NORTHWEST CROPS & SOILS PROGRAM

2023 Spelt Variety Trial

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2023 SPELT VARIETY TRIAL

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Spelt (*Triticum spelta*) is an ancient grain that is closely related to common wheat (*Triticum aestivum).* It was one of the earliest domesticated grains. It has become popular as a health food in Europe, where it is also known as dinkel in Germany and Austria or farro in Italy. It is used as a whole grain in many cooked dishes and spelt flour can be substituted for wheat flour in baking. Spelt has a distinctive nutty flavor and is higher in fiber than wheat. Spelt also has a more digestible form of gluten than wheat, giving it potential as a flour for gluten-sensitive individuals. Its popularity in Europe and potential dietary benefits are leading to increased interest in using and producing spelt in the U.S. Because it is a hulled grain, spelt must be dehulled prior to human consumption, which is an additional processing step requiring specialized equipment. In 2023, the University of Vermont Extension Northwest Crops and Soils Program evaluated eleven varieties of heirloom winter spelt, planted in September 2022, in hopes of identifying varieties well suited for the Northeast climate. The trial was established at Borderview Research Farm in Alburgh, Vermont.

MATERIALS AND METHODS

The experimental plot design was a randomized complete block with four replications (Table 2). Treatments were eleven spelt varieties, which are listed in Table 1 with seed sources.

Table 1. Eleven spelt varieties trialed in Alburgh, VT, 2023.

Spelt variety	Seed source
Altgold	USDA Small Grains Collection
Comet	French's Hybrids, Inc
Elwha River	LINC Malt
Guggisberg	USDA Small Grains Collection
Maverick	French's Hybrids, Inc.
Muri Rotkorn	USDA Small Grains Collection
Oberkulmer	King's AgriSeeds
Pfaelzer Dinkel	Gutenberg University in Mainz, Germany
Rothenburger Rotkorn	USDA Small Grains Collection
Sonic	French's Hybrids, Inc.
Sungold	French's Hybrids, Inc.

All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The field site was previously corn. The area was prepared for planting with a Pottinger TerraDisc. The plots were seeded with a Great Plains NT60 Cone seeder on 17-Sep 2022 at a seeding rate of 350 live seeds per m^2 in a plot size of 5' x 20'. The trial was scouted for arthropod pest damage and plant diseases on 6-Jun 2023. Five plants from each plot were evaluated. The top two leaves were examined and evaluated for the presence of disease and arthropod damage. The Clive James, 'An Illustrated Series of Assessment Keys for Plant Diseases, Their Preparation and Usage' was used to identify and determine the severity of plant

disease symptoms. Data was recorded as a percent of the leaf surface that was affected by each foliar symptom.

Table 2. General plot management of the winter spelt variety trial, 2023.

Location:	Borderview Research Farm Alburgh VT
Soil type	Benson rocky silt loam
Previous crop	Corn
Row spacing (in)	6
Seeding rate (live seeds per m^2**)**	350 live seeds per m^2
Replicates	4
Planting date	17-Sep 2022
Harvest date	31-Jul 2023
Harvest area (ft)	5 x 20
Tillage operations	Pottinger TerraDisc

Grain plots were harvested with an Almaco SPC50 plot combine on 31-Jul 2023. The harvest area was 5' x 20'. On 26-Jul 2023, five days prior to harvest, plant heights and lodging were recorded. The height of three plants per plot were measured in centimeters excluding the awns. Lodging was visually estimated as the percentage of each plot that was too lodged to be harvested. Grain yield and moisture were determined at harvest. The spelt grain was dehulled with a Trumpet Abrasion Dehuller. Following dehulling, test weight was taken on the dehulled spelt grain. Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, Vermont). Samples were ground using the Perten LM3100 Laboratory Mill. Flour was analyzed for protein content using the Perten Inframatic 8600 Flour Analyzer. Falling number was measured (AACC Method 56-81B, AACC Intl., 2000) on the Perten FN 1500 Falling Number Machine. Deoxynivalenol (DON), a vomitoxin, was analyzed using Veratox DON 2/3 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.

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. Data were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. 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. In this example, 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

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

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.

RESULTS

Seasonal precipitation and temperature recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The average fall temperature (Sep 2022 to Nov 2022) was 51.8° F, which was 2.23°F warmer than the 30-year normal. The average temperature from Mar 2023 to Jul 2023 was 1.30° F cooler than the 30-year normal. This growing season was wetter than past years with a total precipitation of 24.1 inches from Mar 2023 to Jul 2023. The catastrophic flash flooding that occurred mid-month in Jul 2023 resulted in 10.75 inches of precipitation, a departure of 6.69 inches more than the 30-year average. From Sep 2022 to Jul 2023, there were 5260 Growing Degree Days (GDDs), which is less than the mean historical GDD trends over the last 30 years.

