Stem rust control in wheat

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Take home messages

- **use of foliar fungicides applied prophylactically at the start of flowering (GS60) gave good control of a late stem rust infection in Yitpi, but were largely uneconomic in 2011**
- **stem rust infection developed in early November (late milky ripe stage) and never reached more than 10% severity on the flag sheath; under these circumstances there was no effect on grain yield**
- **disease control achieved with different foliar fungicide products and rates largely mirrored 2010 results, illustrating the importance of robust rates for the control of this disease, particularly with products such as Folicur (tebuconazole). The results also confirmed the inferiority of Tilt (propiconazole) and foliar applied Impact (flutriafol) compared with the other fungicide products**
- **if growing stem rust susceptible varieties such as Yitpi, be vigilant: check crops regularly and apply Folicur at 290ml/ha if the disease is observed at late head emergence or before**

Background

After the stem rust (*Puccinia graminis f.sp. tritici*) outbreak at the end of 2010, followed by an extremely wet summer, there was an expectation that this disease would pose a serious threat to Yitpi and other susceptible wheats crops throughout the Mallee in 2011. With this in mind, two trials were set up to further verify last year's results on fungicide application.

Both trials were set up to investigate the performance and profitability of foliar fungicides aplied for the control of stem rust. The first trial (Trial 1) was part of a nationally co-ordinated project funded by the GRDC to gather more data on both the efficacy and economics of fungicide products and rates for the control of stem rust. The second trial, funded by BCG and Foundation of Arable Research (FAR), examined the use of fungicide mixtures which are unavailable to the grower as formulated products but which may offer different cost options for stem rust control if the grower mixes current commercial formulations.

Aim

To evaluate the efficacy of different foliar fungicides and fungicide mixtures for the control of stem rust (*Puccinia graminis f.sp. tritici*) in wheat.

Method

Two replicated field trials were set up in the southern Mallee. Both trials were established in an unsprayed commercial crop of Yitpi (S - susceptible rating for stem rust) near Watchem.

Location:	Watchem (28km south of Birchip)
Replicates:	4
Sowing date:	26 May 2011
Crop type:	Yitpi wheat
Sowing rate:	50kg/ha

Fertiliser: MAP 50kg/ha (at sowing)

Seeding equipment: minimum till, chisel plough (5cm points), prickle chain on 30cm row spacing

Trial 1 (GRDC funded trial): products and rates are outlined in Table 1 and were applied at the start of flowering (GS60) on 12 October 2011, **before any infection was recorded**.

Trial 2 (BCG and FAR funded): fungicide mixtures were sprayed at the same time in a trial beside Trial 1; again no disease was present at application. The treatment list for Trial 2 is presented in Table 2.

Table 1. Fungicide treatment and application rate for Trial 1 at Watchem. Label rates for stem rust control are shaded (N.B. Amistar Xtra® is not registered for stem rust control in Australia)

NB:The use of rates lower than label rates in this trial do not constitute a recommendation.

Trt	Fungicide treatment and rate	Rate description	Active ingredient
1.	Prosaro® 420SC 75 ml/ha + BS1000 0.25%	Low	Prothioconazole + Tebuconazole
2.	Prosaro 420SC 150ml/ha + BS1000 0.25%	Mid	
3.	Prosaro 420SC 300ml/ha + BS1000 0.25%	High	
4.	Opus® 125SC 125 ml/ha	Low	Epoxiconazole
5.	Opus 125SC 250 ml/ha	Mid	
6.	Opus 125SC 500ml/ha	High	
7.	Amistar Xtra® 280SC 200 ml/ha	Low	Azoxystrobin + Cyproconazole
8.	Amistar Xtra 280SC 400 ml/ha	Mid	
9.	Amistar Xtra 280SC 800 ml/ha	High	
10.	Tilt® 250EC 125 ml/ha	Low	Propiconazole
11.	Tilt 250EC 250 ml/ha	Mid	
12.	Tilt 250EC 500 ml/ha	High	
13.	Tilt Xtra® 330EC 125 ml/ha	Low	Cyproconazole + Propiconazole
14.	Tilt Xtra 330EC 250 ml/ha	Mid	
15.	Tilt Xtra 330EC 500 ml/ha	High	
16.	Folicur® 430SC 72.5 ml/ha	Low	Tebuconazole
17.	Folicur 430SC 145 ml/ha	Mid	
18.	Folicur 430SC 290 ml/ha	High	
19.	Opera® 147SC 250 ml/ha	Low	Pyraclostrobin + Epoxiconazole
20.	Opera 147SC 500 ml/ha	Mid	
21.	Opera 147SC 1000 ml/ha	High	
22-24.	Untreated		

