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## 2023 Winter Rye Cover Crop and Forage Variety Trial



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**2023 WINTER RYE COVER CROP AND FORAGE VARIETY TRIAL**  
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In addition to the growing value of winter rye as a cereal grain crop, rye has historically been used as a fall cover crop that is terminated in the spring due to its ability to establish late into the fall after row crop harvest and provide ground cover to reduce soil loss. In this role it has been essential in reducing erosion, maintaining a healthy nutrient cycle, and building soil health. Recently, many livestock farmers have also started to harvest the cover crops in the spring for forage. Small grains, such as rye, can produce high quality spring forage and farmers are interested in growing varieties that will provide conservation benefits and produce high yielding and quality forage. In 2023, the University of Vermont Extension Northwest Crops and Soils Program initiated a winter rye variety trial to evaluate rye as both a cover crop and a forage.

### **MATERIALS AND METHODS**

The rye variety trial was initiated at Borderview Research Farm in Alburgh, VT in the fall of 2022. 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 three replicates. The field was prepared with a Pottinger Terra Disc prior to planting. Plots were seeded in 5' x 20' plots with a Great Plains Cone Seeder on 24-Sep 2022 at a seeding rate of 350 live seeds m<sup>-2</sup>. Treatments were twelve varieties of cereal rye including Aroostook, Bono, CoverMax, Danko, Hazlet, ND Dylan, ND Gardner, Progas, Serafino, Spooner, Tayo, and VNS (Ruth's) (Table 2).

**Table 1. Agronomic and trial information for the rye cover crop variety trial, 2022-2023.**

	<b>Borderview Research Farm, Alburgh, VT</b>
Soil type	Benson rocky silt loam
Previous crop	Hemp Fiber
Tillage operations	Pottinger Terra Disc™
Harvest area (ft.)	5 x 20
Seeding rate (live seeds m <sup>-2</sup> )	350
Replicates	3
Planting date	24-Sep 2022
	Green-up: 28-Apr 2023
Harvest dates	Boot: 9-May through 18-May 2023
	Flowering: 6-Jun 2023

**Table 2. Winter rye varietal information, Alburgh, VT, 2022-2023.**

Variety	Source
Aroostook	Albert Lea Seed
Bono	Albert Lea Seed
CoverMax	Albert Lea Seed
Danko	Albert Lea Seed
Hazlet	Albert Lea Seed
ND Dylan	University of North Dakota
ND Gardner	University of North Dakota
Progas	Albert Lea Seed
Serafino	Albert Lea Seed
Spooner	Albert Lea Seed
Tayo	Albert Lea Seed
VNS	Saved Seed

Ground cover evaluations were made using Canapeo application on 8-Nov 2022, prior to hard frost and plant dormancy, and again on 28-Apr 2023 to evaluate spring ground cover and winter survival. After ground cover evaluations in the spring, initial biomass samples were taken on 28-Apr, with subsequent biomass samples taken when each rye variety reached the boot stage (9-May through 18-May 2023) and again post flowering on 6-Jun 2023, each harvested from a 0.25m<sup>2</sup> quadrat.

Wet weights were recorded and an approximate 1 lb subsample was collected and dried to determine dry matter content and calculate dry matter yield. Samples from boot stage harvest times were then ground using a Wiley mill to a 2 mm particle size and then to 1mm using a laboratory cyclone mill from the UDY Corporation.

The samples were analyzed for crude protein (CP), acid detergent fiber (ADF), amylase neutral detergent fiber organic matter (aNDFom), and 30-hour NDF digestibility (NDFDom30) at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) with a FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein content of forages. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of the plant are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. Some of the NDF is digestible, however. This fraction is reported as NDFD and is represented as a percentage of

the total NDF.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). Replications within trials were treated as random effects, and mixtures were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ( $p < 0.10$ ). 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 (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 varieties. Varieties that were statistically similar in performance to one another share a letter.

In this example, variety C is significantly different from variety A but not from variety 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 varieties 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 these varieties yielded significantly different from one another.

Hybrid	Yield
A	6.0b
B	7.5ab
C	<b>9.0a</b>
LSD	2.0

## RESULTS

Seasonal precipitation and temperature recorded at Borderview Research Farm in Alburgh, VT are displayed in Table 3. The average fall temperature (Sep 2022 to Nov 2022) was 51.0°F, which was 0.68°F warmer than the 30-year normal. The average temperature from Mar 2023 to Jun 2023 was 0.27°F warmer than the 30-year normal. This growing season was wetter than past years with a total precipitation of 24.1 inches from Mar 2023 to Jul 2023. The accumulated Growing Degree Days (GDDs) were fairly similar to the 30-year average during this period experiencing 171 GDDs less than the 30-year average.

