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VARIETY AND SEEDING RATE EFFECTS ON COMPETITION IN ORGANICALLY GROWN SPRING CEREALS

Final Research Report W2007-27

INTRODUCTION

Weed competition has been reported to reduce grain yields by up to 29% in barley and 63% in wheat (Harker 2001; Hucl 1998). Some strategies employed by organic grain farmers to increase crop competitive ability include changes to seeding rate and the use of competitive crops and crop varieties. The competitive ability of a crop or variety can be considered in two ways: the ability of the crop to maintain grain yield under competition from weeds; and the ability of the crop to suppress weed growth. When crops are growing with high weed pressure, both maintaining high yields and preventing weeds from producing seeds would be desired.

Using a higher seeding rate has been shown to reduce weed competition and increase grain yield in wheat (Hucl 1998) and barley (O'Donovan et al. 1999). In addition, certain crops such as barley have been found to be more competitive against weeds than other grain crops (e.g. wheat).

Research plots at Steven Snider's Little Red Hen Mills certified organic farm in New Norway, AB (H. Mason)

Differences in varietal performance have also been reported; with competitive varieties yielding 7-9% more grain under weedy conditions than less competitive types (Hucl 1998).

Several plant traits are thought to be associated with competitive ability. Plant height, early season growth, tillering ability, and the ability to intercept light have all been reported to play a role in crop competitive ability. The identification of competitive traits could help plant breeders develop new varieties and producers choose varieties suited to their environment. Knowledge about how increasing the seeding rate influences competition on organic land could help producers overcome some of the problems associated with high weed populations.

A study was conducted at the University of Alberta to determine the effect of variety and seeding rate on the competitive ability and agronomic performance of Canadian spring wheat and barley grown under organic management. We also examined which plant traits were associated with the competitive ability of wheat and barley varieties on organically managed land.

WHAT WAS DONE?

Nine spring wheat and two spring barley varieties were chosen based on height, tillering and maturity characters (Table 1). The 11 varieties were grown under organic management at single (300 seeds m^{-2}) and double (600 seeds m^{-2}) seeding rates, in both 2003 and 2004. In order to guarantee some level of competition from weeds, a tame oat (*Avena sativa* L.) treatment was included in each trial, where plots were cross-seeded with tame oats (as a simulated weed) at a rate of 60 seeds m^{-2}. Field sites were managed according to Organic Crop Improvement Association International certification standards.

Table 1. Variety descriptions for spring wheat and barley varieties included in these trials

Crop	Variety	Description	Year of Release	Country of Origin	Height	Tillering potential	Maturity
Wheat	Kohika	Bread	1997	New Zealand	semidwarf	high	medium
	Sapphire	Bread	1995	New Zealand	semidwarf	low	late
	CDC Go	CWRS	2003	Canada	semidwarf	high	medium
	Katepwa	CWRS	1981	Canada	medium	high	medium
	Park	CWRS	1963	Canada	medium	high	early
	McKenzie	CWRS	1997	Canada	medium	high	medium
	9207-DB3*D	CWRS	unreleased	Canada	medium	low	medium-late
	Hard Red Calcutta	CWRS	1890	India	tall	low	medium
	Marquis	CWRS	1910	Canada	tall	high	late
Barley	Peregrine	6-row hulless	1999	Canada	semidwarf	low	early-medium
	Seebe	2-row feed	1992	Canada	tall	high	medium-late

CWRS – Canada Western Red Spring

Organic sites in Edmonton received annual applications of composted dairy manure at approximately 50% dry matter and 1.3% total nitrogen. At the New Norway organic farm, experiments were planted following green manure plowdowns the previous year.

Plots were seeded in mid-late May and harvested in early-mid September. Data collected included: early season vigour, days to maturity, plant height, spikes m^{-2}, kernel weight, kernels $spike^{-1,}$ grain yield and naturally occurring weed biomass, tame oat biomass (in plots receiving the tame oat treatment), and total weed biomass (natural + tame oat biomass). In all instances, the grain yield of Seebe barley was adjusted downward by 15% to account for the weight of the hull.

