JOURNAL OF THE NACAA

ISSN 2158-9429

VOLUME 16, ISSUE 2 – DECEMBER, 2023

Editor: Linda Chalker-Scott

Noland, R.[1], Palmer, M.[2], Vahlenkamp, M.[3], McCulloch, M.[4], Muir, J.[5], Cherry, N.[6], and Bell, T.[7]

[1]Extension Agronomist, Texas A&M Agrilife Extension Service, San Angelo, Texas, 76901
[2]CEA-Ag, Texas A&M Agrilife Extension Service, Coleman, Texas, 76834
[3]CEA-AG, Texas A&M Agrilife Extension Service, Ballinger, Texas, 76821
[4]Extension Program Specialist, Texas A&M Agrilife Extension Service, San Angelo, Texas, 76901
[5]Regents Professor, Texas A&M Agrilife Research, Stephenville, Texas, 76401
[6]Senior Research Associate and Lab Manager, Texas A&M Agrilife Research, Stephenville, Texas, 76401
[7]CEA-AG, Texas A&M AgriLife Extension Service, Paint Rock, Texas, 76866

Variety selection and seed management of haygrazer in West Central Texas

Abstract

Haygrazer, different varieties or crosses of sorghum and sudangrass, is the most widespread and important warm-season annual forage in West Central Texas. However, aspects of variety selection and planting management are prone to inefficiency and warrant greater understanding. The objectives of this research were to assess the value of common, yet often underserved, planting management decisions: variety selection and seeding rate. Trials were conducted in 2021, 2022, and 2023 among three counties in West Central Texas for a total of six and seven site-years assessing the effects of seeding rate and variety selection on forage production, respectively. Among seed lots evaluated, planting based on live seed per acre, rather than lbs of seed per acre, accounted for up to an 88% increase in seed-use efficiency. Further, forage yield was not affected by seeding rate (treatments ranging 350,000 to 800,000 live seed ac^{-1}), highlighting another opportunity to improve seed-use efficiency. Among varieties tested, important relationships were quantified between maturity, height, yield, and nutritive

value. Notably, the percentage of indigestible fiber increased with plant height, but not necessarily with increased yield, challenging the common perception that taller is better.

Introduction

Annual forage and hay crops are a critical component of agricultural systems in West Central Texas. Sudangrass, forage sorghums, sorghum sudangrass, sorgho-sorghum sudangrass, (collectively termed “haygrazer”) constitute the most widely planted summer annual forage in the region, as well as much of the Southern United States. With respect to regional livestock industries and recently favorable livestock markets, forage and hay crops represent a considerable opportunity for agricultural systems. Aside from near-term economic opportunities, better understanding of forage production will also enhance the outlook and viability of livestock integrated agriculture.

Unlike most other modern annual commodity crops, many aspects of haygrazer management have adhered to traditional tenets of planting whatever is cheap or readily available, and planting with the same drill setting (lbs ac^{-1}) every year. As seed and other input costs continue to increase, so does the importance of optimizing efficiency. Alongside older forage sorghum types and sorghum-sudangrass varieties, newer genetically improved varieties are being marketed for distinctive characteristics. These include heat and drought tolerance, as well as photoperiod sensitive and BMR types. Photoperiod sensitive types remain vegetative until flowering is initiated in response to shorter days, consequently accumulating greater leaf mass. Varieties with the brown mid-rib (BMR) mutation have reduced lignin and are marketed with enhanced nutritive value. The objectives of this work were to evaluate the effects of variety selection and seeding rate on forage yield and input efficiency, and to characterize relationships between forage growth and nutritive value.

Methods

Field research trials were coordinated in West Central Texas in 2021, 2022, and 2023 to assess the effects of variety selection and seeding rate on ultimate forage production.

Trials were planted in annually cultivated fields each year in Coleman County, and in 2021 and 2023 in Concho and Runnels Counties for a total of seven site-years.