**Table 3. Weather data for rye variety trial in Alburgh, VT.**

Alburgh, VT	Sep-22	Oct-22	Nov-22	Mar-23	Apr-23	May-23	Jun-23
Average temperature (°F)	60.2	51.3	41.5	32.2	48.3	57.1	65.7
Departure from normal	-2.52	0.96	2.24	-0.07	2.7	-1.28	-1.76
Precipitation (inches)	4.4	2.56	3.01	2.00	4.94	1.98	4.4
Departure from normal	0.73	-1.27	0.31	-0.24	1.87	-1.78	0.14
Growing Degree Days (base 32°F)	861	607	346	103	280	766	1023
Departure from normal	-61	39	111	-35	-132	-53	-40

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1991-2020) for Burlington, VT.

Ground cover measurements were taken using the Canopeo application in the fall after plant establishment and again in the spring. Fall ground cover measurements were taken as an indicator of stand establishment and plant vigor. Within the trial, Danko showed the highest percentage of ground cover prior to hard frost

in November 2022 with 73.5% cover and was statistically similar to Bono, Covermax, Hazlet, ND Dylan, Spooner, Tayo and VNS. Similarly, spring ground cover measurements showed that most varieties had good survivability throughout the winter going into the spring green-up period with Spooner having the highest percentage of cover at 73.4%. ND Gardner, Progas, and Serafino appeared to have the lowest percentage of cover and overall vigor during these evaluation periods. Those varieties that had the highest fall ground cover also tended to have the best spring cover too. Interestingly, Progas is a forage specific variety that did have some of the highest forage yields but also had the lowest fall and spring cover. This leads to more questions regarding best dual purpose rye varieties for both optimizing conservation goals and forage production.

**Table 4. Winter rye ground cover, Alburgh, VT, 2022-2023.**

Variety	Fall ground cover	Spring ground cover
	%	%
Aroostook	39.4	47.7*
Bono	53.3*†	53.0*
Covermax	62.0*	59.8*
Danko	<b>73.5</b>	62.8*
Hazlet	55.9*	54.7*
ND Dylan	67.5*	61.3*
ND Gardner	38.1	33.6
Progas	36.7	42.3
Serafino	29.8	29.8
Spoooner	65.0*	<b>73.4</b>
Tayo	57.0*	49.2*
VNS	72.4*	56.6*
<b>LSD (0.10) ‡</b>	25.6	30.4
<b>Trial mean</b>	54.2	52.0

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

‡LSD; least significant difference at the p=0.10 level.

Rye forage and straw yields were collected at three key periods throughout the 2023 growing season: spring green-up, boot stage, and flowering (Table 5). Dry matter yields were high across all varieties during this period with Spooner having the highest yields at 3651 lbs ac<sup>-1</sup>. Serafino was the only variety at this period (in addition to boot and flowering stage) that did not perform similarly to other top yielding varieties. Danko produced the highest yields at boot stage at 6,063 lbs ac<sup>-1</sup> and was statistically similar to Bono, Covermax, Hazlet, ND Dylan, ND Gardner, Progas, Spooner, and VNS rye. Highest yields at flowering stage were seen with Covermax at 12,215 lbs ac<sup>-1</sup> and was statistically similar to Aroostook, Bono, Danko, Hazlet, ND Dylan, Progas, Spooner and the VNS rye. Each of these would be suitable for roller crimping and provide good ground cover in addition to producing high amounts of straw.

**Table 5. Winter rye dry matter and yields at spring green-up, boot, and flowering growth stages, Alburgh, VT 2023.**

Variety	Spring forage dry matter	Spring forage dry matter yield	Boot stage dry matter	Boot stage dry matter yield	Flowering stage dry matter	Flowering stage dry matter yield
	%	lbs ac-1	%	lbs ac-1	%	lbs ac-1
Aroostook	21.9	2667*	16.3	3056	36.5	10133*
Bono	21.8	2731*	16.9	5156*	32.2	10940*
Covermax	21.2	3111*	18.0	5685*	32.7	<b>12215</b>
Danko	20.5	3301*	16.4	<b>6063</b>	32.9	10484*
Hazlet	21.5	2921*	17.6	5354*	<b>45.8</b>	10872*
ND Dylan	22.4*†	2674*	16.9	5273*	32.6	9673*
ND Gardner	<b>24.1</b>	2464*	18.1	4684*	35.4	10290*
Progas	21.5	2603*	17.1	5101*	32.4	10139*
Serafino	23.3*	2110	<b>20.7</b>	3494	32.4	8809
Spoooner	22.1*	<b>3651</b>	20.2*	4437*	34.4	12189*
Tayo	23.5*	2914*	18.2*	4206	32.6	8797
VNS	20.1	3124*	16.4	4960*	32.9	10983*
<b>LSD (0.10) ‡</b>	1.98	1474	2.57	1802	8.67	2745
<b>Trial mean</b>	22	2856	17.8	4789	34.4	10460

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

‡LSD; least significant difference at the p=0.10 level.

