2010

Warm Season Annual Forage Performance Trials

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UNIVERSITY OF VERMONT EXTENSION

CULTIVATING HEALTHY COMMUNITIES

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Image 1. Summer annual variety trial.

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2010 Organic Warm Season Annual Forage Performance Trials

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In 2010, the University of Vermont Extension continued their research to evaluate warm season annual forage systems. Warm season annual forages include grasses such as sorghum, sudangrass, sorghum-sudangrass, Japanese millet, and pearl millet varieties. These grasses prefer the warmth of the summer months and generally thrive between June and August. Warm season annuals can be grazed or harvested for stored forage. Since warm season annuals thrive in hot weather they could supplement pasture during the summer slump. The summer slump is a period during the summer that cool season perennial grasses slow in growth and quality. The goal of this project was to evaluate the yield and quality of commercially available varieties of warm season annuals. In addition, we were interested in investigating the value of combining brassica forage with warm season annuals. The goal was to maximize forage yield and quality.

TESTING PROCEDURE

The trial was located at Borderview Farm in Alburgh, VT. A second trial was located at the UVM Horticultural Research Center in Burlington. Only yields were collected from these plots. All plots were managed with conventional tillage practices. Conventional tillage included moldboard plow, disking, and field finishing with a drag harrow. Dairy manure was applied in the spring at 7000 gallons per acre. The experimental design was a randomized complete block with three replicates. Pro-Gro (5-3-2) an organic certified soil amendment was applied at a rate of 50 lbs/acre after first harvest. The application rate was based on soil test analysis and UVM nutrient recommendations for field crops. The treatments were eight commercially available summer annual varieties (Table 1). In addition the AS9301, AS6501, and Summer Prince were grown in combination with Barkant turnip. Plots were seeded with a John Deere grain drill on May 26th, 2010 following cereal forage harvest. The plots were 5' x 50' and replicated three times. The sudangrass and sorghum-sudangrass were seeded at 60 lbs/acre and the millet and millet mix were seeded at 35 lbs/acre. A seeding rate of 6 lbs/acre of turnips was added to the aforementioned grasses. A first harvest for all plots occurred on July 20, 2010. Only the sudangrass and sorghum-sudangrass re-grew to allow a second harvest on August 31, 2010. Trial management can be found in Table 2.

Table 1. Summer annual and turnip varieties and source.

Seed source	Type	Variety	Characteristics
Asgrow	Sudangrass	AS9301	BMR gene 6
Asgrow	Sorghum-Sudangrass	AS6501	BMR gene 6
King's Agriseed	Sorghum-Sudangrass	Summer Prince	BMR gene 6
King's Agriseed	Sorghum-Sudangrass	Summer Queen	BMR gene 6
King's Agriseed	Sorghum-Sudangrass	Summer Dream	BMR gene 6
King's Agriseed	Pearl Millet	Wonderleaf	Non-BMR
King's Agriseed	86% Wonderleaf millet 7% Bonar forage brassica 5% Pasja forage brassica	Summer Feast	Non-BMR
Beidler Family Farm	Japanese Millet	None specified	Non BMR
Barenburg	Turnip	Barkant turnip	

Table 2. Planting date and harvest dates of summer annual trial.

Warm Season Grasses for Forage Trial	
Planting date	May 26, 2010
Seeding rate – sorghum-Sudangrass, Sudangrass	60 lbs/acre
Seeding rate – millet, millet mix	35 lbs/acre
Seeding rate – brassica	6 lbs/acre
Forage harvest – first cut	July 20, 2010
Forage harvest – second cut	August 31, 2010

Plots were harvest with a Jari sickle bar mower every time the forages reached 36 inches in height. Once the plots were harvested, all plant material was collected and weighed on a platform scale. A subsample of approximately 1 lb was taken to determine moisture and quality. All data was analyzed using a mixed model analysis where replicates were considered random effects. Several analyses were conducted to answer several specific questions:

1) What is the yield and quality of commercially available sorghum and sudangrass varieties?
2) Will yield and quality of warm season grasses improve when mixed with brassica crops?
3) What is the yield and quality of commercially available millet varieties?
4) How do sorghum and sudangrass varieties compare with yield and quality of millet varieties?

