2013

Heirloom Winter Wheat Variety Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

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INTRODUCTION

Many consumers are interested in heirloom wheat for flavor, perceived health benefits or its history, while many farmers are interested in heirloom wheat because it may have superior genetics better adapted to the challenging growing conditions in the Northeast. Production of heirloom wheat may also provide a farmer with a value added market with increased returns. This variety trial was established to determine heirloom winter wheat varieties that are suitable for production in Vermont's growing conditions. This was the second year that this trial was conducted in Vermont.

MATERIALS AND METHODS

In the fall of 2012, an heirloom winter wheat variety trial was initiated at Borderview Research Farm in Alburgh, VT. General plot management is listed in Table 1. Plots were managed with practices similar to those used by producers in the surrounding area. The previous crop was spring wheat and prior to that, the site had been in hay. The field was disked and spike tooth harrowed prior to planting. Plots were seeded with a Kincaid Cone Seeder on 21-Sep 2012 at a seeding rate of 100 lbs acre^{-1}.

Population and vigor were measured on 26-Oct 2012. Populations were determined by taking three, 1/3 meter counts per plot. On 19-Apr 2013, winter survival was measured as a percentage of total plot survival. Vigor was based on a visual rating with a 0–5 scale, where 5 represents excellent stand density and 0 represents no stand. Lodging was measured as a percent of plot lodged on 13-Jun and 11-Jul. At the same time, powdery mildew and other leaf diseases were measured with a visual rating on a scale of 0-10, where 0 represents no disease presence.

Plots were harvested with an Almaco SPC50 small plot combine on 17-Jul 2013. The harvest area was 5' x 20'. Prior to harvest, plant heights were measured on 11-Jul, excluding awns. Grain moisture, test weight and yield were determined at harvest. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a subsample was collected to determine quality characteristics. Samples were ground using the Perten LM3100 Laboratory Mill. Flour was analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Most commercial mills target 12-15% protein content. Falling number was measured (AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage in the grain. It is determined by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of a test-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), a vomotoxin, was analyzed using Veratox DON 5/5 Quantitative 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. The varieties of heirloom winter wheat grown are listed in Table 2. Results were analyzed with an analysis of variance in SAS (Cary, NC). The Least Significant Difference (LSD) procedure was used to separate cultivar means when the F-test was significant ($p < 0.10$).

Table 1. General plot management.

Trial Information	Borderview Research Farm Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Spring Wheat
Planting date	21-Sep 2012
Harvest date	17-Jul 2013
Seeding rate	100 lbs acre^{-1}
Tillage methods	Mold board plow, disk, and spike tooth harrow

Table 2. Heirloom winter wheat varieties, market class, year of release and place of origin.

Variety	Market Class	Year	Origin
Blackhull	HRWW	1917	Kansas
Bluejacket	HRWW	1946	Kansas
Clark's Cream	HWWW	1972	Kansas
Columbia	HRWW	1955	Oregon
Coppei	SRWW	1911	Washington
Forward	SRWW	1920	New York
Genesee Giant	SWWW	1893	New York
Goldcoin	SWWW	1890	New York
Honor	SWWW	1920	New York
Kanred	HRWW	1917	Kansas
Oro	HRWW	1927	Oregon
Pride of Genesee	SRWW	1893	New York
Red Chief	SRWW	1901	New York
Red Russian	SRWW	1890	England
Relief	HRWW	1931	Utah
Rio	HRWW	1931	Oregon
Triplet	SRWW	1918	Washington
Ukrainka	HRWW	1926	Kiev, Ukraine
Wasatch	HRWW	1944	Utah

HRWW-Hard Red Winter Wheat, **HWWW**-Hard White Winter Wheat,
SRWW-Soft Red Winter Wheat, **SWWW**-Soft White Winter Wheat.

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 (i.e. yield). Least Significant differences (LSD's) at the 10% level of probability are shown. Where the difference between two treatments 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. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example below, A is significantly different from C but not from B. The difference between A and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these varieties did not differ in yield. The difference between A and C is equal to 3.0, which is greater than the LSD value of 2.0. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that B was not significantly lower than the top yielding variety.

