NORTHWEST CROPS & SOILS PROGRAM

2017 Summer Annual Variety Trial

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2017 SUMMER ANNUAL VARIETY TRIAL

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Warm season grasses, such as sudangrass, and millet can provide quality forage in the hot summer months, when the cool season grasses enter dormancy and decline in productivity. The addition of summer annuals into a rotation can provide a harvest of high-quality forage for stored feed or grazing during this critical time. Generally, summer annuals germinate quickly, grow rapidly, are drought resistant, and have high productivity and flexibility in utilization. The UVM Extension Northwest Crops and Soils team conducted this variety trial to evaluate the yield and quality of warm season annual grasses.

MATERIALS AND METHODS

A trial was initiated at Borderview Research Farm in Alburgh, VT on 12-Jun 2017. Plots were managed with practices similar to those used by producers in the surrounding area (Table 1). The previous crop was winter barley. The field was disked and spike tooth harrowed prior to planting. Sixteen varieties of summer annual species were compared (Table 2). Plots were seeded with a Great Plains small plot drill at a seeding rate of 50 lbs ac^{-1} for the sorghums, sudangrasses and sorghum x sudangrass crosses and 20 lbs ac^{-1} for millets.

Table 1. General plot management, 2017.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Winter barley
Planting date	12-Jun
First harvest date	8-Aug
Second harvest date	13-Sep
Seeding rates: Millet	20 lbs ac^{-1}
Sorghum, Sudangrass, and hybrids	50 lbs ac^{-1}
Tillage methods	Mold board plow, disk, and spike tooth harrow

Plots were harvested with a Carter flail forage harvester on 8-Aug in an area of 3' x 20'. Due to uneven regrowth, only plots which reached at least 24" at the time of the second harvest were harvested by hand in a 0.25m^2 area. An approximate 1 lb subsample from each plot was collected and dried at each harvest to determine dry matter and calculate dry matter yields. The samples were then ground and analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and NDF digestibility (NDFD) at the University of Vermont Cereal Testing Lab (Burlington, VT) with a FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer.

Table 2. Summer annual varieties, characteristics, and seed source, 2017.

Variety	Species	Characteristics	Company
Exceed	Pearl Millet	BMR, Dwarf	Seedway, LLC
FSG 315	Pearl Millet	BMR, Dwarf	Alta Seeds
Prime 180	Pearl Millet	BMR, Dwarf	King's Agriseed
Tifleaf 3	Pearl Millet	Dwarf	Alta Seeds
Wonderleaf	Pearl Millet		Alta Seeds
AF 7102	Sorghum	BMR, Dwarf	Seedway, LLC
AS 6401	Sorghum x Sudangrass		Seedway, LLC
Green Grazer V	Sorghum x Sudangrass		Alta Seeds
Sweet 6	Sorghum x Sudangrass	BMR	Seedway, LLC
400x38	Sorghum x Sudangrass		Richardson Seeds
AS 9301	Sudangrass	BMR	Alta Seeds
Hayking	Sudangrass	BMR	King's Agriseed
Piper	Sudangrass		Seedway, LLC
ProMax	Sudangrass	BMR	Seedway, LLC
SSG 886	Sudangrass	BMR	Seedway, LLC
6-species mix	Buckwheat Annual ryegrass Millet Sunflower Sainfoin Red Clover		

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein (CP) 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 48 hours is represented by NDFD48. The acid detergent fraction (ADF) is composed of highly indigestible fiber and therefore is negatively correlated with digestibility. Results were analyzed with an analysis of variance in SAS (Cary, NC). The Least Significant Difference (LSD) procedure was used to separate cultivar means when the F-test was 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 (LSD's) at the 10% level of probability are shown. Where the difference between two treatments 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.

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

RESULTS

Seasonal precipitation and temperatures recorded with a Davis Instruments Vantage Pro 2 weather station with WeatherLink data logger in Alburgh, VT are shown in Table 3. From June through August there was an accumulation of 2048 Growing Degree Days (GDDs) in Alburgh, which is 354 GDDs more than the 30-year average. Rainfall was above average for all months except for September. Temperatures conversely were below average for June-August but above average for September. Slow emergence and growth of the crop was a result of wet soil conditions and cool temperatures. The poor growing conditions delayed the second harvest until mid-September at which time not all of the varieties had adequate regrowth to allow for harvest. As mild conditions persisted into October, some of the treatments may have gained enough growth to harvest at a later date, however this was not investigated in this trial; such treatments were considered to have not produced two harvests this season.