Eleven haygrazer varieties were acquired from local sources. Initial assessment of the seed lots included measurement of seed mass and germination rate. Seed mass was determined by counting and weighing 300 seeds, and seed size values were converted to seeds per pound (Table 1) for practical application and seeding rate conversion. One hundred seeds from each lot were placed in a single layer between wet paper towels to germ test. Sprouted seeds were counted after 72 hours to determine germination percentage. Seeding rates were calculated based on seed size and germ values to achieve 500,000 live seeds ac^{-1}. In addition to the variety trials, a seeding rate trial was conducted in six of the seven site years, evaluating forage production resulting from four different seeding rates (350,000, 500,000, 650,000, and 800,000 live seed ac^{-1}) of sorghum-sudangrass 'Super Sugar DM'.

All trials were arranged as randomized complete block designs with four replications. Plots were 100 ft^2 (5 × 20 ft) planted with a cone drill on 7-inch row spacing. In 2021, whole plots were harvested with a self-propelled forage harvester, cut at a 6-inch stubble height, weighed, and subsampled. Subsamples were weighed fresh, then dried to determine % water and convert plot weights to dry forage mass per acre. In 2022 and 2023, forage was hand sampled from a 3-foot length of two adjacent rows in the interior of each plot for a total of 6 row-feet. All samples were dried in a forced air oven at 130°F and weighed. Samples from three replications of the variety trial at Coleman in 2021 (highest-yielding site-year) were ground for nutritive analyses. Total N and C were measured via combustion analysis (USDA-NRCS, 2004) to calculate crude protein (CP). Forage neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analyzed using an Ankom fiber analyzer. To estimate nutritive yield, total forage biomass and CP% were used to calculate lbs CP ac^{-1}. Similarly, lbs ADF ac^{-1} was subtracted from total yield to provide an estimate of "mostly digestible forage".

All responses were analyzed using mixed models in SAS 9.4 with treatment as a fixed effect and site-year and block nested within site-year as random. Significance was identified at α = 0.05 and means were separated using Fisher’s LSD. Correlations between continuous variables were analyzed using ‘proc corr’ in SAS.

Table 1. Variety and seed lot characteristics of summer annual forage varieties tested, and corresponding seeding rate at 500,000 live seed ac^{-1}.

Variety	**Type †**	**Germ**	**Seed size**	**Seeding rate ‡**
		--- %---	-- seeds lb^{-1} --	--- lb ac^{-1} ---
Cattle King	SSG	0.92	18853	28.8
Cow Candy	SSG	0.85	18373	32
Hegari	FS	0.88	15487	36.5
845F	FS	0.94	14594	36.4
877F	SSG	0.95	16059	32.8
Piper	SG	0.89	43663	12.9
Red Top Cane	FS	0.79	32737	19.4
Super Sugar DM	SSG (DM)	0.97	18080	28.5
Sweet Bites	SSG	0.98	18981	26.9
Sweeter 'n Honey	SSG (BMR)	0.95	15614	33.7
Zacate	SSSG	0.9	22609	24.5

† SG, sudangrass; SSG, sorghum-sudangrass; SSSG, sorgo-sorghum-sudangrass; FS, forage sorghum; DM, delayed maturity; BMR, brown mid-rib.

‡ All seeding rates are based on planting 500,000 live seeds ac^{-1}.

Results

Within the larger seeded forage sorghums and crosses (excluding Piper sudangrass), seeding rate ranged from 19.4 to 36.5 lbs ac^{-1} to achieve the same plant population (Table 1). If seed is managed on lbs ac^{-1} alone, this represents the potential to plant 88% more seed, or 53% less than the target rate. Weather conditions throughout these field trials were drier than normal, with greater-than-normal rainfall in the summer of 2021 and extreme drought in the summers of 2022 and 2023 (Table 2). Across all site-years P877F, Cow Candy, P845F, Super Sugar DM, Cattle King, and Sweeter ‘n Honey were among the highest yielding varieties (Figure 1). However, yield was not affected by seeding rate and averaged 2637 lb ac^{-1} for Super Sugar DM across seeding rates.

Table 2. Monthly precipitation during the growing season at Coleman, Runnels, and Concho County sites in 2021, 2022, and 2023. Deviations from the 30-year average are shown in parentheses.

