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2012 Heirloom Spring Wheat Variety Trial Report



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2012 HEIRLOOM SPRING WHEAT VARIETY TRIAL

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INTRODUCTION

UVM Extension began its heirloom spring wheat project in 2007 to determine whether heirloom varieties developed before 1950 could thrive in Vermont's climate. Many consumers are interested in heirloom wheat as they feel it has better flavor, while many farmers are also interested in heirloom wheat varieties as they may have superior genetics that are better adapted to the challenging growing conditions in the Northeast. This variety trial was established to determine which heirloom spring wheat varieties are viable in Vermont's growing conditions. Three Vermont heirloom varieties have been re-introduced through this project. Defiance, Champlain and Surprise were developed by famed Vermont plant breeder, Cyrus Pringle 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.

MATERIALS AND METHODS

Fifteen heirloom and two modern varieties of hard red spring wheat (HRSW) were planted at Borderview Research Farm in Alburgh, VT on 6-Apr 2012. Fifteen heirloom and three modern varieties of HRSW were planted at Butterworks Farm in Westfield, VT on 18-Apr 2012 (Table 1). The experimental plot design was a randomized complete block with four replications at both Butterworks Farm and Borderview Research Farm.

Table 1. Varietal information of the heirloom spring wheat, 2012.

| Variety | Developed in | Pedigree | Release Date |
|-----------|-----------------|---|--------------|
| AC Barrie | Sask. Canada | Neepawa/Columbus//BW90 | 1996 |
| Ceres 05 | North Dakota | Marquis/Kota | 1926 |
| Champlain | Vermont | Black Sea/Golden Drop | 1870 |
| Defiance | Vermont | Golden Drop/White Hamburg | 1878 |
| Hope | South Dakota | Yaroslav emmer/Marquis | 1927 |
| Komar | North Dakota | Marquis/Kota; Sister selection of Ceres | 1930 |
| Ladoga | Leningrad, Rus. | - | 1916 |
| Marquis | Ont. Canada | Hard Red Calcutta/Red Fife | 1910 |
| Megantic | Que. Canada | - | 2008 |
| Mida 05 | North Dakota | Mercury//Ceres/Double Cross | 1944 |
| Mida 06 | North Dakota | Mercury//Ceres/Double Cross | 1944 |
| Red Bobs | Sask. Canada | Selection from fields of Bobs | 1926 |
| Reliance | Oregon | Kanred/Marquis | 1926 |
| Scarlet | Washington | Too many to list | 1998 |
| Spinkcota | Washington | Preston sel./red durum//Preston sel. | 1944 |
| Supreme | Sask. Canada | Selection from Red Bobs | 1922 |
| Surprise | Vermont | Chile Club/Michigan Club | 1909 |
| Thatcher | Minnesota | Marquis/Ilumillo//Marquis/Kanred | 1934 |

The seedbeds at both locations were 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 at both locations were seeded with a Kincaid cone seeder and harvested with an Almaco SPC50 small plot combine. Alburgh plots were seeded on 6-Apr and harvested on 31-July. The plots at the Westfield location were planted on 18-Apr and harvested on 6-Aug. Plant populations were determined on 6-May at both the Alburgh site and the Westfield site. The harvest area at both locations was 5 feet by 20 feet.

At the time of harvest, plant heights were measured excluding the awns. In Alburgh, a visual estimate of what percent a plot was lodged and the severity of lodging was recorded based on a visual rating with a 0 – 5 scale, where 0 indicates no lodging and 5 indicates severe lodging and a complete crop loss. There was no lodging of varieties at the Westfield location. In addition, grain moisture, test weight and yield were calculated.

Following harvest, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). 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 12-15% protein. Protein was calculated on a 12% moisture and 14% moisture basis. 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 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.

