2022 Summer Annual Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

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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 7-Jun (Table 1). Prior to seeding, an application of starter fertilizer (7-18-36) was made at a rate of 200 lbs ac^{-1} on 9-May. Plots were seeded with a Great Plains cone seeder at a seeding rate of 625,000 seeds ac^{-1} for the sorghum x sudangrass crosses, 675,000 seeds ac^{-1} for the sudangrasses, and 750,000 seeds ac^{-1} for the Japanese millet. Fifteen varieties of these species were compared, each replicated four times (Table 2). An application of 100 lbs ac^{-1} urea (46-0-0) was made on 12-Jul.

Table 1. General plot management, 2022.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Grain corn
Starter fertilizer	200 lbs ac^{-1} 7-18-36, 9-May
Topdress fertilizer	100 lbs ac^{-1} 46-0-0, 12-Jul
Planting date	7-Jun
First harvest date	25-Jul
Second harvest date	25-Aug
Seeding rates: Sudangrass	675,000 seeds ac^{-1}
Sorghum x sudangrass	625,000 seeds ac^{-1}
Japanese millet	750,000 seeds ac^{-1}
Tillage methods	Pottinger TerraDisc®

Plots were hand harvested on 25-Jul and 25-Aug by cutting the material growing within a 0.25 m^2 quadrat to a height of approximately 4” in each plot. Samples were weighed and a representative subsample was 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 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.

Table 2. Summer annual varieties and characteristics, 2022.

Variety	Species	Characteristics
VNS	Japanese Millet	
Exceed	Pearl millet	BMR
KF Sugar Pro 55 SS	Sorghum x Sudangrass	BMR
AS6501	Sorghum x Sudangrass	BMR
AS6201	Sorghum x Sudangrass	BMR
AS6401	Sorghum x Sudangrass	BMR
FSG 214	Sorghum x Sudangrass	BMR, dry stalk
FSG 215	Sorghum x Sudangrass	BMR
King's 150	Sorghum x Sudangrass	BMR
SSA-251	Sorghum x Sudangrass	BMR, dry stalk
SSA-252	Sorghum x Sudangrass	BMR
SS275	Sorghum x Sudangrass	Male sterile
Viking 510	Sorghum x Sudangrass	BMR
AS9301	Sudangrass	BMR
Viking 210	Sudangrass	BMR

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. 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. The beginning of the season was cooler and wetter than normal with almost 4 inches above normal precipitation being accumulated. These conditions subsided by July when conditions became much drier with approximately normal temperatures. Wetter conditions returned in August, but temperatures remained approximately normal. Overall, there were a total of 1763 Growing Degree Days (GDDs) accumulated during these months, 95 below the 30-year normal.

Table 3. Seasonal weather data collected in Alburgh, VT, 2022.

Alburgh, VT	June	July	August
Average temperature (°F)	65.3	71.9	70.5
Departure from normal	-2.18	-0.54	-0.20
Precipitation (inches)	8.19	3.00	4.94
Departure from normal	3.93	-1.06	1.40
Growing Degree Days (base 50°F)	459	674	630
Departure from normal	-64	-20	-11

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). The first harvest occurred 48 days after planting. With wet and warm conditions, yields at the first harvest were substantial averaging over 2.5 tons ac^{-1} across the trial. The top yielding variety at the first harvest was AS6501 sorghum x sudangrass, which produced an astounding 3.70 tons ac^{-1}. This was statistically similar to three other sorghum x sudangrass varieties. The Japanese and pearl millets yielded lower than the other species with only 1.82- and 1.40-tons ac^{-1} respectively. The plots were allowed to regrow for 31 days before the second harvest was taken. Yields in the second harvest were smaller than the first, but still quite substantial averaging over 1.5 tons ac^{-1} across the trial. In the second harvest, SS275 sorghum x sudangrass was the top performing producing 2.65 tons ac^{-1}. Nine other varieties performed statistically similarly to this top performing variety. Total dry matter harvested for the season averaged 4.50 tons ac^{-1} with SS275 producing an impressive 5.78 tons ac^{-1}. This was statistically similar to seven other varieties. The sorghum x sudangrasses produced on average 4.79 tons ac^{1} while the sudangrass produced 4.72 tons ac^{-1}. Total yield as well as yield from each harvest are summarized in Figure 1.