A simple economic analysis was conducted to determine the net return associated with doubling the seeding rate, based on the seeding rates used, yield gains and kernel weights observed in this trial. Crop prices were obtained from documents detailing Alberta purchase prices for organically grown crops in 2005. Seed costs were calculated as the crop price per bushel plus an additional $0.65 per bushel to account for seed cleaning and transportation (Ehnes Organic Seed Cleaning, personal communication). The net return was calculated as:

$$N = (YP)-C*S$$

where:

N is the net return in \$CAD ha^{-1}
Y is crop yield (t ha^{-1})
P is crop price (\$CAD t^{-1})
C is the cost of seed (\$ t^{-1})
S is the seeding rate (t ha^{-1}).

RESULTS: TAME OAT COMPETITION

Competition from tame oats reduced grain yield by 27% overall. Although only two barley varieties were included in the trial, barley was generally more competitive than wheat, experiencing an average of 20% yield loss from competition with tame oats compared to 29% yield loss in wheat.

Competition also reduced the number of spikes m^{-2}, kernels $spike^{-1}$, kernel weight, by 13%, 6% and 3%, respectively.

VARIETY EFFECTS

Varieties differed for all measured traits. The semidwarf variety CDC Go yielded more grain than all other varieties, while Marquis wheat was among the lowest yielding.

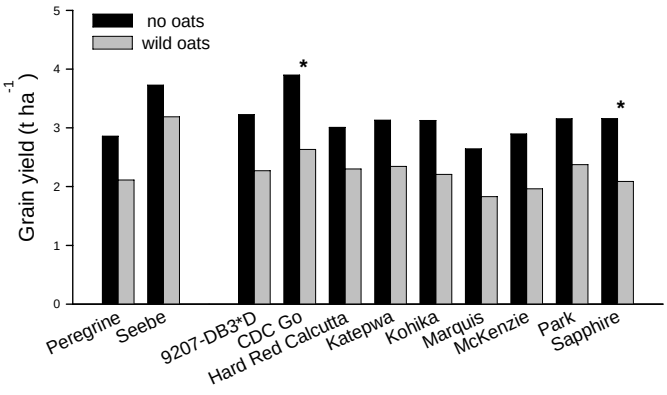

Figure 1. Grain yield of varieties grown with and without tame oat (within each variety, bars with * differ significantly at *P*<0.05 according to the LSD)

In terms of grain yield, varieties performed differently with and without tame oat competition. CDC Go and Sapphire, both semidwarf varieties, experienced the highest yield loss as a result of tame oat competition (Fig. 1). Other varieties still experienced some yield loss when wild oat was present, but loss was not statistically significant. This suggests that varietal choice can influence the ability of a crop to compete against weeds.

COMPETITIVE PLANT TRAITS

Height, strong early season vigour and early maturity were associated with both reduced yield loss and weed suppression (Table 2). The stronger association between height and weed biomass suggests that height is more related to weed suppression, likely through the shading of shorter weeds. Days to maturity was more strongly related to yield loss, suggesting that early maturing varieties may be able to avoid some weed competition.

Preventing yield loss is important, but it may not be the only indicator of performance on organic land. CDC Go was still very high yielding even though it suffered some of the greatest yield losses of any of the varieties in this trial. Thus, it is important to also look at overall grain yielding ability and total weed biomass. Figure 2 shows the relationship between variety grain yield and total weed biomass under tame oat competition.

Varieties differed in their ability to suppress weeds and achieve grain yield (Fig. 2). For example, the trial with Kohika wheat achieved average grain yield with very high weed biomass, while Marquis wheat had low weed biomass but also low grain yield. These different varietal performances indicate that some varieties are better suited to organic production than others.