Month	2021			2022			2023		
	Coleman	**Runnels**	**Concho**	**Coleman**	**Runnels**	**Concho**	**Coleman**	**Runnels**	**Concho**
	---------------- in ----------------								
Mar	0.2 (-2)	1.1 (-0.7)	0.8 (-1)	0.8 (-1.4)	0.4 (-1.4)	0.8 (-1)	1.1 (-1.1)	1.4 (-0.4)	0.6 (-1.2)
Apr	0.7 (-1.3)	1.1 (-0.5)	1.2 (-0.3)	0.1 (-1.9)	0.2 (-1.4)	0.1 (-1.4)	1 (-1)	0.5 (-1)	0.5 (-1)
May	4.1 (0.4)	3.4 (0.3)	2.5 (-0.6)	2.3 (-1.4)	2.3 (-0.8)	2.1 (-0.9)	6.2 (2.6)	6 (2.9)	4.4 (1.4)
Jun	1 (-2.6)	0.7 (-2.4)	1.5 (-2)	1.9 (-1.8)	1.5 (-1.6)	1 (-2.5)	1.9 (-1.7)	0.9 (-2.1)	1.7 (-1.8)
Jul	1.9 (-0.2)	4.4 (2.7)	3.3 (1.2)	0.7 (-1.4)	0 (-1.7)	0.8 (-1.2)	0.8 (-1.3)	0.3 (-1.4)	0 (-2.1)
Aug	4.5 (1.9)	3.7 (1.2)	3.8 (1.4)	3.6 (1)	2.6 (0.2)	1.4 (-1)	0 (-2.5)	0.1 (-2.3)	0 (-2.4)

