2022 Summer Annual Seeding Rate Trial

Dr. Heather Darby, UVM Extension Agronomist
Sara Ziegler, Catherine Davidson, Ivy Krezinski, and Laura Sullivan
UVM Extension Crops and Soils Technicians
802-524-6501

Visit us on the web: http://www.uvm.edu/nwcrops

THE UNIVERSITY OF VERMONT EXTENSION

2022 SUMMER ANNUAL SEEDING RATE TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

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. Varieties of these species can differ widely in their growth characteristics, such as stem width and leaf to stem ratio, which influences their quality potential. Additional traits, such as brown mid-rib (BMR), can further increase the quality of these species through improved fiber digestibility. However, seed costs for these improved varieties can be considerable. With seeding rate recommendations varying between seed company, Extension, and the limited scientific literature, it can be difficult for a farmer to ensure they're using a cost-effective rate. To better understand the yield and quality tradeoffs and accompanying costs of various seeding rates and types of summer annual grasses, the UVM Extension Northwest Crops and Soils Program initiated a field trial in 2022.

MATERIALS AND METHODS

A trial was initiated at Borderview Research Farm in Alburgh, VT on 7-Jun. Twenty-four treatments consisted of two species, two types (BMR vs non-BMR), and eight seeding rates, which were replicated four times (Table 1). Plots were 5' x 20' and were seeded with a Great Plains cone seeder. Approximately 50 lbs N was applied on 12-Jul.

Table 1. General plot management, 2022.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Corn silage
Starter fertilizer	200 lbs ac^{-1} 7-18-36, 9-May
Topdress fertilizer	100 lbs ac^{-1} 46-0-0, 12-Jul
Species/type treatments	BMR sudangrass (variety: AS 9301) Non-BMR sorghum x sudangrass (variety: SS 275) BMR sorghum x sudangrass (variety: SSA 251)
Seeding rate treatments (thousand seeds ac^{-1})	450, 500, 550, 600 650, 700, 750, 800
Planting date	7-Jun
First harvest date	20-Jul
Second harvest date	25-Aug
Tillage methods	Pottinger TerraDisc

Plots were harvested with a Carter flail forage harvester to a height of approximately 4" on 20-Jul and 25-Aug. Plot yields were recorded and a subsample collected to determine dry matter content and forage quality. Due to the number of samples, a subset was selected for quality analysis. These consisted of the BMR and non-BMR sorghum x sudangrass plots at the 450,000, 650,000 and 800,000 seeds ac^{-1} treatments. These samples were ground to 2mm using a Wiley sample mill and then to 1-mm using a UDY cyclone mill. Samples were analyzed 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. 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 2. Conditions at planting were good with warm temperatures and moist soil conditions. However, following planting temperatures remained relatively low with elevated rainfall accumulating through June. By July, temperatures had increased and rainfall diminished. Over 80% of the total rainfall accumulated during July occurred in just three rain events. Similar conditions were observed in August with over 50% of the monthly accumulated rainfall occurring in just two rain events. Overall, there were a total of 1763 Growing Degree Days (GDDs) accumulated during these months, 95 fewer than the 30-year normal. While these summer annual forage species are relatively drought and heat tolerant, they typically do not perform well if those conditions are experienced during establishment or under cool conditions.

Table 2. 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.

Impact of Forage Type

Dry matter yields were statistically similar for the first harvest where all type treatments produced approximately 1.1 tons ac^{-1} (Table 3). However, at the second harvest and then looking at season total yields, the non-BMR sorghums sudangrass yielded 0.3 tons ac^{-1} higher than the other two types at the second cut. Overall, this treatment produced 2.70 tons ac^{-1} across the two harvests, which was statistically similar to the BMR sorghum sudangrass but significantly higher than the BMR sudangrass treatment.

Table 3. Dry matter yield by forage type.

	Dry matter yield (tons ac^{-1})		
Forage type	1st cut	2nd cut	Total
BMR Sorghum sudangrass	1.25	1.23b†	2.49ab
Sorghum sudangrass	1.19	**1.50**a	**2.69**a
BMR Sudangrass	1.07	1.22b	2.28b
LSD (p = 0.10) ‡	NS¥	0.164	0.257
Trial mean	1.17	1.32	2.49

†Treatments that share a letter performed statistically similarly to one another.
Top performer treatments are in **bold.**
‡LSD; least significant difference at the p=0.10 level.
¥NS, not statistically significant.

Forage types also differed in some quality characteristics (Table 4). As expected, the BMR type had higher fiber digestibility being approximately 5% higher than the non-BMR type. This also corresponded to a lower proportion of fiber left undigested after 240 hours of exposure to rumen fluid compared to the non-BMR type. Protein and non-fiber carbohydrate contents did not differ between types. This difference in individual quality characteristics led to a relative forage quality rating higher in the BMR type, but did not correspond to a higher predicted milk yield per ton.

Table 4. Quality characteristics by forage type.

Forage type	CP	NDF	NFC	30-hr NDF digestibility	240-hr uNDF	Milk yield	RFQ
	% of DM			% of NDF		lbs ton^{-1}	
BMR	13.9	58.4	15.8	**71.9**	**9.08**	**3315**	**132**
Non-BMR	**14.6**	**56.9**	**16.7**	66.7	10.8	3306	125
LSD (p = 0.10) ‡	NS¥	1.46	NS	1.64	0.544	NS	5.57
Trial mean	14.3	57.7	16.3	69.3	9.92	3310	129

‡LSD; least significant difference at the p=0.10 level. Top performer treatments are in **bold.**
¥NS, not statistically significant.

