Interaction between fungicide program and in-crop nitrogen timing for the control of yellow leaf spot (YLS) in early-sown wheat

Nick Poole and Michael Straight
FAR Australia in conjunction with Riverine Plains Inc

Key points

- The level of yellow leaf spot (YLS) *Pyrenophora tritici repentis* control achieved with fungicides applied at the tillering (GS22) and third node stage (GS33) in wheat-on-wheat was poor (less than 50% in most assessments).
- Fungicide applied at third node stage (GS33) was more effective at preventing YLS infection on the top three leaves of the crop than when applied at tillering (GS22).
- Fungicide applied at third node stage (GS33) generated a significant (0.44t/ha) yield increase over the untreated crop, while the equivalent fungicide applied at tillering (GS22) gave no yield benefit.
- Applying fungicide at both tillering (GS22) and third node stage (GS33) offered no advantage over a single application at GS33.
- Nitrogen application at tillering (GS22) or first node (GS31) had no effect on yield.
- There was no significant difference in product performance between Tilt® (propiconazole) and Prosaro® (prothioconazole and tebuconazole).

Location: Corowa, NSW
Sowing date: 12 May 2015
Rotation: Second wheat
Variety: Gregory
Stubble: Wheat unburnt
Rainfall:
GSR: 329mm (April – October)
Summer rainfall: 152mm

Method

The trial examined the influence of two nitrogen timings: 40kg N/ha applied at tillering (GS22) or first node (GS31) (Table 1) and four fungicide strategies (untreated, fungicide at tillering — 17 July, third node — 11 September, and fungicide at both timings) on levels of YLS as part of the Riverine Plains Inc *Maintaining Profitable Farming Systems with Retained Stubble in the Riverine Plains Region Project*.

The trial was set up in a block of commercial wheat (cv Gregory) in a wheat-on-wheat rotation position as a balanced split–split plot design, with nitrogen timing as the main plot (Table 1) and fungicide timing as the sub plot and fungicide product as the sub-sub plot, replicated four times.

For each of the fungicide strategies, two fungicides were evaluated at their full rates at both timings: Tilt 0.5L/ha and Prosaro 0.3L/ha. A full list of nitrogen and fungicide treatments is presented in Table 2.

Data has been statistically analysed using analysis of variance (ANOVA), with means separated using the unrestricted least significant difference (LSD) procedure.

The crop had a plant population of 143 plants/m^2 and a tiller population of 295 tillers/m^2 when assessed at the third node stage (GS33) on 11 September, after the final fungicide application.

TABLE 1 Nitrogen application rates and timings

	12 May 2015 (sowing)	15 July 2015 (GS22)	12 August 2015 (GS31)	Total nitrogen applied
	(kg N/ha)			
Tillering timing	6	40	Nil	46
First node timing	6	Nil	40	46

TABLE 2 Treatment list

Treatment	Active ingredient (g/ha ai)		Fungicide timing (mL/ha)		Nitrogen timing (kg N/ha)	
			GS22	GS33	GS22	GS31
1	Untreated				40	
2	Untreated					40
3	Prosaro	Prothioconazole (63) and tebuconazole (63)	300		40	
4	Prosaro	Prothioconazole (63) and tebuconazole (63)	300			40
5	Prosaro	Prothioconazole (63) and tebuconazole (63)		300	40	
6	Prosaro	Prothioconazole (63) and tebuconazole (63)		300		40
7	Prosaro	Prothioconazole (126) and tebuconazole (126)	300	300	40	
8	Prosaro	Prothioconazole (126) and tebuconazole (126)	300	300		40
9	Untreated#				40	
10	Untreated#					40
11	Tilt	Propiconazole (250)	500		40	
12	Tilt	Propiconazole (250)	500			40
13	Tilt	Propiconazole (250)		500	40	
14	Tilt	Propiconazole (250)		500		40
15	Tilt	Propiconazole (500)	500	500	40	
16	Tilt	Propiconazole (500)	500	500		40

#The trial is a balance split–split plot design; hence the replication of the 40kg N/ha at GS22 untreated with fungicide and 40kg N/ha at GS31 untreated with fungicide treatments (9 and 10).