Table 2. General plot management for trials.

| | Borderview Research Farm Alburgh, VT | Butterworks Farm Westfield, VT |
|-----------------------------------|---|---|
| Soil type | Benson rocky silt loam | Dixfield sandy loam |
| Previous crop | Sunflowers | Spring wheat |
| Row spacing (in.) | 6 | 6 |
| Seeding rate lbs ac ⁻¹ | 100 | 100 |
| Replicates | 4 | 4 |
| Planting date | 6-Apr | 18-Apr |
| Harvest date | 31-Jul | 6-Aug |
| Harvest area (ft.) | 5x20 | 5x20 |
| Tillage operations | Fall plow, disc, & spike-toothed harrow | Fall plow, disc, & spike-toothed harrow |

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 treatments is real or whether it might have occurred due to other variations in the field. All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate treatment means when the F-test was significant. At the bottom of each table, a LSD value is presented for each variable (e.g. yield). Least Significant Differences (LSDs) at the 10% level (0.10) 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 values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the example at right, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 400, which is less than the LSD value of 500. This means that these treatments did not differ in yield. The difference between A and C is equal to 650, which is greater than the LSD value of 500. This means that the yields of these treatments were significantly different from one another.

| Variety | Yield |
|----------------|--------------|
| A | 1600* |
| B | 1200* |
| C | 950 |
| LSD (0.10) | 500 |

RESULTS

In Alburgh, VT, temperature and precipitation data for the 2012 heirloom spring wheat growing season were collected with an on-site Davis Instruments Vantage Pro2 weather station (Table 3). For the Westfield location, data was taken from the Northeast Regional Climate Center data for nearby Newport, VT (Table 4). From planting to harvest, there was an accumulation of approximately 4768 Growing Degree Days (GDDs) in Alburgh. This was 267 GDDs more than the 30-year average. In Westfield, there were approximately 4264 GDDs from planting to harvest, 102 GDDs more than the 30-year average. There was an overall less than average precipitation throughout the season and in both locations.

Table 3: Temperature and precipitation summary for Borderview Research Farm, 2012.

| Alburgh, VT | April | May | June | July | August |
|---------------------------------|-------|------|------|------|--------|
| Average temperature (°F) | 44.9 | 60.5 | 67.0 | 71.4 | 71.1 |
| Departure from normal | 0.1 | 4.1 | 1.2 | 0.8 | 2.3 |
| Precipitation (inches)* | 2.6 | 3.9 | 3.2 | 3.8 | 2.9 |
| Departure from normal | -0.2 | 0.5 | -0.5 | -0.4 | -1.0 |
| Growing Degree Days (base 32°F) | 396 | 884 | 1046 | 1221 | 1211 |
| Departure from normal | 12 | 128 | 32 | 23 | 72 |

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

*Precipitation data from June-August is based on Northeast Regional Climate Center data from an observation station in Burlington, VT.

Table 4. Temperature and precipitation summary for Butterworks Farm, 2012.

| Westfield, VT | April | May | June | July | August |
|---------------------------------|-------|------|------|------|--------|
| Average temperature (°F) | 41.8 | 56.7 | 63.0 | 67.9 | 68.1 |
| Departure from normal | -0.9 | 1.9 | -0.8 | -0.1 | 2.0 |
| Precipitation (inches) | 3.2 | 3.6 | 4.0 | 3.6 | 2.8 |
| Departure from normal | 0.4 | 0.0 | 0.0 | -0.7 | -1.8 |
| Growing Degree Days (base 32°F) | 336 | 769 | 928 | 1112 | 1119 |
| Departure from normal | 4 | 64 | -25 | -4 | 63 |

Precipitation and temperature data is based on Northeast Regional Climate Center data from an observation station in Newport, VT. Historical averages are for 30 years of NOAA data from Newport, VT (1981-2010).

Borderview Research Farm: *Wheat yield and quality*

Table 5. Heirloom spring wheat harvest results for Alburgh, VT, 2012.

