

# THE COMPETITIVE ABILITY OF SPRING WHEAT IN ORGANIC CROPPING SYSTEMS

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## INTRODUCTION

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Competition from weeds plays a role in reducing wheat yields on organic farms (Leeson et al. 2000). Organic grain farmers may use several strategies to reduce the impact of weeds, such as the use of crop rotation, intercropping, changes to planting dates and density, and varietal selection. Studies have shown that wheat varieties perform differently under competition from weeds with competitive varieties yielding 7-9% more grain under weedy conditions than less competitive types (Hucl 1998).



Canada Western Red Spring wheat varieties growing under organic management in New Norway, AB in 2004 (H. Mason)

The performance of Canada Western Red Spring (CWRS) wheat varieties grown under organic conditions has not been thoroughly investigated. Plant traits, such as height and tillering, may help wheat varieties compete better under organic growing conditions. Identifying such traits may make the use of competitive varieties a more valuable weed management tool for organic producers. A study was carried out at the University of Alberta to identify which plant traits influence competitive ability of CWRS wheat under organic management.

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## WHAT WAS DONE?

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Twenty seven Canada Western Red Spring (CWRS) wheat varieties were grown at 4 conventionally managed and 3 organically managed sites over a two year period (7 site-years). The conventional sites were located in Edmonton and Lacombe, AB and the organic sites were located in Edmonton and New Norway, AB.

Conventionally managed sites received applications of mineral fertilizer in spring and chemical broadleaf herbicide in late spring. Organically managed sites were managed according to Organic Crop Improvement Association International Certification Standards. 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.

At all sites, varieties were seeded into plots at a rate of 300 seeds m<sup>-2</sup>. Plots were seeded in mid-late May and harvested in early-mid September. Data collected included: early season vigour, days to heading and maturity, plant height, spikes m<sup>-2</sup>, grain yield and weed biomass. Weed biomass samples were taken from 0.25 m<sup>2</sup> areas in each plot.

Weeds present at organic sites included stinkweed (*Thlaspi arvense* L.), common lamb's-quarters (*Chenopodium album* L.), wild buckwheat (*Polygonum convolvulus* L.), shepherd's-purse [*Capsella bursa-pastoris* (L.) Medic.], Canada thistle [*Cirsium arvense* (L.) Scop.] and wild oats (*Avena fatua* L.). Very few weeds were present at conventional sites, due to chemical weed control.

## RESULTS: VARIETAL PERFORMANCE

Grain yields were higher on conventionally managed land, averaging 4.2 t ha<sup>-1</sup> compared to 2.6 t ha<sup>-1</sup> on organically managed land (Table 1). This yield reduction was likely a result of increased weed biomass at the organic sites.

Weed biomass was significantly higher on organic land, averaging 134 g m<sup>-2</sup>, compared to 1.4 g m<sup>-2</sup> on conventional land.

Varieties performed differently from one another in each system. Within the conventional system, varieties performed differently for all traits except early season vigour and weed biomass. Within the organic system, varieties performed differently for all traits (Table 1).

Differences in the grain yield of varieties were more pronounced in the conventional system (Fig. 1), possibly because weed biomass was higher and nutrient levels were lower (data not shown) under organic than under conventional sites of this trial. This highlights the importance of identifying varieties that perform well in higher stress, low input systems.



Canada Western Red Spring wheat varieties growing under organic management in Edmonton, AB in 2003 (H. Mason)

From the varieties tested, there were no clear indications that some were more suitable for organic systems than others. Most varieties that performed well at the organically managed sites performed well at the conventionally managed sites (Fig. 1).

The varieties Park, AC Intrepid, Sinton, Canus and CDC Teal were all relatively high yielding in both systems. Red Fife and Chester were among the lowest yielding varieties in either system.

The variety Garnet was the exception to this, performing relatively better under organic management than conventional. This suggests that there may be some varieties better suited to organic production than conventional production.

**Table 1. Least squares means for agronomic traits of 27 CWRS wheat varieties grown under conventional and organic management in north central Alberta in 2003 and 2004**

	Grain Yield (t ha <sup>-1</sup> )	Early Season Vigour (1-5)	Days to Heading	Days to Maturity	Plant Height (cm)	Spikes m <sup>-2</sup>	Weed Biomass (g m <sup>-2</sup> )
<b>Conventional:</b>							
Overall mean	4.2	4	59	100	102	540	1.4
F-test variety	**	ns	**	**	**	**	ns
<b>Organic:</b>							
Overall mean	2.6	3	58	99	103	495	134
F-test variety	**	*	**	**	**	**	**

\*, \*\* denotes significance at  $P < 0.05$  and  $P < 0.01$ , respectively.

