2022 Perennial Grass Stockpiling Trial

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2022 PERENNIAL GRASS STOCKPILING TRIAL

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Stockpiling is the practice of deferring grazing or harvest of perennial forage stands in order to extend the grazing season later into the fall/winter. While this practice can be a useful tool in managing pasture, limited research on forage species performance, quality, and other management factors that may influence the success of this practice is limited in the Northeast. To address these information gaps, the University of Vermont Extension Northwest Crops and Soils Program initiated a trial evaluating stockpiled forage yield and quality of orchardgrass and tall fescue with, and without various nitrogen treatments including planting in combination with legume species or addition of commercial fertilizer. The 2022 growing season was the second full season after establishment for the trial.

MATERIALS AND METHODS

Forage species and variety information for the trial is summarized in Table 1. The plot design was a randomized complete block with split plots and five replications. Main plots were grass species and sub-plots were nitrogen treatments, which consisted of legume species (clover or alfalfa) or synthetic nitrogen application timing (early-Aug or late-Aug).

The soil type at the Alburgh location was a Benson rocky silt loam (Table 2). Plots were 5' x 20' and replicated 5 times. On 3-Jun, plots were fertilized with 300 lbs ac^{-1} 10-20-20 fertilizer. Through the summer, the trial was mowed when surrounding perennial cool season grass trials were harvested, however, no data were collected at these harvests. Plots receiving the early and late urea nitrogen treatments were fertilized with urea (46-0-0) at a rate of 40 lbs N ac^{-1} on 5-Aug and 28-Aug respectively. Forage from a 3' x 20' area from the center of each plot was harvested using a Carter flail forage harvester equipped with scales on 8-Nov. An approximate 1 lb subsample of the harvested material was collected and dried to determine dry matter content and calculate dry matter yields. The samples were then ground and analyzed for quality at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) via near infrared reflectance spectroscopy (NIR) techniques using a FOSS DS2500 Feed and Forage Analyzer.

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude pro 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. The total fiber content of forage is contained in the neutral detergent fiber (NDF) which includes cellulose, hemicellulose, and lignin. This measure indicates the bulky characteristic of the forage and therefore is negatively correlated with animal dry matter intake. The portion of the NDF that is digestible within 30 hours is represented by NDFD30. The acid detergent fraction (ADF) is composed of highly indigestible fiber and therefore, is negatively correlated with digestibility.

Table 1. Trial treatment information.

Treatment	Species	Variety	Seeding rate† lbs ac^{-1}	Nitrogen source
Fescue no N	Tall fescue	Kora	25	None
Orchardgrass no N	Orchardgrass	Echelon	25	None
Fescue/orchardgrass mix no N	Tall fescue	Kora	12.5	None
	Orchardgrass	Echelon	12.5	
Fescue + alfalfa	Tall fescue	Kora	10	Alfalfa
	Alfalfa	Enhancer II	15	
Orchardgrass + alfalfa	Orchardgrass	Echelon	10	Alfalfa
	Alfalfa	Enhancer II	15	
Fescue/Orchardgrass mix+ alfalfa	Tall fescue	Kora	5	Alfalfa
	Orchardgrass	Echelon	5	
	Alfalfa	Enhancer II	15	
Fescue + clover	Tall fescue	Kora	15	Red clover
	Red clover	Juliet	10	
Orchardgrass + clover	Orchardgrass	Echelon	15	Red clover
	Red clover	Juliet	10	
Fescue/Orchardgrass mix+ clover	Tall fescue	Kora	7.5	Red clover
	Orchardgrass	Echelon	7.5	
	Red clover	Juliet	10	
Fescue + early N	Tall fescue	Kora	25	Urea in early August
Orchardgrass + early N	Orchardgrass	Echelon	25	Urea in early August
Fescue/Orchardgrass mix+ early N	Tall fescue	Kora	12.5	Urea in early August
	Orchardgrass	Echelon	12.5	
Fescue + late N	Tall fescue	Kora	25	Urea in late August
Orchardgrass + late N	Orchardgrass	Echelon	25	Urea in late August
Fescue/Orchardgrass mix+ late N	Tall fescue	Kora	12.5	Urea in late August
	Orchardgrass	Echelon	12.5	

†Perennial forage established in spring of 2020 with some reseeding in spring of 2021.

Table 2. Trial management, Alburgh, VT.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Perennial forages
Tillage operations	Pottinger TerraDisc
Planting equipment	Great Plains small plot cone seeder
Replications	5
Plot size (ft.)	5 x 20
Planting date	29-Apr 2020 and 7-May 2021 (just fescue)
Harvest date	8-Nov 2022

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). Generally, the 2022 season was cooler and wetter than normal, however, there were periods of hot dry weather. Temperatures were below normal for all months except for May and October. Winter temperatures were particularly low in January and February. Precipitation fluctuated from month to month but overall, a total of approximately 32 inches of rain fell from April through October, which is 5.36 inches above normal for that time period. Cooler temperatures led to slightly below average Growing Degree Days (GDDs) being accumulated between April through October with a total of 4365 GDDs; 31 below the 30-year normal.