Table 4. Yield of 15 summer annual varieties, 2022.

Variety	Species	1st cut	2nd cut	Season total
			DM tons ac^{-1}	
VNS	Japanese Millet	1.82fg†	1.94abc	3.76e
Exceed	Pearl millet	1.40g	0.518d	1.65f
KF Sugar Pro 55 SS	Sorghum x Sudangrass	3.34ab	2.07abc	5.40ab
AS6501	Sorghum x Sudangrass	**3.70a**	1.50bc	5.20abc
AS6201	Sorghum x Sudangrass	2.62cde	1.27d	3.89de
AS6401	Sorghum x Sudangrass	2.85bcde	1.88abc	4.73abcde
FSG 214	Sorghum x Sudangrass	2.48def	1.75abc	4.23cde
FSG 215	Sorghum x Sudangrass	2.70bcde	1.91abc	4.61bcde
King's 150	Sorghum x Sudangrass	2.51def	1.62bc	4.13cde
SSA-251	Sorghum x Sudangrass	2.73bcde	2.34ab	5.07abc
SSA-252	Sorghum x Sudangrass	3.22abc	1.68bc	4.90abcd
SS275	Sorghum x Sudangrass	3.13abcd	**2.65a**	**5.78a**
Viking 510	Sorghum x Sudangrass	2.83bcde	1.95abc	4.78abcde
AS9301	Sudangrass	2.75bcde	2.35ab	5.10abc
Viking 210	Sudangrass	2.401ef	1.93abc	4.34bcde
LSD (p = 0.10) ‡		0.713	0.939	1.14
Trial mean		2.68	1.82	4.50

†Treatments that share a letter performed statistically similarly.
Top performer in each column indicated in **bold**.
‡ LSD; least significant difference at the p=0.10 level

