NORTHWEST CROPS & SOILS PROGRAM

2013 Summer Annual Variety Trial

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2013 SUMMER ANNUAL VARIETY TRIAL

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Warm season grasses, such as sorghums, sudangrass, crosses, and millets are high-yielding summer annuals that can provide quality forage in the hot summer months, when cool season grasses are not as productive. The addition of summer annuals into a rotation can provide a harvest of high-quality forage for stored feed or grazing. Generally, summer annuals germinate quickly, grow rapidly, are drought resistant, and have high productivity and flexibility in utilization. However, it is important to know the challenges of growing summer annuals, including the high cost of annual establishment, increased risk of stand failure due to variable weather, and the risk of toxic levels of nitrates and prussic acid in sorghum and sudangrass crops. UVM Extension conducted this variety trial to evaluate the yield and quality of warm season annual grasses.

MATERIALS AND METHODS

Twelve varieties of summer annuals were planted at Borderview Research Farm in Alburgh, VT on 5-Jun 2013 (Table 2). General plot management is listed in Table 1. Plots were managed with practices similar to those used by producers in the surrounding area. The previous crop was a winter grain cover crop. The field was disked and spike tooth harrowed prior to planting. Plots were seeded with a Great Plains small plot drill at a seeding rate of 55 lbs acre^{-1} for the sorghums, sudangrasses and sorghum x sudangrass crosses, 28 lbs acre^{-1} for the millet, and 8 lbs acre^{-1} for the teff.

Stand establishment was measured on 9-Jul with a visual 1-10 assessment, where 1 represented poor stand establishment and 10 represented 100% germination. Plots were harvested with a Carter forage harvester on 24-Jul and 6-Sep. Heights were measured just prior to each harvest. The harvest area was 3' x 20'. The species and variety of summer annuals grown are listed in Table 2. Silage quality was analyzed by Cumberland Valley Analytical Forage Laboratory in Hagerstown, Maryland. Plot samples were dried, ground and analyzed for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and various other nutrients. The Nonstructural Carbohydrates (NSC) and Total Digestible Nutrients (TDN) were calculated from forage analysis data. Performance indices, such as Net Energy Lactation (NEL), were calculated to determine forage value. 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). Chemically, this fraction includes cellulose, hemicellulose and lignin. The NSC or non-fiber carbohydrates (NFC) include starch, sugars and pectins. 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

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

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.

Table 1. General plot management.

Trial Information	Borderview Research Farm Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Rye
Planting date	5-Jun
First cut harvest date	24-Jul
Second cut harvest date	6-Sep
Seeding rate: Teff	8 lbs acre^{-1}
Millets	28 lbs acre^{-1}
Sorghums, Sudangrass, and crosses	55 lbs acre^{-1}
Tillage methods	Mold board plow, disk, and spike tooth harrow

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

Variety	Species	Characteristics	Seeding Rate (lbs. ac^{-1})	Seed Source
AF 7101	Forage Sorghum	BMR	55	King's Agriseed
AF 7201	Forage Sorghum	BMR	55	King's Agriseed
AS 6401	Sorghum x Sudangrass	BMR	55	King's Agriseed
AS 6402	Sorghum x Sudangrass	BMR	55	King's Agriseed
AS 6501	Sorghum x Sudangrass	BMR	55	King's Agriseed
AS 9301	Sudangrass	BMR	55	King's Agriseed
Black Hawk	Sorghum x Sudangrass	BMR	55	Albert Lea
Elite II	Pearl Millet	non-BMR	28	Arrow Seed
Hayking	Sudangrass	non-BMR	55	King's Agriseed
Summer Feast	Pearl Millet & Rape	non-BMR	28	King's Agriseed
Teff	Teff	non-BMR	8	King's Agriseed
Wonderleaf	Pearl Millet	non-BMR	28	King's Agriseed

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at a weather station in Alburgh, VT are shown in Table 3. From June to September, there was an accumulation of 4139 Growing Degree Days (GDDs) in Alburgh which is 71 GDDs less than the 30-year average. Rainfall was above average during planting, with 9.2 inches of rain in June, while the remainder of the growing season was drier than average, with an accumulated 5.2 inches less than normal for July through September.

