Yield response of kabuli and desi chickpea (*Cicer arietinum* L.) genotypes to row spacing in southern Australia

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Abstract

A field experiment was undertaken in 2007 at Roseworthy, South Australia, to investigate the response of kabuli (n=3) and desi (n=3) chickpea genotypes to row spacing (18, 36 and 54 cm). The response of chickpeas to RS was related to the branching habit of the genotype. Among kabuli genotypes, Almaz which had a lower branch number per plant showed greater yield loss at the wider row spacing than Genesis 079 and Genesis 090 which had greater branch number. All three desi genotypes showed similar sensitivity to widening row spacing In the three desi cultivars, grain yield decreased by 4-21% as RS increased from 18 cm to 36 cm and by 17-36% at 54 cm RS. Grain yield of desi genotypes was correlated to podding (r^2=0.60-0.69) and branch number (r^2=0.62-0.75). Of the kabuli types, there was a strong correlation between pod number and grain yield for Almaz (r^2=0.70) with seed number per pod and seed size stable across all genotypes. Although Genesis kabuli genotypes showed lower yield potential (694-1158 kg ha^{-1}) than desi genotypes (1036-1636 kg ha^{-1}), they were less sensitive to widening row spacing which could be related to their greater branching capacity and appear better suited to wide row cropping systems in southern Australia.

Key Words

Row spacing, yield, kabuli, desi, chickpea

Introduction

In addition to excellent gross margins, kabuli and desi chickpeas are grown in cropping rotations in southern Australia to enhance soil nitrogen and to provide a disease break for cereal crops. Recent introduction of cultivars with improved resistance to ascochyta blight has renewed grower interest in chickpeas. Traditionally chickpeas have been grown on narrow row spacing (18 cm) in southern Australia; however, increasing adoption of no-till farming and desire to maintain stubble cover when sowing legumes has resulted in an increase in the row spacing of chickpeas (25-50 cm). Furthermore, potential to reduce the incidence of fungal disease with open canopy architecture (Gan *et al*. 2007) and reports of yield increases (Felton *et al*. 2004) have also encouraged growers to pursue wider row spacings for chickpeas.

Previous research undertaken by Felton *et al*. (1996) in northern New South Wales showed that in low yielding environments row spacing (25-100 cm) had a negligible effect on chickpea yield. Similarly, no yield reduction was reported for several accessions of desi and kabuli chickpeas when grown on wide rows in vertisol soils of Queensland (Beech and Leach 1988). Beech and Leach (1988) concluded that chickpeas are well suited to changes to row spacing because they exhibit substantial plasticity in growth and development. However, they also acknowledged that under different management and field conditions (e.g. delayed sowing, limited stored soil moisture) yield responses to row spacing could vary somewhat with significant changes to radiation interception and water extraction between close and wide row spacings.

Given that much of the research investigating the response of both kabuli and desi chickpeas to row spacing has been undertaken in northern New South Wales and Queensland where chickpeas are primarily grown on stored soil moisture, it is important to investigate crop responses to row spacing in southern Australia where most of the plant available water comes from rainfall received during the growing season.

Methods

A field experiment was established in 2007 at Roseworthy (34?32'S, 138?41'E), South Australia, to investigate the response of kabuli (Almaz, Genesis 079 and Genesis 090) and desi (Sonali, CICA 0510 and CICA 0512) chickpea genotypes to row spacing (18, 36 and 54 cm). The 18 cm row spacing is considered the conventional standard for the district. The growing season rainfall (Apr-Oct) was 237 mm in 2007, well below the long-term average of 330 mm for Roseworthy. The experimental design was a split-plot, with row spacing randomly assigned to main-plots and chickpea genotype to sub-plots, with four replicates. The site was direct drilled on the 3rd of June into barley stubble (~4.0 t/ha) using knife-points and press wheels. Crop density for kabuli (30 plants/m^2) and desi (50 plants/m^2) chickpeas was similar for all three spacing treatments with seed rate adjusted according to seed weight. Diammonium phosphate supplying 18 kg N/ha and 20 kg P/ha was applied with inoculated seed (Group N). Plots were 5 m long and 1.26, 1.44 and 1.62 m wide, and contained 7, 4 and 3 rows for 18, 36 and 54 cm row spacing treatments respectively; border rows were excluded from sampling to avoid edge effects. Weeds were controlled with applications of residual and grass selective herbicides, and fungicide mancozeb applied when required. At physiological maturity a bundle sample (5 plants) was taken to determine branching habit (branches/plant) and yield components (pod no./plant, seeds/pod and seed size). Grain yield was determined at maturity using a small plot harvester.

