

# Wheat Breeding for Organic Production: Is it Beneficial?

A.P. Kirk<sup>1,2</sup>, S.L. Fox<sup>1</sup>, and M.H. Entz<sup>2</sup>

<sup>1</sup>Cereal Research Centre, Agriculture and Agri-Food Canada, 195 Dafoe Road, Winnipeg, MB R3T 2M9; <sup>2</sup>Department of Plant Science, University of Manitoba, Winnipeg, MB R3T 2N2



## Introduction

Organic production systems represent a different soil and weed environment that is not considered in conventional wheat breeding programs. Due to increased crop stresses under organic management, cultivar performance may be affected to the extent where breeding specifically for organic environments is recommended (Mason and Spaner 2006).

When selection is conducted in the environment where future varieties will be grown, response to selection is maximized (Ceccarelli 1994).

## Materials and Methods

Populations of wheat from the same crosses were selected under both organic and conventional breeding programs. After five generations, populations from seven crosses were identified where there were at least four F2:6 or F3:6 lines remaining from each cross selected in respective conventional and organic management environments. To provide a uniform seed source for this experiment, all lines used to develop the population bulks and check cultivars were increased together. Lines contributing to a bulk were mixed on an equal weight basis.

This experiment was conducted over a period of two years at three organic locations and four conventional locations for a total of 8 site years. The long-term organic locations used for this study were the Glenlea Long-Term Rotation at Glenlea, Manitoba, the Organic Field Crops Laboratory, at Carman, Manitoba, and an organic farm located at Oxbow, Saskatchewan. The conventional sites were located at Agriculture and Agri-Food Canada research stations at Glenlea, Portage and Brandon, Manitoba, and Saskatoon, Saskatchewan.

Conventional sites received fertilizer and herbicides as needed, while organic sites were managed according to organic standards, including post emergence harrowing.

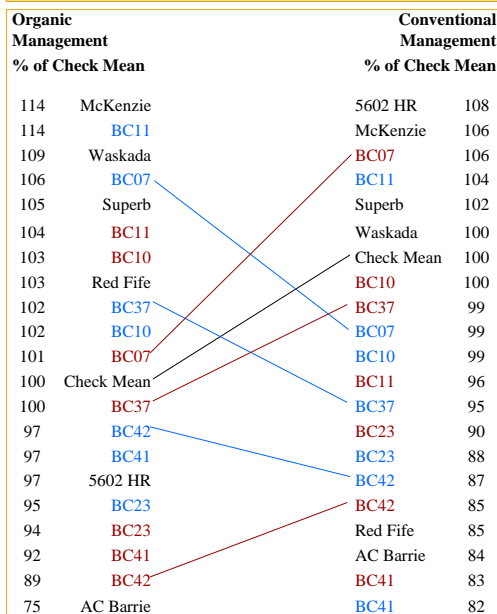
## Results and Discussion

Results are presented as the combination of organically managed experiments and conventionally managed experiments.

### Grain Yield:

Under organic management the organically selected populations yielded significantly higher than the conventionally selected populations (Table 1). Yield of conventionally selected populations was not significantly higher under conventional management, although there was a significant interaction between population and method of selection (Table 2).

Figure 1. Population and check rank as a percent of check mean under two management environments. Check mean includes all modern CWRS checks. Organically selected lines are blue and conventionally selected lines are brown.



## Results and Discussion

Table 1: Yield, protein, and 1000 kernel weight (KWT) of populations under organic management. ANOVA tests do not include checks.

Method of Selection	Yield (kg/ha)	Protein (%)	KWT (g)
Organic	2312	14.86	32.46
Conventional	2232	14.59	31.78
Check Mean	2271	14.34	32.8
<b>ANOVA Tests</b>			
Population	****	****	****
Method	**	****	****
Interaction	ns	**	**

Table 2: Yield, protein, and 1000 kernel weight (KWT) of populations under conventional management. ANOVA tests do not include checks.

Method of Selection	Yield (kg/ha)	Protein (%)	KWT (g)
Organic	3307	15.09	34.25
Conventional	3325	14.91	33.57
Check Mean	3443	14.45	34.70
<b>ANOVA Tests</b>			
Population	****	****	****
Method	ns	**	****
Interaction	**	****	**

Populations responsive to selection environment are shown in figure 1. The populations highlighted show higher rank when grown in the environment in which they were selected.

### Protein:

Organically selected populations had higher levels of protein than conventionally selected populations. The method of selection had a significant effect on protein levels of the seven populations (Table 1 and 2). This may indicate a greater ability of organically selected populations to uptake nitrogen.

### 1000 Kernel Weight:

Populations selected under organic management had higher kernel weights than the conventionally selected populations, but lower kernel weight than the checks (Table 1 and 2). Higher kernel weights may indicate that wheat selected under organic management may be better suited to deal with stresses such as disease.

## Conclusions

The environment in which selection is performed does matter. Under organic management yield, protein, and 1000 kernel weight of organically selected wheat was significantly higher than that of conventionally selected wheat.

- Different plant characteristics are being selected for under organic compared to conventionally managed breeding nurseries
- Rank changes occur between management environments (Figure 1), therefore selection under conventional management may not result in identifying the best lines for organic cropping systems
- Overall, this study indicates that there is value in an organic breeding program



## References

Ceccarelli, S. 1994. Specific adaptation and breeding for marginal conditions. *Euphytica* 77: 205-219.  
 Mason, H.E. and Spaner, D. 2006. Competitive ability of wheat in conventional and organic management systems: a review of the literature. *Can. J. Plant Sci.* 86: 333-343.

## Acknowledgements

We gratefully acknowledge financial support from Agriculture and Agri-Food Canada, The Canadian Wheat Board, and Manitoba's ARDI program.