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SEEDING RATE FOR WEED CONTROL IN ORGANIC SPRING WHEAT

Final Research Report E2006-08

INTRODUCTION

Do higher seeding rates lead to lower weed competition in spring wheat? This was the question investigated in a two-year research program by the Organic Agriculture Centre of Canada (OACC) and farmers from across the country.

Producer manuals often recommend that organic spring wheat be seeded at a rate 25% higher than conventional farmers would use. A higher seeding rate can also help compensate for losses from post-emergence harrowing, for a low germination rate, or for an uneven seedbed. By increasing seeding rate, the crop is expected to become a stronger competitor against weeds. At a high density, developing crop plants can cover the ground more quickly and shade out weeds. Their roots are distributed more evenly, and they can access more of the water and nutrients. Where there are few crop plants, weeds gain a greater proportion of the resources.

Some research has been done on the potential for higher crop density to suppress weeds, particularly in conventional systems in western Canada. But is this strategy effective for all farmers, or is it just a waste of good organic seed? If it does work, how will it affect crop yield and quality? The best seeding rate for a competitive crop may be different for organic farms. Weed management, cropping history, and nutrient availability can differ in organic systems. Collaborating with farmers across Canada allows testing of this theory across a wide range of farming practices and environments. This can help assess if the recommendation to seed at a higher rate is applicable for all organic grain growers.

Plots of spring wheat grown at different seeding rates show varying degrees of weed competition (R. Beavers)

METHODS

The objective of this research was to assess the effects of increased seeding rates of spring wheat on weed competition and wheat yield and quality.

To address this objective, two trials were conducted: a **plot-scale trial** at the Brookside Pasture of the Nova Scotia Agricultural College (Truro, NS) and an **on-farm trial**, where organic grain growers across Canada grew wheat at different seeding rates. The farm scale trial was needed to assess what actually happens in the field, considering all of the different management practices and variable conditions on organic farms. Farmers were enthusiastic and interested, and there was participation from Saskatchewan, Manitoba, Ontario, Québec, PEI and Nova Scotia. It was the largest on-farm organic field experiment conducted in Canada to date!

Table 1. Targeted conventional (1X) seeding rates for the organic farm trials in each region

Region	lb ac^{-1}	kg ha^{-1}
Dry Prairie (brown and dark brown soil zones of Saskatchewan)	80	90
Moist Prairie (black and dark grey soil zones of Manitoba and Saskatchewan)	105	118
Atlantic Canada	105	118
Ontario and Québec	134	150

The seeding rates we assessed were: the recommended rate for conventional production (1X), an increase of 25% (1.25X), an increase of 50% (1.5X), and double the usual rate (2X), plus an unseeded control (0X). In the Nova Scotia plot trial the conventional rate was 134 kg ha^{-1}, and half the plots were fertilized with a pelletized poultry manure which encouraged weed growth. This allowed us to test if a denser crop stand would be able to out-compete the weeds in a higher fertility scenario. Data characterizing wheat-weed interactions were collected. The years were assessed separately with the mixed procedure of SAS.

Cooperating farmers examined the same four seeding rates (conventional, 1.25X, 1.5X and 2X), based on recommended rates appropriate for each region of the country (see Table 1). The conventional rates were difficult to determine, as a range of seeding rates are often recommended. These participating organic farmers seeded strips of wheat at each of the four different seeding rates. Prior to harvest, samples of aboveground weeds were collected from within each seeding rate. During harvest, the yield of was assessed by the means most appropriate for each farm concerned (scale and combine, or quadrat harvest), and grain samples were submitted for analysis. Statistical analysis was performed using the mixed procedure of SAS for all site-year combinations.

Results – Brookside Plots

In both years of the study, weed competition was lower and the weeds took up less nitrogen where the crop was seeded more heavily. In fertilized plots, higher seeding rates (1.5X or 2X) reduced weed competition. In plots that were not fertilized there was less weed competition overall, and the 1.25X rate was as effective at competing with weeds (Figure 1). Increased seeding rate reduced the biomass of most weed species, although the degree of reduction depended on the species and fertility level.

The wheat at a higher seeding rate had a denser canopy that blocked more light at the stem extension stage (Zadoks GS30), which reduced the light reaching weeds below. Wheat plants matured slightly faster and grew taller at higher seeding rates. These factors gave the wheat a competitive advantage over the weeds that translated into higher crop yield. Highest yield was obtained at a double seeding rate in 2003 (data not shown) and at the three highest seeding rates in 2004 (Table 2), although crop plant density was similar at these rates due to differences in wheat plant emergence between years.

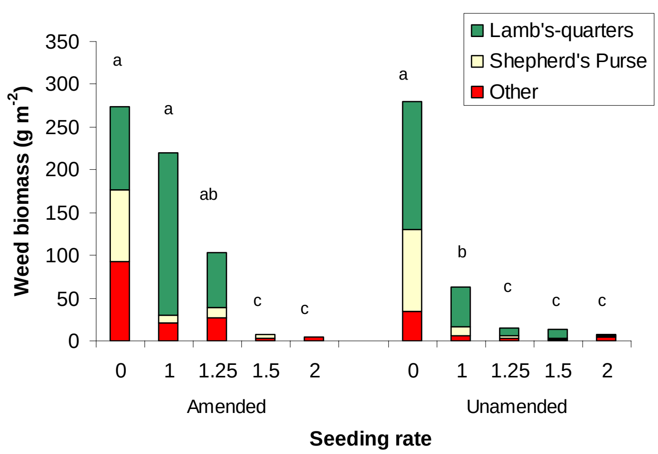

Figure 1. Weed biomass (August 2004) at varying seeding rates and fertility levels. Means for total weed biomass with the same letter are not significantly different (LS Means, P<0.05)

