

# 2011 VERMONT HEIRLOOM SPRING WHEAT VARIETY TRIAL

## INTRODUCTION

UVM Extension began evaluating heirloom spring wheat varieties in 2007 in order to determine whether heirloom varieties developed before 1950 would thrive in Vermont's climate. Many consumers are interested in heirloom wheat based on the perception that it has better flavor, while many farmers are also interested in heirloom wheat based on the perception that they may have superior genetics that are better adapted to the challenging growing conditions in the Northeast. This variety trial was established to determine what heirloom spring wheat varieties are viable in Vermont's growing conditions. Three Vermont heirloom varieties have been re-introduced through this project. Famed Vermont plant breeder, Cyrus Pringle, developed Defiance, Champlain, and Surprise during the late 1800s. In addition to the heirloom varieties, AC Barrie and Scarlet, modern spring wheat varieties commonly grown in the Northeast, were planted as a comparison.

## METHODS

Fifteen heirloom and two modern varieties of spring wheat were planted at Borderview Research Farm in Alburgh, VT on May 13, 2011 and at Butterworks Farm in Westfield, VT on June 3, 2011. The experimental plot design was a randomized complete block with four replications at Butterworks. Space constraints resulted in only one replication at Borderview Farm. Spring wheat varieties evaluated are listed in Table 1.

**Table 1: Varietal information of the heirloom spring wheat.**

Variety	Type	Developed in	Pedigree	Release Date
AC Barrie	HRSW	Sask. Canada	Neepawa/Columbus//BW90	1996
Ceres 05	HRSW	North Dakota	Marquis/Kota	1926
Champlain	HRSW	Vermont	Black Sea/Golden Drop	1870
Defiance	HRSW	Vermont	Golden Drop/White Hamburg	1878
Hope	HRSW	South Dakota	Yaroslav emmer / Marquis	1927
Komar	HRSW	North Dakota	Marquis/Kota; Sister selection of Ceres	1930
Ladoga	HRSW	Leningrad, Rus.	-	1916
Marquis	HRSW	Ont. Canada	Hard Red Calcutta/ Red Fife	1910
Mida 05	HRSW	North Dakota	Mercury//Ceres/Double Cross	1944
Mida 06	HRSW	North Dakota	Mercury//Ceres/Double Cross	1944
Red Bobs	HRSW	Sask. Canada	Selection from field of Bobs	1926
Reliance	HRSW	Oregon	Kanred/Marquis	1926
Scarlet	HRSW	Washington	*Too many to list	1998
Spinkcota	HRSW	Washington	Preston sel./red durum//Preston sel.	1944
Supreme	HRSW	Sask. Canada	Selection from Red Bobs	1922
Surprise	HRSW	Vermont	Chile Club/Michigan Club	1909
Thatcher	HRSW	Minnesota	Marquis/Ilumillo//Marquis/Kanred	1934

\*HRSW – Hard red spring wheat

The seedbed at both locations was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The plots were seeded with a Carter cone seeder and harvested with an Almaco SPC50 small plot combine on August 5, 2011. Plant populations and a visual assessment of early season plant vigor were determined on June 29 at the Westfield site and May 28 at the Alburgh site. Plant vigor was evaluated on a 1 to 5 scale where 1 indicated the lowest vigor and 5 the highest.

This trial evaluated spring wheat based on standard testing parameters used by commercial mills. Yield, moisture, and test weight (a measure of grain density) were recorded at the time of harvest. Following harvest, samples were cleaned with a Clipper M2B seed cleaner. A one-pound subsample was dried at 40° C and ground with a Perten LM3100 Laboratory Mill. Protein content was determined using a Perten Inframatic 8600 Flour Analyzer. Protein content is an indicator of gluten strength and bread quality. Commercial mills aim to purchase hard wheat with 14-15% protein. Falling Number was determined with a Perten NF 1500 Falling Number Machine. Falling number indicates the level of sprout damage in the grain. It measures the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Falling numbers greater than 350 indicate low enzymatic activity and sound quality wheat. A falling number below 200 seconds indicates high enzymatic activity and poor quality wheat. Deoxynivalenol (DON) analysis was done using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. (Lansing, MI). This test has a detection range of 0.5 to 5 ppm. DON values greater than 1 ppm are considered unsuitable for human consumption (FDA, 1993). Grain with DON levels greater than 1 ppm is not suitable for human consumption. Data from the Westfield site was statistically analyzed with PROC MIXED procedure in SAS using a Tukey-Kramer pairwise comparison. Statistical analysis could not be conducted on vigor, test weight, or harvest moisture due to high levels of missing data. Some plots yielded so low there wasn't enough seed to collect these measurements. Levels of significance are reported when the p-value is less than 0.10.