Variety	Yield
A	6.0
B	7.5*
C	9.0*
LSD	**2.0**

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. Spring and early summer, May and June, had almost 7 inches more rain than the 30 year average. From March to July, there was an accumulation of 3487 Growing Degree Days (GDDs) which is 134 GDDs higher than the 30-year average. Many of the heirlooms in the trial were developed in environments much different than New England. Hence, it is important to evaluate the varieties for tolerance to our climate. Most varieties were able to survive the winter although the 2012/2013 winter was mild. The variety Coppei suffered significant plant loss to the winter months while most other varieties had acceptable survival rates (Table 4). Wet conditions during flowering likely resulted in high levels of disease in the wheat trial (Table 4). Powdery mildew (*Blumeria graminis* DC) was prevalent in the heirloom wheat and there were differences in susceptibility among the varieties. Leaf diseases such as stripe rust (*Puccinia striiformis* Westend) and aschocyta leaf spot *(Ascochyta spp.)* plagued the wheat. Significant differences were not detected among varieties likely due to the fact that leaf disease was assessed as a whole and not by individual disease.

Table 3. Seasonal weather data collected in Alburgh, VT, 2013.

Alburgh, VT	Sept. 2012	Oct. 2012	Nov. 2012*	Mar. 2013	Apr. 2013	May 2013	Jun. 2013	Jul. 2013
Average temperature (°F)	60.8	52.4	36.7	32.1	43.6	59.1	64.0	71.7
Departure from normal	0.2	4.2	-1.5	1.0	-1.2	2.7	-1.8	1.1
Precipitation (inches)	5.36	4.13	0.68	1.04	2.12	4.79	9.23 ł	1.89
Departure from normal	1.72	0.53	-2.44	-1.17	-0.70	1.34	5.54	-2.26
Growing Degree Days (base 32°F)	896	652	144	89	348	848	967	1235
Departure from normal	38	150	-40	89	-36	91	-47	37

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

* November 2012 data are based on National Weather Service data from cooperative observation stations in South Hero, VT. (http://www.nrcc.cornell.edu/page_summaries.html)

ł June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT. (http://www.nrcc.cornell.edu/page_summaries.html)

Winter wheat heirloom varieties had an average yield of 1562 lbs acre^{-1}. The highest yielding variety was Forward, which yielded 2868 lbs acre^{-1} (Table 5). Forward was also the highest yielding variety in 2012 (data not shown). Of the eight top yielding varieties, 6 were soft wheat's developed in New York State. Soft wheat's are generally lower in protein and better suited for pastries and cookies. The highest yielding hard wheat, which is generally desired for bread baking, was Clark's Cream (a HWWW released in 1972 from Kansas), which yielded 2137 lbs acre^{-1}. Bluejacket was the highest yielding heirloom in the hard red wheat market class, which yielded 1602 lbs acre^{-1}. Bluejacket was developed in Kansas in 1946.

Pride of Genessee was the tallest growing heirloom wheat, which grew 53.9 inches, almost 4 inches taller than the second tallest variety (Table 5). In organic systems, taller plants are generally desired for their ability to shade out competing weeds. All of the varieties grown in this study would be considered tall when compared to many of today's modern cultivars. Tall wheat may be prone to lodging depending on many factors such as stalk strength and over-fertilization. Lodging was measured twice during the season and ranged between 0 – 95% (Table 4). By harvest time, all varieties had some level of lodging.

Test weight is the measure of grain density determined by weighing a known volume of grain. Generally, the heavier the wheat is per bushel, the higher baking quality. Genessee Giant had the highest test weight of 58.3 lbs bushel^{-1} which exceeds the industry standard of 56 lbs bushel^{-1} (Table 5).

Table 4. Characteristics of heirloom winter wheat varieties, Alburgh, VT, 2013.