Trial 1 was laid out as a split plot design with fungicide rate as the main plot and fungicide product as the sub plot. In each rate block there was an untreated plot resulting in three untreated plots per replicate (low, med and high rate blocks). This allowed a more robust statistical analysis of results to be carried out between treatments and the untreated (LSE effect).

Table 2. Fungicide products and mixtures used in Trial 2 at Watchem

N.B. use of product mixtures and use of rates lower than label rates in this trial do not constitute a recommendation

Trt	Product mix	Approx Cost ($/ha)
1	Untreated	0
2	Folicur 145ml/ha	3
3	Folicur 290ml/ha	6
4	Opus 250ml/ha + Folicur 145ml/ha	10
5	Opus 125ml/ha + Folicur 290ml/ha	9.5
6	Tilt 500ml/ha + Folicur 145ml/ha	11.8
7	Tilt 500ml/ha + Folicur 290ml/ha	14.8
8	Tilt 250ml/ha + Folicur 145ml/ha	7.4
9	Opus 250ml/ha + Amistar Xtra 200ml/ha	17
10	Opera 500ml/ha + Amistar Xtra 200ml/ha	28.5
11	Prosaro 150ml/ha + BS1000 (0.25% v/v)	10.5
12	Prosaro 300ml/ha + BS1000 (0.25% v/v)	21
13	Prosaro 72.5ml/ha + Opus 125ml/ha + BS1000	8.75
14	Prosaro 72.5ml/ha + Opera 250ml/ha + BS1000	14.8
15	Flutriafol 500ml/ha + BS1000 (0.25% v/v)	10.2

Trial 2 was set up as a randomised complete block.

All products for both trials were applied with a hand boom applied at walking pace (4 – 5km/hr), according to the details outlined in Table 3.

Table 3. Application details (date, growth stage, water rate and nozzle settings)

Application date	Growth stage	Water rate (l/ha)	Nozzles & pressure
October 12	GS60 (start of flowering)	160	DG 110-02, 2.0 bar

In Trial 1, stem rust was assessed in the untreated plots at 7 and 14 days after application and then all treatments were assessed 25 and 37 days after application. Ten or 15 stems were sampled randomly from each plot (40 - 60 stems per treatment, depending on assessment timing) and percentage stem rust incidence and severity was assessed on different sections of the stem: ear, peduncle (true stem below the ear), and flag leaf, flag leaf sheath, flag-1, flag-1 sheath and flag-2 sheath. Trial 2 was assessed 37 days after application, but would have been subject to the same infection build up (since it adjoined trial 1).

Results

Trial 1: products and rates

Disease control

In the untreated plots, stem rust developed to 100% incidence (100% of stems infected) and just under 10% severity (%area affected) on the flag leaf sheath by the late dough stage (GS85-87) (Figure 1). The leaf sheath displayed the highest infection of those plant parts assessed (approximately 6% infection on the peduncle, 10% on the flag sheath and 5% on flag-1 sheath). The trial was also subject to low levels of leaf rust and stripe rust (approx. 1% on flag-1). However, these rusts became less important as the leaves and lower leaf sheathes senesced.

Appreciable levels of stem rust did not start developing on the stem until early November (25 days after application), by which time the crop had reached the end of milky ripe stage (GS77). At this assessment, the effect of fungicide treatment became significant, though infection was still less than 1% severity and only 30% incidence. At 37 days after application the influence of fungicide treatment was much clearer, products giving between 40-95% control depending on product and rate (Table 4).

