NORTHWEST CROPS & SOILS PROGRAM

2020 Summer Annual Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2020 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 cool season perennial 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 Program 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 22-May 2020. Plots were managed with practices similar to those used by producers in the surrounding area (Table 1). Fifteen varieties of summer annual species were compared (Table 2). Plots were seeded with a Great Plains cone seeder at a seeding rate of 50 lbs ac^{-1} for the sorghums, sudangrasses, and sorghum x sudangrass crosses, at 20 lbs ac^{-1} for millet, and at 30 lbs ac^{-1} for annual ryegrass. The mixtures were seeded according to the recommendation on the labels. Approximately 92 lbs N was applied in the form of urea (46-0-0) on 23-Jun.

Table 1. General plot management, 2020.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Hemp
Planting date	22-May
First harvest date	15-Jul
Second harvest date	10-Aug
Seeding rates: Millets	20 lbs ac^{-1}
Sorghum, Sudangrass, and hybrids	50 lbs ac^{-1}
Annual ryegrass	30 lbs ac^{-1}
Mixture (Summer Feast)	20 lbs ac^{-1}
Mixture (Ray's Crazy Summer Mix)	50 lbs ac^{-1}
Mixture (Summer 2020 Mix)	50 lbs ac^{-1}
Tillage methods	Mold board plow, disk, and spike tooth harrow

Prior to harvest, plant heights were measured at three random locations within each plot. Treatments that did not reach a minimum of 24" were not harvested. Plots were harvested with a Carter flail forage harvester outfitted with scales on 15-Jul and 10-Aug from the center 3' x 20' of each plots. 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 quality at the E. E. Cummings Crop Testing Laboratory (Burlington, VT) via near infrared reflectance spectroscopy (NIR) techniques using a FOSS DS2500 Feed and Forage Analyzer.

Table 2. Summer annual varieties, characteristics, and seed sources, 2020.

Variety	Species	Characteristics	Company
KF Prime 180	Pearl Millet	BMR, Dwarf	King Fisher
KF Prime 360	Pearl Millet	BMR, Dwarf	King Fisher
FSG 315	Pearl Millet	BMR, Dwarf	Farm Science Genetics
VNS	Japanese Millet		Seedway, LLC
KF Sugar Pro 55 SS	Sorghum x Sudangrass	BMR	King Fisher
Green Grazer V	Sorghum x Sudangrass	Green Top	Seedway, LLC
AS 9302	Sorghum x Sudangrass	BMR6, Dwarf	Alta Seeds
FSG 214	Sorghum x Sudangrass	BMR	Farm Science Genetics
FSG 215	Sorghum x Sudangrass	BMR	Farm Science Genetics
AS 5201	Sudangrass		Alta Seeds
Big Bang	Annual ryegrass		Seedway, LLC
Centurion	Annual ryegrass		Seedway, LLC
Ray's Crazy Summer Mix	Cowpeas (62%) AS 9302 sudangrass (11%) Peredovik sunflower (10%) Leafy T millet (7%) Daikon radish (7%) T-Raptor hybrid brassica (3%)	BMR sundangrass	King's Agriseeds
Summer 2020 Mix	Cowpeas (45%) Sorghum Sudan TR (17%) Sunnhemp (11%) Peredovik sunflower (10%) Millet TR (7%) Daikon radish (7%) Barkant forage turnip (3%)		King's Agriseeds
Summer Feast Mix	Wonderleaf pearl millet (88%) T-Raptor hybrid brassica (12%)		King's Agriseeds

Mixtures of true proteins, composed of amino acids, and non-protein nitrogen make up the crude protein 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. aNDFom is the NDF content on an organic matter basis which can help avoid overestimation in cases of high ash content. This measure indicates the bulky characteristic of the forage and therefore is negatively correlated with animal dry matter intake. The portion of NDF which is predicted to be left undigested after 240 hours of incubation in rumen fluid is reported as undigestible NDF (uNDF240). The acid detergent fraction (ADF) is composed of highly indigestible fiber and therefore, is negatively correlated with digestibility. Water soluble carbohydrates (WSC) include sugars and other compounds that are water soluble including fructans. These are utilized by ruminants for energy.

