Ascochyta blight severity and yield response to fungicides in field pea

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Key findings

- Understanding the key drivers of ascochyta blight (AB) disease in field pea, such as the level of starting inoculum and seasonal conditions pre and post sowing, is crucial to effective and economical management of this disease.
- In high disease risk seasons, foliar fungicides applied either before, or at the first sign of disease, and a follow up spray at early flowering reduced further spread.
- An additional foliar spray during spring may be required when wet and cool conditions cause late season infection on new growth.
- Recently registered products for AB on field peas demonstrated greater disease control and yield gain than older products.
- Disease control and yield improvement responses to fungicides have been observed where yield potential is >1.5 t/ha. Below that threshold, responses are generally not measurable and fungicides may not be economical.

Why do the trial?

Ascochyta blight (AB) (blackspot) is a serious disease in field pea associated with significant yield reductions if not managed. It is caused by fungi originating from infected field pea stubble, soil borne inoculum, or diseased seed. Pre-sowing rainfall conditions in summer and autumn influence spore maturation on the stubble, the timing of spore release and the risk of blackspot infecting an establishing crop. Once mature, the spores are transported by wind and rain onto a crop where infection begins. Severity of AB depends on the level of inoculum and the seasonal conditions including duration of in-crop rainfall and sometimes dew.

The current trial work was part of a four year research program that was conducted by SARDI under the Southern Pulse Agronomy project (SPA) funded by the GRDC (DAV00150). So far, our research has developed an improved fungicide strategy using recently registered products targeting early disease control at the 4-6 node growth stage. The aim of the current research was to evaluate the efficacy of new foliar fungicide actives applied as standalone in comparison to their combinations with a seed treatment. This information will provide new insight into the role of the seed dressing and the performance of new fungicides in managing AB disease in field pea.

How was it done?

Three years (2016 - 2018) of experimental field trials were conducted in low (Minnipa, Upper Eyre Peninsula), and medium (Hart, Mid-North) rainfall environments in SA. A number of fungicide treatments were tested and applied as shown in Table 1.

In 2016 and 2018 the trials at Hart and Minnipa were designed as randomized complete block design, with three replications. In 2017, a time of sowing experiment was conducted at Hart only. The aim was to simulate sowing under high and low disease risk, and evaluate the efficacy of the fungicides on disease control and yield response. PBA Coogee was used in 2016 and PBA Oura in 2017 and 2018, sown at 55 plants/m^2.

AB infected field pea stubble was incubated to achieve maximum or minimum AB spore maturation pre-sowing. The incubated stubble was spread on trials to ensure disease infection. Table 2 presents the dates at which the trials were sown and the corresponding disease assessment dates. Disease severity was assessed as the percentage plant area diseased (purplish-black necrotic lesions on leaves) by frequency of infected plants per plot. Plots were machine harvested and grain yields recorded for each treatment at physiological maturity.

Table 1. Fungicide treatments and application timings in field pea blackspot management trials conducted at Hart and Minnipa in 2016-2018.

Year and site	Fungicide treatments	Fungicide application timing
2016 Hart & Minnipa	Nil	Nil
	PPT®	Seed treatment
	Mancozeb® (plus PPT)	6 WAS + early flowering
	Chlorothalonil® (plus PPT)	Fortnightly
	Aviator Xpro® (plus PPT)	6 WAS + early flowering
	Aviator Xpro® (plus PPT) + mancozeb	4 Node + early flowering + mancozeb at podding
2017 Hart	Nil	Nil
	PPT®	Seed treatment
	Mancozeb® (plus PPT)	Early disease sighting (occurred at 8 node) + early flowering
	Chlorothalonil® (plus PPT)	Fortnightly
	Aviator Xpro® (plus PPT)	Early disease sighting (occurred at 8 node) + early flowering
	Aviator Xpro® (plus PPT) + mancozeb	4 Node + early flowering + mancozeb at podding
2018 Hart and Minnipa*	Nil	Nil
	Chlorothalonil® (plus PPT)	Fortnightly
	Aviator Xpro® (minus PPT)	4 Node + early flowering
	Aviator Xpro® (plus PPT)	Early disease sighting + early flowering
	Veritas® (minus PPT)	4 Node + early flowering
	Veritas® (plus PPT)	Early disease sighting + early flowering
	Aviator Xpro® (plus PPT) + mancozeb	Early disease sighting + early flowering + mancozeb at podding

#All fungicide treatments were treated with Apron® (350 g/L Matalaxyl-M) seed dressing to control downy mildew

Notes:

- In 2018, disease occurred earlier at Hart (4 node growth stage) and as a result, the fungicides which were to be applied at early disease sighting were also applied at the 4 node growth stage. At Minnipa, disease was light early in the season and the earliest fungicides were applied at 4 node while the fungicide which were to be applied at 'early disease sighting' were applied at 6 node growth stage.
- In 2018, a final disease rating (disease index) was not conducted at Minnipa as not much rainfall was recorded post September 4.