The 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 hybrids 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) at the 10% level of probability are shown in the results. Where the difference between two treatments within a column is equal to or greater than the LSD value you can be sure 9 times out of 10 that there is a real difference between the two treatments.

WEATHER DATA

Seasonal precipitation and temperatures recorded at a weather station in close proximity to the 2010 research sites are shown in Table 3. This year presented a beautiful growing season with temperatures slightly higher than usual, and while we had a drier spring, overall, we ended up with above average rainfall. Overall, the growing season resulted in 449 more Growing Degree Days (GDD) than the 30 year average. Warm temperatures in the summer months were ideal for warm season annual growth.

Table 3. Temperature, precipitation, and Growing Degree Day summary, Alburgh, VT.

	April	May	June	July	August	September	October
Average Temperature (°F)	49.3	59.6	66.0	74.1	70.4	64.0	50.6
Departure from Normal	5.80	3.00	0.20	3.00	1.40	3.60	1.80
Precipitation (inches)	2.76	0.92	4.61	4.30	5.48	4.32	missing
Departure from Normal	0.25	-2.01	1.40	0.89	1.63	0.86	data
Growing Degree Days (base 50°)	141	332	479	747	634	419	129
Departure from Normal	101	71.4	4.50	94.6	45.0	107	26.4
Growing Degree Days (base 32°)	521	854	1019	1305	1192	959	578
Departure from Normal	176	91.5	4.5	94.6	45.0	107	57.4

Based on National Weather Service data from cooperative observer stations in close proximity to field trials. Historical averages are for 30 years of data (1971-2000).

SILAGE QUALITY

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 nonprotein 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

Overall, there was no significant difference in yield among the sorghum-sudangrass and sudangrass varieties for either cutting (Table 4 and Table 5). On average the first harvest of the sorghum-sudangrass and sudangrass varieties produced over 3 tons of dry matter and the second harvest only 1.5 tons per acre (Table 4 and Table 5). The total yield across the two harvests ranged from 6.70 to 4.66 dry tons per acre (Figure 1). The dry matter at harvest was lowest for AS9301, Summer Queen, and Summer Prince. This is important especially if the crop is being used for stored forage. Overall the sudangrass variety AS9301 had the highest dry matter and hence would potentially wilt and dry down to harvestable moisture contents. With the exception of CP in the first harvest, there were few quality differences among the varieties. Summer Prince had significantly higher protein levels than the other varieties at first harvest (Table 4). There were no significant quality differences in the second cut.

Table4. First harvest dry matter yield and quality of sorghum-sudangrass and sudangrass varieties.

Variety	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
AS6501	14.3	6920	11.5	40.7	63.5	64.4	57.0	8.67	0.58
AS9301	**15.4***	6820	10.7	**40.1**	63.0	62.9	**57.5**	**10.1***	**0.59**
Summer Dream	13.4	6000	11.8	40.9	63.3	**64.5**	56.5	8.07	0.58
Summer Prince	14.7*	6840	**13.0***	40.8	**62.9**	61.7	56.3	7.87	0.58
Summer Queen	15.0*	**7250**	11.4	40.8	63.9	63.4	56.6	8.60	0.58
LSD (0.10)	0.96	NS	1.12	NS	NS	NS	NS	0.83	NS
Means	14.6	6770	11.7	40.6	63.3	63.4	56.8	8.67	0.58

**; indicates the variety is not significantly different than the top performing variety.*

NS; indicates that there were no significant differences among the varieties.

Table 5. Second harvest dry matter yield and quality of sorghum-sudangrass and sudangrass varieties.

Variety	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
AS6501	13.0	3250	12.6	40.7	61.7	65.2	56.7	8.30	0.58
AS9301	**15.0**	3100	13.2	40.2	60.7	**69.0**	57.2	**8.70**	0.58
Summer Dream	14.1	3310	**13.5**	**39.9**	61.8	65.3	**57.5**	8.47	**0.59**
Summer Prince	13.2	**3570**	12.4	40.5	62.3	65.5	56.8	8.23	0.58
Summer Queen	11.3	2820	13.4	**39.9**	**59.7**	65.8	56.6	8.20	0.58
LSD (0.10)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Means	13.3	3210	13.0	40.2	61.2	66.1	57.0	8.38	0.58

NS; indicates that there were no significant differences among the varieties.

