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

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Key points

- Positive yield responses from the control of yellow leaf spot (YLS) (*Pyrenophora tritici repentis*) were recorded despite disease levels not exceeding 10% on the top three leaves in this wheat-on-wheat rotation position.
- For the second year in succession there was a significant yield increase (0.23t/ha mean of two fungicide products) from two fungicide applications made at the late tillering stage and the second node stage (GS25 and GS32).
- The yield response from two fungicides corresponded to significantly better disease control than the untreated control and increased the crop canopy greenness.
- Although single fungicide timings produced little or no evidence of YLS control, significant yield increases were measured (0.13–0.14t/ha).
- Nitrogen timing (application of 40kg/ha nitrogen at either tillering (GS22) or first node stage (GS31)) had no significant effects on disease levels, yield or quality.

Location: Coreen, NSW
Sowing date: 28 April 2014
Rotation: Second wheat
Variety: Gregory
Stubble: Wheat unburnt
Rainfall:
GSR: 382.3mm (April – October)
Summer rainfall: 109.2mm

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 late tillering — 2 July 2014, second node — 5 August 2104 and fungicide at both timings) on levels of yellow leaf spot (YLS) (*Pyrenophora tritici repentis*) 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 commercial crop of wheat (cv Gregory) in a wheat-on-wheat rotation position as a balanced split-split plot design with nitrogen timing as the main plot, 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 116 plants/m^2 and a tiller population of 250 tillers/m^2 when assessed at the second node stage (GS32) on 6 August 2014, one day after the final fungicide application.

Results

i) Disease assessment data

At the first fungicide application YLS was present on all the older leaves (Table 3), but the severity was still relatively low (up to 22.5%).

When assessed a month later on 6 August 2014 the disease had progressed onto newer leaves (flag-3 and flag-4). At this stage the different timings of nitrogen fertiliser had not had a significant effect on YLS levels. There was no significant difference between the two fungicide products evaluated. Fungicide applied at tillering (2 July 2014) significantly reduced disease severity on flag-3 and flag-4, however the level of control was little better than 50% control on flag-4 (Table 4).

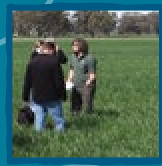
  

TABLE 1 Nitrogen application rates and timings

Nitrogen rates	28 April 2014 (sowing)	19 June 2014 (GS22)	14 July 2014 (GS31)	Total nitrogen applied
40kg/N applied	6kg N/ha	40kg N/ha	Nil	46kg N/ha
40kg/N applied	6kg N/ha	Nil	40kg N/ha	46kg N/ha

TABLE 2 Treatment list

Treatment		Active ingredient (g/ha ai)	Fungicide timing (mL/ha)		Nitrogen timing (kg N/ha)	
			GS25	GS32	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 balanced 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 2 July 2014 three tillers–start of stem elongation stage (GS23–30) on the newest fully-emerged leaf (flag-5) and older leaves (flag-6, flag-7 and flag-8) just before fungicide application

GS23–30	YLS (%)			
	Flag-5	Flag-6	Flag-7	Flag-8
Disease severity	0.0	0.8	5.9	22.5
Disease incidence	0.0	58.8	97.5	100.0

When assessed at GS33, the disease had progressed onto flag-2, however severity was low at less than 7% in the untreated crop. There were no nitrogen timing effects evident in the levels of disease observed (Table 5). The only fungicide treatment observed to significantly reduce YLS infection severity and incidence on flag-2 was the two-spray program with applications at GS23–26 and GS32. There was a significant interaction between fungicide product and timing illustrating greater impact of a two spray program when Prosaro was used compared to Tilt (Figure 1). Disease incidence on flag-1 was reduced by all fungicide treatments. There were no significant differences between fungicide products.

Disease progress was slowed by the dry spring conditions such that at 50% ear emergence (GS55) YLS infection was less than 1% on the flag leaf and flag-1. There was evidence the application of fungicide did influence greenness of the crop canopy as measured by the Greenseeker® crop sensor using crop reflectance (normalised difference vegetation index — NDVI). The two-spray program gave significantly higher NDVI readings than the untreated crop at GS39 and GS55 (Table 6).