Table 3. Seasonal weather data collected in Alburgh, VT, 2017.

Alburgh, VT	June	July	August	September
Average temperature (°F)	65.4	68.7	67.7	64.4
Departure from normal	-0.39	-1.90	-1.07	3.76
Precipitation (inches)	5.64	4.88	5.54	1.84
Departure from normal	1.95	0.73	1.63	-1.80
Growing Degree Days (base 50°F)	468	580	553	447
Departure from normal	-7	-60	-28	129

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.

Variety Performance by Cutting

At the first harvest, varieties differed significantly in height and forage quality characteristics but not in yield (Table 4). Heights ranged from 46.2 cm to 134 cm. The shortest varieties were pearl millet varieties while the tallest were sudangrass varieties and the 6-species mixture. Crude protein levels varied considerably ranging from 11.4% to 17.0%. The highest protein level was produced by the pearl millet variety Exceed at 17.0%. This was statistically similar to five other varieties including all other pearl millet varieties and one sorghum x sudangrass variety 400x38. The ADF values ranged from 31.3% to 40.7%. The lowest content was found in the pearl millet variety ‘Tifleaf 3’ which was statistically similar to ten others varieties. ADF was highest in the 6-species mixture. The NDF concentrations followed a similar

pattern with the lowest levels also observed in the millet varieties. The NDF digestibility ranged from 45.6% to 67.1%. The highest digestibility was found in the pearl millet variety Prime 180. This was statistically similar to five other varieties including three other pearl millets and two sorghum x sudangrass varieties. The lowest digestibility was found in the 6-species mixture. This was likely due to the high proportion of tall-stemmed buckwheat and sunflowers in the mixture. Yields ranged from 0.996 to 2.86 tons ac^{-1}. However, due to high variation within the treatments, these differences were not statistically significant. In general, however, the yield attained in this trial was high considering the lack of GDDs and high rainfall through the season. The yields were consistent with previous trials in which we see a higher yield potential from the sudangrasses compared to millet or sorghum x sudangrass varieties.

Table 4. Yield and quality of 16 summer annual varieties, 1st cut, 2017.

Variety	Species	Height	Dry matter (DM)	DM yield	Crude protein	ADF	NDF	NDFD48
		cm	%	tons ac^{-1}	----------% of DM----------			% of NDF
Exceed	Pearl Millet	55.9	18.8	1.68	**17.0**	31.4*	51.9*	65.5*
FSG 315	Pearl Millet	46.2	21.0	0.996	15.2*	31.6*	52.8*	64.8*
Prime 180	Pearl Millet	58.8	19.0	1.61	16.6*	32.4*	52.6*	**67.1**
Tifleaf 3	Pearl Millet	61.7	17.9	1.27	15.7*	**31.3**	**51.3**	63.4
Wonderleaf	Pearl Millet	72.5	18.3	1.69	16.0*	31.9*	52.6*	64.6*
AF 7102	Sorghum	69.3	19.6	1.80	12.8	35.4*	58.4	62.8
AS 6401	Sorghum x Sudangrass	84.7	17.3	1.60	11.4	33.8*	57.2	65.1*
Green Grazer V	Sorghum x Sudangrass	97.6	19.1	1.65	11.9	35.9	59.4	58.3
Sweet 6	Sorghum x Sudangrass	76.7	**23.2**	1.37	12.3	34.6	58.7	63.6*
400x38	Sorghum x Sudangrass	63.8	22.1	1.57	14.6*	32.5*	55.1*	62.4
AS 9301	Sudangrass	98.5	18.6	2.33	12.6	35.3*	59.1	62.0
Hayking	Sudangrass	106*	20.6	2.48	13.2	34.9*	57.9	60.4
Piper	Sudangrass	109*	21.9	2.62	12.4	37.6	61.6	54.6
ProMax	Sudangrass	109*	20.4	1.79	13.1	36.6	59.0	57.6
SSG 886	Sudangrass	93.2	20.1	1.99	12.2	34.6*	58.5	62.2
Mix	6-species mixture	**134**	21.3	**2.86**	12.6	40.7	55.1*	45.6
LSD (p = 0.10)		32.3	NS	NS	2.90	4.24	5.15	3.56
First Cut Mean		83.5	19.9	1.83	13.7	34.4	56.3	61.2

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

NS- Not statistically significant.