Table 2. Correlations of plant traits with percent yield loss and total weed biomass

	Percent Yield Loss	Total Weed Biomass
Height	-0.1*	-0.3**
Early Season Vigour	-0.4**	-0.2*
Days to Maturity	0.8**	0.5**

*,** denotes significance at $P<0.1$ and 0.05, respectively

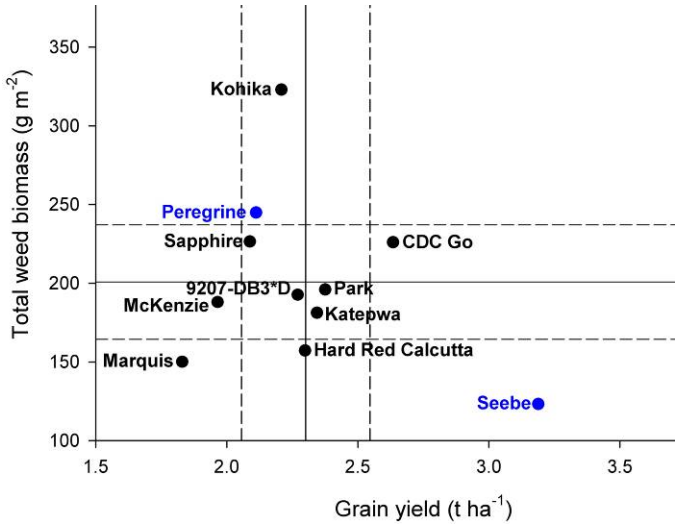

Figure 2. Relationship between grain yield and total weed biomass for barley and wheat varieties (solid lines indicate the mean values and dotted lines represent the 95% confidence limits)

While few of the plant traits studied here consistently explained grain yielding ability, the highest weed biomass occurred in trials with semidwarf varieties (Kohika, Peregrine, Sapphire, CDC Go) and those with lowest weed biomass were among the tallest (Seebe, Hard Red Calcutta, Marquis). This further indicates that height is involved in weed suppression. It appears that semidwarf varieties are not as effective at weed suppression as their taller counterparts.

DOUBLING THE SEEDING RATE

On average, doubling the seeding rate increased grain yield by 10%, while natural weed biomass was reduced by an average of 28% (Table 3). This suggests that doubling the seeding rate may be a suitable strategy for managing weeds on organically managed land. Further, the beneficial effects of doubling the seeding rate were not variety specific, which may make it a less complex and more effective option than choosing a variety that is both weed tolerant and suppressive. It is important to note that these results may not be the same under different soil types, soil nutrient and/or moisture levels, or under different weed pressures.

Table 3. The effect of doubling the seeding rate on grain yield and naturally occurring weed biomass

	Grain yield (t ha^{-1})	Natural weed biomass (g m^{-2})
Seeding Rate		
Single (300 seeds m^{-2})	2.6	98
Double (600 seeds m^{-2})	2.9	71
F test	***	***
SE_{diff}	0.06	3.6

*** F values significant at $P<0.01$

Economic Analysis

Net economic gains associated with doubling the seeding rate of wheat ranged from \$34.62 ha^{-1} to \$53.72 ha^{-1}, depending on grade. Seebe and Peregrine barley differed enough to warrant separate analyses. The net return for Seebe barley at the doubled rate was a loss of \$7.99 ha^{-1}, while the gain for Peregrine was \$15.74 ha^{-1}. Price premiums for CWRS wheat are responsible for part of the difference in returns on barley and wheat.

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Credits

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Wheat (vertical rows) cross-seeded with tame oats (horizontal rows) as a simulated weed (H. Mason)

The Bottom Line...

Crop types and varieties differed in their competitive ability on organic land, with barley being generally more competitive than wheat.

Differences in varietal performance under weed competition on organic land indicate that some of the varieties tested are better suited to organic production. Height, strong early season vigour and early maturity are plant traits related to competitive ability on organic land.

Doubling the seeding rate appears to be a generally effective tool for suppressing weeds and increasing grain yield and economic returns under organic growing conditions.

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