2014

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

**2014 ORGANIC WINTER WHEAT VARIETY TRIAL**

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In 2014, the University of Vermont Extension conducted an extensive organic variety trial to evaluate hard red winter wheat in order to determine which varieties thrive in the Northeast. The trial was established at the Borderview Research Farm in Alburgh, Vermont.

## MATERIALS AND METHODS

The experimental plot design at both locations was a randomized complete block with four replications. The sixteen winter wheat varieties evaluated are listed in Table 1.

**Table 1. 2014 Winter wheat varieties planted in Alburgh, VT**

| Winter Wheat Varieties | Type† | Origin and Year of Release‡ | Seed Source |
|---|---|---|---|
| App. White | HW | NC, 2009 | USDA-ARS, NC |
| Arapahoe | HR | NE, 1998 | Albert Lea Seed House, MN |
| Expedition | HR | SD, 2002 | Albert Lea Seed House, MN |
| Ideal | HR | SD, Pending | North Dakota State Univ. |
| Morley (AC) | HR | Canada | Bramhill Seeds, Canada |
| Neo 5425 | HR | NE, Experimental | University of Nebraska-Lincoln |
| Neo 6469 | HR | NE, Experimental | University of Nebraska-Lincoln |
| NEO6545(Freeman) | HR | NE, Experimental | University of Nebraska-Lincoln |
| Neo 6607 | HR | NE, Experimental | University of Nebraska-Lincoln |
| Neo 7409 | HR | NE, Experimental | University of Nebraska-Lincoln |
| NuEast | HR | NC, 2009 | USDA-ARS, NC |
| Overland | HR | NE, 2006 | Albert Lea Seed House, MN |
| Redeemer | HR | Canada | Bramhill Seeds, Canada |
| Robidoux | HR | NE, 2011 | USDA-ARS, NE |
| Sherman | SR | OR, 1928 | 2012 Saved seed, VT |
| Warthog | HR | Canada | Seedway, VT |

† HR = hard red, HW = hard white, SW = soft white.
‡ Year of release was not always available.

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 2). The previous crop planted at the Alburgh site was spring wheat, oats and barley. The field was fall plowed, disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains Cone Seeder on 26-Sep 2013.

Flowering dates of the wheat were recorded when at least 75% of the spikes were in bloom. Throughout the growing season other pertinent observations on wheat development were recorded.

Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 22-Jul, and the harvest area was 5' x 20'. At the time of harvest, 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. 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.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The Least Significant Difference (LSD) procedure was used to separate cultivar means when the F-test was significant ($P< 0.10$). There were significant differences among the two locations for most parameters, and therefore data from each location is reported independently.

**Table 2. General plot management of the 2014 winter wheat trial.**

| Trial Information | Winter wheat variety trial |
|---|---|
| **Location** | Alburgh, VT<br>Borderview Research Farm |
| **Soil type** | Benson rocky silt loam |
| **Previous crop** | Spring wheat, oats, and barley |
| **Row spacing (in)** | 6 |
| **Seeding rate (lbs ac$^{-1}$)** | 125 |
| **Replicates** | 4 |
| **Planting date** | 26-Sep 2013 |
| **Harvest date** | 22-Jul 2014 |
| **Harvest area (ft)** | 5 x 20 |
| **Tillage operations** | Fall plow, disk & spike tooth 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 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** |

# RESULTS

Seasonal precipitation and temperature recorded at weather stations in close proximity to the 2013 and 2014 sites are shown in Table 3. The growing season this year was marked by lower than normal temperatures in September, April, and July, and higher than normal rainfall throughout the growing season (Apr-Jul). In Alburgh, there was an accumulation of 4756 Growing Degree Days (GDD), which is 284 GDDs below the 30 year average.