TABLE 3 Yellow leaf spot severity and incidence assessed 20 July 2015 two–three tillers (GS22–23) on the newest fully-emerged leaves (flag-6, flag-7 and flag-8)

GS22–23	YLS (%)		
	Flag-6	Flag-7	Flag-8
Disease severity	1.0	8.4	72.3
Disease incidence	52.5	97.5	100

Results

i) Disease assessment data

At the first fungicide application timing (GS22) there was a high level of disease incidence on the lowest leaves (Table 3).

When assessed at third node (GS33) before the second fungicide application timing, there was little evidence of earlier treatment effects (Table 4).

TABLE 4 Yellow leaf spot severity (% leaf area infected) and incidence (% of leaves infected) assessed 11 September 2015 third node stage (GS33), on the second newest fully-emerged leaf (flag-2, flag-3 and flag-4)

Nitrogen timing	YLS (%)				
	Flag-2		Flag-3		Flag-4
	Severity	Incidence	Severity	Incidence	Severity
GS22	1.0[a]	70.0[a]	7.3[a]	98.3[a]	44.0[a]
GS31	1.1[a]	62.0[b]	7.8[a]	97.5[a]	49.3[a]
Mean	**1.1**	**66.0**	**7.6**	**97.9**	**46.7**
LSD	0.3	7.5	2.4	2.3	6.9
Fungicide timing					
Untreated control	1.1[a]	65.4[a]	8.2[a]	99.2[a]	54.7[a]
GS23	0.9[a]	66.7[a]	6.9[a]	96.7[a]	38.5[b]
LSD	0.4	10.6	3.3	3.3	9.8
Product					
Prosaro	1.2[a]	70.8[a]	8.7[a]	98.3[a]	47.3[a]
Tilt	0.9[b]	61.2[b]	6.4[a]	97.5[a]	46.0[a]
LSD	0.3	7.5	2.4	2.3	6.9

Figures followed by different letters are regarded as statistically significant.

Note: The newest emerged leaf (flag-1) had no disease as very newly emerged.

Later-applied nitrogen (at GS31) decreased YLS incidence on flag-2, but the difference was small. Fungicide applied during tillering (GS22–23) gave a small reduction in YLS severity on the top three leaves assessed, but the difference was only significant on flag-4.

At flag leaf emergence the impact of the later spray at third node (GS33) was evident in the YLS infection levels recorded on flag-1, flag-2 and flag-3, however only poor control (less than 50%) was achieved (Table 5). No differences in product performance were recorded at this assessment.

Disease assessments at head emergence (GS59) showed a significant decrease in YLS severity and incidence on flag-1 and flag-2 when fungicides were applied at both tillering and third node stage (GS23 and GS33) compared with the untreated control (Table 6, Figure 1). There was no difference between the two-spray program and the single application at the third node stage (GS33) on disease severity.

Early nitrogen application decreased YLS severity on flag-2, however the differences were only small.

TABLE 5 Yellow leaf spot severity and incidence assessed 24 September 2015 flag leaf just visible (GS37) on the newest fully-emerged leaf (flag-1, flag-2 and flag-3)

GS37	YLS (%)					
	Flag-1		Flag-2		Flag-3	
Nitrogen timing	**Severity**	**Incidence**	**Severity**	**Incidence**	**Severity**	**Incidence**
GS22	0.5[a]	51.3[a]	2.4[a]	95.6[a]	11.7[a]	100.0[a]
GS31	0.5[a]	48.4[a]	2.2[a]	92.5[a]	13.1[a]	100.0[a]
Mean	**0.5**	**49.9**	**2.3**	**94.1**	**12.4**	**100.0**
LSD	0.1	11.0	0.4	4.8	2.9	-
Fungicide timing						
Untreated control	0.6[a]	56.3[a]	2.9[a]	97.5[ab]	16.3[a]	100.0[a]
GS23	0.6[a]	58.1[a]	2.8[a]	99.4[a]	14.2[a]	100.0[a]
GS33	0.5[ab]	46.3[ab]	2.0[b]	92.5[bc]	9.5[b]	100.0[a]
GS23 and 33	0.4[b]	38.8[b]	1.5[b]	86.9[c]	9.6[b]	100.0[a]
LSD	0.2	15.6	0.5	6.8	4.0	-
Product						
Prosaro	0.5[a]	49.7[a]	2.3[a]	95.9[a]	11.7[a]	100.0
Tilt	0.5[a]	50.0[a]	2.3[a]	92.2[a]	13.1[a]	100.0
LSD	0.1	11.0	0.4	4.8	2.9	-

Figures followed by different letters are regarded as statistically significant.