**Table 2: General plot management for trials.**

	<b>Borderview Farm Alburgh, VT</b>	<b>Butterworks Farm Westfield, VT</b>
Soil type	Benson rocky silt loam	Dixfield sandy loam
Previous crop	organic corn	grass sod
Row spacing (in.)	6	6
Seeding rate	100 lbs acre <sup>-1</sup>	100 lbs acre <sup>-1</sup>
Replicates	1	4
Planting date	5/13/11	6/3/11
Harvest date	8/12/11	9/12/11
Harvest area (ft.)	5x20	5x20
Tillage operations	Fall plow, disc, & spike-toothed harrow	Fall plow, disc, & spike-toothed harrow

## RESULTS AND DISCUSSION

Seasonal precipitation and temperatures recorded at weather stations in close proximity to Alburgh and Westfield are shown in Table 3. Excessive spring rains prohibited a timely planting at both locations, but planting was extremely delayed until June 3<sup>rd</sup> in Westfield. Severe weather conditions continued throughout the season impacted yield and quality of the wheat crop. We intended to plant the spring wheat mid-April. From planting to harvest, there was an accumulation of approximately 4,349 Growing Degree Days (GDD) in Alburgh. This was 335 GDDs more than the 30-year average. In Westfield, there were approximately 4,004 GDD from planting to harvest, 152 GDD less than the 30-year average.

**Table 3: Temperature and precipitation summary for Alburgh and Westfield, VT, 2011.**

South Hero (Alburgh)	April	May	June	July	August
Average Temperature (F)	46.6	58.7	67.1	74.4	70.4
Departure from Normal	3.1	2.1	1.3	3.3	1.6
Precipitation (inches)	7.88	8.67	3.52	3.68	10.23
Departure from Normal	5.00	5.35	0.09	-0.29	6.38
Growing Degree Days (base 32)	465	826	1088	1314	1121
Departure from Normal	120	63.6	74.1	104	-26.3

Newport, VT (Westfield)	April	May	June	July	August	September
Average Temperature (F)	39.9	56	62.4	68.1	66.3	60.4
Departure from Normal	-2.9	-0.1	-2.2	-0.8	1.1	2.9
Precipitation (inches)	6.52	8.94	3.09	4.57	8.05	7.12
Departure from Normal	3.59	5.27	-0.84	0.38	3.63	3.68
Growing Degree Days (base 32)	274	742	942	1119	1063	879
Departure from Normal	-70.7	-20.1	-71.6	-91.4	-83.7	94.4

\*Based on National Weather Service data from stations in close proximity to trials. When data from South Hero was not available, data from Burlington, VT was used. Departure from normal from historical averages of 30 years of data (1971-2000).

