2020 Rye Nitrogen Fertility Trial

Dr. Heather Darby, UVM Extension Agronomist
Henry Blair
UVM Extension Crops and Soils Technicians
(802) 524-6501

Visit us on the web at: http://www.uvm.edu/nwcrops

2020 RYE NITROGEN FERTILITY TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

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 in recent years. This winter-hardy grain has the ability to survive cold winters and can be more tolerant of marginal land not suitable for other crops. As a result, farmers and end-users are requesting yield and quality information on cereal rye varieties. In 2019/2020, University of Vermont Extension Northwest Crops and Soils (NWCS) Program conducted a nitrogen (N) fertility trial to evaluate yield and quality of cereal rye under variable nitrogen application scenarios.

MATERIALS AND METHODS

The experimental design of the study was a randomized complete block with treatment plots replicated five times (Table 1). Treatments were four nitrogen application timings: 90 lbs N ac^{-1} applied in the fall, 90 lbs N ac^{-1} applied in the spring, 45/45 lbs N ac^{-1} split application applied in fall and spring, and a control receiving no N application (Table 2). Nitrogen was applied in the form of calcium ammonium nitrate (21-0-0). The field was plowed, disked, and prepared with a spike tooth harrow to prepare the seedbed for planting. The plots were 5’ x 20’ and the rye variety, Hazlet was planted with a Great Plains cone seeder on 20-Sept 2019 at a rate of 100 lbs ac^{-1}.

Table 1: Agronomic and trial information for the rye cover crop variety trial, 2019-2020.

	Borderview Research Farm, Alburgh, VT
Soil Type	Benson rocky silt loam
Previous Crop	Sweet corn
Rye variety	Hazlet
Tillage Operations	Fall plow, disc, and spike tooth harrow
Harvest Area (ft.)	5 x 20
Seeding Rate (lbs ac^{-1})	100
Replicates	4
Fertilizer	Calcium ammonium nitrate (21-0-0)
Planting Date	20-Sept 2019
Harvest Date	23-Jul 2020

Table 2. 2018-2019 Winter rye nitrogen application dates.

Treatment	Application date
90 lbs N ac^{-1} Fall	11-Oct
90 lbs N ac^{-1} Spring	8-Apr
45/45 lbs N ac^{-1} Fall/Spring	11-Oct/8-Apr
Control	N/A

Grain plots were harvested at the Alburgh site with an Almaco SPC50 plot combine on 23-Jul. Ergot (*Claviceps purpurea*) is a fungal disease found most commonly in rye, and it can lead to yield reductions and health problems in humans and animals. To assess the amount of ergot present, two 1 ft^2 samples were collected per plot just prior to harvest, and the ergot incidence (percent of affected heads) was recorded. 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.

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 yields of these varieties were significantly different from one another. The letters 'a' and 'b' indicate which varieties are statistically similar to each other in terms of yield; variety B is similar to both varieties A and C, but variety A and C are not statistically similar to each other.

Variety	**Yield**
A	3161^{b}
B	3886^{ab}
C	**4615^{a}**
LSD	**889**

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 3). The winter temperatures were warmer than average, leading to strong winter survival. A cooler than average spring but warmer and drier summer led to 3,433 Growing Degree Days (GDDs) accumulated April to July, which was 55 GDDs above the 30-year average. Precipitation from April to July was 3.81 inches below normal. Overall, precipitation across the entire growing season from September to July, was 1.61 inches below average, with a total of 5317 GDDs from September through July, which was 30 less than average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2018 and 2019.

	2019				2020						
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Average temperature (°F)	60.0	50.4	31.2	26.0	23.5	21.8	35.0	41.6	56.1	66.9	74.8
Departure from normal	-0.51	2.32	-6.76	0.46	4.62	0.41	3.94	-3.19	-0.44	1.08	4.17
Precipitation (inches)	3.87	6.32	2.38	1.29	2.63	1.19	2.79	2.09	2.35	1.86	3.94
Departure from normal	0.21	2.76	-0.74	-1.06	0.63	-0.53	0.57	-0.72	-1.04	-1.77	-0.28
Growing Degree Days (32°-95°F)	840	571	128	67	37	48	193	315	746	1046	1326
Departure from normal	-15	58	-122	-13	-12	-8	27	-99	-13	35	132

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).