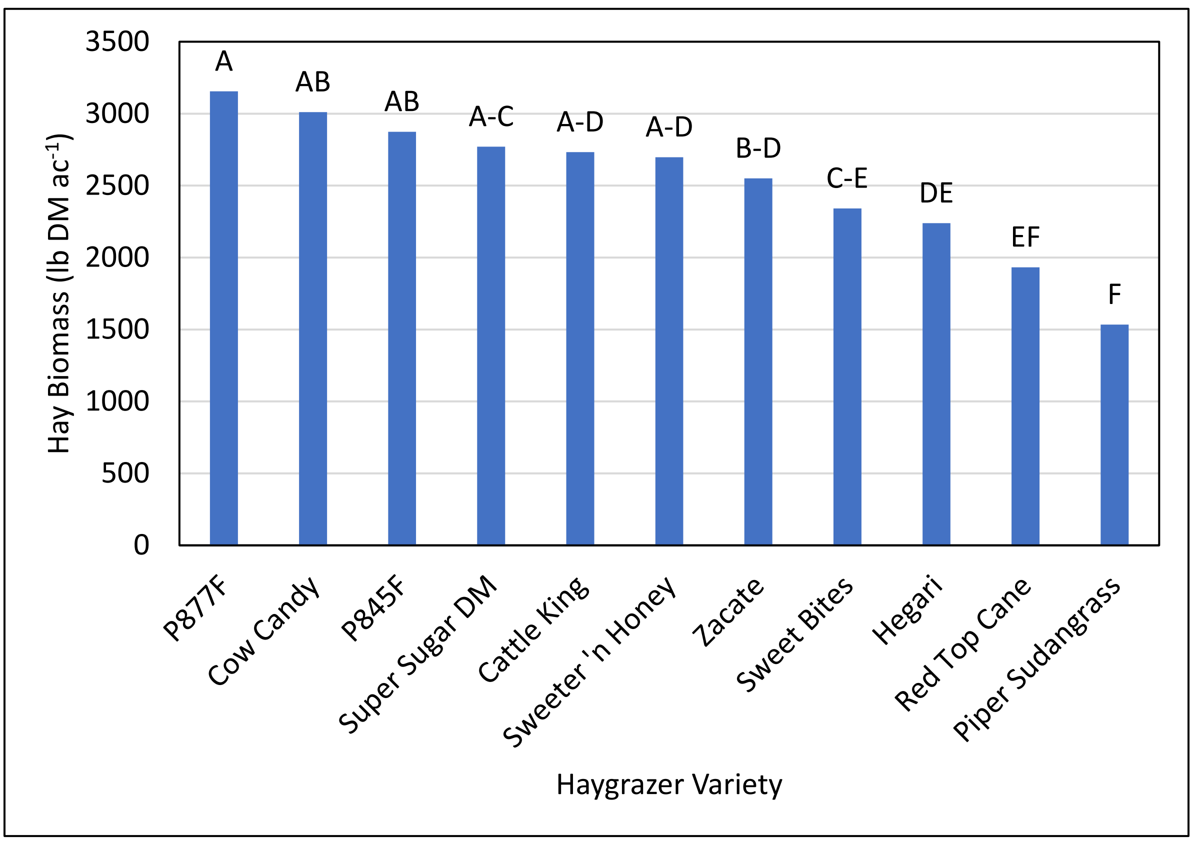

Figure 1. Variety effect on forage biomass across seven site-years in West Central Texas in 2021, 2022, and 2023.

At Coleman in 2021, P877F, P845F, and Super Sugar DM yielded the most biomass (Table 3), however, Sweeter ‘n Honey yielded the most forage crude protein per acre. Height did not correlate with yield (Table 4), as illustrated in Figure 2. The lowest yielding variety (Piper sudangrass) was among the tallest, and one of the highest yielding varieties (P845F) was among the shortest. Across the samples analyzed for nutritive value, crude protein declined as forage yield increased (Figure 3). NDF and ADF both increased with plant height, with ADF being the most correlated (Figure 3). However, neither of the fiber concentrations were correlated with yield (Table 4).

Table 3. Haygrazer variety effect on nutritive value, forage yield, and nutritive yield at Coleman, TX in 2021.

Entry	Growth Stage	Height	ADF	NDF	CP	Yield	Crude Protein	Mostly digestible biomass*
			-------------- %	--------------		---------------- lb/ac	----------------	
P877	late boot	69.5 a-c	**36.5 ab**	63.9 b	5.1 d	**6068 a**	**320 ab**	**3984 a**
P845	early boot	49 d	35.1 bc	**64.3 ab**	5.6 cd	**5525 ab**	**310 ab**	**3572 ab**
Super Sugar DM	vegetative	76.3 ab	35.1 bc	62.2 bc	5.3 d	**5450 ab**	**297 a-c**	**3649 ab**
Sweeter 'n Honey	late veg.	67.8 c	33.2 d	61.3 bc	6.8 b	5113 bc	**345 a**	**3412 a-c**
Cow Candy	vegetative	74.3 a-c	34.7 b-d	61.4 bc	5.1 d	4971 b-d	266 b-d	**3326 a-d**
Zacate	late boot	68.8 bc	34.6 cd	62.7 b	5.3 d	4790 b-d	247 cd	3062 b-d
Cattle King	early head	68.5 bc	34.6 cd	61.5 bc	5 d	4370 c-e	208 d	2723 d
Sweet Bites	headed	67.8 c	35.2 bc	62.7 b	5.4 cd	4202 de	228 d	2811 cd
Red Top Cane	boot	50 d	31.1 e	59.2 cd	6 b-d	3851 e	257 b-d	2608 d
Hegari	late boot	52 d	30.6 e	57.2 d	6.2 bc	3788 e	237 d	2639 d
Piper sudangrass	headed	77 a	**37.7 a**	**67.7 a**	**8.1 a**	2417 f	214 d	1608 e

*Expressed as total yield minus ADF (largely indigestible fiber).

§ Within columns, means with the same letter are not significantly different at $P < 0.05$ according to Fisher’s LSD. Uppermost mean groups within each response are also indicated in bold font.