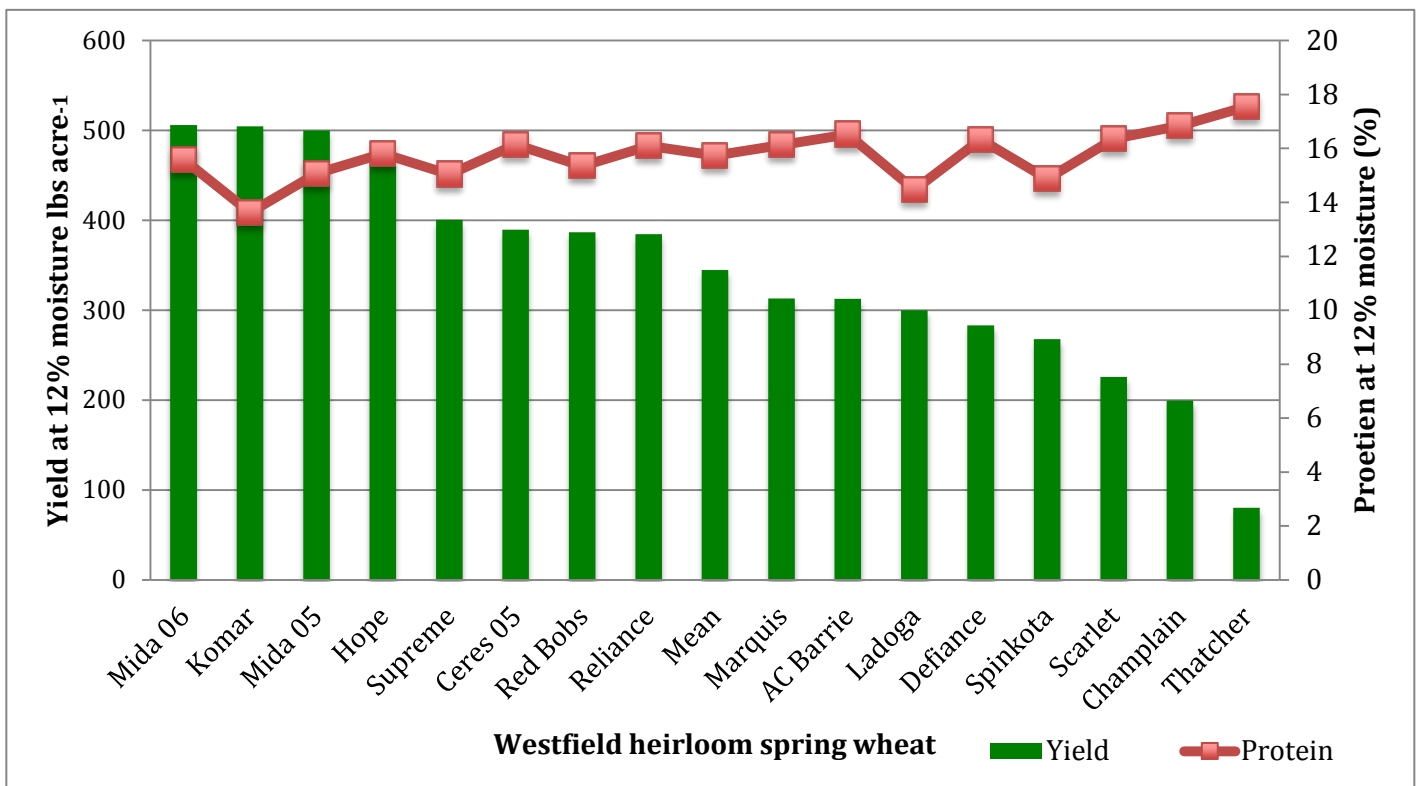
Due to the wet spring and late planting, yields of the spring wheat were severely diminished. The average yield in Westfield was 345 lbs acre<sup>-1</sup> (Table 4). Mida 06 was the highest yielding heirloom, yielding about 200 lbs ac<sup>-1</sup> more than the two modern varieties included in this trial (AC Barrie and Scarlet). This may be evidence that some heirloom varieties are able to outperform modern varieties in certain challenging growing conditions, such as those we experienced in 2011. Other higher yielding varieties included Mida 05, Komar, Hope and Supreme. As well as being the highest yielder, Mida 06 had the highest falling number in this trial, 253, which is just over the industry threshold for sound quality wheat. Most of the falling numbers were low in this trial, indicating high alpha amylase enzyme activity and pre-harvest sprouting. The harvest in Westfield was also delayed until September 12<sup>th</sup>. There were many periods of wet weather in August and September, including Tropical Storm Irene on August 28, where the dry, harvest-ready wheat was exposed to wet, humid conditions that are ideal for pre-mature sprouting when the grain is still in the head.

Ladoga had the highest test weight of the varieties at 52 lbs bushel<sup>-1</sup>. The average test weight for the trial was 45.5 lbs bushel<sup>-1</sup>, which is very low compared to the standard of 60 lbs bushel<sup>-1</sup>. Grain protein levels in Westfield averaged 15.7% and ranged from 13.6 to 17.6% with Thatcher having the highest protein. All of the varieties had levels of DON below the 1 ppm standard, and therefore are considered safe for human consumption. Mida 06 and Thatcher had the lowest levels of DON of all the varieties.