**Table 3. Temperature and precipitation summary for Alburgh, VT, 2013 and 2014.**

| **Alburgh, VT** | Sep-13 | Oct-13 | Apr-14 | May-14 | Jun-14 | Jul-14 |
|---|---|---|---|---|---|---|
| Average temperature (°F) | 59.3 | 51.1 | 43.0 | 57.4 | 66.9 | 69.7 |
| Departure from normal | -1.30 | 2.90 | -1.80 | 1.00 | 1.10 | -0.90 |
| | | | | | | |
| Precipitation (inches) | 2.20 | 2.39 ◊ | 4.34 | 4.90 | 6.09 | 5.15 |
| Departure from normal | -1.44 | -1.21 | 1.52 | 1.45 | 2.40 | 1.00 |
| | | | | | | |
| Growing Degree Days (base 32°F) | 825 | 600 | 330 | 789 | 1041 | 1171 |
| Departure from normal | -33.4 | 98.2 | -53.9 | 32.8 | 27.3 | -26.9 |

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.
◊ October 2013 precipitation data based on National Weather Service data from cooperative stations in Burlington, VT (http://www.nrcc.cornell.edu/page_nowdata.html).

**Winter Wheat Growth and Development:**

During the 2014 growing season, several observations and measurements were recorded on wheat development. Foliar diseases such as Powdery Mildew (*Erysiphe graminis f. sp. Tritici*) and Ascochyta Leaf Spot (*Didymella exitialis*) were observed throughout the trial. Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. A diseased plant typically exhibits reduced vigor, growth and seed fill. The earlier occurrence, the greater degree of host susceptibility, and the longer duration of conditions favorable for disease development will increase yield loss. Although foliar diseases were noted, the overall severity was minimal.

The flowering date was recorded when approximately 75% of the plot was in bloom for each of the varieties (Table 4). At this trial location most varieties were in full bloom by 14-Jun (Image 1). In general, bird damage and weed pressure were slight.

**Table 4. Flowering date of 16 winter wheat varieties, Alburgh, VT.**

| Variety | Flowering Date |
|---|---|
| App. White | 12-Jun |
| Arapahoe | 14-Jun |
| Expedition | 9-Jun |
| Ideal | 14-Jun |
| Morley (AC) | 14-Jun |
| Neo 5425 | 9-Jun |
| Neo 6469 | 9-Jun |
| NEO6545(Freeman) | 9-Jun |
| Neo 6607 | 12-Jun |
| Neo 7409 | 9-Jun |
| NuEast | 16-Jun |
| Overland | 14-Jun |
| Redeemer | 14-Jun |
| Robidoux | 14-Jun |
| Sherman | 14-Jun |
| Warthog | 14-Jun |

**Image 1. 2014 Flowering winter wheat, Alburgh, VT**

Loose smut caused by the fungus, *Ustilago tritici*, was observed in several of the trial plots. The loose smut fungus is carried as dormant mycelium within healthy-looking seed and is spread by planting infected seed. A smut-infected seed or plant cannot be distinguished from an uninfected one until the head starts to emerge. The disease is most obvious just after the time of heading by the characteristic dusty black appearance of diseased heads. The spores are dispersed by the wind during wheat flowering and can infect healthy plants.

**Winter Wheat Yield and Quality:**

The yields among varieties were not significantly different (Table 5 & Figure 1). The highest yielding variety was Warthog (4003 lbs $ac^{-1}$) and lowest yielding variety was Sherman (2452 lbs $ac^{-1}$). The trial mean yield in Alburgh (3334 lbs $ac^{-1}$) was 500 lbs higher than the mean yield in 2013.

Grain moisture and test weights were significantly different. The variety with the lowest moisture at the time of harvest was Expedition (13.8%). Only three other varieties, Neo 6607, Neo 7409, and Robidoux, had moistures below 14% at the time of harvest, which is necessary for optimal grain storability. 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. NuEast had the highest test weight of 61.9 lbs $bu^{-1}$. All of the 16 winter wheat varieties trialed attained the optimal 56 to 60 lb $bu^{-1}$ test weight for wheat.

