2023 Fall Annual Forages Trial

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In the Northeast, cool season perennial grasses dominate pastures and hay meadows that dairy farmers rely on. Extending the grazing season later into the fall can help avoid feeding the stored forages necessary to sustain the herd through the winter months when no pasture will be available. For farms purchasing large portions of their herd's stored forage needs, this can be an effective strategy for increasing the operation's profitability. Depending on the species utilized they may also be harvested for stored feed, increasing stored forage inventories. Incorporating legumes into a mixture with grasses can help supply nitrogen, increase protein and fiber digestibility. However, forage legumes tend to be less aggressive and productive than grasses and can be more challenging to establish in a mixture. Therefore, in 2023 we compared two varieties of oats (one for forage, one for grain) to a variety of winter triticale with three rates of pea inclusion or supplemental nitrogen applied. These treatments were evaluated for potential differences in forage yield and quality when harvested prior to a killing frost. While the information presented can begin to describe the yield and quality performance of these mixtures in this region, it is important to note that the data represent results from only one season and one location.

MATERIALS AND METHODS

The trial was established at Borderview Research Farm in Alburgh, VT, and the plot design was a randomized complete block with four replications (Table 1). The soil type was Benson rocky silt loam. The previous crop was winter canola. Treatment information is summarized in Table 2.

Table 1. Annual forage trial management, Alburgh, VT, 2023.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter canola
Tillage operations	Pottinger TerraDisc™
Planting equipment	Great Plains Cone Seeder
Treatments (species/mixtures)	12
Replications	4
Plot size (ft)	5 x 20
Planting date	24-Aug
Harvest date	26-Oct

The seedbed was prepared with a Pottinger TerraDisc™. The trial was planted with a cone seeder on 24-Aug into 5' x 20' plots. The seeding rate was 100 lbs ac^{-1} with pea inclusions of 0%, 25%, and 50%. The 0% pea inclusion plots were either left with no additional nitrogen. Plots receiving nitrogen were fertilized with 50 lbs N ac^{-1} with urea (46-0-0) on 25-Sep. On 26-Oct, plots were harvested in a 3'x20' section in each plot using a Carter small plot forage flail harvester equipped with scales. Wet weights were recorded and an approximate 1 lb subsample was collected and dried to determine dry matter content and calculate dry matter yield. The samples were then ground using a Wiley mill to a 2 mm particle size and then to 1 mm using a laboratory cyclone mill from the UDY Corporation.

Table 2. Treatment information, 2023.

Variety/Species	Pea inclusion	Nitrogen applied
	%	lbs ac^{-1}
Sumo grain oat	0	0
	0	50
	25	0
	50	0
Everleaf 126 forage oat	0	0
	0	50
	25	0
	50	0
Surge triticale	0	0
	0	50
	25	0
	50	0

The samples were analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and 30-hour NDF digestibility (NDFD), water soluble carbohydrates (WSC), relative forage quality (RFQ), net energy of lactation (NE_L), and total digestible nutrients (TDN) 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.

Results were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. 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 (LSD's) 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. 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 shown in bold.

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

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). Temperatures were above normal in both September and October. After excessive rainfall in July and August, September's rainfall was over an inch below normal. However, the rains returned in October where precipitation accumulation was over 1.5 inches above normal. A total of 1151 Growing Degree Days (GDDs) were accumulated during these months which is 195 above the 30-year normal. Ample rainfall and warm temperatures through late October provided ideal growing conditions prior to frost.

Table 3. Weather data for Alburgh, VT, 2022.

	September	October
Average temperature (°F)	63.7	54.4
Departure from normal	1.03	4.11
Precipitation (inches)	2.40	5.38
Departure from normal	-1.27	1.55
Growing Degree Days (base 41°F)	706	445
Departure from normal	54	141

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.