**Table 4: Spring wheat populations, early season plant vigor, yield at 12% moisture, harvest moisture, test weight, crude protein, falling number and deoxynivalenol (DON) levels of heirloom spring wheat varieties grown in Westfield, VT, 2011**

	Population plants ft <sup>-2</sup>	Vigor (1-5)	Yield lbs ac <sup>-1</sup>	Moisture %	Test weight lbs bushel <sup>-1</sup>	Protein %	Falling number seconds	DON ppm
AC Barrie	22.6	2.8	312	13.0	47.0	16.5*	185	0.5*
Ceres 05	18.4	3.5	389	14.5	46.3	16.1	141	0.7
Champlain	19.0	3.8	199	20.0	46.0	16.8*	83	0.4*
Defiance	18.5	3.3	283	16.4	44.0	16.3*	149	0.4*
Hope	18.1	3.3	460	15.9	46.7	15.8	221*	0.7
Komar	16.1	3.8	504	14.7	43.0	13.6	147	0.7
Ladoga	17.9	4.0	300	17.3	<b>52.0</b>	14.5	129	0.4*
Marquis	19.9	<b>4.3</b>	313	13.9	45.0	16.1	177	0.6
Mida 05	<b>22.9</b>	4.0	500	<b>10.5</b>	45.7	15.1	226*	0.4*
Mida 06	19.6	3.5	<b>506</b>	14.6	47.0	15.6	<b>253*</b>	<b>0.3*</b>
Red Bobs	16.6	3.5	387	17.3	44.0	15.4	197	0.9
Reliance	16.5	3.0	384	14.5	41.5	16.1	143	0.5*
Scarlet	17.4	3.0	226	14.8	44.0	16.4*	111	0.9
Spinkcota	15.0	3.8	268	14.4	45.0	14.9	106	0.9
Supreme	21.5	3.8	400	13.2	46.5	15.0	164	0.4*
Thatcher	17.5	2.8	80	15.7	44.0	<b>17.6*</b>	109	<b>0.3*</b>
Mean	18.6	3.5	345	16.7	45.5	15.7	159	0.5
p-value	NS	-	NS	-	-	0.0006	<0.0001	0.0083

\*Results that are not significantly different than the top performer in a particular column are indicated with an asterisk. NS; indicates that there was no significant difference among treatments. - not statistically analyzed.



**Figure 1: Yield and protein of heirloom spring wheat varieties grown in Westfield, VT.**

**Table 5: Spring wheat populations, early season plant vigor, crude protein at 12% moisture, falling number and deoxynivalenol (DON) concentrations of heirloom spring wheat varieties grown in Alburgh, VT, 2011.**

<b>Wheat Variety</b>	<b>Population</b> plants ft <sup>-2</sup>	<b>Vigor</b> (1-5)	<b>Protein</b> %	<b>Falling number</b> seconds	<b>DON</b> ppm
AC Barrie	21	<b>5</b>	14.7	<b>384</b>	<b>0.0</b>
Ceres 05	23	3	14.3	347	0.2
Champlain	15	4	14.7	242	0.3
Defiance	17	4	13.4	268	0.2
Hope	21	4	13.5	335	0.3
Komar	14	5	14.2	300	0.2
Ladoga	21	4	12.0	347	0.3
Marquis	8	2	13.8	327	0.2
Mida 05	26	4	14.9	259	0.1
Mida 06	13	4	14.9	254	0.1
Red Bobs	20	4	14.7	345	0.3
Reliance	13	4	13.9	273	0.3
Scarlet	18	2	12.6	294	0.2
Spinkcota	11	3	<b>15.2</b>	266	0.3
Supreme	<b>30</b>	3	13.1	345	<b>0.0</b>
Surprise	21	3	12.6	331	0.3
Thatcher	15	3	M	M	M
Trial mean	17.9	3.6	13.9	307	0.2

\*Results are from one replication and were not statistically analyzed. m; missing data.

Protein levels in Alburgh were also high (Table 5), although not as high as those in Westfield. Mean protein levels in Alburgh ranged from 12.0 to 15.2%. Yields were not recorded at this site, but other spring grains and heirloom wheat grown in Westfield had drastically reduced yields, which likely increased grain protein concentrations. There is an inverse relationship between yield and protein. As yield increases, protein levels generally decrease, and when yields are low, protein levels are generally high.

Most of the varieties grown in Alburgh had high falling numbers over 250 seconds, except Champlain, which had a falling number of 242 seconds (Table 5). The harvest in Alburgh took place on August 12 in generally drier conditions than those in Westfield. Therefore, the wheat did not experience the wet conditions ideal for pre-harvest sprouting; the falling numbers indicate low enzymatic activity and sound quality wheat for baking. All varieties grown in Alburgh had DON levels less than 1 ppm, which is within acceptable levels for human consumption. Without replicates and statistical analysis, it is challenging to draw conclusions with any confidence about the differences between varieties.

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