Chickpea competition with annual ryegrass

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Key findings

- Although chickpea yields were higher than previous years at Hart, the rapid finish to the season favoured earlier flowering and maturing varieties such as Genesis^{TM}079 and Sonali.
- Ryegrass competition at 31 and 86 plants/m^2 reduced chickpea grain yield by 31% and 56%, respectively.
- Breeder's line "Chickpea 4" recorded the lowest yield loss from ryegrass competition at both sites (9% at the low ryegrass density at Hart), and also displayed 35% better tiller suppression than other varieties at Hart.
- Early vigour appeared an important trait in chickpea for improved competiveness with ryegrass, whilst short plant height was a disadvantage.

Why do the trials?

Chickpeas are widely recognised as poor competitors, with previous research showing high yield losses caused by competition with ryegrass. This trial was established with the aim of identifying chickpea plant types which are more competitive with ryegrass. Traits of particular interest included chickpea height, vigour, maturity and plant architecture (eg branching angle).

How was it done?

Plot size	1.4 x 10m	**Fertiliser**	MAP @ 76 kg/ha + 2% Zn
Seeding date	22nd May 2009	**Inoculant**	Group N granular

Trial design		Randomised complete block design with 3 replicatess	
Seeding rate	(1)	35 plants/m^2 (kabuli) 50 plants/m^2 (desi)	
Varieties	(10)	See Table 1	
Treatments	(3)	Nil ryegrass	Nil ryegrass
		Low ryegrass [a]	Sown with ryegrass @ 40 plants/m^2
		High ryegrass [a]	Sown with ryegrass @ 100 plants/m^2

[a] Ryegrass = cv. Wimmera annual ryegrass, no herbicide resistances

Table 1: Attributes of chickpea varieties included at Hart in 2009

	Variety	Early Growth Habit [a]	Early Vigour	Canopy Density [b]	Height	Maturity
Kabuli	Almaz	semi-erect	poor	medium	medium	late
	Genesis^{TM} 079	semi-erect	moderate	medium	short	early
	Genesis^{TM} 090	semi-erect	good	dense	medium	mid
Desi	Genesis^{TM} 509	semi-erect	moderate	thin	medium	mid
	PBA Slasher$^{\Phi}$	semi-spread	moderate	medium-thin	medium	mid
	Sonali	semi-erect	good	medium	tall	early
	Chickpea 1 [c]	semi-erect	very good	dense	very tall	mid-late
	Chickpea 2 [c]	erect	good	very dense	tall	mid
	Chickpea 3 [c]	semi-erect	moderate	dense	medium	mid
	Chickpea 4 [c]	erect	very good	very thin	medium	mid

[a] Early growth habit refers to the initial branching angle, where spread denotes prostrate branching and erect denotes upright branching.

[b] Canopy density refers to the density of the mature canopy, and is important in preventing light penetration.

[c] Denotes Pulse Breeding Australia advanced chickpea line.

Results

Grain yield

Grain yields at Hart in 2009 were significantly higher than previous years, with weed free control plots averaging 1.34 t/ha, compared with just 0.54 t/ha in 2008, and 0.87 t/ha in 2007. The dry finish to the 2009 season favoured the earlier maturing varieties Genesis^{TM}079 and Sonali (Figure 1a), which recorded more than double the yield of late maturing varieties e.g. Almaz. Trends observed at Hart were supported by a similar trial at Turretfield (Figure 1b), however grain yields were much lower (nil treatments averaging 0.57 t/ha) due to high temperatures during early pod fill at this site.

All lines at both sites generally decreased in yield as ryegrass density increased, although Chickpea 4 at low ryegrass density yielded similarly to the nil, and Chickpeas 1 and 2 showed little difference in yield at low and high ryegrass densities. Genesis^{TM}079 and Sonali in the absence of ryegrass were the highest yielding varieties at Hart, followed by new release PBA Slasher$^{\Phi}$ and chickpea breeder's lines 3 and 4 (at Turretfield these lines all yielded similarly and higher than other lines). In competition with ryegrass the same varieties were generally still higher yielding although CICA0512 also performed similarly to this group.

