2017

Perennial Forage Trial

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NORTHWEST CROPS & SOILS PROGRAM

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2017 PERENNIAL FORAGE TRIAL

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In 2015, the University of Vermont Extension Northwest Crops and Soils Program initiated a trial investigating forage yield, quality, and nitrogen use efficiency of cool season perennial grasses alone and in combination with red clover. The grass species selected were orchardgrass, timothy, brome, and meadow fescue. These grasses were chosen as they have been shown in previous research to have adequate survivability and forage production in this region compared to other species such as perennial ryegrass or festulolium. The goal of this trial is to evaluate these species not only for forage yield and quality, but also nitrogen use efficiency as this could help determine species and varieties that may be better suited to organic production systems. In addition, we hope to identify any differences in performance when legumes are incorporated. In 2017, with the stands fully established, evaluation of these perennial forage treatments continued.

MATERIALS AND METHODS

Forage species and variety information for the trial initiated in 2015 is summarized in Table 1. Four varieties of four perennial grass species were planted alone and in combination with red clover at Borderview Research Farm in Alburgh, VT. The plot design was a randomized complete block with five replications. Treatments were grass varieties with and without clover evaluated for nitrogen use efficiency, forage yield, and quality.

Table 1. Perennial grass species information.

Species	Variety	Seed Source	Certified Organic
Brome	AC Success	Seedway, LLC	No
	Carlton smooth	King's Agriseed	No
	Hakari Alaska	Barenbrug	No
	York smooth	Seedway, LLC	No
Meadow Fescue	HDR	Barenbrug	No
	Laura	King's Agriseed	Yes
	Liherold	King's Agriseed	Yes
	Preval	Seedway, LLC	No
Orchardgrass	Echelon	King's Agriseed	No
	Endurance	King's Agriseed	No
	Extend	Seedway, LLC	No
	Niva	King's Agriseed	Yes
Timothy	Barpenta	Barenbrug	No
	Clair	King's Agriseed	No
	Climax	King's Agriseed	Yes
	Crest	Seedway, LLC	No
Red Clover	Freedom	Barenbrug	Yes

The soil type at the Alburgh location was a Benson rocky silt loam (Table 2). The seedbed was moldboard plowed, disked, and finished with a spike tooth harrow. The previous crop was winter wheat. Plots were 5' x 20'and replicated 5 times. Plots were harvested with a carter forage harvester in 3' x 20' area on 1-Jun, 19-Jul, and 11-Sep. At the first harvest, an additional sample was collected from a 0.25m^2 area from each clover treatment plot. These samples were sorted into grass and clover fractions which were weighed and then dried to determine botanical composition of the treatments.

Table 2. Perennial forage trial management, Alburgh, VT, 2015-2017.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Winter wheat
Tillage operations	Moldboard plow, disk and spike tooth harrow
Planting equipment	Great Plains small plot drill
Treatments	32
Replications	5
Plot size (ft.)	5 x 20
Planting date	1-May 2015
Harvest dates (2017)	1-Jun, 19-Jul, and 11-Sep

An approximate 1 lb subsample of the harvested material was collected and dried to calculate dry matter yield and forage quality. At the time this report was written, forage quality analysis was not complete for all samples and therefore only yields are reported. Plots were also rated for disease severity on 6-Sep prior to the third harvest. Plots were rated on a 1-10 scale where 1 was low infection and 10 was high infection for rust (*Puccina sp.)* and for other diseases.

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 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. 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

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). In general, the fall of 2016 was warmer and drier than normal. These conditions persisted through the winter with temperatures well above average in both January and February. Throughout the 2017 season, the weather was cooler and wetter than normal until the fall when temperatures rose above normal and the precipitation subsided. These conditions led to a total of 4036 Growing Degree Days (GDDs) which is 333 above the 30-year average.

Table 3. 2017 weather data for Alburgh, VT.

	2016		2017								
	November	December	January	February	March	April	May	June	July	August	September
Average temperature (°F)	40.0	26.8	27.0	27.0	25.1	47.2	55.7	65.4	68.7	67.7	64.4
Departure from normal	1.82	0.89	8.23	5.47	-6.05	2.37	-0.75	-0.39	-1.90	-1.07	3.76
Precipitation (inches)	3.00	1.60	1.00	1.50	1.60	5.20	4.10	5.60	4.90	5.50	1.80
Departure from normal	-0.13	-0.82	-1.05	-0.29	-0.63	2.40	0.68	1.95	0.73	1.63	-1.80
Growing Degree Days (base 41°F)	125	9	9	42	27	247	463	727	859	829	699
Departure from normal	125	9	9	42	27	133	-14	-17	-59	-33	111

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

This year, the species did not differ significantly in terms of the ratio of grass and clover present at the first harvest (Table 4). The trial average was 77.2% grass, considerably higher than last year's average of 53.1%. As the stands have established, any species differences in dominance in the mixture have dissipated leaving an approximate 80:20 mixture of grass and clover. This trend is somewhat expected as the medium red clover used in this trial is short-lived, however, a decrease in clover of this magnitude within one year could have been exacerbated by weather conditions as similar trends were observed in trials with alfalfa.