Results were analyzed using a general linear model procedure of SAS (SAS Institute, 2008). Replications were treated as random effects, and treatments were treated as fixed. Mean comparisons were made using

the Least Significant Difference (LSD) procedure where the F-test was considered significant, at $p<0.10$. 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 between treatments (i.e. varieties) is likely attributable to the treatment or random variation. At the bottom of each table, an LSD value may be presented. 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 treatments. Treatments that were not significantly lower in performance than the highest value in a particular column is 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 a WeatherLink data logger in Alburgh, VT, are shown in Table 3. Although the early season brought cool, wet conditions, temperatures quickly rose, and rainfall dissipated by the time of planting this trial. Rainfall was below normal with the region being designated as D0 or abnormally dry (Drought.gov) throughout the season. Much of the rain that fell throughout the season came in short duration storms. For example, in August there were only 6 rain events that accumulated at least 0.1". Of these, 2 events, totaling 1.53" and 2.98" each, contributed 67% of the month's entire accumulation. Furthermore, temperatures remained above normal for much of the mid-summer. In July, 75% of the month saw temperatures climb above 80° F with some days reaching above 90° F. On average, July temperatures were over 4 degrees above normal. These temperatures contributed to above normal Growing Degree Days (GDDs) accumulations of 1851, 158 above the 30-year normal.

Table 3. Seasonal weather data collected in Alburgh, VT, 2020.

Alburgh, VT	June	July	August
Average temperature (°F)	66.9	74.8	68.8
Departure from normal	1.08	4.17	0.01
Precipitation (inches)	1.86	3.94	6.77
Departure from normal	-1.77	-0.28	2.86
Growing Degree Days (base 50°F)	516	751	584
Departure from normal	35	121	2

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.

Prior to harvest, heights were measured in all plots. Treatments that did not reach at least 24" (61cm) in height or were assessed to have high variability in density or high weed pressure were not harvested. Heights for all treatments for both cuttings are summarized in Table 4.

Table 4. Height of all summer annual treatments across both harvests, 2020.

Variety	Species	Height (cm)	
		1st cut	2nd cut
KF Prime 180	Pearl Millet	47.9e	59.5f
KF Prime 360	Pearl Millet	43.4ef	57.1f
FSG 315	Pearl Millet	46.9e	59.7f
VNS	Japanese Millet	41.2ef	70.5def
KF Sugar Pro 55 SS	Sorghum x Sudangrass	76.2bc	84.1bcd
Green Grazer V	Sorghum x Sudangrass	88.4a	95.9ab
AS 9302	Sorghum x Sudangrass	61.2d	68.7ef
FSG 214	Sorghum x Sudangrass	69.3cd	80.8cde
FSG 215	Sorghum x Sudangrass	79.0b	86.6bc
AS 5201	Sudangrass	**94.2a**	**101a**
Big Bang	Annual ryegrass	36.3fg	14.3g
Centurion	Annual ryegrass	27.8gh	8.92g
Ray's Crazy Summer Mix	Mixture	36.5fg	65.0f
Summer 2020 Mix	Mixture	48.9e	86.6bc
Summer Feast Mix	Mixture	24.6h	57.9f
LSD (p = 0.10)		9.37	14.0
Trial Mean		54.8	66.4

Treatments that share a letter performed statistically similarly to one another.
The top performing treatment is indicated in **bold.**

Although these species are typically very good at withstanding drought conditions and high temperatures, only the sudangrass and sorghum x sudangrass varieties were substantial and consistent enough to warrant harvest. Despite some species eventually regaining height by the 2nd harvest, for statistical analysis only treatments that were harvested at the first harvest were harvested a second time. The remaining results presented in this report will only reflect the subset of treatments that were deemed harvestable.