TABLE 4 Yellow leaf spot severity (% leaf area infected) and incidence (% of leaves infected) assessed 6 August 2014 second node stage (GS32), on the second newest fully-emerged leaf, flag-3 and flag-4.

	YLS (%)			
	Flag-3		Flag-4	
	Severity	Incidence	Severity	Incidence
Nitrogen timing				
GS22	1.3^{a}	68.8^{a}	8.1^{a}	98.6^{a}
GS31	1.2^{a}	71.3^{a}	8.8^{a}	99.4^{a}
Mean	**1.3**	**70.0**	**8.5**	**99.1**
LSD	1.05	19.22	4.05	1.99
Fungicide timing				
Untreated control	1.6^{a}	75.0^{a}	11.5^{a}	100.0^{a}
GS25	1.0^{b}	65.0^{a}	5.4^{b}	98.0^{a}
LSD	0.4	13.2	2.2	2.3
Product				
Prosaro	1.2^{a}	69.4^{a}	7.2^{a}	99.4^{a}
Tilt	1.4^{a}	70.6^{a}	9.7^{a}	98.8^{a}
LSD	0.7	13.1	3.2	2.6

Note: The newest emerged leaf (flag-2) had no disease as very newly emerged.

TABLE 5 Yellow leaf spot severity (% leaf area infected) and incidence (% of leaves infected) assessed 19 August 2014 third node stage (GS33), on the newest fully-emerged leaf flag-1 and flag-2

	YLS (%)			
	Severity		Incidence	
	Flag-1	Flag-2	Flag-1	Flag-2
Nitrogen timing				
GS22	0.9^{a}	5.5^{a}	50.3^{a}	94.1^{a}
GS31	0.9^{a}	5.5^{a}	50.6^{a}	94.4^{a}
Mean	**0.9**	**5.5**	**50.5**	**94.2**
LSD	0.53	1.31	14.65	7.68
Fungicide timing				
Untreated control	1.0^{a}	6.7^{a}	63.8^{a}	96.9^{a}
GS25	0.9^{a}	5.5^{ab}	48.8^{b}	93.8^{ab}
GS32	0.8^{a}	5.2^{ab}	50.6^{b}	94.4^{ab}
GS25 and GS32	0.8^{a}	4.5^{b}	38.8^{b}	91.9^{b}
LSD	0.44	2.04	12.43	4.6
Product				
Prosaro	0.9^{a}	5.3^{a}	49.7^{a}	92.2^{a}
Tilt	0.8^{a}	5.6^{a}	51.3^{a}	96.3^{a}
LSD	0.25	1.13	10.5	4.45

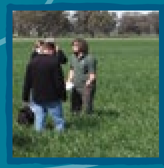
ii) Yield and quality results

Influence of nitrogen timing

There were no differences in yield or quality due to nitrogen timing during tillering or at first node.

Influence of fungicide timing

All fungicide timings generated a significant yield increase over the untreated control (Table 6). There was no difference in yield between the individual fungicide timings (GS22 vs GS32) both creating a 0.13–0.14t/ha yield increase. If both fungicide timings were used there was an additional 0.1t/ha yield increase giving a combined 0.23t/ha increase. There was a small but significant effect on screenings with fungicide application reducing screenings by approximately 1%.