Table 3. Weather data for spelt variety trial in Alburgh, VT.

Alburgh, VT	Sep-22	Oct-22	Nov-22	Mar-23	Apr-23	May-23	Jun-23	Jul-23
Average temperature (°F)	60.2	51.3	41.5	32.2	48.3	57.1	65.7	72.2
Departure from normal	-2.52	0.96	2.24	-0.07	2.7	-1.28	-1.76	-0.24
Precipitation (inches)	4.4	2.56	3.01	2.00	4.94	1.98	4.4	10.75
Departure from normal	0.73	-1.27	0.31	-0.24	1.87	-1.78	0.14	6.69
Growing Degree Days (base 32°F)	861	607	346	103	280	766	1023	1274
Departure from normal	-61	39	111	-35	-132	-53	-40	22

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1991-2020) for Burlington, VT.

During the 2023 growing season, several observations and measurements were recorded before and during harvest of the eleven spelt varieties. Pre-harvest data (heights, lodging, and disease/arthropod scouting) are shown in Table 4. The tallest variety was Sonic at 131 cm; varieties Muri Rutkorn, Oberkulmer, Rothernburger Rutkorn, and Sungold were statistically similar to this height. Comet had the lowest lodging at 0%, which was statistically similar to Elwha River, Muri Rutkorn, and Pfaelzer Dinkel. Maverick had the highest degree of lodging at 90%, the next greatest degree of lodging was the variety Sonic at 66.3% lodged. The most prevalent disease found in the trial was mosaic virus, with all varieties being affected by this virus. Every variety also had some arthropod damage, with Maverick having the highest severity of arthropod damage and Guggisburg the least. Varieties Altgold, Elwha River, Rothernburger Rutkorn, Comet, Sungold, Sonic, and Oberkulmer had statistically similar arthropod damage as Guggisburg. Similarly, Guggisburg also had the least damage to foliar and Maverick the greatest, which included assessment of foliar disease, arthropod damage, and physical damage.

Table 4. Pre-Harvest results of the eleven spelt varieties, Alburgh, VT, 2023.

Variety	Height	Lodging	Disease severity	Arthropod Damage	Total Foliar Damage
	cm	%	% foliar surface affected	% foliar surface affected	% foliar surface affected
Altgold	117	43.8	2.31*	2.13*	2.41*
Comet	106	**0.00**	2.97	2.93*	2.92
Elwha River	108	1.25*	3.25	2.20*	3.15
Guggisberg	119	50.0	1.60*	**1.67**	**1.63**
Maverick	118	90.0	5.19	5.87	4.81
Muri Rutkorn	126*†	7.50*	2.31*	4.73	3.11
Oberkulmer	122*	33.8	1.59*	3.27*	1.78*
Pfaelzer Dinkel	109	22.5*	3.13	4.27	3.63
Rothenburger Rutkorn	120*	33.8	1.88*	2.67*	2.11*
Sonic	**131**	66.3	4.31	3.13*	3.78
Sungold	120*	27.5	**1.57**	2.93*	1.73*
LSD (p= 0.10)	11.8	22.8	1.16	1.87	0.96
Trial Mean	118	34.7	2.74	3.25	2.82

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

Harvest data is displayed in Table 5. The variety that had the highest yield was Sungold at 3900 lbs ac^{-1}, with both Pfaelzer Dinkel and Elwha River being statistically similar. These were also the highest yielding varieties in 2022. The lowest yielding variety was Rothenburger Rutkorn at 1558 lbs ac^{-1}, with Guggisburg, Maverick, and Sonic being statistically similar (1738 lbs ac^{-1}, 1864 lbs ac^{-1}, and 2151 lbs ac^{-1}, respectively).

Table 5. Harvest results of the eleven spelt varieties, Alburgh, VT, 2023.

Variety	Yield @ harvest moisture	Grain moisture	Test weight
	lbs ac^{-1}	%	lbs bu^{-1}
Altgold	2288	15.8*	42.5
Comet	2852	15.3*	**57.1**
Elwha River	3338*†	16.2	53.0*
Guggisberg	1738	17.7	48.3
Maverick	1864	15.7*	52.3*
Muri Rotkorn	3135	15.1*	49.3
Oberkulmer	3148	15.4*	45.5
Pfaelzer Dinkel	3591*	**13.8**	52.8*
Rothenburger Rotkorn	1558	16.0*	48.3
Sonic	2151	**13.8**	44.8
Sungold	**3900**	16.3	52.5*
LSD (p= 0.10)	635	2.38	4.91
Trial Mean	2687	15.5	49.7

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

Harvest moisture below 14% is desirable for grain storage. Grain above this moisture content has to be dried down after harvest, adding time and cost to farmers. Two varieties had a grain moisture at harvest lower than 14%, Sonic and Pfaelzer Dinkel had the lowest harvest moisture at 13.8%. Guggisburg had the highest moisture content at harvest of 17.7%, however this value was statistically similar to seven other varieties. The varieties differed in maturity so it makes sense moisture contents of varieties might differ. The industry standard for hulled spelt test weight is 40 lbs bu^{-1}. All varieties were above the industry standard for hulled spelt. Comet had the highest test weight of 57.1 lbs bu^{-1}, followed by Elwha River (53.0 lbs bu^{-1}), Pfaelzer Dinkel (52.8 lbs bu^{-1}), Sungold (52.5 lbs bu^{-1}), and Maverick (52.3 lbs bu^{-1}), which were all statistically similar.