Table 4. Proportion of grass/clover by species, 1st cut 2017.

Species	Grass %	Clover %
Brome	76.1	23.9
Meadow Fescue	**78.4**	21.6
Orchardgrass	78.2	21.8
Timothy	76.0	**24.0**
LSD (*p*=0.10)	NS	NS
Trial Mean	77.2	22.8

Top performer treatments are in **bold.** NS, No significant difference.

Overall, the grass species performed well, despite the poor weather, producing a total dry matter yield of 4.87 tons ac^{-1} across three cuttings (Table 5). Yields in the first cutting were quite high with an average of 2.26 tons ac^{-1}. The highest yielding species was timothy with 2.39 tons ac^{-1}, however this was statistically similar to all other species except for orchardgrass. The second cutting was approximately 1 ton ac^{-1} less than the first with timothy still producing the highest yield which was statistically similar to orchardgrass. The third cutting produced the lowest yields in which orchardgrass produced the highest yield of 1.36 tons ac^{-1} in which varieties did not differ statistically. Overall, timothy produced the highest yield of 5.12 tons ac^{-1}, however varieties did not differ statistically. These yields are considerably higher than last year where the average combined yield was 3.41 tons ac^{-1}, however, similar trends were observed with timothy producing the highest yields in multiple cuttings.

Table 5. Yield over three harvests by species, 2017.

Species	DM yield tons ac^{-1}			
	1st cut	2nd cut	3rd cut	Total
Brome	2.31*	1.35	1.13	4.79
Meadow Fescue	2.32*	1.24	1.26	4.82
Orchardgrass	2.02	1.38*	**1.36**	4.76
Timothy	**2.39**	**1.51**	1.22	**5.12**
LSD (p=0.10)	0.199	0.140	NS	NS
Trial Mean	2.26	1.37	1.25	4.87

Treatments with an asterisk* performed similarly to the top performer in **bold.**
NS-No significant difference.

There were also significant differences between the species in terms of foliar diseases (Table 6). Orchardgrass had the lowest rust severity rating of 0.00 which was statistically similar to all other species except for timothy. However, overall rust severity was very low averaging only 0.069 across the trial. Other leaf diseases were more severe than rust and also differed across species. Brome had the lowest rating with 0.650 which was statistically similar to all other species except for orchardgrass which had an average rating of 2.33. Additional research will be conducted to determine foliar diseases present in 2018. Foliar diseases appear in grass stands after prolonged periods of wet weather which tend to be late in the season and therefore do not often impact yields. This appears to be the case in this trial, however, foliar diseases could impact forage quality which has yet to be analyzed.

Table 6. Disease severity rating by species, 2017.

Species	Rust	Other
	1-10 scale	
Brome	0.000*	**0.650**
Meadow Fescue	0.125*	0.850*
Orchardgrass	**0.000**	2.33
Timothy	0.150	0.750*
LSD (p=0.10)	0.105	0.223
Trial Mean	0.069	1.14

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

Impact of Variety

The perennial grass species differed by variety for yield, but this was often dependent on harvest time. (Table 7). In the first harvest, the only species with varietal differences in yield was orchardgrass, The variety Echelon produced only 1.62 tons ac^{-1} which was significantly lower than all other varieties. No species showed varietal differences for the second harvest. At the third harvest, the only species with varietal differences was brome. The variety Hakari Alaska produced the highest yield of 1.34 tons ac^{-1} which was statistically similar to the Carlton smooth variety. No species showed varietal differences in overall yield. This was quite different from last year's trends in which varietal differences among species were observed both between harvests and for total yields.

Table 7. Yield and disease severity by variety at 1st, 2nd, and 3rd cuts, 2017.

