Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Relative Competitive Ability of Canola Cultivars Versus Small Grain Cereals

K. Neil Harker[1], John T. O'Donovan[1], Robert E. Blackshaw[2], Eric N. Johnson[3], Frederick A. Holm[4], and George W. Clayton[2]

Agriculture and Agri-Food Canada: [1]Lacombe and [2]Lethbridge, Alberta; and [3]Scott, Saskatchewan; [4]University of Saskatchewan, Crop Development Centre, Saskatoon, Saskatchewan. E-Mail: neil.harker@agr.gc.ca

Background

- Early in their life cycle, weeds are relatively susceptible to the negative influences of shade (Fenner 1978, Mohler 2001).
- The germination of some weed seeds is inhibited when solar radiation filters through crop canopies and becomes red-light depleted (Górski 1975, King 1975, Silvertown 1980).
- Hybrid canolas compete more strongly with weeds than open pollinated cultivars (Harker et al. 2003, Zand & Beckie 2002) and also "close the crop canopy" more quickly than open pollinated cultivars.
- The relative competitiveness of some western Canada crops has been summarized as follows:
  - Barley > Rye > Wheat > Oats > Flax (Pavlychenko & Harrington, 1934)
  - Barley > Wheat > Flax (Dew, 1972)
  - Barley > Rapeseed > Wheat > Flax (O'Sullivan et al., 1982)
  - Barley > Canola > Peas (Harker, 2001)
- A study was designed to evaluate the relative competition of various open-pollinated and hybrid canola cultivars with several spring cereal species/cultivars.

Objectives

The objectives of the study were to:

1) determine which cereal or canola species / cultivar competes most strongly with weeds.
2) to determine if there are environmental conditions where canola hybrids would compete as well as barley.

Materials and Methods

- Direct-seeding experiments were conducted at Lacombe, Lethbridge, Beaverlodge, and Scott (AAFC) from 2006 to 2008, and at Saskatoon (U of S) from 2007 to 2008.
- Prior to crop seeding, cultivated oat (100 seeds m^{-2}) was uniformly seeded across the plot area to simulate a weed infestation and to ensure relatively uniform "weed" densities across plots.
- Several different types of spring canola (seed rate 150 seeds m^{-2}) were compared to spring cereal cultivars (seed rate 300 seeds m^{-2}) of barley, wheat, triticale and rye.
- Crop cultivars/species allowing the least weed biomass production at crop maturity were considered to be most competitive.
- No pre-emergence residual or in-crop herbicides were applied.
- The experiment was designed as a randomized complete block with 4 replications. Plot size was 3 x 15 m.
- Statistical analyses included a partial least squares procedure (PROC PLS) which allowed environmental parameters for each environment (site-year) to be grouped in terms of their association with weed biomass results. Environments were treated as random in the statistical analyses. Weed biomass means were predicted according to low, average, and high composite environmental [Latent Variables (LV)] scores.

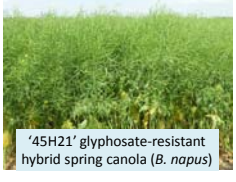
Table 1. Abbreviations of crop species and cultivars (see Figure 2 and Table 2).

Bar-Met	'AC Metcalfe' spring barley
Bar-Viv	'Vivar' barley
Hyb-CF	'45H72' imidazolinone-resistant hybrid spring canola (*Brassica napus*)
Hyb-LL	'InVigor 5020' glufosinate-resistant hybrid spring canola (*B. napus*)
Hyb-RR	'45H21' glyphosate-resistant hybrid spring canola (*B. napus*)
OP-Exc	'AC Excel' open pollinated spring canola (*B. napus*)
OP-rap	'ACS-C7' synthetic spring canola (*B. rapa*)
OP-RR	'3465' glyphosate-resistant open pollinated spring canola (*B. napus*)
OP-Wes	'Westar' open pollinated spring canola (*B. napus*)
Rye-Gaz	'Gazelle' spring rye
Tri-Pro	'Pronghorn' spring triticale
Whe-CPS	'AC Foremost' semi-dwarf Canada Prairie Spring Red (CPS) wheat
Whe-HRS	'AC Superb' HRS Canada Western Red Spring (HRS) wheat.

