NORTHWEST CROPS & SOILS PROGRAM

2021 Summer Annual Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2021 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 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 23-Jun 2021. Plots were managed with practices similar to those used by producers in the surrounding area (Table 1). Twenty-three 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 30 lbs ac^{-1} for millet, and at 30 lbs ac^{-1} for annual ryegrass, sainfoin, and sunn hemp. An application of approximately 100 lbs ac^{-1} urea (46-0-0) was made following harvest.

Table 1. General plot management, 2021.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Milkweed
Planting date	23-Jun
First harvest date	9-Aug
Second harvest date	22-Sep
Seeding rates: Millets	30 lbs ac^{-1}
Sorghum, Sudangrass, and hybrids	50 lbs ac^{-1}
Annual ryegrass, sainfoin, and sunn hemp	30 lbs ac^{-1}
Tillage methods	Pottinger TerraDisc

Plots were harvested with a Carter flail forage harvester outfitted with scales on 9-Aug and 22-Sep from the center 3’ x 20’ of each plot. 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 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.

Table 2. Summer annual varieties, characteristics, and seed sources, 2021.

Variety	Species	Characteristics	Source
Exceed	Pearl Millet	BMR, Dwarf	King's Agriseed
FSG300	Pearl Millet	BMR, Dwarf	Seedway, LLC
KF Prime 180	Pearl Millet	BMR, Dwarf	G Boucher Fertilizer
KF Prime 360	Pearl Millet	BMR, Dwarf	King's Agriseed
VNS	Japanese Millet		G Boucher Fertilizer
KF Sugar Pro 55 SS	Sorghum x Sudangrass	BMR	G Boucher Fertilizer
Green Grazer V	Sorghum x Sudangrass	Green Top	Seedway, LLC
AS6501	Sorghum x Sudangrass	BMR	G Boucher Fertilizer
AS6201	Sorghum x Sudangrass	BMR	G Boucher Fertilizer
AS5201	Sorghum x Sudangrass		G Boucher Fertilizer
King's 150	Sorghum x Sudangrass	BMR	G Boucher Fertilizer
SSA-251	Sorghum x Sudangrass	BMR, Dry stalk	Seedway, LLC
SSA-252	Sorghum x Sudangrass	BMR	Seedway, LLC
SS275	Sorghum x Sudangrass	Male sterile	King's Agriseed
AS9301	Sudangrass	BMR	King's Agriseed
AS9302	Sudangrass	BMR, Dwarf	G Boucher Fertilizer
SSAM31	Sudangrass	BMR	Seedway, LLC
SSAM32	Sudangrass	BMR, Dwarf	Seedway, LLC
Piper	Sudangrass		Seedway, LLC
Centurion	Annual ryegrass		Seedway, LLC
Fria	Annual ryegrass		Seedway, LLC
VNS	Sainfoin		Oliver Seed Co.
Cresent Sun	Sunn hemp		Oliver Seed Co.

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 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 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 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.

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

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.

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 early June, the typical planting time for summer annual forages. Due to excessively dry conditions, planting was delayed in an attempt to plant the trial into soil with adequate moisture. Rainfall was below normal with the region being designated as experiencing abnormally dry or moderate drought conditions (Drought.gov) throughout the season. Much of the rain that fell throughout the season came in short duration storms. On average, July temperatures were over 4 degrees below normal while August temperatures were 3 degrees above normal. Both July and August rainfall accumulations were over an inch below normal. Rain finally began falling in late August and September and brought approximately normal temperatures and rainfall accumulation in September. Overall, there were a total of 653 Growing Degree Days (GDDs) accumulated during these months, 42 below the 30-year normal.

Table 3. Seasonal weather data collected in Alburgh, VT, 2021.

Alburgh, VT	July	August	September
Average temperature (°F)	68.1	74.0	62.8
Departure from normal	-4.31	3.25	0.14
Precipitation (inches)	2.92	2.29	4.09
Departure from normal	-1.14	-1.25	0.42
Growing Degree Days (base 50°F)	561	727	394
Departure from normal	-134	85	7

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.

Variety Performance by Cutting

Varieties differed significantly in yield at both harvests and in total biomass for the season (Table 4). At the first harvest, the sorghum x Sudangrass variety KF Sugar Pro 55 SS was the top yielder producing 1.76 tons of dry matter per acre. This was statistically similar to five other varieties of sorghum x Sudangrass or Sudangrass. The sainfoin, sunn hemp, and the annual ryegrasses produced less than one ton ac^{-1}. The pearl millets yielded lower than the sorghum x Sudangrass and Sudangrass varieties averaging just over 1.0 ton ac^{-1} similar to the trial average. The plots were allowed to regrow for 44 days before the second harvest was taken. Despite hot weather and some much needed rainfall arriving during this time, neither the sainfoin nor sunn hemp regrew adequately to harvest and the annual ryegrass biomass was minimal. All other treatments were harvestable. With the optimal weather conditions, more varieties produced levels of biomass similar to the top performer which again produced 1.76 tons ac^{-1} but was Sudangrass variety Piper. Ten varieties of sorghum x Sudangrass and Sudangrass performed statistically similarly to Piper in the