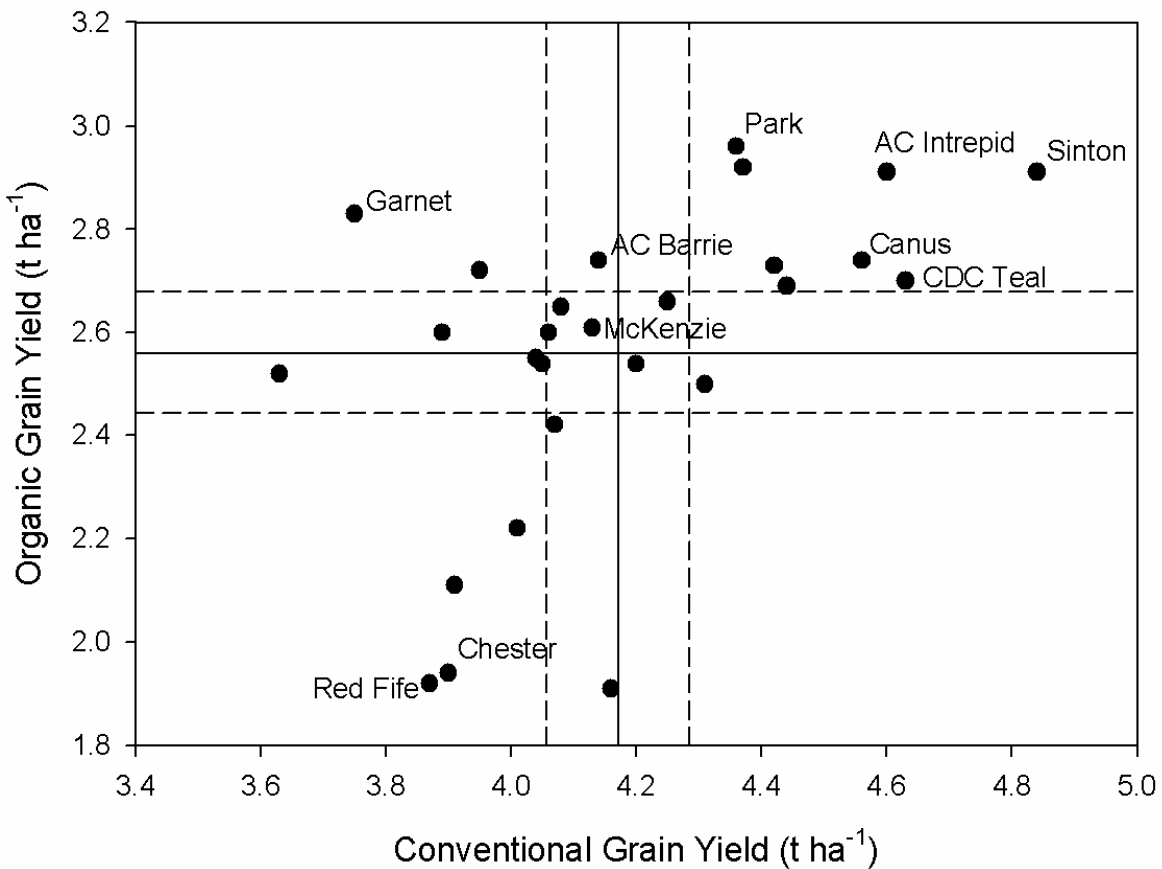


Figure 1. Grain yield of 27 CWRS varieties grown at 4 conventional and 3 organic sites in north central Alberta in 2003 and 2004. Solid lines represent system means, dashed lines represent the 95% confidence limits.

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## RESULTS: COMPETITIVE TRAITS

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Increased grain yield was associated with strong early season vigour, tallness, and early heading and maturity in both conventionally and organically managed systems (Table 2).

Under organic management, higher grain yields were related to increased tiller number, where the opposite relationship was observed under conventional management. This indicates that tillering is important for wheat grain yield in organic systems.

Reductions in weed biomass on organically managed land were associated with increased early season vigour, faster time to maturity, increased height and an increased number of fertile tillers (Table 2). Strong early season vigour was also correlated with reduced time to maturity and increased tiller number on organic land.

These results suggest that a wheat variety suitable for organic production would be a taller variety with strong early season growth, early maturity and a high number of fertile tillers.

**Table 2. Correlations of plant traits for 27 CWRS varieties grown under organic and conventional management in north central Alberta in 2003 and 2004**

	Early Season Vigour	Days to Heading	Days to Maturity	Plant Height	Spikes m <sup>-2</sup>	Weed Biomass	Grain Yield
Early Season Vigour	-	-	-0.30*	-	-	-	0.34**
Days to Heading	-	-	0.83**	-	-	-	-0.35**
Days to Maturity	-0.72**	-	-	-0.39**	0.49**	-	-0.55**
Plant Height	-	-	-	-	-0.82**	-	0.61**
Spikes m <sup>-2</sup>	0.47**	-0.40*	-0.44*	-	-	-	-0.85**
Weed Biomass	-0.23*	-	0.59**	-0.48**	-0.53**	-	-
Grain Yield	0.23*	-0.40*	-0.63**	0.36**	0.61**	-0.73**	-

Values above the diagonal represent conventional management, those below diagonal represent organic.

\*,\*\* denotes r values significant at  $P < 0.05$ ,  $P < 0.01$ , respectively.

- indicates no significant correlation ( $P \geq 0.05$ )

### THE BOTTOM LINE...

Organic and conventional systems differed in terms of weed biomass, which contributed to reduced grain yield in the organic system.

Differences among varieties were more pronounced in the conventional system, probably due to increased crop stress in the organic system.

In general, varietal yield rankings were similar in the two systems, although the variety Garnet appeared to perform better in organic systems.

A competitive wheat variety for organic production would be a tall plant, with strong early season vigour, early maturity and high tiller number.

### REFERENCES

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