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HELPING WHEAT COMPETE

Final Research Report W2008-34

INTRODUCTION

Competition with weeds is known to decrease crop yield on the Canadian prairies. Weed density can be higher in organic farms compared to farms which use herbicides (Leeson et al., 2000), but crops with improved competitive ability can decrease weed biomass, improving yields in organic systems (Mason et al., 2007). The study of competitive crops can be problematic as the concept is vague, difficult to measure, and depends on how competition is defined. Distinguishing between crop tolerance, measured in percent yield loss due to weeds (competitive response), and weed suppression (competitive effect), is important in understanding competitive relationships. However, wheat cultivars can show both types of competitive ability, suppressing weed growth while maintaining their yield (Lemerle et al., 2001b)

We investigated the genetic relationships between weed suppression and different agronomic traits to better understand the nature of competitive wheat.

WHAT WAS DONE

One hundred and eight random sister lines from the International Triticeae Mapping Initiative (ITMI) mapping population were kindly provided by Dr. C. O. Qualset (University of California, Davis).

This population has been used in many studies including tillering, growth habit, spike morphology, gross morphology, heading, maturity, plant height, and leaf color. Many of these traits are thought to contribute to competitive ability (Lemerle et al. 2001a).

The population was grown on two sites for two years (2005 and 2006) with two competition treatments (competitive – wheat with oats, and non-competitive – wheat monocrop) in two replications per site. All locations were on conventionally managed land in or near Edmonton AB. Plots were seeded at 250 seeds m^{-2} and competition treatments were cross seeded with 'Grizzly' tame forage oats at 60 seeds m^{-2} to simulate weed competition. Plots were planted mid to late May and harvested late September to early October both years.

Two plots growing without competition on the Ellerslie Research Station near Edmonton Alberta (T. Reid)

Table 1: The effects of oat competition on mean measured traits in the ITMI wheat population

	Yield (t/ha)	Plant Height (cm)	Spikes m^{-2}	Days to Maturity	Early Season Vigour	Oat Yield (t/ha)	Light Captured (%)
Without Oat Competition	4.9	79	102	90	3.3	–	85
With Oat Competition	3.2	81	77	89	3.2	1.6	–
T-test	**	NS	**	NS	NS	–	–

** Significant at P<0.0001

Competition and non competition plots at the Edmonton research station (T. Reid)

Data collected include wheat and oat grain yield, early season vigour (ESV), spikes per m^2, plant height at maturity, and days to maturity (DTM). Percentage of light captured was only measured in the weed free treatments.

Yields were estimated from 0.25 m^2 samples taken at maturity. Both wheat and oats were cut from the sampling area. The two crops were dried and separated in the lab prior to threshing, cleaning, and weighing the grain. Genetic correlations were calculated for each measured trait both between and within competitive treatments.

WHAT HAPPENED?

Wheat yield and spikes per m^2 were significantly reduced by oat competition (Table 1). Yield was reduced by 35% in the presence of oats, and spikes per m^2 was reduced by 25%. Plant height, days to maturity, and early season vigour were not significantly affected by competition. Mean oat yield was half the average wheat yield, and on average this population captured 85% of the available light.

Positively correlated pairs of traits will change in the same direction. Negatively correlated pairs change in opposite directions. Correlations close to zero show there is no relationship between the traits. Correlations were calculated for different traits under the competitive treatment (wheat and oat) and the non-competitive treatment (wheat alone).

The following results were observed through correlation analysis as presented in Table 2:

- **Spikes per m^2** had a significant positive correlation with wheat grain yield under competition and a significant negative correlation with oat grain yield. This means lines with increased spikes per m^2 had an increased wheat yield and decreased oat yield.

- **Early season vigour** was significantly positively correlated with wheat yield under competition, meaning the more vigorous lines had higher yields when

weeds were present than their less vigorous sisters.

- **Days to maturity** had a significant negative correlation with wheat yield and a significant positive correlation with oat yield. This means that the longer the wheat took to mature, the greater the oat yield, and the lower the wheat yield. There was also a significant negative correlation between days to maturity and early season vigour meaning that vigorous lines matured earlier.

- **Light captured** had a significant negative correlation with oat grain yield (–0.58). This means that wheat lines which captured more light also had reduced oat grain yield. Both plant height and spikes per m^2 were correlated with light capture in the weedy treatment, but plant height was not significantly correlated to oat yield or spikes per m^2. Therefore using a taller wheat cultivar may not reduce oat yield as greatly as a high tillering wheat, and despite both traits helping to capture more light, the two are not related.

Table 2: Genetic correlations made within and between competitive treatments for seven traits measured on 108 lines of the ITMI population for four locations in Alberta, Canada. Correlations equal to or greater than one are due to experimental variation.

		Grain Yield		Plant Height		Spikes m^{-2}		Early Season Vigour		Days to Maturity	
		N[1]	C	N	C	N	C	N	C	N	C
Grain Yield	C	0.92*									
Plant Height	N	0.31*	0.31*								
	C	0.29*	0.26*	1.00*							
Spikes m^{-2}	N	0.42*	–[2]	0.04	0.07						
	C	0.43*	0.61*	-0.01	-0.05	0.80*					
Early Season Vigour	N	-0.05	0.44*	0.01	0.00	0.10	0.61*				
	C	0.02	0.48*	-0.08	-0.08	0.12	0.68*	1.03*			
Days to Maturity	N	0.13	-0.27*	0.30*	0.27*	-0.06	-0.54*	-0.83*	-0.89*		
	C	0.09	-0.35*	0.28*	0.25*	-0.09	-0.61*	-0.90*	-0.93*	0.98*	
Oat Yield	C	-0.33*	-0.75*	-0.24*	-0.19	–	-0.89*	–	–	0.60*	0.64*
% Light Captured	N	0.67*	0.47*	0.53*	0.45*	0.77*	0.38*	-0.23	-0.25	0.36*	–

* Significant at P = 0.05

[1] N: Non-competitive treatment. C: Competitive treatment.

[2] Dashes: correlation not estimable

THE BOTTOM LINE...

Competition from oats reduced wheat yield in all sites but using vigorous, early maturing cultivars could help improve yields of wheat in weedy fields. Competition also reduced spikes per m^2, but a high tillering cultivar in a weed free environment could produce a high number of tillers in a competitive environment. High tillering cultivars help capture more light and they can increase wheat yield while helping to suppress competition from other plants.

Farmers with weedy fields should emphasize high tillering, seedling vigour, and early maturity when selecting a cultivar for a weedy environment.

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Todd Reid stands in wheat competition plots at the University of Alberta (B. Frick)

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