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# Heirloom Spring Wheat Variety Trial

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# NORTHWEST CROPS & SOILS PROGRAM



## 2013 Heirloom Spring Wheat Variety Trial



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## **2013 HEIRLOOM SPRING WHEAT VARIETY TRIAL**

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### **INTRODUCTION**

University of Vermont 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**

In the spring of 2013, an heirloom spring wheat variety trial was initiated at Borderview Research Farm in Alburgh, VT and at Butterworks Farm in Westfield, VT. General plot management is listed in Table 1. Plots were managed with practices similar to those used by producers in the surrounding area. In Alburgh, the previous crop was corn and in Westfield, the previous crop was sunflowers. Plots were seeded with a Kincaid Cone Seeder at a seeding rate of 125 lbs acre<sup>-1</sup>. Wheat was planted on 22-Apr in Alburgh and 1-May in Westfield.

Populations were measured on 21-May in Alburgh and 4-Jun in Westfield. Populations were determined by taking three, 1/3 meter counts per plot. Plots in Westfield were weeded and fertilized with 200 lbs ac<sup>-1</sup> Pro-Gro and 400 lbs ac<sup>-1</sup> Pro-Booster on 19-Jun. The date of flowering was recorded in Alburgh based on greater than fifty percent of the plot flowering on that date. Lodging was measured as a percent of plot fallen over on 5-Aug in Alburgh. After assessing the amount of the plot lodged, a severity measurement was taken based on a 0-5 scale, where 0 was mild and 5 represented wheat unable to be picked up by the combine. At the same time, heights were measured.

Plots were harvested with an Almaco SPC50 small plot combine on 5-Aug 2013 in Alburgh and 20-Aug in Westfield. The harvest area was 5' x 20'. 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 spring 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.**

|                                   | <b>Borderview<br/>Research Farm<br/>Alburgh, VT</b> | <b>Butterworks Farm<br/>Westfield, VT</b> |
|-----------------------------------|---|---|
| Soil type                         | Benson rocky silt loam                              | Dixfield sandy loam                       |
| Previous crop                     | Corn  | Sunflowers                                |
| Row spacing (in.)                 | 6   | 6   |
| Seeding rate lbs ac <sup>-1</sup> | 125   | 125                                       |
| Replicates                        | 4   | 4   |
| Planting date                     | 22-Apr  | 1-May                                     |
| Harvest date                      | 5-Aug   | 20-Aug                                    |
| Harvest area (ft.)                | 5 x 20  | 5 x 20                                    |
| Tillage operations                | Fall plow, disc, & spike tooth harrow               | Fall plow, disc, & spike tooth harrow     |

**Table 2. Heirloom spring wheat varieties, place of development, pedigree, and year of release.**

| <b>Variety</b> | <b>Developed in</b> | <b>Pedigree</b>                         | <b>Release Date</b> |
|----------------|---------------------|---|---------------------|
| 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                |
| 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/Illumillo//Marquis/Kanred       | 1934                |

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*       |
| <b>LSD</b> | <b>2.0</b> |

## RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. It rained almost 7 inches more than the 30 year average in April and May. There was an accumulation of 4510 Growing Degree Days (GDDs) throughout the growing season in Alburgh, 18 GDDs higher than the 30-year average. In Westfield, temperatures hovered around the 30-year normal while it rained almost 9 inches more than average in May, June, and July (Table 4). There was an accumulation of 4031 GDDs in Westfield, 85 less than the 30-year average.

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

| Alburgh, VT                     | April | May  | June  | July  | August |
|---------------------------------|-------|------|-------|-------|--------|
| Average temperature (°F)        | 43.6  | 59.1 | 64    | 71.7  | 67.7   |
| Departure from normal           | -1.2  | 2.7  | -1.8  | 1.1   | -1.1   |
| Precipitation (inches)          | 2.12  | 4.79 | 9.23† | 1.89  | 2.41   |
| Departure from normal           | -0.7  | 1.34 | 5.54  | -2.26 | -1.5   |
| Growing Degree Days (base 32°F) | 348   | 848  | 967   | 1235  | 1112   |
| Departure from normal           | -36   | 91   | -47   | 37    | -27    |

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.