Grain quality was analyzed for protein, falling number, and DON (Table 6). The industry standard for crude protein content for spelt is between 12 and 15%. The variety with the highest crude protein was Rothenburger Rutkorn at 15.8% and was statistically similar to Guggisburg (15.1%), Sonic (14.3%), and Altgold (13.9%). Elwha River was the only variety tested that did not meet the industry standard for percent crude protein at 10.9%.

Table 6: Grain quality results of the eleven spelt varieties, Alburgh, VT, 2023.

Variety	**Crude protein at 12% moisture**	**Falling number**	**DON**
	%	seconds	ppm
Altgold	13.9*†	235*	2.70*
Comet	12.2	**288***	**0.13**
Elwha River	10.9	240*	1.33*
Guggisberg	15.1*	256*	1.83*
Maverick	12.7	104	4.03
Muri Rotkorn	12.7	223*	0.50*
Oberkulmer	12.0	252*	2.27*
Pfaelzer Dinkel	13.2	256*	1.83*
Rothenburger Rotkorn	**15.8**	233*	0.73*
Sonic	14.3*	176	7.80
Sungold	12.2	269*	2.53*
LSD (0.10)	2.11	66.6	3.46
Trial Mean	13.2	230	2.34

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

The falling number measures viscosity, which is an indicator of enzymatic activity in the grain. Falling numbers are best understood for wheat, in which case values between 250-350 indicate low enzymatic activity and sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat, typically as a result of pre-harvest sprouting damage in the grain. This is most common if there are rain events as the grain is ripening prior to harvest. All but Maverick and Sonic had falling numbers above 200 (104 seconds, and 176 seconds, respectively). Comet had the highest falling number of 288 seconds. Interestingly, Comet was also the variety with the highest falling number in 2022. All other varieties were statistically similar to Comet, excluding Sonic and Maverick which showed falling numbers of 176 and 104 seconds respectively.

Three replicates per variety were tested for deoxynivalenol (DON) vomitoxin. Eight of the eleven varieties tested in this variety trial tested over the 1 ppm DON threshold that renders it to be unsuitable for human consumption. Those suitable for human consumption included Comet, Muri Rotkorn and Rothenburger Rotkorn. While not falling within the range for human consumption, Elwha River, Pfaeltzer Dinkel, Guggisburg, Oberkulmer, Sungold, and Altgold were all statistically similar to those varieties with less than 1ppm DON. The variety with the highest amounts of DON present was Sonic at 7.8 ppm, which was significantly more than any of the other varieties tested. This shows that there may be some varietal resistance to fusarium infection and subsequent DON production.

DISCUSSION

In July of 2023, Vermont experienced significant precipitation causing considerable flooding which affected the yield and quality of crops statewide, including the research field trials at Borderview Research Farm in Alburgh, VT. This season was considerably wetter than the 30-year average and had fewer growing degree days. In both 2022 and 2023, Sungold was the top yielding spelt variety. In 2023, Sungold yielded 3900 lbs ac^{-1}, which was approximately 2000 lbs ac^{-1} less than what was produced in the 2022 growing season. As a whole, the spelt trial averaged 2223 lbs ac^{-1} yields less than the 2022 growing season, with yields and quality impacted by growing conditions. Similarly, weather conditions contributed to a growing environment conducive to *Fusarium graminearium,* a fungus that infects cereal grains and produces the mycotoxin deoxynivalenol (DON) vomitoxin. This was reflected in the data with abnormally high levels of DON present in the 2023 spelt varieties, wherein only three of the eleven varieties contained low enough levels of DON to be considered safe for human consumption.

It is important to remember that the results only represent one year of data and that more research is needed to know which varieties will thrive in the Northeastern climate and fluctuating weather. More information is needed to better understand quality standards for spelt, including test weight, protein and falling number in order to evaluate for potential end-use performance. When viewing the data, consider that the quality measurements for spelt are recorded using hulled grain. Spelt that has not been dehulled will be significantly different than the hulled grain results. Spelt may have potential as a specialty grain crop for farmers in the Northeast. Because additional processing is required (dehulling) before it is suitable for human consumption, and existing markets may still be limited, it is important to communicate with potential buyers prior to planting spelt.

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