**Table 5. Harvest results of 16 winter wheat varieties, Alburgh, VT.**

| Variety | Yield @ 13.5% moisture | Harvest moisture | Test weight |
|---|---|---|---|
| | lbs $ac^{-1}$ | % | lbs $bu^{-1}$ |
| Morley (AC) | 3438 | 16.7 | 59.5 |
| App. White | 3375 | 14.8 | 60.3 |
| Arapahoe | 3112 | 14.5* | 59.3 |
| Expedition | 3507 | **13.8*** | 61.0* |
| Ideal | 3375 | 15.8 | 59.4 |
| Neo 5425 | 3362 | 14.2* | 60.9* |
| Neo 6469 | 3363 | 14.8* | 61.8* |
| Neo 6545(Freeman) | 3561 | 14.4* | 60.0 |
| Neo 6607 | 3196 | 13.9* | 59.8 |
| Neo 7409 | 3196 | 13.9* | 59.0 |
| NuEast | 3620 | 15.0 | **61.9*** |
| Overland | 3764 | 15.4 | 60.5 |
| Redeemer | 3136 | 14.4* | 61.1* |
| Robidoux | 2881 | 13.9* | 60.8 |
| Sherman | 2452 | 17.6 | 56.6 |
| Warthog | **4003** | 15.6 | 61.5* |
| *LSD (0.10)* | NS | 0.94 | 1.12 |
| *Trial Mean* | 3334 | 14.9 | 60.2 |

Values shown in **bold** are of the highest value or top performing.

* Wheat that did not perform significantly lower than the top performing variety in a particular column is indicated with an asterisk.

NS - None of the varieties were significantly different from one another.

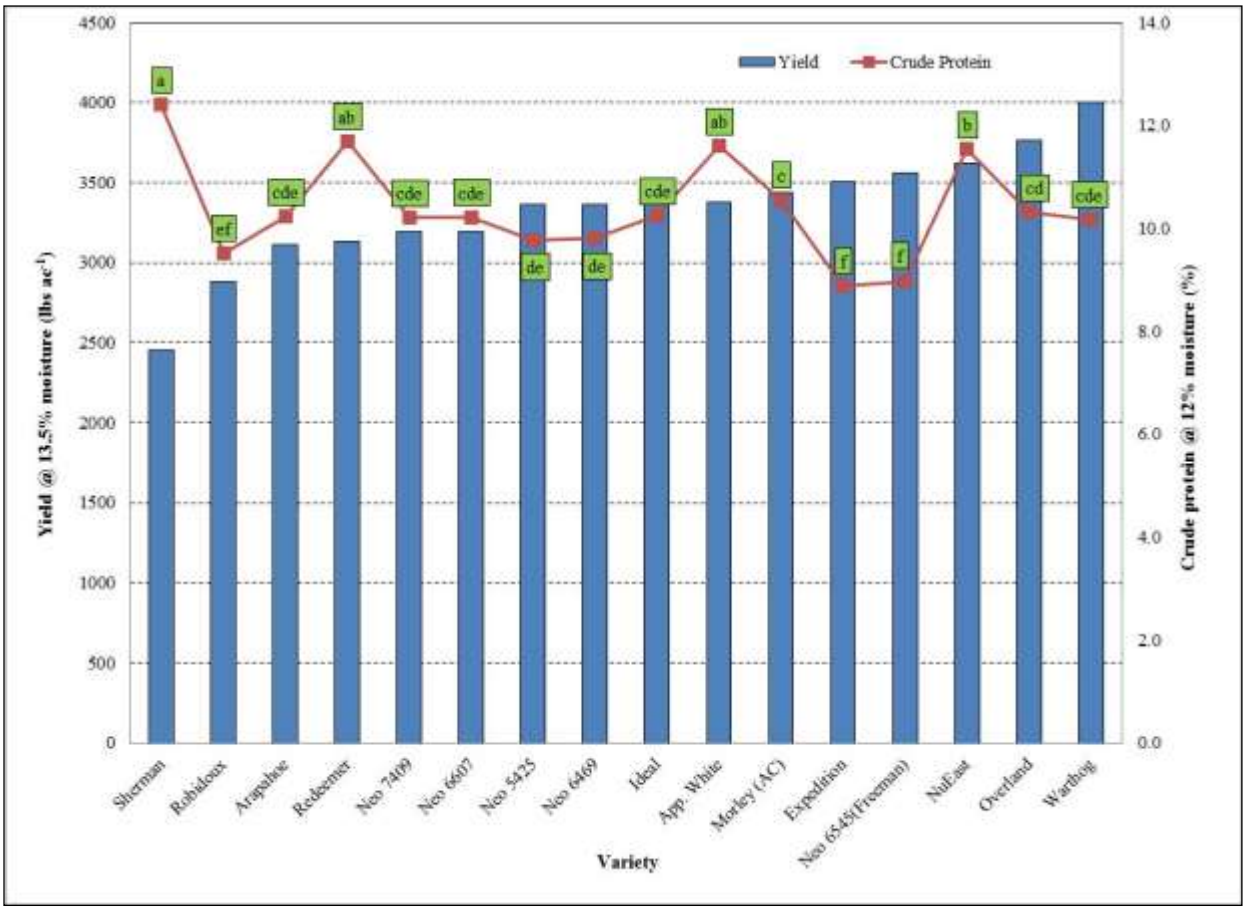


**Figure 1. Yield and protein concentration of 16 winter wheat varieties, Alburgh, VT.**
Varieties with the same letter did not differ significantly in yield or protein.

