significant yield increase and quality advantage over the nil treatment was the combination of Jockey® + tebuconazole at the Wirrinya and Goonumbla sites (Table 7). Significant yield increases were in the order of 17% (0.31 t/ha) at the Wirrinya site and 16% (0.52 t/ha) at the Goonumbla site. Significant screening reductions were also recorded at the Wirrinya and Goonumbla sites, and a significantly higher test weight was recorded at the Wirrinya site. It is suggested that the combination treatment provided early and late control of stripe rust. A consistent trend of small yield benefits from Jockey® and Z45 foliar fungicide treatments (applied alone) appears in these data at the Wirrinya and Goonumbla sites, however, they were not statistically significant.

No benefits were observed from stripe rust control at the low stripe rust infection level the Gunning Gap site and as such this data has been omitted.

Table 6: Pathology assessments of the effect of fungicide products on stripe rust in H45 at 3 sites in 2004

Treatment			Gunning gap		Wirrinya			Goonumbla		
Fungicide	Rate	Timing	Flag area %[A]	Incid-ence %[B]	Flag area %[A]	Incid-ence %[B]	Leaf area %[c]	Flag area %[A]	Incid-ence %[B]	Leaf area %[c]
Nil			0.54 c	20 b	8.9 c	98 f	19.5 c	6.9 c	92 e	10.9 b
Jockey® (Fluquinconazoie)	450 ml/t	at sowing	0.54 c	20 b	4.0 b	83 e	14.0 b	2.1 b	67 d	2.7 a
Jockey® + Tebuconazole	145 ml/ha	Z45	0.00 a	0a	0.6 a	27 a	0.4 a	0.4 a	23 ab	0.0 a
Triadimefon	1000 ml/ha	Z45	0.27 b	7a	1.7 a	70 d	1.3 a	1.3 ab	61 d	0.4 a
Tebuconazole	145 ml/ha	Z45	0.00 a	0a	1.2 a	59 c	0.7 a	0.6 ab	29 bc	0.5 a
Tebuconazole	290 ml/ha	Z45	0.00 a	0a	0.7 a	39 b	0.1 a	0.2 a	14 a	0.0 a
Propiconazole	250 ml/ha	Z45	0.01 a	1 a	1.5 a	60 cd	1.4 a	0.6 ab	34 c	0.2 a
Propiconazole	500 ml/ha	Z45	0.00 a	0a	0.9 a	43 b	0.4 a	0.5 ab	28 bc	0.2 a
lsd (p<0.05)			0.22	7	1.8	10	5.2	1.7	10	4.8

Results within columns that have different letters beside them are significantly different (p<0.05)

[A]flag area % = the % of flag leaf area covered with SR at Z70

[B]incidence% = the % of flag leaves with SR visibly present at Z70

[c]Leaf area % = the % of leaf area (all leaves) covered with SR at Z70

Table 7: Grain yield and quality results of fungicide products on H45 at 2 sites in 2004

Treatment			Wirrinya					Goonumbla				
Fungicide	Rate	Timing	Yield t/ha	% of nil	Screen	Protein %	Weight kg/hl-	Yield t/ha	% of nil	Screen %	Protein "	Weight kg/hl.
Nil			1.79 a	100	11.8	13.4	70.6	3.27 ab	100	6.9	9.2	74.0
Jockey" - Fluquinconazole	450 ml/t	at sow	2.01 ab	113	10.6	13.5	72.6	3.55 be	108	5.1	9.5	74.7
Joekey[R]+ Tebuconazole	145 ml/ha	Z45	2.10b	117	7.2	13.4	74.4	3.79 c	116	5.7	9.5	72.4
Triadimefon	1000 ml/ha	Z45	1.99 ab	111	9.7	13.8	72.8	3.33 ab	102	6.0	9.6	74.0
Tebuconazole	145 ml/ha	Z45	1.85 ab	103	10.8	13.4	72.9	3.52 be	107	6.9	9.4	72.5
Tebuconazole	290 ml/ha	Z45	2.00 ab	112	10.2	13.6	72.1	3.57 be	109	5.9	9.5	73.7
Propiconazole	250 ml/ha	Z45	1.89 ab	106	10.3	13.5	72.7	3.43 be	105	6.9	9.7	73.7
Propiconazolc	500 ml/ha	Z45	1.86 ab	104	8.2	14.4	72.6	3.37 ab	103	5.3	9.9	74.7
Propiconazole	250 ml/ha	Z70	1.79 a	100	8.5	13.9	71.3	3.04 a	93	6.5	9.3	70.4
Propiconazole	250 ml/ha	Z45 + Z70	1.93 ab	108	10.5	13.9	73.6	3.49 be	107	6.9	9.5	68.9
lsd (P< 0.05)			0.25	14	3.6	0.5	2.2	0.37	11	ns	ns	2.4

Results within columns that have different letters beside them are significantly different (P<SU.UD |.