Influence of fungicide product and rate on stem rust incidence and severity

- all fungicide treatments resulted in the control of stem rust, with the highest rates of active ingredient giving the best control, particularly with Folicur (tebuconazole)
- at the high rates tested, there was no difference in stem rust control (severity) between Amistar Xtra (not currently registered), Folicur, Opera (NB. It is 500ml/ha rate that is registered for stem rust control, not 1000ml/ha), Opus and Prosaro. These products gave the best control (85-95% control). Folicur, Opera and Opus were significantly more effective than Tilt and Tilt Xtra.
- Tilt gave the poorest level of control at all rates of application. Increasing the rate of Tilt did little to reduce the incidence or severity of stem rust.
- the addition of cyproconazole to propiconazole in Tilt Xtra gave improved control of stem rust relative to straight Tilt, but it was still inferior to Opus and Folicur at the highest rates tested
- at lower rates Prosaro and Opus were better options, being statistically superior to Folicur, Tilt and Tilt Xtra, but the advantage over Amistar Xtra and Opera was not statistically significant
- Folicur was very effective at the label rate of 290ml/ha, but showed a sharp falloff in activity at the low rate (72ml/ha)
- the addition of the strobilurin pyraclostrobin to Opus (in the product Opera) gave little advantage in terms of stem rust control over straight Opus

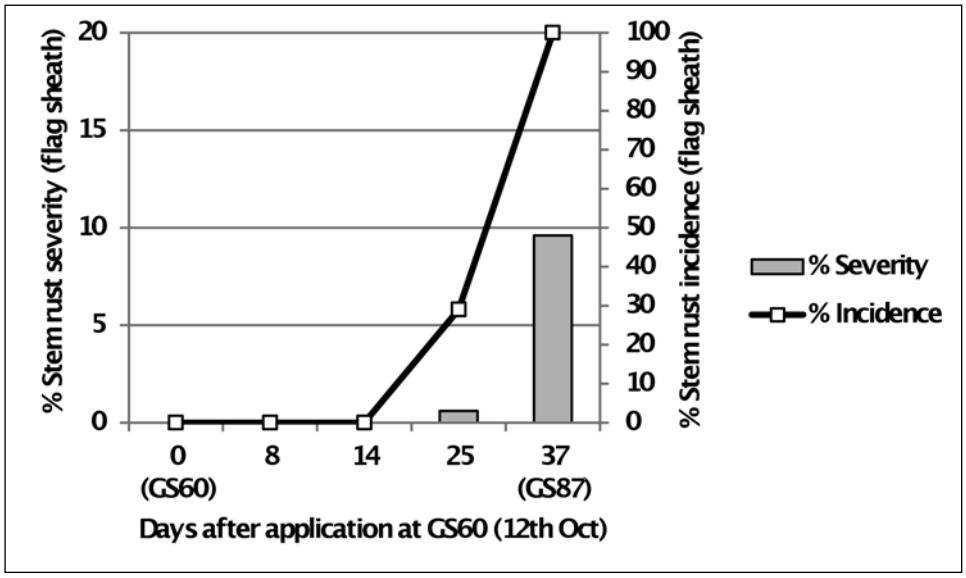

Figure 1. Stem rust development (% incidence and severity) on the flag sheath of the untreated crop 0, 7, 14, 25 and 37 days following trial treatment application, Watchem (Trial 1). Note: incidence is the % of stems infected; severity is the % of flag sheath area affected by disease

Table 4. Influence of fungicide product on %incidence and %severity of stem rust on the flag sheath at the three application rates tested 37 days after application (37 DAA) – GS85-87 (late dough) 19 November 2011

