NORTHWEST CROPS & SOILS PROGRAM

2022 Triticale Variety Trial

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2022 TRITICALE VARIETY TRIAL

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Triticale is a hybrid grain from crossing rye and wheat. Triticale was developed to combine favorable characteristics of both rye and wheat. Triticale has the growth vigor, cold tolerance and high protein from rye, and baking characteristics of wheat. There are both spring and winter types available with most triticale being produced in Poland and Germany. Triticale is primarily grown as a feed grain because it is rich in vitamins, minerals, and has higher protein levels than wheat or barley. Triticale is also considered to have broad adaptability compared to wheat. Triticale is gaining popularity for human consumption, and is found in health foods including cereals, breads, crackers, flours, and as whole triticale berries. With the revival of the small grains industry in the Northeast and the strength of the locavore movement, there is an increasing interest from craft breweries, distilleries, maltsters, and bakers for locally grown grains. In 2021-2022, University of Vermont Extension Northwest Crops and Soils (NWCS) Program conducted a variety trial to evaluate yield and quality of fall planted cereal triticale.

MATERIALS AND METHODS

The triticale variety trial was initiated at Borderview Research Farm in Alburgh, VT in the fall of 2021. Plots were managed with practices like those used by producers in the surrounding area. Agronomic information is displayed in Table 1. The experimental design was a randomized complete block with four replicates. The seedbed was prepared with a Pottinger TerraDisc® prior to planting. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 29-Sep 2021 at a seeding rate of 350 live seeds m^{-2}. Treatments were nine varieties of cereal triticale, including Fredro, NE426GT, NT09423, NT12404-1, NT13416, Short Beard Thunder, Tulus, UCT3131, and UCTUKR04 (Table 2). All varieties survived the winter.

Table 1. Agronomic and trial information for the triticale cover crop variety trial, 2021-2022.

	Borderview Research Farm, Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Summer annual grasses
Tillage operations	Pottinger TerraDisc®
Harvest area (ft.)	5 x 20
Seeding rate (live seeds m^{-2})	350
Replicates	4
Planting date	29-Sep 21
Harvest date	3-Aug 22

Table 2. Winter triticale varietal information, Alburgh, VT, 2021-2022.

Variety	**Source**
Fredro	Danko Hodowla Roslin
NE426GT	University of Nebraska & Iowa
NT09423	USDA-University of Nebraska
NT12404-1	USDA-University of Nebraska

NT13416	USDA-University of Nebraska
Short Beard Thunder	USDA-University of Nebraska
Tulus	Albert Lea Seed
UCT3131	California Grain Foundation
UCTUKR04	California Grain Foundation

On 1-Aug 2022, two days prior to harvest, three plant heights per plot were measured for each plot, excluding awns. Lodging was assessed visually as percent lodged, with 0% indicating no lodging and 100% indicating the entire plot was lodged. Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 3-Aug 2022. Seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN) and a one-pound subsample was collected to analyze quality characteristics (Table 4). Grain quality was determined at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT). Grains were analyzed for crude protein and starch content using the Perten Inframatic 9500 NIR Grain Analyzer (Perkin Elmer, Waltham, MA). The samples were then ground into flour using the Perten LM3100 Laboratory Mill (Perkin Elmer). Falling number for all triticale varieties were determined using the AACC Method 56-81B, AACC Intl., 2000 on a Perten FN 1500 Falling Number Machine Mill (Perkin Elmer). The falling number indirectly measures enzymatic activity in the grain, which is typically used as an indicator of pre-harvest sprouting. 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. Deoxynivalenol (DON) analysis was done using Veratox DON 2/3 Quantitative test from the NEOGEN Corp (Lansing, MI). 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. Samples from one replicate were evaluated for DON and all samples tested below the FDA threshold for human consumption (1 ppm) (data not shown).

