2016

Summer Annual Variety Trial

Heather Darby
University of Vermont, heather.darby@uvm.edu

Sara Ziegler
University of Vermont

Nate Brigham
University of Vermont

Julija Cubins
University of Vermont

2016 Summer Annual Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, Nate Brigham, and Julija Cubins
UVM Extension Crops and Soils Technicians
802-524-6501

Visit us on the web: http://www.uvm.edu/extension/cropsoil

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2016 SUMMER ANNUAL VARIETY TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

Warm season grasses, such as sorghum x sudangrass crosses, sudangrass, and millet are high-yielding annuals that can provide quality forage in the hot summer months, when the cool season grasses that make up most pastures and hay meadows in the Northeast 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 16-Jun 2016. Plots were managed with practices similar to those used by producers in the surrounding area (Table 1). The previous crop was corn silage. The field was disked and spike tooth harrowed prior to planting. Thirteen 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, 2016.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Corn silage
Planting date	16-Jun
First harvest date	3-Aug
Second harvest date	30-Aug
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 3-Aug and 30-Aug with a harvest area of 3’ x 20’. Due to uneven emergence, some of the plots had to be 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, 2016.

Variety	Species	Characteristics	Company
FSG 300	Millet	non-BMR	Seedway
Wonderleaf	Millet	non-BMR	Alta Seeds
Exceed	Millet	Dwarf, BMR	King’s Agriseed
AF 7101	Sorghum	non-BMR	Alta Seeds
AF 7201	Sorghum	non-BMR	Alta Seeds
FSG 214	Sorghum x Sudangrass	BMR	Seedway
FSG 215	Sorghum x Sudangrass	BMR	Seedway
AS 6401	Sorghum x Sudangrass	BMR	Alta Seeds
Green Grazer V	Sorghum x Sudangrass	non-BMR	Seedway
SSG 886	Sudangrass	BMR	Seedway
AS 5201	Sudangrass	non-BMR	Alta Seeds
Hayking	Sudangrass	BMR	King's Agriseed
Pro Max	Sudangrass	BMR	Seedway

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 30 hours is represented by NDFD30. 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 the example on right, 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 1784 Growing Degree Days (GDDs) in Alburgh, which is 90 GDDs more than the 30-year average. Rainfall was below normal at planting by almost an inch. Slow and patchy emergence of the crop was a result of dry soil conditions. These droughty conditions persisted through the growing season with the driest month being July, which was almost 2.5" below normal. Temperatures during the season were approximately normal with the exception of August, which was about 3 degrees above normal. These warm dry conditions continued into September causing poor regrowth and no third harvest.

Table 3. Seasonal weather data collected in Alburgh, VT, 2016.

Alburgh, VT	June	July	August
Average temperature (°F)	65.8	70.7	71.6
Departure from normal	0.00	0.10	2.90
Precipitation (inches)	2.80	1.80	3.00
Departure from normal	-0.88	-2.37	-0.93
Growing Degree Days (base 50°F)	481	640	663
Departure from normal	7	1	82

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

Dry matter yields per acre varied drastically by variety for the first harvest (Table 4). Yields ranged from 1.29 to 2.97 tons ac^{-1} dry matter with the average for the trial being 2.03 tons ac^{-1}. The highest yielding variety was AS 6401, a BMR sorghum-sudangrass, which performed statistically similarly to four other varieties. The lowest yielding varieties were FSG 300 pearl millet and Pro Max sudangrass, which only produced 1.29 and 1.30 tons ac^{-1} respectively. All quality parameters also varied statistically across varieties in the first harvest. Crude protein levels ranged from 12.2% to 20.3%. The variety with the highest protein was Exceed, a dwarf BMR pearl millet, with a crude protein concentration of 20.3%. This was statistically similar to the protein levels of FSG 300 and Wonderleaf, the other two millet varieties trialed, as well as Pro Max sudangrass. The other nine varieties produced protein levels of 15.1% or less. The ADF and NDF concentrations also varied statistically with the lowest levels being observed in the Exceed pearl millet with 27.0% ADF and 51.3% NDF. For both of these parameters, FSG 300 millet was the only other variety that performed statistically similarly with 28.3% ADF and 52.4% NDF. The trial averages were 31.8% and 57.8% ADF and NDF respectively. The sudangrass variety Pro Max had the most digestible fiber but performed statistically similarly to seven other varieties.

