Using Winter Rye as Forage in Corn Silage Systems

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Producing sufficient high quality forage throughout the year is becoming difficult given current economic and environmental pressures. Farmers are looking for strategies to improve yield and quality of their own forage to reduce the financial burden of purchasing feed off-farm. In addition, with increasing focus on managing farm nutrient balances for environmental reasons, farmers are also looking to decrease the importation of additional nutrients from feed onto their farms. One strategy for accomplishing this is utilizing winter grains, such as winter rye, as forage crops. These crops could be grazed or harvested in the fall to extend the grazing season, and in the spring providing early forage prior to planting corn silage. To better understand how to successfully integrate winter rye forage into corn silage cropping systems, the University of Vermont Northwest Crops and Soils Program initiated a trial altering winter rye planting dates in combination with varying corn maturities.

MATERIALS AND METHODS

In the fall of 2016, winter rye was planted at Borderview Research Farm on three dates spanning the month of September (Table 1). Soil was sampled at each planting date and analyzed for nitrate nitrogen and available phosphorus content at the University of Vermont Agricultural and Environmental Testing Laboratory in Burlington, VT.

Table 1. Winter Rye and Corn Maturity Trial Management, Alburgh, VT 2015-2016.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Soybeans
Tillage operations (rye/corn)	Chisel plow, disk and spike tooth harrow / aerway and harrow
Planting equipment (rye/corn)	Cone seeder / No-till corn planter
Seeding rates (rye/corn)	110 lbs ac^{-1} / 34,000 seeds ac^{-1}
Treatments (main plot)	Rye planting date: 2-Sep 2016 15-Sep 2016 30-Sep 2016 No cover crop
Treatments (subplot)	Corn maturity and variety: Short Season (Dyna-Gro D27GT59; 87 RM) Mid-Season (Dyna-Gro D32RR56; 92 RM) Long Season (Dyna-Gro D47RR23; 107 RM)
Replications	4
Plot size (ft)	10 x 30
Corn planting dates	25-May, 14-Jun, 25-Jun, 2017
Harvest dates (rye/corn)	27-Oct 2016, 23-May 2017 / 20-Oct 2017

Forage was harvested in the fall when temperatures remained below 40° F for an extended period of time designating the end of the growing season for the rye. On 27-Oct 2016, plots were harvested in a 0.25m^2 area in each plot to a height of three inches simulating grazing. The rye planted on the third planting date was not of harvestable size at this time and therefore, dry matter yields were not determined. An approximate 1 lb subsample was collected, dried, ground, and then analyzed for forage quality, nitrogen and phosphorus content. Dry matter content and yield were calculated. After harvest, the entire trial area was mowed to a height of three inches and soil was sampled and again analyzed for nitrate nitrogen and available phosphorus.

In the spring, forage was harvested when the boot stage was reached. All plots were harvested on 23-May 2016 using a Carter forage harvester in a 3' x 30' area. An approximate 1 lb subsample of the harvested material was collected, dried, ground, and then analyzed for forage quality. Dry matter content and yield were calculated. After harvest the remainder of the plots were mowed to three inches and soil was sampled for nitrate nitrogen and available phosphorus. Winter grain stubble was terminated with Lumax® on 3-Jun at a rate of 1 quart ac^{-1}. Three varieties of corn were planted into the grain plots using a John Deere 1750 no-till corn planter at a rate of 34,000 live seeds ac^{-1} on 25-May. Dyna-Gro variety D27GT59 was used as the short season corn variety with a relative maturity of 87 days. This variety is an Agrisure GT variety. Dyna-Gro variety D32RR56 was used as the mid-season corn variety with a relative maturity of 92 days. This variety is a Roundup Ready® variety. Dyna-Gro variety D47RR23 was used as the long season corn variety with a relative maturity of 107 days. This variety is also a Roundup Ready® variety. Starter fertilizer (10-20-20) was applied at planting at a rate of 200 lbs ac^{-1}. Due to intense seed predation from birds, corn was replanted on 14-Jun and again on 25-Jun. Plots were fertilized with 46-0-0 treated with AGROTAIN® urease inhibitor at a rate of 300 lbs ac^{-1} on 5-Jul. Just prior to harvest, plant populations and number of ears were counted in each plot. Corn stalk nitrate samples were also collected from each plot at this time by cutting an eight-inch segment of corn stalk at a height of six inches off the ground from five random plants in each plot. The samples were dried, ground, and sent to the University of Massachusetts, Amherst for analysis. Corn in all plots was harvested on 20-Oct. An approximate 1 lb subsample of harvested material was dried, ground, and then analyzed for quality.

