High yields and quality are achieved from European canola types grown in the high rainfall zone of south-western Victoria

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ABSTRACT

Field experiments were conducted at Hamilton in south west Victoria in 2010 to assess the potential and limitations of high yielding European canola cultivars for the High Rainfall Zone (HRZ) of southern Australia. The yields and quality of four late maturing European cultivars (winter and spring types) were compared to the high yielding Australian spring cultivar, Hyola 50. Crops were grown under +/- spring irrigation and +/- plant growth regulator (PGR) treatments. The European types produced approximately 20% more grain than Hyola 50 with grain yields as high as 8.0 t ha^{-1} under irrigation. The application of 45 mm of irrigation in spring resulted in approximately 1 t ha^{-1} more grain than the rain fed treatment but did not increase grain oil or protein content. Oil and protein (meal and seed) contents (%) of the European spring cultivar CBI8802 were the greatest, possibly due to the longer duration of grain fill both in terms of days and thermal time. Results indicate that the introduction of European cultivars into the HRZ of southern Australia could increase yields and returns for growers.

Key words: winter – *Brassica napus* – meal protein – oil – irrigation – plant growth regulator

INTRODUCTION

Canola types with a spring maturity have traditionally been grown in Australia. Long season winter types were considered poorly adapted to the traditional cropping regions and were therefore eliminated from breeding programs early in the development of the Australian canola industry (Cowling 2007). With the recent expansion of cropping into the HRZ, the potential of longer season canola types is being assessed. Recent experiments showed unexpected high grain yields in the HRZ of Victoria from winter canola types imported from Europe (Riffkin 2009). However winter types tested to date have flowered 4 weeks later than the commercially available spring types pushing grain fill into warmer, drier conditions. High mean daily temperatures and water stress during grain fill have been associated with reduce grain yields and quality (Hocking 1997). An experiment was conducted at Hamilton, Victoria in 2010 to test the hypothesis that longer season canola cultivars from Europe will produce higher yields than Australian spring cultivars but that grain yield and quality may be reduced due to water stress and high temperatures during grain fill.

MATERIALS AND METHODS

A field experiment was conducted at Hamilton in southwest Victoria (long/lat 37°45'S, 142°03'E) in 2010. Five cultivars were sown in autumn (April 30) onto raised beds with +/- spring irrigation (i.e. irrigation and rain fed) and +/- plant growth regulator (PGR) treatments. The experimental design was a split-plot design with irrigation as the main block and cultivar x PGR randomised within each irrigation block with three replicates giving a total of 60 plots. Plot size was 16 m long x 4 beds giving a total plot area of 109 m^2 (including furrows). Grain yield was determined from hand harvests (2 m^2 per plot) taken at crop maturity. Oil and protein contents were analysed through whole seed NIR calibrated against reference methods according to the Australian Oilseed Federation manual. The experiment was analysed through ANOVA using GenStat 12th Edition (GenStat Committee 2003).

Cultivars included three European winter types, CBI206, Taurus and CBW03, one spring European type, CBI8802 and one Australian spring type, Hyola 50. Hyola 50 was selected as a high yielding cultivar for the region based upon long term cultivar evaluation experiments (DPI 2010). All cultivars were conventional hybrids. Irrigation was applied to the irrigation + plots in spring when readily available water readings from gypsum blocks placed at a depth of 30 cm were between -30 and -50 kPa. The total amount of irrigation applied was 44.8 mm in 3 applications (26 Oct, 19 Nov and 2 Dec). An experimental growth regulator was applied when the bud had extended to between 30 and 50 cm (Aug 9 and Sep 17 for the spring and winter types respectively). Daily minimum and maximum screen temperatures (°C) and rainfall (mm) data was collected from the DPI weather station approximately 500 m from the site.