Table 4. Yield and quality of 13 summer annual varieties, 1st cut, 2016.

Variety	Species	DM Yield	Crude protein	ADF	NDF	NDFD
		tons ac^{-1}	% of DM	% of DM	% of DM	% of NDF
FSG 300	Millet	1.29	19.9*	28.3*	52.4*	61.3*
Wonderleaf	Millet	2.14*	18.1*	30.4	56.2	55.8
Exceed	Millet	1.67	**20.3***	**27.0***	**51.3***	60.8*
AF 7101	Sorghum	2.56*	13.0	34.6	62.5	55.7
AF 7201	Sorghum	2.04	13.5	34.3	61.1	55.5
FSG 214	Sorghum x Sudangrass	2.19*	14.0	31.7	58.4	62.8*
FSG 215	Sorghum x Sudangrass	2.00	14.5	31.8	57.8	59.2*
AS 6401	Sorghum x Sudangrass	**2.97***	12.2	34.8	60.8	59.7*
Green Grazer V	Sorghum x Sudangrass	2.29*	13.3	33.4	59.4	54.3
SSG 886	Sudangrass	1.61	15.1	30.9	57.5	59.7*
AS 5201	Sudangrass	2.13*	13.8	32.8	59.8	58.3*
Hayking	Sudangrass	2.19*	13.8	33.0	58.9	54.0
Pro Max	Sudangrass	1.30	16.5*	30.3	55.9	**63.0**
LSD (p = 0.10)		0.967	3.89	3.17	4.31	5.92
First Cut Mean		2.03	15.2	31.8	57.8	58.5

*Treatments with an asterisk were statistically similar.
The treatment in **bold** was the top performer for that variable

All varieties had NDF digestibilities of at least 54% with four varieties having over 60%. Although some of the varieties trialed were BMR varieties, they did not necessarily perform drastically different from their non-BMR counterparts in terms of NDF digestibility. This could have been due to high temperatures and drought conditions which can increase fiber content and decrease digestibility. For example, Hayking and Pro Max are both BMR sudangrass varieties. However, Pro Max had the highest digestibility of 63.0% while Hayking had the lowest of 54.0%. Interestingly, Exceed and FSG 300 millets had similar NDFD and were both about 5% higher than Wonderleaf, however only Exceed is a BMR variety.

For the second harvest, yields did not differ statistically between varieties; however quality parameters did differ among varieties. Dry matter yields ranged from 0.86 to 1.54 tons ac^{-1} dry matter with FSG 300 being the top producer and the entire trial averaging 1.10 tons ac^{-1}. The two sorghum species yielded less than 0.90 tons ac^{-1}, all other varieties produced approximately 1 ton. Protein levels were considerably higher in the 2nd cutting than the first ranging from 17.4% to 21.5%. The sorghum variety AF 7201 had the highest protein but was statistically similar to FSG 300, Wonderleaf, Exceed, AF 7101, and AS 6401. The ADF concentration ranged from 28.1% to 32.0% with an average of 30.5%, similar to the first harvest. Wonderleaf millet had the lowest ADF which was statistically similar to that of FSG 300, Exceed, AF 7101, and AF 7201. The NDF content ranged from 51.5% to 57.5%. Wonderleaf millet had the lowest NDF, although statistically similar to FSG 300 and AF 7101. The NDF digestibility ranged from 57.0% to 67.4% with an average of 62.3%, a little higher than the 1st cut. Four of the 12 other varieties performed similarly to the top performer AF 7201 at 67.4%. Interestingly in this second harvest, the highest values for digestibility were produced by all non-BMR varieties except for AS 6401.

