Evaluation of fungicide management strategies to control spot-form of net blotch in barley

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Key words

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Take home messages

- Spot-form of net blotch (SFNB) caused at least 18-21% yield loss in the susceptible barley varieties La Trobe⦶ and Spartacus CL⦶ in trials conducted at Tamworth and Dubbo in 2016. Note Dubbo also had another leaf disease, scald develop late in the season.
- Foliar fungicides provided effective suppression of SFNB + scald with associated yield benefits when applied at both GS31 and GS49.
- The seed treatment Systiva® provided useful levels of SFNB suppression post GS49 under moderate disease pressure at Tamworth but activity appeared to have waned by this growth stage under higher disease pressure at Dubbo.
- Systiva® basically had similar efficacy to the GS31 application of foliar fungicides when both strategies were backed up by a second foliar application at GS49.
- Product Z, an experimental foliar fungicide, appears to have improved SFNB activity compared to Amistar Xtra® which was then slightly better than Tilt®250 in these experiments.
- Barley growers are still urged to use integrated disease management (IDM) strategies to limit losses from SFNB and scald, with fungicides being only one component. IDM of barley leaf diseases will reduce disease pressure and the reliance on fungicides as the sole management tool but importantly also delays the development of resistance to these valuable chemical options.

Background

Spot-form of net blotch (SFNB), caused by the fungus *Pyrenophora teres*, is a common foliar disease of barley in the northern grains region. The pathogen survives between seasons in barley stubble so risk is elevated with both stubble retention and barley-on-barley rotations. Barley grass can also be an inoculum source. SFNB lesions reduce green leaf area (photosynthetic area) which can reduce both yield and grain quality. Losses to SFNB are most likely in wet seasons which favour infection and when greater than 10% infection occurs on the top four barley leaves during grain filling (Jayasena *et al.* 2007).

Avoiding barley-on-barley rotations, growing varieties with improved levels of resistance and application of foliar fungicides are currently the most effective management options for limiting losses to SFNB. Unfortunately, many of the common barley varieties grown in the northern grains region and recent releases have limited levels of resistance to SFNB so there is a tendency towards reliance on foliar fungicides in wetter seasons. A new fungicide seed treatment, Systiva® (fluxapyroxad) was recently registered by BASF for the control of SFNB but there is limited data from the northern grains region. Growers in the region were also interested in the relative efficacy of some of the registered foliar fungicide options against SFNB and a new Bayer CropScience fungicide (Product Z) which is in the advanced stages of evaluation and registration.

Research in 2016

Two replicated experiments were conducted in 2016 with one site at Tamworth and the second near Dubbo. The Dubbo site was established into standing stubble of a SFNB susceptible (cv. Hindmarsh⦶) barley crop grown in 2015 whilst the Tamworth site was inoculated at the 2-3 leaf growth stage with a low level (100 kg/ha) of locally sourced infected cv. Urambie⦶ stubble.

Two SFNB susceptible barley varieties La Trobe⦶ and Spartacus CL⦶ were used in both experiments at a target plant population of 100 plants/m^2 with seed treatments evaluated being:

1. Dividend M® (difenoconazole 92 g/L + metalaxyl-M 23 g/L) at 260 mL/100 kg seed
2. Systiva® (fluxapyroxad 333 g/L) at 150 mL/100 kg seed

Dividend M® is NOT registered for the control of SFNB but was included to represent a commonly used seed treatment for bunt and smut control and as the base seed treatment for evaluating the efficacy of foliar fungicides. All seed was further treated with Emerge® (imidacloprid at 240 mL/100 kg seed) to prevent early aphid feeding and the potential transmission of Barley Yellow Dwarf Virus (BYDV) compromising the experiments. The experiment at Dubbo was sown on the 20th May whilst the Tamworth trial was sown on the 16th June 2016.