| Variety | Height | Lodging | Severity | Yield | Moisture | Test weight |
|------------|-------------|--------------|--------------|----------------------|-------------|----------------------|
| | in | % | (1-5) | lbs ac ⁻¹ | % | lbs bu ⁻¹ |
| AC Barrie | 39.4 | 41.3* | 2.75 | 1879 | 11.4 | 60.8* |
| Ceres 05 | 36.8 | 73.3 | 3.63 | 1236 | 11.2 | 59.5 |
| Champlain | 44.1 | 28.8* | 1.75* | 1502 | 10.2 | 59.0 |
| Defiance | 42.8 | 22.5* | 2.00* | 2211 | 10.5 | 59.6 |
| Hope | 38.0 | 60.0 | 3.75 | 1566 | 11.9 | 58.8 |
| Komar | 43.2 | 52.0 | 2.50 | 1413 | 11.7 | 59.8* |
| Ladoga | 41.5 | 46.3 | 1.00* | 1644 | 10.8 | 59.0 |
| Marquis | 39.2 | 75.0 | 1.75* | 1920 | 10.4 | 60.5* |
| Mida 05 | 42.0 | 65.0 | 3.25 | 1591 | 11.8 | 60.4* |
| Mida 06 | 41.1 | 76.8 | 4.00 | 1725 | 12.0 | 59.8* |
| Red Bobs | 42.3 | 28.8* | 1.50* | 2091 | 11.8 | 60.3* |
| Reliance | 42.1 | 18.8* | 1.50* | 1981 | 10.7 | 59.8* |
| Scarlet | 41.4 | 12.5* | 1.25* | 2035 | 11.5 | 59.5 |
| Spinkcota | 42.6 | 51.3 | 2.50 | 1527 | 11.1 | 61.0* |
| Supreme | 40.5 | 60.0 | 3.00 | 2408 | 10.7 | 59.1 |
| Surprise | 42.1 | 10.0* | 1.00* | 1379 | 12.3 | 58.4 |
| Thatcher | 42.9 | 22.5* | 2.00* | 1393 | 11.0 | 59.3 |
| LSD (0.10) | NS | 34.2 | 1.30 | NS | NS | 1.3 |
| Trial mean | 41.3 | 43.8 | 2.30 | 1735 | 11.2 | 59.7 |

*Treatments that did not perform significantly lower than the top-performing treatment in a particular column are indicated with an asterisk.

NS- Treatments were not significantly different from one another.

Treatments indicated in **bold** had the top observed performance in a particular column.

At the Alburgh, VT location plant heights were measured on 31-Jul. The average height was 41.3 inches (Table 5). A visual estimation of lodging (%) were performed at the Alburgh location on 31-Jul. Lodging is defined as, the collapse of top heavy plants, particularly grain crops because of excess growth or beating by rain. If lodging was present, its severity was recorded based on a 1 to 5 scale with 1 being indicating the entire plot could be harvested with the plot combine and 5 signifying an inability to harvest the plot. The average lodging was 43.8% with the average severity being 2.30. There was no significant difference in yield among heirloom varieties (Figure 1). The average yield for the trial was 1735 lbs per acre. The average moisture for the Alburgh location was 11.2% and the highest test weight was in the variety ‘Spinkcota’ (61 lbs per bushel).

