Management of Paterson's curse (*Echium plantagineum*) through canola interference

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Summary Canola is a major oilseed crop in Australia but weeds reduce yield and quality. Paterson's curse (*Echium plantagineum L.*) is an aggressive winter weed in Australia and often causes yield losses in canola crops. The prospects of herbicide resistance in weed species necessitate the search for alternative weed control options, such as canola interference (crop competition and allelopathy). A field experiment was conducted with two different sowing times, to investigate the interference ability of six canola genotypes. The results showed that canola genotypes had an effect on the number of *E. plantagineum* plants in the early sowing. Genotypes that display strong interference such as Av-opal, Pak85388-502 and Av-garnet significantly reduced the vegetative growth of *E. plantagineum* at both early and late sowing times, while genotypes Atr409, Cb-argyle and Barossa showed a much weaker interference ability.

Keywords Canola, allelopathy, competition, sowing time.

INTRODUCTION

Canola is the third largest broadacre crop in Australia (Zhang *et al.* 2011). It provides the additional rotational benefits of a disease break and some options to control weeds (Norton 2003). Despite of modern blackleg resistance varieties (Cowling 2007), weeds are still a major cost to canola production. Paterson's curse (*E. plantagineum*) is a common and aggressive weed in canola fields in southern Australia (Lemerle *et al.* 2001). It produces prolific quantities of dormant seed and has robust vegetative growth (Naughton *et al.* 2006) and can significantly reduce the yield of canola.

Chemical herbicides are an effective tool to control Paterson's curse but herbicides have other negative impacts with evolves resistant in weeds. In such circumstances, crop interference becomes a potential weed control tool.

Crop interference involves the combined effect of crop competition and allelopathy (Zimdahl 2007). Competition is the negative interaction between two or more plant species for resources (e.g. light, water and nutrients) within a limited space (Donald 1963). In contrast, allelopathy is a mechanism where a plant gives itself a competitive advantage by placing phytotoxins into the adjacent environment to reduce the viability of competitors (Pratley 1996). The phenomenon varies with plant species, cultivar, growth stage and various stress factors but overall is gaining interest among weed scientist as a tool for weed suppression. Furthermore, in the field situation both competition and the allelopathy phenomenon act collectively (Olofsdotter *et al.* 1999). Thus, canola cultivars with strong weed-suppressing ability, as a result of optimising both competitive and chemical interference, could become an important tool for weed management. We hypothesed that canola shows interference ability against Paterson's curse under a field environment via competition and allelopathy or both.

MATERIALS AND METHODS

Plant materials Six canola genotypes were selected for this study. Previous field and laboratory screening results showed that among the six genotypes Av-opal and Pak85388-502 are strongly allelopathic, while Atr409 and Barossa are weakly allelopathic (Asaduzzaman *et al.* 2014). The other two genotypes were chosen based on a previous canola competition study by Lemerle *et al.* (2011): Av-garnet was strongly competitive, Cb-argyle was weakly competitive. To investigate the influence of environmental factors two different sowing dates were used. All seed was obtained from the National *Brassica* Germplasm Improvement Program, located at New South Wales Department of Primary Industries, Wagga Wagga, Australia. The early and late sowing was done on 12 May and 11 June 2013 respectively with 140 kg ha^{-1} of Grain-u-Lok fertiliser treated with the fungicide Jubilee (fluquinconazole, Farmoz) to protect against the fungal disease Blackleg (*Leptosphaeria maculans*). The experimental area was previously a barley crop grown for grain. No herbicide was used after barley harvest and during canola was grown.

Experimental design The experimental layout of each sowing date was designed by DiGGER design software (Coombes, 2002). The individual plot size was 10 m × 1.8 m and row-to-row distance was 20 cm. To maximise experimental precision, each genotype was replicated six times.

Measurement and statistical analysis At ninety days after sowing (DAS) of canola, the number of Paterson's curse plants was counted (plants per plot). In addition, the diameter of five random rosettes per plot was measured. Data from two different sowing dates was analysed separately. All data of field experiments were subjected to analysis of variance using Genstat v16 (VSN International, Hemel Hempstead, UK) using the REML analysis model where fixed effects = genotypes, random effects = replication + range + row. Treatments means were compared using the least significance difference (LSD) at a 5% level of probability. Plots of residual versus fitted values were examined for all traits to ensure that the assumptions of analysis of variance were met.

