Seeding Rate Influence on Hard Red Winter Wheat in Northeast North Dakota

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Hard red winter wheat (hrww) acreage has been variable across North Dakota the last ten years ranging from 60,000 in 1998 to 650,000 in 2008. Acreage in northeastern North Dakota ranged from 4,600 in 1999 to 75,000 in 2008. Acreage has been on the rise since 2003. Improved cultural practices have allowed hrww to be grown on greater acreage in the northeast region of the state. Major advantages of growing hrww include efficient labor and machinery utilization and greater competition with weeds. Proper seeding rates are important criteria to ensure maximum yields. A three year study was conducted to evaluate the effect of various seeding rates on yield and other agronomic traits of hrww in northeast North Dakota.

MATERIAL AND METHODS

Experiments were conducted on a rain-fed site at the North Dakota State University Langdon (48°30' N, 98°21' W, elevation 1611 ft) Research Extension Center. Experiments were conducted using best management practices for seeding date, fertility, crop rotation, and pest and harvest management. Planting dates were 9, 13, and 12 September for 2005, 2006 and 2007, respectively. Harvest dates were 26 July, 9 and 21 August for 2006, 2007 and 2008, respectively. The trials were planted into 8 inch flax stubble in 2005 and 2006 and 8 inch canola stubble in 2007 in order to trap snow which aids in winter survival. Soil fertility levels for nitrogen and phosphorus were adjusted for a seed yield goal of 60 bushels per acre. Weeds were controlled by a post emergence spray application of bromoxynil-ester and MCPA-ester at 0.8 pt/acre plus fluroxypr-ester at 0.5 pt/acre.

The experimental design was a randomized complete block design with four replications. Seeding depth was approximately 1.5 inches. Seeding rate was 0.75, 1.0, 1.25, and 1.5 million pure live seed (PLS) per acre. The cultivar 'Jerry' with a seed weight of 40.8 g 1000^{-1} and germination of 96 percent was used. Corresponding seeding rates in pounds per acre was 72, 96, 120, and 144. The cultivar was sown in seven rows, spaced seven inches apart with a split disk no-till openers and press wheels. Plots were harvested with a Wintersteiger self propelled plot combine with a harvest area of 16 ft x 5.08 ft. Data were collected on seed weight, grain heads ft^{-2}, lodging, plant height, heading date, winter survival, grain protein, test weight and seed yield. Grain heads ft^{-2} were taken just prior to harvest by counting grain heads that contained seed in two random four foot lengths within each plot. Heading date was a visual determination when 50 percent of the heads were at Feekes 10.5. Plant height was an average of erect plant height taken at maturity. Lodging was a visual estimate with the score of 0 indicating plants in the plot were standing erect and a score of 9 indicaticating plants were lying horizontal. Yield samples were forced air dried at 90° F to a uniform moisture level, cleaned, weighed, and a subsample taken for protein content. Grain protein is reported at 13 percent moisture. Field observations were also noted for leaf and head diseases. Daily precipitation and temperature were also recorded and monthly averages reported (Table 1). Analysis of variance (general liner model) considered years as environments and a random effect in the statistical analysis. Seeding rate was considered a fixed effect in the analysis. The source of variation, degrees of freedom, and expected mean squares for evaluated characters appear in Table 2. Separation of means was performed by F-protected LSD comparisons at $P \leq 0.05$.

RESULTS AND DISCUSSION

Soil moisture and precipitation levels were adequate throughout the growing seasons for good germination and crop growth (Table 1). September-August precipitation levels were slightly below normal in 2005-2006 and 2007-2008 while 2006-2007 was much above normal. Snowfall levels were above normal all three crop season. Winter survival was in the high 90's in 2005-2006 and 2007-2008 and in the 80's in 2006-2007. The trial was on a side hill that year allowing the area to be more windswept which resulted in less snow cover. Temperatures were above normal in 2005-2006 during the growing season of April-August and near normal other years.

Seed yield and grain heads ft^{-2} was significantly affected by seeding rate (Table 2). The 0.75 million PLS^{-acre} seeding rate was significantly lower than the three higher seeding rates. The combined yield of the three highest seeding rates yielded 4 percent greater than the 0.75 million PLS^{-acre} seeding rate (Table 3). Grain heads ft^{-2} were significantly higher at 1.0, 1.25, and 1.5 million PLS^{-acre} seeding rate compared to the 0.75 million PLS^{-acre} seeding rate. The environment x seeding rate interaction for protein was significant but was likely a result of magnitude differences among environments. All other agronomic characters including test weight, protein, winter survival, heading date, plant height, lodging and seed weight were not significantly affected by differences in seeding rate. Field observations on leaf and head diseases were low with no significant differences occurring between seeding rates (data no shown).

Table 1. Total monthly precipitation, snowfall, mean temperature and departure (Dep) from long-term average during the 2006, 2007, and 2008 cropping seasons at Langdon, ND.

	September-March		April-August		September-March		September-March		April-August	
Crop season	Total	Dep.	Total	Dep.	Total	Dep.	Total	Dep.	Total	Dep.
	---------Precipitation, inches----------				-Snowfall, inches-		----------Air temperature, °F----------			
2005-2006	6.78	+0.32	10.63	-1.55	68.9	+30.7	26.8	+4.5	59.7	+3.3
2006-2007	6.27	-0.19	16.70	+4.52	48.1	+9.6	23.0	-0.3	57.5	+1.3
2007-2008	4.36	-2.10	11.81	-0.37	44.5	+6.3	21.7	-0.6	54.9	-1.3

Table 2. Source of variation, df, and mean square values of evaluated agronomic hard red winter wheat characters from the combined analysis of variance at Langdon, ND 2006-2008.

Source	df	Seed yield	Test weight	Protein	Winter survival	Heading date	Plant height	Lodging	Grain heads	df†	Seed weight
Environment (E)	2	5417.1	6.09	9.97	769	1485.18	491.59	1.68	1239	1	12.25
Rep within E	9	79.9	0.51	0.77	18	1.30	2.68	1.38	28	6	3.31
Seeding Rate (SR)	3	30.3*	0.08	0.30	31	0.13	1.15	0.31	190*	3	3.64
E x SR	6	5.7	0.24	0.23*	22	0.13	0.80	0.08	22	3	0.49
CV, %		6.2	0.8	2.4	3.2	1.6	1.8	127.0	14.4		4.5
Mean		76.0	59.6	11.3	95.1	16.8	43.8	0.38	43.6		30.0

*Significant a P≤0.05

† Two environments evaluated.

Table 3. Influence of seeding rate on hard red winter wheat yield and various agronomic characters at Langdon, ND 2006-2008.

Seeding rate	Seed yield	Test weight	Protein	Winter survival	Heading date	Plant height	Lodging	Grain heads	Seed weight
million PLS/acre	bu/a	lbs/bu	%	%	June	inches	0-9	heads/ft^2	g 1000^{-1}
0.75	73.7	59.6	11.3	93.0	16.8	43.4	0.2	38.5	31.0
1.00	76.6	59.5	11.3	94.8	16.9	44.0	0.5	43.6	29.7
1.25	76.2	59.6	11.2	95.9	16.7	43.7	0.3	44.1	29.6
1.50	77.4	59.5	11.3	96.8	16.8	44.1	0.5	48.2	29.5
LSD (0.05)	2.4	NS	NS	NS	NS	NS	NS	4.7	NS

PLS=pure live seed.
Variety =Jerry