The economics of managing Ascochyta in chickpea when disease occurs at different growth stages and implications for spray timing

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GRDC code

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Take home messages

- Impact of Ascochyta at different growth stages was investigated in a 2020 field experiment at Trangie with varieties Kyabra⁽ᴾ⁾, PBA HatTrick⁽ᴾ⁾ and PBA Seamer⁽ᴾ⁾
- Ascochyta caused yield losses from 100% to nil depending on when the disease occurred, and the variety grown
- Highest gross margin (GM)'s (> $800/ha) occurred with the lowest incidence of Ascochyta and also with the least susceptible variety, i.e. PBA Seamer⁽ᴾ⁾
- Manage Ascochyta early and grow varieties with best resistance to minimise impact of Ascochyta
- Follow current Ascochyta advice to maximise enduring profitability.

Why did we do this research?

Current management of chickpea Ascochyta in north central/northern NSW and southern QLD is based on results of field trials conducted mostly at Tamworth, grower experiences and feedback from agronomists. The Tamworth experiments have tried to simulate what happens in most farmers crops, i.e. initial infection occurs during the first post emergence rainfall event – accordingly, all the Tamworth experiments have established Ascochyta during that event. But what is the impact if infection occurs at later stages of growth and how does that affect management? The Trangie Agricultural Research Centre provided an opportunity to address that question – the soil and climate are typical of the Macquarie valley, a major chickpea production region. Overhead irrigation (lateral) and inoculation with conidia and infected spreader plants optimised infection and disease development.

Experiment details

Treatments

Aim: to assess the impact of Ascochyta blight (AB) disease occurring at three different growth stages, on yield of three chickpea varieties with different levels of AB resistance.

Ascochyta treatments (5):

1. **LOW (NIL)**: un-inoculated (NIL disease = CONTROL) plus foliar chlorothalonil fungicide (1.0 L/ha, chlorothalonil 720g/L) applied before rain or irrigation events
2. **HIGH**: inoculated with disease twice (at seedling (SDG, 3-4 nodes) and vegetative (VEG, 7-8 nodes) growth stages); NIL fungicide applied

3. **SDG**: inoculate with disease at seedling stage (3-4 nodes), allow disease to progress for 2-3 rain events to 7-8 nodes, then control disease for rest of season with chlorothalonil
4. **VEG**: protect plants from emergence to vegetative stage (7-8 nodes) with chlorothalonil; inoculate with disease and allow to progress for 2-3 rain events to first pods, then control disease with chlorothalonil
5. **POD**: protect plants from emergence to reproductive stage (first pods) with chlorothalonil, inoculate with disease and allow disease to progress through to harvest.

Variety treatments (3, and level of AB resistance):

1.	**Kyabra**Ⓟ	VS = Very susceptible
2.	**PBA HatTrick**Ⓟ	MS = Moderately susceptible
3.	**PBA Seamer**Ⓟ	MR = Moderately resistant

Replication: 4 reps

Method

The experiment was conducted at Trangie Agricultural Research Centre in central west NSW, on a grey vertosol soil with access to overhead (lateral) irrigation. The experiment was sown as a randomised block design using a small plot seeder, with each plot 2m x 10m. Buffer plots were sown (with PBA SeamerⓅ) at the same plot size between each treatment plot, to reduce the impact of inter-plot interference from Ascochyta inoculation and fungicide application. A back-pack sprayer with a 2m wide hand-held wand and 015 110 degree flat fan nozzles @ 50cm, was used to apply both Ascochyta inoculum and fungicide. Buffer plots received the full set of six fungicide applications.

Ascochyta disease was generated in treatment plots by a combination of two inoculation methods:
1. Ascochyta applied to whole plot as conidial suspension (600,000 conidia/mL), and
2. Ascochyta infected spreader plants transplanted to centre of plot.

Ascochyta treatments for each growth stage were applied just prior to either a forecast rain event, or irrigation.

Ascochyta treatment and fungicide were applied as follows:

up to 1 July	NIL fungicides applied prior to first disease treatment
1 July	**inoculation 1 - SDG & HGH treatments (pre-irrigation)**
9 July	fungicide 1 pre-rain - applied to LOW, VEG & POD (not SDG or HGH)
5 August	**inoculation 2 - VEG & HGH treatments (pre-rain)**
13 August	fungicide 2 pre-rain – applied to LOW, SDG & POD (not VEG or HGH)
9 September	fungicide 3 pre-rain – applied to LOW, SDG & POD (not VEG or HGH)
19 September	**inoculation 3 - POD treatment (pre-rain)**
29 September	fungicide 4 pre-rain – applied to LOW, SDG & VEG plots (not POD or HGH)
7 October	fungicide 5 pre-rain – applied to LOW, SDG & VEG plots (not POD or HGH)
21 October	fungicide 6 pre-rain – applied to LOW, SDG & VEG plots (not POD or HGH)

Site details & agronomy management

Sowing date: 26 May 2020
Harvest date: 27 November 2020
Seed treatment:
PBA SeamerⓅ pre-treated with thiram at purchase
KyabraⓅ & PBA HatTrickⓅ treated with P-Pickel T® pre-sowing
Fertiliser at sowing: Granulock® Z @ 80 kg/ha