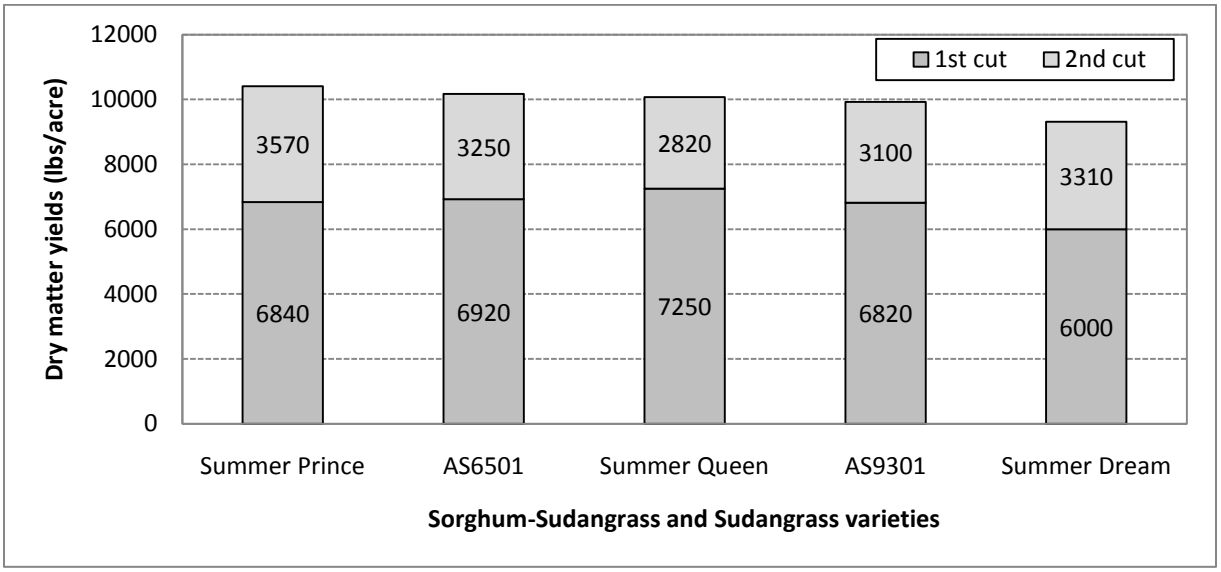

Figure 1. Total dry matter yield of sorghum-sudangrass and sudangrass varieties. No statistical significance was detected between varieties.

Mixing a brassica crop with annual forage may improve overall yield and quality. Brassica crops are known for their near concentrate feed quality. In this study sorghum-sudangrass and sudangrass varieties were grown with Barkant turnips to evaluate yield and quality as compared to warm season grass forage. At first harvest, warm season grasses interseeded with brassica yielded an average of 2000 lbs less than just the warm season grasses. AS6501 interseeded with Barkant turnips had the lowest ADF and NDF, and highest dNDF (Table 6). Interestingly at the second harvest, Summer Prince interseeded with turnips had the highest dry matter yields (Figure Table 7), although not statistically different than AS6501, AS9301, and Summer Prince without turnips. No statistical significance was determined between the varieties with respect to quality (Table 7). Overall, interseeding sorghum-sudangrass and sudangrass with forage turnips significantly increased protein and reduced fiber content but resulted in reduced dry matter yields (Table 8 and Figure 2).

Table6. First harvest yield and quality of sorghum-sudangrass and sudangrass with and without turnips.

Treatment	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
AS6501	14.3	**6920***	11.5	40.7	63.5	64.4*	57	8.67	0.58
AS6501 & Barkant turnip	11.2	4340	14.4*	**38.1***	**53.6***	**66.5***	56.7	9.23*	0.58
AS9301	**15.4***	6820*	10.7	40.1	63.0	62.9	**57.5**	**10.1***	**0.59**
AS9301 + Barkant turnip	13.1	5810	13.0*	39.4*	59.0	62.1	56.4	8.93*	0.57
Summer Prince	14.7*	6840*	13.0*	40.8	62.9	61.7	56.3	7.87	0.58
Summer Prince & Barkant turnip	12.4	4540	**14.6***	38.9*	55.2*	64.6*	56.5	9.10*	0.58
LSD (0.10)	1.01	764	1.78	1.58	3.48	2.56	NS	1.24	NS
Means	13.5	5880	12.9	39.7	59.5	63.7	56.7	8.99	0.58

**; indicates the variety is not significantly different than the top performing variety.*

NS; indicates that there were no significant differences among the varieties.