Impact of Species/Variety

Plots were harvested 63 days after planting on 26-Oct. Despite relatively conducive conditions, yields were lower than in previous years and averaged 1328 lbs ac^{-1} across the trial (Table 4). However, there was a wide range in yields from under 500 lbs to over 2100 lbs ac^{-1}. Triticale is generally slower growing and less productive than oats, however, winter triticale will survive the winter and can provide additional forage the following spring while the oats will winterkill. These data only reflect the biomass produced in the fall prior to a hard frost. Triticale also has a more prostrate, or horizontal, growth habit compared to oats, which can impact mechanical harvest. The grain oats produced the highest biomass of 1966 lbs ac^{-1} which was about 500 lbs higher than the forage oats, but both oats produced more than twice the biomass of the triticale. However, the triticale produced forage with about 5-8% higher crude protein than the forage and grain oats respectively. On the other hand, water soluble sugars were highest in the grain oats followed by the forage oats and about 2-5% lower in the triticale. Fiber digestibility was high (>75%) across all treatments with the forage oats being >80% digestible while the grain oats and triticale were similar to one another. This also translated into a relative forage quality rating of 203 for the forage oats versus 179 and 165 for the grain oat and triticale respectively. Combining several aspects of forage quality to predict resulting milk production, no differences in predicted milk yield were seen per ton of each forage treatment.

Table 4. Dry matter yield and average forage quality metrics by species/variety, 2023.

Species/Variety	Dry matter yield	Crude protein	WSC	30-hr NDF digestibility	RFQ	Milk yield
	lbs ac^{-1}	% of DM		% of NDF		lbs ton^{-1}
Everleaf 126 forage oat	1406b†	16.7b	12.5b	**83.8a**	**203a**	**4114**
Sumo grain oat	**1966a**	13.4c	**15.0a**	78.2b	179b	4074
Surge triticale	615c	**21.6a**	10.6c	78.6b	165b	4163
LSD (p = 0.10)‡	327	1.41	1.12	1.75	15.2	NS§
Trial mean	1329	17.2	12.7	80.2	183	4117

†Treatments that share a letter performed statistically similarly to one another.
‡LSD; least significant difference at the *p* = 0.10 level.
§NS; not statistically significant.
In each column the top performing treatment is indicated in **bold.**

Combining dry matter yield and quality can be a helpful way to evaluate the resulting yield of quality components and milk resulting from feeding different forage treatments (Table 5). When considered this way, we see the grain oat variety yielding in all categories except performing similarly to the forage oat in protein yield. These data indicate that, while the forage variety often produced similar or higher quality forage as the grain variety, when you consider the higher dry matter yield of the grain variety, you ultimately yield more of the quality components on a per acre basis with the grain variety. Triticale, with lower dry matter yield and often similar or lower quality as the grain variety, produced the lowest quality components. Again, it is important to recognize, however, that the triticale is a winter grain that will survive the winter and continue to produce biomass the following spring while the oats are producing all their biomass in the fall prior to winterkilling. If fall and spring forage are desired, a winter grain such as triticale can be used and will provide forage in both seasons.

Table 5. Yield of quality components and predicted milk yield by species/variety, 2023.

Species/Variety	Protein	WSC	30-hr digestible NDF	Milk yield
		lbs ac^{-1}		cwt ac^{-1}
Everleaf forage oat	238a†	165b	515b	29.0b
Sumo grain oat	266a	292a	719a	39.8a
Surge triticale	132b	63.9c	211c	12.8c
LSD (p = 0.10)‡	60.7	43	122	6.67
Trial mean	212	173	482	27.2

†Treatments that share a letter performed statistically similarly to one another.
‡LSD; least significant difference at the *p* = 0.10 level.

Impact of nitrogen treatment

Dry matter yields did not differ statistically across the nitrogen/pea inclusion treatments (Table 6). This means that dry matter yields were not substantially increased or decreased when peas were included up to 50% of the seeding rate. In addition, when no peas were included, the addition of 50 lbs of nitrogen did not increase yields compared to the treatment with no peas and no nitrogen added. There were, however, some differences in average quality parameters. Crude protein was similar in all treatments except 7% higher in the treatment receiving additional nitrogen. The additional soluble nitrogen increased forage protein concentration, but did not increase dry matter yields. Fiber digestibility was also highest in the supplemental nitrogen treatment. Conversely, WSC content was lowest for this treatment and was at least 3% higher in all other treatments. Overall, relative forage quality ratings did not differ statistically, and predicted milk yields were similar for all treatments except for the highest pea inclusion treatment.

Table 6. Yield and average quality by nitrogen/pea treatment, 2023.