Inoculant: Group N, liquid inject at sowing
Target plant density: 30 plants/m^2
Actual establishment achieved:

Kyabra⍦ & PBA Seamer⍦ = 31 plants/m^2 (new seed)
PBA HatTrick⍦ = 21 plants/m^2 (retained seed ex 2019 harvest, poor storage conditions)

Buffers between treatment plots: PBA Seamer⍦ at 30 plants/m^2

Herbicide management:

pre-sow: TriflurX® (trifluralin 480 g/L) @ 1.7 L/ha
PSPE: Terbyne® Xtreme® (terbuthylazine 875 g/kg) @ 0.86 kg/ha
in-crop: haloxyfop 520 @ 100 mL/ha + clethodim 240 @ 250 mL/ha

Fungicide application:

up to 6 chlorothalonil 720g/L @ 1.0 L/ha for LOW (NIL disease) treatment; total number of applications varied for each growth stage treatment

Insecticide & mouse management:

17 Sept Affirm® (emamectin) insecticide @ 300 mL/ha (by plane)
6 Oct Altacor® (chlorantraniliprole) insecticide @ 70 g/ha (by plane)
12 Oct Zinc phosphide mouse bait @ 1.0 kg/ha (by plane)

Harvest management:

desiccation not required due to heatwave conditions from 15 November on
experiment harvested at 9% moisture content.

Pre-sowing rainfall (1/01/20 to 25/05/20): 351 mm
In-crop rainfall (26/05/20 to 27/11/20): 201 mm in 49 events
Plus in-crop irrigations: 20 mm (as 2 x 10 mm events)

Table 1. Summary of dates of disease inoculations and fungicide applications for 2020 Trangie chickpea Ascochyta management trial, relative to dates of subsequent rain or irrigation events.

2020 date	Disease inoculation	Fungicide application	Rain > 2.0mm	Irrigation (mm)	Cumulative >2.0mm # Events	Cumulative >2.0mm (mm)
01 Jul	SDG & HIGH		0.0	10.0	1	10.0
09 Jul		LOW, VEG & POD				
10-13 Jul			31.6		2	41.6
25-27 Jul			35.8		3	77.4
05 Aug	VEG & HIGH					
06-12 Aug			19.2		4	96.6
13 Aug		LOW, SDG & POD				
14-22 Aug			18.8		5	115.4
09 Sep		LOW, SDG & POD	3.8		6	119.2
14 Sep			0.0	10.0	7	129.2
19 Sep	POD					
19-25 Sep			33.8		8	163.0
29 Sep		LOW, SDG & VEG				
7 Oct		LOW, SDG & VEG	6.8		9	169.8
17 Oct			3.4		10	173.2
21 Oct		LOW, SDG & VEG				
23-25 Oct			17.6		11	190.8
4-5 Nov			7.8		12	198.6

Table 2. Log of operations for 2020 Trangie experiment on managing chickpea Ascochyta when disease occurs at different growth stages: Inoc = inoculation, DAS = days after sowing, DAI = days after inoculation.

	Ascochyta treatment			
Operation	**HIGH**	**SDG**	**VEG**	**POD**
Sow date	26/05/2020	26/05/2020	26/05/2020	26/05/2020
1st Inoc date	1/07/2020	1/07/2020	5/08/2020	19/09/2020
2nd Inoc date	5/08/2020	not done	not done	not done
1st Inoc DAS	36	36	71	116
2nd Inoc DAS	71	not done	not done	not done
Score 1 date	26/08/2020	26/08/2020	26/08/2020	26/08/2020
Score 2 date	1/10/2020	1/10/2020	1/10/2020	1/10/2020
Score 3 date	14/10/2020	14/10/2020	14/10/2020	14/10/2020
Score 1 DAI	56	56	21	na
Score 2 DAI	92	92	57	12
Score 3 DAI	105	105	70	25

Results

The effects of Ascochyta treatment, Variety and Ascochyta x Variety were highly significant (P<0.001) for all variables measured.

Disease incidence

The seedling, (SDG) and HIGH Ascochyta treatments were inoculated on 1 Jul 20, 36 days after sowing, DAS (Table 2). The HIGH treatment was inoculated a second time on 5 Aug (71 DAS) to maximise disease development (Table 2). This resulted in severe early disease (assessed on 26 Aug) in Kyabraⓓ, moderate disease in PBA HatTrickⓓ and demonstrated the improved Ascochyta resistance in PBA Seamerⓓ (Table 3). The vegetative, VEG treatment was inoculated on 5 Aug (71 DAS), prior to which plants had been protected with foliar fungicide applied on 9 Jul. This regime produced low disease in Kyabraⓓand PBA HatTrickⓓ at the 1st and 2nd assessments (26 Aug, 1 Oct) and nil in PBA Seamerⓓ (Table 3). The podding, POD treatment was inoculated on 19 Sep (116 DAS), prior to which plants had been protected with foliar fungicides applied on 9 Jul, 13 Aug and 9 Sep. This regime produced nil disease in all three varieties at the 1st assessment (26 Aug) and low disease at the two subsequent assessments (1 Oct, 14 Oct) (Table 3). We assign the low incidence of Ascochyta with the POD treatment as a consequence of the three fungicide sprays applied before inoculation and less favourable seasonal conditions.