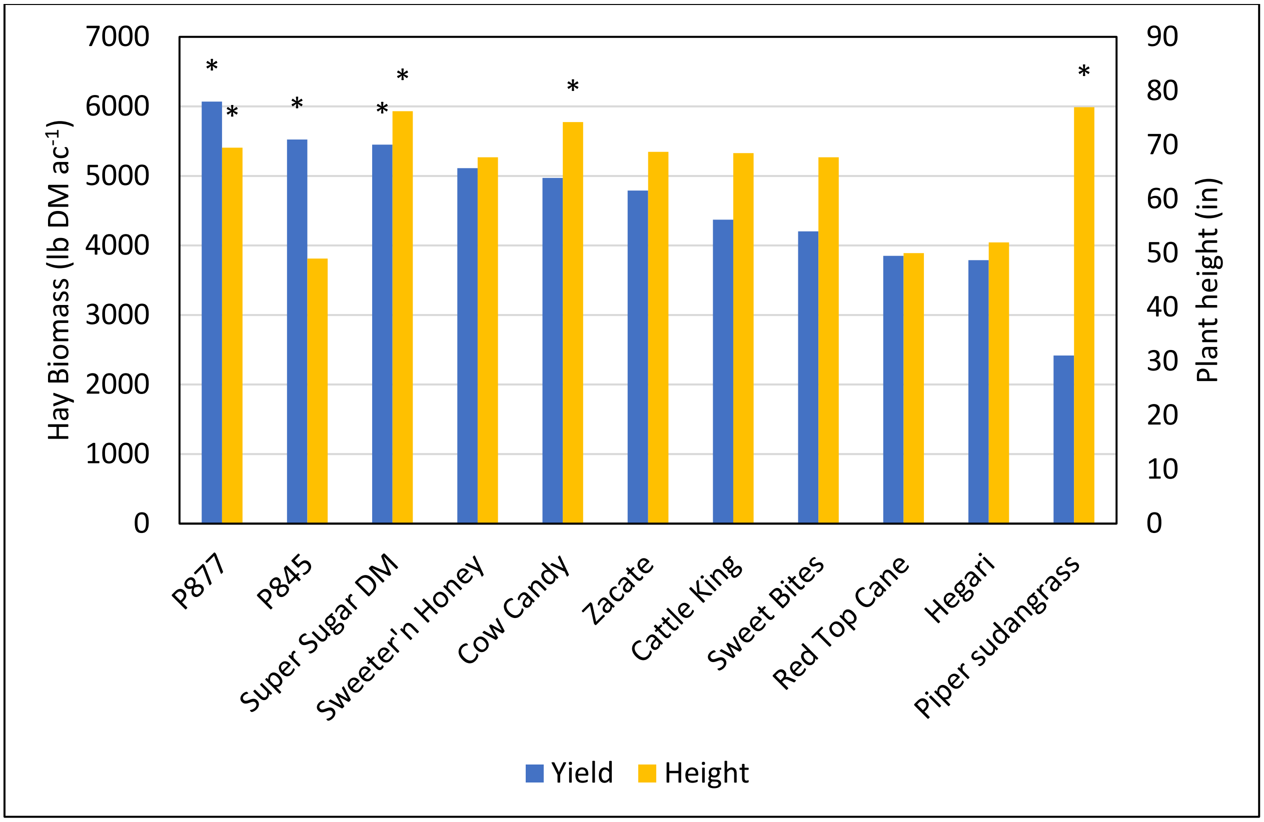

Figure 2. Comparison of forage yield vs. standing height across varieties tested at Coleman, TX in 2021. * indicates the uppermost mean group within the corresponding response.

Table 4. Significance of correlations between continuous variables measured among haygrazer varieties at Coleman, TX in 2021.