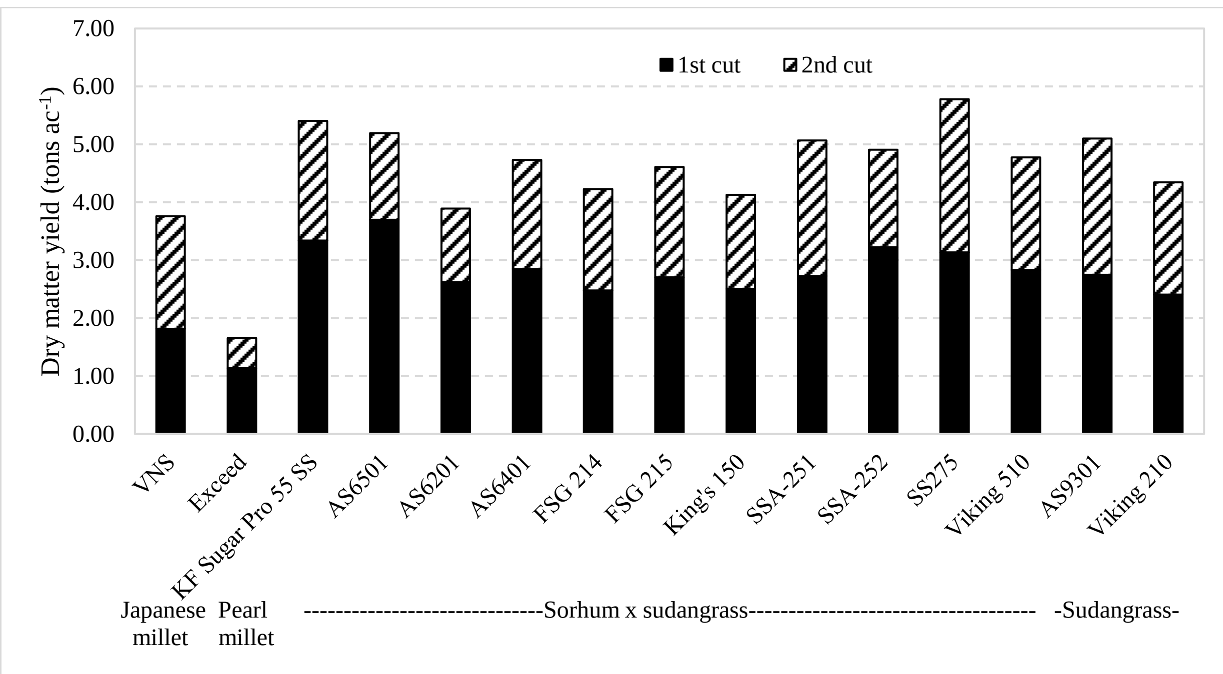

Figure 1. Total yield of 15 summer annual varieties by harvest, 2022.

Forage Quality Across Cuttings

In addition to yield, quality also varied significantly across varieties (Table 5). Crude protein levels ranged from 11.5 to 17.6% and averaged 13.7% across the trial. Water soluble carbohydrates (WSC) ranged from 7.03 to 12.4% and averaged 10.1% across the trial. NDF content ranged from 55.6 to 59.6% with a range in NDF digestibility from 63.2 to 75.1%. When dry matter yield is considered in tandem with these nutrient contents, protein yields per acre averaged 0.601 tons ac^{-1}, WSC 0.456 tons ac^{-1}, digestible NDF 1.83 tons ac^{-1}, and predicted milk 7.17 tons ac^{-1}.

Table 5. Average quality and component yields of 15 summer annual varieties, 2022.

Variety	Species	Average quality				Component and milk yield			
		CP	WSC	NDF	NDF digestibility	CP	WSC	Digestible NDF	Milk
		% of DM			% of NDF	tons ac^{-1}			
VNS	Japanese Millet	13.2	9.04	58.5	63.9	0.512	0.330	1.36	5.86
Exceed	Pearl Milet	**17.6**	7.03	**54.0**	**75.1**	0.284	0.123	0.679	2.91
KF Sugar Pro 55 SS	Sorghum x Sudangrass	13.2	9.93	57.5	71.9	0.682*	0.528*	**2.23**	8.35*
AS6501	Sorghum x Sudangrass	13.1	9.93	56.0*	72.6*	0.707*	0.513*	2.12*	8.43*
AS6201	Sorghum x Sudangrass	13.7	10.9	56.5*	73.9*	0.521	0.424	1.61	6.14
AS6401	Sorghum x Sudangrass	13.7	9.66	58.1	70.4	0.640*	0.451	1.94*	7.56*
FSG 214	Sorghum x Sudangrass	14.4	9.51	56.0*	73.0*	0.606*	0.395	1.72	6.83*
FSG 215	Sorghum x Sudangrass	13.7	11.1*†	56.5*	73.9*	0.614*	0.510*	1.93*	7.53*
King's 150	Sorghum x Sudangrass	13.4	11.6*	55.8*	74.0*	0.551	0.464	1.71	6.70
SSA-251	Sorghum x Sudangrass	14.2	9.30	58.1	71.9	0.695*	0.460	2.14*	8.00*
SSA-252	Sorghum x Sudangrass	12.5	**12.4**	55.6*	73.0*	0.581*	**0.596**	1.99*	7.72*
SS275	Sorghum x Sudangrass	11.5	9.50	59.6	63.2	0.668*	0.543*	2.17*	**8.69**
Viking 510	Sorghum x Sudangrass	14.5	11.3*	56.3*	73.3*	0.665*	0.543*	1.96*	7.84*
AS9301	Sudangrass	14.6	10.3	56.8	73.7*	**0.736**	0.515*	2.14*	8.32*
Viking 210	Sudangrass	12.9	10.4	57.7	71.9	0.547	0.444	1.80*	6.75
LSD (p = 0.10) ‡		1.75	1.43	2.56	2.68	0.171	0.131	0.458	1.89
Trial mean		13.7	10.1	56.9	71.7	0.601	0.456	1.83	7.17

†Treatments with an asterisk performed statistically similarly to the top performer in **bold.**
‡ LSD; least significant difference at the p=0.10 level

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.

