NW CROPS & SOILS PROGRAM

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2010
Heirloom Wheat Variety Trial

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2010 VERMONT HEIRLOOM WHEAT VARIETY PERFORMANCE TRIALS

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The heirloom wheat project began in 2007; its primary purpose is to evaluate 15 heirloom wheat varieties to determine if they will thrive in Vermont's climate. Heirloom wheat can bring a premium because of its superior taste. Many farmers are interested in determining what heirlooms are viable for Vermont growing conditions. Through this project three Vermont heirloom varieties are being reintroduced into the state. Defiance, Champlain, and Surprise were developed by Vermont plant breeder Cyrus Pringle at the turn of the twentieth century. In addition to the heirloom varieties, AC Barrie and Scarlet, modern spring wheat varieties commonly grown in the Northeast, were planted as a comparison.

The experimental design for the heirloom wheat variety trial was a randomized complete block with four replications. Wheat varieties evaluated are listed in Table 1.

Table 1. Varietal information of the heirloom spring wheat.

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

WEATHER DATA

Seasonal precipitation and temperature recorded at weather stations in close proximity to the 2010 sites are shown in Table 2. . This growing season's weather was ideal for growing wheat. Due to the warm spring the wheat got off to an early start and continued to be at least a week early in reaching major developmental stages. From planting to harvest in Westfield there was an accumulation of 4890 Growing Degree Days (GDD), 611 GDDs higher than the 30 year average.

Table 2. Temperature and precipitation summary for Westfield, VT, 2010.

Newport, VT (Westfield)	April	May	June	July	August
Average Temperature (F)	45.6	55.7	61.7	70.3	65.1
Departure from Normal	2.80	-0.40	-2.90	1.40	-1.70
Precipitation (inches)	3.62	1.63	6.86	3.02	7.44
Departure from Normal	0.69	-2.04	2.93	-1.17	3.26
Growing Degree Days (base 32)	521	854	10189	1305	1192
Departure from Normal	188	107	40.5	163	113

*Based on National Weather Service data from cooperative observer stations in close proximity to field trials. Historical averages are for 30 years of data (1971-2000)

CULTURAL PRACTICES

The seedbed was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 3). The plots were seeded with a Carter Cone Seeder and harvested with an Almaco SP50 plot combine. At harvest plot yield and moisture were recorded.

Table 3. General plot management of the heirloom wheat trials.

Trial Information	Heirloom Wheat Variety Trial
Location	Westfield, VT Butterworks Farm
Soil type	Sandy loam
Previous crop	soybeans
Plot size (ft.)	5x20
Seeding rate	100 lbs/acre
Replicates	4
Planting date	4-13-10
Harvest date	8-18-09
Tillage operations	Fall plow, spring disk

Image 1. Laying out heirloom wheat plots.

Following harvest, seed was cleaned with a small Clipper cleaner. An approximate one pound subsample was collected to determine quality. Quality measurements included standard testing parameters used by commercial mills. Test weight was measured by the weighing of a known volume of grain. Generally the heavier the wheat is per bushel, the higher baking quality. The acceptable test weight for bread wheat is 56-60 lbs per bushel. Once test weight was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill. At this time flour was evaluated for its protein content, falling number, and mycotoxin levels. Grains were analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Grain protein affects gluten strength and loaf volume. Most commercial mills target 14-15% protein. The determination of falling number (AACC Method 56-81B, AACC Intl., 2000) was measured on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by 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 lower than 200 indicates high enzymatic activity and poor quality wheat. Deoxynivalenol (DON) analysis was analyzed using Veratox DON 5/5 Quantitaive test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant (P< 0.10).

LEAST SIGNIFICANT DIFFERENCE (LSD)

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (e.g. yield). Least Significant Differences at the 10% level of probability are shown. Where the difference between two varieties within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two varieties. Wheat varieties that were not significantly lower in performance than the highest variety in a particular column are indicated with an asterisk. In the example below variety A is significantly different from variety C but not from variety B. The difference between A and B is equal to 725 which is less than the LSD value of 889. This means that these varieties did not differ in yield. The difference between A and C is equal to 1454 which is greater than the LSD value of 889. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that variety B was not significantly lower than the top yielding variety.