Nitrogen treatment	Dry matter yield	Crude protein	WSC	30-hr NDF digestibility	RFQ	Milk yield
	lbs ac^{-1}	% of DM		% of NDF		lbs ton^{-1}
0% pea, no N	**1486**	15.1b	13.7a	82.3b	183	**4198a**
0% pea, 50# N	1394	**22.8a**†	10.2b	**85.5a**	**188**	4170a
25% pea	1259	15.1b	**13.8a**	77.8c	181	4102ab
50% pea	1176	15.8b	13.2a	75.3d	179	3998b
LSD (p = 0.10)‡	NS§	1.63	1.3	2.02	NS	107
Trial mean	1329	17.2	12.7	80.2	183	4117

†Treatments that share a letter performed statistically similarly to one another.
‡LSD; least significant difference at the *p* = 0.10 level.
§NS; not statistically significant.
In each column the top performing treatment is indicated in **bold.**

Table 7. Yield of quality components and predicted milk yield by nitrogen/pea treatment, 2023.

Nitrogen treatment	Protein	WSC	30-hr digestible NDF	Milk yield
		lbs ac^{-1}		cwt ac^{-1}
0% pea, no N	211b†	206	566	31.0
0% pea, 50# N	291a	140	510	28.1
25% pea	172b	183	451	25.8
50% pea	173b	165	400	23.8
LSD (p = 0.10)‡	70.1	NS§	NS	NS
Trial mean	212	173	482	27.2

†Treatments that share a letter performed statistically similarly to one another.
‡LSD; least significant difference at the *p* = 0.10 level.
§NS; not statistically significant.
In each column the top performing treatment is indicated in **bold.**

When dry matter yield and quality were considered together, nitrogen treatments only differed in protein yield with the 0% pea + 50# N treatment producing 80-119 lbs protein more than the other treatments (Table 7). The treatment including the fertilizer application costs approximately $30.50 more per acre than the same treatment without the fertilizer. This additional $30.50 per acre yielded an additional 80 lbs of protein per acre. If you also consider the difference in seed costs between forage and grain varieties, it is likely that the grain oats with no additional fertilizer provide the most economical annual forage at this time of the year. Table 8 summarizes the dry matter and quality component yields per acre for all treatments.

Table 8. Dry matter and quality component yields for all treatments, 2023.

Species/variety	Nitrogen treatment	Dry matter yield	Protein	WSC	30-hr digestible NDF	Milk yield
			lbs ac^{-1}			cwt ac^{-1}
Everleaf forage oat	0% pea, no N	1484	198	185	576	31.9
	0% pea, 50# N	1582	362	151	563	32.2
	25% pea	1352	196	175	502	27.8
	50% pea	1205	196	147	418	24.1
Sumo grain oat	0% pea, no N	2059	247	**339**	777	**41.9**
	0% pea, 50# N	**2120**	**377**	226	**795**	41.8
	25% pea	1937	227	319	698	39.5
	50% pea	1746	213	284	605	36.1
Surge triticale	0% pea, no N	915	190	92.8	345	19.3
	0% pea, 50# N	479	133	44.3	171	10.3
	25% pea	488	94.4	55.4	153	10.2
	50% pea	577	110	63.2	177	11.2
	Trial mean	1329	212	173	482	27.2

DISCUSSION

Fall annual forage crops can help extend the grazing season or provide additional high-quality stored forage. They can also be beneficial in helping to prepare fields for renovation while still obtaining decent yield and quality forage during the rotation period. While there are varieties of small grains, such as oats, developed specifically for forage production, in this study we found that a fast growing grain variety oat provided higher dry matter, water soluble carbohydrate, digestible fiber, and predicted milk yields compared to the forage variety oat. While the concentration of protein and fiber digestibility of the forage variety were higher than the grain variety, the increased yield of the grain variety led to higher yields of these desirable components on a per acre basis. In addition, grain varieties typically cost less than forage varieties. The addition of nitrogen to the forages in the form of urea did not increase dry matter yields, but increased protein content considerably. Unfortunately, this came at the expense of water soluble carbohydrates which decreased with the added nitrogen. Increased sugar content is desirable for ensiling, providing energy for the bacteria to properly ferment the feed. Mixing forage peas with the oats did not impact dry matter yields but decreased fiber digestibility and predicted milk yields. These data suggest that utilizing an early maturing grain oat variety could provide greater return when producing fall annual forage compared to a forage-specific oat variety.

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