	Yield	Height	CP	NDF
	-------------------- P > F --------------------			
Yield	-	-	-	-
Height	0.89	-	-	-
CP	**0.005**	0.52	-	-
NDF	0.66	**0.01**	0.66	-
ADF	0.38	**<.0001**	0.23	**<.0001**

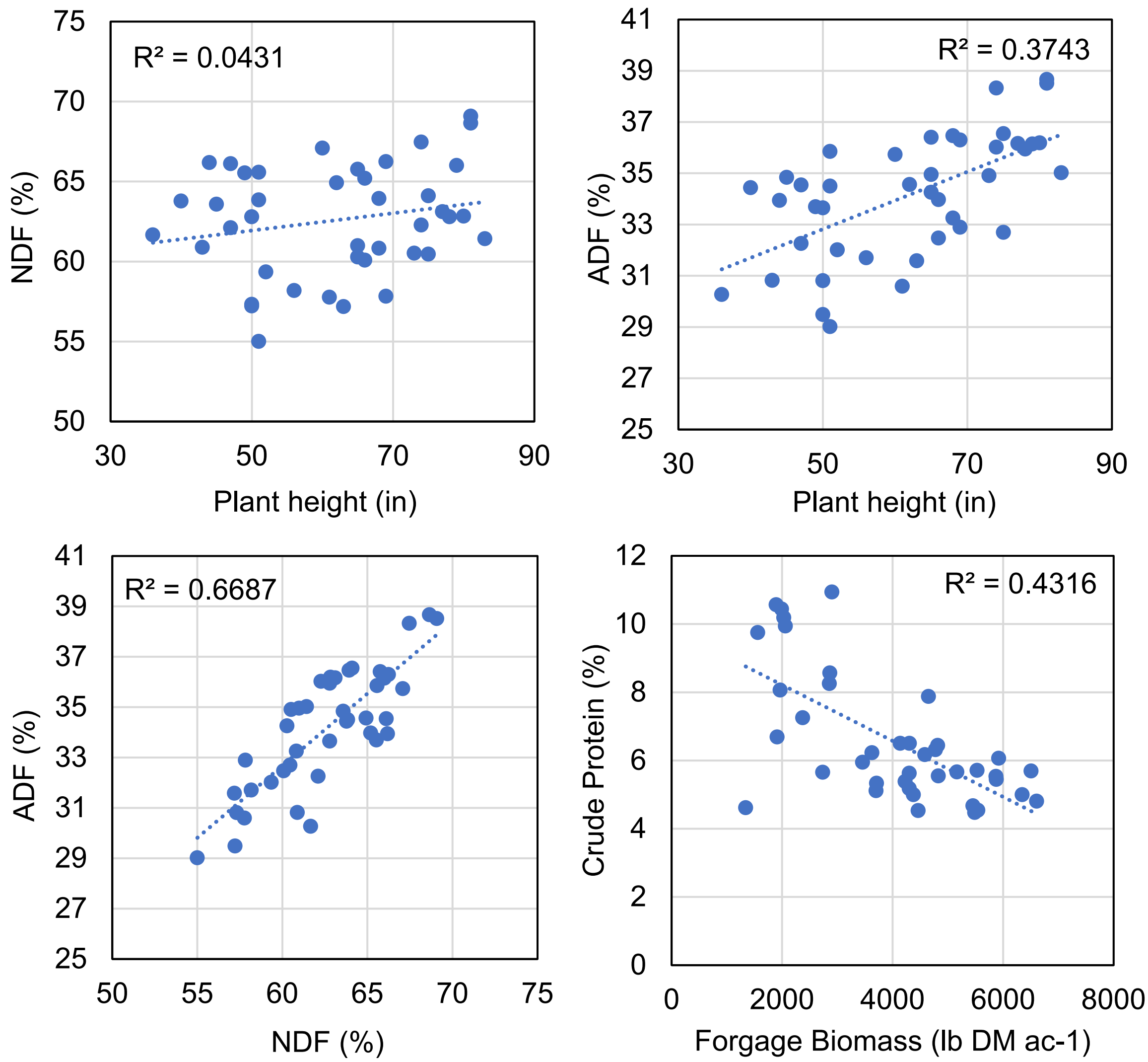

Figure 3. Relationships between standing plant height and forage neutral detergent fiber (NDF) (top left), plant height and acid detergent fiber (ADF) (top right), NDF and ADF (bottom left), and forage biomass and crude protein (bottom right) and among haygrazer varieties tested at Coleman, TX in 2021.