The average dry matter yield for the trial was 2.44 and 2.03 tons ac^{-1} for the first and second harvests respectively (Table 5). Due to slow emergence and growth in the very dry conditions, the first harvest was made 54 days after planting. With rain finally arriving in August, the second harvest was able to occur 26 days after the first harvest which is a more typical regrowth interval for these grasses. Total yields ranged from 3.64 to 4.88 tons ac^{-1} and did not differ statistically between varieties. A distribution of yields by cutting for each variety can be seen in Figure 1.

Quality differed statistically by variety (Table 6). Crude protein was highest in the sorghum x sudangrass variety AS9302, which averaged 24.3%. All varieties produced over 21.0% protein. The ADF content averaged 33.4% across the trial and did not differ by variety. The NDF content as expressed on an organic matter basis (aNDFom) averaged 55.3%. The lowest NDF content was produced by variety AS9302 with 52.8%. This was statistically lower than any other variety. High NDF content will negatively impact dry matter intake. However, some of this NDF is digestible and is reported as NDFD. The variety AS9302 also had the highest NDF digestibility at 80.3% with two varieties, AS5201 and Green Grazer V having significantly lower NDF digestibility than all other varieties. Similarly, NDF left undigested after 240 hours (uNDF240) was significantly higher in these two varieties. Water soluble carbohydrates, a source of energy,

also differed by variety ranging from 7.39% to 9.37%. The estimated portion of overall dry matter that contains digestible nutrients (TDN) ranged from 52.9% to 57.1%. However, utilizing these quality metrics, the estimated amount of energy available to an animal for lactation, as estimated by net energy of lactation (NEL) did not differ statistically.

Table 5. Yield of six summer annual varieties across two cuttings.

Variety	**Dry matter (DM)**	**DM yield**		
		1st cut	2nd cut	Total
	%	tons ac^{-1}		
KF Sugar Pro 55 SS	15.3	**2.60**	2.05	4.65
Green Grazer V	15.6	2.52	2.19	4.71
AS 9302	15.4	2.03	1.60	3.64
FSG 214	16.0	2.49	1.91	4.40
FSG 215	**14.6**	2.59	1.95	4.54
AS 5201	15.7	2.40	**2.49**	**4.88**
LSD (p = 0.10)	NS‡	N/A†	N/A	NS
Trial mean	15.4	2.44	2.03	4.47

The top performing treatment is indicated in **bold.**
N/A†; statistical analysis not performed within individual cuttings.
NS‡; not statistically significant.

