3-2023

2022 Summer Annual Mixtures Trial

Heather Darby
University of Vermont, heather.darby@uvm.edu

Sara Ziegler
University of Vermont, sara.ziegler@uvm.edu

NORTHWEST CROPS & SOILS PROGRAM

2022 Summer Annual Mixtures 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 MIXTURES 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. However, these grasses require lots of nitrogen which can be very costly, especially in organic systems. Adding a legume into the mixture with these grasses could help lower the nitrogen requirement of the crops and potentially increase protein content of the forage. However, the competitive nature of the grasses makes it challenging to establish an adequate balance without sacrificing yield or increasing costs from seed. To identify adequate seeding rates of summer annual grass/legume mixtures, the UVM Extension Northwest Crops and Soils Program conducted this trial to evaluate the yield and quality of warm season annual grass/legume mixtures.

MATERIALS AND METHODS

A trial was initiated at Borderview Research Farm in Alburgh, VT on 2-Jun. Plots were managed with practices similar to those used by producers in the surrounding area (Table 1). Twenty treatments consisting of different mixtures of summer annual grasses (sudangrass or pearl millet) and legumes (crimson or red clover) were compared (Table 2). Plots were seeded with a Great Plains cone seeder. Approximately 50 lbs N was applied in the form of urea (46-0-0) on 12-Jul. Prior to harvest, heights of both the grass and legume species present in each plot were measured.

Table 1. General plot management, 2022.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Sweet potatoes
Planting date	2-Jun
First harvest date	22-Jul
Second harvest date	25-Aug
Tillage methods	Pottinger TerraDisc

Plots were hand-harvested by cutting the forage growing within a 0.25 m^2 quadrat in each plot to a height of 5” on 22-Jul and 25-Aug. The material in each plot was sorted into summer annual grass, legume, and weed fractions. Each fraction was weighed and a composite sample of each planted species and an overall composite sample of weeds were weighted and dried to determine dry matter content.

Table 2. Summer annual mixture seeding ratio treatments, 2022.

Grass species	Legume species	Seeding rate (lbs ac^{-1})		Seeding ratio
		Grass	Legume	Grass : Legume
Sudangrass Variety: AS 9301	Red clover Variety: Alta-Swede	0	12	0:100
		7.5	9	40:60
		15.0	6	70:30
		22.5	3	90:10
		30	0	100:0
Sudangrass Variety: AS 9301	Crimson clover Variety: Dixie	0	15	0:100
		7.5	11.3	40:60
		15.0	7.5	70:30
		22.5	3.75	90:10
		30	0	100:0
Pearl Millet Variety: Prime 360	Red clover Variety: Alta-Swede	0	12	0:100
		6.25	9	40:60
		12.5	6	70:30
		18.8	3	90:10
		25.0	0	100:0
Pearl Millet Variety: Prime 360	Crimson clover Variety: Dixie	0	15	0:100
		6.25	11.3	40:60
		12.5	7.5	70:30
		18.8	3.75	90:10
		25.0	0	100:0

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. Conditions at planting were good with warm temperatures and recent ample rainfall. 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 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.

The highest yielding treatment was the 40:60 mixture of sudangrass and red clover which produced 3.04 tons of dry matter per acre over the season, almost twice as much as the lowest yielding treatment (Table 4). However, the top yielding treatment performed statistically similarly to twelve other treatments which included all treatments except for 100% legume treatments and the 40:60 treatments where pearl millet was the grass. This indicates that reducing the proportion of sudangrass to as low as 40% and as low as 70% for millet and replacing that portion with clover seed did not significantly impact yields. The sudangrass treatments yielded slightly higher overall compared to the pearl millet treatments. In addition, more of the biomass in the pearl millet treatments was weeds not millet. The sudangrass treatments averaged less than half the weed proportion as the same treatments with pearl millet.

Clover establishment was low across the trial, however the crimson clover performed better than the red clover. Across all treatments the red clover had trouble germinating and growing quickly to outpace the weeds and compete with even the lowest rates of sudangrass and millet. In general, yields increased once 40% grass was included in the mixture and weeds declined, however further increases in grass proportions did not increase yields or decrease weeds significantly (Figure 1). Overall, the yields were much lower and the weed biomass much greater than in 2021. These data indicate that red clover and crimson clover may not be suitable legumes to mix with summer annual grasses but also demonstrates the challenge utilizing these species that thrive under hot conditions. With the cool wet weather in the beginning of the season, these species did not establish and grow quickly enough to outpace the weeds and thus yielded poorly.

Table 4. Yield and composition of summer annual mixtures, 2022.