Results

Desi chickpeas, which have been reported to be better suited to dryland cultivation (Beech and Leach 1988), responded better to the dry growing conditions and produced higher grain yields (1036-1636 kg ha^{-1}) relative to the kabuli types (694-1158 kg ha^{-1})(Figure1). In 2007, the interaction between genotype and row spacing was non-significant but this interaction was significant in 2008 (data not shown). Even in 2007, the response of chickpeas to row spacing was somewhat different between the two crop types. Two of the 3 kabuli genotypes (Genesis 079 and Genesis 090) showed no decline in yield up to 54 cm row spacing. However, two out of three desi genotypes showed a significant reduction in yield at the widest row spacing. In the three desi genotypes, grain yield decreased by 4-21% as row spacing increased from 18 cm to 36 cm and by 17-36% at 54 cm. Of the kabuli genotypes, Almaz was the exception showing a yield loss of 23% as row spacing increased from 18 cm to 36 cm and a further 20% decline with increase in row spacing to 54 cm.

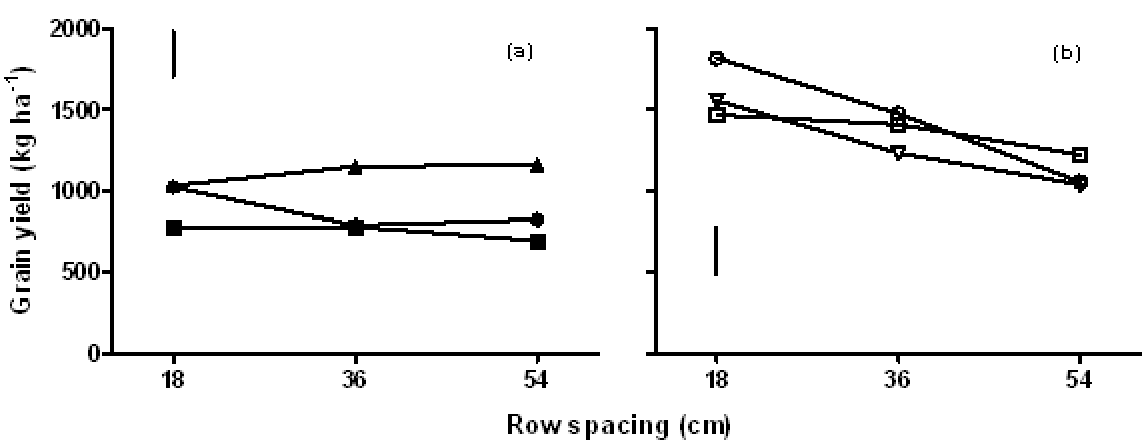

Figure 1. Grain yield responses of a) three kabuli (˜, Almaz; ?, Genesis 079; p, Genesis 090) and b) three desi chickpea genotypes (s, Sonali; ™, CICA 0510; ?, CICA 0512) to row spacing (18, 36 and 54 cm) at Roseworthy in 2007. Error bars represent LSD (0.05) for genotype*row spacing interaction.

Table 1. Correlation coefficients between grain yield and yield components for kabuli and desi chickpea genotypes grown at Roseworthy in 2007.