Results and Discussion

Crop Competition with Monocot Weeds

- Monocot weeds were much more dominant than dicot weeds (seeded cultivated oat) (Figure 2).
- Across all sites, barley and rye were most competitive with monocot weeds.
- Across all sites, canola hybrids led to slightly higher weed biomass than barley and rye, but weed biomasses in hybrid canola were less variable (Figure 2).
- In most environments, **Bar-Met, Rye-Gaz**, and **Bar-Viv** were the most competitive crop species (Table 2).
- In low precipitation environments such as Beaverlodge in 2007, **Hyb-LL** canola was the 5th ranking competitive crop .



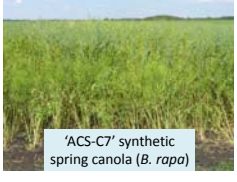


Figure 1. Selected experimental plots from Lacombe 2006.

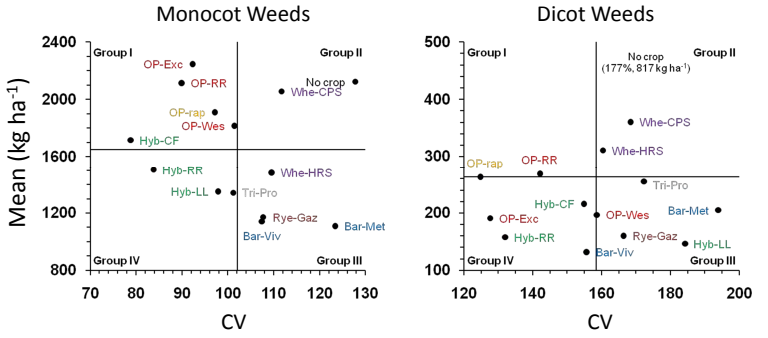


Figure 2. Biplots for the mean weed biomass and biomass CV of each crop/cultivar treatment. Lines within each biplot show the mean of the means (horizontal) and CVs (vertical). The lines allow crop/species treatments to be divided into four categories: Group I = high mean, low variability; Group II = high mean, high variability; Group III = low mean, high variability; and Group IV = low mean, low variability.

Crop Competition with Dicot Weeds

- Across all sites, some canola cultivars had similar competitive ability with dicot weeds as did barley and rye (Figure 2).
- Across all sites, most canola cultivars led to less dicot weed biomass variability (Figure 2 Groups I & IV) than cereal crops.
- Across all sites, both cultivars of wheat were poor competitors with dicot weeds and resulted in high levels of dicot weed variability (Figure 2 Group II).
- In high GDD environments, such as Saskatoon in 2008, barley and rye were the most competitive crops.
- In low GDD environments such as Beaverlodge in 2007, all three canola hybrids had a higher rank for competition with dicot weeds than barley or any other small-grain cereal crop.
- Plants compete more strongly against species that exploit similar environmental resources than against less-related species (Harper 1977). In this case, similar canola crop and dicot weed leaf orientation, canopy architecture and tap root structure may have promoted more intense competition versus the competition among small-grain cereal crops and dicot weeds.

Table 2. Competitive **ranking** of crops species / cultivars based on the lowest weed species biomass at maturity (1st mature crop) in a given environment. Values in parenthesis are precipitation (mm) and GDD (0 C base) for monocot and dicot weed biomass, respectively. Precipitation and GDD had the highest "Variable Importance in Projection" (VIP) values for monocot and dicot weed biomass, respectively. Estimates of weed biomass means are based on sites with the lowest, average, and highest LV1 scores.