Species	Variety	DM Yield tons ac^{-1}				Disease Severity	
						Rust	Other
		1st cut	2nd cut	3rd cut	Overall	1-10 scale	
Brome	AC Success	2.41	1.41	0.950	4.77	**0.00**	0.500*
	Carlton smooth	2.20	**1.42**	1.16*	4.78	0.00	0.600*
	Hakari Alaska	2.20	1.22	**1.34**	4.76	0.00	1.00
	York smooth	**2.41**	1.37	1.07	**4.85**	0.00	**0.500**
	LSD (*p*=0.10)	NS	NS	0.242	NS	NS	0.390
	Species Mean	2.31	1.35	1.13	4.79	0.00	0.650
Meadow Fescue	HDR	2.22	**1.37**	1.31	**4.90**	0.000*	0.800
	Laura	2.26	1.24	1.23	4.73	0.400	**0.800**
	Liherold	**2.58**	1.06	1.19	4.83	0.100*	0.900
	Preval	2.23	1.28	**1.32**	4.83	**0.000**	0.900
	LSD (*p*=0.10)	NS	NS	NS	NS	0.298	NS
	Species Mean	2.32	1.24	1.26	4.82	0.125	0.850
Orchardgrass	Echelon	1.62	**1.47**	1.31	4.40	0.00	**1.80**
	Endurance	2.16*	1.34	**1.49**	4.99	0.00	2.70
	Extend	**2.20**	1.26	1.20	4.66	0.00	2.50
	Niva	2.11*	1.46	1.46	**5.03**	**0.00**	2.30
	LSD (*p*=0.10)	0.453	NS	NS	NS	NS	0.495
	Species Mean	2.02	1.38	1.36	4.76	0.00	2.33
Timothy	Barpenta	2.28	**1.53**	1.10	4.91	0.100	0.700
	Clair	**2.53**	1.46	1.33	5.32	**0.100**	1.00
	Climax	2.38	1.51	1.00	4.89	0.200	0.700
	Crest	2.36	1.53	**1.47**	**5.36**	0.200	**0.600**
	LSD (*p*=0.10)	NS	NS	NS	NS	NS	NS
	Species Mean	2.39	1.51	1.22	5.12	0.150	0.750

Treatments with an asterisk* performed similarly to the top performer in **bold.**
NS-No significant difference.

Impact of clover

Species varied in yield performance with and without clover for some of the harvests (Table 8). These differences were not as large as in 2016 as overall less clover was present this year. There was no difference in yield between clover treatments for any of the species in the first cutting. In the second cutting, orchardgrass yielded approximately 0.30 tons ac^{-1} higher when planted alone than in a mixture. In the third cutting, meadow fescue yielded approximately 0.25 tons ac^{-1} higher when planted alone than in a mixture.

Table 8. Yield across all cuts by species with and without clover.

Species	**DM Yield** tons ac^{-1}				**Disease severity** Rust	Other
	1st cut	2nd cut	3rd cut	Total	1-10 scale	
Brome	2.22	**1.43**	**1.15**	**4.80**	**0.00**	0.850
with clover	**2.39**	1.28	1.11	4.78	0.00	**0.450**
LSD (*p*=0.10)	NS	NS	NS	NS	NS	0.276
Species Mean	2.31	1.35	1.13	4.79	0.00	0.650
Meadow Fescue	2.24	**1.27**	**1.39**	**4.90**	**0.100**	**0.750**
with clover	**2.40**	1.20	1.14	4.74	0.150	0.950
LSD (*p*=0.10)	NS	NS	0.321	NS	NS	NS
Species Mean	2.32	1.24	1.26	4.82	0.125	0.850
Orchardgrass	**2.05**	**1.52**	**1.39**	**4.96**	**0.00**	**2.30**
with clover	2.00	1.24	1.34	4.95	0.00	2.35
LSD (*p*=0.10)	NS	0.245	NS	NS	NS	NS
Species Mean	2.02	1.38	1.36	4.77	0.00	2.33
Timothy	**2.44**	**1.63**	1.22	**5.29**	**0.300**	**0.700**
with clover	2.33	1.39	**1.23**	4.95	0.00	0.800
LSD (*p*=0.10)	NS	NS	NS	0.344	0.215	NS
Species Mean	2.39	1.51	1.22	5.12	0.150	0.750

Top performer is shown in **bold.**

NS-No significant difference.

Image 1. Visual difference between grass-only (left) and grass-clover plots

DISCUSSION

Overall, performance of these perennial forages was high and likely a result of the cool weather and abundant moisture. Yields were considerably higher this season compared to last season averaging 4.87 tons ac^{-1}. This yearly differences in yield may be a result of climatic conditions. The 2017 season was cool and wet whereas the 2016 season was hot and dry. There were few varietal differences in terms of yield, disease, and clover abundance this year. Furthermore, clover abundance was significantly lower this year compared to last year with mixture plots averaging only 22.8% clover. This was somewhat expected due to the short-lived nature of the red clover used in this trial. Farmers around the region noted high yields but low quality from perennial forages in 2017. This report will be updated with forage quality data as it becomes available. It is important to recognize that these data only represent one year and should not alone be used to make management decisions.

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