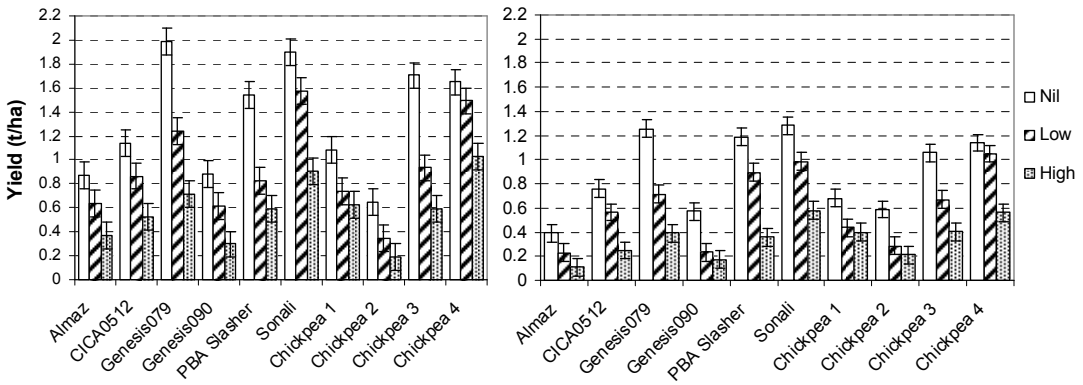

Figure 1a: Effect of ryegrass density on the yield of 10 chickpea lines, Hart 2009.
Figure 1b: Effect of ryegrass density on the yield of 10 chickpea lines, Turretfield 2009.

Percentage Yield Loss

Across all varieties competition from ryegrass reduced grain yields by an average of 31% at Hart and 33% at Turretfield in the low ryegrass treatment, and 56% and 61% respectively in the high density treatment.

Breeder's line Chickpea 4 showed the lowest percentage yield loss at both ryegrass densities at Hart (9% and 38% loss at low and high densities respectively – Figure 2a). A similar result was found at Turretfield, with Chickpea 4 showing 8% and 51% yield losses at low and high ryegrass densities (Figure 2b). At both sites Sonali showed relatively low yield loss at the low ryegrass density only, while Chickpea 1 displayed relatively lower yield loss at the high density. All these varieties have good to very good levels of early vigour (Table 1).

Chickpea 2 suffered higher yield losses than most other varieties across both sites, supporting similar results in 2008. Other varieties showing high yield loss under ryegrass competition included PBA Slasher$^{\Phi}$, Genesis^{TM}079, Genesis^{TM}090, Almaz, CICA0512, and Chickpea 2. All these varieties have poor to moderate levels of early vigour, with the exception of Chickpea 2 which showed good early vigour.

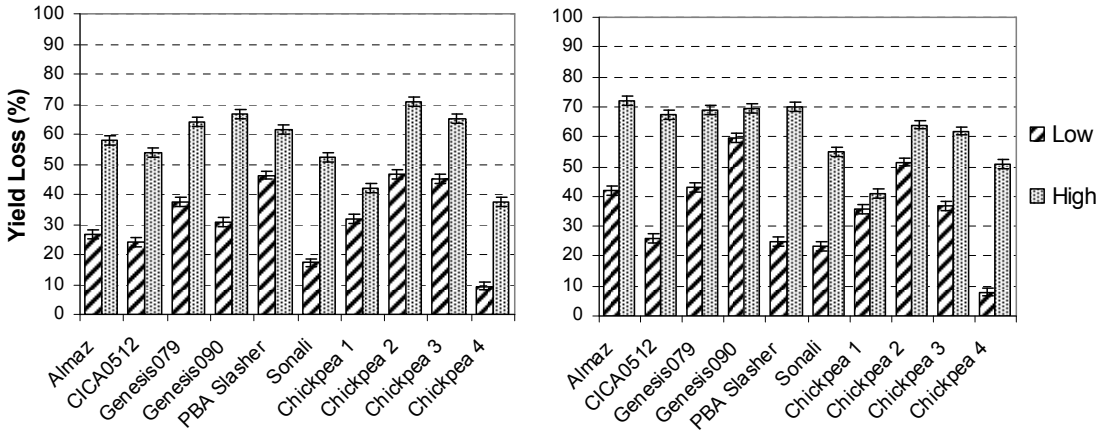

Figure 2a: Percentage yield loss of chickpeas under low and high ryegrass densities, Hart 2009
Figure 2b: Percentage yield loss of chickpeas under low and high ryegrass densities, Turretfield 2009

Ryegrass plant and tiller counts

The ability of chickpea lines to suppress tillering in ryegrass was deemed to be one of the most important measurements indicating competitiveness. Ryegrass tiller counts showed an almost four-fold increase in tillering in 2009 compared with that found in 2008.

