NORTHWEST CROPS & SOILS PROGRAM

2015 Perennial Forage Trial

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UNIVERSITY OF VERMONT EXTENSION
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2015 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. As these are perennial forages, we will continue to monitor yield, quality, and nitrogen use of these grasses over multiple years. The following is a summary of the first year establishing these grasses.

MATERIALS AND METHODS

In 2015, 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 stand establishment, forage yield and quality. Forage species and variety information is summarized in Table 1.

Table 1. Perennial grass species information.

Species	Variety	Seed source	Certified organic
Brome	AC Success	Seedway	No
	Carlton smooth	King's Agriseed	No
	Hakari Alaska	Barenbrug	No
	York smooth	Seedway	No
Meadow Fescue	HDR	Barenbrug	No
	Laura	King's Agriseed	Yes
	Liherold	King's Agriseed	Yes
	Prevail	Seedway	No
Orchardgrass	Echelon	King's Agriseed	No
	Endurance	King's Agriseed	No
	Extend	Seedway	No
	Niva	King's Agriseed	Yes
Timothy	Barpenta	Barenbrug	No
	Clair	King's Agriseed	No
	Climax	King's Agriseed	Yes
	Crest	Seedway	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. The trial was planted with a Great Plains small plot drill on 1-May. The seeding rates were 28 lbs. ac^{-1} for grass alone and when mixed with clover the rates were 20 and 8 lbs. ac^{-1} for grass and clover respectively. Since this was the seeding year, only one harvest was removed from the experimental area. Plots were harvested with a carter forage harvester on 9-Jul. Stand establishment was determined on 5-Oct. Plots were evaluated on a scale from 0-5 where 0 indicated that the treatment did not establish at all and 5 indicated excellent establishment. The rating was done visually by plot by identifying and rating the presence and vigor of the planted species. After evaluation, the plots were mowed to a height of about 4 inches to remove additional biomass to avoid smothering and winterkill.

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

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
Harvest date	9-Jul

Yield was only measured on the 9-Jul harvest date. An approximate 1 lb. subsample of the harvested material was collected and dried to calculate dry matter yield. Due to a high proportion of weeds in some samples, the samples were not analyzed for quality or nitrogen content as these parameters would inaccurately represent the species and varieties that were intended for evaluation.

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 ($p<0.10$).

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

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.

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).

Table 3. 2015 weather data for Alburgh, VT.

	May	June	July	August	September	October
Average temperature (°F)	61.9	63.1	70.0	69.7	65.2	46.5
Departure from normal	5.5	-2.7	-0.6	0.9	4.6	-1.7
Precipitation (inches)	1.94	6.42	1.45	0.00	0.34	2.51
Departure from normal	-1.51	2.73	-2.70	-3.91	-3.30	-1.09
Growing Degree Days (base 41°F)	655	669	908	903	740	252
Departure from normal	178	-75	-10	41	152	29

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 May through October there were an accumulated 4127 GDDs, at a base temperature of 41° F. This is 315 more than the long term average. Temperatures were above average in May and September by 5.5 and 4.6 degrees respectively. Warmer temperatures and less rainfall in early May allowed for adequate field preparation and timely planting. However, following planting in May, June had over 6 inches of rain, almost 3 inches above average. The weather conditions were advantageous for weed growth and it was difficult early in the season to determine if the new seedlings would be able to survive the competition. A nurse crop may have helped reduce weed pressure. The remainder of the season saw much lower than average rainfall with under 2 inches from July through September. Favorable fall weather allowed the grasses additional time to grow when the weed pressure was much lower. In October, all plots were mowed to avoid smothering and winterkill the following year.

Prior to planting, the soil was analyzed for basic parameters (Table 4). In August, the site was sampled again and analyzed for nitrate content.

Table 4. Trial site soil characteristics.

Soil pH	Available P	K	Mg	Al	Ca	Organic matter	NO_3
	ppm	ppm	ppm	ppm	ppm	%	mg kg^{-1}
6.63	2.35	85	157	19	3407	5.8	11.8

*Clover * Variety Interactions*

There was a statistically significant interaction between clover treatment and variety (p = 0.03). This indicates that the sixteen grass varieties responded differently, in terms of dry matter yield, when planted in mixtures compared to monocultures. This interaction provides us information about which of these varieties may be better suited for organic systems where integration of legumes for nitrogen are an essential management practice. There was not an interaction between clover treatment and variety in terms of establishment (p = 0.22). Since this was only the establishment year and the resident nitrate level was moderately high (11.8 mg kg^{-1}) these differences may become more pronounced as the stand ages and resident nutrients are utilized.

