Economic chickpea production for southern Australia through improved cultivars and strategic management to control ascochyta blight.

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Abstract

In 1998 the chickpea industry in south-eastern Australia was devastated by the outbreak of ascochyta blight (*Ascochyta rabiei)*, reducing area from 150,000 hectares to less than 10,000 hectares within two years. The high risk and increased cost of controlling ascochyta blight often made desi chickpea production unprofitable but higher value kabuli types remained profitable. Cultivars with improved resistance to ascochyta blight became available in 2005, but the successful economic management of the disease needed to be demonstrated to growers. Experiments were sown at four locations over two seasons in southern Australia to assess fungicide (chlorothalonil or mancozeb) application timing and efficacy in controlling ascochtya blight in cultivars varying in ascochyta blight resistance. Resistant (R) cultivars were successfully grown with two or less fungicide applications during podding. Moderately resistant (MR), moderately susceptible (MS) and susceptible (S) cultivars always required at least three and up to nine fungicide applications to prevent yield loss. In all experiments the podding treatment of chlorothalonil had equivalent or greater grain yields than the mancozeb podding treatment. The use of resistant cultivars with one or two strategic foliar fungicide applications ensures chickpeas are a low risk, profitable option in medium rainfall (350-450mm) cropping areas of southern Australia.

Key Words

ascochyta blight, chickpea, resistant cultivars, foliar fungicides, disease management

Introduction

Chickpeas (*Cicer arietinum* L.) were an important part of southern farming systems crop rotations until the late 1990's. They provided both economic and sustainability benefits to growers throughout southern Australia until widespread outbreak of ascochyta blight (*Ascochyta rabiei* (Pass.) Labr.) in 1998. All cultivars grown at this time were susceptible to the disease and as a result of the epidemic, the area sown reduced from 150,000 hectares to less than 10,000 hectares within two years (ABARE. 2006). To successfully control ascochyta blight in susceptible cultivars, the application of fungicides every 2-3 weeks throughout the growing season was often required. This resulted in up to eight fungicide applications at a cost of up to $160 per hectare. Growers using this intensive spray management favoured the higher valued kabuli seed types (Bretag *et al.* 2003), however the increased risk of crop failure and lower economic returns remained. The availability of cultivars with improved resistance from 2005, as a major component of an integrated disease management strategy, will allow growers in southern Australia to economically grow this crop again. However to reinitiate chickpea production, the benefits of a reliable ascochyta blight management strategy must be clearly demonstrated to growers after the devastation and large economic losses caused by ascochyta blight. This paper describes field experiments, established to determine fungicide regimes that minimise grain yield loss and fungicide inputs for cultivars with improved levels of resistance to ascochyta blight.

Methods

Experimental design

Field experiments were sown in 2004 and 2005 across south-eastern Australia to compare the effect of different fungicide regimes on ascochtya blight foliar symptoms and grain yield of cultivars varying in levels of ascochyta blight resistance. Trials were located at Turretfield (light clay over medium clay; annual rainfall (AR) - 456mm) and Hart (clay loam over heavy clay; AR - 399mm), in the Mid North district of South Australia (SA) in 2004 and 2005. In 2005, trials were also located at Kalkee in the Wimmera (black cracking clay, AR - 450mm) and at Beulah in the southern Mallee (calcareous sandy loam over medium clay, AR - 375mm) of Victoria (Vic). Five fungicide regimes were compared in each experiment: Nil - no foliar fungicide sprays, Fortnightly application of chlorothalonil (Fn, 1440 gai/ha at SA sites and 750 gai/ha at Vic sites) applied every fourteen days from eight weeks after sowing till end of podding (six to nine sprays), Strategic application of chlorothalonil (St, three sprays at SA sites and four at Vic. sites from eight weeks after sowing through to podding, single application at early podding of chlorothalonil (PoC), and mancozeb (PoM, 1650 gai/ha at SA sites and 750 gai/ha at Vic sites). The podding treatments at Turretfield in 2005 included a second application of the same chemical three weeks after the first. Cultivars varied across experiments depending upon seed availability and suitability for each district (Table 1). Nevertheless, all experiments included an ascochyta blight S cultivar (Howzat - desi type) and R cultivars (Genesis™ 090 – kabuli type and Genesis™ 509 – desi type). Ascochyta blight ratings of other cultivars evaluated were Genesis™ 508 (desi type R), Sonali (desi type, MS) and Almaz (kabuli type MR). All treatments were replicated four times utilising either split plot (SA sites in 2004 and Vic. sites) or randomised complete block designs (SA sites in 2005).