Table 2. Plot scale yield and grain quality analysis means comparisons for seeding rate trials, 2004

Seeding rate		Yield	Yield components					Protein content	Test weight
		(t ha^{-1})	Plants m^{-2}	Heads plant^{-1}	Heads m^{-2}	Kernels head^{-1}	TKW^{z} (g)	(%)	(kg hL^{-1})
1X		1.60 b	177 c	2.02 a	355 b	29	32.6	13.1	69.2 c
1.25X		2.01 a	208 bc	1.82 ab	376 b	30	33.1	12.7	71.2 bc
1.5X		2.01 a	221 b	1.68 bc	371 b	29	32.8	12.5	71.8 b
2X		2.30 a	295 a	1.50 c	439 a	24	32.8	12.6	74.4 a
ANOVA source of variation									
Seeding rate	*P* =	0.001**	<0.001**	<0.001**	0.053^{MS}	0.328	0.929	0.415	<0.001**
Fertility	*P* =	0.371	0.351	0.408	0.103	0.422	0.014*	<0.001**	0.016*
Rate*fertility	*P* =	0.396	0.449	0.927	0.208	0.879	0.742	0.299	0.152

^{z} Thousand kernel weight
a-c Means in the same column with the same letter are not significantly different (LS Means, $P < 0.05$)
^{MS}, *, ** = Significant at $P < 0.10$, $P < 0.05$ and $P < 0.01$, respectively

As shown in Table 2, at higher seeding rates each wheat plant had fewer tillers but there were more plants and heads in a given area. No difference was seen in the number of kernels per head. Wheat quality was not reduced at higher seeding rates: protein content and kernel weight were unaffected. Test weight, a measure of how evenly kernels have filled, actually increased at higher seeding rates.

Results – Organic Farms

The on-farm results confirmed most of the results observed in the plot trial. When all organic farm trials were assessed together, yield was similar at the three highest seeding rates (Table 3). The use of 1.25X seeding rate provided a yield benefit at the least cost. There were no differences observed between seeding rates for protein content, kernel weight or test weight. However, grain samples were not obtained from all farms, so these results should be treated with caution.

Weed biomass was numerically lower at high seeding rates, but this difference was not statistically significant. When we looked at the results for individual farms, we found that increased seeding rate did not reduce weed biomass at several sites in Ontario and Québec. At these farms, there was a high level of weed competition and an increased frequency of grassy weeds. The conventional seeding rate may have provided similar weed control to the higher rates at these sites, or the weed species present may have been better competitors for available resources than the wheat.

A 1X seeding rate adjacent to a double (2X) rate on a Manitoba organic farm (R. Guilford)

Table 3. Weed biomass and wheat yield and quality means comparison for organic farm seeding rate trials, 2003-2004

Seeding rate	Weed biomass [z] ($g\ m^{-2}$)	Wheat yield ($t\ ha^{-1}$)	TKW (g)	Protein content (%)	Test weight ($kg\ hL^{-1}$)
1X	149	1.96 b	28.3	12.8	71.4
1.25X	140	2.22 a	28.1	12.5	72.0
1.5X	127	2.36 a	28.3	12.4	72.3
2X	128	2.29 a	28.6	12.6	72.1
ANOVA source of variation					
P =	0.341	0.003**	0.854	0.534	0.224
n	23	21	14	13	7

z Means have been backtransformed after a square root(x) transformation
a-b Means in the same column with the same letter are not significantly different ($P < 0.05$, LS Means comparison)
** = Significant at $P < 0.01$

This emphasizes an important point: the effect of seeding rate is variable and results in your field will depend on factors like cultivar choice, environmental conditions, and the types of weeds present.

Researchers are interested in assessing the kind of approaches that organic farmers have been using to see if they are effective, to determine how they work and to help improve techniques where possible. This study determined that the use of a 25% higher seeding rate for organic spring wheat was effective at increasing yield and reducing weeds at most sites, but in very weedy conditions this rate may not be high enough!

The Bottom Line...

Increasing seeding rate by 25% or more can be a viable means of improving yield and controlling weeds in organic spring wheat production, but differences in management, environment and weed pressures between farms can affect the outcome of crop-weed competition.

Credits

Roxanne Beavers (Graduate student), Andy Hammermeister, Brenda Frick, Derek Lynch and Ralph C. Martin.

Acknowledgements

Farmer Cooperators:

Saskatchewan: N. Bromm, N. Collinge, M. Loiselle, K. McCuaig, M. Meinert, D. Montgomery, D. Rempel, St. Peters Abbey, K. Tomlin and B. Wagner
Manitoba: J. Finnie, R. Guilford and R. Miller
Ontario: S. Carruthers, B. Duncan and M. O'Connor
Québec: F. Bertrand and S. Giard
Maritimes: F. Dollar, A. Kernohan and C. Welsh

Researchers:

OACC technicians, especially Jennifer Bromm in Saskatchewan
Wendy Asbil (Kemptville College, U. of Guelph)
Sophie Boudreau (Club Agri-Avenir, PQ)
Martin Entz (University of Manitoba)
Steve Shirtliffe (University of Saskatchewan)

Funding

Natural Sciences and Engineering Research Council (NSERC)
In-kind support provided by Western Ag Innovations (SK) and Envirem Technologies, Inc. (NB)

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Agriculture et Agroalimentaire Canada

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