Foliar fungicide treatments and application timings were:

1. Nil control where no foliar fungicide was applied
2. Tilt®250 (propiconazole at 500 mL/ha) applied at GS31
3. Amistar Xtra® (azoxystrobin + cyproconazole) applied at GS31
4. Product Z (experimental) applied at GS31
5. Tilt®250 applied at GS31 + GS49
6. Amistar Xtra® applied at GS31 + GS49
7. Product Z applied at GS31 + GS49

In addition the efficacy of a fungicide management strategy using Systiva® for early SFNB control in combination with a later (GS49) application of each of these three foliar fungicides was investigated. The full treatment combinations examined are outlined in Table 1 with four replicates of each treatment in the Dubbo experiment and six at Tamworth. The GS31 application of foliar fungicides occurred on the 9th August at Dubbo and 30th August at Tamworth; whilst the GS49 treatments were applied at Dubbo on the 13th September and at Tamworth on the 27th September.

Visual assessments of the severity of SFNB (and scald at Dubbo) were recorded after GS49 for each plot on a 0-10 scale related to the estimated leaf area infected with lesions where 0 = no lesion and 10 = 100% of leaf area infected. At each assessment the top three leaves and the bottom of the canopy (lower leaves) were scored separately. The retention of green leaf area (GLR) within the whole canopy was also visually assessed in each plot late in the season on a 0-10 scale, where 0 = no remaining green leaves and 10 = 100% of canopy still green. Both experiments were harvested using plot headers and grain samples retained for quality assessments which were unfortunately not available at the time of writing this paper.

Results

Seasonal conditions were very conducive to the development of SFNB at both sites in 2016 with frequent rainfall events and mild temperatures through Spring. Although La Trobe is rated susceptible (S) to SFNB whilst Spartacus is rated susceptible-very susceptible (S-VS) this difference in resistance level did not result in any signifcant interaction between variety and fungicide treatments at either site. Hence, throughout this paper results are presented as the average of these two SFNB and scald suscpetible barley varieties.

Tamworth 2016

The Tamworth experiment was inoculated at the seedling stage with stubble collected from SFNB suspectible barley crop (cv. Urambie) grown in 2015. This avoided any issues with establishment but created a more moderate build-up of disease pressure from SFNB throughout the season compared to the Dubbo experiment. Scald was not evident in this experiment throughout the season with SFNB being the only leaf disease observed.

The use of the seed treatment Systiva® alone provided a visual reduction in the severity of SFNB in both post GS49 assessments compared with the base seed treatment (Dividend M®) with a corresponding slight increase in GLR late in the season (Table 1). The levels of disease control and GLR provided by each of the three foliar fungicides when applied at GS31 only, were largely comparable with that achieved with the Systiva® alone treatment.

The severity of SFNB in the later assessment was further reduced with each foliar fungicide product when applied at both GS31 and then GS49, compared to application at GS31 only. Two applications of each product provided better disease control and GLR than the use of Systiva® alone with efficacy generally Product Z>Amistar Xtra®>Tilt®250 (Table 1).

Levels of disease control and GLR achieved in the second assessment (3rd November) with Systiva® were all improved when followed by a GS49 application of a foliar fungicide and were comparable to that achieved with two applications (GS31 + GS49) of each respective foliar fungicide (Table 1). Again efficacy of foliar fungicide products was generally Product Z>Amistar Xtra®>Tilt®250 when applied at GS49 following seed treatment with Systiva®.

Table 1. Effect of fungicide treatments on the severity of SFNB in the whole canopy in October, in the bottom and top of barley canopies in November and green leaf retention scores – Tamworth 2016

Seed treatment	In-crop fungicide	Score 7.10.16[A]		Bottom 3.11.16[B]		Top 3.11.16[B]		GLR 3.11.16[B]	
Dividend M	Nil	5.6	f	9.1	g	7.3	h	2.0	h
	Tilt GS31	3.8	e	7.8	f	5.6	g	3.0	g
	Amistar Xtra GS31	2.3	b	7.2	ef	4.7	ef	3.7	def
	Product Z GS31	2.5	bc	6.9	e	4.3	e	3.8	de
	Tilt GS31 + GS49	3.4	de	5.1	d	3.0	d	4.4	c
	Amistar Xtra GS31 + GS49	2.3	b	3.1	bc	1.6	bc	5.3	b
	Product Z GS31 + GS49	1.4	a	1.8	a	0.8	a	7.0	a
Systiva	Nil	3.0	cd	7.5	ef	4.9	ef	3.2	efg
	Tilt GS49	3.0	cd	5.3	d	2.8	d	4.2	cd
	Amistar Xtra GS49	3.0	cd	3.4	c	1.8	c	5.8	b
	Product Z GS49	2.6	bc	2.5	ab	1.0	ab	6.9	a

Values followed by the same letter are not significantly different (*P*=0.05).