Grass species	Legume species	Approximate ratio Grass : Legume	Dry matter yield tons ac^{-1}	Grass % of dry matter	Legume % of dry matter	Weeds % of dry matter
Sudangrass	Red clover	0:100	1.60e	0.00e	8.09cd	91.9i
		40:60	**3.04**a	66.1ab	1.03d	32.9bcdef
		70:30	2.53abc	68.4ab	1.92d	29.7abcde
		90:10	2.99ab	79.1a	0.583d	20.4abc
		100:0	2.79ab	80.3a	0.00d	19.7ab
Sudangrass	Crimson clover	0:100	1.78de	2.08e	23.5ab	74.4hi
		40:60	2.58abc	69.3ab	5.95cd	24.7abcd
		70:30	2.75ab	78.6a	0.899d	20.5abc
		90:10	2.75ab	76.7a	0.951d	22.3abc
		100:0	2.59abc	**86.0**a	2.92d	**11.1**a
Pearl Millet	Red clover	0:100	1.99cde	4.19e	7.26cd	88.6i
		40:60	2.02cde	32.6d	4.36d	63.0gh
		70:30	2.40abcd	52.4cd	7.26cd	40.3cdef
		90:10	2.32bcd	34.5cd	3.48d	62.1gh
		100:0	2.45abcd	37.1	0.00d	62.9gh
Pearl Millet	Crimson clover	0:100	1.79de	0.00e	14.2bc	85.8i
		40:60	2.29bcde	38.2cd	**24.6**a	37.2bcdef
		70:30	2.60abc	45.6cd	4.28d	50.1fg
		90:10	2.65abc	53.9bc	2.18d	43.9defg
		100:0	2.44abcd	52.9bc	0.00d	47.1efg
LSD (p = 0.10)			0.704	20.1	9.46	20.0
Trial mean			2.42	47.9	5.68	46.4

†Treatments that share a letter performed statistically similarly to one another.
Top performing treatment indicated in **bold**.

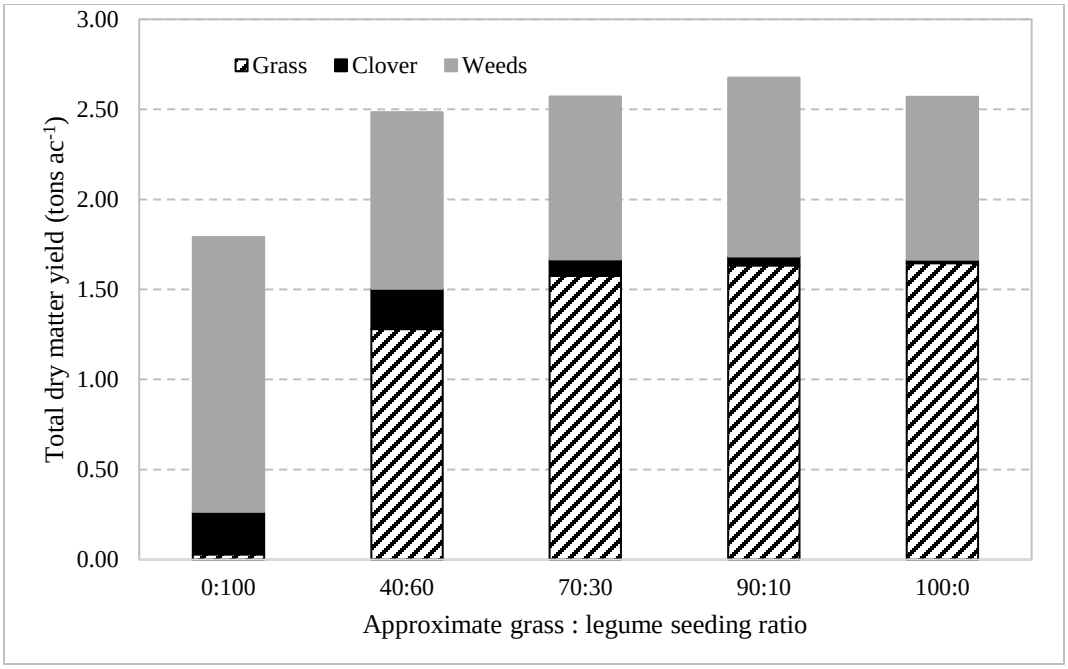

Figure 1. Forage composition of total dry matter by grass : legume seeding ratio, 2022.

DISCUSSION

These data suggest that red clover and crimson clover are not suitable legumes to create well-balance mixtures with sudangrass or pearl millet. Even at the highest inclusions, minimal legume biomass was attained. Interestingly this year virtually all the mixture ratios resulted in a similar total yield with only slight changes in the proportions of grass, legume and weeds in the mixture. Due to wet cool weather the overall establishment and resulting yields were poor and weed pressure high. In general, however, perhaps the mixtures would have been more balanced had seeding rates of the grasses been lower than 6 lbs ac^{-1} coupled with legume rates over 10 lbs ac^{-1}, however, the reduction in total biomass may be too substantial compared to the cost of the seed in these instances. Different legumes that are better suited to the hot dry conditions, such as cowpea, may be a more suitable option, however, in years where conditions are cool and wet, no summer annual forage species will perform optimally.

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

This project was supported by the Northeast Sustainable Agriculture Research and Education program (project no. 2018-02802) from the USDA National Institute of Food and Agriculture. 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.