NORTHWEST CROPS & SOILS PROGRAM

2019 Rye Harvest Date

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THE UNIVERSITY OF VERMONT EXTENSION

2019 RYE HARVEST DATE

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The interest in growing cereal rye for grain to be sold as cover crop seed, or to other value-added markets (distillers and bakers), has increased considerably across the Northeast region. As a result, farmers and end-users are requesting yield and quality information on cereal rye varieties. In 2019, University of Vermont Extension Northwest Crops and Soils (NWCS) Program conducted a harvest date trial to evaluate harvest date yield and quality of cereal rye. The overall goal of this project is to determine the impact of harvest timing on rye yield and quality. Wheat and barley require timely harvest to maintain quality, especially falling number, for baking and brewing. It is unclear if harvest timing impacts falling number in cereal rye. Subsequently, there is little knowledge if rye with high falling number is required for baking. The goal of this project was to evaluate the impact of harvest date on yields and quality parameters across two rye varieties.

MATERIALS AND METHODS

The field was plowed, disked, and prepared with a spike tooth harrow to prepare the seedbed for planting. The experimental design was a randomized complete block with split plots and 4 replicates. The main plots were harvest date and the split plots variety (Danko and Hazlet). The plots were planted with a Great Plains cone seeder on 6-Oct 2018; plots were 5' x 20' (Table 1). Prior to first harvest date, on 30-Jul 2019 and each subsequent harvest date, three plant heights per plot were measured.

Table 1: Agronomic and trial information for the rye cover crop variety trial, 2017-2018.

	Borderview Research Farm, Alburgh, VT
Soil Type	Benson rocky silt loam
Previous Crop	Winter Wheat
Tillage Operations	Fall plow, disc, and spike tooth harrow
Harvest Area (ft.)	5 x 20
Seeding Rate (live seeds m^{-2})	350
Replicates	4
Planting Date	6-Oct 2018
Harvest Dates	HD 1: 30-Jul 2019 HD 2: 5-Aug 2019 HD 3: 14-Aug 2019 HD 4: 19-Aug 2019

Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 30-Jul, 5-Aug, 14-Aug, and 19-Aug. Following harvest, seed was cleaned with a small Clipper M2B cleaner (A.T. Ferrell, Bluffton, IN). Grain moisture, test weight, and yield were calculated. 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. 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. 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. Deoxynivalenol (DON) analysis was done 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.

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 this example, 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.

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

RESULTS

Weather data was recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 2). During the time of this trial, temperatures were below average for every month except July. During the 2018-2019 season, most months saw below average precipitation with the exception of November ('18), December ('18), April ('19) and May ('19) which saw above average precipitation. There were 5199 growing degree days (GDDs) across the whole season, 20 growing degree days more than the historical average.

Table 2. Temperature and precipitation summary for Alburgh, VT, 2018 and 2019.

Alburgh, VT	2018			2019							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Average temperature (°F)	45.8	32.2	25.4	15.0	18.9	28.3	42.7	53.3	64.3	73.5	68.3
Departure from normal	-2.36	-5.99	-0.55	-3.77	-2.58	-2.79	-2.11	-3.11	-1.46	2.87	-0.51
Precipitation (inches)	3.53	4.50	2.96	1.53	1.70	1.36	3.65	4.90	3.06	2.34	3.50
Departure from normal	-0.07	1.38	0.59	-0.52	-0.06	-0.85	0.83	1.45	-0.63	-1.81	-0.41

Growing Degree Days (32-95°F)	435	136	72	23	38	108	346	660	970	1286	1125
Departure from normal	-67	-50	72	23	38	108	-38	-96	-44	88	-14

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. (http://www.nrcc.cornell.edu/page_nowdata.html).

Impact of Harvest Date

Yield, harvest moisture, and test weight were measured at cereal rye harvest (Table 3). From the four different harvest dates (HD), yields were highest at HD3 on 14-Aug at 3195 lbs ac^{-1} but yields were not significantly different from other harvest dates. Harvest moisture varied across the month long period with highest harvest moisture occurring during the last period on 19-Aug. Lowest harvest moisture was observed on the second harvest date on 5-Aug. Test weight was highest in HD2 at 56.6 lbs bu^{-1} with HD1 similarly high at 56.5 lbs bu^{-1}. Lowest test weight was observed at HD4 at 54.6 lbs bu^{-1}.