Table 2. Sowing date and disease assessment dates in field pea blackspot management trials conducted at Hart and Minnipa in 2016-2018.

Year	Site	Sowing date	Growth stage and date at disease severity assessment	Growth stage and date at disease index assessment
2016	Hart	10-May	13 Node (July 27)	Flowering (Sep 1)
	Minnipa	6-May	13 Node (July 29)	Flowering (Aug 31)
2017	Early sowing, Hart	27-Apr	14 Node (July 12)	Flowering (Aug 29)
	Delayed sowing, Hart	31-May	17 Node (August 29)	Flowering (Oct 19)
2018	Hart	8-May	19 Node (Aug 22)	Flowering (Sept 3)
	Minnipa	28-May	17 Nodes (Sept 4)	Not scored

Seasonal conditions and disease severity over three years

In 2016, the growing season rainfall (GSR) was above long-term average at Minnipa and Hart (Figure 1 and Figure 2). The two trials were sown in late autumn into relatively dry seed bed conditions. This was followed by wet conditions that allowed AB establishment and progression in winter and a relatively cool spring which lengthened the crop growing season, particularly at Hart. The prolonged growing season at Hart resulted in late disease infection at this site.

The 2017 season started with a late break in most parts of SA occurring in mid-April to mid-May at Hart and mid-July at Minnipa. As a result, a sowing time field pea trial was only at Hart. Growing season and annual rainfall were well below the long-term annual average for Hart (Figure 1). Early AB infection and progression was low due to an extended dry period during the growing season. However, high rainfall events occurred in late winter/early spring and favoured disease spread in the latter growing stages. Severe frost events occurred in the last week of August, which coincided with the critical development period of pod filling in the early sown crops.

In 2018, weather conditions were extremely dry over summer and autumn (Figure 1 and Figure 2). The dry start to the season meant that there was a delay in maturation of the stubble borne fungal spores and spore release occurred in late autumn at Hart and early winter at Minnipa when the opening rains occurred. Growing seasonal rainfall (GSR) was well below the long term average GSR at both sites with most of the in-crop rainfall falling in the month of August. Significant frost events occurred through the months of July to October at Hart. The sustained dry seasonal conditions influenced crop establishment and reduced the progression of AB during the 2018 cropping season.

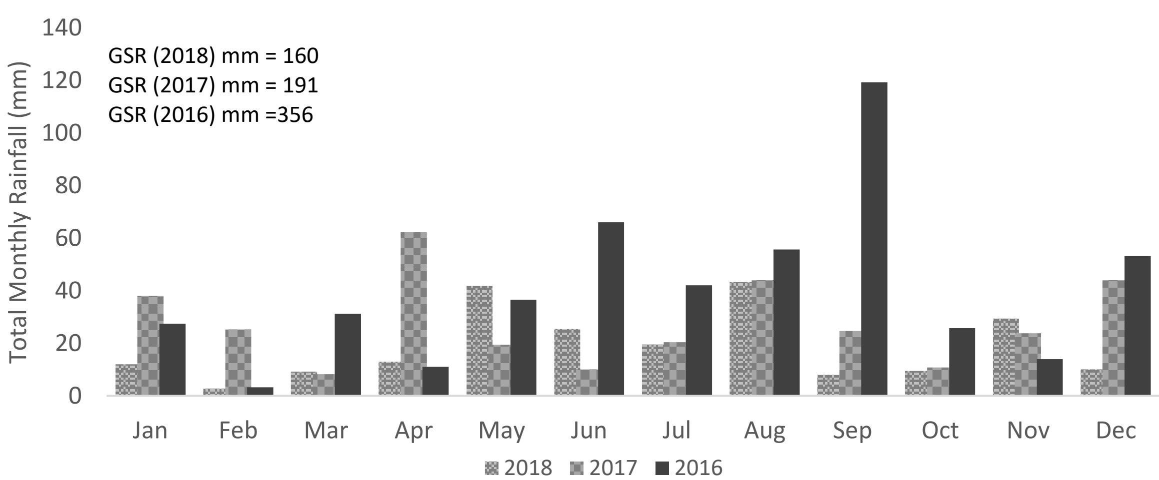

Figure 1. Total monthly rainfall (mm) over a three-year (2016 - 2018) period at Hart (Mid-North, SA).