Table 5. Yield and quality of 13 summer annual varieties, 2nd cut, 2016.

Variety	Species	DM Yield	Crude protein	ADF	NDF	NDFD30
		tons ac^{-1}	% of DM	% of DM	% of DM	% of NDF
FSG 300	Millet	**1.54**	20.0*	29.0*	53.3*	64.2*
Wonderleaf	Millet	1.06	20.8*	**28.1***	**51.1***	57.0
Exceed	Millet	0.96	19.7*	29.4*	54.3	59.6
AF 7101	Sorghum	0.86	20.4*	29.9*	53.8*	65.7*
AF 7201	Sorghum	0.86	**21.5***	29.8*	52.7	**67.4**
FSG 214	Sorghum x Sudangrass	1.01	18.0	31.7	56.0	60.1
FSG 215	Sorghum x Sudangrass	1.04	17.9	31.8	55.6	61.0
AS 6401	Sorghum x Sudangrass	0.98	19.8*	30.8	54.0	65.3*
Green Grazer V	Sorghum x Sudangrass	1.16	18.4	32.0	55.9	62.9*
SSG 886	Sudangrass	1.08	19.3	30.4	54.6	63.1
AS 5201	Sudangrass	1.24	17.4	32.0	57.5	63.4*
Hayking	Sudangrass	1.02	18.5	30.6	54.0	61.5
Pro Max	Sudangrass	1.47	19.3	30.9	55.6	58.7
LSD (p = 0.10)		NS	2.02	1.77	2.24	5.29
Second Cut Mean		1.10	19.3	30.5	54.5	62.3

*Treatments with an asterisk were statistically similar
The treatments in **bold** was the top performer for that variable
NS - varieties did not differ significantly within a column.

Variety Performance across Cuttings

Some of the species and varieties exhibited slower regrowth after cutting and therefore, may be less suitable for grazing or multi-cut systems. Figure 1 shows a stacked bar graph with the total dry matter production separated by the two cuttings. This diagram allows one to visualize the regrowth for these different species and varieties; the more even the two bars, the better the regrowth after the 1st cut. Two varieties, FSG 300 and Pro Max, regrew to produce more than 100% of their 1st cut yields in just 27 days. Others, such as AS 6401 and AF 7101, only produced about 30% of their 1st cut yields after the same regrowth period. Noting these differences between varieties could be an important factor in choosing the best fit for a particular system or set of goals. The overall yields, combining both cuttings, did not statistically differ across varieties although the graph appears to show significant differences. This was due to high variation between plots within variety, making it difficult to accurately state differences. The lack of precipitation impacted stand establishment and likely yield, as well as regrowth following first harvest. Overall, the millets had higher quality than most sorghum, sudangrass, and sorghum x sudangrass crosses.