Table 3. 2021 weather data for Alburgh, VT.

	2021									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Average temperature (°F)	10.7	20.0	32.3	44.8	60.5	65.3	71.9	70.5	60.7	51.5
Departure from normal	-10.20	-2.93	-0.03	-0.81	2.09	-2.18	-0.54	-0.20	-1.99	1.24
Precipitation (inches)	0.28	1.14	2.52	5.57	3.36	8.19	3.00	4.94	4.40	2.56
Departure from normal	-1.85	-0.63	0.28	2.50	-0.40	3.93	-1.06	1.40	0.73	-1.27
Growing Degree Days (base 41°F)	0	11	60	201	617	726	953	909	593	366
Departure from normal	0	11	38	-14	77	-67	-20	-11	-59	63

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) from Burlington, VT.

Impact of Species

The three grass treatments performed similarly in terms of dry matter yield (Table 4). Each species and the mixture of the two yielded approximately 1.4 tons ac^{-1} from the stockpiled harvest. Last year, there was a slight advantage to the mixture over tall fescue alone, which could indicate differences in establishment between the two species. In terms of yield from a single stockpiled harvest, no advantage to using either orchardgrass, tall fescue, or a mixture of the two species is gained.

Table 4. Dry matter yield by species, 2022.

Grass species	Dry matter yield
	tons ac^{-1}
Orchardgrass	**1.41**
Orchardgrass/Tall Fescue	1.34
Tall Fescue	1.40
LSD (p = 0.10) ‡	NS†
Trial mean	1.38

Top performer treatments are in **bold.**
‡LSD; least significant difference at the p=0.10 level.
†NS, not statistically significant.

There were, however, differences in forage quality across the species treatments (Table 5). Crude protein (CP) levels were highest in the tall fescue plots, moderate in the mixture, and lowest in the orchardgrass plots. Fiber content and non-fiber carbohydrate contents did not differ across the species treatments. However, fiber digestibility and indigestible fiber contents did differ. The mixture and orchardgrass plots had 2-3% higher digestibility than the tall fescue alone. This corresponded to these treatments also having the lowest proportion of fiber left undigested after 240 hours of exposure to rumen fluid. These differences in individual quality parameters led to the mixture and orchardgrass plots having higher overall relative forage quality ratings and predicted milk yield per ton of dry matter. The 7-10 point increase in RFQ observed in the plots containing orchardgrass corresponded to a 150-170 lb ton^{-1} increase in predicted milk yield.

Table 5. Forage quality characteristics by species treatment, 2022.

Grass species	CP	NDF	NFC	30-hr NDF digestibility	240-hr uNDF	Milk yield	RFQ
		% of DM		% of NDF		lbs ton^{-1}	
Orchardgrass	9.92c†	54.8	24.8	57.4a	15.2a	3579a	139a
Orchardgrass/Tall Fescue	10.7b	53.8	**25.1**	**58.5**a	**14.3**a	**3598**a	**143a**
Tall Fescue	**11.5**a	**53.5**	25.1	55.5b	16.5b	3426b	133b
LSD (p = 0.10) ‡	0.523	NS¥	NS	1.62	1.14	73.7	5.05
Trial mean	10.7	54.0	25.0	57.2	15.3	3534	138

†Treatments that share a letter performed statistically similarly to one another. Top performer treatments are in **bold.**
‡LSD; least significant difference at the p=0.10 level.
¥NS, not statistically significant.

If we look at both yield and quality together, we can obtain a better understanding of whether the differences in quality will be substantial enough to equate to differences on a per acre basis (Table 6). Previously we saw there was no dry matter yield difference between the species. The differences in digestibility and predicted milk yield per ton ultimately were not great enough to translate into statistical differences on a per acre basis. While the orchardgrass alone treatment produced 886 lbs ac^{-1} 30-hr digestible NDF, this was not statistically different from the other treatments likely due to variability within each treatment. Similarly, the predicted milk yield per acre was numerically higher for orchardgrass, but not statistically different. These quality and yield data suggest there may be increased quality characteristics by including orchardgrass in stands intended for fall stockpiling as opposed to tall fescue alone, however, similar dry matter, digestible fiber, and milk yields may be achieved per acre.

Table 6. Dry matter, digestible NDF, and milk yield by grass species.

Grass species	DM Yield	30-hr Digestible NDF	Milk yield
	tons ac^{-1}	lbs ac^{-1}	
Orchardgrass	**1.41**	**886**	**5034**
Orchardgrass/Tall Fescue	1.34	845	4789
Tall Fescue	1.40	835	4812
LSD (p = 0.10) ‡	NS†	NS	NS
Trial mean	1.38	855	4878

‡LSD; least significant difference at the p=0.10 level. Top performer treatments are in **bold.**
†NS, not statistically significant.