TABLE 6 Yellow leaf spot severity and incidence assessed 9 October 2015 head completely emerged (GS59) on the second newest fully-emerged leaf (flag-1, flag-2) and green leaf retention (GLR) on flag-3

	YLS (%)				GLR (%)
	Flag-1		Flag-2		Flag-3
Nitrogen timing	**Severity**	**Incidence**	**Severity**	**Incidence**	**GLR**
GS22	1.3[a]	81.3[a]	7.2[b]	97.2[a]	40.9[a]
GS31	1.5[a]	83.4[a]	10.5[a]	97.5[a]	34.3[a]
Mean	**1.4**	**82.4**	**8.9**	**97.4**	**37.6**
LSD	0.3	8.9	2.0	2.7	6.8
Fungicide timing					
Untreated control	1.6[ab]	87.5[a]	12.3[a]	99.4[a]	27.3[b]
GS23	1.7[a]	88.1[a]	11.5[a]	98.8[a]	32.6[b]
GS33	1.3[bc]	80.6[ab]	6.2[b]	98.1[a]	45.3[a]
GS22 and 33	1.0[c]	73.1[b]	5.4[b]	93.1[b]	45.3[a]
LSD	0.4	12.5	2.8	3.8	9.7
Product					
Prosaro	1.3[a]	80.9[a]	8.9[a]	97.2[a]	37.7[a]
Tilt	1.5[a]	83.8[a]	8.8[a]	97.5[a]	37.6[a]
LSD	0.3	8.9	2.0	2.7	6.8

Figures followed by different letters are regarded as statistically significant.

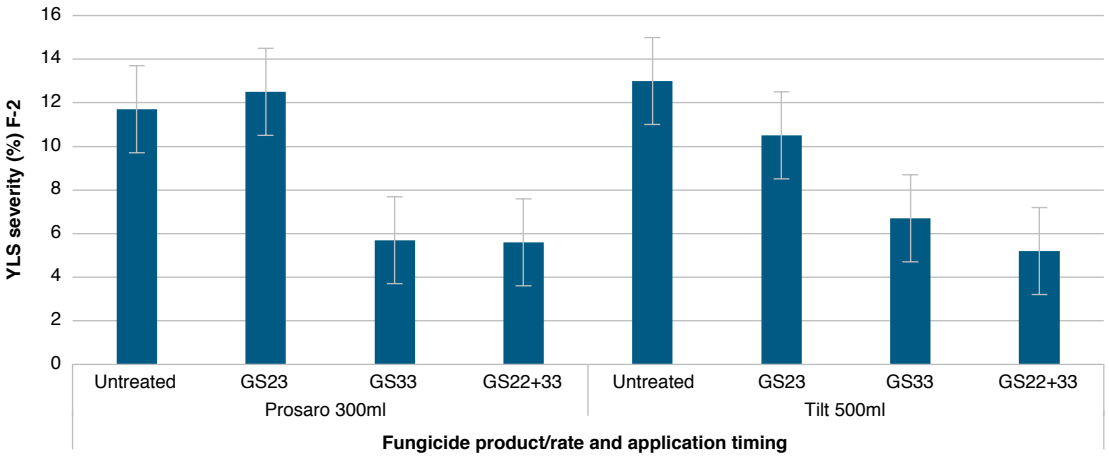

FIGURE 1 Interaction between fungicide application timing* and product on YLS severity (flag-2), assessed head emergence (GS59), 9 October 2015

*Mean of two nitrogen application timings

The error bars are a measure of LSD

Green leaf retention assessed at the watery ripe stage (GS71) showed there to be a significantly greater percentage of the leaf area of flag-3 to be greener where fungicide was applied at the third node stage.