second harvest. Total dry matter harvested for the season averaged 2.41 tons ac^{-1}. The sorghum x Sudangrasses produced on averaged 2.94 tons ac^{1} while the Sudangrass produced 2.87 tons ac^{-1} and the pearl millets produced 2.22 tons ac^{-1}. Total yield, as well as yield from each harvest, are summarized in Figure 1.

Table 4. Yield of 23 summer annual varieties, 2021.

Variety	Species	Dry matter (DM)	1st cut	2nd cut	Season total
		%	DM tons ac^{-1}		
Exceed	Pearl Millet	20.9	1.05	1.21	2.25
FSG300	Pearl Millet	19.9	1.13	1.28	2.41
KF Prime 180	Pearl Millet	20.2	1.12	0.727	1.85
KF Prime 360	Pearl Millet	21.0	1.25	1.32	2.57
VNS	Japanese Millet	22.3	1.25	0.772	2.02
KF Sugar Pro 55 SS	Sorghum x Sudangrass	18.2	**1.76**	1.31	3.07*
Green Grazer V	Sorghum x Sudangrass	18.9	1.58*†	1.45*	3.03*
AS6501	Sorghum x Sudangrass	17.2	1.20	1.43*	2.63
AS6201	Sorghum x Sudangrass	18.0	1.45	1.53*	2.97*
AS5201	Sorghum x Sudangrass	18.0	1.31	1.59*	2.90*
King's 150	Sorghum x Sudangrass	16.9	1.31	1.48*	2.79
SSA-251	Sorghum x Sudangrass	18.2	1.69*	1.51*	3.19*
SSA-252	Sorghum x Sudangrass	17.6	1.21	1.33	2.53
SS275	Sorghum x Sudangrass	18.5	1.70*	1.66*	**3.36**
AS9301	Sudangrass	18.4	1.32	1.64*	2.97*
AS9302	Sudangrass	18.5	1.26	1.54*	2.80
SSAM31	Sudangrass	17.7	1.51*	1.47*	2.98*
SSAM32	Sudangrass	18.1	1.49*	1.15	2.64
Piper	Sudangrass	19.0	1.21	**1.76**	2.98*
Centurion	Annual ryegrass	19.2	0.467	0.297	0.764
Fria	Annual ryegrass	19.6	0.500	0.306	0.806
VNS	Sainfoin	**14.8**	0.932	0.00	0.932
Cresent Sun	Sunn hemp	15.5*	0.889	0.00	0.889
LSD (p = 0.10)		1.74	0.309	0.365	0.480
Trial mean		18.6	1.24	1.16	2.41

†Treatments with an asterisk performed statistically similar to the top performer in **bold** at the p=0.10 level**.**

