Evaluating Forage Sorghum and Pearl Millet for Forage Production and Quality in the Texas High Plains

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INTRODUCTION

Alternative forage crops that utilize less water must be identified to meet the demands of the livestock industry in the Texas High Plains region as water levels in the Ogallala Aquifer continue to decline. Forage sorghum [*Sorghum bicolor* (L.) Moench] is widely utilized in the High Plains region because of its drought and heat tolerance. Forage sorghums have the potential to produce large amounts of nutritious forage during summer months and their versatility allows them to fit into many different types of cropping or livestock operations (Marsalis, 2011). However, pearl millet [*Pennisetum glaucum* (L.) Leeke] may have the potential to meet similar forage needs.

Regrowth of pearl millet is affected by stubble height, cutting frequency, and stage of harvest (Stephenson and Posler, 1984). Unlike many sorghums, pearl millet contains no prussic acid (Stephenson and Posler, 1984). Both species have varieties that contain the brown midrib trait; therefore, they have reduced lignin to increase forage quality and give producers more flexibility in harvest scheduling (Staggenborg, 2016).

Therefore, pearl millet may have the opportunity to be as productive as forage sorghum and provide the same quality. Cutting height and yield attributes of pearl millet and forage sorghum have been evaluated in Kansas and New Mexico, but not in the Texas High Plains (Marsalis, 2011; Stephenson and Posler, 1984). However, additional information is required to find the best cutting interval to optimize yield and quality in the region. The objectives of this study were to i) evaluate forage sorghum and pearl millet forage production under three different harvest intervals and ii) evaluate the effects of harvest interval on feed nutritive components and value.

Fig. 1. Metered drip system.

Fig. 2. 2017 sorghum emergence.

MATERIALS & METHODS

This study was conducted during the 2016 and 2017 growing seasons at the West Texas A&M University Nance Ranch near Canyon, TX (34°58′6″N, 101°47′16″ W; 1097 m above sea level). Treatments were arranged as a nested split plot with four replicates.

Fields with Olton clay loam soil (fine, mixed, superactive, thermic, Aridic Paleustoll) were prepared for planting with two passes of a tandem disk followed by one pass with a rotary tiller. Bodacious BMR sorghum sudangrass (7272 seeds kg^{-1}, 85% germination, 98% purity) and Graze King BMR pearl millet (36363 seeds kg^{-1}, 85% germination, 98% purity) were planted on 17 June 2016 and 31 May 2017 using a tractor mounted 150 cm wide Great Plains 3P500 grain drill (Great Plains Manufacturing, Salina, KS) with 19-cm row widths. The sorghum sudangrass was planted at a rate of 75 seeds m^{-2} and the pearl millet was planted at 85 seeds m^{-2}. Main plot size was 24.4 by 18.2 m. The planted area for each sub plot was 3 by 6.1 m in 2016 and 2017.

The crops were irrigated with a flow metered drip line system with two lines 152 cm apart and drip line emitters every 61 cm. The emitters applied 7.5 L hour and 25 mm of water was applied weekly for 10 weeks. Nitrogen fertilizer was applied on 12 July 2016 and 7 July 2017 at 84.06 kg ha^{-1} and 78.45 kg ha^{-1}, respectively.

Forage dry matter (DM) was sampled in three harvest regimes: three 30 d, two 45 d and one 90 d harvest. Samples were cut at 15 cm cutting height using a meter quadrat. Samples were dried at 60°C for 120 h.

Leaf Area Index (LAI) was determined every 14 days and after harvest beginning on 12 July 2016 and 21 June 2017 using Li-Cor 2200 plant canopy analyzer (Li-Cor Incorporated, Lincoln, NE). Two LAI measurements were obtained in each plot. A LAI measurement is defined as one above canopy (incident) reading and four below canopy readings. The four below canopy readings were taken across three rows and averaged for one LAI value. Measurements were collected under low light at sunrise, sunset or overcast conditions.

Forage analysis samples were taken from biomass samples, ground with a wood chipper and sent to Servi-Tech Laboratories (Amarillo, TX). Samples were ground through a Wiley mill (Arthur H. Thomas Co., Philadelphia, PA) to pass a 1-mm screen. Crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and relative feed value (RFV) were measured.