† 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](http://www.nrcc.cornell.edu/page_summaries.html))

**Table 4. Seasonal weather data collected in Westfield, VT, 2013.**

| Westfield, VT                   | April | May  | June  | July | August |
|---------------------------------|-------|------|-------|------|--------|
| Average temperature (°F)        | 39.4  | 55.7 | 62.2  | 69.3 | 64.6   |
| Departure from normal           | -3.2  | 0.9  | -1.6  | 1.3  | -1.5   |
| Precipitation (inches)          | 2.78  | 6.53 | 7.08† | 7.29 | 2.78   |
| Departure from normal           | -0.03 | 2.86 | 3.12  | 2.96 | -1.83  |
| Growing Degree Days (base 32°F) | 221   | 736  | 906   | 1156 | 1012   |
| Departure from normal           | -102  | 26   | -48   | 84   | -45    |

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.

† 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](http://www.nrcc.cornell.edu/page_summaries.html))

**Table 5. Characteristics of heirloom spring wheat varieties, Alburgh, VT, 2013.**

| Variety      | Population<br>plants m <sup>-2</sup> | Moisture<br>% | Test weight<br>lbs bushel <sup>-1</sup> | Yield at<br>13% moist<br>lbs ac <sup>-1</sup> | Crude<br>protein<br>% | Falling<br>number<br>sec | DON<br>ppm  |
|--------------|--------------------------------------|---------------|---|---|-----------------------|--------------------------|-------------|
| AC Barrie    | <b>617*</b>                          | 11.1*         | 55.0*                                   | 1275*   | 14.5                  | <b>386*</b>              | 6.2         |
| Ceres 05     | 553*                                 | 11.9*         | 53.4                                    | 1046  | 14.6                  | 364*                     | 5.5*        |
| Champlain    | 509                                  | 14.2          | 52.3                                    | 1204  | <b>16.0*</b>          | 255                      | 4.2*        |
| Defiance     | 577*                                 | 10.6*         | 53.5                                    | 1239*   | 15.3                  | 313                      | 4.7*        |
| Hope         | 495                                  | 12.1*         | <b>55.8*</b>                            | 905   | 14.5                  | 377*                     | 6.1         |
| Komar        | 456                                  | 12.1*         | 52.0                                    | 1262*   | 15.6*                 | 315                      | 4.7*        |
| Ladoga       | 571*                                 | 10.3*         | 53.3                                    | <b>1535*</b>                                  | 15.0                  | 352*                     | 4.7*        |
| Marquis      | 490                                  | 11.5*         | 54.0*                                   | 1339*   | 15.6*                 | 350*                     | <b>4.3*</b> |
| Mida 05      | 476                                  | 10.2*         | 53.3                                    | 1133  | 15.4*                 | 345*                     | 5.0*        |
| Mida 06      | 415                                  | 11.2*         | 53.8                                    | 1167  | 15.6*                 | 333                      | 6.2         |
| Red Bobs     | 466                                  | 11.0*         | 54.5*                                   | 1259*   | 14.7                  | 336                      | 6.4         |
| Reliance     | 554*                                 | 13.0          | 52.8                                    | 586   | 15.4*                 | 330                      | <b>4.3*</b> |
| Scarlet      | 394                                  | 10.5*         | 51.5                                    | 1219  | 14.6                  | 357*                     | 8.1         |
| Spinckota    | 553*                                 | 13.3          | 54.8*                                   | 1175  | 15.9*                 | 318                      | 4.9*        |
| Supreme      | 527*                                 | <b>10.1*</b>  | 53.8                                    | 1363*   | 14.0                  | 361*                     | 6.8         |
| Surprise     | 533*                                 | 12.4          | 54.3*                                   | 1318*   | 14.6                  | 352*                     | 5.6         |
| Thatcher     | 509*                                 | 11.5*         | 53.8                                    | 1042  | 15.2                  | 313                      | 4.7*        |
| Mean         | 511                                  | 11.6          | 53.6                                    | 1180  | 15.1                  | 339                      | 5.4         |
| LSD (p<0.10) | 94.52                                | 2.086         | 1.766                                   | 314.4   | 0.702                 | 44.47                    | 1.3         |