Standard characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within the trial were treated as random effects, and treatments were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Treatment	**Yield**
A	**2100***
B	1900*
C	1700
LSD	300

Variations in project results 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. At the bottom of each table, a LSD value is presented for each variable (e.g. 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 values. Treatments that were not significantly lower in performance than the highest value in a particular column are indicated with an asterisk. In the previous example, treatment A is significantly different from treatment C but not from treatment B. The difference between A and B is equal to 200, which is less than the LSD value of 300. This means that these treatments did not differ in yield. The difference between A and C is equal to 400, which is greater than the LSD value of 300. This means that the yields of these treatments were significantly different from one another.

RESULTS

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station (Hayward, CA) at Borderview Research Farm in Alburgh, VT and are displayed in Table 3. The winter temperatures were slightly warmer than average, leading to strong winter survival. This growing season was wetter than past years with a total precipitation of 22.6 inches, which is over twice the precipitation during the 2021 growing season (total precipitation of 10.2 inches). The average temperature of the primary growing season (April to July) was 1.44° F below normal. From September 2021 to July 2022, there were 5546 Growing Degree Days (GDD), which is consistent with historical means GDD trends over the last 30 years.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2021 and 2022 growing season.

	2021			2022				
	Sep	**Oct**	**Nov**	**Mar**	**Apr**	**May**	**Jun**	**Jul**
Average temperature (°F)	63.1	54.6	37.6	32.3	44.8	60.5	65.3	71.9
Departure from normal	0.4	4.31	-1.68	-0.03	-0.81	2.09	-2.18	-0.54
Precipitation (inches)	4.49	6.23	2.26	2.52	5.57	3.36	8.19	3
Departure from normal	0.82	2.4	-0.44	0.28	2.5	-0.4	3.93	-1.06
Growing Degree Days (32°-95°F)	933	701	232	170	391	883	1000	1236
Departure from normal	11	133	-3	32	-20	65	-64	-17

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2020) for Burlington, VT.

Table 4. Agronomic characteristics, yield, and quality data by triticale variety, Alburgh, VT, 2022.

Variety	**Height**	**Lodging**	**Moisture**	**Test weight**	**Yield @ 13.5% moisture**	**Crude protein @ 12% moisture**	**Starch**	**Falling number**	**DON**
	cm	**%**	**%**	**lbs bu^{-1}**	**lbs ac^{-1}**	**%**	**%**	**seconds**	**ppm**
Fredro	119	**0.00***	17.3	49.4*	5899*	12.2	62.1	83	1.20
NE426GT	115	3.75	15.2*	48.7*	5428	12.3	62.6*	116	0.80*
NT09423	108	5.00	17.2	**50.9***	6027*	11.9	**62.8***	**156***	0.30*
NT12404-1	115	2.50*	15.9*	50.8*	**6506***	12.0	62.1	93	**0.20***
NT13416	107	3.75	15.6*	46.5	4234	**15.2***	59.8	77	3.80
Short Beard Thunder	112	**0.00***	15.3*	44.4	5541	12.4	61.6	121	1.90
Tulus	119	**0.00***	**14.6***	48.4*	6500*	11.7	62.6*	70	1.30
UCT3131	118	1.25*	16.3	48.3	5899*	12.5	62.2	64	0.40*
UCTUKR04	118	2.50*	16.9	47.6	5387	11.9	62.0	92	2.20
LSD (p=0.10)‡	NS	3.44	1.16	2.60	815	0.67	0.36	16	0.77
Trial mean	115	2.08	16.0	48.3	5713	12.5	62.0	97	1.30

†Within a column, varieties with an asterik (*) were not statistically different from the top performer (in **bold**).

‡LSD; least significant difference at the p=0.10 level. NS – no significance.

All varieties grew to statistically similar heights at the time of harvest, with the mean height being approximately 115 cm (Table 4). There was very little lodging across all triticale varieties tested. Two days before harvest there was on average only 2.1% lodging, and a third of the varieties showed no lodging at all (Fredro, Short Beard Thunder, and Tulus).

