NORTHWEST CROPS & SOILS PROGRAM

2021 Summer Annual Mixtures Trial

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THE UNIVERSITY OF VERMONT EXTENSION

2021 SUMMER ANNUAL MIXTURES TRIAL

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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. However, these grasses require substantial 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 2021. 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 of N was applied in the form of urea (46-0-0) on 24-Jun. Prior to harvest, heights of both the grass and legume species present in each plot were measured.

Table 1. General plot management, 2021.

Trial Information	Borderview Research Farm-Alburgh, VT
Soil Type	Benson rocky silt loam
Previous crop	Winter cover crops
Planting date	2-Jun
First harvest date	22-Jul
Second harvest date	24-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. 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. An approximate 1 lb sample of the planted species from each plot were then recombined and dried for quality analysis via near infrared reflectance spectroscopy (NIR) techniques. At the time this report was written, the quality analysis were not yet complete. Therefore, this report will summarize the yield and composition results and will be updated with quality when the data are available.

Table 2. Summer annual mixture seeding ratio treatments, 2021.

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. Although the early season brought cool, wet conditions, temperatures quickly rose, and rainfall dissipated by early June, the typical planting time for summer annual forages. Rainfall was below normal with the region being designated as experiencing abnormally dry or moderate drought conditions (Drought.gov) throughout the season. Much of the rain that fell throughout the season came in short duration storms. On average, July temperatures were over 4 degrees below normal while August temperatures were 3 degrees above normal. Both July and August rainfall accumulations were over an inch below normal. Overall, there were a total of 1885 Growing Degree Days (GDDs) accumulated during these months, 24 more than the 30-year normal.

Table 3. Seasonal weather data collected in Alburgh, VT, 2021.

Alburgh, VT	June	July	August
Average temperature (°F)	70.3	68.1	74.0
Departure from normal	2.81	-4.31	3.25
Precipitation (inches)	3.06	2.92	2.29
Departure from normal	-1.20	-1.14	-1.25
Growing Degree Days (base 50°F)	597	561	727
Departure from normal	73	-134	85

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 70:30 mixture of Sudangrass and red clover which produced 6.55 tons of dry matter per acre over the season, almost three times as much as the lowest yielding treatment (Table 4). However, the top yielding treatment performed statistically similarly to four other treatments, which all included Sudangrass representing at least 70% of the mixture seeded. This indicates that, while the amount of Sudangrass seed planted declined in place of clover seed, yields did not significantly decline. Furthermore, yields were dramatically reduced when Sudangrass proportions dropped below 70%. However, a less severe decline was found with the pearl millet treatments. Overall, the Sudangrass treatments yielded higher than the pearl millet treatments. The highest proportions of pearl millet produced approximately 4.5 tons ac^{-1}, one to two tons less than the same ratios including Sudangrass.

Clover establishment was low across the trial, however the crimson clover performed better than the red clover. The hot dry conditions at and following planting were challenging for the red clover to germinate and grow quickly to outpace the weeds and compete with even the lowest rates of Sudangrass and millet. In general, as the proportion of grass in the mixture increased, yield increased and the proportion of weeds in the resulting mixture decreased (Figure 1). The lowest grass inclusions equated to 7.50 and 6.25 lbs ac^{-1} for Sudangrass and millet respectively. Reducing these inclusions lower will likely only result in additional weed pressure unless a more aggressive legume is used. These data indicate that red clover and crimson clover may not be suitable legumes to mix with summer annual grasses.

Table 4. Yield and composition of summer annual mixtures, 2021.

