Determining critical growth periods of canola – Wagga Wagga 2016

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Key findings

- All crops go through stages of development known as critical growth periods (CGP) where stress can reduce yield potential more than at any other time.
- Shading can be used to induce defined periods of stress on a crop to identify CGP.
- The critical growth period for canola was identified as approximately 100–400 degree days (°C.days) after the start of flowering (defined as 50% plants with one open flower).
- There was minimal effect of pre- and post-flowering stress on grain yield.

Introduction

Seed number and grain yield of crops are most sensitive to environmental stresses during specific growth stages or periods – termed critical growth periods (CGP). These periods have been identified for most winter crops in Australia, but not for canola. Artificial shading is used to reduce crop photosynthesis, and although the stress of shading might appear to be different to that caused by drought or heat, the physiological effect is the same – reduced photosynthesis and potential impacts on yield. The aim of this experiment was to determine the CGP of field-grown canola so that sowing date and variety can be selected to ensure that the CGP (the period when the crop is most sensitive to environmental stresses) occurs when the growing environment is likely to be the most favourable (a balance between adequate moisture, heat and frost stress, and adequate solar radiation).

Site details

Location	Downside, approximately 25 km north-west of Wagga Wagga
Soil type	Gravelly red–brown chromosol
Previous crop	Faba beans
Fallow rainfall	243 mm (November 2015–March 2016)
In-crop rainfall	625 mm (April 2016–October 2016)
Sowing date	2 May
Variety	Pioneer® 44Y89 (CL)
Soil pH_{Ca}	5.3 (0–10 cm, 29 April)
Soil nitrogen	133 kg/ha (0–120 cm, 29 April)
Nitrogen applied	Urea (46% nitrogen) 217 kg/ha, 28 March (broadcast then incorporated by plot seeder) Urea 217 kg/ha, 8 June (broadcast)
Soil phosphorus	31 mg/kg (Colwell)
Starter fertiliser	100 kg/ha mono-ammonium phosphate (11% nitrogen, 22.7% phosphorus, 2% sulfur), treated with 2.8 L/t flutriafol (500 g/L)

Treatments

Shading periods

Fifteen different shade periods (plus an untreated control) were applied to different canola plots for around 100 degree days (°C.days) (Table 1). The duration of 100 °C.days was equivalent to nine days for the first shade period (June), up to 13 days for the shade period in the colder, mid-winter period (July), and seven days for the final shade period in mid spring as temperatures increased (Table 1).

Table 1. Starting date and duration of 15 shade periods to determine critical growth periods for canola at Wagga Wagga, 2016.

Shading period	Start date	Duration (days)
Nil	N.A.	N.A.
1	7 June	9
2	16 June	12
3	28 June	13
4	11 July	11
5	22 July	13
6	4 August	12
7	16 August	10
8	26 August	10
9	5 September	9
10	14 September	8
11	22 September	9
12	1 October	6
13	7 October	7
14	14 October	7
15	21 October	7

The first shade period started when the crop was at the 4–6 leaf stage (Figure 1). The first six periods were all completed before the start of flowering. Flowering started on 17 August and finished on 26 September, with periods 7–11 falling within the flowering window. Periods 12–15 were all completed after flowering. The plots were hand-harvested on 8 November, 11 days after the final shading period was completed.

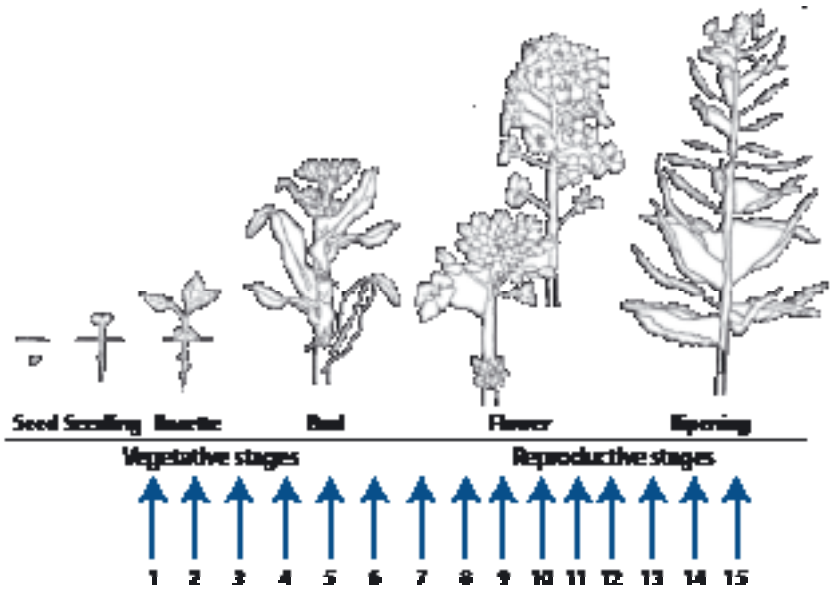

Figure 1. Timing of 15 shade periods (start of each period indicated by arrow) in relation to crop growth stage in an experiment to determine critical growth periods of canola at Wagga Wagga, 2016.