Variety	Yield
A	3161
B	3886*
C	**4615***
LSD	**889**

Image 2. Heirloom wheat harvest

RESULTS

The yield of the heirloom wheat varieties is presented in Table 4. There were significant yield differences between the wheat varieties (Figure 1). Ladoga had the highest yeild of 1670 lbs ac^{-1}, the lowest yeilding variety was Komar, 740 lbs ac^{-1}. Interestingly Ladoga and Champlain yielded above the modern day varieties. Ladoga has consistently been a high yielding heirloom variety and also has several other favorable characteristics such as stalk strength, head size, and weed competiveness. Grain moisture was not significantly different, but it is interesting to note that two of the top yielding varieties also had the lowest grain harvest moistures.

Table 4. Yield and quality of 15 heirloom and 2 modern day spring wheat varieties.

Variety	Yield @ 13.5% moisture	Harvest moisture	Test weight	Crude protein @ 14% moisture	Falling number	DON
	lbs ac^{-1}	%	lbs bu^{-1}	%	seconds	ppm
AC Barrie	1182	14.6	53.8	15.0*	284*	0.48
Ceres 05	1024	14.5	53.8	14.2	267*	0.55
Champlain	1471*	13.1	55.4*	**15.7***	185	0.23
Defiance	1123	11.9	54.0*	14.7	208	0.40
Hope	1011	15.2	53.0	14.6	290*	0.53
Komar	740	15.1	55.0*	15.1*	196	0.48
Ladoga	**1670***	11.9	55.5*	14.5	209	0.28
Marquis	1293	15.1	53.5	14.2	**292***	0.20
Mida 05	1347	14.5	53.9	14.5	280*	0.28
Mida 06	1207	15.1	55.3*	15.1*	251	0.20
Red Bobs	1114	15.2	55.4*	14.3	268*	0.55
Reliance	948	15.5	52.8	14.6	230	0.38
Scarlet	949	15.1	51.8	13.9	242	**1.25***
Spinkota	1394*	12.8	**56.3***	15.8*	200	0.35
Supreme	1429*	13.7	52.6	12.9	197	0.58
Surprise	958	13.3	49.8	13.9	248	0.80
Thatcher	1073	**15.8**	53.3	14.6	204	0.38
Trial Mean	1173	14.3	53.8	14.6	238	0.46
LSD (0.10)	304	NS	1.9	0.8	32	0.25

*Results that are not significantly different than the top performer in a particular column are indicated with an asterisk.

The common measures used by commerial mills to evaluate wheat quality are: grain protein, falling number, test weight, and mycotoxin (DON) content. The test weights were significantly different among varieties. Spinkota had the highest test weight at 56.3 lbs/bu. Test weight is one of the basic quality measurements of wheat. The amount of weed seed, plant debris and shriveled seed all effect the test weight by reducing the number of pounds in a bushel. 60 lbs bu^{-1} is the standard test weight for wheat. The protein concentrations were significantly different among varieties. Spinkota had the highest crude protein concentration of 15.8% (Figure 2). The amount of protein is a crucial factor in determining baking quality. Mill standards for bread wheat protein range from 10-15%. In general, spring wheat usually has higher protein levels than winter wheat varieties. The falling number measures the amount of sprout damage that has occurred in the field before harvest. Values under 200 indicate a high level of sprout damage which will effect the baking quality of the wheat. The variety with the highest falling number was Marquis with a value 292, Champlain had the lowest falling number of 185. Falling number is partially influenced by genetic potential of a variety. The differneces among varieties may be attributed to genetic potential. DON analysis measures the amount of the mycotoxin deoxynivalenol in a given sample. Levels over 1ppm are considered unsafe for human consumption (FDA 1993). All of the heirloom varieties, with the exception of Scarlet, were all below 1ppm.

