Maximizing Forage Yields in Corn Silage Systems with Winter Grains

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Producing sufficient high quality forage on farms 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 rye, wheat and triticale, 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. The fall planted forage also provides essential soil cover during winter months to reduce soil and nutrient loss. In the fall of 2016, the University of Vermont Northwest Crops and Soils Program initiated a trial investigating the integration of winter grains for forage into corn silage cropping systems.

MATERIALS AND METHODS

The soil type at the Alburgh location was a Benson rocky silt loam (Table 1). The seedbed was chisel plowed, disked, and finished with a spike tooth harrow. The previous crop was spring barley. Plots were 10’ x 30’and replicated 4 times. The winter grain portion of the trial was planted with a Sunflower no-till grain drill (Beloit, KS) on 2-Sep 2016. Forage was harvested in the fall when temperatures remained below 40° F for an extended period of time. On 27-Oct, plots were harvested by cutting forage in a 0.25m^2 area in each plot to a height of three inches simulating grazing.

Table 1. Winter Grain Forage Trial Management, Alburgh, VT, 2016-2017.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Spring Barley
Tillage operations (forage/corn)	Chisel plow, disk and spike tooth harrow/aerway and harrow
Planting equipment (forage/corn)	Sunflower no-till grain drill/No-till corn planter
Seeding rates (forage/corn)	110 lbs ac^{-1}/34,000 seeds ac^{-1}
Treatments (main plot)	Winter Rye (VNS) Winter Wheat (Malabar) Winter Triticale (Trical 815)
Treatments (subplot)	0 lbs ac^{-1} N 25 lbs ac^{-1} N 50 lbs ac^{-1} N
Corn variety	Dyna-Gro D27GT59, 87 RM
Replications	4
Plot size (ft)	10 x 30
Planting dates (forage/corn)	2-Sep 2016 / 25-May, 14-Jun, 25-Jun 2017
Harvest dates (forage/corn)	27-Oct 2016, 23-May and 31-May 2017 / 20-Oct 2017

An approximate 1 lb subsample was collected, dried, ground, and then analyzed for forage quality, nitrogen and phosphorus content. Dry matter yields were calculated. After harvest, the entire trial area was mowed to a height of three inches.

In early spring as soon as fields were accessible, nitrogen treatments of 0, 25, and 50 lbs ac^{-1} were hand applied to individual plots using calcium ammonium nitrate on 27-Apr 2017. Forage was harvested when the boot stage was reached. Rye plots were harvested on 23-May and wheat and triticale plots on 31-May 2017 as they matured later than the rye. Plots were harvested 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 yields were calculated. After harvest, the remainder of the plots were mowed to three inches. Winter grain stubble was terminated with Lumax® on 3-Jun at a rate of 1quart ac^{-1}. Short season corn was planted into the plots using a John Deere 1750 no-till corn planter at a rate of 34,000 live seeds ac^{-1} on 25-May into rye plots and 2-Jun for wheat and triticale plots. Starter fertilizer (10-20-20) was applied at planting at a rate of 200 lbs ac^{-1}. Due to intense seed predation from birds, plots were replanted on 14-Jun and again 25-Jun. The soil was loosened using an aerway and lightly harrowing prior to seeding. Plots were fertilized with 46-0-0 treated with AGROTAIN® urease inhibitor at a rate of 300 lbs ac^{-1} on 5-Jul. Prior to corn harvest, plant populations and number of ears were counted. Corn stalk nitrate samples were also collected by removing an eight-inch section of corn stalk six inches above the ground for five random plants in each plot. These samples were dried, ground, and sent to the University of Massachusetts, Amherst for nitrate analysis. Corn was harvested on 20-Oct. An approximate 1 lb subsample was collected, dried, ground, and then analyzed for quality. Soils were sampled for available nitrate nitrogen and phosphorus on 23-Oct and were analyzed at the University of Vermont Agricultural and Environmental Testing Laboratory, Burlington, VT.

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 the example above, 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. This means that the yields of these hybrids were significantly 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 grain forage 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. 2016-2017 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					
Departure from normal	91	57	85	72	66	99	98	75	-23					
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 Winter Grain Species

Winter grain treatments varied significantly in terms of fall yields (Table 3). In the fall, yields averaged 1.00 ton ac^{-1} with rye producing the highest yields of 1.13 tons ac^{-1}. However, this was statistically similar to both triticale and wheat yields. Therefore, in the fall, winter grain species did not differ in yield but all yielded significantly more than the control. The control plots were harvested as there was significant biomass present due to volunteer barley from the previous crop. In the spring, winter grain species varied considerably in yields (Image 1). Rye produced the highest yield of 3.23 tons dry matter ac^{-1}. Wheat was the next highest producing grain species with 2.57 tons ac^{-1}. It is important to note that the rye was ready to harvest approximately a week before the wheat and triticale. In 2016, the rye, also harvested first, only produced 1.64 tons ac^{-1} which was significantly less than the triticale harvested more than a week later with 2.66 tons ac^{-1}. However, the rye produced significantly higher quality forage compared to the triticale and wheat. As quality analyses are completed for the 2017 season this report will be updated.

Table 3. Fall 2016 and spring 2017 forage yield by species.

Species	Fall DM yield	Spring DM yield
	tons ac^{-1}	
Rye	**1.13**	**3.23**
Triticale	0.967*	1.62
Wheat	1.10*	2.57
No cover crop	0.808	0.00
LSD (p = 0.10)	0.186	0.161
Trial mean	1.00	1.86

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

Image 1. Winter grain harvest, spring, 2017.

Impact of Spring Nitrogen Rate

Spring forage yields also varied significantly by nitrogen treatment (Table 4). The highest yields were obtained by the 25 lbs ac^{-1} N treatment which produced 2.05 tons ac^{-1}. This was statistically similar to the 50 lbs ac^{-1} treatment indicating that no additional yield was gained from increasing spring N application rates to 50 lbs ac^{-1}. These data indicate that the addition of 25 lbs ac^{-1} of nitrogen in early spring can increase winter grain forage yields. This trend was also observed in the 2016 season. There was no significant interaction between nitrogen treatment and winter grain species, indicating that the different species showed similar yield responses to the nitrogen treatments. In 2016, we observed interactions for quality parameters including RFV, ADF, and protein. Interactions for quality parameters could arise as quality analyses are completed for this season.

Table 4. Spring 2017 forage yields by nitrogen treatment.

Nitrogen treatment	Spring DM yield
lbs ac^{-1}	tons ac^{-1}
0	1.55
25	**2.05**
50	1.97*
LSD (p = 0.10)	0.309
Trial mean	1.86

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

DISCUSSION

Winter grains can provide substantial, high quality forage late and early in the growing season to supplement perennial pasture and extend the grazing season. These data demonstrate that these species have the potential to provide approximately 1 ton ac^{-1} in the fall and up to 3 tons ac^{-1} in the spring. Rye provided the highest biomass and was ready to harvest at least one week earlier than triticale or wheat.

This is particularly important when integrating winter grains into a corn silage cropping system as delayed planting can have significant impacts on yields, especially in this region with such a short growing season. Furthermore, these data demonstrate that winter grain yields can be increased from the addition of approximately 25 lbs ac^{-1} nitrogen early in the spring but higher N rates did not increase yields further.

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