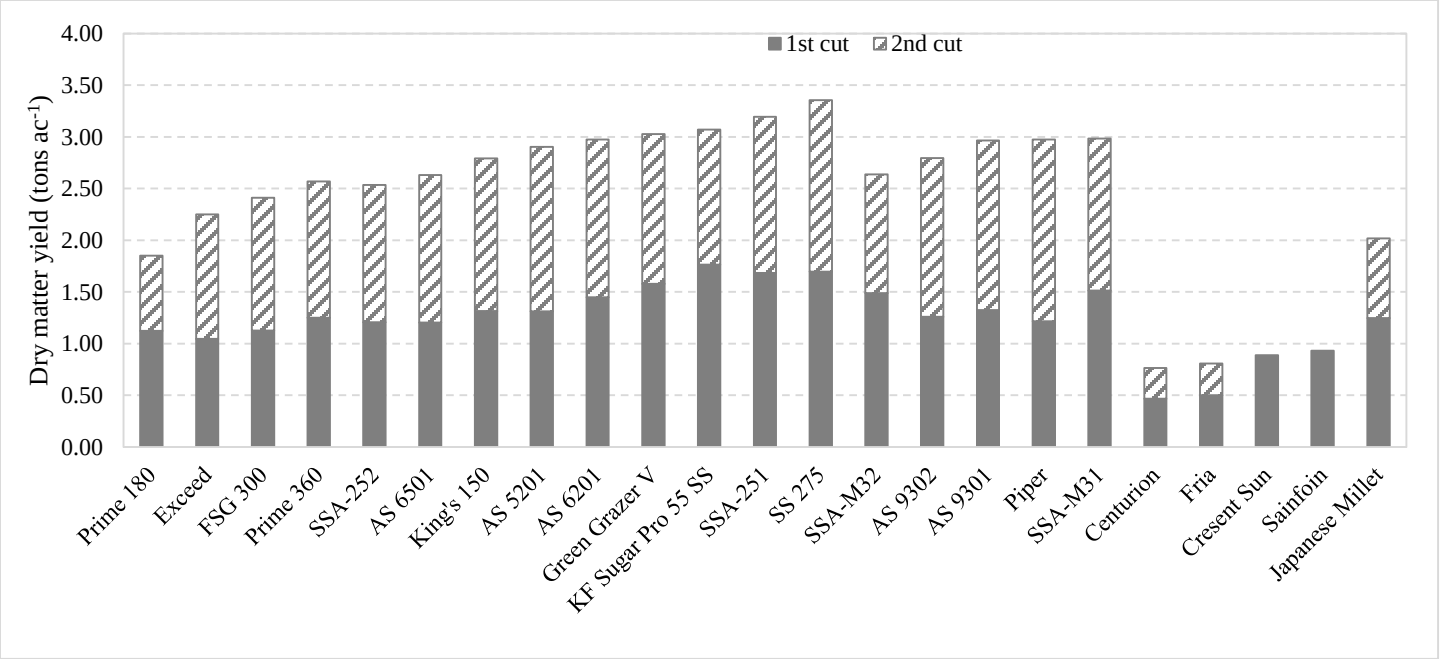

Figure 1. Total yield of 23 summer annual varieties by harvest, 2021.

Forage Quality Across Cuttings

In addition to yield, quality also varied significantly across varieties (Table 5). Crude protein levels ranged from 12.6 to 26.0% and averaged 16.6% across the trial. The ADF and NDF levels were significantly lower in the annual ryegrass, sainfoin, and sunn hemp compared to all other grasses. There was also a large range in 240-hr uNDF and 30-hr NDF digestibility both across species and across varieties within a species. For example, the annual ryegrasses had some of the lowest 240-hr uNDF levels and highest 30-hr NDF digestibility levels in the trial, however the two varieties were statistically different from one another in both these metrics. Similarly, the sorghum x Sudangrass variety SS275 had significantly higher 240-hr uNDF and lower 30-hr NDFD than most other sorghum x Sudangrass varieties.

Table 5. Average quality of 23 summer annual varieties, 2021.

Variety	Species	CP	ADF	NDF	NFC	NEL	240-hr uNDF	30-hr NDFD
			% of DM			Mcal lb^{-1}	% of NDF	
Exceed	Pearl Millet	13.3	31.9	54.9	17.2	0.547	7.40	73.8
FSG300	Pearl Millet	14.9	32.6	54.3	16.7	0.543	9.13	70.4
KF Prime 180	Pearl Millet	19.5	31.2	52.6	13.6	0.555	8.38	74.5
KF Prime 360	Pearl Millet	17.6	32.1	52.2	15.2	0.552	7.00	74.5
VNS	Japanese Millet	16.4	34.0	55.0	18.6	0.553	13.4	64.8
KF Sugar Pro 55 SS	Sorghum x Sudangrass	14.4	34.0	57.8	15.5	0.524	10.1	72.0
Green Grazer V	Sorghum x Sudangrass	12.7	35.5	58.5	17.8	0.517	11.8	67.8
AS6501	Sorghum x Sudangrass	15.2	34.3	57.7	15.4	0.511	10.1	72.8
AS6201	Sorghum x Sudangrass	15.4	33.4	56.5	16.8	0.538	9.59	74.0
AS5201	Sorghum x Sudangrass	14.3	34.8	57.5	17.2	0.527	12.0	67.3

King's 150	Sorghum x Sudangrass	14.2	33.0	56.6	17.4	0.526	10.3	72.7
SSA-251	Sorghum x Sudangrass	14.5	33.5	58.1	15.9	0.519	9.51	74.1
SSA-252	Sorghum x Sudangrass	14.6	32.8	55.7	18.2	0.546	9.49	74.0
SS275	Sorghum x Sudangrass	12.6	35.8	59.7	16.0	0.493	13.3	65.0
AS9301	Sudangrass	14.1	32.7	57.5	17.0	0.528	9.98	72.9
AS9302	Sudangrass	15.4	33.5	57.9	15.0	0.533	9.38	74.7
SSAM31	Sudangrass	15.1	32.1	56.3	16.6	0.532	9.31	74.0
SSAM32	Sudangrass	16.2	32.9	56.6	16.1	0.534	9.51	75.0
Piper	Sudangrass	14.1	35.4	58.8	16.6	0.496	13.5	65.2
Centurion	Annual ryegrass	25.3*	30.2	42.1	18.5	0.581	5.78*	**80.9**
Fria	Annual ryegrass	22.8	30.0	45.6	16.7	0.585	7.95	76.4
VNS	Sainfoin	**26.0**	27.4*	41.0	14.3	0.580	5.53*	80.3*
Cresent Sun	Sunn hemp	23.9*	**26.7**	**36.1**	**25.3**	**0.647**	**4.40**	79.9*
LSD (p = 0.10)		2.18	2.36	2.38	2.65	0.029	1.62	3.33
Trial mean		16.6	32.6	53.9	16.8	0.542	9.43	72.9