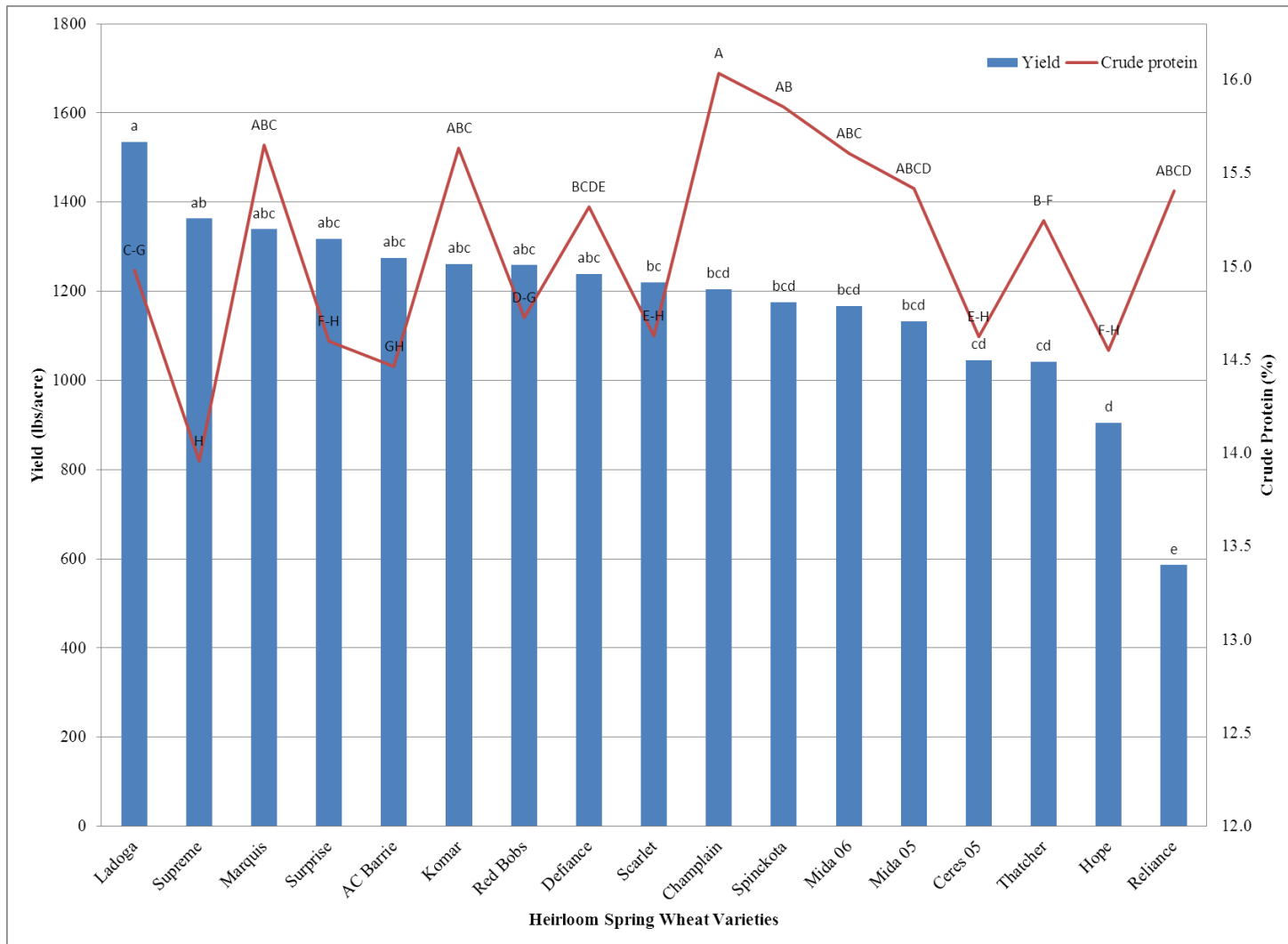
\*Varieties with an asterisk are not significantly different than the top performer in **bold**.