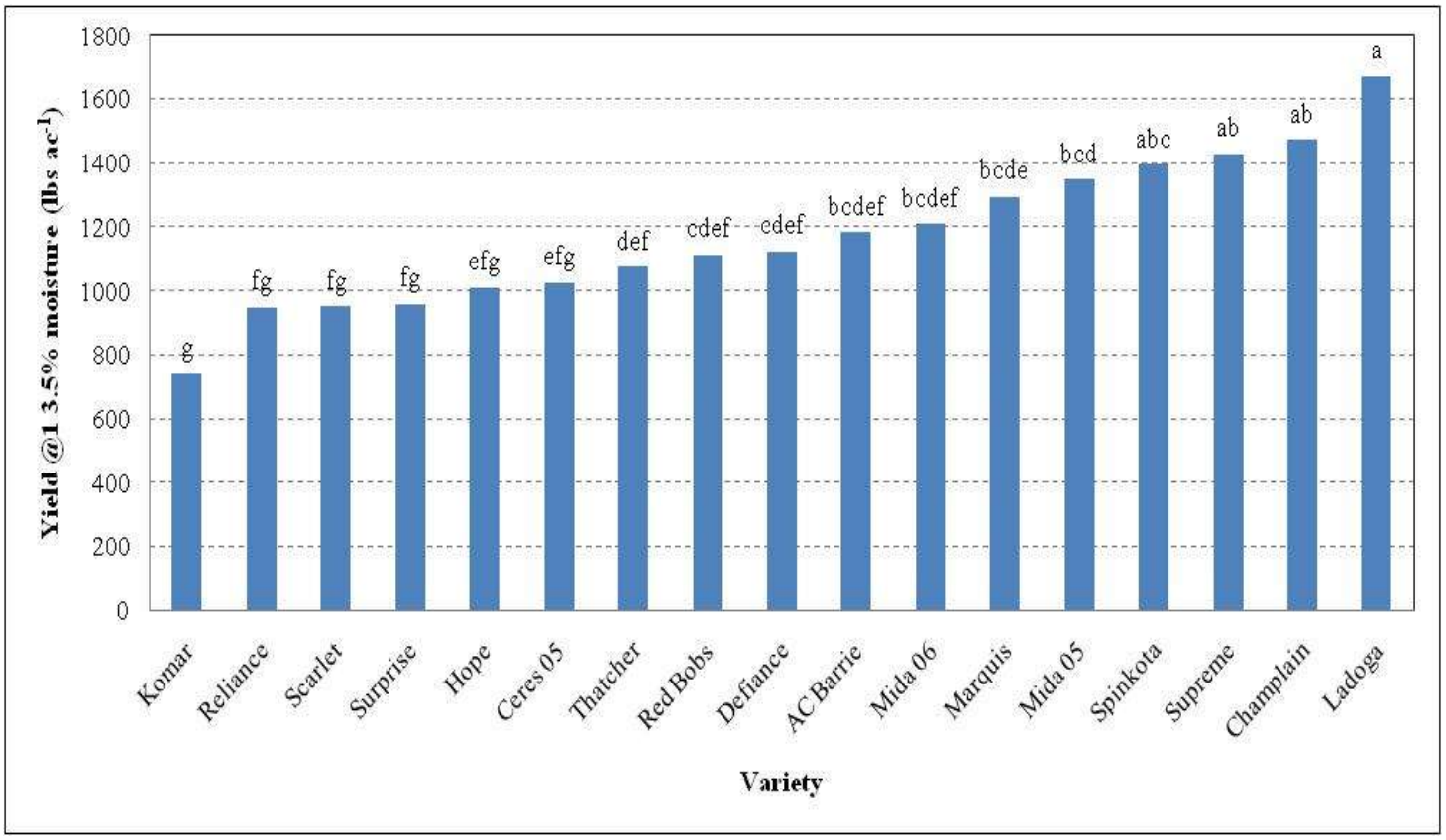

Figure 1. Yield of 15 heirloom and 2 modern day spring wheat varieties, Westfield, VT, 2010.