RESULTS

Effect of canola interference on Paterson's curse density At 90 days after sowing, the number of Paterson's curse plants was significantly different between the genotypes in the early sowing (P <0.001) but not in late sowing. In the early sowing, the highest number of Paterson's curse plants were recorded under the genotype Atr409 followed by Barossa, Cb-argyle and Av-garnet. In contrast, a much lower number was recorded with Av-opal and Pak85388-502 (Figure 1).

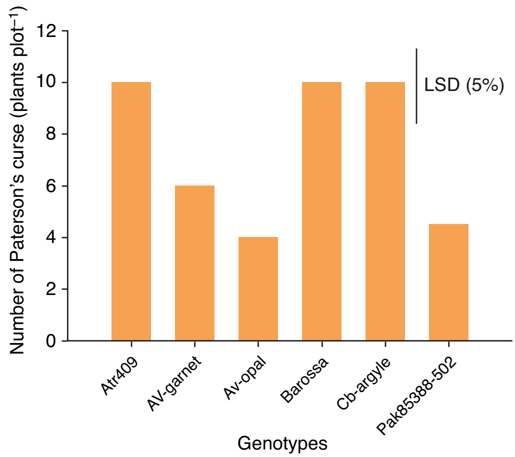

Figure 1. Number of Paterson's curse plants present under six canola genotypes at an early sowing time.

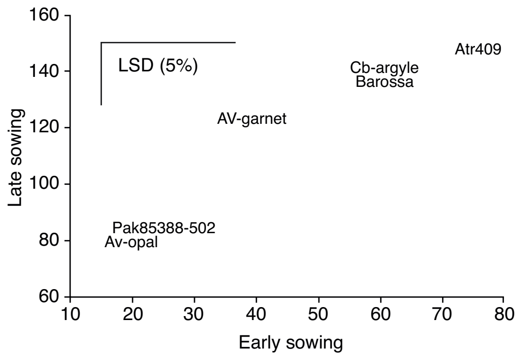

Figure 2. The rosette diameter (cm) of Paterson's curse plants under six canola genotypes at early and late sowing times.

Effect of canola interference on Paterson's curse rosette diameter For both sowing dates, canola genotypes differentially reduced weed vegetative growth. Strong interference by some canola cultivars such as Av-opal and Pak85388-502, significantly reduced the weed rosette diameter by 55 cm and 51 cm respectively, relative to the weak (Figure 2). The vegetative growth of Paterson's curse was increased in the late sowing compared to the early sowing time, but still varied significantly between canola genotypes (P <0.001). It was also observed that with the weak allelopathic or competitive genotypes, Paterson's curse emerged early and produced more reproductive organs early (in October 2013), whereas its reproductive stage was delayed (in December 2013) by the strong allelopathic and competitive genotypes (Figure 3).

DISCUSSION

Early sowing of canola established a greater competitive advantage over Paterson's curse relative to late sowing in some genotypes. Farmers who sow canola relatively late are likely to require a pre-sowing knockdown herbicide (e.g. glyphosate) to ensure that any established weeds are killed prior to the sowing. Some canola genotypes showed strong interference by reducing the diameter of Paterson's curse rosettes. This suggests that canola competition and allelopathy

Figure 3. Flowering stage of Paterson's curse in 10 m long × 1.8 m wide plots of suppressive (left) (Av-opal) and less suppressive (right) canola genotypes (Barossa) in 2013 at Wagga Wagga. In the Av-opal plot there were no flowering Paterson's curse plants visible. On the right, there are many Paterson's curse plants visible (purple flowered plants).

tactics can be applied to reduce the weed pressure in the field. It can be argued that impact of canola interference on Paterson's curse rosette size may not influence the weed competitive ability and seed production. However, any reduction in weed vigour is an advantage (Cousens and Mortimer 1995). The use of high interference canola genotypes may, therefore, have an important long-term effect on the Paterson's curse weed population in a canola rotation.

Combined early sowing and strong canola interference is likely to have a major effect on Paterson's curse.

ACKNOWLEDGMENTS

We thank David Roberts for technical assistance. The field trial was partially funded by GRDC through project DANØØ1Ø8.

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