	Monocot weed biomass						Dicot weed biomass					
	Bea 2007 (167)		Sco 2007 (191)		Lac 2007 (346)		Sas 2008 (1316)		Sco 2007 (1251)		Bea 2007 (1189)	
	g m^{-2}		g m^{-2}		g m^{-2}		g m^{-2}		g m^{-2}		g m^{-2}	
1	**Bar-Met**	**1149***	**Bar-Met**	**1954**	**Bar-Met**	**3538**	**Bar-Met**	**5**	**Bar-Viv**	**86**	**Hyb-CF**	**316**
2	**Bar-Viv**	**1290**	**Rye-Gaz**	**2238**	**Rye-Gaz**	**4001**	**Bar-Viv**	**5**	**Bar-Met**	**92**	**Hyb-LL**	**324**
3	**Rye-Gaz**	**1331**	**Bar-Viv**	**2245**	**Bar-Viv**	**4171**	**Rye-Gaz**	**13**	**Hyb-LL**	**96**	**Hyb-RR**	**343**
4	**Tri-Pro**	**1444**	Tri-Pro	2588	**Tri-Pro**	**4967**	**Hyb-LL**	**18**	**Rye-Gaz**	**113**	**OP-Exc**	**411**
5	**Hyb-LL**	**1500**	Hyb-LL	2812	Whe-HRS	5508	**Tri-Pro**	**20**	**Hyb-RR**	**148**	**Rye-Gaz**	**566**

***** Cultivars/species in **bold type** within a column are those leading to the lowest weed biomass in the same statistical grouping according to Fisher's protected LSD ($\alpha = 0.05$) on transformed means.

Conclusions

- In most environments, barley and rye competed more strongly with weeds than canola.
- However, given, low GDD (temp.) environments, canola hybrids can compete as well as barley (esp. with dicot weeds).
- Competitive crops provide opportunities to implement integrated weed management systems.

Literature Cited

Dew, D. A. 1972. An index of competition for estimating crop loss due to weeds. Can. J. Plant Sci. 52:921-927.
Fenner, M. 1978. Susceptibility to shade in seedlings of colonizing and closed turf species. New Phytol. 81, 739-744.
Górski, T. 1975. Germination of seeds in the shadow of plants. Physiol. Plant. 34, 342-346.
Harker, K. N. 2001. Survey of yield losses due to weeds in central Alberta. Can J. Plant Sci. 81:339-342.
Harker, K. N., G. W. Clayton, R. E. Blackshaw, J. T. O'Donovan and F. C. Stevenson. 2003. Seeding rate, herbicide timing and competitive hybrids contribute to integrated weed management in canola (*Brassica napus*). Can. J. Plant Sci. 83, 433-440.
Harper, J. L. 1977. Mechanisms of interactions between species. Pages 347-381 *In* J. L. Harper (ed.) Population Biology of Plants. Acad. Press, London.
King, T. J. 1975. Inhibition of seed germination under leaf canopies in *Arenaria serpyllifolia*, *Veronica arvensis* and *Cerastum* (*sic*) *holosteoides*. New Phytol. 75, 87-90.
Mohler, C. L. 2001. Weed life history: identifying vulnerabilities. M. Liebman, C. L. Mohler, and C. P. Staver eds. Ecological Mgmt. of Agricultural Weeds. Cambridge University Press, UK, 40-98.
O'Sullivan, P. A., V. C. Kossatz, G. M. Weiss, and D. A. Dew. 1982. An approach to estimating yield loss of barley to Canada thistle. Can. J. Plant Sci. 62:725-731.
Pavlychenko, T. K. and J. B. Harrington. 1934. Competitive efficiency of weeds and cereal crops. Can. J. Res. 10:77-94.
Silvertown, J. 1980. Leaf-canopy-induced seed dormancy in a grassland flora. New Phytol. 85, 109-118.
Zand, E. and H. J. Beckie. 2002. Competitive ability of hybrid and open-pollinated canola (*Brassica napus*) with wild oat (*Avena fatua*). Can. J. Plant Sci. 82, 473-480.

Canada