Of the sixteen varieties in the trial, only 9 reached heights of at least 24" at the time of the second harvest and were therefore harvested (Table 5). The variety that regrew to the tallest height was the sudangrass variety Hayking which reached 74.0 cm at the time of the second harvest. This was statistically similar to three other varieties. Yield ranged from 0.964 to 1.92 tons ac^{-1} with the sudangrass variety Hayking also producing the highest yield. Due to high variation within the treatments, these differences were not statistically significant. Varieties also did not differ in terms of CP which averaged 14.5% for this cut.

Table 5. Yield and quality of 16 summer annual varieties, 2nd cut, 2017.

Variety	Species	Height	Dry matter	Dry matter yield	Crude protein	ADF	NDF	NDFD48
		cm	%	tons ac^{-1}		% of DM		% of NDF
Exceed	Pearl Millet	57.3	22.4	1.45	15.0	33.1	54.9*	**65.3**
FSG 315	Pearl Millet	50.3	22.1	1.43	13.5	34.1	57.4	63.5*
Prime 180	Pearl Millet	51.8						
Tifleaf 3	Pearl Millet	59.7	22.4	1.44	14.5	33.3	**54.4**	63.4*
Wonderleaf	Pearl Millet	67.6*	22.3	1.72	14.4	33.3	54.9*	63.4*
AF 7102	Sorghum	45.4						
AS 6401	Sorghum x Sudangrass	40.0	20.3	1.06	13.6	33.1	56.4	61.8
Green Grazer V	Sorghum x Sudangrass	53.0						
Sweet 6	Sorghum x Sudangrass	41.9						
400x38	Sorghum x Sudangrass	45.4						
AS 9301	Sudangrass	51.3	21.2	0.964	15.2	**31.9**	55.1*	64.1*
Hayking	Sudangrass	**74.0**	**23.9**	**1.92**	14.8	33.7	56.6	63.0*
Piper	Sudangrass	73.5*	23.1	1.32	**15.9**	37.0	59.8	53.0
ProMax	Sudangrass	68.9*	22.0	1.08	13.5	33.3	56.4	60.7
SSG 886	Sudangrass	53.0						
Mix	6-species	0.00						
LSD (p = 0.10)		13.8	NS	NS	NS	1.05	1.80	2.74
Second Cut Mean		53.3	22.2	1.38	14.5	33.6	56.2	62.0

*Treatments with an asterisk performed statistically similarly to the top performer in **bold.** NS- Not statistically significant.

Varieties did differ in terms of the quality parameters ADF, NDF, and NDF digestibility. The ADF concentration was lowest in the sudangrass variety AS 9301, which was statistically lower than all other varieties. The lowest NDF content was found in the pearl millet variety Tifleaf 3, which was statistically similar to three other varieties. The highest ADF and NDF concentrations were found in the sudangrass variety Piper with 37.0% and 59.8% respectively. The NDF digestibility was also lowest for this variety at 53.0% while the highest digestibility was 65.3% found in the pearl millet variety Exceed. This was statistically similar to five other varieties including all other millet and two sudangrass varieties.

Variety Performance across Cuttings

Over both cuttings, summer annual varieties differed significantly in yields (Figure 1). Overall, total yields ranged from 1.61 to 4.39 tons ac^{-1}. The highest yielding variety was the sudangrass variety Hayking which performed statistically similarly to three other varieties. The lowest yielding variety was the sorghum x sudangrass hybrid Sweet 6, which produced under 2 tons of dry matter per acre and was statistically similar to six other varieties. By species, we observed the highest yields being produced by sudangrasses followed by the 6-species mixture and pearl millets. However, the species and varieties also differed in their regrowth and quality. The millets, in general, offered higher protein, lower ADF and NDF contents, and higher NDF digestibility. All of these factors should be considered when selecting varieties.

