Cool temperatures favour hybrid canola competition with weeds

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Abstract. Hybrid, herbicide-resistant cultivars dominate canola production in Canada. These cultivars have greater competitive ability than previously popular open pollinated cultivars resulting in improved canola competition with weeds and less reliance on herbicides. Direct-seeded (no-till) experiments were conducted at five western Canada locations (Beaverlodge AB, Lacombe AB, Lethbridge AB, Saskatoon SK, and Scott SK) from 2006 to 2008 comparing the relative competitive ability of several open pollinated- and hybrid-spring canola cultivars with spring barley, rye, triticale, and wheat. Cultivated oat was seeded across plot areas and oat biomass was used to determine the relative competitive ability of each crop cultivar. After a single pre-seeding glyphosate burn-off application, no further herbicides were applied to the plots. In most cases, barley produced the greatest crop biomass and was the most competitive species; particularly when monocot weed biomass was considered. Hybrid canola produced less crop biomass than most cereal cultivars. At relatively high temperature and high precipitation sites, most cereals were more competitive than canola. However, under cool conditions more favourable to canola, several canola cultivars had a higher competitive ranking against dicot weed species than any small-grain cereal. Opportunities for integrated weed management practices that rely on less frequent herbicide applications in canola are most likely in relatively cool environments. Under these conditions one can reduce selection pressure for weed resistance by limiting in-crop herbicide applications.

Introduction

Canola is not considered to be a particularly competitive crop. Barley has generally been found to be a stronger competitor with weeds than crops such as wheat, canola, flax (*Linum usitatissimum* L.) or field pea (*Pisum sativum* L.) (Dew 1972; Harker 2001; O'Sullivan et al. 1982; Pavlychenko and Harrington 1934). However, given the introduction and success of canola hybrids in western Canada, we felt it was important to reassess the relative competitive ability of canola cultivars/species versus several small-grain cereals.

Competitive cultivars increase opportunities to practice integrated weed management and to reduce herbicide inputs (Harker et al. 2003; Swanton and Weise 1991). Our objectives were to rank the competitive ability of several canola and small-grain cereal cultivars/species, and to determine the climate and site-related factors that influenced competitive rankings. In this paper we defined competitive ability as the relative ability of a crop species or cultivar to reduce weed biomass.

Materials and Methods

Direct-seeded (no-till) experiments were conducted in western Canada from 2006 to 2008 at Beaverlodge, AB; Lacombe, AB; Lethbridge, AB (2006 to 2007); Saskatoon, SK (2007 to 2008); and Scott SK. After a single pre-seeding glyphosate application (450 to 900 g ae ha^{-1}), no further herbicides were applied to the plots. Immediately prior to crop seeding, 'AC Morgan' oat was seeded at 100 seeds m^{-2} at a depth 2 to 3 cm across the entire plot area (perpendicular to test crop species) to supplement natural weed infestations. Test crop species of canola (150 seeds m^{-2}, 1 cm depth) and spring small-grain cereals (300 seeds m^{-2}, 2 to 3 cm depth) were seeded perpendicular to the oat with direct-seeding equipment using 1 cm wide knife openers on 23 cm row spacing. Fertilizer was side-banded during planting 2 cm beside and 3-4 cm below the seed row at recommended levels based on soil tests. Plot size was 2 by 5 m at Scott and Saskatoon and 3 by 15 m at all other locations. Experiments were designed as randomized complete blocks with four replications.

The species/cultivars tested in this study were: 'AC Metcalfe' spring barley, 'Vivar' spring barley, '45H72' imidazolinone-resistant hybrid spring canola (*Brassica napus*), 'InVigor 5020' glufosinate-resistant hybrid spring canola (*B. napus*), '45H21' glyphosate-resistant hybrid spring canola (*B. napus*), 'AC Excel' open pollinated spring canola (*B. napus*), 'ACS-C7' synthetic spring canola (*B. rapa*), '3465' glyphosate-resistant open pollinated spring canola (*B. napus*), 'Westar' open pollinated spring canola (*B. napus*), 'Gazelle' spring rye, 'Pronghorn' spring triticale, 'AC Foremost' semi-dwarf Canada Prairie Spring Red (CPS) wheat, and 'AC Superb' Canada Western Red Spring (HRS) wheat.