**Table 6. Characteristics of heirloom spring wheat varieties, Westfield, VT, 2013.**

| Variety      | Population<br>plants m <sup>-2</sup> | Moisture<br>% | Test weight<br>lbs bushel <sup>-1</sup> | Yield at<br>13% moist<br>lbs ac <sup>-1</sup> | Crude<br>protein<br>% | Falling<br>number<br>sec | DON<br>ppm |
|--------------|--------------------------------------|---------------|---|---|-----------------------|--------------------------|------------|
| AC Barrie    | 342                                  | 11.8          | 56.2                                    | 611   | 14.0                  | <b>311*</b>              | 0.7        |
| Ceres 05     | 340                                  | 12.6          | 56.7                                    | 467   | 13.6                  | 277                      | 0.9        |
| Champlain    | 325                                  | 15.1          | 54.5                                    | 1018*   | 14.4*                 | 202                      | 1.1        |
| Defiance     | 288                                  | 12.2          | 56.7                                    | 666   | 13.6                  | 253                      | 0.5        |
| Hope         | 384                                  | 12.3          | 56.3                                    | 642   | 13.3                  | 291*                     | 1.1        |
| Komar        | 354                                  | 11.8          | 58.0                                    | 653   | 13.4                  | 246                      | 0.9        |
| Ladoga       | 344                                  | 13.5          | 56.8                                    | 1042*   | 13.8                  | 254                      | 0.5        |
| Marquis      | 354                                  | 11.6          | 58.0                                    | 841*  | 13.9                  | 252                      | 0.6        |
| Mida 05      | 310                                  | 12.0          | 55.0                                    | 341   | 14.2                  | 251                      | 0.6        |
| Mida 06      | 300                                  | 13.4          | 55.3                                    | 458   | <b>15.2*</b>          | 238                      | 1.1        |
| Red Bobs     | 335                                  | 13.2          | 56.5                                    | 638   | 13.4                  | 263                      | 0.9        |
| Reliance     | 344                                  | 13.5          | 55.0                                    | <b>1082*</b>                                  | 14.7*                 | 258                      | 1.4        |
| Scarlet      | 399                                  | 14.7          | 54.8                                    | 542   | 14.1                  | 255                      | 0.9        |
| Spinckota    | 290                                  | 15.2          | 55.8                                    | 639   | 14.6*                 | 221                      | 0.6        |
| Supreme      | 317                                  | 11.3          | 57.5                                    | 520   | 12.5                  | 300*                     | 1.3        |
| Surprise     | 327                                  | 13.6          | 56.0                                    | 520   | 12.5                  | 247                      | 0.8        |
| Thatcher     | 362                                  | 12.0          | 57.0                                    | 434   | 12.9                  | 220                      | 0.3        |
| Mean         | 336                                  | 12.9          | 56.3                                    | 654   | 13.8                  | 255                      | 0.8        |
| LSD (p<0.10) | NS                                   | NS            | NS                                      | 323   | 0.9                   | 26.1                     | NS         |

\*Varieties with an asterisk are not significantly different than the top performer in **bold**.

NS – No significant difference amongst varieties.