Impact of Nitrogen Treatment

The five nitrogen treatments evaluated in this trial differed statistically in yield (Table 7). As expected, the control treatment that received no additional nitrogen produced the lowest yield of 0.810 tons ac^{-1}.

Table 7. Dry matter yield by nitrogen treatment, 2022.

Nitrogen treatment	Dry matter Yield
	tons ac^{-1}
Early N	1.63a
Late N	1.29b
Alfalfa	1.51ab
Clover	**1.68a†**
None	0.810c
LSD (p = 0.10) ‡	0.242
Trial mean	1.38

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

Interestingly, the early applied urea, alfalfa, and clover treatments all produced statistically similar yields. This is consistent with results found in 2021 as well. This suggests that planting orchardgrass or tall fescue with alfalfa or red clover can replace an early application of nitrogen fertilizer for stockpiling. The reduction in yield produced by the later application of nitrogen compared to the earlier application could be due to having more time for the nitrogen to make its way to the plant roots and be utilized for dry matter production. While weather conditions at the time of fertilizing can influence losses due to volatilization or leaching, conditions were the same at both fertilizing times. Therefore, the results are likely a function of the timing of application.

However, unlike in 2021, this year we did see a significant grass species by nitrogen treatment interaction, which suggests that the grass species responded differently to the nitrogen treatments. Figure 1 shows the interaction in which tall fescue had a much stronger yield response to the late applied nitrogen fertilizer than the other two grass treatments. Similarly, the mixture had a smaller response to being planted with clover than the other grasses or than when it was planted with alfalfa. These differences may be related to competition during establishment and compatibility differences between these legumes and the grass species treatments. This may also indicate that tall fescue may be actively growing later in the season compared to orchardgrass. It may also be more efficient at utilizing nitrogen given nearly double yields of tall fescue with no nitrogen application compared to orchardgrass.

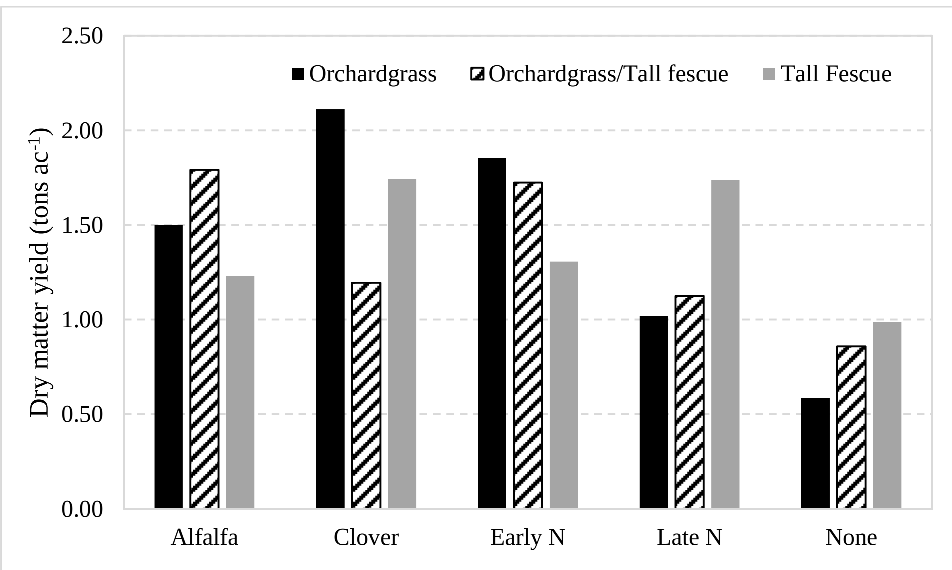

Figure 1. Grass species by nitrogen treatment interaction.

Nitrogen treatments also resulted in different qualities of forage (Table 8). Crude protein levels were highest in the late nitrogen application treatment at 12.2%. Interestingly, this was approximately 3% higher than the early nitrogen treatment. The red clover and no supplemental nitrogen treatments produced protein levels of 11.5%. Plots with red clover had higher protein than the plots with alfalfa by approximately 2%. Fiber content also varied with the lowest NDF values observed in the no nitrogen and late nitrogen treatments. Fiber digestibility also varied with the late nitrogen treatment producing significantly higher fiber digestibility levels of 62.7% than any other treatment. While this was only approximately 4% higher than the early nitrogen and no nitrogen treatment, it was almost 6% higher than the plots with clover and 12% higher than plots with alfalfa. This is to be expected as these legumes have a more upright growing habit with woody branching stems compared to grasses which essentially only contain leafy material that is more digestible. Ultimately, these differences in individual quality components yielded a higher predicted milk output from the late nitrogen treatment, which was over 100 lbs ton^{-1} more than the next highest treatments. Similarly, the relative forage quality was highest in the late nitrogen treatment followed by the clover, no nitrogen, and early nitrogen treatments with the lowest quality including alfalfa.