Table 3. Seasonal weather data[1] collected in Alburgh, VT, 2013.

Alburgh, VT	June	July	August	September
Average temperature (°F)	64	71.7	67.7	59.3
Departure from normal	-1.8	1.1	-1.1	-1.3
Precipitation (inches)	9.23 ł	1.89	2.41	2.2
Departure from normal	5.54	-2.26	-1.5	-1.44
Growing Degree Days (base 32°F)	967	1235	1112	824.7
Departure from normal	-47	36.8	-27.2	-33.35

[1]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.
ł June 2013 precipitation data based on National Weather Service data from cooperative stations in South Hero, VT (http://www.nrcc.cornell.edu/page_summaries.html)

The forage sorghums, sudangrasses and crosses had a higher rate of establishment than the millets or teff (Table 4). However, these differences did not translate into yield differences for first cut. Hayking sudangrass was the tallest variety at 56.3 inches, significantly taller compared to some of the shorter varieties that only reached 30 inches tall. But these differences did not result in a statistically significant yield difference for the summer annual varieties. Average dry matter yield for the first harvest was 2900 lbs acre^{-1} and ranged from 1806-3540 lbs acre^{-1}. Summer Feast millet had the highest crude protein, relative feed value, and lowest ADF and NDF values (Table 4). In general, the millets and the teff had significantly higher protein than the sorghums, sudangrasses, and crosses. Acid detergent fiber (ADF) was most desirable for the millets, AF7101 sorghum, and Black Hawk sorghum x sudangrass cross. Neutral detergent fiber (NDF) was lowest in Elite and Summer Feast millet and teff. Digestible NDFD was lowest in the teff and wonderleaf millet. The other varieties trialed were similar in digestible levels of fiber.

Table 4. Yield and quality of summer annual forages, 1st cut, Alburgh, VT, 2013.

Variety	Estab.[1]	Height	DM	DM Yield	CP	ADF	NDF	NDFD	TDN	NEL	RFV
	(1-10)	(in.)	%	lbs. ac^{-1}	% of DM	% of DM	% of DM	% of NDF	% of DM	Mcal lb^{-1}	
AF 7101	8.0*	47.8	17.9*	2622	15.1	33.7*	57.7	64.6*	60.5	0.623	102.8
AF 7201	**8.8***	46.7	17.2*	3215	14.8	36.0	61.3	**66.4***	60.2	0.620	92.5
AS 6401	6.8	48.4*	17.9*	2861	15.6	35.8	58.5	64.3*	60.3	0.618	97.3
AS 6402	5.0	44.8	19.3	3521	15.2	36.6	56.9	65.9*	59.0	0.605	98.8
AS 6501	8.0*	50.3*	**17.1***	3314	15.7	36.4	60.0	65.4*	59.0	0.608	94.3
AS 9301	7.3*	51.7*	17.4*	3540	14.2	37.1	60.4	61.8	59.3	0.608	92.5
Black Hawk	6.8	51.0*	18.4*	2859	14.9	34.5*	57.9	65.5*	59.4	0.610	99.8
Elite II	3.0	44.9	19.9	3132	16.9*	33.2*	54.7*	63.1*	60.3	0.618	107.5*
Hayking	7.3*	**56.3***	18.6*	3014	14.4	36.8	60.0	60.8	60.2	0.618	93.5
Summer Feast	3.3	30.3	17.8*	1806	**18.0***	**32.7***	**51.7***	62.4*	59.1	0.608	**114.8***
Teff	2.0	31.4	19.7	2376	17.3*	35.4	53.9*	55.9	57.9	0.593	105.8
Wonderleaf	3.5	36.3	19.3	2539	17.4*	35.1*	55.7	58.5	57.5	0.588	103.0
Means	5.8	45.0	18.4	2900	15.8	35.3	57.4	62.9	59.4	0.609	100.2
LSD (p<0.10)	1.6414	8.1052	1.7456	NS	2.1267	2.4871	3.6848	4.4192	NS	NS	8.9479

[1]Estab.= stand establishment measured one month after planting.
Treatments indicated in **bold** had the top observed performance.
*Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.
NS – no significant difference was determined between treatments.