Impact of Clover

Grasses mixed with clover established significantly better than grasses planted in monocultures (Table 5). Better establishment of grass mixed with clover may be related to weed suppression. Clover often germinates faster than grass and can provide ground cover that would help reduce subsequent weed growth. Dry matter yield was not statistically impacted by the addition of clover. Yields were higher, although not statistically different, in the grass-only plots. However, it is important to note that although the grass-only treatment produced higher yields, it had lower establishment. This can be explained by the presence of more weeds in the grass-only treatment. Since establishment was measured by visually identifying the planted species and judging establishment of that particular species not grass generally, although the biomass showed high yields, it was more largely composed of other species than the intended perennial grass. Due to the high proportion of weeds in some treatments, forage quality was not analyzed in this first year. In the following years, we will continue to monitor this establishment and determine if this first year trend of higher weed pressure in grass-only treatments continues as well as test for forage quality and nitrogen use efficiency.

Table 5. Impact of clover on yield and establishment of grasses in organic forage systems.

Treatment	DM yield	Establishment
	tons ac^{-1}	0-5
Grass	**2.57**	2.55
With Clover	2.40	**2.81**
Trial Mean	2.48	2.68
LSD (p=0.10)	NS	0.251

Impact of Variety

There was a significant difference in dry matter yield and establishment by variety (Table 6). The highest dry matter yield of 3.07 tons ac^{-1} was observed in plots planted with the variety ‘Barpenta’ timothy. There were six other varieties that were statistically similar to ‘Barpenta’ in yield including ‘Echelon’ orchardgrass, ‘Niva’ orchardgrass, and ‘Prevail’ meadow fescue. The lowest yielding variety was ‘York’ brome and the trial average for yield was 2.49 tons ac^{-1}.

Table 6. Impact of variety on yield and establishment.

Species	Variety	DM yield	Establishment
		tons ac^{-1}	0-5
Brome	Carlton	2.31bc	1.80e
Brome	Hakari Alaska	2.63abc	1.60e
Brome	Success	2.32bc	2.30cde
Brome	York	2.14c	1.80e
Meadow Fescue	HDR	2.38bc	3.50a
Meadow Fescue	Laura	2.37bc	2.60bcd
Meadow Fescue	Liherold	2.46bc	3.40a
Meadow Fescue	Prevail	2.69abc	**3.60a**
Orchardgrass	Echelon	2.87ab	3.20ab
Orchardgrass	Endurance	2.32bc	3.20ab
Orchardgrass	Extend	2.29bc	3.50a
Orchardgrass	Niva	2.71abc	3.00abc
Timothy	Barpenta	**3.07a**	2.30cde
Timothy	Clair	2.48abc	2.60bcd
Timothy	Climax	2.19c	2.20de
Timothy	Crest	2.60abc	2.30cde
Trial Mean		2.49	2.68
LSD (*p*=0.10)		0.60	0.71

Treatments with the same letter did not differ significantly from one another (p=0.10).

The variety with the highest establishment was 'Prevail' meadow fescue with a rating of 3.60. There were five other varieties that were statistically similar to 'Prevail', three orchardgrass varieties and two meadow fescue varieties. Both meadow fescue and orchardgrass averaged over 3 in establishment across varieties whereas timothy averaged 2.35 and brome 1.88. This suggests that in addition to varietal differences there may be species differences in ability to establish robust stands. Since we observed high weed pressure in the trial, these differences may indicate weed competitiveness of certain species/varieties. As this information only represents the seeding year through the fall, we will continue to monitor the plots this coming spring for winter survival and other signs of successful survival.

DISCUSSION

The data collected during the establishment year of this forage trial seem to suggest that species and variety selection will be critical for adequate establishment of a crop in an organic production system. By species there did not appear to be a significant difference in terms of yield, however, there was a significant difference in establishment. Meadow fescue and orchardgrass with and without clover established better compared to timothy and brome. Yield did not differ between the grass-only and with-clover treatments; however, when clover was present there was significantly better establishment of the

forage. This suggests that some of the biomass measured was not the planted variety but another grass or weed. It is possible that the clover is providing some weed suppression or additional nitrogen to the grass. When clover was seeded with grass, the establishment was better than just a grass planted monoculture. Since the forage was not analyzed for quality or nitrogen content due to the potentially high proportion of weed biomass, we have yet to investigate differences in quality or nitrogen use efficiency. We will continue to monitor these treatments for the next two years for differences in yield, establishment and persistence, quality, and nitrogen use efficiency to hopefully gain insight into species and varieties that may be better suited to organic dairy operations in the Northeast.

ACKNOWLEDGEMENTS

Funding for this project was through the USDA NIFA CARE Grant (2015-67028-23636). UVM Extension would like to thank Roger Rainville and his staff at Borderview Research Farm in Alburgh for their generous help with the trials. We would like to acknowledge Hillary Emick, Lindsey Ruhl, and Dan Ushkow for their assistance with data collection and entry. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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