	Grain yield			
Genotype	Branch no./plant	Pod no./plant	Seeds/pod	Grain size
Kabuli-type				
Almaz	0.59	0.70*	0.35	-0.09
Genesis 079	-0.10	-0.10	-0.11	-0.24
Genesis 090	0.39	0.34	-0.15	-0.22
Desi-type				
Sonali	0.72**	0.62*	0.11	-0.15
CICA 0510	0.75**	0.69*	0.39	-0.37
CICA 0512	0.62*	0.60*	0.12	-0.39

*$P < 0.05$; **$P < 0.01$.

The yield response of all desi genotypes was correlated to pod (r^2=0.62-0.70) and branch number (r^2=0.62-0.75) (Table 1). Among the kabuli types, there was a strong correlation between pod number and grain yield for Almaz (r^2=0.70) but not for Genesis 079 and Genesis 090. Seed number per pod and seed size was generally stable across all genotypes, showing no correlation with grain yield. The yield response of chickpeas to row spacing appears to be driven mainly by pod number. Previous research from Western Australia (Siddique and Sedgley 1986) investigating the effect of sowing time on chickpeas, similarly reported that variation in yield was influenced mostly by the number of pods rather than by seed number per pod and/or seed weight which remained constant.

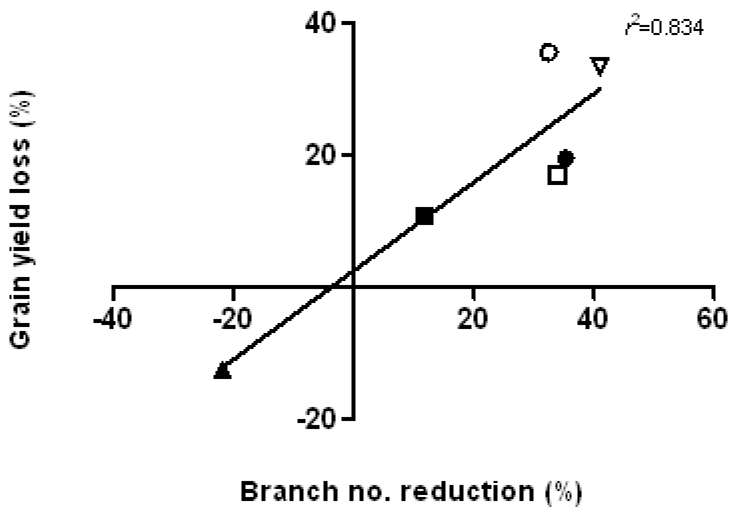

Figure 2. The relationship between branch number reduction and grain yield loss for kabuli (˜, Almaz; ?, Genesis 079; p, Genesis 090) and desi chickpea genotypes (s, Sonali; ™, CICA 0510; ?, CICA 0512) grown on wide rows (54 cm RS) relative to the 18 cm row spacing.

The responses of chickpeas to row spacing appeared to be related to the branching habit of the genotype (Figure 2). Among the kabuli genotypes, Genesis 079 and Genesis 090 which maintained greater branch number at wider row spacings (36 and 54 cm) showed little or no decline in yield. In contrast, kabuli genotype Almaz and all three desi genotypes showed a steady decline in branch number and grain yield at the wider row spacing. Reduction in branching at the wider row spacings in these genotypes could be related to increased intra-specific competition amongst plants growing at higher density within the crop rows. Furthermore, reduction in branching in more sensitive cultivars may have limited their ability to intercept radiation and maintain growth rates. It appears the capacity of chickpea genotypes to maintain branch number is an important characteristic for maintaining yield under wide rows. In this respect kabuli cultivars showed greater capacity to maintain branching and yield in wider rows. However, branching and yield of Almaz (kabuli) showed similar sensitivity to wide rows as the desi cultivars. If these responses to row spacing could be replicated over seasons and sites then it appears feasible to select for chickpea cultivars with greater suitability for wide row systems by selecting for branching and yield in trials undertaken in wide rows.

Conclusion

Genesis 090 and 079 kabuli chickpeas were less sensitive to wider row spacing which could be related to their ability to maintain branching even when crowded by higher neighbour density. Evaluation of germplasm in wide rows should enable selection of cultivars better suited for wide row cropping systems in southern Australia.

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