RESULTS

Climate

Annual and growing season rainfalls (GSR: April to November) were higher than the long term average (LTA) mainly due to high August and December rainfall. Mean temperatures during grain fill were similar to the LTA and ranged between 11.2 °C for Hyola 50 and 13.2 °C for the European winter cultivars. The crop was not exposed to frost (temperatures <0°C) or extreme, high temperatures (>32°C) during flowering and grain fill (Fig. 1).

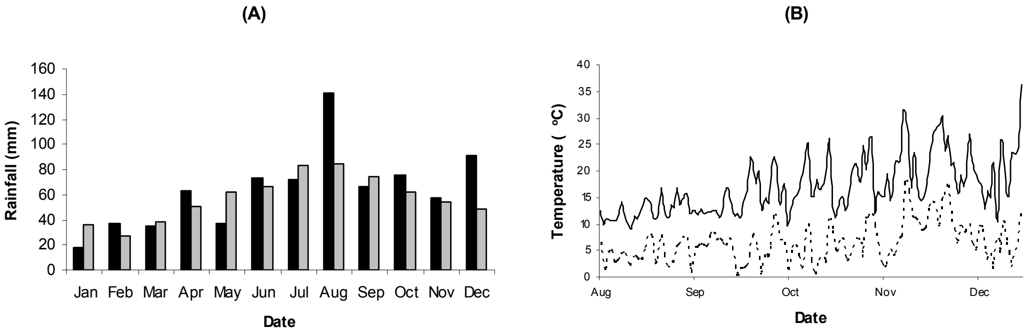

Fig. 1. (A) long-term average (grey bars) and 2010 (black bars) rainfall and (B) minimum (dotted line) and maximum (solid line) temperature data in 2010 at Hamilton.

Phenology

The winter canola types reached the bud and flowering stages of development approximately 4 weeks later than the spring types. The European cultivars matured approximately 10 (spring type) and 16 (winter types) days later than the Australian spring type (Fig. 2). Thermal time from first flower to harvest was similar for the Australian spring and European winter cultivars (1000 °C days) but longer for the European spring type (1200 °C days).

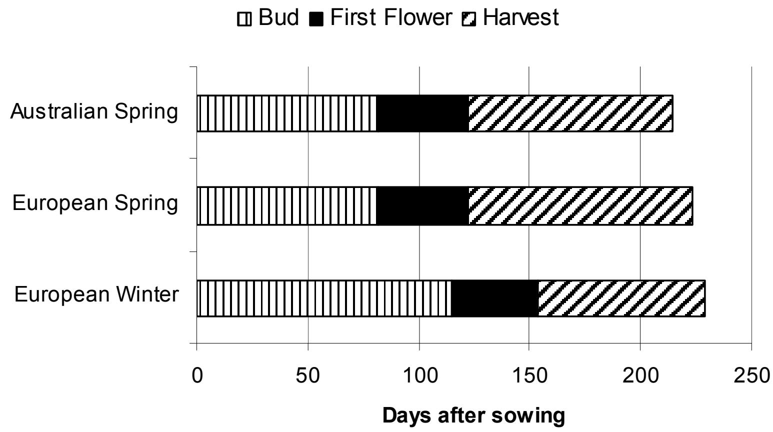

Fig. 2. Number of days from sowing to bud visible (vertical lines), bud visible to first flower (solid black bars) and first flower to harvest (diagonal lines) for the three maturity groups of canola sown at Hamilton in 2010.

Grain Yield and Quality

Grain yields were significantly (*P*<0.001) greater from the European cultivars than the Australian cultivar and significantly greater under irrigation than the rain fed treatments (Table 1). The PGR significantly reduced plant height (*P*<0.001) but had no effect on grain yield or harvest index. There were no significant interactions between treatments. Yields ranged from 5.7 t ha^{-1} for rain fed Hyola 50 to 8.0 t ha^{-1} for the winter type CBI206 under irrigation (data not shown). The European cultivars produced up to 6.8 t ha^{-1} under rain fed conditions with yields more than 1 t ha^{-1} greater than Hyola 50 regardless of irrigation treatment. The grain yields of both European types (winter and spring) were not significantly different to each other.