[A]Assessment was 113 days after application (DAA) for Systiva®, 38 DAA for GS31 foliar fungicides and 10 DAA for GS49 foliar fungicides.

[B]Assessment was 140 DAA for Systiva®, 65 DAA for GS31 foliar fungicides and 37 DAA for GS49 foliar fungicides.

Yield outcomes in the Tamworth experiment predominantly corresponded to levels of SFNB control achieved and the retention of green leaf area late in the season. Although there was no “true” nil disease control in the experiment, the yield difference between the highest treatment and the nil control represented 18% yield loss (Figure 1).

The use of the seed treatment Systiva® alone provided a 7% (0.27 t/ha) yield benefit over the base seed treatment (Dividend M®) in the absence of foliar fungicide application which was equivalent to the levels of benefit provided by the GS31 only applications of each foliar fungicide product (Figure 1).

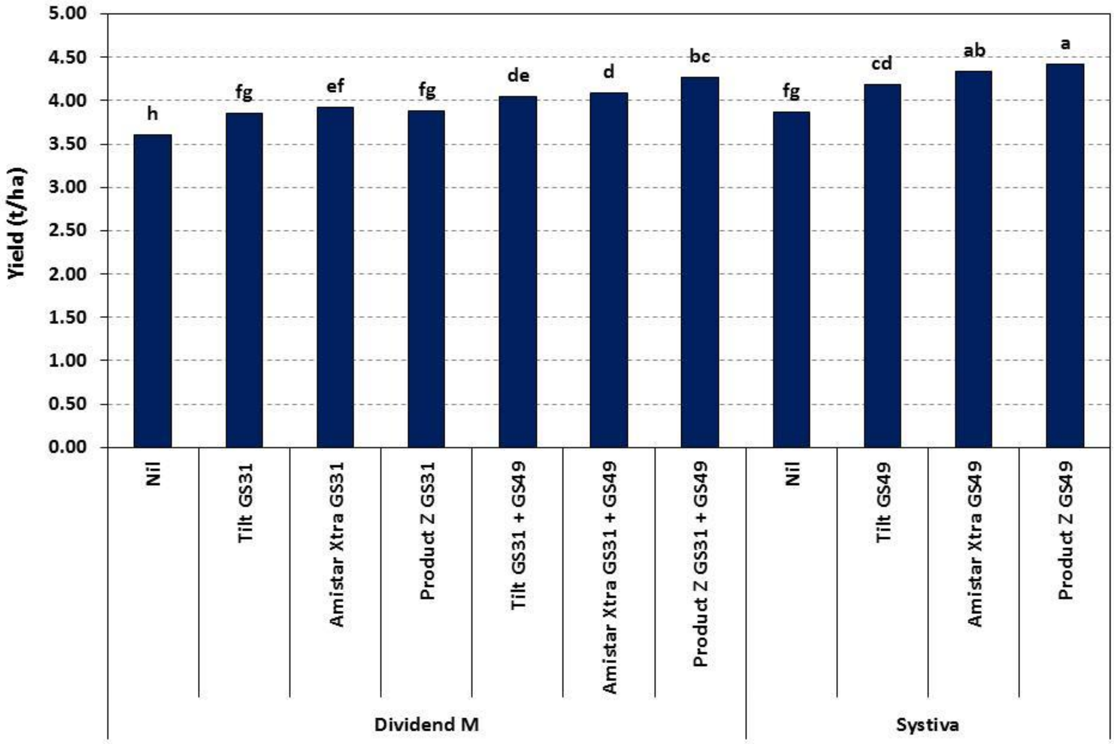

Figure 1. Effect of fungicide treatments on barley yield (average of La Trobe⁽ᴰ⁾ and Spartacus CL⁽ᴰ⁾) in the presence of SFNB infection – Tamworth 2016

Bars with the same letter are not significantly different (*P*=0.05).