Table 4 displays field and harvest measurements. Highest yields occurred in the 90 lbs N ac^{-1} spring application with similarly high yields from the 90 lbs N ac^{-1} fall application, though the yield differences were not statistically significant across all four treatments. Test weights were highest for the control plots and lowest the 90 lbs N ac^{-1} spring application, but once again there was no significant difference between treatments within the trial. All plots reached the industry ideal test weight of 56 lbs $^{bu-}$1. Although there was no significant difference in plant height between treatments, there were significant differences in lodging. The plots with split 45 lbs N ac^{-1} fall/spring and 90 lbs N ac^{-1} spring applications lodged much more than the 90 lbs N ac^{-1} fall and control plots. Nitrogen can weaken plant stems which may make plants like rye, which tend to be taller than other grains, more susceptible to lodging. Plots with spring-applied N lodged much more significantly than plots with only fall-applied N or the control plots which received no N.

Table 4: Harvest measurements by treatment, Alburgh, VT, 2020.

Treatment	Height cm	Lodging %	Yield lbs ac^{-1}	Test weight lbs bu^{-1}
45/45 lbs N ac^{-1} Fall/Spring	134	60 ^{a†}	5288	56.5
90 lbs N ac^{-1} Fall	137	20 ^{b}	5314	56.4
90 lbs N ac^{-1} Spring	135	44 ^{a}	5465	56.3
Control	136	13 ^{b}	5256	56.3
LSD (p=0.10)ŧ	NS	22	NS	NS
Trial mean	136	34	5331	56.5

†Treatments marked with the same letter do not differ significantly. NS – no significant differences.
ŧLSD; least significant difference at p=0.10.

The four treatments were analyzed for crude protein concentration, adjusted for 12% moisture, and falling number (Table 5). There was a significant difference between treatments for crude protein, with plots receiving an N application in the spring having higher protein levels. Falling number also had significant differences between treatment with 45/45 lbs N ac^{-1} having the highest falling number and 90 lbs N ac^{-1} spring having the lowest. An ideal falling number falls for wheat is between 250 and 300 seconds, however, lower falling numbers around 150 seconds have been acceptable to bakers using rye flour. Falling number for all treatments appear to be within an acceptable range for baking. Overall, DON levels were low this year and all treatments had levels of DON less than the 1 ppm threshold for safe human consumption.

Table 5: Grain quality by treatment, Alburgh, VT, 2020.

Treatment	Crude protein @ 12% moisture %	Falling number seconds
45/45 lbs N ac^{-1} Fall/Spring	8.7 [a†]	191 [a]
90 lbs N ac^{-1} Fall	8.1 [b]	170 [ab]
90 lbs N ac^{-1} Spring	9.0 [a]	163 [b]
Control	8.2 [b]	178 [ab]
LSD (p=0.10)ŧ	0.40	25.0
Trial mean	8.5	175

†Treatments marked with the same letter do not differ significantly
ŧLSD; least significant difference at p=0.10.

DISCUSSION

Fall nitrogen applications to cereal rye may improve stand establishment and spur growth before winter dormancy periods. However, from this experiment, it appeared as if fall timing of nitrogen applications had minimal impact on the yield and quality of rye produced. While spring applied nitrogen treatments appeared to have slightly higher yield than other treatments, these differences were not significant enough to suggest a treatment response. There was a slight increase in protein and a significant increase in lodging with spring-applied N treatments and, which may indicate a treatment response The University of Vermont Extension Northwest Crops and Soils (NWCS) Program intends to repeat this trial in the 2020/2021 growing season as additional research is required to determine impacts of N application timing and rate on cereal rye productivity in the Northeast.

ACKNOWLEDGEMENTS

UVM Extension would like to thank Roger Rainville and his staff at the Borderview Research Farm in Alburgh, VT, for hosting this trial. This project was funded through a USDA SARE Partnership Grant (project number ONE18-312). We would also like to thank John Bruce, Catherine Davidson, Hillary Emick, Rory Malone, Ivy Luke, Lindsey Ruhl, and Sara Ziegler for their assistance with data collection and entry. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.