This was the first year of winter triticale variety evaluation. Therefore, we cannot draw conclusions about relative successes of yields this year against prior season's data. However, on average, 2022 winter triticale resulted in higher yields than the 2022 winter wheat variety trial, but less than the 2022 winter rye variety trial adjusted at 13.5% moisture (triticale average yield 5713 lbs ac^{-1}, wheat 4599 lbs ac^{-1}, rye 6749 lbs ac^{-1}). NT12404-1 was the variety with the highest yield (6506 lbs ac^{-1}) and was statistically similar to varieties Fredro (5899 lbs ac^{-1}), NT09423 (6027 lbs ac^{-1}), Tulus (6500 lbs ac^{-1}), and UCT3131(5800 lbs ac^{-1}); NT13416 resulted in the lowest yields (4234 lbs ac^{-1}) (Table 4).

Harvest moisture below 14% is necessary for grain storage. Grain above this moisture content has to be dried down after harvest, adding time and cost to farmers. All triticale varieties had moistures exceeding 14%, on average 16% moisture at harvest, and required drying before storage (Table 4).

Test weight is the measure of grain density, which is determined by weighing a known volume of grain. The trial average test weight this year was 48.3 lbs bu^{-1} (Table 4). NT09423 had the highest test weight (50.9 lbs bu^{-1}) and was statistically similar to Fredro, NE426GT, NT12404-1, and Tulus; Short Beard Thunder had the lowest test weight at 44.4 lbs bu^{-1} (Table 4).

The average triticale crude protein in this trial was 12.5% (Table 4), which exceeded the trial average of percent crude protein in the 2022 winter wheat and rye variety trials (10% and 7.8%, respectively). This result was expected, as triticale is understood to have higher protein contents than other grain types. Wheat with 12-15% crude protein is generally considered ideal for baking bread. However, even though triticale typically meets or exceeds these preferred protein levels, compared to wheat flour, triticale has significantly less gluten, which yields very dense and undesirable bread made from 100% triticale flour. It therefore is often mixed with other flour types for baking. The majority of triticale produced is used in animal feed, as its relatively high protein content, nutrient composition, and digestibility are advantageous in swine, poultry, and forage feed.

Falling number is a laboratory test that measures the viscosity of flour. There are well established ranges for falling number as an indicator of baking and malting quality in wheat and barley, but the ideal range for triticale is not yet clearly documented. The ideal falling number range for wheat and barley is 250-350 seconds, however lower falling numbers around 150 seconds are acceptable and may be preferable to bakers using rye flours. The average triticale falling number in this study was 97 seconds, with the highest falling number at 156 seconds (NT09423) and the lowest at 64 seconds (UCT3131) (Table 4). Although there is little data available about idea falling numbers for triticale, this trial provides preliminary data in the efforts to establish these standard quality parameters for triticale flour.

Each of the nine triticale varieties were tested for deoxynivalenol (DON) vomitoxin, four of which exceeded the FDA threshold for DON levels considered safe for human consumption (1 ppm) (Table 4). NT13416 had the highest DON levels at 3.8 ppm, followed by Short Beard Thunder at 1.9 ppm, Tulus at

1.3 ppm, and Fredro at 1.2 ppm. Out of all of the winter grain variety trials conducted in 2022 by the University of Vermont Extension Northwest Crops and Soils (NWCS) Program at Borderview Farm (triticale, rye, wheat, spelt, and barley), triticale was the only grain that resulted in DON levels greater than 1 ppm. Contamination of wheat with DON is directly related to the incidence of Fusarium head blight and strongly associated with relative moisture and timing of rainfall at flowering. More data is necessary before drawing conclusions about the susceptibility of triticale to Fusarium and DON contamination.

DISCUSSION

Interestingly, despite the majority of Vermont experiencing drought conditions, the 2022 growing season at Borderview farm (Alburgh, VT) had over twice the precipitation than the growing season in 2021.This may in part explain the elevated DON levels observed. This study provides foundational data examining the relative successes, agronomic, yield, and quality characteristics of nine cereal triticale varieties grown in field conditions in in Alburgh, Vermont. More research is needed to assess the practicality and profitability of growing winter triticale in the Northeast.

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