Hayking sudangrass was also the tallest summer annual at the 2nd cut harvest on 6-Sep (Table 5). For second cut, the tallest varieties were also two of the highest yielders. Average dry matter yields for second cut were 2394, about 500 lbs. less than first harvest means. Three varieties had second cut yields higher than first cut—AF 7201, AF 6401, and Black Hawk sorghum x sudangrass. Crude protein, ADF, and NDF did not differ by variety for the second harvest. Crude protein averaged 20.0% for second cut, 4% higher than the first cut average. The digestible fiber was highest in the sorghum, sudangrass, and crosses. Overall, total digestible nutrients and net energy of lactation were higher for the second harvest than first harvest. The NEL was highest in AF7101, AF7201, AS6402, and AS9301.

Table 5. Yield and quality of summer annual forages, 2nd cut, Alburgh, VT, 2013.

Variety	Height	DM	DM Yield	CP	ADF	NDF	NDFD	TDN	NEL	RFV
	(in.)	%	lbs. ac^{-1}	% of DM	% of DM	% of DM	% of NDF	% of DM	Mcal lb^{-1}	
AF 7101	41.3	16.3*	2244	21.9	33.2	59.8	71.0*	**63.6***	**0.658***	98.3
AF 7201	39.7	18.5	**3341***	17.5	34.2	61.2	69.2*	63.0*	0.650*	95.0
AS 6401	41.3	17.4	2945*	18.5	34.8	61.5	69.8*	61.9	0.638	93.8
AS 6402	32.3	18.1	2049	23.0	33.9	61.4	**71.5***	62.8*	0.648*	95.0
AS 6501	46.1	**15.4***	2843*	20.1	34.2	60.5	69.0*	62.5*	0.645	96.0
AS 9301	42.9	16.6*	2509	19.4	34.4	60.3	71.1*	63.0*	0.653*	95.8
Black Hawk	49.0*	16.5*	3213*	19.6	35.7	61.4	68.3	62.3	0.640	92.3
Elite II	32.2	21.2	1523	20.7	33.6	60.1	64.7	60.7	0.620	97.0
Hayking	**50.0***	18.5	2804*	17.5	35.6	62.1	63.5	62.6*	0.645	91.5
Summer Feast	36.5	20.2	1736	21.0	34.2	60.6	62.9	61.1	0.630	96.0
Teff	33.3	25.6	1600	19.7	35.1	62.3	63.7	61.0	0.625	91.8
Wonderleaf	35.0	20.6	1925	20.8	33.2	59.9	63.2	61.2	0.628	98.0
Means	40.0	18.7	2394	20.0	34.3	60.9	67.3	62.1	0.640	95.0
LSD (p<0.10)	3.7943	1.6896	607.54	NS	NS	NS	2.7783	1.1644	0.0122	NS

Treatments indicated in **bold** had the top observed performance.

*Treatments indicated with an asterisk did not perform significantly lower than the top-performing treatment in a particular column.

NS – no significant difference was determined between treatments.

Overall yields are presented in Figure 2. The sorghum variety AF 7201 yielded the highest at 6557 lbs. acre^{-1} dry matter. Average total yields for the summer annuals were over 2.5 tons acre^{-1} dry matter. Generally, the sorghums, sudangrasses, and sorghum x sudangrass crosses yielded the highest. Yields in 2013 (2.5 tons acre^{-1}) were nearly 45% of the 2012 yields (3.72 acre^{-1}). Cooler weather during the 2013 growing likely led to lower yields of the summer annuals.