Comparisons between low and high ryegrass treatments showed that ryegrass tillering was reduced by 39% at Hart and 25% at Turretfield as the sown ryegrass density was increased from 40 to 100 plants/m^2. Ryegrass tillering was also higher at Hart than Turretfield (16 tillers/plant compared with 12 tillers/plant at the low density).

At Hart all varieties performed similarly in their abilities to reduce ryegrass tillering, regardless of ryegrass density. As with yield, PBA Slasher$^{\Phi}$ and Chickpeas 2 and 3 were amongst the worst competitors at Hart (Figure 3a). Chickpea 4 was again found to be more competitive with ryegrass as it showed a 65% reduction in tillering compared to the crop-free treatment, and was more than 35% better than all other varieties (Figure 3a). In contrast, PBA Slasher$^{\Phi}$ featured as one of the best competitors based on ryegrass tiller suppression at Turretfield (Figure 3b), together with Chickpea 4. Although Genesis^{TM}079 and Sonali yielded well, Figure 3b shows relatively high ryegrass tillering in these varieties, once again suggesting that while they yield well they do not necessarily compete well with ryegrass. By contrast, Chickpea 4 consistently competed well with ryegrass, and yielded relatively well compared to other varieties.

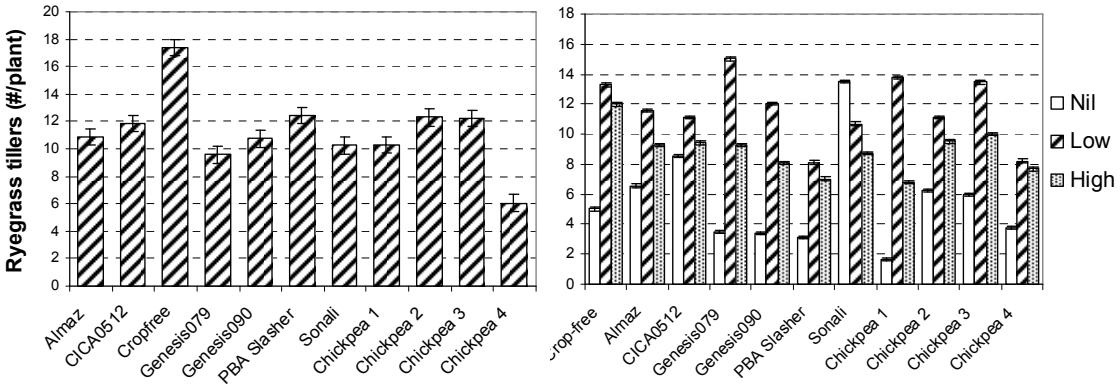

Figure 3a: Ryegrass tillering under competition with 10 chickpeas lines, Hart 2009.
Figure 3b: Effect of ryegrass density on its tillering under competition with 10 chickpeas lines, Turretfield 2009.

Summary

The higher yielding chickpeas without ryegrass competition were also higher yielding with competition. This is likely because the moisture stressed environment created by competition with ryegrass is similar to the moisture stress caused by a hot and dry season finish, as seen in 2008 and 2009, and these conditions are likely to favour early flowering and maturing lines such as Genesis^{TM}079 and Sonali.

Genesis^{TM}079 yielded well in 2009, but also displayed high relative yield loss and poor rye grass tiller suppression. The early maturity of Genesis^{TM}079 allows it to yield relatively well in moisture stressed situations (ie short season or under competition), however its short plant height and only moderate early vigour compromised its ability to compete with ryegrass.

Chickpea 4, which has very good early vigour, consistently performed well at both sites for yield loss and ryegrass tiller suppression, suggesting it has plant traits which enable it to compete well with ryegrass. Other varieties showing low yield loss also had good to very good early vigour, while those varieties suffering high yield losses generally had moderate to poor early vigour. Therefore agronomic strategies aimed at maximising early vigour are likely to be important in suppressing ryegrass in chickpea production.

Chickpea 2, which has traits that on paper should enable it to compete well, showed the highest yield loss, as well as poor ryegrass tiller suppression. PBA Slasher$^{\Phi}$ showed poor tiller suppression at Hart, but good suppression at Turretfield. These ambiguous findings and the lack of understanding of the impact of canopy density on ryegrass competition may be due to the unfavourable seasonal conditions for chickpea production which prevailed in SA last year. However, they do indicate the need for more work in a more favourable growing season, and potentially on a larger set of phenotypes (particularly those similar to Chickpea 4).

Acknowledgements

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