Table 3: Harvest measurements for winter rye harvest dates, Alburgh, VT, 2019.

Harvest Date	Yield @ 13.5% moisture lbs ac^{-1}	Harvest moisture %	Test weight lbs bu^{-1}
30-Jul	3138	15.2 ab	56.5 a
5-Aug	3065	14.3 b	**56.6 a**
14-Aug	**3195**	14.7 ab	55.0 b
19-Aug	3018	**15.7 a**	54.6 b
LSD (0.10)	NS	1.20	1.44
Trial mean	3105	15.0	55.7

*Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold**.
LSD – Least significant difference.
NS – No significant difference between treatments.

The four harvest dates were also analyzed for crude protein concentration at 12% moisture and falling number (Table 4). Crude protein ranged from 6.8% to 7.7% with the highest values observed during the first three harvest dates, which were all statistically similar. Harvest date 1 had the highest concentration of crude protein at 7.7% with decreasing values over the next three weeks. Falling number was highest at HD2 with a value of 282 seconds and was statistically similar to HD1 at 270 seconds. After the first two harvest dates, values decreased greatly for HD3 at 195 seconds and HD4 at 163 seconds. Overall, tested DON levels were low this year and all varieties had a DON level suitable for human consumption.

Table 4: Grain quality for the four cereal rye variety harvest dates, Alburgh, VT, 2019.

Variety	Crude protein @ 12% moisture %	Falling number seconds
30-Jul	**7.7 a**	270 a
5-Aug	7.5 a	**282 a**
14-Aug	7.5 a	195 b

19-Aug	6.8 b	163 c
LSD (0.10)	0.47	13.5
Trial mean	7.4	228

*Within a column treatments marked with the same letter were statistically similar (p=0.10). Top performers are in **bold**.
LSD – Least significant difference.

Impact of Variety

While yields did not differ as an impact of harvest date, there were varietal differences between varieties Danko and Hazlet with an average trial yield of 3347 lbs ac^{-1} and 2862 lbs ac^{-1} respectively (Table 5). There were also differences in falling number between the two varieties with Danko at 258 seconds and Hazlet at 196 seconds for the trial average. Overall, Danko had significantly higher yields as well as falling number, yet varieties were statistically similar in terms of crude protein, harvest moisture, and test weight.

Table 5. Harvest measurements and grain quality for winter rye varieties and harvest dates, Alburgh, VT 2019.

Variety	Harvest date	Yield @ 13.5% moisture	Harvest moisture	Test weight	Crude protein @ 12% moisture	Falling number
		lbs ac^{-1}	%	lbs bu^{-1}	%	seconds
Danko	30-Jul	3271	13.3	56.6	7.7	290
Danko	5-Aug	3476	14.4	56.2	7.6	294
Danko	14-Aug	3551	14.7	55.7	7.8	236
Danko	19-Aug	3090	16.1	54.7	6.8	214
Hazlet	30-Jul	3006	17.2	56.4	7.8	250
Hazlet	5-Aug	2656	14.1	57.1	7.3	270
Hazlet	14-Aug	2840	14.7	54.3	7.3	153
Hazlet	19-Aug	2947	15.2	54.6	6.8	112
Danko	Trial average	**3347 a**	14.6	55.8	7.5	**258 a**
Hazlet	Trial average	2862 b	15.3	55.6	7.3	196 b
LSD (0.10)		328.9	NS	NS	NS	9.5
Trial mean		3105	15.0	55.7	7.4	227

NS – No significant differences.

Harvest date x variety interactions

There were statistically significant harvest date x variety interactions for falling number and harvest moisture. These interactions indicate that the varieties responded differently to harvest date for these parameters. In terms of harvest moisture, lowest values for Danko were seen prior to the fourth harvest date (16.1%), whereas lowest values were seen after the first harvest date (17.2%) for Hazlet. With falling number, Hazlet appeared to have a more severe drop as a response to delayed harvest date when compared to Danko, as well as overall lower values (Figure 1). Hazlet from HD4 showed a falling number of 112 seconds compared to Danko on HD 4 at 214 seconds. These interactions between harvest date and variety also indicate that shifting harvest dates to drop falling number for Hazlet would be more effective than with Danko, and variety selection may be important while attempting to do so.