The yield benefit increased with two applications of each foliar fungicide product compared to the GS31 only equivalent treatment by between 12% (0.44 t/ha) with Tilt®250 up to 18% (0.66 t/ha) with Product Z at GS31 + GS49 (Figure 1). Yield benefit with two in-crop foliar applications was Product Z>Amistar Xtra® = Tilt®250.

The yield benefit associated with the seed treatment Systiva® was improved when followed by the application of a foliar fungicide at GS49. Yield in the Systiva® + Tilt®250 at GS49 treatment was equivalent to the application of Tilt®250 at both GS31 + GS49. However, with the other two foliar fungicide products the yield benefit was increased when used in combination with Systiva® compared to two applications of that product. Systiva® followed by Amistar Xtra® at GS49 provided a 0.74 t/ha (20%) yield benefit while Systiva® followed by Product Z at GS49 provided a 0.81 t/ha (23%) yield increase over the nil control treatment (Figure 1).

Dubbo 2016

The Dubbo experiment was established into a relatively heavy stubble load of a SFNB suspectible barley crop (cv. Hindmarsh) grown in 2015. Unfortunately, this resulted in patch establishment within plots but created severe disease pressure throughout the season from SFNB with another stubble-borne leaf disease, scald (*Rhynchosporium secalis*) becoming evident later in the season.

The use of the seed treatment Systiva® alone did not provide any visual reduction in the severity of SFNB in either the top or bottom of canopies compared with the base seed treatment (Dividend M) in either post GS49 assessment (Table 2). However, Systiva® alone did provide a slight reduction in the severity of scald.

Application of the three different foliar fungicides at GS31 only provided modest reductions in the severity of SFNB in the first assessment but were less pronounced in the later assessment with no clear diffence between products. However, all three foliar fungicides when applied at GS31 roughly halved the severity of scald late in the season (Table 2). Note: Amistar Xtra is not registered for control of scald in barley.

The severity of SFNB was further reduced with each foliar fungicide product when applied at both GS31 and then GS49, with the level of control achieved with Tilt®250 and Amistar Xtra® generally being equivalent, but Product Z having improved efficacy (Table 2). Two applications of each foliar fungicide product nearly eliminated the presence of scald late in the season. Levels of disease control achieved with Systiva® were all improved when followed by a GS49 application of a foliar fungicide. However, efficacy was generally lower than that achieved with two applications (GS31 + GS49) of each respective foliar fungicides (Table 2).

Table 2. Impact of fungicide treatments on the severity of SFNB in the bottom and top of barley canopies at two dates, scald* severity in top of canopy and green leaf retention scores – Dubbo 2016

Seed treatment	In-crop fungicide	Bottom 28.9.16[A]		Top 28.9.16[A]		Bottom 20.10.16[B]		Top 20.10.16[B]		Scald 20.10.16[B]		GLR 27.10.16[C]	
Dividend M	Nil	8.0	h	6.1	e	8.3	h	7.8	f	6.6	d	1.8	gh
	Tilt GS31	5.8	efg	4.9	cd	7.4	fgh	6.3	de	3.6	b	2.5	fg
	Amistar Xtra GS31	4.6	cd	4.0	c	7.1	efg	6.0	d	3.3	b	2.8	f
	Product Z GS31	3.8	bc	4.3	cd	8.3	h	7.0	ef	3.1	b	2.3	fgh
	Tilt GS31 + GS49	4.8	cde	3.0	b	5.5	cd	3.9	bc	0.5	a	4.5	de
	Amistar Xtra GS31 + GS49	3.5	b	2.5	b	4.6	bc	3.4	b	0.0	a	5.8	bc
	Product Z GS31 + GS49	2.4	a	1.5	a	3.1	a	1.6	a	0.0	a	6.9	a
Systiva	Nil	8.0	h	6.3	e	7.6	gh	7.3	f	5.4	c	1.5	h
	Tilt GS49	6.3	g	4.6	cd	6.4	def	4.5	c	0.3	a	4.3	e
	Amistar Xtra GS49	6.6	g	4.5	cd	6.1	de	4.4	c	0.5	a	5.1	cd
	Product Z GS49	5.1	def	3.0	b	4.1	ab	2.1	a	0.5	a	6.4	ab