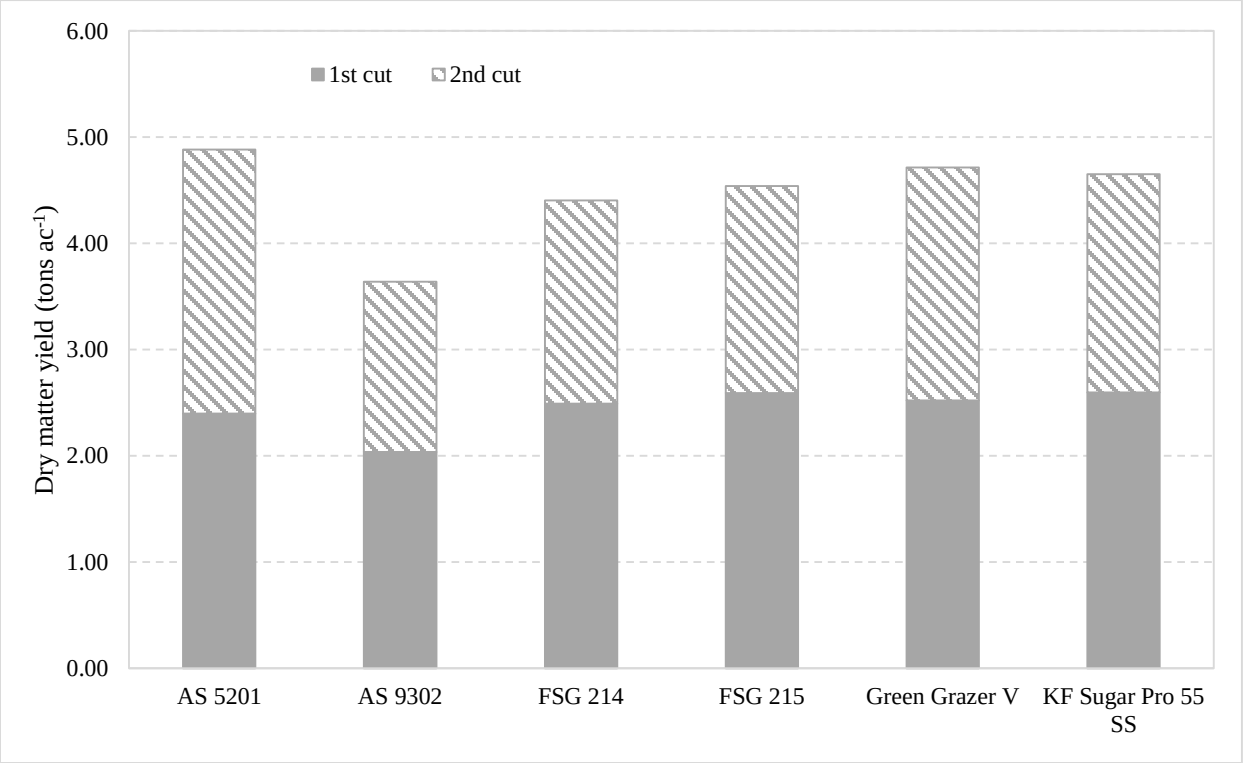

Figure 1. Total yield of six summer annual varieties across harvests, 2020.

Table 6. Forage quality of six summer annual varieties across two cuttings.

Variety	CP	ADF	aNDFom	WSC	TDN	NDFD	uNDF240	NEL	Milk yield
			% of DM			% of NDF		Mcal lb^{-1}	lbs ton^{-1}
KF Sugar Pro 55 SS	22.6bc	33.2ab	55.6bc	7.91bc	55.8ab	76.6b	8.1a	0.522	3546b
Green Grazer V	21.2c	34.3b	57.2c	8.71ab	**57.1a**	72.0c	10.5b	**0.531**	3530b
AS 9302	**24.3a**	33.2ab	**52.8a**	7.39c	52.9c	**80.3a**	**7.83a**	0.507	**3789a**
FSG 214	22.5bc	33.2ab	55.0b	8.29ab	55.0b	77.9ab	8.17a	0.515	3574b
FSG 215	23.0ab	33.6ab	55.4b	8.12bc	55.1b	76.5b	8.21a	0.522	3606b
AS 5201	21.6bc	**32.8a**	55.8bc	**9.37a**	56.0ab	73.3c	9.82b	0.523	3472b
LSD (p = 0.10)	1.57	NS‡	1.76	1.12	1.84	2.42	0.794	NS	146
Trial mean	22.5	33.4	55.3	8.30	55.3	76.1	8.78	0.520	3586

Treatments that share a letter performed statistically similarly to one another.
The top performing treatment is indicated in **bold.**
NS‡- not statistically significant.

Finally, milk yield is an estimated value of the lbs of milk produced from a ton of the forage. This calculation combines multiple quality parameters into one metric to simplify comparison. Variety AS9302 has a significantly higher milk yield than any other variety and all other varieties were statistically similar to one another.

DISCUSSION

These data demonstrate the value of integrating summer annual forages into forage production systems in the Northeast. In a year with above average temperatures and below average precipitation, summer annual grasses on average produced almost 4.5 tons ac^{-1}. Summer annuals can provide substantial dry matter of high quality feed to supplement lactating dairy cows at the time of the year when perennial cool season grass growth slows. Harvests should be made when the grasses are tall enough, but while they are still relatively leafy and vegetative to increase the proportion of fiber that is digestible. Although other species can be grown during this part of the growing season, sorghum x sudangrass and sudangrass varieties were better able to handle the extreme drought conditions and were reliably harvestable for two cuttings. However, these data only represent one year of data and should not be used alone to make management decisions.

With growing summer annuals, it is important to also be aware of the risk of nitrate accumulation and the presence of prussic acid. 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 can be toxic. To avoid prussic acid poisoning from summer annuals:

- 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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