Table 3. Incidence of Ascochyta (% plot with disease) in Kyabra⑩, PBA HatTrick⑩ and PBA Seamer⑩ chickpeas when disease was established at different growth stages but controlled before and after; l.s.d. (*P*=0.05) for Scores 1, 2 & 3 = 13.26%, 8.63% & 11.74%, respectively.

Variety	Ascochyta treatment	Score 1 26 Aug 20	Score 2 01 Oct 20	Score 3 14 Oct 20
Kyabra ⑩	LOW	1.3	0.0	5.2
PBA HatTrick ⑩	LOW	0.0	0.0	11.2
PBA Seamer ⑩	LOW	0.0	0.0	3.0
Kyabra ⑩	SDG	92.0	57.5	70.0
PBA HatTrick ⑩	SDG	37.5	22.5	40.0
PBA Seamer⑩	SDG	0.0	0.0	2.8
Kyabra ⑩	VEG	8.8	12.5	31.2
PBA HatTrick ⑩	VEG	5.0	8.8	22.5
PBA Seamer⑩	VEG	0.0	0.0	3.0
Kyabra ⑩	POD	0.0	0.5	7.8
PBA HatTrick ⑩	POD	0.0	2.5	5.2
PBA Seamer⑩	POD	0.0	0.0	3.8
Kyabra⑩	HIGH	88.8	100.0	100.0
PBA HatTrick ⑩	HIGH	32.5	52.5	57.5
PBA Seamer ⑩	HIGH	0.0	0.0	4.0

This approach, i.e. inoculating Ascochyta at different times and protecting before and after, allowed us to determine the impact of disease at those stages on yield.

Impact on yield

Table 4. Effect of Ascochyta on grain yield, gross margin (GM) and yield loss for three chickpea varieties when disease occurs at different growth stages; l.s.d. (*P*=0.05) yield 286 kg/ha. GM is based on chickpea price of $600/t, fungicide product $16/ha/application, fungicide ground rig application $5/ha, other production costs $300/ha.

Variety	Ascochyta Treatment	Yield (kg/ha)	GM ($/ha)	% Yield Loss (kg/ha)
Kyabra ⑩	LOW	1878	701	0
PBA HatTrick ⑩	LOW	1840	678	0
PBA Seamer ⑩	LOW	2138	857	0
Kyabra ⑩	SDG	10	-399	99
PBA HatTrick ⑩	SDG	965	174	48
PBA Seamer⑩	SDG	2080	843	3
Kyabra ⑩	VEG	1483	506	21
PBA HatTrick ⑩	VEG	1504	518	18
PBA Seamer ⑩	VEG	2211	943	-3
Kyabra ⑩	POD	2041	862	-9
PBA HatTrick ⑩	POD	1880	765	-2
PBA Seamer ⑩	POD	2101	898	2
Kyabra ⑩	HIGH	0	-300	100
PBA HatTrick ⑩	HIGH	234	-160	87
PBA Seamer ⑩	HIGH	1903	842	11

Grain yield (Table 4) ranged from nil (Kyabra⊕ HIGH) to over 2 t/ha (all PBA Seamer⊕ treatments). For the very susceptible Kyabra⊕, lowest yields occurred with the SDG and HIGH treatments with yield losses of 99% and 100% respectively. The moderately susceptible PBA HatTrick⊕ also had lowest yields for SDG and HIGH treatments, with losses of 48% and 87% respectively (Table 4). The least susceptible variety PBA Seamer⊕ only lost 3% and 11% yield from SDG and HIGH treatments.

Gross Margins, GM

The highest GM's occurred with the lowest incidence of Ascochyta (LOW) and also with the least susceptible variety PBA Seamer⊕ (Table 4). All PBA Seamer⊕ treatments, including the one with most Ascochyta, (HIGH) had GM over $800/ha (Table 4). However, the experiment showed that controlling Ascochyta in the very susceptible Kyabra⊕ is profitable with a GM of $701/ha and $862/ha for the LOW and POD treatments respectively.

Conclusions

Generating chickpea Ascochyta at different stages of growth showed when and how disease affects yield. The impact of disease on a chickpea crop depends primarily on when the disease occurs, how it is managed, and the variety grown. Allowing Ascochyta to establish early in the life of your crop results in greatest impact on yield and lowest profitability, even if the disease is subsequently controlled with foliar fungicides. This is especially true for very susceptible and moderately susceptible varieties. Your best option for minimising impact of Ascochyta on chickpea production and maximising profitability is to follow current recommendations (Moore and Heuston, 2020) by controlling disease early and growing the least susceptible variety. This approach will also reduce the build-up and carryover of Ascochyta inoculum for your and your neighbour's future chickpea crops.

References

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