Variety	Winter survival (%)	Vigor (0-5)	Lodging 13-Jun (%)	Powdery mildew (0-10)	Leaf disease (0-10)	Plant infected (%)	Lodging 11-Jul (%)
Blackhull	75	3.8	42.5	4.0*	5.8	65.0	45.0
Bluejacket	85*	4.8*	22.5*	8.5	5.8	27.5	36.3
Clark's Cream	**90***	4.5*	**0.0***	2.8*	3.3	40.0	7.5*
Columbia	80*	3.8	11.3*	7.5	5.8	45.0	15.0*
Coppei	61	3.3	7.5*	5.5	4.3	35.0	5.0*
Forward	83*	4.3	3.8*	3.3*	3.3	27.5	8.8*
Gen. Giant	81*	4.3	**0.0***	**2.0***	4.8	22.5	**1.3***
Gold Coin	86*	4.3	20.0*	**2.0***	3.0	25.0	30.0
Honor	84*	4.5*	47.5	2.3*	5.0	40.0	53.8
Kanred	76	3.8	58.8	4.8	4.3	42.5	61.3
Oro	**90***	**5.0***	89.5	5.0	4.8	45.0	95.0
Pride of Gen.	80*	4.5*	42.5	3.5*	2.5	10.0	30.0
Red Chief	88*	4.5*	8.8*	4.5	5.3	22.5	31.3
Red Russian	81*	4.3	30.0	4.8	4.5	37.5	47.5
Relief	78	3.8	36.3	4.5	4.3	40.0	33.8
Rio	85*	4.3	62.5	4.3	3.5	30.0	77.5
Triplet	88*	4.5*	67.5	3.5*	3.8	20.0	92.5
Ukraine	89*	4.8*	38.8	**2.0***	3.3	30.0	31.3
Wahsatch	78	4.5*	61.3	4.5	3.3	27.5	90.0
Trial Mean	82	4.3	34.3	4.2	4.2	33.3	41.7
LSD (p<0.10)	11.23	0.7435	25.339	2.0884	NS	NS	24.772

*Varieties with an asterisk are not significantly d ifferent than the top performer in **bold**.
NS – No significant difference amongst varieties.

Table 5. Yield and quality of heirloom winter wheat, Alburgh, VT, 2013.

Variety	Height (inches)	Population plants m^{-2}	DM yield lbs $acre^{-1}$	Moisture (%)	Test weight lbs $bushel^{-1}$	Protein @ 14% %	Falling number seconds	DON ppm
Blackhull	45.4	328	751	15.6	53.4	12.7	423*	**6.0***
Bluejacket	46.7	395	1602	14.7	57.3*	13.2	409*	7.2*
Clark's Cream	42.9	405	2137	12.6	55.5*	12.1	405*	11.2
Columbia	40.4	405	1101	12.1*	55.3*	11.8	418*	8.2*
Coppei	47.0	372	1255	13.5	56.0*	13.3	399*	10.8
Forward	49.3	389	**2868***	9.7*	56.1*	10.9	369	7.9*
Gen. Giant	43.0	374	2184	11.0*	**58.3***	11.2	355	7.3*
Gold Coin	49.6	308	2134	14.2	52.8	12.2	366	12.3
Honor	50.2	413	1796	**7.9***	54.8*	11.5	381	9.9
Kanred	47.1	318	850	15.7	50.4	13.7	405*	7.5*
Oro	44.3	354	847	12.1*	54.8*	**14.7***	408*	7.6*
Pride of Gen.	**53.9***	376	1683	14.3	56.5*	13.2	388	12.2
Red Chief	46.3	341	1832	16.0	56.4*	13.5	**426***	6.7*
Red Russian	48.1	372	1427	17.8	50.5	14.1*	399*	7.8*
Relief	47.4	315	1361	13.8	56.5*	12.8	412*	7.1*
Rio	43.5	384	1262	15.7	53.3	12.6	384	7.5*
Triplet	48.6	**592***	1258	9.9*	56.3*	14.3*	410*	7.7*
Ukraine	46.4	425	1860	12.6	57.5*	13.5	414*	9.9
Wahsatch	47.0	297	1479	15.1	57.9*	13.3	422*	7.3*
Trial Mean	46.7	377	1562	13.4	55.2	12.9	400	8.5
LSD (p<0.10)	2.8952	99.55	419.15	4.4994	4.1625	0.8541	31.433	2.2555

*Varieties with an asterisk are not significantly different than the top performer in **bold**.
NS – No significant difference amongst varieties.