Table7. Second harvest yield and quality of sorghum-Sudangrass and Sudangrass with and without turnips.

Treatment	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
AS6501	13.0*	3250*	12.6	40.7	61.7	65.2	56.7	8.30	0.58
AS6501 + Barkant turnip	8.36	1990	13.5	**38.8**	**58.3**	64.8	57.0	8.63	0.58
AS9301	**15.0***	3100*	13.2	40.2	60.7	69.0	57.2	8.70	0.58
AS9301 + Barkant turnip	12.9*	2640	**13.8**	39.7	60.7	**67.1**	**57.4**	8.13	**0.59**
Summer Prince	13.2*	3570*	12.4	40.5	62.3	65.5	56.8	8.23	0.58
Summer Prince + Barkant turnip	13.7*	**3590***	12.3	40.2	61.7	65.0	57.3	**9.40**	**0.59**
LSD (0.10)	3.22	868	NS	NS	NS	NS	NS	NS	NS
Means	12.7	3020	13	40	60.9	66.1	57.1	8.57	0.58

**; indicates the variety is not significantly different than the top performing variety.*
NS; indicates that there were no significant differences among the varieties.

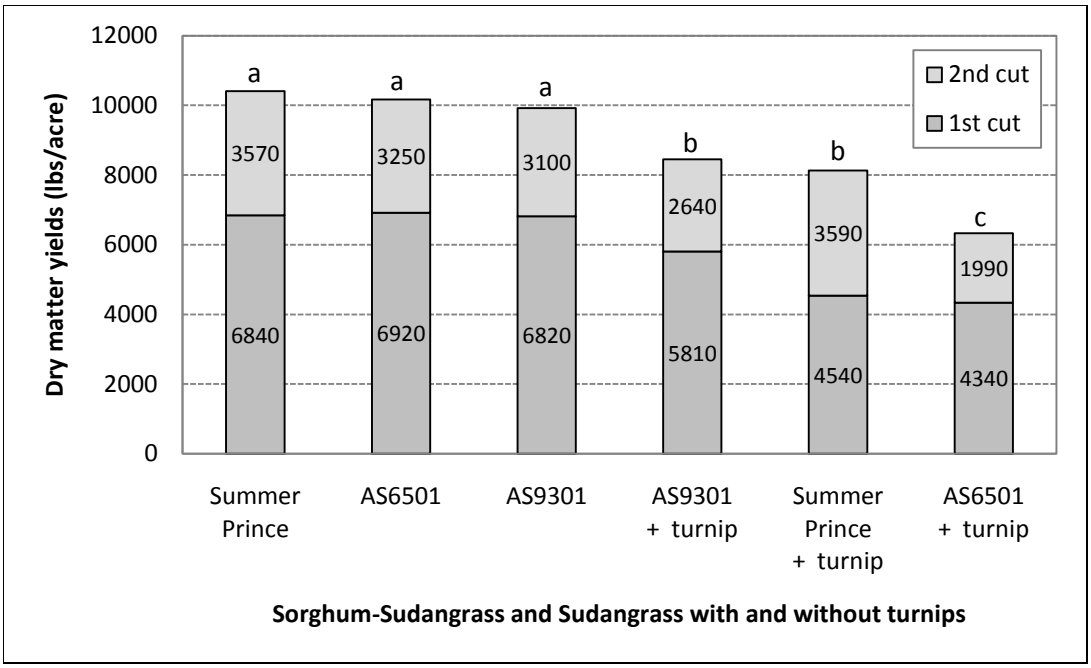

Figure 2. Total dry matter yield for both harvests of the sorghum-sudangrass and sudangrass varieties with and without forage turnips.

Table8. Dry matter yield and quality of sorghum-Sudangrass and Sudangrass with and without turnips.

