Variation in the response of canola cultivars to changes in row spacing

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Abstract

Field experiments were conducted at Roseworthy, South Australia, in 2007 and 2008 to determine the response of four canola cultivars to 3 row spacings (RS) (18, 36 and 54 cm). Although total growing season rainfall (GSR) was similar for the two seasons (237 and 255 mm), spring rainfall (Aug to Sep) was lower in 2007 (50 mm) than 2008 (102 mm). Consequently, cultivar ? RS ? year interaction for yield was significant ($P \leq 0.05$). In the drier growing season (2007), 3 of the 4 cultivars showed no decline in yield up to 36 cm RS, but yields did decline by 17-29% at the widest RS. Hyola 50 was an exception to this trend showing no yield loss even at 54 cm RS. Tarcoola was the most responsive cultivar to RS with yield loss relative to 18 cm RS of 26% and 29% at 36 and 54 cm, respectively. Under higher yielding conditions of 2008, all cultivars showed a similar rate of yield loss with increase in RS. In both years, the yield response of all the cultivars was strongly correlated (r^2=0.76-0.92) with pod density. In low rainfall seasons, more vigorous canola cultivars (e.g. Hyola 50) were able to maintain similar light interception across the row spacing treatments which enabled them to maintain yield. However in seasons with higher rainfall when maximum light interception was greater in narrow rows (18 cm), all cultivars showed some decline in grain yield.

Key Words

Row spacing, yield, canola, light interception

Introduction

Traditionally rain-fed broad acre crops in southern Australia have been grown on a row spacing of 18 cm (7") and rows wider than 18 cm are often considered wide rows for many crops. Growers have adopted wide row spacings (22.5 to 55 cm) for several different reasons which include; improved stubble handling ability of sowing equipment (Riethmuller and Amjad 1996), weed management opportunities to combat herbicide resistance (Peltzer et al*.* 2009) and potential in drier areas to defer use of stored soil water from between rows until the grain filling stage (French and Harries 2006). Furthermore, adoption of wide row cropping has also been encouraged by reports of yield increases for crops such as lupins and chickpeas grown on wide rows (Felton et al*.* 2004; French and Harries 2006).

Below average growing season rainfall across much of southern Australia over the past five years has also provided a trigger for many growers to explore management practices such as wide rows in order to improve the WUE of dryland crops. Research recently undertaken by French and Harries (2006) showed that increased grain yields for lupins in wide rows resulted from deferred use of soil water until grain filling. Deferring soil water use until later in the growing season would be extremely beneficial to the yield outcome of canola given its sensitivity to moisture and heat stress during the reproductive phase (Chen et al. 2005). Furthermore, the prostate and branching growth habit of canola may allow it to compensate more effectively when grown in wide rows.

Since the significant shift by growers in southern Australia to stubble retention and wide row farming systems, there has been limited research on the effect of row spacing on the performance of different canola cultivars. Here we report data from field experiments undertaken in South Australia in 2007 and 2008, evaluating the response of four canola cultivars to changes in row spacing.

Methods

Field experiments were established in 2007 and 2008 at Roseworthy (34?32’S, 138?41’E), South Australia, to determine the response of four canola cultivars (AV-Garnet, Tarcoola, Hyola 50 and Hyola 75) to 3 row spacings (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 and 255 mm in 2007 and 2008, 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 canola cultivar to sub-plots, with four replicates. The sites were direct-drilled on the 3rd and 5th of June in 2007 and 2008, into lentil stubble (~2.0 t/ha) using knife-points and press wheels. Similar crop density (50 plants/m^2) was obtained for all three spacing treatments with seed rates adjusted according to the seed weight. Diammonium phosphate was applied with the seed to provide 18 kg N/ha and 20 kg P/ha. 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 insecticide dimethoate applied when required. Canopy light interception measurements were taken monthly from July to October from 3 random locations within a plot using an AccuPar-ceptometer (Delta-T Devices Ltd.). Plots were windrowed prior to physiological maturity and a bundle sample (5 plants) taken to determine yield components (pods/m^2, seeds/pod and seed size). At maturity, grain yield was determined using a small plot harvester.

Results

Although total GSR was similar for the two seasons at Roseworthy (237 and 255 mm), spring rainfall (Aug to Sep) was lower in 2007 (50 mm) than 2008 (102 mm). Consequently, cultivar ? row spacing ? year interaction was significant (Table 1). In the drier growing season (2007), 3 of the 4 cultivars showed no decline in yield up to 36 cm row spacing, but yields did decline by 17-29% at the widest row spacing (54 cm). Hyola 50 was an exception to this trend showing no yield loss even at 54 cm row spacing. Tarcoola was the most responsive cultivar to row spacing with yield loss relative to 18 cm row spacing of 26% and 29% at 36 and 54 cm, respectively. However, under higher yielding conditions in 2008, all cultivars showed a similar rate of yield loss with increase in row spacing.

Table 1. Grain yield of four canola cultivars grown on three row spacings (18, 36 and 54 cm) at Roseworthy in 2007 and 2008.

	Row spacing (cm)					
	18	36	54	18	36	54
Cultivar		2007			2008	
	kg/ha					
AV-Garnet	1490	1562	1244	1869	1723	1451
Tarcoola	1748	1294	1240	1564	1245	1341
Hyola 50	1134	1228	1268	1867	1679	1360
Hyola 75	1371	1416	1101	1751	1584	1476

LSD (P=0.05)†	297

†Represents the significance (P < 0.05) of the interaction between row spacing, cultivar and year.