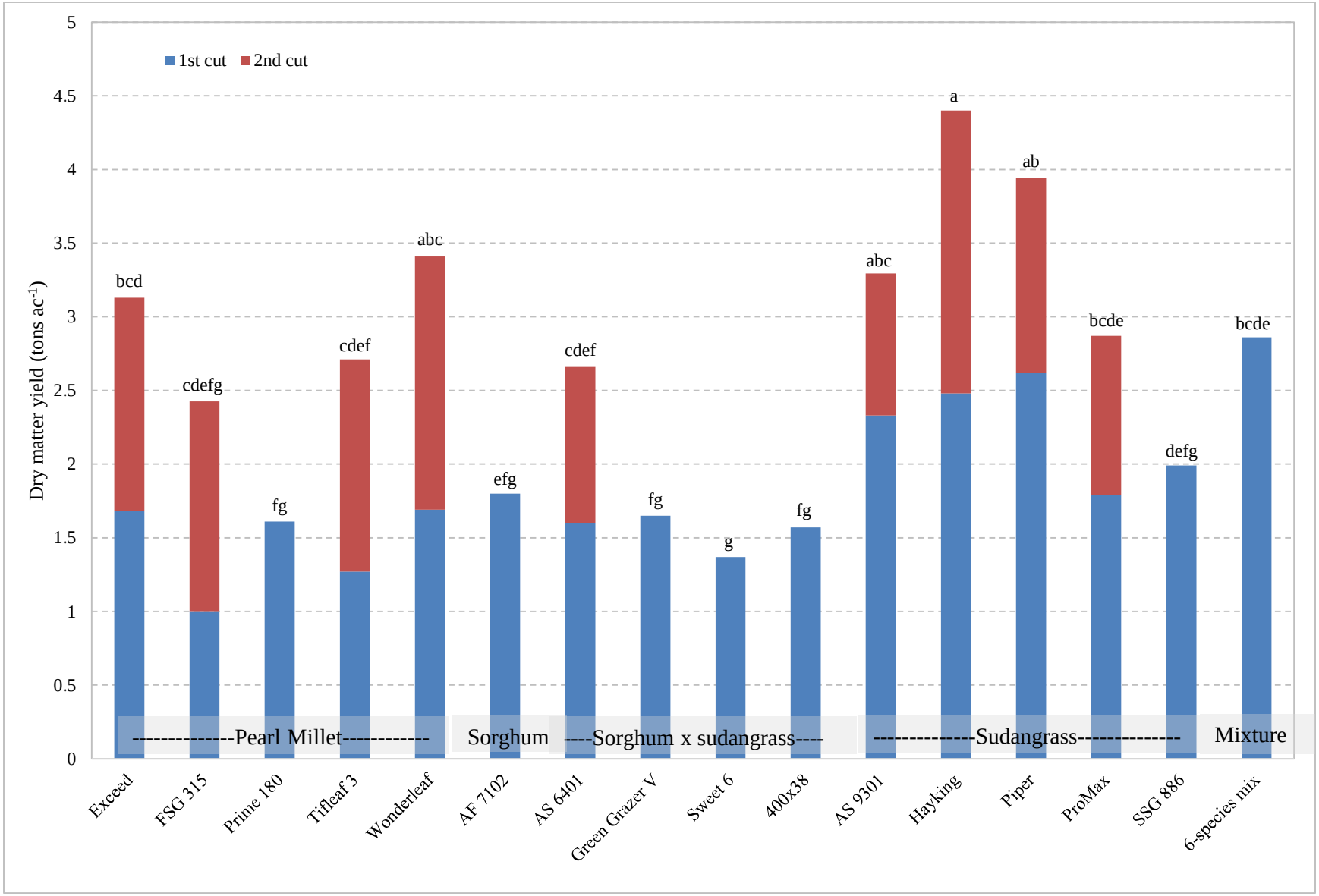

Figure 1. Yield of 16 summer annual varieties, 2017.
Treatments that share letters performed statistically similarly in terms of overall yield.

DISCUSSION

Although cool, wet weather delayed growth and harvest of these summer annuals, ultimately very high yields were attained by some species. In general, the highest yields were attained by sudangrass varieties followed by pearl millets. Quality tended to be higher in the pearl millets with higher protein, lower ADF and NDF content, and higher NDF digestibility. Varieties also differed in their ability to regrow given the undesirable weather and reach harvestable heights by the second harvest. Although it was not considered in this trial, the cost and availability of these varieties, as well as the intended use (grazing, haylage, dry hay) should also be considered before selecting a summer annual species or variety.

It is important to be aware of the risk of nitrate accumulation and the presence of prussic acid when growing summer annuals. Nitrates are considered relatively safe for feed up to 5000 ppm; however, there is a risk of excessive nitrate accumulation under excessive fertility, and immediately after a drought stressed crop receives rainfall. Additionally, sorghums, sudangrasses, and hybrids may contain prussic acid which is toxic when present. To avoid prussic acid poisoning:

- Graze when the grasses are at least 18 inches tall.
- Do not graze plants during and shortly after drought periods when growth is severely reduced.
- Do not graze wilted plants or plants with young tillers.
- Do not graze after a non-killing frost; regrowth can be toxic.
- Do not graze after a killing frost until plant material is dry (the toxin usually dissipates within 48 hours).
- Do not graze at night when frost is likely. High levels of toxins are produced within hours after frost occurs.
- Delay feeding silage six to eight weeks following ensiling.

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