Desi chickpea cultivars were sown to achieve a plant density of 50 plants/m^2 and kabuli cultivars 35 plants/m^2. Seed was inoculated with Group N rhizobium and sown with suitable rates of fertiliser at appropriate sowing dates for chickpeas in each cropping region. All experiments were sown in paddocks not containing or not close to chickpeas or chickpea stubbles, and were artificially inoculated with infected stubble approximately between five and six weeks after emergence to induce significant ascochyta blight disease pressure.

Measurement and analysis

Disease severity was assessed visually on the foliage and pods using a 1-9 scale (1 - no visible lesions on any plants, 9 - complete plant death (Reddy and Singh. 1984)) or using a scale of 0-100%, defining the percentage of the aerial plant tissue expressing ascochyta blight symptoms (0 – no expression of symptoms). All experiments were machine harvested and grain yields and grain weights recorded. Disease severity scores, grain yields and grain weights were analysed within each experiment using ANOVA.

Results and Discussion

The effect of foliar fungicide application timing

A significant interaction between cultivar and fungicide timing for foliar ascochyta blight infection occurred at all sites. In all experiments, the R cultivars Genesis 090, Genesis 508 and Genesis 509 showed lower levels of foliar symptoms in all treatments (score < 2.5 or % < 22) (Table 1). In contrast, ascochyta blight severity in nil treatments of the S cultivar Howzat ranged from a score of 6.8 – 7.0 (Hart and Turretfield) in 2004 to greater than 9.0 and more than 90% infection in 2005 at Beulah, Turretfield, Hart and Kalkee. Disease ratings in nil treatments of MS (Sonali) and MR (Almaz) cultivars were intermediate with scores of 5.3 or 30 – 45% infection, respectively. However these cultivars were only evaluated at sites with higher levels of disease intensity. Unlike the resistant cultivars, foliar symptoms in Howzat, Sonali and Almaz were reduced substantially with Fn treatments. At sites with lower disease severity, the foliar disease level of Howzat was reduced with St treatments compared to the nil treatment but not to the level of the Fn treatment. The St treatment had no effect at sites where disease levels were high. This partial reduction in foliar disease also occurred in Sonali and Almaz with St, PoM and PoC treatments at most sites. Gan *et al*. (2006) suggested application of foliar fungicides at seedling stages for MR cultivars to minimise the impact of intense showers of ascospores. Our data indicates that while S and partial resistant (MS and MR) cultivars may require this early spray to minimise disease intensity, R cultivars did not.

The interaction between cultivar and fungicide timing for grain yield was significant in all experiments, except Hart in 2004 where dry and hot seasonal conditions during podding resulted in low grain yields. Grain yield was reduced at all other sites in nil treatments of Howzat compared to Fn treatments, with yield reductions ranging from 66 to 99% (Table 1). The grain yield of R cultivars was not always reduced in nil treatments when compared with Fn treatments. Where grain yield reductions in these cultivars did occur it was substantially lower than in all other cultivars, ranging from 0 to 37% in Genesis 090, 0 to 43% in Genesis 508 and 0 to 37% in Genesis 509. Nil treatments of Sonali and Almaz incurred yield loss in all experiments, ranging from 84 to 96% and 51 to 94%, respectively. The PoC and St treatments in Howzat, Sonali and Almaz had substantially lower grain yields than those of the fortnightly treatments in all experiments. At sites with lower disease intensities such as Turretfield in 2004 and Beulah the St treatment reduced yield loss in Howzat by only 12 and 17% respectively, compared to the Fn treatment. However, higher disease intensity grain yield losses increased to 50 and 96% at Hart in 2005 and Turretfield in 2005, respectively. A similar pattern also occurred in Sonali for these treatments, however yield losses were generally less than for Howzat. Grain yield loss of Almaz when compared with the Fn treatment ranged from 20 to 64% in the PoC treatment and 13 to 76% in the St treatment, significantly less than that incurred for Howzat and Sonali. Grain yields were similar in the PoC and St treatment for Almaz, whereas Sonali and Howzat generally had a greater losses in the PoC treatment. This clearly indicates that Almaz has a higher level of ascochyta blight resistance than Howzat and Sonali and would require fewer foliar fungicides sprays for successful production.