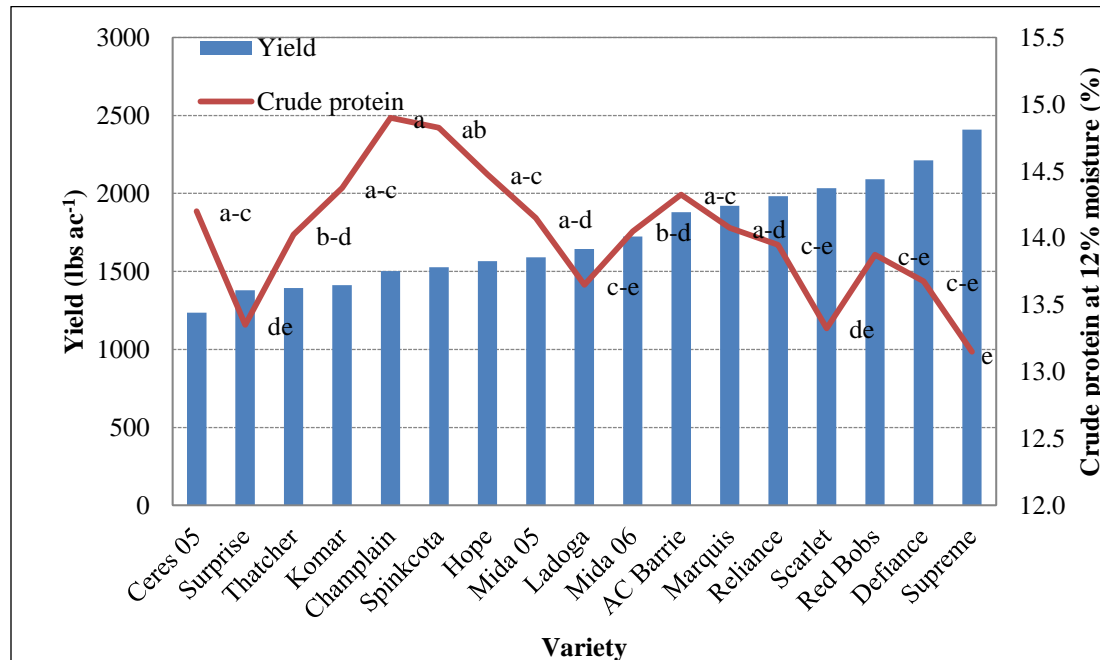


Figure 1. Yield and protein of heirloom spring wheat varieties grown in Alburgh, VT, 2012. Treatments that share a letter did not differ significantly by variety (p=0.10.) There was no significant difference in yield by variety.

Protein levels at the Alburgh site ranged from 13.2 to 14.9 percent. Champlain had the highest CP concentrations but was not significantly different than Spinkcota, Marquis, Midas 05, AC Barrie, Ceres05, Hope and Komar. All of the varieties grown in Alburgh had high falling numbers over 250 seconds. The average falling number was 429 seconds, which once again indicates low enzymatic activity and sound quality wheat. Varieties grown in Alburgh had DON levels of 1.0 ppm or less, which is within acceptable levels for human consumption.

Table 6: Quality of heirloom spring wheat for Alburgh, VT, 2012.

| Variety | Crude protein at 12% moisture | Crude protein at 14% moisture | Falling number | DON |
|------------|----------------------------------|----------------------------------|-------------------|-------------|
| | % | % | Sec | PPM |
| AC Barrie | 14.3* | 14.0* | 469* | 0.6 |
| Ceres 05 | 14.2* | 13.9* | 411 | 0.4* |
| Champlain | 14.9* | 14.5* | 426 | 0.4* |
| Defiance | 13.7 | 13.4 | 427 | 0.3* |
| Hope | 14.5* | 14.1* | 448* | 0.5 |
| Komar | 14.4* | 14.1* | 429 | 0.3* |
| Ladoga | 13.7 | 13.4 | 443* | 0.2* |
| Marquis | 14.1* | 13.8* | 472* | 0.2* |
| Mida 05 | 14.2* | 13.8* | 420 | 0.7 |
| Mida 06 | 14.1 | 13.7* | 412 | 0.7 |
| Red Bobs | 13.9 | 13.6 | 420 | 0.4* |
| Reliance | 14.0 | 13.7 | 421 | 0.4* |
| Scarlet | 13.3 | 13.0 | 414 | 1.0 |
| Spinkcota | 14.8* | 14.5* | 402 | 0.4* |
| Supreme | 13.2 | 12.9 | 451* | 0.4* |
| Surprise | 13.4 | 13.0 | 407 | 0.6 |
| Thatcher | 14.0 | 13.7 | 415 | 0.4* |
| LSD (0.10) | 0.8 | 0.8 | 34 | 0.3 |
| Trial mean | 14.0 | 13.7 | 429 | 0.4 |

*Treatments that did not perform significantly lower than the top-performing treatment in a particular column are indicated with an asterisk. Treatments indicated in **bold** had the top observed performance in a particular column.