Variations in yield and quality can occur because of variations in genetics, soil, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids 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 (LSDs) at the 0.10 level of significance are shown. Where the difference between two hybrids within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Hybrids that were not significantly lower in performance than the highest hybrid in a particular column are indicated with an asterisk. In this example, hybrid C is significantly different from hybrid A but not from hybrid B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these hybrids did not differ in yield. The difference between C and A is equal to 3.0, which is greater than the LSD value of 2.0, meaning the hybrid yields were different from one another. The asterisk indicates that hybrid B was not significantly lower than the top yielding hybrid C, indicated in bold.

Hybrid	Yield
A	6.0
B	7.5*
C	**9.0***
LSD	2.0

At the time this report was written, forage quality and soil analyses were not yet completed. Therefore, this report only summarizes winter rye yields.

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).

Table 2. 2015-2016 weather data for Alburgh, VT.

	2016				2017									
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Average temperature (°F)	63.6	50.0	40.0	26.8	27.0	27.0	25.1	47.2	55.7	65.4	68.7	67.7	64.4	57.4
Departure from normal	3.03	1.80	1.82	0.89	8.23	5.47	-6.05	2.37	-.075	-0.39	-1.90	-1.07	3.76	9.20
Precipitation (inches)	2.5	5.0	3.0	1.6	1.0	1.5	1.6	5.2	4.1	5.6	4.9	5.5	1.8	3.3
Departure from normal	-1.17	1.39	-0.13	-0.82	-1.05	-0.29	-0.63	2.40	0.68	1.95	0.73	1.63	-1.80	-0.31
Growing Degree Days (base 32°F)	949	559	270	72	66	99	98	459	733	1002	1138	1108	971	786
Departure from normal	91	57	85	72	66	99	98	75	-23	-12	-60	-31	113	285
Growing Degree Days (base 50°F)										468	580	553	447	287
Departure from normal										-7	-60	-28	129	175

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.

From September 2016 through May 2017 there were 3305 Growing Degree Days (GDDs) accumulated for the winter grains, 620 more than the 30-year normal. Precipitation during this time was below normal for all months except October, April, and May. For the corn, there were 2335 GDDs accumulated from June through October, 209 more than normal. Precipitation during this time was above normal for all months except for September and October. The fall of 2016 was warm and dry followed by a relatively warm winter with low precipitation. The spring and summer of 2017, however, was cool and wet. Luckily, temperatures remained higher than normal through the fall and the precipitation subsided, allowing the corn to capture necessary GDDs to reach maturity.

Impact of Planting Date

Planting date significantly impacted winter rye fall and spring yields (Table 3). In the fall, highest yield was obtained from rye planted on 2-Sep which produced 1.20 tons ac^{-1}. As demonstrated in Image 1, rye height and thickness was dramatically different across planting dates. The early planted rye had enough time to establish and tiller quite profusely compared to the other two planting dates. Rye planted by the end of September was not of a harvestable size by the end of October. In the spring, the highest yields were obtained by the first planting date which produced 3.26 tons ac^{-1}. This was statistically similar to the second planting date (15-Sep) with 3.11 tons ac^{-1}. The third planting date (30-Sep) yielded 50% of the first two planting dates.

Table 3. Fall and spring rye yields by planting date.

Planting date	Fall DM yield	Spring DM yield
	tons ac-1	
2-Sep	**1.20**	**3.26**
15-Sep	0.836	3.11*
30-Sep	0.00	1.37
LSD (*p*= 0.10)	0.265	0.395
Trial mean	0.679	2.58

Treatments with an asterisk* performed statistically similarly to the top performer in **bold**.

Image 1. Rye at fall harvest in late October. From left to right: planted 30-Sep, 15-Sep, and 2-Sep.

DISCUSSION

These data demonstrate that winter rye, when planted between early and mid-September, can produce significant biomass that can be utilized for forage in the fall and spring after and prior to a corn silage crop. Rye planted after mid-September may not adequately establish to provide fall forage and will subsequently not yield as much in the spring due to reduced tillering. Therefore, to plant winter rye reliably by mid-September, short maturity corn silage varieties should be selected.

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