The common measures used by commercial mills to evaluate wheat quality are grain protein, falling number, test weight, and mycotoxin (DON) content (Table 6). Quality differed significantly among the varieties. The variety with the highest protein content was Sherman. Other high protein varieties were Redeemer (11.7%) and Appalachian White (11.6%). Sherman however was the only variety that met the 12-15% protein level required by most commerical bakers. Expedition had the lowest protein level (8.9%). All varieties had falling numbers above 300 seconds. The variety with the highest falling number was Warthog (408 seconds). Additional varieties with high falling numbers include: NuEast, Overland, Redeemer, Robidoux.

**Table 6. Quality of 16 winter wheat varieties, Alburgh, VT.**

| Variety | Crude protein @ 12% moisture | Crude protein @ 14% moisture | Falling number @ 14% moisture | DON |
|---|---|---|---|---|
| | % | % | seconds | ppm |
| Morley (AC) | 10.6 | 10.3 | 322 | **0.63*** |
| App. White | 11.6* | 11.4* | 328 | 2.90 |
| Arapahoe | 10.2 | 10.0 | 354 | 0.70* |
| Expedition | 8.9 | 8.7 | 365 | 1.67 |
| Ideal | 10.2 | 10.0 | 341 | 2.17 |
| Neo 5425 | 9.8 | 9.5 | 319 | 2.33 |
| Neo 6469 | 9.8 | 9.6 | 350 | 1.27* |
| Neo 6545(Freeman) | 9.0 | 8.8 | 356 | 1.00* |
| Neo 6607 | 10.2 | 10.0 | 333 | 1.03* |
| Neo 7409 | 10.2 | 10.0 | 331 | 0.80* |
| NuEast | 11.5 | 11.3 | 390* | 2.03 |
| Overland | 10.3 | 10.1 | 397* | 2.23 |
| Redeemer | 11.7* | 11.5* | 387* | 1.43 |
| Robidoux | 9.5 | 9.3 | 382* | 1.90 |
| Sherman | **12.4*** | **12.1*** | 335 | 1.10* |
| Warthog | 10.2 | 9.9 | **408*** | 1.03* |
| *LSD (0.10)* | 0.78 | 0.77 | 39.0 | 0.69 |
| *Trial Mean* | 10.4 | 10.1 | 356 | 1.51 |

Values shown in **bold** are of the highest value or top performing.
* Wheat that did not perform significantly lower than the top performing variety in a particular column is indicated with an asterisk.

In the Northeast, *Fusarium* head blight (FHB) is predominantly caused by the species *Fusarium graminearum*. This disease is very destructive and causes yield loss, low test weights, low seed germination and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. The spores are usually transported by air currents and can infect plants at flowering through grain fill. Eating contaminated grain greater than 1ppm poses a health risk to both humans. The DON levels of the varieties were highly variable in 2014 (Figure 2). Twelve of the 16 varieties trialed were above the FDA's 1ppm limit.The lowest DON level was AC Morley (0.63ppm). Other varieties with low DON levels include; Arapahoe, Neo 7409, Neo 6545 (Freeman), Neo 6607, and Warthog. The variety with the highest DON level was Appalachian White (2.90 ppm).