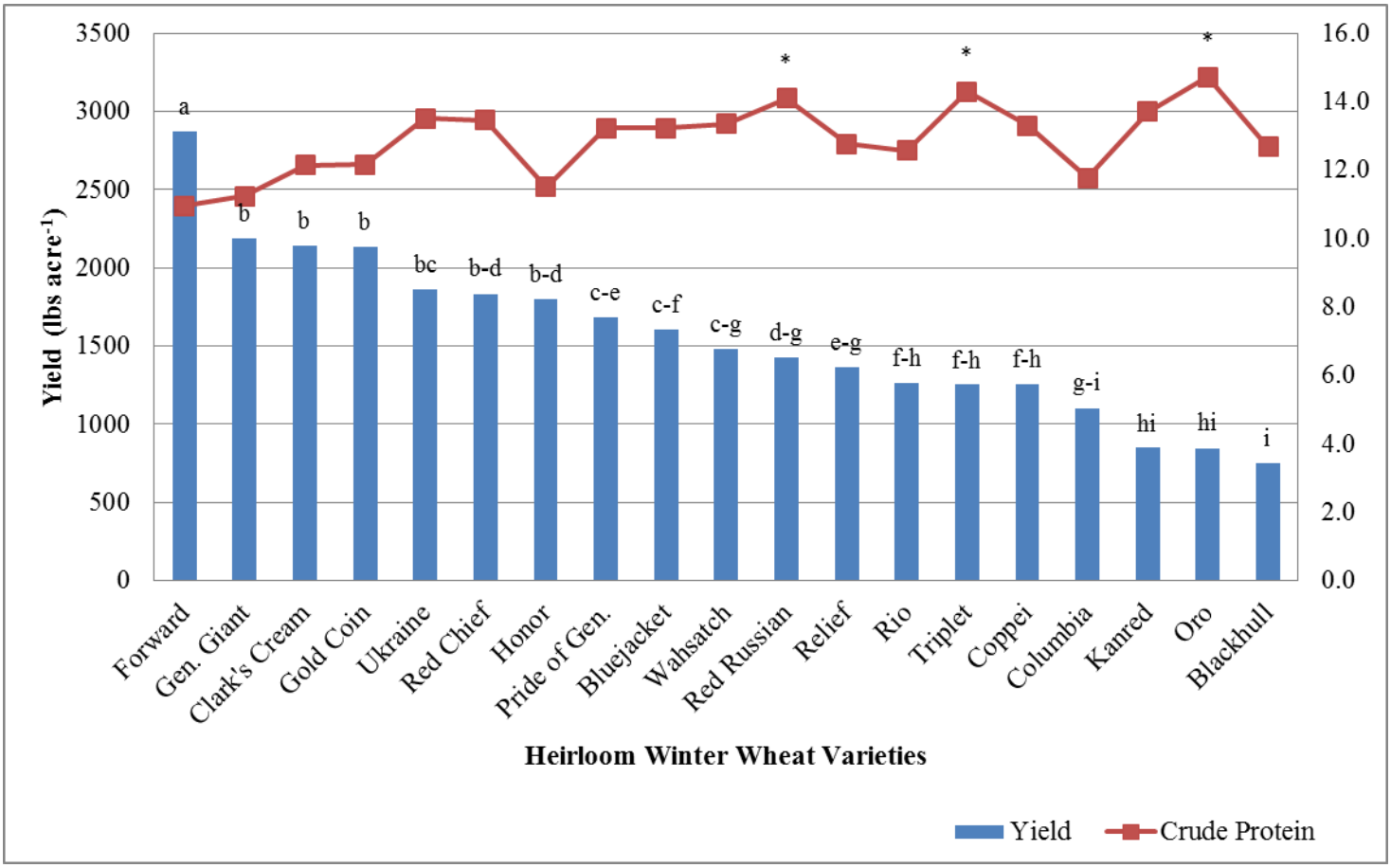

Figure 1. Yield and protein of heirloom winter wheat varieties, Alburgh, VT, 2013. For protein, varieties with an asterisk are the top performer and not significantly different from one another. For yield, varieties with the same letter are not significantly different from one another.

The three varieties with the highest protein content were among the lower yielding varieties (Figure 1). There is often an inverse relationship seen between yield and protein. Oro, Triplet, and Red Russian had crude protein levels over 14%, significantly higher than the other varieties. Falling numbers for all varieties were over 350 seconds, indicating low enzymatic activity and sound quality wheat (Table 5). Additionally, DON levels for all varieties were well above the FDA threshold of 1 ppm and considered un-safe for human consumption (Figure 2). All of the wheat grown at Borderview Research Farm in 2013 has tested well over the FDA threshold of 1 ppm in 2013. The wet conditions during growth and flowering were conducive for Fusarium Head Blight (FHB) infections. In 2013, with such strong *Fusarium* pressure, it is informative to look at varieties with the lowest DON levels because they may show some *Fusarium* resistance, while varieties with the highest levels of DON were most susceptible to *Fusarium* infection.