Values followed by the same letter are not significantly different (P=0.05).

[A]Assessment was 100 days after application (DAA) for Systiva®, 50 DAA for GS31 foliar fungicides and 15 DAA for GS49 foliar fungicides.

[B]Assessment was 122 DAA for Systiva®, 72 DAA for GS31 foliar fungicides and 37 DAA for GS49 foliar fungicides.

[C]Assessment was 129 DAA for Systiva®, 79 DAA for GS31 foliar fungicides and 43 DAA for GS49 foliar fungicides.

* Amistar Xtra is not registered for control of scald in barley

Treatment trends in the retention of green leaf area (GLR) largely reflected the level of leaf disease control (SFNB + scald) achieved. In regards to foliar fungicide products, GLR was higher in treatments with two fungicide inputs with GLR generally being Product Z>Amistar Xtra®> Tilt® (Table 2).

Unfortunately, patchy establishment resulting from sowing into a heavy stubble load from the previous season increased the variability of yield outcomes in this experiment. Hence, differences apparent in the levels of leaf disease control and GLR did not necessarily translate into significant yield outcomes (Figure 2). Significance was only achieved at the 83% (P=0.17) confidence level so yield findings from this site should be interpreted with caution. Although there was no “true” nil disease control in the experiment, the yield difference between the highest treatment (Systiva® + Product Z at GS49) and the nil control (Dividend M® with no foliar fungicide application) represented a 0.95 t/ha difference or 21% yield loss (Figure 2). Fungicide strategies that used two inputs (Systiva® + GS49 foliar fungicide or GS31 + GS49 foliar applications) provided the most consistent yield benefits over the nil control of between 0.47 t/ha (13%) with Systiva® + Tilt®250 at GS49, up to 0.95 t/ha (26%) with Systiva® + Product Z at GS40 (Figure 2).