- *Foliar fungicide rate effects*

The higher rates of tebuconazole and propiconazole provided significantly better stripe rust control than the lower rates at the Wirrinya site. A significant rate effect was observed at the Goonumbla site only for tebuconazole. No rate effect was observed at the low level stripe rust site of the Gunning Gap site. However, despite the high rates of tebuconazole and propiconazole giving as good if not better control of stripe rust than the combination treatment of Jockey® + tebuconazole, they did not provide any significant yield or quality advantages over the Nil treatment as recorded with the combination treatment.

- *Timing effects*

The effects of the late applications of propiconazole at Z70 on stripe rust infection were difficult to assess as the dry seasonal conditions naturally slowed the stripe rust development. There was no yield or quality response to the late applications. However, the fact that the combination treatment of a seed applied + foliar was the only treatment to result in a significant yield and quality advantages suggests that early control is likely to be very important for obtaining maximum advantage.

Yellow leaf spot (YLS) control

- *Variety effects*

Diamondbird was far more susceptible to YLS at all stages than H45 (Table 4). This is well known and publicised in extension literature such as the NSW Winter Crop Variety Sowing Guide (McRae et al,,2005).

- *Fungicide product and rate effects*

Jockey® seed dressing provided no control of YLS. Jockey® is not promoted to control YLS and this result is to be expected.

Significant YLS control was observed with some of the foliar fungicides when all the leaves were assessed at Z70. No significant differences were observed when only the flag leaf was assessed at Z70, suggesting that most of the control occurred on the lower leaves.

Tebuconazole and propiconazole provided significant control of YLS in Diamondbird (Table 8). However, high rates of tebuconazole were needed to achieve significant control of YLS, while both high and low rates of propiconazole achieved significant YLS control. Triadimefon provided no control of YLS. As with Jockey®, triadimefon is not promoted to control YLS and this result is to be expected. Despite significant YLS control with tebuconazole and propiconazole, no fungicide treatment resulted in any significant grain yield or quality advantages in Diamondbird.

No significant levels of YLS disease or its control were observed in H45 at the Goonumbla site and as such these data are not presented.

Economic analysis

An economic analysis of stripe rust control in H45 using the product prices (Table 1) and grain yield / quality responses (Table 7) was conducted to determine if the relative profitability of fungicide treatments. Grain prices used in the analysis are based on actual Graincorp Trading cash prices for the 2004/05 harvest (delivered Parkes Sub Terminal). Base prices for bin grades (not varietal grades) are taken as averages for the main harvest delivery period (15.11.04 to 29.12.04). All prices used are GST exclusive and on a net delivered silo basis. In addition to the base price, protein and screenings increments (price premium/deductions) were calculated using the applicable Graincorp matrices. Moisture was assumed to be a standard 12.5% (i.e. no price premium or discount) for all treatments.

Table 8. Pathology assessments of the effect of fungicide products on YLS in Diamondbird at Goonumbla in 2004

Treatment			Z13 Leaf area %[D]	Z70 Flag area %[E]	Z70 Leaf area %[D]
Fungicide	Rate	Timing			
Nil			50	28	38 cd
Jockey® (Fluquinconazole)	450 ml/t	at sowing	53	31	34 bcd
Jockey® + Tebuconazole	145 ml/ha	Z45	-	26	34 bcd
Triadimefon	1000 ml/ha	Z45	-	29	42 d
Tebuconazole	145 ml/ha	Z45	-	27	32 bc
Tebuconazole	290 ml/ha	Z45	-	26	28 ab
Propiconazole	250 ml/ha	Z45	-	25	22 a
Propiconazole	500 ml/ha	Z45	-	29	21 a
lsd (p<0.005)			ns	ns	7.24

Results within columns that have different letters beside them are significantly different (p<0.05)
[D]YLS area % = the % of leaf area (all leaves) covered with YLS at Z30 or Z70
[E]YLS area % = the % of flag leaf area covered with YLS at Z70

The results of the economic analysis should be treated as only a guide to the expected relative profitability of fungicide treatments. The base grain price plummet by over $30/t when screenings were greater than 10%. Screenings levels at the Wirrinya site were around 10%, and so the price achieved may represent a statistical 'quirk' rather than a real fungicide effect. In addition the net benefit results have not been statistically analysed.