Table 1. Effect of various foliar fungicide regimes on foliar ascochyta blight severity (0-9 and 0-100% assessed during flowering/podding) and grain yield (t/ha) of chickpea cultivars varying in resistance to ascochyta blight across South Australia and Victoria 2004 and 2005.

		Foliar ascochyta blight severity (1–9) or %						Grain yield (t/ha)					
Site	Treat-ment	How-zat	Son-ali	Al-maz	Gen. 090	Gen. 508	Gen. 509	How-zat	Son-ali	Al-maz	Gen. 090	Gen. 508	Gen. 509
Hart	Nil	7.0			1.7	1.7	1,7	0.19			0.32	0.25	0.38
2004	PoM	6.9			1.4	1.9	1.9						
	PoC	6.9			1.4	1.4	1.4	0.14			0.32	0.25	0.35
(1-9)	St	5.0			1.0	1.3	1.0	0.25			0.33	0.27	0.35
	Fn (6)	2.7			1.3	1.0	1.0	0.27			0.25	0.28	0.38
		lsd (P<0.01) = 0.99						NS					
T/	Nil	6.8			2.2	1.8	1.6	0.70			1.77	1.58	1.89
field	PoM	6.5			2.2	2.0	1.8	0.99			1.87	1.58	1.85
2004	PoC	6.5			2.4	1.3	1.8	1.07			1.90	1.60	1.73

(1-9)	St	2.5			0.9	1.3	1.1	1.79			1.85	1.63	1.94
	Fn (6)	1.8			0.7	1.0	0.8	2.04			1.91	1.64	1.88
				lsd (P<0.01) = 0.94						lsd (P<0.05) = 0.23			
Beu-	Nil	8.0	6.8		2.3		1.3	0.54	0.29		2.38		2.10
lah	PoM	7.5	7.0		2.3		1.8	0.46	0.16		2.50		2.02
2005	PoC	6.5	6.5		2.0		1.8	0.51	0.53		2.31		2.00
(1-9)	St	3.8	3.3		1.0		1.0	1.96	1.94		2.76		2.32
	Fn (7)	1.8	1.8		1.0		1.0	2.35	2.75		2.77		2.30
				lsd (P<0.05) = 1.0						lsd (P<0.05) = 0.30			
Hart	Nil	92	84	30	15	9	12	0.05	0.29	0.89	1.37	1.30	1.51
2005	PoM	76	61	29	21	10	14	0.20	0.68	1.09	1.52	1.39	1.61
	PoC	71	56	28	14	10	8	0.49	0.99	1.44	1.83	1.43	1.70
(%)	St	61	44	20	11	12	8	0.89	1.23	1.54	1.77	1.58	1.74
	Fn (8)	25	21	11	9	8	5	1.89	1.84	1.8	1.81	1.62	1.85
				lsd (P<0.05) = 9						lsd (P<0.05) = 0.2			
Kal-	Nil	8.3	7.5	5.3	1.8	1.3	1.3	0.01	0.11	0.53	1.85	1.67	2.01
kee	PoM	8.3	7.8	5.0	1.5	1.5	1.3	0.03	0.18	0.58	1.80	1.60	1.87
2005	PoC	8.5	7.8	5.8	1.8	1.5	1.5	0.04	0.20	0.71	1.90	1.65	1.87
(1-9)	St	8.3	7.0	4.3	1.3	1.0	1.5	0.18	0.44	1.37	2.16	1.72	1.95