Table 8. Quality characteristics by nitrogen treatment.

Nitrogen treatment	CP	NDF	NFC	30-hr NDF digestibility	uNDF	Milk yield	RFQ
	% of DM			% of NDF		lbs ton^{-1}	
Early N	9.15c†	55.6b	24.8	58.7b	13.9ab	3560b	137b
Late N	**12.2**a	52.9a	24.3	**62.7**a	**12.6**a	**3671**a	**150**a
Alfalfa	9.54c	56.6b	24.3	50.9d	18.9d	3384c	125c
Clover	11.5b	52.6a	**26.2**	56.2c	16.3c	3537b	140b
None	11.2b	**52.5**a	25.5	57.4bc	14.8b	3519b	139b
LSD (*p* = 0.10) ‡	0.675	1.49	NS¥	2.09	1.47	95.1	6.52
Trial mean	10.7	54.0	25.0	57.2	15.3	3534	138

†Treatments that share a letter performed statistically similarly to one another. Top performer treatments are in **bold.**
‡LSD; least significant difference at the p=0.10 level.
¥NS, not statistically significant.

Since there were differences both in dry matter yield and individual quality characteristics, looking at the yield of these quality components can help us better understand the impact per acre (Table 9). The highest dry matter yields were observed in the clover, early nitrogen, and alfalfa treatments, which ultimately also had the highest predicted milk yield per acre. However, because of the lower digestibility of the alfalfa, the yield of 30-hr digestible NDF was lower in the alfalfa than the clover and early nitrogen treatments. The no nitrogen treatment had lower dry matter yield and lower quality in many aspects and therefore produced the lowest milk and digestible fiber yield per acre. These quality and yield data suggest that higher dry matter yield and quality on a per acre basis can be attained by an early application of nitrogen or the addition of a legume compared to a late application of nitrogen or no additional nitrogen source when stockpiling forage.

Table 9. Yield of quality components by nitrogen treatment.

Nitrogen treatment	DM Yield	30-hr Digestible NDF	Milk yield
	tons ac^{-1}	lbs ac^{-1}	
Early N	1.63a	**1073**a	5808a
Late N	1.29b	846b	4721b
Alfalfa	1.51ab	873b	5103ab
Clover	**1.68a†**	993ab	**5925**a
None	0.810c	491c	2834c
LSD (*p* = 0.10) ‡	0.242	0.081	858
Trial mean	1.38	855	4878

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

Despite these yield and quality benefits, it is important to understand the cost of these different strategies relative to their benefit. Using price estimates for urea and seed at the time this report was written, the red clover treatment appears to be a similarly priced option as an early application of urea but much less expensive than a later application or a mixture with alfalfa. (Table 10). This is critical for organic producers who cannot apply urea and do not have a comparably priced soluble nitrogen fertilizer source. While the cost per acre of an unfertilized grass stand is the lowest, because of its significantly lower yield, its cost per pound of dry matter produced is significantly higher than the other nitrogen treatments. Similarly, when you express the cost on a per milk hundredweight basis, the unfertilized grass stand also has the highest cost as the least production was gained from that treatment. With the volatile prices of seed and fertilizer, it is important to consider the costs in your area. Furthermore, the costs shown here include the cost of the seed which, after the first year, are not incurred while the nitrogen benefit is still gained. Therefore, utilizing legumes, if dry matter yields can be maintained, can be a longer-term solution to higher fertilizer prices and one that can be utilized on organic operations.

Table 10. Cost by nitrogen treatment, 2022.

Treatment	Cost		
	$ ac^{-1}	₵ lb DM^{-1}	₵ cwt milk^{-1}
Grass + early N	87	2.67	1.50
Grass + late N	87	3.37	1.84
Grass + alfalfa	103	3.41	2.02
Grass + clover	94	2.80	1.59
Grass only	70	4.32	2.47

cwt; 100 lbs of milk

DISCUSSION

Stockpiling perennial grasses for later grazing can be a successful strategy for this region to extend the grazing season. When left to grow for approximately 3 months following the second harvest in late July, stockpiled orchardgrass and tall fescue produced over 1.5 tons ac^{-1}. Similar yields could be attained by either applying 40 lbs ac^{-1} N in the form of urea in early August or planting the grasses with alfalfa or red clover. Depending on the cost of fertilizer and seed, the cost and subsequent return of these nitrogen treatments may vary, however, not providing fertilizer or a legume to the grass will result in a higher cost per pound of dry matter and milk produced and overall lower yields. 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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