Biomass Yield and Quality of Annual Forage Mixtures Compared With Sorghum Monocrops

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Summary

Annual forage mixtures are a good source of forage with high nutritional value for ruminant consumption. Determining what forage mixture to use for ruminant grazing is important. Treatment 7 (a mixture of oats, phacelia, faba beans, peas and Brachytic sorghum) had the highest biomass yield of 0.8 ton/acre. No difference ($P > 0.05$) in forage yield was found between the monocrops and mixtures, excluding a late-planted brassica mix.

Sorghum x sudan monocrop had the highest total digestible nutrients (TDN) at 43%, and differences ($P \leq 0.05$) in total digestible nutrients (TDN) were observed between the monocrops (Treatments 8 to 12) and mixtures (Treatments 1 to 7). Crude protein ranged from 9% to 17% in the mixtures and 14% to 18% in monocrops. Acid detergent lignin was less than 7% in all the treatments.

Introduction

Annual forage mixtures are a valuable biomass feed source for ruminants (Smith et al., 2014). Annual forage mixtures also extend the grazing period of livestock (Acuña and Villamil, 2014). Other benefits such as increasing plant biodiversity and improving the soil micro fauna and flora are attributed to annual forage mixtures (Rodriguez et al., 2009).

Biomass yield of forage mixtures can be optimized using proper agronomic practices (Foster et al., 2013). The seeding rate is considered the biggest factor affecting forage yield (Vlachostergios et al., 2018). Seeding a variety of high-yielding forage crops in the appropriate proportion balances the botanical composition of the mixture (DeHaan et al., 2010; Bonin and Tracy, 2012).

Environmental factors, animal grazing and management practices change the botanical composition of a mixture during a period of time (Belesky et al., 2002). This change in botanical composition impacts nutritive value and makes maintaining diverse crop mixtures difficult (Sleugh et al., 2000).

Methodology

The study was a randomized complete block design conducted at the Central Grasslands Research Extension Center near Streeter, N.D. The soil type was Hecla-Ulen loamy fine sands with low water storage and 0% to 6% slope (U.S. Department of Agriculture, Natural Resources Conservation Service, 2020). Rainfall was below average through the duration of the study in 2020 except in August (Table 1).

The experiment was planted May 19, 2020, using an eight-cone continuous plot drill with row spacing of 6 inches for mixture treatments and 12 inches for monocultures. Experimental areas have been in no-till for five years or more. All plots were fertilized with 71 pounds of N/acre and 89 pounds of P_2O_5/acre before seeding.

Table 1. Rainfall and average temperature between May and August 2020 at Central Grasslands Research Extension Center near Streeter, N.D. (North Dakota Agricultural Weather Network, 2020).

Month	Mean temperature	Soil temperature	Total rainfall	Departure from normal total rainfall
	---------- °F ----------		---------- inches ----------	
May	50.98	49.47	1.81	-0.64
June	67.43	66.19	1.35	-2.06
July	71.23	73.84	2.13	-1.07
August	68.65	71.44	2.73	0.42

Seventeen forage species ranging from cool-season and warm-season varieties and brassicas were used to develop 12 annual forage treatments (Table 2, next page). Seven treatments (Treatments 1 to 7) were mixtures and five treatments (Treatments 8 to 12) were monocrops. The majority of the experiment was impacted by invasive weeds and ground squirrels, impacting forage production.

Hand weeding was done on June 2, June 16, June 24 and Aug. 13, 2020. The harvest date was Aug. 19, 2020. Plots were harvested with a flail forage harvester; the wet weight was recorded and a sample was taken to determine moisture. The fresh sample was dried and after it was dry, the percentage of dry weight was calculated to calculate the dry weight of the total plot.

Nutritional analysis of samples was conducted at the North Dakota State University Nutrition Lab using AOAC standards (AOAC, 2019). The wet chemistry data was calibrated for biomass mixtures using near-infrared (NIR) spectroscopy equipment. Total digestible nutrients (TDN) were determined using the formula developed by the National Research Council, 2001:

$$TDN = [(NFC \times 0.98) + (CP \times 0.93) + (FA \times 0.97 \times 2.25) + (NDF \times (NDFD/100)-7)]$$

where the parameters were nonfiber carbohydrate (NFC), crude protein (CP), fatty acid (FA), neutral detergent fiber (NDF) and neutral detergent fiber digestibility (NDFD).

The design was a randomized complete block design with four replicates. Data analyzed used a general linear model in SAS (SAS version 9.4; SAS Inst. Inc., Cary, N.C.) (Duncan, 1955). Means were separated using the least significant differences (LSD) at 5% significance.

Results

Treatment 7 had the highest biomass yield of 0.8 ton/acre (Figure 1). Treatment 2 biomass yield was lower than all other treatments ($P \leq 0.05$). However, no difference ($P > 0.05$) in yield was found between the monocrops and mixtures (Figure 1).

The TDN contents of monocrops (Treatments 8 to 12) were statistically higher ($P \leq 0.05$) than those of the mixtures (Treatments 1 to 7). The sorghum x sudan monocrop (Treatment 12) had the highest TDN at 43% (Figure 1).