While some differences in quality characteristics were seen, the differences in dry matter yield may outweigh these quality differences when we consider the yield of these components on a per acre basis. In terms of protein and non-fiber carbohydrates, the non-BMR type produced more of these compounds per acre due to the higher dry matter yield compared to the BMR type (Table 5). However, due to the increased digestibility in the BMR type, there was no statistically significant difference in the amount of digestible NDF produced per acre. This demonstrates that, while BMR types may be lower yielding than non-BMR alternatives, they make up for this in producing more digestible fiber.

Table 5. Yield of protein, fiber, and non-fiber carbohydrates by forage type.

Forage type	CP	NFC	30-hr digestible NDF	240-hr uNDF
	tons ac^{-1}			
BMR	0.358	0.384	1.05	**0.133**
Non-BMR	**0.438**	**0.453**	**1.10**	0.175
LSD (p = 0.10) ‡	0.071	0.054	NS¥	0.022
Trial mean	0.398	0.418	1.07	0.154

‡LSD; least significant difference at the p=0.10 level. Top performer treatments are in **bold.**
¥NS, not statistically significant.

Impact of Seeding Rate

Dry matter yields did not differ statistically at either of the two harvests or when combined into a season total yield (Table 6). This indicates that no additional yield benefit was observed when summer annual grasses were seeded at rates exceeding 450,000 seeds ac^{-1}. This was true whether we used a sudangrass or sorghum sudangrass, and whether the variety was a BMR-type or non-BMR type. However, given this season's unusually wet and cool conditions, these trends may have been different if optimal summer annual growing conditions were experienced.

In addition to yield, we also looked at the quality characteristics of a low, moderate, and high seeding rate across BMR and non-BMR type sorghum sudangrass (Table 7). Crude protein content was the only statistically significant difference observed with the lowest seeding rate producing the highest protein content. However, to better understand the impacts of yield and quality differences in combination, the yield of quality components on a per acre basis can be compared (Table 8). No statistical differences were observed in the yield of any quality components indicating that seeding rate did not impact forage quality.

Table 6. Dry matter yield by seeding rate.

Seeding rate	**Dry matter yield**		
thousand seeds ac^{-1}	**1st cut**	**2nd cut**	**Total**
450	1.16	1.36	2.52
500	1.12	1.30	2.42
550	1.13	1.10	2.23
600	**1.29**	1.37	2.66
650	1.21	1.32	2.54
700	1.12	1.39	2.51
750	1.07	1.30	2.36
800	1.25	**1.41**	**2.66**
LSD (p = 0.10) ‡	NS¥	NS	NS
Trial mean	1.17	1.32	2.49

‡LSD; least significant difference at the p=0.10 level. Top performer treatments are in **bold.**
¥NS, not statistically significant.

Table 7. Quality characteristics by seeding rate.

Seeding rate	CP	NDF	NFC	30-hr NDF digestibility	240-hr uNDF	Milk yield	RFQ
thousand seeds ac^{-1}	% of DM			% of NDF		lbs ton^{-1}	
450	**15.8**a†	**56.6**	15.9	**70.0**	**9.63**	**3352**	128
650	13.8b	58.4	16.3	68.7	10.11	3275	**129**
800	13.3b	58.0	**16.6**	69.2	10.0	3305	129
LSD (p = 0.10) ‡	1.88	NS¥	NS	NS	NS	NS	NS
Trial mean	14.3	57.7	16.3	69.3	9.92	3310	129

†Treatments that share a letter performed statistically similarly to one another. Top performer treatments are in **bold.**
‡LSD; least significant difference at the p=0.10 level.
¥NS, not statistically significant.

Table 8. Yield of quality components per acre by seeding rate.

Seeding rate	CP	NFC	30-hr digestible NDF	240-hr uNDF
(thousand seeds ac^{-1})	tons ac^{-1}			
450	0.452	0.425	1.10	0.152
650	0.348	0.370	0.969	0.144
800	0.394	0.460	1.15	0.166
LSD (p = 0.10) ‡	NS¥	NS	NS	NS
Trial mean	0.398	0.418	1.07	0.154

‡LSD; least significant difference at the p=0.10 level.
¥NS, not statistically significant.

DISCUSSION

These data suggest that, while BMR-type summer annual grasses do have increased fiber digestibility, they ultimately produce similar yields of digestible NDF and other quality components on a per acre basis. This is true regardless of seeding rate, even the highest rate we investigated of 800,000 seeds ac^{-1}. Therefore, no yield or quality benefit was observed by exceeding a seeding rate of 450,000 seeds ac^{-1}. Depending on the size of the seed, which can vary widely between species and varieties, this may equate to 25-35 lbs ac^{-1}. Due to the below average temperatures and above average rainfall for much of the summer, these results may have differed if conditions were optimal for these summer annual species. These results represent only one location and growing season 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.

ACKNOWLEDGEMENTS

The UVM Extension Northwest Crops and Soils Program would like to thank Roger Rainville and the staff at Borderview Research Farm for their generous help with this research trial. We would also like to acknowledge John Bruce, Lindsey Ruhl, and Sophia Wilcox Warren for their assistance with data collection and entry. This information is presented with the understanding that no product discrimination is intended and neither endorsement of any product mentioned, nor criticism of unnamed products, is implied.

UVM Extension helps individuals and communities put research-based knowledge to work.

THE UNIVERSITY OF VERMONT EXTENSION