Fungicide Treatment	% Stem rust infection on flag leaf sheath					
	Incidence (%)			Severity (%)		
	Low rate	Mid rate	High rate	Low rate	Mid rate	High rate
Prosaro	80	78	53	2.3	1.9	1.4
Opus	80	88	50	2.5	2.5	1.0
Amistar Xtra	83	90	60	2.9	3.4	1.4
Tilt	98	95	100	4.8	5.5	4.3
Tilt Xtra	95	95	95	3.9	3.8	2.6
Folicur	98	63	30	3.9	1.5	0.5
Opera	100	80	45	3.0	3.3	0.9
Untreated	100			9.6		
Sign. Diff						
Product	**P <0.001**			**P <0.001**		
Rate	**P <0.01**			**P <0.05**		
Product x Rate	**P <0.01**			**NS**		
LSD (P=<0.05)	**14%**			**0.8%**		
Product	**13%**			**1.1%**		
Rate						
Product x Rate	**24%**			**1.4**		
Same rate	**26%**			**1.7**		
Different rate	**22**			**37**		
CV%						

Yield (t/ha) and Margin ($/ha)

There was no significant yield benefit from fungicide application in Trial 1 when products and rates were compared. When the LSE (least significant effect) is employed to compare the product and rates treatments with the untreated control, Opus, at the low and high rate of application, gave a significant (P=0.05) yield increase over the untreated. All other treatments gave yields that were not statistically different from the untreated (Table 5). There were no significant yield differences between fungicides tested at the highest rate, but at the lowest rate of product application there was a significant yield advantage to Opus over Tilt, Tilt Xtra, Opera and Amistar Xtra. Margins were in the main negative, given the small differences in yield generated (3.06-3.60t/ha). Opus gave the best margins at the highest and lowest rate tested, but it was only at the lowest rate that the margin was significantly better than the untreated.

Table 5. Influence of fungicide product on yield (t/ha) and margin ($/ha) after chemical and application cost relative to untreated set at 0

Fungicide Treatment	% Stem rust infection on flag leaf sheath					
	Yield (t/ha)			Margin ($/ha)		
	Low rate	Mid rate	High rate	Low rate	Mid rate	High rate
Prosaro	3.36	3.11	3.35	22	-35	3
Opus	3.60	3.04	3.50	73	-47	42
Amistar Xtra	3.23	3.29	3.32	-11	-7	-22
Tilt	3.07	3.21	3.42	-36	-9	32
Tilt Xtra	3.06	3.23	3.25	-41	-8	-13
Folicur	3.35	3.33	3.20	23	18	-10
Opera	3.12	3.19	3.20	-33	-28	-44
Untreated	3.21					
Sign. Diff *Product* *Rate* *Product x Rate* ***CV%***	**NS** **NS** **NS** **6.85**			**NS** **NS** **NS** **823**		
Sign. Diff LSE (effect) (0.05)	**P <0.05** **0.26 t/ha**			**P<0.05** **$55/ha**		

Cost of fungicides used and margin over untreated at the high rate of application. Note: grain price $214.25/t; 2.5% wheel damage was subtracted from the treated yield.

Trial 2: fungicide mixtures

All treatments in the Fungicide mixtures trial were applied on October 12th at the start of flowering (GS60). The development of disease was identical to trial 1, since the two trials were adjoining. Stem rust developed late and was assessed 37 days after application for the control of the disease at mid-late dough stage (GS85-87). Stem rust infection, % control, yield and margin are presented in Table 6.

Table 6. Influence of fungicide products and mixtures on % stem rust infection (severity on flag leaf sheath), % control, yield (t/ha) and margin after chemical/application cost relative to the untreated. Watchem Trial 2 cv Yitpi.