Butterworks Farm, Westfield, VT: *Wheat yield and quality.*

At the Westfield location, plant height was measured on 6-Aug. The average height throughout the wheat was 38.4. However, Champlain exceeded the average height and stood 43.9 inches, though this was not significantly taller than five other varieties which included Defiance, Komar, Marquis, Reliance and Spinkcota (Table 7). The average 2012 yield in Westfield was 771 lbs ac⁻¹ (Table 6, Figure 2). Ladoga was the highest yielding heirloom (1152 lbs per acre). A modern variety, Megantic had the highest test weight of the varieties at 60.5 lbs per bushel. The average test weight for the trial was 56.4 lbs per bushel, which is low compared to the standard of 60 lbs bu⁻¹. Grain protein levels in Westfield averaged 12.8% and ranged from 12.0 to 13.6 %. The average falling number for the heirloom wheat was 379 seconds which indicates low enzymatic activity and sound quality wheat. Megantic had the highest falling number (471 seconds), while Champlain had the lowest falling number (317 seconds). All of the varieties had levels of DON below the 1.0 ppm limit for human consumption.

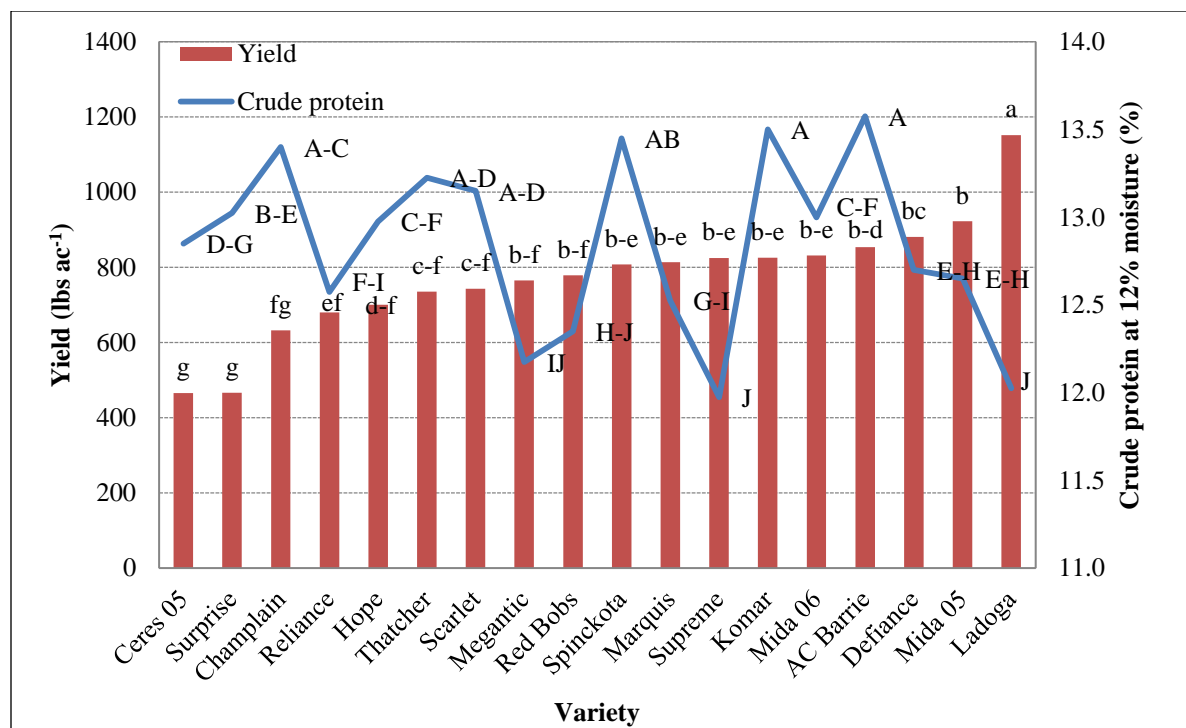


Figure 2: Yield and protein of heirloom spring wheat varieties grown in Westfield, VT.
Treatments that share a letter did not differ significantly by variety ($p=0.10$, compare lowercase letters for yield and capital letters for crude protein).