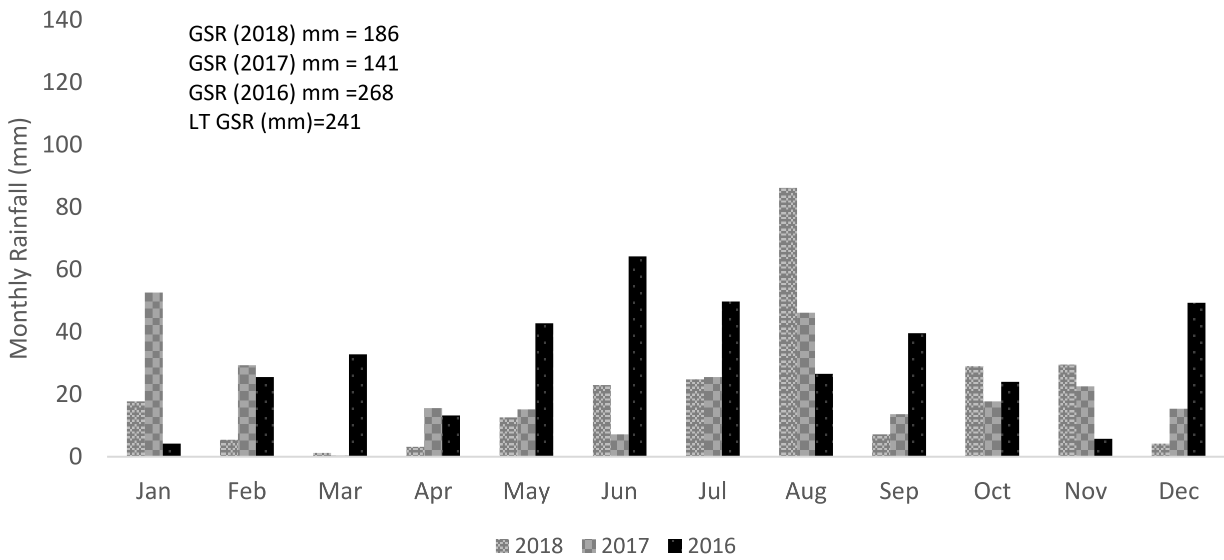

Figure 2. Total monthly rainfall (mm) over a three-year (2016 - 2018) period at Minnipa (Upper Eyre Peninsula, SA).

Results and discussion

Disease severity and yield responses from fungicide application

Results showed a complex interaction between AB and environment (sites and seasonal conditions) and the response in disease control and yield improvement from fungicide application. In some seasons in the low rainfall site, disease occurred earlier and was more severe than the medium rainfall environment. As such, application timing and type of product was important where disease occurred earlier.

2016 and 2017 Results

In 2016, above average rainfall favoured early and high disease severity at Minnipa prior to the first foliar applied at 6 weeks post sowing. In contrast, at Hart, there was low disease severity early in the season. The above average spring rainfall and cooler conditions resulted in extended crop growth and meant that the crop was exposed to late AB infection. Consequently, there was a significant site interaction for disease severity and grain yield responses to the fungicide treatments. The mancozeb applications reduced AB severity compared to the nil at Hart but not at Minnipa (Table 3) most likely due to the differences in early disease establishment. No significant yield gains were associated with this product (Table 3). Two sprays of Aviator Xpro® significantly reduced disease scores at Hart but not at Minnipa. Aviator Xpro® recorded significant yield gains over the nil treatment at both sites (Table 3). The highest yields were associated with two sprays of Aviator Xpro® and fortnightly sprays of chlorothalonil (Table 3). In comparison to mancozeb, Aviator Xpro®, showed yield benefits of at least 19 % across the two sites under high disease severity.