N.B. use of product mixtures and use of rates lower than label rates in this trial do not constitute a recommendation

Trt	Product mix	% Stem Rust	% Control	Yield t/ha	Margin $/ha
1	Untreated	8.7[a]	0	3.31	0
2	Folicur 145ml/ha	3.2[c]	63	3.15	-73
3	Folicur 290ml/ha	0.8[d]	91	3.41	-22
4	Opus 250ml/ha + Folicur 145ml/ha	0.7[d]	92	3.43	-21
5	Opus 125ml/ha + Folicur 290ml/ha	1.1[cd]	87	3.30	-47
6	Tilt 500ml/ha + Folicur 145ml/ha	1.7[cd]	80	3.24	-64
7	Tilt 500ml/ha + Folicur 290ml/ha	0.8[d]	91	3.31	-53
8	Tilt 250ml/ha + Folicur 145ml/ha	1.5[cd]	83	3.35	-36
9	Opus 250ml/ha + Amistar Xtra 200ml/ha	2.1[cd]	76	3.15	-87
10	Opera 500ml/ha + Amistar Xtra 200ml/ha	2.1[cd]	76	3.20	-88
11	Prosaro 150ml/ha + BS1000 (0.25% v/v)	2.0[cd]	77	3.39	-33
12	Prosaro 300ml/ha + BS1000 (0.25% v/v)	1.9[cd]	78	3.36	-48
13	Prosaro 72.5ml/ha + Opus 125ml/ha + BS1000	2.3[cd]	74	3.44	-19
14	Prosaro 72.5ml/ha + Opera 250ml/ha + BS1000	2.3[cd]	74	3.34	-55
15	Flutriafol 500ml/ha + BS1000 (0.25% v/v)	6.1[b]	30	3.34	-40
	Significant Difference **LSD (P=<0.05)** **CV %**	**P< 0.001** **2.2** **63**		**NS** **5.8**	**NS** **81**

Disease infection figures followed by the same letter are not statistically different.

Disease control

There were significant differences in stem rust control on the flag sheath due to fungicide application. The least effective foliar fungicide treatment was flutriafol (the same active ingredient as fertiliser treatments of Intake®/Impact®) which gave only 30% control of the disease. Other treatments illustrated no additional stem rust control over and above what could be achieved with Folicur applied at the 290ml/ha rate. Low rate fungicide mixtures combining Prosaro and Opus were as successful as Prosaro at 150 and 300ml/ha, though the low rate of Prosaro alone was not trialled in Trial 2. In the neighbouring trial (Trial 1) Prosaro alone at the low rate was a relatively strong option, meaning that there may have been little value of other fungicides with it at this lower rate.

Yield (t/ha) and Margin($/ha)

There were no significant differences in yield amongst fungicide treatments and none of the treatments was significantly different from the untreated control. All fungicide treatment margins were negative relative to the untreated crop, but the differences were not quite statistically significant (p=0.06).

Interpretation

In terms of disease control, the results largely endorsed research findings from 2010, confirming the importance of robust rates for control of stem rust, particularly with products such as Folicur (a feature that showed up in Trials 1 & 2). The results also confirmed the inferiority of Tilt for stem rust control as well as flutriafol which had not been tested in the 2010 season as a foliar spray.

In terms of yield, the late nature of the stem rust build up, coupled with low spring rainfall, meant that there was little correlation between stem rust present at the end of grain fill and final yield. Only in Trial 1 did Opus significantly out-yield the untreated control at two of the three rates tested.

The work illustrated that lower rainfall and lower yield potential means that, even with stem rust infection, large economic rewards from fungicide application are not a foregone conclusion. Growers continuing with Yipti must continue to be vigilant for this disease, given that there was still reasonable infection present in untreated crops at the end of 2011. Much will of course depend on the conditions for rust carryover, but, in theory, the conditions cannot be worse than those in the 2010 green bridge period. The information generated this season in these two trials and at Corack should encourage growers to use the best products, rates and timings in order to provide protection against this disease, should infection develop earlier in the growing season or if the season is more conducive to the disease. These results mirror those from Corack (see Using flutriafol (Intake®) in combination with foliar fungicides for the control of yellow leaf spot and stem rust) and remind us of the need to keep fungicide spending in check for Mallee regions.

Commercial practice: what this means for the farmer

If growing stem rust-susceptible varieties such as Yitpi be vigilant: check crops regularly and apply Folicur at 290ml/ha if the disease is observed at late head emergence or before.

Acknowledgments

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