Table 7. Heirloom spring wheat harvest and quality data, Westfield, VT, 2012

| Variety | Height | Yield | Harvest moisture | Test weight | Crude protein at 12% moisture | Crude protein at 14% moisture | Falling number | DON |
|-----------|--------------|----------------------|------------------|----------------------|-------------------------------|-------------------------------|----------------|-------------|
| | inches | lbs ac ⁻¹ | % | lbs bu ⁻¹ | % | % | seconds | ppm |
| AC Barrie | 34.1 | 854 | 14.2 | 56.0 | 13.6* | 13.3* | 428 | 0.33 |
| Ceres 05 | 32.0 | 466 | 16.3 | 55.5 | 12.9 | 12.6 | 423 | 0.40 |
| Champlain | 43.9* | 633 | 16.1 | 54.7 | 13.4* | 13.1* | 317 | 0.28 |
| Defiance | 42.3* | 881 | 16.7 | 56.8 | 12.7 | 12.4 | 361 | 0.30 |
| Hope | 37.2 | 701 | 14.3 | 56.5 | 13.0 | 12.7 | 418 | 0.45 |
| Komar | 43.1* | 826 | 16.2 | 56.9 | 13.5* | 13.2* | 357 | 0.53 |
| Ladoga | 39.6 | 1152* | 15.2 | 57.4 | 12.0 | 11.8 | 376 | 0.23 |
| Marquis | 40.5* | 814 | 14.9 | 56.0 | 12.5 | 12.2 | 372 | 0.33 |
| Megantic | 36.7 | 766 | 14.9 | 60.5* | 12.2 | 11.9 | 471* | 0.33 |
| Mida 05 | 38.0 | 923 | 16.7 | 56.6 | 12.7 | 12.4 | 353 | 0.43 |
| Mida 06 | 38.0 | 832 | 15.2 | 55.9 | 13.0 | 12.7 | 364 | 0.43 |
| Red Bobs | 34.7 | 779 | 15.4 | 56.3 | 12.4 | 12.1 | 405 | 0.58 |
| Reliance | 40.7* | 680 | 15.6 | 56.0 | 12.6 | 12.3 | 344 | 0.43 |
| Scarlet | 33.6 | 743 | 15.2 | 55.5 | 13.2* | 12.9* | 364 | 0.53 |
| Spinckota | 42.3* | 808 | 17.1 | 58.8* | 13.5* | 13.2* | 307 | 0.38 |

| | | | | | | | | |
|------------|------|-----|-------------|------|-------|-------|-----|------|
| Supreme | 36.9 | 825 | 13.9 | 55.4 | 12.0 | 11.8 | 434 | 0.39 |
| Surprise | 38.5 | 467 | 15.5 | 56.0 | 13.0 | 12.7 | 383 | 0.26 |
| Thatcher | 40.0 | 736 | 16.2 | 55.3 | 13.2* | 12.9* | 348 | 0.43 |
| LSD (0.10) | 3.5 | 167 | NS | 2.5 | 0.4 | 0.4 | 29 | NS |
| Trial mean | 38.4 | 771 | 15.5 | 56.4 | 12.8 | 12.5 | 379 | 0.39 |

*Treatments that did not perform significantly lower than the top-performing treatment in a particular column are indicated with an asterisk.

NS- Treatments were not significantly different from one another.

Treatments indicated in **bold** had the top observed performance in a particular column.

DISCUSSION

The less than average precipitation encountered during 2012 helped lead to a successful spring wheat harvest. In 2011, yields were extremely low, which can be attributed to the high overall precipitation Vermont experienced. In 2012, the heirloom spring wheat at the Alburgh location did much better than the wheat at the Westfield location. At the Alburgh location, Supreme had the highest yield (2408 lbs per acre), and was almost double the highest yield (1152 lbs per acre) from the Westfield location. The low yields in Westfield could be attributed to the lack of fertility in the soil and low precipitation, while the high yields at the Alburgh location could be attributed to the higher soil fertility. Higher fertility at the Alburgh site most likely contributed to the high lodging severity observed at this site. There is generally an inverse relationship between yield and protein. As yield increases, protein levels generally decrease, and when yields are low, protein levels are generally high. However, this was not always the case with the heirloom wheat. Ladoga was the highest yielding heirloom at the Westfield location (1152 lbs per acre), yielding about 300 lbs per acre more than the modern variety ‘AC Barrie’ and 400 lbs per acre more than the modern variety ‘Scarlet.’ This may be evidence that some heirloom varieties are able to outperform modern varieties in the challenging growing conditions of Vermont. Based on the trials, there are several heirloom varieties that will perform well under Vermont growing conditions in both yield and quality.

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