Treatment	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NEL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
Summer annual with turnips	11.9	3820	**13.6**	**39.2**	**58.1**	**65.0**	**56.9**	**8.9**	**0.58**
Summer annuals with no turnips	**14.3**	**5080**	12.2	40.5	62.3	64.8	**56.9**	8.65	**0.58**
LSD (0.10)	1.11	996	*	*	*	NS	NS	NS	NS
Means	13.1	4450	12.9	39.8	60.2	64.9	56.9	8.78	0.58

**; indicates the variety is not significantly different than the top performing variety.*
NS; indicates that there were no significant differences among the varieties.

Forage Millets

Forage millets are another warm season annual that can be used for grazing or stored forage. Millet is also being marketed to producers already blended with forage brassica. The goal was to evaluate millet with and without brassica crops. Unfortunately we were only able to harvest once during the summer season. It is unclear why the millet did not regrow adequately to provide additional harvests of forage. The first harvest indicated no difference among yields between treatments. The first cut yields were almost half that of the sorghum-sudangrass. Interseeding with brassicas increased the CP, and decreased NDF concentrations (Table 9).

Table9. Dry matter yield and quality of different forage millets interseeded with turnips.

Variety	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
Japanese millet	**14.9***	3650	13.1	39.5	61.9	57.2	56.1	8.90	0.57
Japanese millet + Barkant turnips	11.8	**4610**	14.6*	38.3	55.8*	**64.2***	56.7	8.97	0.58
Summer Feast	11.8	3480	**15.8***	**38.1**	**55.6***	60.2	55.7	7.93	0.57
Wonderleaf	14.3*	3550	14.4	38.9	60.1	56.9	56.2	8.83	0.57
LSD (0.10)	1.51	NS	1.29	NS	2.45	1.66	NS	NS	NS
Means	13.2	3820	14.5	38.7	58.4	59.6	56.2	8.66	0.57

**; indicates the variety is not significantly different than the top performing variety.*
NS; indicates that there were no significant differences among the varieties.

Table10. Dry matter yield and quality comparison between millet and sorghum-Sudangrass/Sudangrass.

Variety	DM at harvest	DM yield	Forage quality characteristics						
			CP	ADF	NDF	dNDF	TDN	NSC	NeL
	%	lbs/ac	%	%	%	%	%	%	Mcal/lb
Millet	13.2	3820	**14.5**	**38.7**	**58.4**	59.6	56.2	8.66	0.57
Sorghum-sudangrass, sudangrass	**14.6**	**6770**	11.7	40.6	63.3	**63.4**	**56.8**	**8.67**	**0.58**
LSD (0.10)	0.90	558	0.77	0.55	1.50	2.21	0.50	NS	0.01
Means	14.0	5460	12.9	39.8	61.1	61.7	56.5	8.66	0.58

**; indicates the variety is not significantly different than the top performing variety.*
NS; indicates that there were no significant differences among the varieties.

RESULTS

Overall, warm season annual grasses have the potential to produce 6 tons of dry matter per acre. This is similar and often higher than corn silage yields obtained on organic farms. It remains unclear why millets regrew poorly and did not provide a second cut of forage. The quality of the warm season forages has at least twice as much CP compared to corn silage. However the fiber content (ADF and NDF) was higher than corn but similar to perennial grasses. The ADF values of 40 percent and higher may indicate that the forage would have low digestibility levels. Due to budget constraints we were unable to measure lignin in this study. Interestingly the level of digestible fiber was well above that of corn silage and even approached BMR corn silage levels. The sorghum-sudangrass varieties had the BMR genetics and hence would have lower lignin and higher sugar levels. Overall the sorghum-sudangrass and sudangrass varieties yielded higher than the millets. The CP of millets was on average 3 percentage points higher than that of sorghum-sudangrass varieties. Overall, there was some quality value to adding brassica crops to the summer warm season annuals. The benefits were highly variable among the harvest times and varieties. More research would need to be conducted to better evaluate potential forage quality and economical benefits.

The UVM Extension Crops and Soils Team would like to thank Borderview Research Farm for their generous help with the trials and acknowledge Organic Valley FAFO fund for their financial support.

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