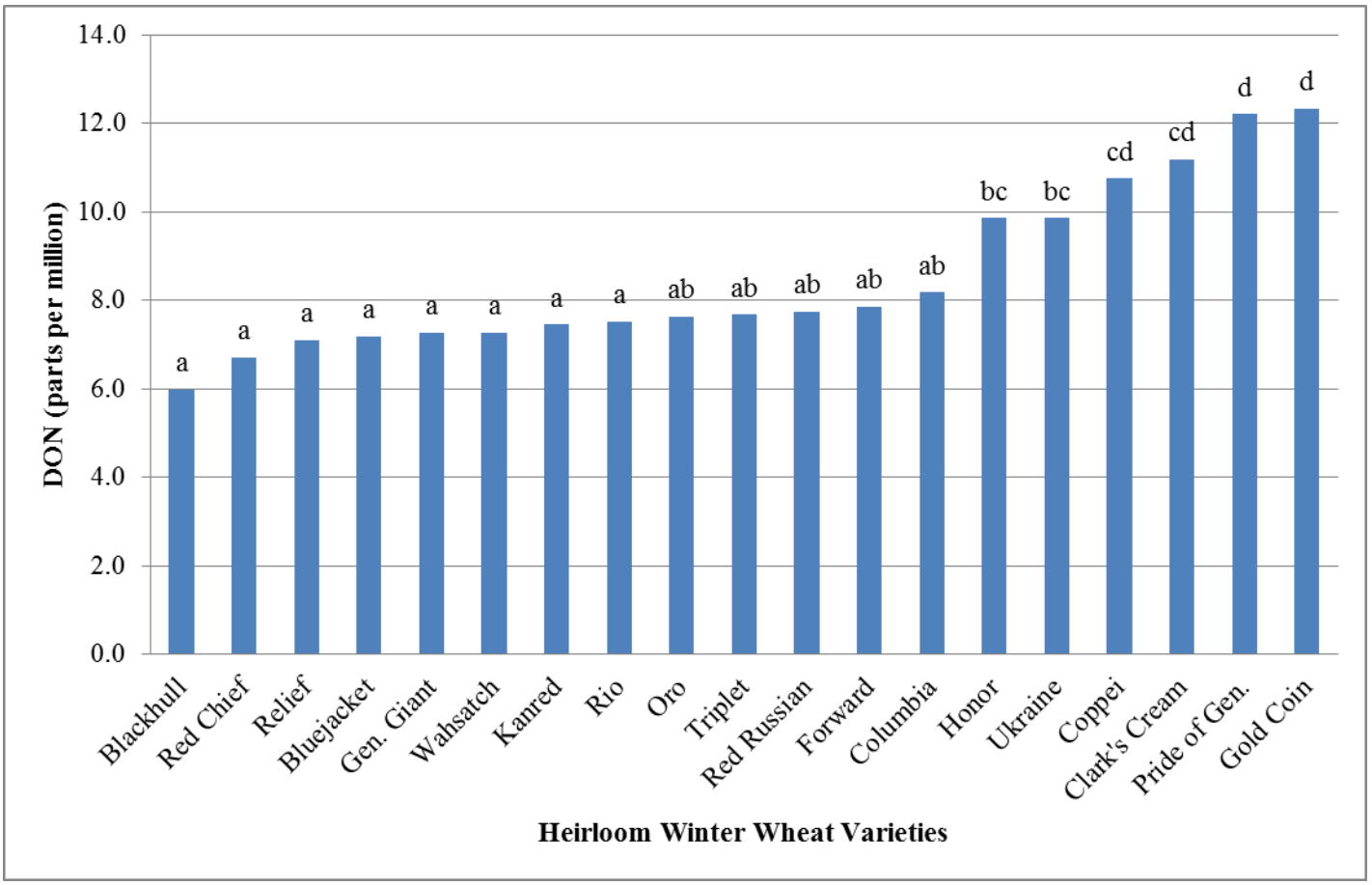

Figure 2. Levels of the toxin, deoxynivalenol (DON) in heirloom winter wheat grown in Alburgh, VT. Varieties with the same letter are not statistically different at the P>0.10.

ACKNOWLEDGEMENTS

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