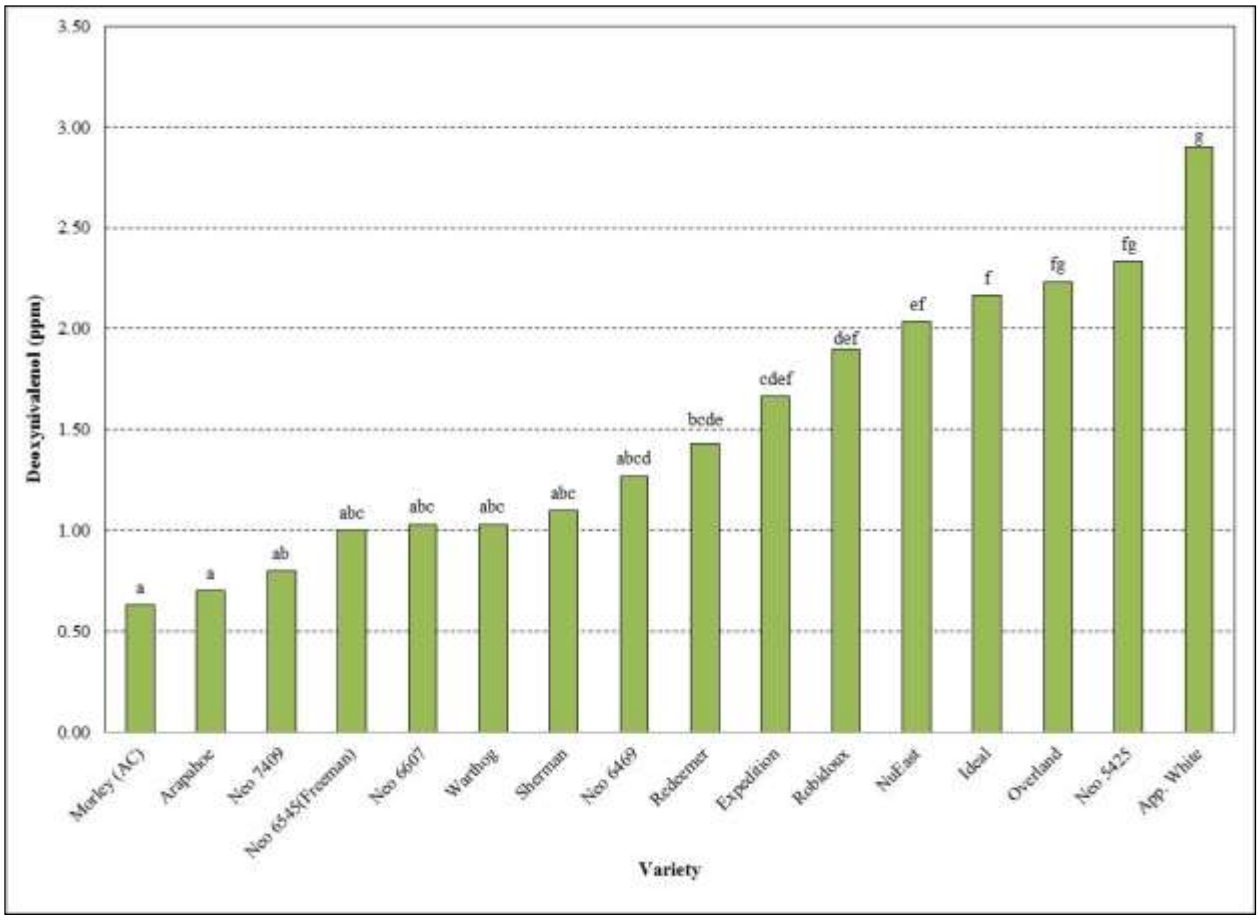


**Figure 2. Deoxynivalenol (DON) level of 16 winter wheat varieties, Alburgh, VT.**
Varieties with the same letter did not differ significantly in DON levels.

## DISCUSSION

It is important to remember that the results only represent one year of data. The 2014 growing season brought many challenges to the grain growing industry. The cold winter and limited snow cover caused some winter kill. In addition, the prolonged cool and wet spring further delayed wheat development, this might help explain the later flowering dates and higher grain moistures at harvest. The mean yield, although higher than 2013, was still approximately 1000 lbs $ac^{-1}$ below the 2012 average.

The below average temperatures, and above average rainfall, persisted throughout the growing season which resulted in delayed wheat development and dry down. Interestingly, DON levels were not nearly as high as they were in 2013. Four varieties out of the 16 trialed were at or below the 1ppm FDA recommended limit for DON concentration. The average DON level in 2014 was 1.51 ppm, 4.96 ppm below average DON level in 2013.

It is important, as you make variety choices on your farm, that you evaluate data from test sites that are as similar to your region as possible.

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