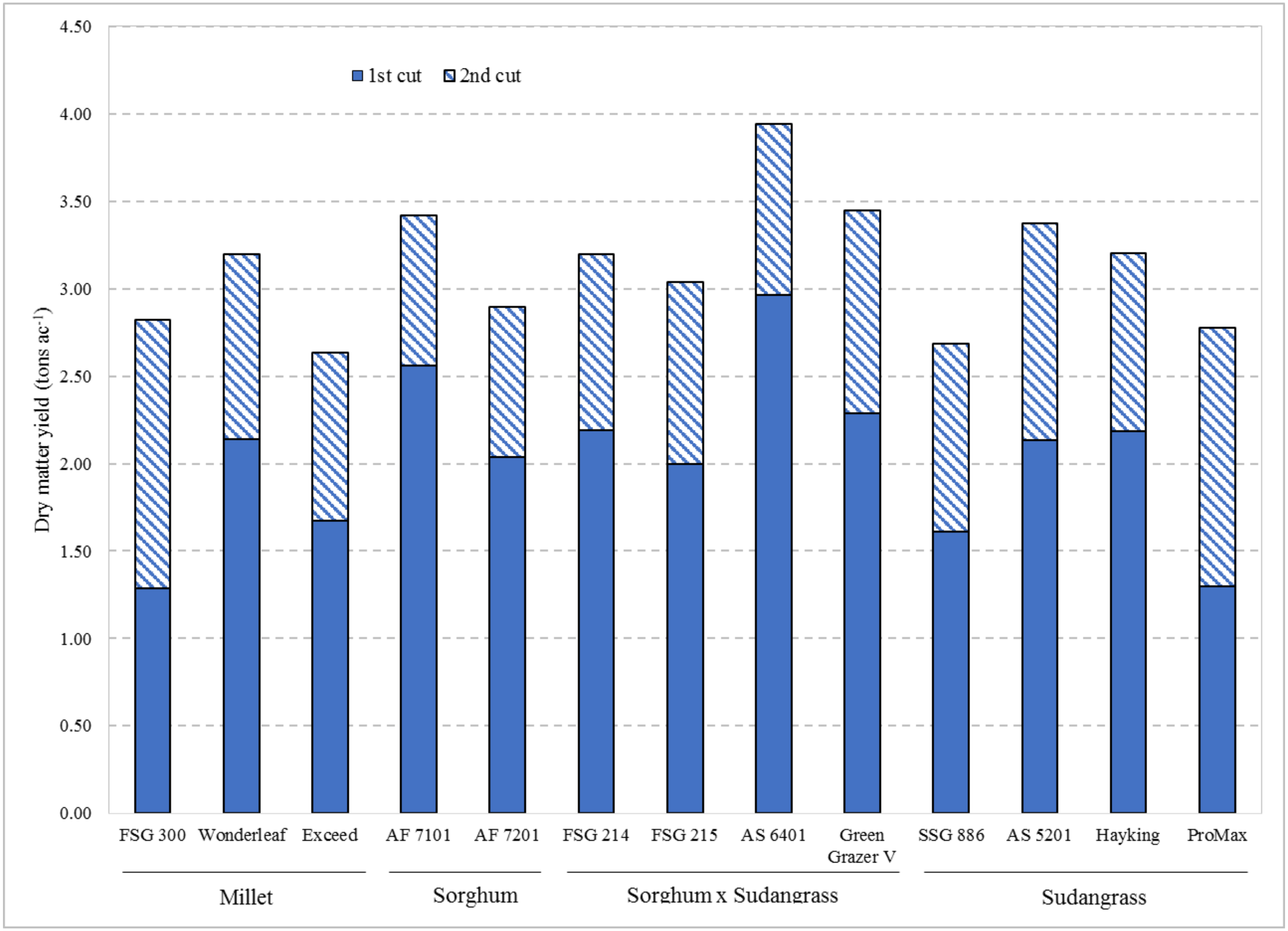

Figure 1. Yields of 13 summer annual grass varieties across two cuttings, 2016.

DISCUSSION

Summer annual grasses can provide substantial dry matter yields at a very crucial time of the grazing and forage production season in the Northeast. They can also provide the producer with flexibility to use the grasses as needed for grazing, hay, or silage. As with any decision on the farm, it is important to consider the goals of integrating summer annuals into the system as well as the specific management concerns for each species when deciding which is best. In addition, as this experiment has shown, there can be dramatic differences in yield, quality, and growth habit of different varieties of these species. Important consideration of all of these factors is necessary to successfully integrate these grasses into the farm's feeding system.

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.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial. We would also like to acknowledge Erica Cummings, Kelly Drollette, Hillary Emick, Abha Gupta, Julian Post, Lindsey Ruhl, and Xiaohe "Danny" Yang for their assistance with data collection and entry. This project was made possible through a USDA CARE grant. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.