Monocot and dicot weed biomass were determined in each plot at three intervals each growing season. The most competitive crop was defined as the crop that led to the lowest weed biomass. Crop yields were also determined but are not of primary interest here. Site and weather data were collected to determine their influence on crop competition rankings. Data were analyzed via PROC GLIMMIX and PROC PLS procedures in SAS.

Results and Discussion

Competition with Monocot Weeds. The environmental parameter that best accounted for monocot weed biomass variability across sites and years was growing season precipitation (PROC PLS analyses). In terms of reducing monocot weed biomass, barley was the most competitive crop (followed closely by rye and triticale) (Table 1). At low and average precipitation levels, 'InVigor 5020' canola was the 5th ranked most-competitive crop cultivar. At the highest precipitation site (Lacombe 2007), 'AC Superb' wheat replaced canola as the 5th ranked most-competitive crop cultivar. Ranking barley as the most competitive species is consistent with similar rankings in other research studies (Dew 1972; Harker 2001; O'Sullivan et al. 1982; Pavlychenko and Harrington 1934).

Table 1. The five most competitive crop species/cultivars when monocot weed biomass means at crop maturity were adjusted according to sites with the lowest, average, and highest growing season precipitation (mm)*.

Rank	Beaverlodge 2007 (167 mm)	~Scott 2007 (191 mm)	Lacombe 2007 (326 mm)
1	Barley – 'AC Metcalfe'	**Barley – 'AC Metcalfe'**	**Barley – 'AC Metcalfe'**
2	Barley – ' Vivar'	**Rye – 'Gazelle'**	**Rye – 'Gazelle'**
3	Rye – 'Gazelle'	**Barley – ' Vivar'**	**Barley – ' Vivar'**
4	Tritcale – 'Pronghorn'	Tritcale – 'Pronghorn'	**Tritcale – 'Pronghorn'**
5	Canola – 'InVigor 5020'	Canola – 'InVigor 5020'	Wheat –'AC Superb'

*__Bolded__ cultivars/species within a column reduced monocot weed biomass significantly more than other listed cultivars/species in the same column.

Competition with Dicot Weeds. The environmental parameter that best accounted for dicot weed biomass variability across sites and years was growing degree days (0 C base) (PROC PLS analyses). In terms of reducing monocot weed biomass, barley was usually the most competitive crop (Table 2). Under relatively high temperature conditions such as at Saskatoon in 2008, four of the top five ranked competitive crops were cereals. Conversely, under cool (low GDD) conditions typical of Beaverlodge 2007, four of the top five ranked competitive crops were canola cultivars. Under cool conditions, hybrid canola cultivars occupied the top three competitive ranks in terms of reducing dicot weed biomass.

Table 2. The five most competitive crop species/cultivars when dicot weed biomass means at crop maturity were adjusted according to sites with the lowest, average, and highest growing degree days (GDD – 0 C base)*.

Rank	Beaverlodge 2007 (1189 GDD)	~Scott 2007 (1251 GDD)	Saskatoon 2008 (1316 GDD)
1	Canola – '45H72 CF'	Barley – ' Vivar'	Barley – 'AC Metcalfe'
2	Canola – 'InVigor 5020'	Barley – 'AC Metcalfe'	Barley – ' Vivar'
3	Canola – '45H21 RR'	Canola – 'InVigor 5020'	Rye – 'Gazelle'
4	Canola – 'AC Excel'	Rye – 'Gazelle'	Canola – 'InVigor 5020'
5	Rye – 'Gazelle'	Canola – '45H21 RR'	Tritcale – 'Pronghorn'

*Although rankings varied, none of the cultivars/species within a column reduced dicot weed biomass significantly more than the other cultivars/species listed.

Complete results of this project including a complete list of all species/cultivars studied, competitive rankings earlier in the growing season, crop and weed biomass variability, crop yields, and species/cultivar effects on oat seed production are available in Harker et al. (2011).

Conclusions

Barley is usually a more competitive crop than canola. However, under cool environmental conditions favourable to canola, hybrid canola cultivars are at least if not more competitive with dicot weeds than small-grain cereals. Opportunities for integrated weed management practices that rely on less frequent herbicide applications in canola are most likely in relatively cool environments. Under these conditions one can reduce selection pressure for weed resistance by limiting in-crop herbicide applications.

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