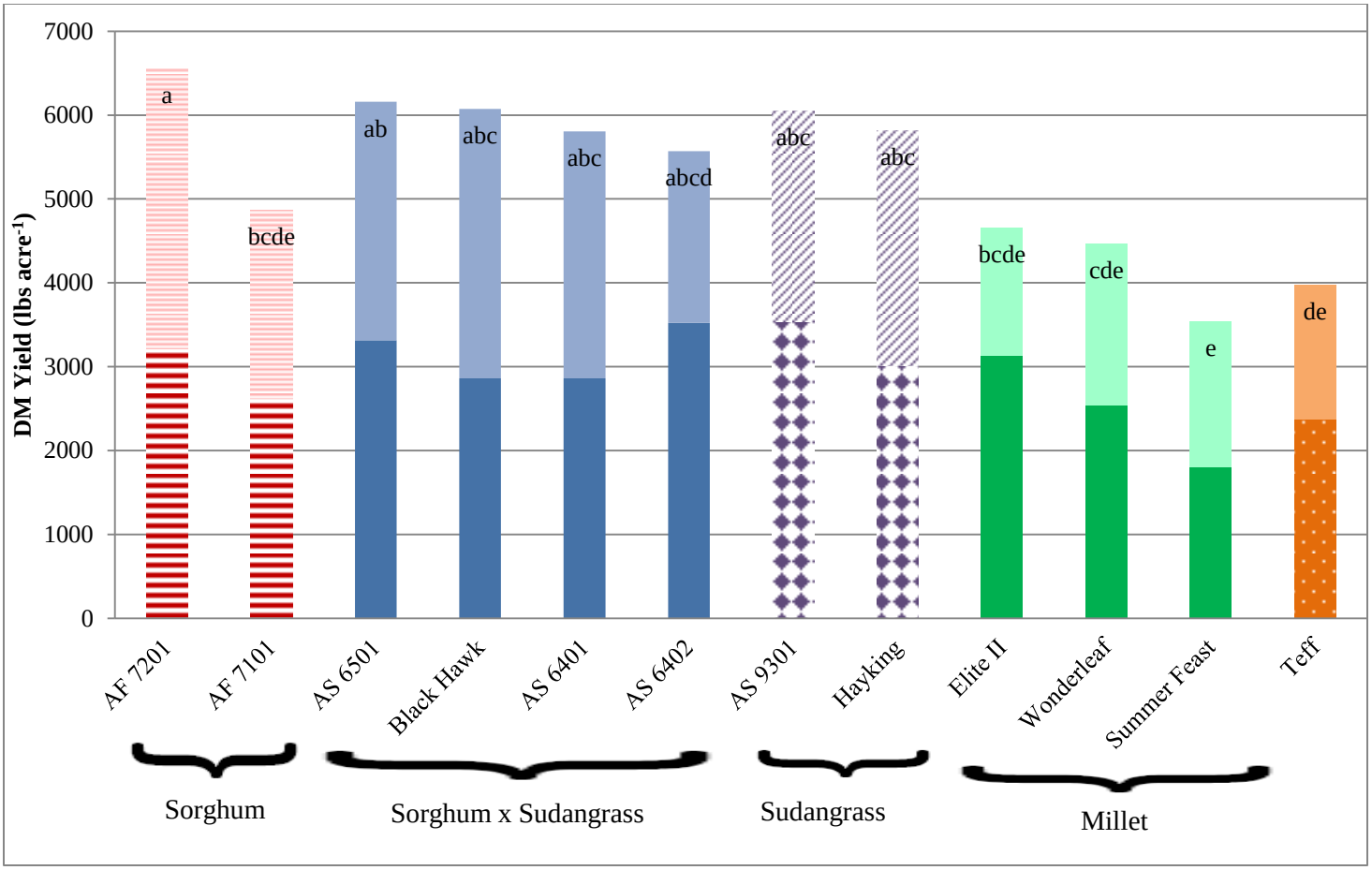

Figure 2. Dry matter yield of summer annuals. 1st cut yields= bottom bar, 2nd cut yields=top bar. Varieties with the same letter are not significantly different from each other.

Some risks to be aware of when growing summer annuals include 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 and sudangrasses may contain prussic acid which is toxic when present. To avoid prussic acid poisoning:

- Graze sorghum or crosses when they 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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