Shade shelters consisted of steel frames, two metres wide and three metres long. The frame was covered with green shade cloth that blocked 85% of incoming solar radiation. The height of the frame was raised throughout the growing season as the frames were moved onto increasingly

taller plots, but was always kept approximately 50 cm above the crop canopy (Figure 2). The southern end remained open to ensure temperature and humidity within the covers did not deviate significantly from outside, at the same time minimising light entering the covered area.

Figure 2. Shade shelter on canola critical growth period experiment at Wagga Wagga on 23 June 2016. The lid was made to slide up the four corner poles throughout the year and remain approximately 50 cm above the crop canopy.

Results

Grain yield

Shade periods 8–10 showed a marked reduction in grain yield compared with the unshaded controls, and compared with other shade periods (Figure 3). Periods 8–10 all occurred within the flowering window with period 8 starting nine days after the start of flowering and period 10 finishing four days before the end of flowering. The largest effect of shading was at period 10 with a 37% lower yield than the unshaded control. There was either a small or no effect of shading on grain yield before flowering and after flowering finished.

As flowering will progress at different rates in different environments according to temperature, a thermal time approach should be used to define the CGP. In this experiment, together with a sister experiment conducted at Riverton in South Australia, the critical period for canola could be identified as the time from 100 °C.days to 400 °C.days after flowering started.

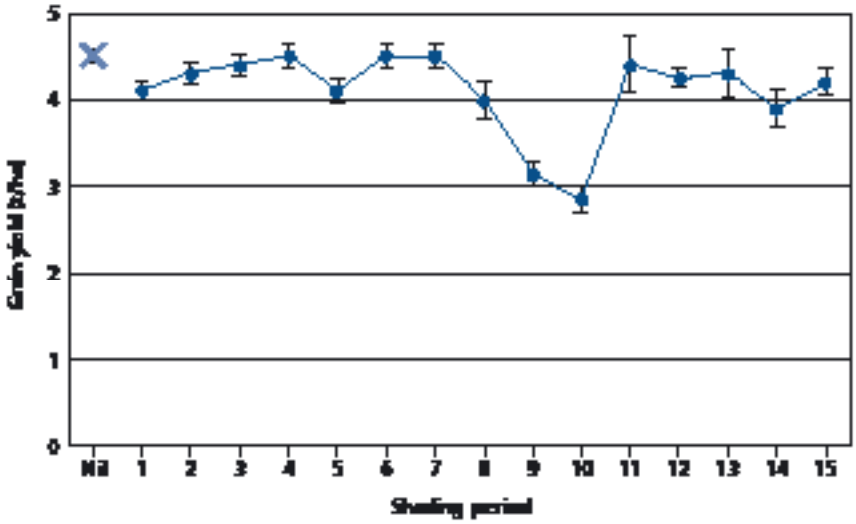

Figure 3. The effect of 15 separate periods of shading (●) on canola grain yield at Wagga Wagga, 2016. The unshaded control is marked as ✕.

Yield components

The unshaded control yielded approximately 133 000 seeds/m² with a seed size of 3.4 mg/seed. The lowest yielding shade period (period 10) had 48% less seeds/m² than the unshaded control.

An increase in seed size, from 3.4 mg to 4.0 mg (18%), provided some yield compensation during period 10, however, it did not compensate fully for the reduced seed number.

Summary

Growers and agronomists that make canola planting decisions in any environment need to ensure that the crop's critical period coincides with the optimum environmental conditions. In effect, the period when the crop is most sensitive to stress needs to be timed to when the growing environment has the least risk of stress (least risk of frost and heat, with optimum moisture and radiation availability). For canola, this critical period had not previously been clearly defined. This experiment clearly showed the critical period from 100 °C.days to 400 °C. days after the start of flowering.

The Optimised Canola Profitability project has characterised the phenology of many commercially available varieties, especially in their response to early sowing. This improved understanding of varietal phenology will enable growers and agronomists to select appropriate sowing dates to ensure that the critical period coincides with the optimum environmental conditions.

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