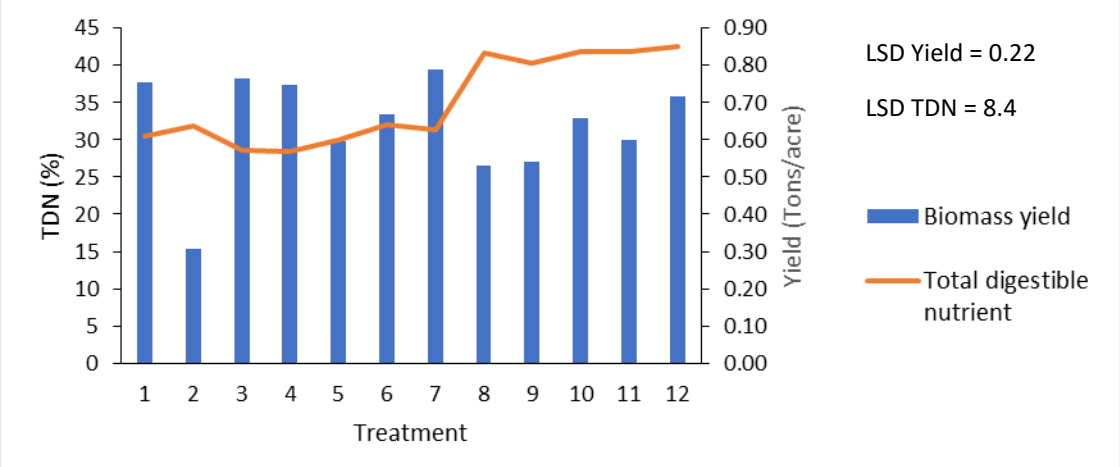

Figure 1. TDN and biomass yield of the 12 treatments at the Central Grasslands Research Extension Center in 2020.

Table 2. Seeding rate of annual forage mixtures.

Treatment	Crop	Cultivar	Seeding rate lbs/acre
1	Annual ryegrass Chicory Plantain Red clover	Crusader Choice Tonic Relish	12 2 3 3
2	Hybrid brassica Turnip	Winfred New York	2 2
3	Hybrid brassica Oats Forage peas Forage sorghum blend Foxtail millet	Winfred Paul Arvika Pampa Legion Siberian	2 5 5 2 2
4	Turnip Forage sorghum blend Forage peas Hybrid brassica Oats Faba beans Forage pearl millet	New York Pampa Tribuno Arvika Winfred Paul Sampo Pampa mijo II BMR6	1 2 5 1 2 2 2
5	Forage pearl millet Hybrid brassica	Pampa mijo II BMR6 Winfred	5 2
6	Sorghum x sudan Radish	ADSGS6504 Graza	2 2
7	Oats Phacelia Forage peas Faba beans Brachytic sorghum BMR	Paul VNS Arvika Sampo AF7101	5 1 5 5 3
8	Forage sorghum blend	Pampa Legion	10
9	Forage pearl millet	Pampa mijo II BMR6	10
10	Pearl millet	Platino non-BMR	10
11	Brachytic sorghum BMR	AF7101	10
12	Sorghum x sudan	ADSGS6504	10

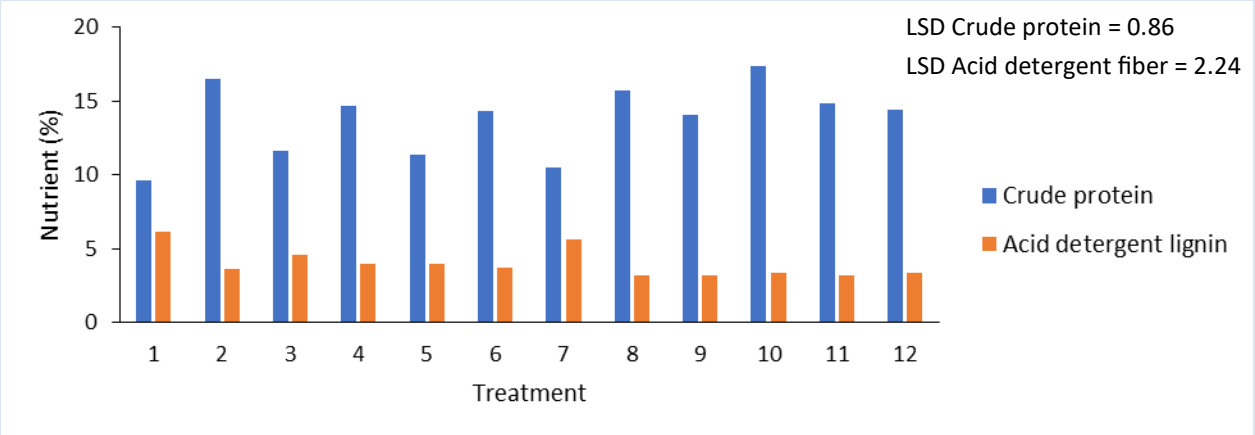

Figure 2. Acid detergent lignin and crude protein of the 12 treatments at the Central Grasslands Research Extension Center in 2020.

The highest CP content was 18% (Treatments 2 and 10) and lowest just under 10% (Treatment 1) (Figure 2). No difference ($P > 0.05$) was found among treatments 2, 4, 6, 8, 10, 11 and 12 in CP (Figure 2). Acid detergent lignin was less than 7% in all the treatments (Figure 2).

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