Seed oil content ranged from 40.27% to 44.79%. The European spring cultivar CBI8802 had significantly (*P*<0.001) greater oil and protein contents than the other cultivars. With the exception of CBI206, there was no significant difference between the winter cultivars and Hyola 50 for oil %. Seed and meal protein contents were generally lower for the winter types (Table 1). There was no significant effect of irrigation or PGR on oil and protein content.

Table 1. Grain yield and quality for three European winter types (CBI206, CBW03 and Taurus), one European spring cultivar (CBI8802) and the Australian spring control (Hyola 50) sown at Hamilton in 2010. Results for cultivar are the mean of the irrigation and PGR treatments. Results for irrigation are the mean values of the cultivars and PGR treatments.

Treatment	Grain Yield DM (t ha-1)	Seed Oil (%)	Seed Protein (%)	Meal Protein (%)
Cultivar (mean of Irrigation and PGR treatments)				
Hyola50	6.06	42.22	19.89	36.10
CBI8802	7.26	44.79	20.95	40.03
CBI206	7.36	40.27	19.13	33.47
CBW03	7.20	41.78	19.58	35.23
Taurus	7.12	41.72	19.35	34.79
F Prob	<0.001	<0.001	<0.001	<0.001
LSD	0.588	0.643	0.467	0.555
Irrigation (mean of Cultivar and PGR treatments)				
+ irrigation	7.48			
Rain fed	6.51			
F Prob	<0.001			
LSD	0.045			

DISCUSSION

Significantly (*P*<0.001) greater yields from the European germplasm compared to the high yielding Australian cultivar support the hypothesis that European cultivars are able to produce greater yields in the HRZ than the spring types currently available to growers. These results support findings from previous experiments at the same location (Riffkin 2009) and indicate that greater productivity may be achieved in the HRZ of southern Australia by introducing new genetic material. Grain yields in excess of 6.5 t ha-1 under rain fed conditions show that the HRZ of south-eastern Australia has a high yield potential. However, the greater yields achieved under irrigation suggest that soil moisture stress in spring will limit the yield of these cultivars. Cultivars with drought tolerant traits or management practises that conserve soil water into the grain fill period will be required to maximise yields in this environment.

There was no significant effect of irrigation on grain oil or protein content, indicating that yield is more sensitive to moisture stress than grain quality. Four weeks delay in flowering from the winter types resulted in a 2°C increase in mean daily temperature during grain fill. However, with the exception of CBI206, there was no significant difference in oil content between Hyola 50 and the winter types despite the difference in mean daily temperatures during grain fill (11.2 °C and 13.2 °C respectively). Reductions in oil content of up to 2.7% per 1°C increase in mean daily temperature during grain fill have been reported (Hocking *et al* 1997), however these relationships were established under higher temperatures (range 12 – 20°C) than were experienced in this experiment. With little difference in grain fill temperatures between cultivars, the higher oil content from CBI8802 was possibly due to the longer grain fill period (200 °C days longer). Temperatures experienced during grain fill in 2010 were similar to the long term average and it would therefore be expected that late flowering in this environment would not have a significant effect on grain quality. CBI8802 also had a significantly higher seed and meal protein content than both the winter and Australian spring cultivars. Generally there is an inverse relationship between grain protein and oil content (Brennan 2000, Hocking *et al* 1997) with a reported constant value for oil plus protein of around 62-64% (Hocking and Stapper 2001, Brennan 2000). In this experiment combined oil and protein contents were similar (62% mean of all cultivars) with CBI8802 higher at 65.7%. The further testing of long season spring types from Europe may provide additional yield and quality improvements.

This study indicates that long season canola types imported from other regions of the world have the potential to provide significant improvements to the yield and quality of canola in the HRZ. Further testing of cultivars with a range of phenologies and the identification of traits and management practises to conserve soil moisture into the grain filling period may provide further opportunities to increase crop yields and quality in the HRZ of southern Australia.

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