In 2017, early AB disease onset and progression in the Hart time of sowing trial was low due to an extended dry period during the growing season and non-conducive environmental conditions. AB leaf spotting was first noted at 8 node growth stage. High rainfall events occurred in late winter/early spring (Figure 1) and may have favoured disease spread in the later growing stages. The fungicide treatments had a significant effect on disease severity and disease index (Table 4), but there was no interaction with sowing date. All fungicide treatments, except mancozeb, significantly reduced disease compared to the untreated plots. Grain yields increased up to 15% from the use of the new products over mancozeb in the early sown plots at Hart in 2017 (Table 4). The three spray strategy of Aviator Xpro® at 4 node growth stage, early flowering followed by a late spray of mancozeb at podding produced similar yields to fortnightly chlorothalonil in the early sown plots, a 25% increase over the untreated plots (Table 4). In contrast, this response was not found in 2016 (Table 3), where fortnightly Chlorothalonil had higher yields than the three spray strategy. This may be due to a number of Chlorothalonil sprays being applied in seasons with more favourable and wetter finishing conditions. Although 2017 was generally a drier year, a substantial amount of rain fell in late winter/early spring and the late spray of mancozeb in the Aviator Xpro® treatment was beneficial in controlling the spread of AB resulting in yield increases in early sown crops similar to the fortnightly treatment. In the later sowing, there was no yield response to fungicides and a yield penalty of approximately 1 t/ha was observed across all treatments compared to early sown plots (Table 4).

Table 3. Ascochyta blight disease severity (% plot severity) assessed at between 9 and 13 node growth stage and grain yield under different fungicide treatments at Hart and Minnipa, 2016.

Fungicide treatments	**Fungicide application timing**	**Disease severity (%)**		**Grain yield (t/ha)**	
		Hart	**Minnipa**	**Hart**	**Minnipa**
Nil	Nil	32	51	1.49	0.95
Mancozeb (plus PPT)	6 weeks after sowing + early flowering	24	47	1.54	1.19
Aviator Xpro® (plus PPT)	6 weeks after sowing + early flowering	24	46	1.93	1.40
Aviator Xpro® (plus PPT) + mancozeb	4 Node + early flowering + mancozeb at podding	17	42	1.65	1.58
Chlorothalonil® (plus PPT)	Fortnightly	14	25	2.67	1.67
LSD (P<0.05) Fungicide x site		7.8		0.34	

Table 4. Ascochyta blight disease severity (% plot severity) assessed at between 9 and 13 node growth stage in field pea (PBA Coogee) under different fungicide treatments at Hart (Mid-North, SA) in 2017.

Fungicide treatments	**Fungicide application timing**	**Disease severity (%)**	**Grain yield (t/ha)**	
			27 April	**31 May**
Nil	Nil	55	2.66	2.28
Mancozeb (plus PPT)	Early disease sighting (occurred at 8 node) + Early flowering	48	2.76	2.31
Aviator Xpro® (plus)	Early disease sighting (occurred at 8 node) + Early flowering	39	3.22	2.33
Aviator Xpro® (plus PPT) + mancozeb	4 Node + Early flowering + mancozeb at podding	37	3.42	2.19
Chlorothalonil® (plus PPT)	Fortnightly	2	3.53	2.29
LSD (P<0.05) Fungicide		8.1		
LSD (P<0.05) Fungicide x sowing time			0.19	

2018 Results

Compared to 2016 and 2017, AB infection was low in 2018 at both locations. Early disease severity was slightly higher at Hart with early leaf spotting sighted on all 4 nodes prior to the first spray application (Table 5).

At Minnipa AB leaf spotting started to appear at 6 node growth stage. It is worth noting that the 4 node fungicide treatments had already been applied prior to this early disease sighting at Minnipa. Hart had slightly more intermittent in-season rainfall at the start of the season, which may have contributed to early disease spread. In contrast, rainfall was delayed at Minnipa with majority of rain occurring in August (Figure 2).

At Hart, the disease index, assessed at mid-podding, was significantly reduced by all fungicide applications compared to the nil treatment (Table 5). Plots sprayed with chlorothalonil every fortnight had the lowest disease scores at the both assessment periods compared to all other treatments (Table 5). There was a reduction in disease severity from 4 of the foliar fungicides compared to the nil treatment at Hart (Table 5). Foliar fungicides with and without PPT had the same responses in disease severity at Hart. This indicates PPT did not reduce AB disease severity when using foliar fungicides at an early growth stage.

At Minnipa, all fungicide treatments had significantly less disease than the nil treatment. Both Aviator Xpro® and Veritas® gave the same level of response with or without PPT (Table 6).

No significant yield gains were associated with the treatments at either site, most likely due to the dry seasonal conditions that limited the spread of disease and lowered yield potential.