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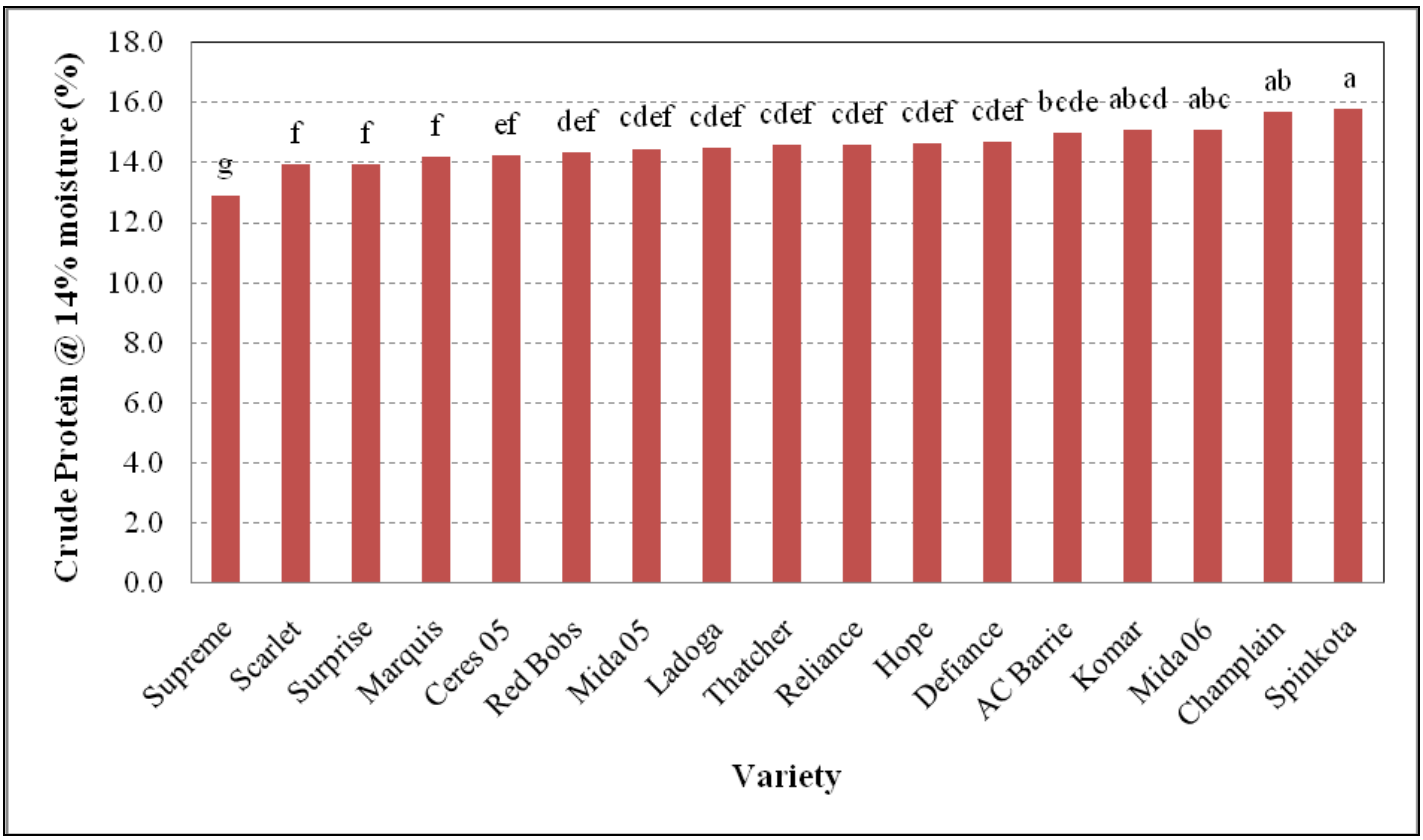

Figure 2. Crude protein concentrations of 15 heirloom and 2 modern day spring wheat varieties, Westford, VT, 2010

Heirloom Wheat Tasting

Another goal of the heirloom project is to build heirloom seed quanitites so that more farms will have access to seed in the future. Several of the top yielding varieties (Ladoga, Red Bobs, Mida 05, Marquis, and Supreme) produced enough seed in 2009 to allow grain producer Jack Lazor of Butterworks Farm to plant larger seed increase plots in 2010. These larger plots all yielded at least 50lbs of seed, and in the case of Ladoga, Mida 05, and Red Bobs, over 100 lb ac^{-1}. With increased seed quantities it was time to bring wheat to local bakers to evaluate for baking quality and taste. On October 5, 2010 the Northern Grain Growers Association (NGGA), an organization comprised of Vermont grain producers, processors, researchers, bakers and consumers, teamed up with City Market (Burlington, VT) and UVM Extension to host a taste test of bread baked with heirloom wheat versus the modern day varieties AC Barrie (spring wheat) and AC Warthog (winter wheat). This event allowed the NGGA to gain valuable insight as to which varieties were popular among consumers and bakers. Preliminary survey data suggests that Ladoga was the most favored variety.

This event gave consumers direct access to their local grain producers, and enabled them to ask questions and find out more about local grain production. Overall, the consumers chose heirloom varieties over the modern day ones as their favorite, remarking that they had excellent taste.

Image 4. Dr. Heather Darby and Jack Lazor of Butterworks Farm sample the fruits of their labor.

The UVM Extension Crops and Soils Team would like to thank the Butterworks Farm for their generous help with the trials. Any reference to commercial products, trade names, or brand names is for information only, and no endorsement or approval is intended.

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