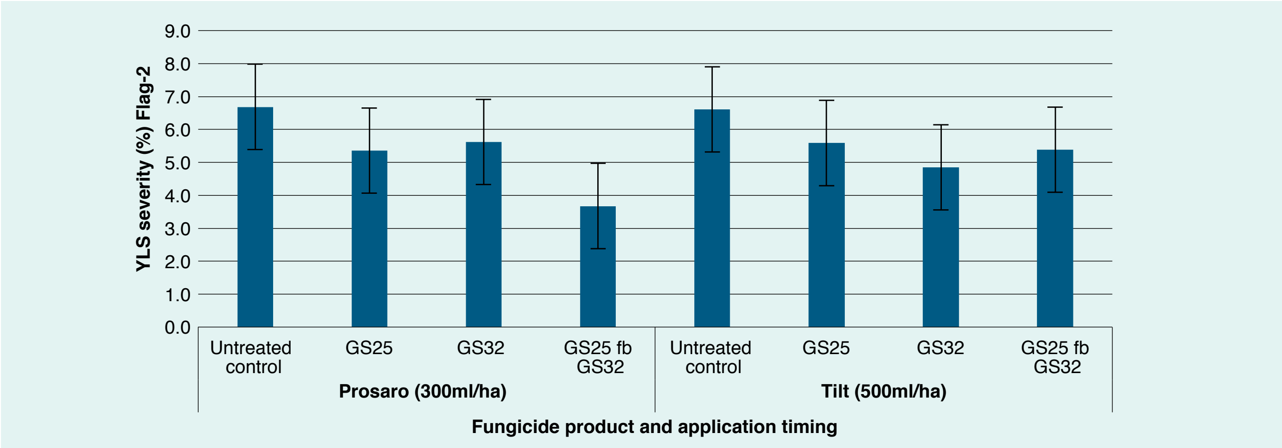


FIGURE 1 Interaction between fungicide application timing and product (mean of two nitrogen application timings)
* The error bars are a measure of LSD

TABLE 6 NDVI (scale 0–1) 6 August 2014 second node (GS32), 19 August 2014 third node (GS33), 5 September 2014 flag leaf fully emerged (GS39) and 16 September 2014 ear half emerged (GS55)

	NDVI			
	GS32	GS33	GS39	GS55
Nitrogen timing				
GS22	0.67^{a}	0.65^{a}	0.57^{a}	0.52^{a}
GS31	0.65^{a}	0.65^{a}	0.57^{a}	0.52^{a}
Mean	**0.66**	**0.65**	**0.57**	**0.52**
LSD	0.04	0.02	0.02	0.03
Fungicide timing				
Untreated control	0.66^{a}	0.64^{ab}	0.55^{c}	0.51^{b}
GS25	0.66^{a}	0.65^{ab}	0.57^{ab}	0.53^{a}
GS32	0.66^{a}	0.64^{b}	0.57^{bc}	0.52^{ab}
GS25 and GS32	0.66^{a}	0.66^{a}	0.58^{a}	0.53^{a}
LSD	0.01	0.01	0.01	0.01
Product				
Prosaro	0.66^{a}	0.65^{a}	0.56^{a}	0.52^{a}
Tilt	0.66^{a}	0.65^{a}	0.57^{a}	0.52^{a}
LSD	0.01	0.01	0.02	0.01

Influence of fungicide product

Although no differences were observed in disease control between Prosaro and Tilt, there was a significant yield advantage with Prosaro (0.06t/ha or 60kg/ha). There was also significantly higher protein with Prosaro, despite being the higher yielding treatment, which normally decreases the protein content through a dilution effect (Table 7).

There were two significant interactions indicating that Prosaro gave a significant yield response to a second application while Tilt did not. In addition the Prosaro treatments interacted positively with later nitrogen timing and a second fungicide spray (Figure 2).

Conclusions

For the second year in succession there have been responses to foliar fungicides for YLS control, despite yields being below 3t/ha and disease levels being relatively low (less than 10% on the top three leaves). In both years the crops had higher yield potential than 3t/ha but in both seasons the yield potential was reduced by frost.

These results do challenge current wisdom in two respects; firstly that fungicide application for YLS gives little value applied at late tillering, and secondly that despite low levels of disease on the top three leaves there were yield responses to application. Overall the yield differences are small (0.13–0.23 t/ha) but they are statistically (and potentially economically) significant.

