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THE CONNECTIONS BETWEEN WHEAT CULTIVAR CHOICE, BREADMAKING QUALITY AND SOIL MICROBIAL COMMUNITIES

Final Research Report W2008-35

INTRODUCTION

Consumers are increasingly choosing organic foods largely because they perceive organic foods as having superior quality to conventional foods. However, research comparing nutritional and sensory profiles of organic and conventional foods has not yielded consistent results (Bourne and Prescott 2002).

Soil microbial communities play an important role in soil fertility and nutrient cycling, and may affect final crop quality. Microbial communities are affected by production practices such as management system (Bossio et al. 1998) and cultivar choice (Germida and Siciliano 2001).

A study was conducted at the University of Alberta to determine the effect of spring wheat cultivar choice and management system on soil microbial diversity, crop productivity and quality.

WHAT WAS DONE

Six western Canadian spring wheat cultivars (Elsa, Marquis, Park, Glenlea, Go and Superb) were grown at one organically managed and one conventionally managed field site in 2005 and 2006 in Edmonton, AB.

Research plots at the University of Alberta, Edmonton, AB

Table 1. Breadmaking Quality Measures

Parameter	Label	Importance	Standard values
Grain protein	PRO	Important for gluten formation	over 12%
Flour yield	FLY	Measures milling quality	over 78%
Falling number	FN	Indicates sprouting resistance	over 400
Particle size index	PSI	Indicates kernel hardness	50-55 PSI
Mixing development time	MDT	Time needed to develop the dough	2-3 minutes

Table 2. Least squares means for yield and breadmaking quality measures of wheat grown organically and conventionally in Edmonton, AB

	Yield	PRO	FLY	FN	PSI	MDT
	(t ha^{-1})	(%)	(%)	-	(%)	(min.)
Conventional	5.3	15.1	73	486	52	2.7
Organic	2.1	16.9	70	472	49	2.4
F test mgmt	*	*	NS	NS	NS	NS

NS = non-significant difference, * significance at P<0.10

Soil samples were taken during the growing season, and the soil microbial community was characterized using phospholipid fatty acid analysis (PLFA), which measures viable soil microbial biomass. Total biomass, % Gram negative bacteria, % Gram positive bacteria, % fungi, PLFA richness, evenness and diversity were measured on the soil microbes.

Harvested grain was sent to the Cereal Research Centre, Agriculture and Agri-Food Canada, for breadmaking quality analysis. Measures taken are listed in Table 1.

WHAT HAPPENED?

Productivity & Breadmaking Quality

Yields under organic management were about half of those under conventional management. Grain protein levels were 12% higher in the organic system compared to the conventional system. Protein content of grain is an important factor in breadmaking quality, and was higher in the organic system. Other experiments have reported protein levels in organic systems to be lower (Poutala et al. 1993) or the same (Ryan et al. 2004) as conventional systems. Lower yields and heavy applications of compost for many years prior to the wheat crops in the organic system may explain the higher protein content in organic wheat. However, this experiment demonstrates that it is possible to have similar protein levels in organic and conventional systems.

The 6 cultivars differed in all the breadmaking quality measures when compared within the organic and conventional systems separately, however, all quality measures were within standard levels. Yield differed among the cultivars in the conventional system, but not in the organic system (Table 3).

Soil Microbial Community

In the soil microbial community, cultivar altered the percentage of fungi, PLFA evenness and PFLA diversity in the conventional system. However, cultivar did not affect any of the PLFA measures in the organic system. Management system also did not affect microbes. It appears that factors other than cultivar are important in determining microbial community structure in organic grain production systems.

Grain was harvested from the research plots and sent to Agriculture and Agri-Food Canada for breadmaking quality analysis

Table 3. Least squares means for yield of six wheat cultivars grown organically and conventionally in Edmonton, AB

Cultivar	Conventional Yield ($t\ ha^{-1}$)	Organic Yield ($t\ ha^{-1}$)
Superb	6.0a	2.3ab
Glenlea	5.9ab	2.0ab
Go	5.4ab	2.5ab
Elsa	5.4ab	2.1ab
Park	5.0ab	2.1ab
Marquis	4.4b	2.0ab

Means followed by the same letter are not significantly different (P<0.05)

Associations among Grain Quality and Soil Microbial Community

There were some associations between grain quality and the soil microbial community in both the organic and conventional systems. However, there were more correlations in the organic system. Sixteen of 42 correlations were significant in the organic system (Table 4), and only 7 of 42 correlations were significant in the conventional system (data not shown).

The percentage fungi was positively associated with yield under organic management (r=0.9) (Table 4) and under conventional management (r=0.7). A positive association means that as the percentage of fungi in the soil increased, yields did as well. The positive correlation between yield and % fungi may be due in part to mycorrhizal fungi, as mycorrhizae can benefit plant nutrient uptake and crop productivity.

PLFA analysis measures the viable soil microbial biomass, and can be used to characterize the microbial community structure

More significant relationships between grain quality and soil microbes in the organic system may indicate that soil microbes play a greater role in determining crop quality in the organic system than the conventional system.

Table 4. Correlations of grain breadmaking measures with soil microbial measures in the organic system

	Total biomass	% Gram- bacteria	% Gram+ bacteria	% Fungi	PLFA Richness	PLFA Evenness	PLFA Diversity
Yield	-	-0.68**	-0.60*	0.91**	-0.91**	-0.79**	-0.91**
PRO	-	-	0.58*	-	-	0.56*	0.57*
PSI	-	-	-0.62**	0.70**	-	-0.58*	-0.59*
FN	-	-	-	0.66**	-	-	-
FLY	-	-	-	-	-0.58*	-	-
MDT	-	-	0.67**	-	-	-	-

*, ** denotes r values significant at P<0.10, P<0.05, respectively. - denotes no significant correlation (P>0.10)

THE BOTTOM LINE...

Yields were lower in the organic system, but protein levels and standard breadmaking quality at least equal to conventional systems can be achieved in organic systems.

Cultivar choice altered grain quality and yield in both systems, however, quality measures all fell within standard levels. Cultivar did not have an effect on soil microbial communities in the organic system, indicating that something other than cultivar is affecting the structure of the microbial community.

Soil microbes may play a greater role in determining crop quality in organic systems than in conventional systems.

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Wheat plants from the research plots

CREDITS

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