Grass species	Legume species	Approximate ratio Grass : Legume	Dry matter yield	Grass	Legume	Weeds
			tons ac^{-1}	% of dry matter		
Sudangrass	Red clover	0:100	2.23i†	0.00h	11.3cd	88.7h
		40:60	3.85efgh	70.2fg	2.39ef	27.4e
		70:30	**6.55a**	93.5ab	0.472f	6.02abc
		90:10	6.40ab	**98.8a**	0.129f	**1.07a**
		100:0	6.16ab	98.4a	0.00f	1.60a
Sudangrass	Crimson clover	0:100	2.78hi	0.00h	**57.2a**	42.8f
		40:60	4.52de	83.0cde	3.85def	13.2abcd
		70:30	5.72abc	91.5abc	1.51ef	7.00abcd
		90:10	5.97ab	96.8ab	0.091f	3.07a
		100:0	5.46bcd	94.5ab	0.00f	5.51ab
Pearl Millet	Red clover	0:100	2.89hi	9.05h	9.60cde	81.3h
		40:60	3.85efgh	79.6def	1.73ef	18.6cde
		70:30	4.01efg	80.7de	0.854f	18.4bcde
		90:10	4.28ef	92.1abc	0.257f	7.63abcd
		100:0	4.49de	87.9bcd	3.28def	8.81abcd
Pearl Millet	Crimson clover	0:100	3.12ghi	0.00h	35.9b	64.1g
		40:60	3.22fghi	66.0g	16.0c	18.0bcde
		70:30	4.03efg	74.8efg	5.84def	19.4de
		90:10	4.68cde	91.6abc	0.545f	7.88abcd
		100:0	4.52de	94.4ab	0.00f	5.61ab
LSD (p = 0.10)			1.08	10.3	8.47	12.9
Trial mean			4.44	70.1	7.54	22.3

†Treatments that share a letter performed statistically similarly to one another

Top performing treatment indicated in **bold**.

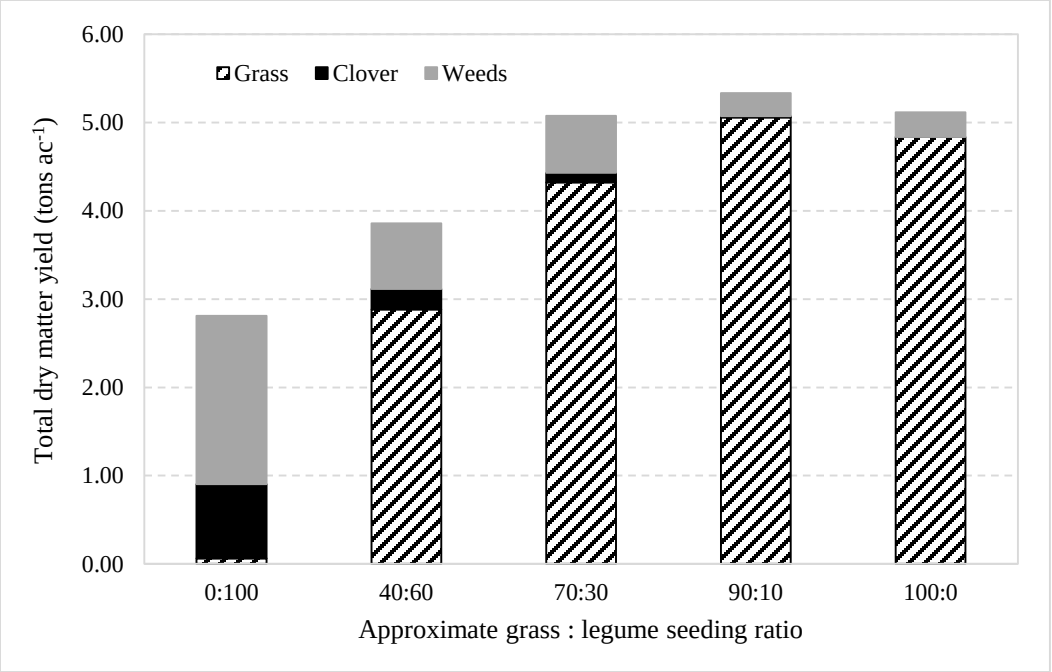

Figure 1. Forage composition of total dry matter by grass: legume seeding ratio, 2021.

DISCUSSION

These data suggest that red clover and crimson clover are not suitable legumes to create well-balance mixtures with sudangrass or pearl millet with the ratios used in this study. Increasing legume inclusion resulted in lower yields, higher proportions of weeds, and did not produce ample legume biomass even at the highest inclusions. 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.

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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