Forage quality was analyzed for each rye sample at boot stage as this would be indicative of the optimum period for quality and yields (Table 6). Each of these varieties reached boot stage between 9-May and 18-May 2023. Highest observed crude protein concentrations were seen in Aroostook at 15.37% and was statistically similar to Covermax, Hazlet, ND Dylan, Serafino, Spoooner, and Tayo. When looking at forage quality, no significant differences were observed in Acid Detergent Fiber (ADF). Conversely, differences in rye varieties were observed in amylase Neutral Detergent Fiber organic matter (aNDFom) and Neutral Detergent Fiber Digestibility 30hr (NDFDom30). NDFDom30 indicates the percentage of NDF digested in 30 hours of fermentation, whereas the NDFDom30 yields are indicative of the total amount of feed that would be fermentable during this 30-hour period. All of the varieties within the trial were of good quality for NDFDom30 when compared to other forages with those with highest percentage of digestible fibers seen in Aroostook at 76.80% and was statistically similar to Covermax, Hazlet, ND Dylan, Serafino, and Spoooner. NDFDom30 yields show a uniform digestible fiber yields were highest for ND Dylan at 2,710 lbs ac<sup>-1</sup> and was statistically similar to Bono, Covermax, Danko, and Hazlet.

**Table 6. Winter rye forage quality at plant boot stage. Alburgh, VT 2023**

Variety	Boot stage harvest date	Crude protein	ADF	aNDFom	NDFDom30	NDFDom30
	%	%	%	%	% NDF	lbs ac-1
Aroostook	<b>9-May</b>	<b>15.4</b>	28.5	48.2	<b>76.8</b>	1125
Bono	15-May	12.5	31.6	<b>54.4</b>	68.9	1935*
Covermax	18-May	14.3*†	29.8	51.5*	72.0*	2109*
Danko	15-May	11.0	31.0	54.1*	65.8	2167*
Hazlet	18-May	13.9*	28.4	51.2*	74.3*	2048*
ND Dylan	18-May	13.6*	29.8	51.4*	72.3*	<b>2710</b>
ND Gardner	15-May	12.1	31.1	52.9*	67.3	1670
Progas	18-May	12.2	29.1	51.7*	68.6	1799
Serafino	11-May	14.5*	28.2	48.3	74.9*	1136
Spooner	11-May	13.5*	28.3	49.9*	71.7*	1569
Tayo	18-May	13.4*	30.1	52.0*	69.9	1516
VNS	15-May	11.3	29.8	52.2*	67.7	1760
<b>LSD (0.10) ‡</b>	-	2.46	NS§	4.92	62.3	793
<b>Trial mean</b>	-	13.1	29.7	51.5	70.9	1795

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

‡LSD; least significant difference at the p=0.10 level.

§NS-No significant difference between treatments.

## DISCUSSION

In colder climates rye can serve as a late season cover crop that has the ability to establish in a corn production system after harvest. Like other cover crops, it provides long term benefits towards soil erosion control and improvements in soil health over time. When looking at these twelve rye varieties in this region in terms of stand establishment and ground cover, the majority of the varieties performed similarly in the cover crop function providing decent cover throughout winter months. The varieties ND Gardner, Progas, and Serafino appeared to be less vigorous in this period when compared to the other varieties in the trial. During spring green-up periods, rye also has the benefit of putting on rapid growth in early season months where other crops may struggle to develop.

Past research has shown that while forage quality may be high after spring green-up, yields are far lower than those at boot stage, whereas high yields can be observed at flowering stage, but quality is lower. When looking across other forage types, each of these rye varieties shows high potential as a feed component with decent protein levels as well as NDFDom30 being above 65%. Comparatively, many corn silages and

legumes fall below this mark showing that rye could serve as a high-quality feed in addition to the many benefits seen as a cover crop. This could also help to provide good feed early in the season where other crops may not be quite at a suitable harvest stage. While varieties such as Aroostook and Serafino had some of the highest percentages of crude protein as a feed, dry matter yields and NDFDom30 yields were comparatively low, whereas Covermax, Hazlet, and ND Dylan showed a more ideal intersection of high protein levels and high NDFDom30 yields. This would indicate that these three varieties in particular could serve as some of the higher quality and highest yielding feed ingredients. Furthermore, the benefits of a rye crop could surpass cover cropping and feed through straw production, which could provide an additional source of income if a harvest window is missed for higher quality feed.

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