Table 5. Ascochyta blight disease severity (%) assessed at early flowering, disease index (%) assessed at mid-podding growth stages and mean grain yield (t/ha) of field pea (PBA Oura) under different fungicides at Hart (Mid-North, SA), 2018.

Fungicide Treatment	Fungicide application timing	Disease Severity (%)	Disease Index (DI) (%)	Grain yield (t/ha
Nil	Nil	37	68	1.41
Aviator Xpro® (plus PPT) + mancozeb	Early disease sighting (occurred at 4 node) + early flowering	34	56	1.44
Aviator Xpro® (plus PPT)	Early disease sighting (occurred at 4 node) + early flowering	33	51	1.45
Aviator Xpro® (minus PPT)	4 node + early flowering	31	48	1.39
Veritas® (minus PPT)	4 node + early flowering	31	51	1.38
Veritas® (plus PPT)	Early disease sighting (occurred at 4 node) + early flowering	31	51	1.32
Chlorothalonil® (plus PPT)	Fortnightly	5	20	1.56
LSD		4.8	7.0	ns

NB: Both fungicides scheduled at 4 node and at early disease sighting were applied at 4 node growth stage which was also when the initial AB spotting was observed.

Table 6. Ascochyta blight disease severity (%) assessed at early flowering, Disease index (%) assessed at mid-podding growth stages and mean grain yield (t/ha) of field pea (PBA Oura) under different fungicides at Minnipa (upper Eyre Peninsula, SA), 2018.

Fungicide Treatment	Fungicide application timing	Disease Severity (%)	Grain yield (t/ha)
Nil	Nil	32	1.11
Aviator Xpro® (plus PPT) + mancozeb	Early disease sighting (occurred at 6 node) + early flowering	21	1.20
Aviator Xpro® (plus PPT)	Early disease sighting (occurred at 6 node) + early flowering	17	1.23
Aviator Xpro® (minus PPT)	4 node + early flowering	13	1.19
Veritas® (minus PPT)	4 node + early flowering	18	1.14
Veritas® (plus PPT)	Early disease sighting (occurred at 6 node) + early flowering	21	1.06
Chlorothalonil® (plus PPT) (fortnightly)	Fortnightly	18	1.14
Lsd		9.8	ns

NB: The 4 node fungicide treatment was applied at this growth stage while the 'early disease sighting' fungicide treatment was applied at the 6 node growth stage when leaf spotting was first observed.

Summary of key findings

This study has led to a better understanding of some of the principles underlying management of AB disease in field peas and has developed strategies for growers.

Manipulating sowing time – The ideal sowing time to minimise AB in field pea is when the majority, at least 60% of AB spores, have been released from infected stubble prior to crop emergence. This information can be obtained from the Blackspot manager. Spore release varies depending on summer and autumn conditions

Fungicide use – Fungicides play an important role in controlling AB progression in-season. Our results show that early sowing in high disease situations with no fungicides will result in significant yield losses. The response from fungicide use is complex and may not always be economic as disease severity varies from season to season.

- In seasons where disease established early (by 4 node growth stage) a foliar application with mancozeb (2kg/ha) at the 9 node growth stage was too late for effective disease control. Application of Aviator Xpro® at 4 node growth stage showed greater efficacy.
- Where disease severity was not initially severe early in the season, mancozeb (2 kg/ha) reduced disease over the nil, however there were no yield improvements.
- Early sprays with new fungicides at 4 node showed greater efficacy in controlling disease and improving yield compared to those applied at 9 nodes.
- New fungicides were effective in reducing disease and improving yields in early sown crops and in high disease situations (>50 % disease severity) sustained by wet in-crop growing conditions and yield potentials of >1.5 t/ha. These conditions were achieved both in 2016 and 2017.
- A three-spray strategy of Aviator Xpro® at 4 node growth stage, early flowering followed by a late spray of mancozeb at podding spray may be required for high yielding crops in wetter spring conditions that extend late season disease infection on new growth. Therefore, a late spray at podding may be required to prevent AB pod and seed infection.

Acknowledgements

Funding for this work was provided through GRDC project DAV00150 (Southern Pulse Agronomy) and their support is greatly appreciated. We also acknowledge the support of research colleagues from the SARDI teams at Clare and Minnipa. Much gratitude also goes to the land owners/managers of the different farms where the trial sites were located, and to chemical companies for providing us with experimental fungicides to run our trials.