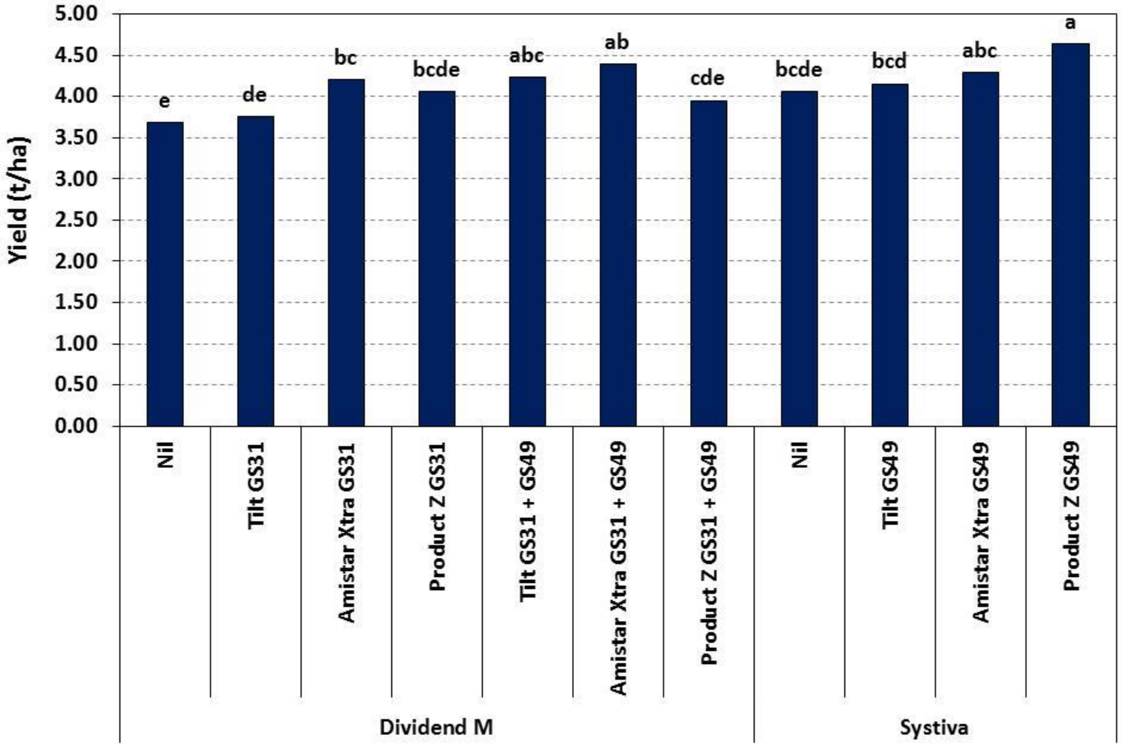

Figure 2. Effect of fungicide treatments on barley yield (average of La Trobe⟨PBR⟩ and Spartacus CL⟨PBR⟩) in the presence of SFNB and scald infection – Dubbo 2016

Bars with the same letter are not significantly different (P=0.17).

Implications

SFNB caused significant yield losses in the susceptible barley varieties La Trobe⟨PBR⟩ and Spartacus CL⟨PBR⟩ at both sites under the wet seasonal conditions experienced in northern NSW in 2016. Combined application of foliar fungicides at both stem elongation (GS31) and awn emergence (GS49) provided good suppression of SFNB in both experiments and also provided effective control of scald in the Dubbo trial. While all three foliar fungicide products examined reduced the severity of SFNB, efficacy was generally Product Z>Amistar Xtra®>Tilt®250. Product Z, an experimental fungicide from Bayer CropScience appears a quite promising option for improved management of SFNB. Each of the foliar fungicides examined also provided good control of scald late in the season although Amistar Xtra not registered for the control of scald.

The seed treatment Systiva® provided useful suppression of SFNB in post GS49 assessments under moderate disease pressure at Tamworth but activity appeared to have waned by this later growth stage under higher pressure at Dubbo. However, disease suppression was improved at both sites when combined with a foliar fungicide application at GS49. In management strategies which involved two fungicide inputs, Systiva® was competitive with GS31 foliar fungicide applications at both sites when each option was backed up by a GS49 foliar fungicide application. Both of these strategies provided significant increases in grain yield under both moderate (Tamworth) and high (Dubbo) pressure from SFNB.

Although the fungicide strategies examined in these experiments provided significant yield benefits it should be stressed that no treatment provided complete disease control. Hence, some level of yield loss is still likely to have occurred. These experiments were also either inoculated (Tamworth) or sown into a high stubble load (Dubbo) of a SFNB susceptible barley variety with only SFNB and scald susceptible varieties examined in this study. This represents a high risk scenario for the development of these stubble-borne leaf diseases and places considerable pressure on disease management strategies which rely solely on the use of fungicides and is likely to accelerate selection for fungicide resistant strains of these pathogens. Stewardship with the seed treatment Systiva® involves only using this product every second year to delay the development of resistance and under high disease pressure monitor infection levels then apply a late foliar fungicide (ideally non SDHI) beyond GS31 if needed.

The results presented here should not be interpreted as the ideal production system for barley in the northern grains region, even though significant disease suppression and yield benefits were evident. Rather growers are urged to consider an integrated approach to barley disease management incorporating rotation with non-host crops (avoid barley-on-barley), stubble management and growing varieties with improved levels of resistance to reduce disease pressure. Fungicide strategies are then placed under less pressure in terms of both control and development of resistance. Additionally the economics of planned fungicide strategies needs to be considered given the higher costing of some products and marginal returns, especially with current barley prices.

References

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