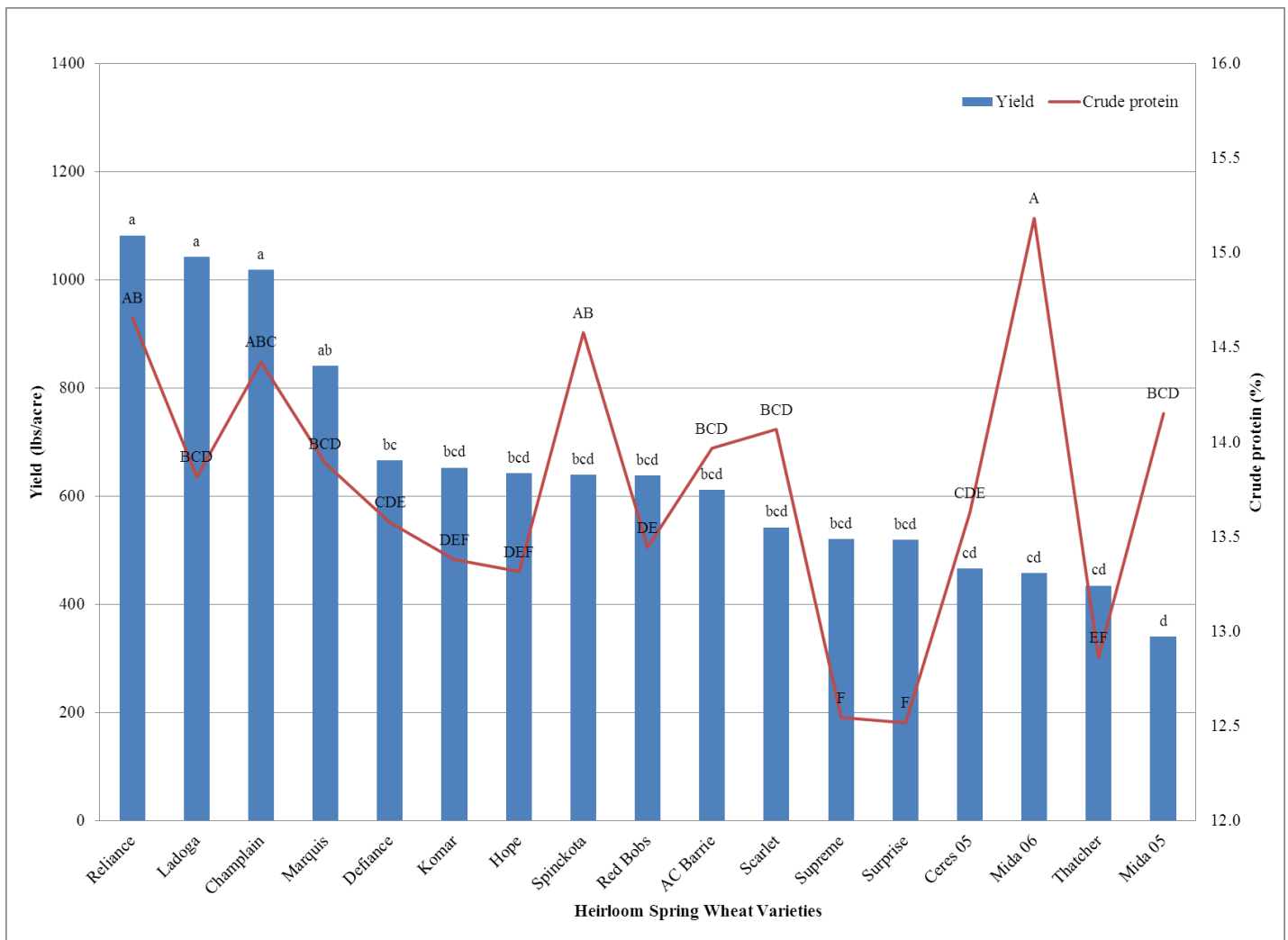
**Figure 1. Yield and protein of heirloom spring wheat varieties, Alburgh, VT, 2013. Varieties with the same letter are not significantly different from one another.**

Average yields in Alburgh—1180 lbs acre<sup>-1</sup> were almost twice the average yields in Westfield—654 lbs acre<sup>-1</sup> (Table 5 and 6). Ladoga was a top yielder at both locations. Interestingly, Reliance was the highest yielder in Westfield but the lowest yielding variety in Alburgh. The soils and climate in Westfield may be better suited for this variety. In Alburgh, two of the heirloom varieties bred in Vermont, Surprise and Defiance, were statistically similar to the top yielding variety. Champlain, also bred in Vermont, was a top yielder in Westfield.

In Alburgh, two of the highest yielding varieties, Marquis and Komar—yielding about 1300 lbs acre<sup>-1</sup>, also had the highest crude protein levels—over 15% (Figure 1). In Westfield, the two of the highest yielding varieties, Reliance and Champlain—yielding over 1000 lbs acre<sup>-1</sup>, also had the highest crude protein levels—over 14% (Figure 2).