	Fn (8)	2.3	1.8	1.3	1.0	1.0	1.0	1.82	1.68	1.71	2.19	1.74	2.05
					lsd (P<0.05) = 1.0					lsd (P<0.05) = 0.21			
T/	Nil	98	95	41	12	11	12	0.03	0.12	0.12	1.76	1.88	2.06
field	PoM	99	90	41	14	11	12	0.07	0.18	0.22	1.87	1.96	2.34
2005	PoC	100	84	39	16	14	11	0.10	0.47	0.76	2.26	2.20	2.58
(%)	St	90	64	46	12	14	9	0.10	0.98	0.47	2.41	2.62	3.04
	Fn (9)	29	28	12	10	8	9	2.34	3.16	1.91	2.79	3.32	3.28
					lsd (P<0.05) = 8					lsd (P<0.05) = 0.28			

in () after Fn indicates total number of sprays applied for this treatment at that site

Treatments PoC and St in Genesis 509 and Genesis 508 and the St treatment in Genesis 090 yielded the same as the Fn treatment in all experiments except for Turretfield in 2005. There was also no difference in grain yields in the PoC and Fn treatments of Genesis 090 at Turretfield in 2004 and Hart in 2005. However, grain yields were 17%, 13% and 19% lower in the PoC treatment at Beulah, Kalkee and Turretfield in 2005, respectively. In Turretfield 2005 a second spray of chlorothalonil was used in the PoC spray regime due to an extended period of wet weather and an abnormally long flowering and podding period. Ascochyta blight pressure was particularly severe in this experiment and even MR cultivars were likely to have incurred a yield penalty even with the Fn treatment (Table 1). Botrytis grey mould (*Botrytis cinerea)* disease was also present at Turretfield in 2005 and pod infection and abortion across all cultivars was observed, potentially confounding results, despite two applications of procymidone (250 gai/ha). Results indicated that R cultivars, unlike all other cultivars evaluated, could be successfully grown with fungicide applications only during podding, apart from in situations of extreme disease severity such as those at Turretfield in 2005.

Efficacy of mancozeb and chlorothalonil fungicides as a podding spray

Chlorothalonil had greater efficacy than mancozeb when applied as a podding spray at some sites, particularly on cultivars rated MR or less to ascochyta blight. At Hart in 2005, pod infection was greater in all cultivars (Table 2) in the PoM compared to the PoC treatment. Grain yields (Table 1) and grain weight (Table 2) were less in all cultivars except Genesis 509 (R) and Genesis 508 (R). Grain yields at Turretfield in 2005 for Sonali (MS), Almaz (MR) and Genesis 090 (R) and Beulah in 2005 for Sonali were significantly less in the PoM compared to PoC treatment. For all varieties at all sites grain yield in the PoM treatment were never significantly greater than PoC.

Table 2. Comparison of chlorothalonil (PoC) and mancozeb (PoM) foliar fungicide treatments at podding on pod ascochyta blight severity (0-100% assessed at maturity) and grain weight (g/100seeds) of chickpea cultivars varying in resistance to ascochyta blight at Hart in South Australia, 2005.

		Podding ascochyta blight severity (%)						Grain weight (g/100 seeds)					
Site	Treat-ment	How-zat	Son-ali	Al-maz	Gen. 090	Gen. 508	Gen. 509	How-zat	Son-ali	Al-maz	Gen. 090	Gen. 508	Gen. 509
Hart	PoC.	75.0	58.8	11.3	9.3	4.0	13.5	20.1	17.5	44.5	33.9	15.7	15.7
2005	PoM	96.3	97.5	80.0	75.0	40.0	38.8	15.5	16.2	38.0	29.6	14.5	15.3
		lsd (P<0.05) = 23.3						lsd (P<0.05) = 1.6					

Conclusion

Cultivars with R to ascochyta blight can be successfully grown under high disease pressure in southern Australia with only one or two fungicide applications during podding. This will allow growers to economically produce chickpeas again. Under the same conditions MS cultivars will require between three and nine fungicides to avoid severe yield loss. Cultivars with MR will require fungicide sprays prior to flowering in addition to podding sprays to prevent significant yield loss. This is likely to limit production of MR cultivars in southern Australia to the higher valued large seeded kabuli types, which are best adapted to the medium to high rainfall growing areas.

Acknowledgements

We thank Greg Antonoff, John Nairn, Andrew Bird and Bradley Bennett for technical support for the project, Kathy Haskard for re-analysis of Turretfield & Hart 2004 data and GRDC for financial support.

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