Similarly, research undertaken in Canada (Morrison et al. 1990) showed site-year ? row spacing interactions for yield, with canola yields declining when row spacing increased from 15 to 30 cm (12-29%). In their study, higher yield at the narrower than wider row spacing was attributed to lower interplant competition which resulted in greater number of pods per plant and seeds per pod. Our results also tend to suggest that the decline in canola yield in response to widening row spacing was greater under higher yield potential situations.

Table 2. Correlation coefficients between grain yield and yield components of four canola cultivars grown at Roseworthy in 2007 and 2008.

	Grain yield							
	pods/m^2		seeds/pod	seed size	pods/m^2		seeds/pod	seed size	
Cultivar			2007				2008		
AV-Garnet	0.82	**	-0.26	-0.08	0.84	***	-0.10	0.39	
Tarcoola	0.78	**	-0.14	0.05	0.82	**	0.37	0.63	*
Hyola 50	0.76	**	-0.19	0.27	0.90	***	-0.46	0.23	
Hyola 75	0.85	***	-0.40	0.43	0.92	***	-0.20	0.22	

*P < 0.05; **P < 0.01; ***P < 0.001.

In both years, the yield response of all cultivars was strongly correlated (r^2= 0.76-0.92) with pod density. Seeds per pod tended to show small variation in response to row spacing and this was reflected in absence of any correlation with grain yield. Similarly, individual seed size was not correlated with grain yield in all comparisons with the exception of Tarcoola in 2008. Pod density was clearly the major factor responsible for the observed yield responses. Taylor and Smith (1992) also showed that canola yield was strongly correlated to pod density concluding that it is the component most affected by crop vigour and duration of the vegetative and stem elongation phases.

In both years there was a significant (P<0.01) positive relationship between light interception by the crop canopy and grain yield (Figure 1). In 2007, with lower spring rainfall, maximum light interception tended to be lower than in 2008. In 2007 some cultivars such as Hyola 50 were able to maintain stable light interception across the row spacing treatments and consequently showed no reduction in grain yield in wide rows. Other cultivars such as Tarcoola had a lower LI in wide rows and showed a similar level of decline in grain yield. In 2008 which had higher rainfall, LI was greater in all cultivars at 18 cm relative to 54 cm rows. Consequently, all four canola cultivars showed yield reduction in wide rows relative to 18 cm row spacing. The results indicate that it is feasible to grow some cultivars (e.g. Hyola 50) in wide rows up to 54 cm without affecting yield under dry conditions where maximum LI is constrained by plant available water. However, under higher rainfall conditions wide rows were unable to achieve LI similar to the 18 cm rows which reduced their grain yield perhaps due to reduced photosynthesis and biomass production.

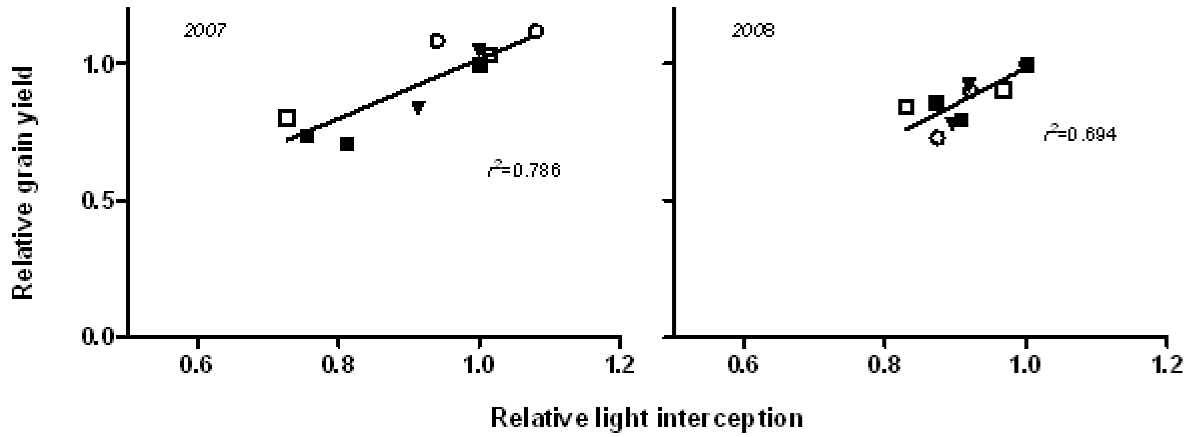

Figure 1.The relationship between light interception and grain yield of four canola cultivars (,, AV-Garnet; ?, Tarcoola; ™, Hyola 50; ?, Hyola 75) grown on wide rows (36 and 54 cm RS) relative to the 18 cm row spacing at Roseworthy in 2007 and 2008.

Conclusion

Sensitivity of canola cultivars to wider row spacing appears to be related to pod density and the ability of the crop canopy to maintain light interception. In low rainfall seasons, more vigorous canola cultivars (e.g. Hyola 50) were able to maintain similar light interception across the row spacing treatments which may have influenced soil evaporation and enabled them to maintain yield. However in seasons with higher rainfall when maximum light interception was greater in narrow rows (18 cm), all cultivars showed some decline in grain yield.

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