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

Since differences in yield and quality were found, it can be helpful to visualize both of these simultaneously to understand which varieties and species are capable of optimizing both. Figure 2 shows total season dry matter yield versus 30-hr NDF digestibility for all varieties. Varieties that land it the upper right corner represent the highest yielding varieties with the highest digestible fiber content.

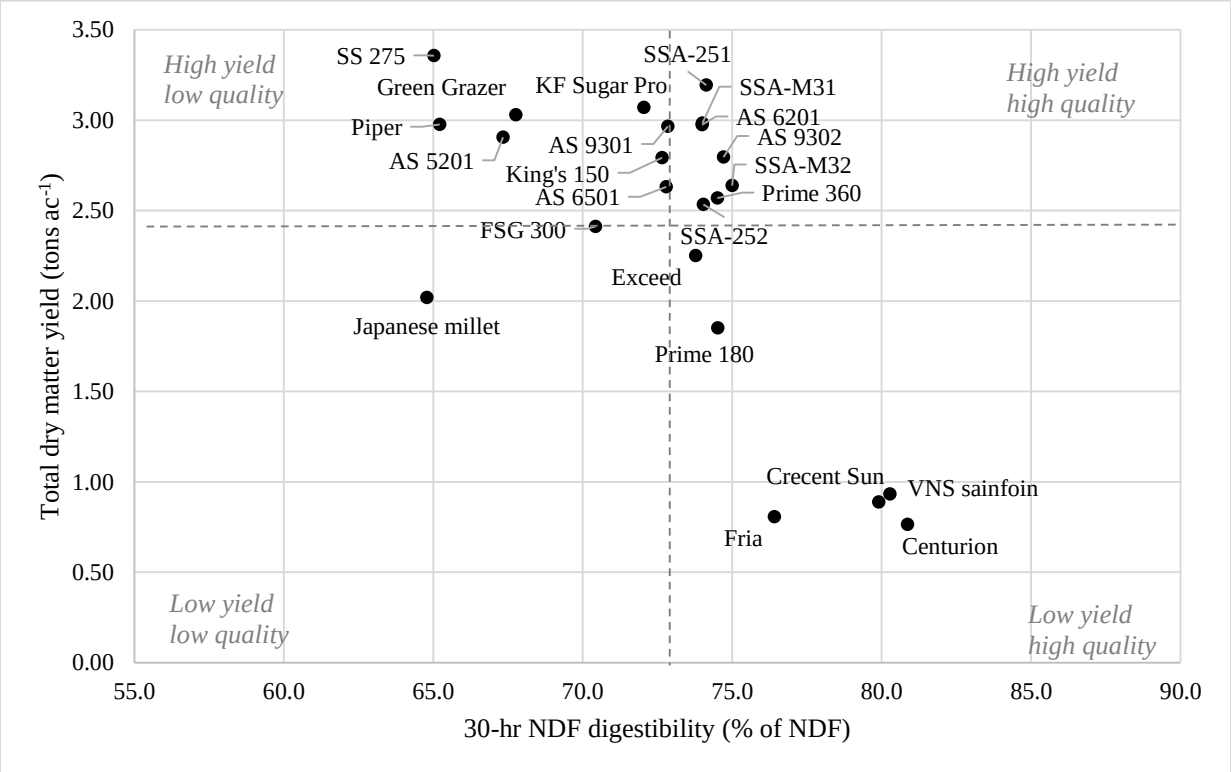

Figure 2. Total yield and 30-hr NDF digestibility of 23 summer annual varieties across harvests, 2021.

DISCUSSION

These data demonstrate the value of integrating summer annual forages into forage production systems in the Northeast. In a year with precipitation below normal and July temperatures above the 30-year normal, summer annuals produced on average 2.41 tons ac^{-1} high quality forage. In terms of 30-hr NDF digestibility, all varieties resulted in NDF digestibility greater than 65%. Varietal selection is important as varieties differ in performance in terms of yield and quality. Piper sudangrass, for example, was one of the highest yielding varieties in the trial. However, its quality was substantially lower than all the other varieties. Piper is sold primarily as a summer cover crop. In contrast to Piper sudangrass, Centurion annual ryegrass had high quality but produced one of the lowest yields. The pearl millets KF Prime 180 and Exceed also produced higher quality forage despite lower yields.

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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