Discussion

The findings of this work support the value of improved forage varieties, as differences were consistent between entries. The advantage of enhanced nutritive value was demonstrated as Sweeter 'n Honey (the only BMR variety) resulted in greater crude protein yield, despite slightly lower biomass yields. This benefit aligns with other reports comparing nutritive value and actual feed efficiency of sorghum sudangrass varieties

(McCuistion et al., 2003; Wedig et al., 1987). The one ‘Delayed Maturity’ variety was also consistently among the highest yielding, which is supported by McCollum et al. (2005). However, some decades-old varieties, Cow Candy and Cattle King (Jones, 1985) also yielded consistently well, highlighting the importance to compare available options. The traditional perception in favor of tall and headed-out forage is challenged by our results that show no positive relationships between height and yield or nutritive value and emphasize the value of vegetative rather than reproductive growth.

In all trials, forage biomass sampling represented only one harvest, as field sites were rotated to other crops in 2021, and forage growth ceased under the drought conditions in 2022 and 2023. This is an important consideration. While annual forage systems in this region are often limited to one harvest, and subsequent harvests typically yield less (Beuerlein et al, 1968), it is common to get a second cutting under favorable conditions. It is unlikely that the seeding rates tested would influence regrowth, as Sowiński and Szydelko (2011) demonstrate yield stability due to increased tillering with lower seeding rates and following cutting. However, regrowth potential could be affected by variety, which may warrant assessment in future research.

Conclusion

Haygrazer variety selection should be informed by both yield potential and nutritive value. Forage height should not be associated with greater yield, as these factors were unrelated; although taller forages did result in greater concentrations of indigestible fiber. To optimize input-use efficiency, seeding rates should be based on live seeds per acre specific to the seed size and % germination of a given seed lot, rather than pounds per acre. There is also likely potential to maintain productivity with lower seeding rates than historically recommended.

Literature Cited

Beuerlein, J.E., H.A. Fribourg, and F.F. Bell. 1968. Effects of environment and cutting on regrowth of a sorghum-sudangrass hybrid. Crop Sci. 8:152-155.

Jones, R.M. 1985. Forage yield and crude protein content of sudan-sorghum hybrids. Forage Research in Texas. https://overton.tamu.edu/files/2022/03/article1294.pdf

McCollum III, T., K. McCuistion, and B. Bean. 2005. Brown midrib and photoperiod-sensitive forage sorghums, pp. 36-46. In: *Proceedings of the 2005 Plains Nutrition Council Spring Conference April 14-15, 2005* San Antonio, Texas. Publication No. AREC 05-20 Texas A&M University Agricultural Research and Extension Center Amarillo. https://theplainsnutritioncouncil.com/web/wp-content/uploads/2019/10/2005-Plains-Nutrition-Council-proceedings1.pdf#page=43

McCuistion, K., T. McCollum, W. Greene, B. Bean, R. Van Meter, J. Vasconcelos, and J. Silva. 2003. Performance of steers grazing photoperiod-sensitive and brown midrib varieties of sorghum-sudangrass Texas Cooperative Extension and Texas Agricultural Experiment Station Amarillo. ASWeb-112. https://college.agrilife.org/animalscience/wp-content/uploads/sites/14/2012/04/beef-performance.pdf

Sowiński, J. and E. Szydelko. 2011. Growth rate and yields of sorghum-sudangrass hybrid variety grown on a light and a medium-heavy soil as affected by cutting management and seeding rate. *Polish Journal of Agronomy* 4: 23-28.

USDA-Natural Resources Conservation Service. 2004. Soil survey laboratory methods manual. *Soil Survey Investigations* Report 42, Version 4. https://nrcspad.sc.egov.usda.gov/DistributionCenter/pdf.aspx?productID=886

Wedig, C.L., E.H. Jaster, K.J. Moore, and N.R. Merchen. 1987. Rumen turnover and digestion of normal and brown midrib sorghum × sudangrass hybrid silages in dairy cattle. Journal of Dairy Science 70(6):1220-1227. https://doi.org/10.3168/jds.S0022-0302(87)80134-0.