TABLE 7 Yield, test weight, protein and screenings at harvest (GS99) 28 November 2014

	Yield and quality			
	Yield (t/ha)	**Test weight (kg/hL)**	**Protein (%)**	**Screening (%)**
Nitrogen timing				
GS22	2.71^{a}	77.9^{a}	11.8^{a}	5.3^{a}
GS31	2.70^{a}	77.7^{a}	12.0^{a}	6.0^{a}
Mean	**2.70**	**77.8**	**11.9**	**5.6**
LSD	0.04	0.8	0.4	1.8
Fungicide timing				
Untreated control	2.58^{c}	77.6^{a}	12.0^{a}	6.2^{a}
GS25	2.72^{b}	77.6^{a}	11.9^{a}	5.4^{b}
GS32	2.71^{b}	78.0^{a}	11.7^{a}	5.4^{b}
GS25 and GS32	2.81^{a}	77.9^{a}	11.9^{a}	5.5^{b}
LSD	0.07	0.7	0.4	0.5
Product				
Prosaro	2.73^{a}	77.6^{a}	12.2^{a}	5.9^{a}
Tilt	2.67^{b}	78.0^{a}	11.5^{b}	5.4^{a}
LSD	0.03	0.4	0.4	0.7

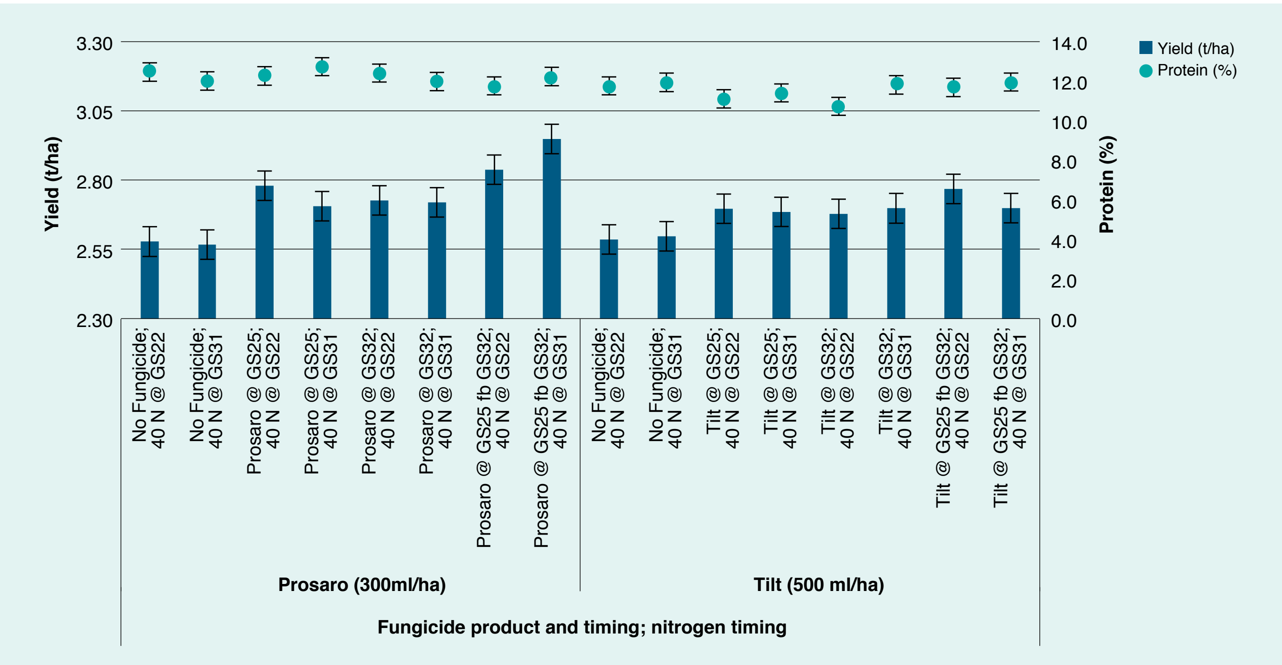


FIGURE 2 Influence of nitrogen timing, fungicide strategy on yield and protein, 28 November 2014

* The error bars are a measure of LSD

At $300/t such yield increases would generate gross income increases of 39–69$/ha. Allowing for cost of fungicide and application the return on input is approximately 2:1 for both one and two spray programs in this trial.

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