Crop canopy greenness (measured as crop reflectance with the Greenseeker®) was significantly increased by applying fungicide at the third node stage (GS33) compared with the untreated control, however the differences were small (Table 7).

ii) Yield and quality results

Influence of nitrogen timing

The timing of nitrogen application (main dose applied at the tillering or first node stage) did not influence yield or grain quality (Table 8). There was a small but significant reduction in screenings when nitrogen was applied at the first node stage (GS31).

Influence of fungicide timing and product

Applying fungicide at tillering (GS22) did not increase yields (Table 8). However, when applied at the third node stage (GS33) there was a significant yield increase over the untreated control and the tillering applications (averaged across two products and nitrogen timings).

There were no yield or quality differences measured between Tilt and Prosaro. In this trial both products partially controlled the disease, which rarely scored above 50% control (Figure 2).

TABLE 7 NDVI 11 September 2015 third node stage (GS33), 24 September 2015 flag leaf just visible (GS37), 9 October 2015 head fully emerged (GS59) and 21 October 2015, grain watery ripe (GS71)

Treatment	NDVI			
Nitrogen timing	**GS33**	**GS37**	**GS59**	**GS71**
GS22	0.43[a]	0.54[a]	0.59[a]	0.51[a]
GS31	0.43[a]	0.55[a]	0.58[a]	0.49[a]
Mean	**0.43**	**0.54**	**0.59**	**0.50**
LSD	0.03	0.04	0.04	0.03
Fungicide timing				
Untreated control	0.40[b]	0.53[b]	0.57[b]	0.49[b]
GS23	0.43[ab]	0.51[b]	0.58[b]	0.47[b]
GS33	0.45[a]	0.60[a]	0.63[a]	0.54[a]
GS23 and 33	0.43[ab]	0.55[ab]	0.58[b]	0.50[ab]
LSD	0.04	0.06	0.05	0.04
Product				
Prosaro	0.43[a]	0.55[a]	0.59[a]	0.50[a]
Tilt	0.42[a]	0.54[a]	0.59[a]	0.50[a]
LSD	0.03	0.04	0.04	0.03

Figures followed by different letters are regarded as statistically significant.

TABLE 8 Yield, protein, test weight and screenings at 26 November 2015, harvest (GS99)

Treatment	Grain yield and quality			
Nitrogen timing	**Yield (t/ha)**	**Protein (%)**	**Test weight (kg/hL)**	**Screenings (%)**
GS22	3.81[a]	11.4[a]	82.0[a]	3.4[a]
GS31	3.64[a]	11.5[a]	81.8[a]	3.1[b]
Mean	**3.73**	**11.5**	**81.9**	**3.3**
LSD	0.19	0.2	0.6	0.2
Fungicide timing				
Untreated control	3.57[b]	11.4[ab]	82.0[a]	3.3[a]
GS23	3.62[b]	11.3[b]	82.2[a]	3.3[a]
GS33	3.97[a]	11.6[ab]	82.2[a]	3.2[a]
GS23 and 33	3.74[ab]	11.7[a]	81.3[a]	3.2[a]
LSD	0.26	0.3	0.9	0.3
Product				
Prosaro	3.65[a]	11.6[a]	81.7[a]	3.3[a]
Tilt	3.80[a]	11.4[a]	82.1[a]	3.2[a]
LSD	0.19	0.2	0.6	0.2

Figures followed by different letters are regarded as statistically significant.

Conclusions

For the third year in succession there have been responses to foliar fungicides for YLS control, despite yields being below 4t/ha during 2015 (3t/ha the two previous seasons) and disease levels being relatively low (less than 20% on the top three leaves).

Previous years of the trial have challenged current wisdom in two respects; firstly that fungicide application for YLS gives little value when applied at late tillering, and secondly, despite low levels of disease on the top three leaves there were yield responses to fungicide application. On balance it is the later of the two fungicide applications at GS32–33 that has been more effective for YLS control, although in previous years a two-spray program has performed better than one fungicide.