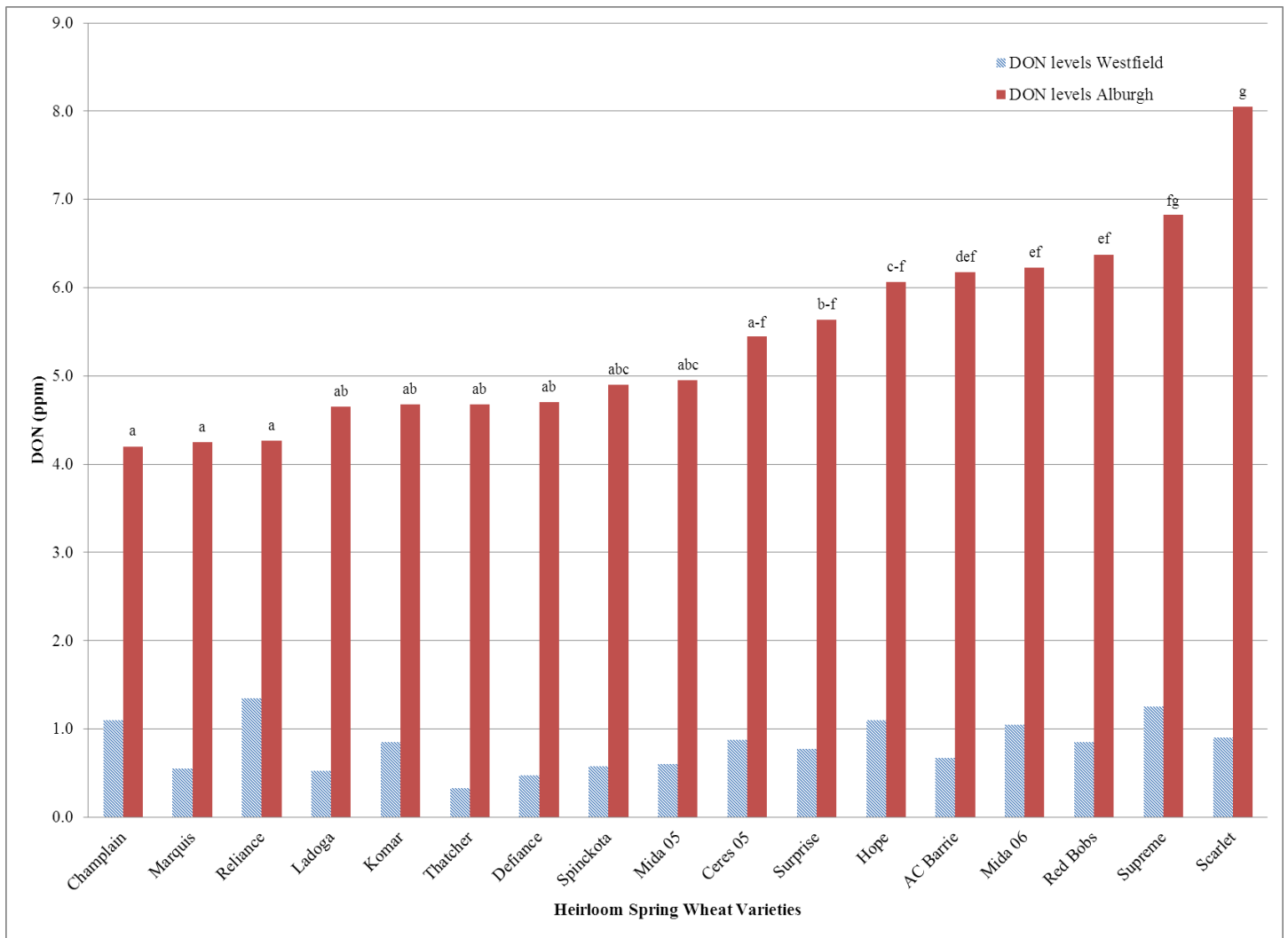
The falling number of the heirloom varieties in Alburgh averaged 339 seconds, indicating sound quality wheat (Table 5). In Westfield, falling numbers averaged 255 seconds, and ranged from 202-311 seconds (Table 6). A falling number lower than 200 seconds indicates pre-harvest sprout damage. While no variety fell below this threshold, it is interesting to note that Champlain had the lowest falling number at both locations.

Levels of the toxin deoxynivalenol (DON) were very different at each location (Figure 3), which indicates different levels of infection of the *Fusarium spp.* fungus. It is likely the weather was cool and wet in Alburgh during flowering, which provided the right conditions for infection and development of the toxin, which averaged 5.4 ppm (Table 5). DON levels in Westfield averages 0.8 ppm (Table 6). Wheat with DON levels below 1ppm is suitable for human consumption.



**Figure 2. Yield and protein of heirloom spring wheat varieties, Westfield, VT, 2013. Varieties with the same letter are not significantly different from one another.**





**Figure 3. Levels of the toxin, deoxynivalenol (DON) in heirloom spring wheat grown in Westfield and Alburgh, VT. Varieties with the same letter are not statistically different at the  $p>0.10$  level.**

## ACKNOWLEDGEMENTS

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