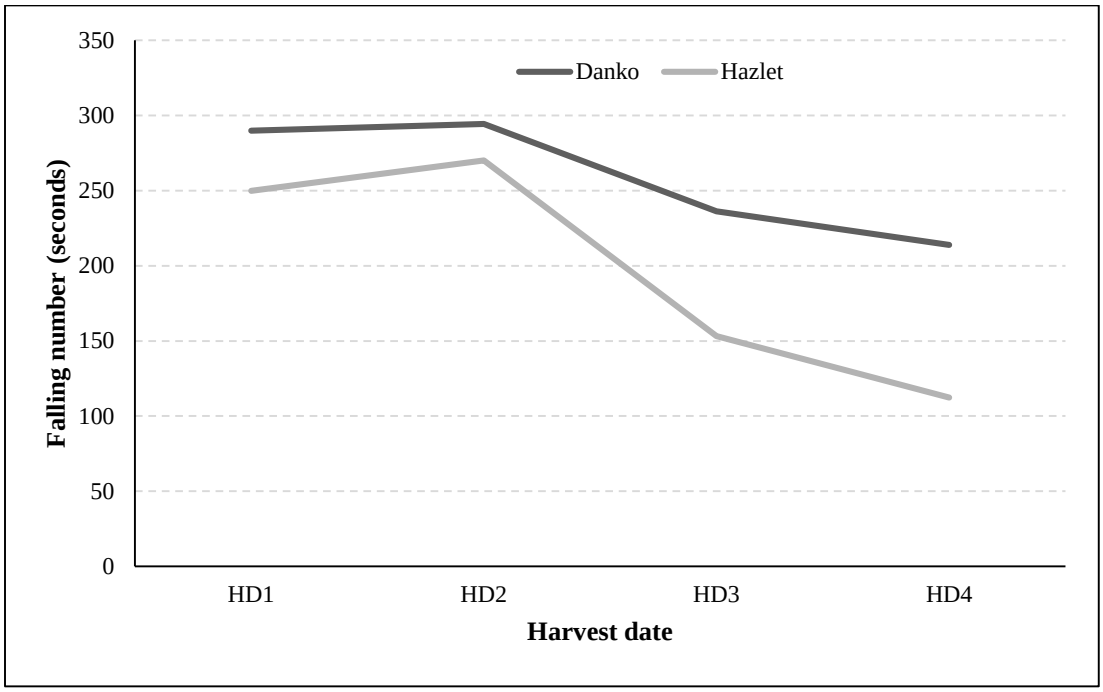

Figure 1. Interaction between harvest date and variety for falling number, 2019.

DISCUSSION

The weather during the 2018-2019 season was cooler and wetter than average, with 74 less growing degree days than the 30 year average. Looking back at the 2017-2018 season, it was warmer and drier than average and it resulted in high yields and quality for cereal rye varieties overall when compared to the 2018-2019 growing season for rye. During a harvest period with greater amounts of rainfall from week to week, there is greater potential for reduced quality crops. This can be an important consideration when attempting to determine ideal harvest windows as you may be forced to harvest at an earlier date to salvage a crop and maintain grain quality. A number of factors could have impacted trial average yields of cereal rye including the harsh winter and adverse growing conditions early in the growing season, but harvest date did not appear to have an influence on yields during this harvest period. While harvest date did not appear to impact yields, it did seem to have an effect on grain quality. Crude protein and falling number appeared to have a decreasing trend from the first harvest date until the last harvest date over the four week window. Falling numbers around or above 250 seconds are often deemed ideal for flours. However, lower falling numbers below this threshold have been acceptable to bakers while solely using rye flours. In this instance, waiting longer to harvest may result in grains that are preferable to bakers but end use should be considered, among other factors, when determining harvest date. This trial also indicates that for some parameters, such as harvest moisture and falling number, varietal selection can also be important and varieties may react differently to a delayed harvest.

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