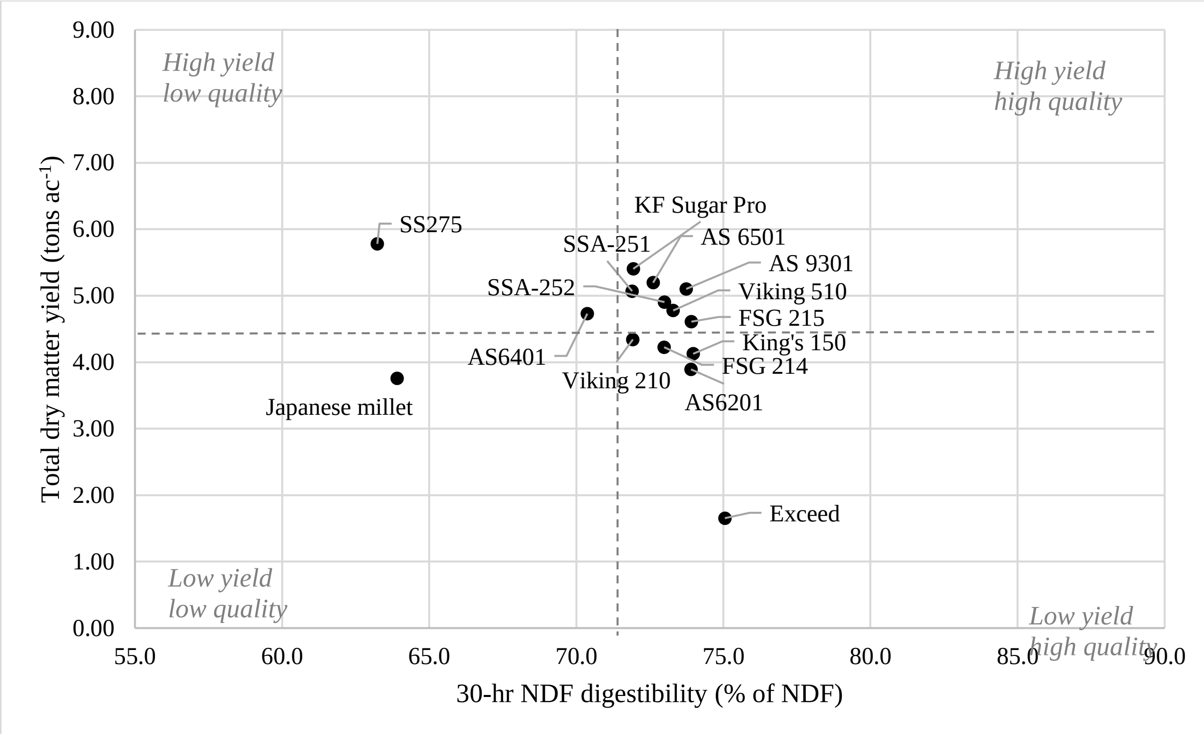

Figure 2. Total yield and 30-hr NDF digestibility of 15 summer annual varieties across harvests, 2022.

DISCUSSION

These data demonstrate the value of integrating summer annual forages into forage production systems in the Northeast. In a year with temperatures that were relatively low with fluctuating precipitation , summer annuals produced on average 4.5 tons ac^{-1} high quality forage. In terms of 30-hr NDF digestibility, all varieties resulted in NDF digestibility greater than 60%. Varietal selection is important as varieties differ in performance in terms of yield and quality. Some varieties of sorghum x sudangrass produced very high yields and quality, while SS275 yielded well but was lower digestibility than the other varieties. Conversely, the pearl millet Exceed 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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