Overall, the yield differences are small (0.05–0.4t/ha) this season. At $300/t such yield increases would generate gross income increases of $15–$120/ha. Allowing for cost of fungicide and application at $9/ha (approximately $15/ha with Tilt and $29/ha for Prosaro) the maximum

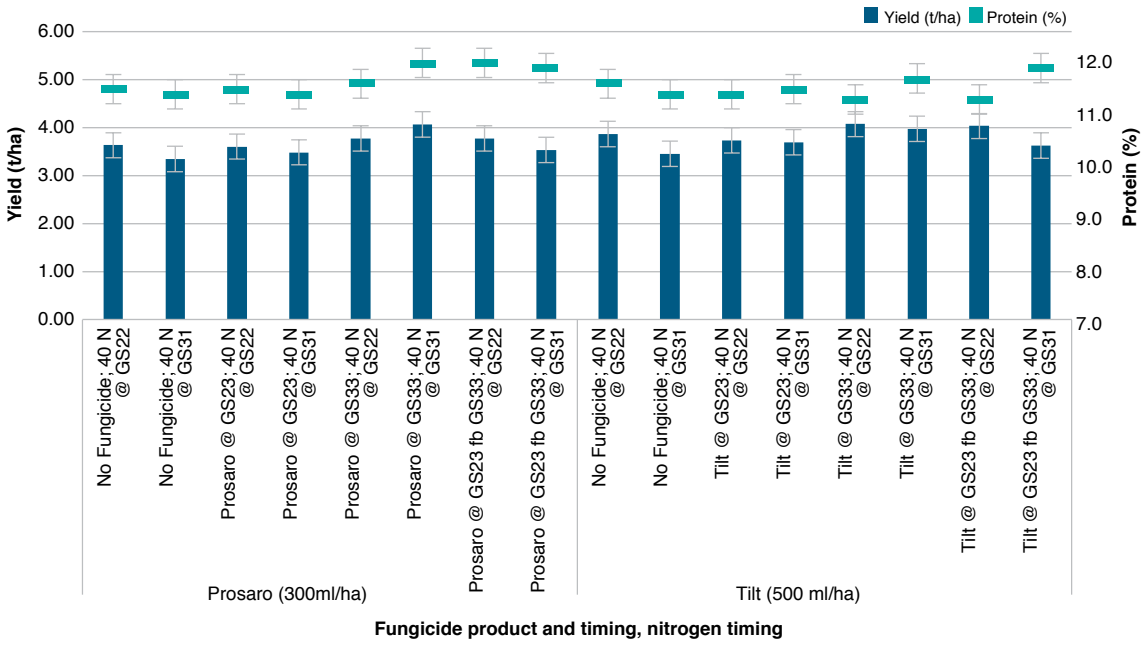

FIGURE 2 Influence of fungicide strategy and nitrogen timing on yield and protein, 26 November 2015
*The error bars are a measure of LSD

Application details:

T1 Application 17/07/2015

Application description		Application equipment	
Application date	17/7/15	Nozzle brand	Lechler
Actual growth stage at application	GS23	Nozzle type	AI110
Crop height (cm)	10 cm	Nozzle size	01
Method/equipment used	Hand boom	Nozzle spacing (cm)	50
Soil moisture	Moist	Boom height above crop(cm)	50
Air temperature (oC)	10	Operating pressure (kPa)	300
Cloud cover (%)	35	Ground speed (km/h)	4.8
Relative humidity (%)	67	Spray volume (L/ha)	100
Wind velocity (kph) (start/finish)	0-5		
Wind direction (start/ finish)	W		
Dew presence (Y/N)	N		
Crop cover (%)			

T2 Application 11/09/2015

Application description		Application equipment	
Application date	11/9/15	Nozzle brand	Lechler
Actual growth stage at application	GS33	Nozzle type	AI110
Crop height (cm)	40cm	Nozzle size	01
Method/equipment used	Hand boom	Nozzle spacing (cm)	50
Soil moisture	Moist	Boom height above crop(cm)	50
Air temperature (ºC)	17	Operating pressure (kPa)	300
Cloud cover (%)	20	Ground speed (km/h)	4.8
Relative humidity (%)	60	Spray volume (L/ha)	100
Wind velocity (kph) (start/finish)	0 to 5		
Wind direction (start/ finish)	N		
Dew presence (Y/N)	N		
Crop cover (%)			

return on input was approximately 8:1 and 4:1 respectively for the late fungicide application (GS32–33), which was the most successful program. The tillering application of fungicide on its own was not cost effective this year.

Contact

Michael Straight FAR Australia

E: michael.straight@far.org.nz