The analysis results (Table 8) suggest that economically viable responses to fungicide treatment were achieved in H45 at the Wirrinya and Goonumbla sites despite the dry conditions in 2004. Low levels of stripe rust and a lack of any significant yield responses meant it was not economically viable to control stripe rust in H45 and Diamondbird at the Gunning Gap site, and in Diamond at the Wirrinya and Goonumbla sites, and as such these data have not been included in this report.

Conclusion

H45 proved far more susceptible to stripe rust than Diamondbird. However, when yield potentials and stripe rust infection pressure are low due to dry seasonal conditions (e.g. Gunning Gap site) stripe rust infection did not have a negative effect on H45 yield. At all three sites H45 yielded equal or better than Diamondbird even when stripe rust was not controlled. This shows the agronomic advantage of H45 for late sowings and dry spring finishes.

These trials show that seed applied and foliar fungicides can be used to control stripe rust in susceptible varieties such as H45. The seed applied fungicide Jockey® can provide lasting control of stripe rust when infection occurs early. However, it offers little or no protection to late infections. Of the 3 foliar fungicides trialled, tebuconazole and propiconazole appeared to provide superior stripe rust control over triadimefon. Rate responses with tebuconazole and propiconazole were obvious at the high level stripe rust infected Wirrinya site. None of the fungicides alone provided a significant grain yield increase regardless of rate.

The combination of a seed applied + foliar fungicide was the best option in these trials, providing early and late control of stripe rust, with the result being an increase in H45 yields by 16-17%o at the 2 sites where stripe rust was above threshold levels. It also resulted in a significant improvement in grain

Table 9: Grain grade, price and net economic benefit from fungicide treatments on H45 in 2004.

Treatment			Wirrinya			Goon mbla		
			Grade	Price	Net benefit	Grade	Price	Net benefit
Fungicide	Rate	Timing		$/t	$/ha		$/t	$/ha
Nil			HPS1	$128	-	AUH2	$152	-
Jockey® conazole)	450 ml/t	at sowing	HPS1	$128	$8	AUH2	$152	$21
Jockey® + Tebuconazole	145 ml/ha	Z45	AUH2	$152	$56	AUH2	$152	$45
Triadimefon	1000 ml/ha	Z45	AUH2	$152	$65	AUH2	$152	**$0**
Tebuconazole	145 ml/ha	Z45	HPS1	$128	-$6	AUH2	$152	$24
Tebuconazole	290 ml/ha	Z45	HPS1	$128	$2	AUH2	$152	$21
Propiconazole	250 ml/ha	Z45	AUH2	$152	$48	AUH2	$152	**$13**
Propiconazole	500 ml/ha	Z45	HPS1	$128	-$13	AUH2	$152	**-$7**
Propiconazole	250 ml/ha	Z70	AUH2	$152	$32	AGP1	$139	**-$85**
Propiconazole	250 ml/ha	Z45 + Z70	AUH2	$152	$43	AGP1	$139	**-$33**

Net benefit = $/ha benefit above Nil treatment after taking into account additional income and costs.

quality (screenings and test weight) at Wirrinya.

Given the level of stripe rust was above threshold levels in H45 at the Wirrinya and Goonumbla sites; a greater response to stripe rust control was expected. These trials highlight that dry spring conditions can dramatically limit stripe rust development and the potential for obtaining economic benefits from its control.

Diamondbird proved far more susceptible to YLS than H45. Tebuconazole and propiconazole provided significant control of YLS on the lower leaves. However, reducing YLS infection had no effect on grain yield or quality at the Goonumbla site. Further trials are needed to determine whether YLS has any major effect on wheat yield and quality in southern NSW. This trial series will be continued in 2005.

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