The experiment had a nested split plot design. Statistical analysis was performed using the PROC GLM of the Statistical Analysis System Version 9.4 (SAS Institute, 2017). A LSD (α = 0.05) was used to test significant differences between treatment means.

Fig. 3. Recently harvested plots in 2016.

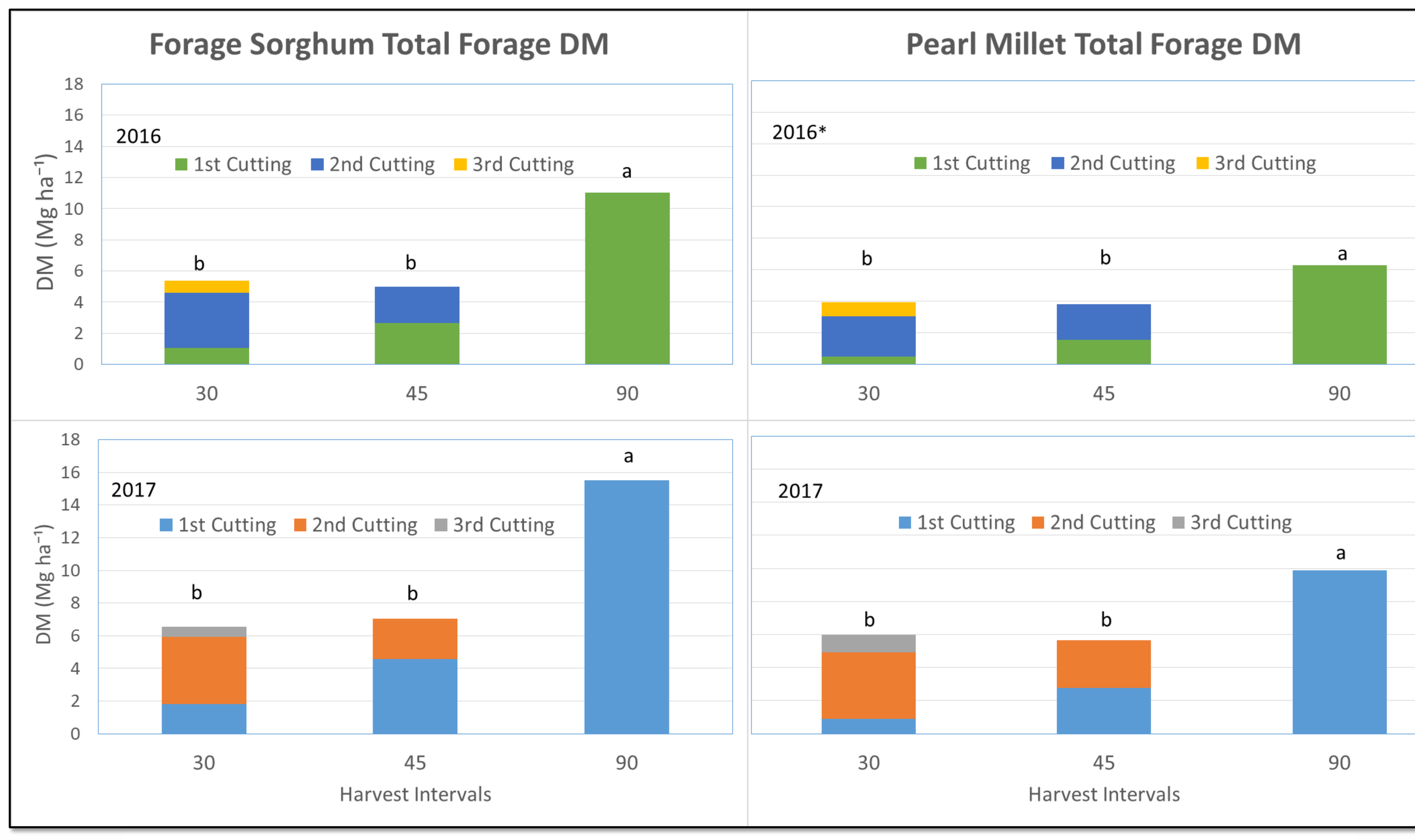

Fig. 4. Pearl millet and forage sorghum total forage DM from three 30 d, two 45 d, and one 90 d harvest.
Columns with the same letter are not different between harvest regimes within crop with $p<0.05$.
* 2016 pearl millet significant with a $p<0.1$ all other data significant at $p<0.05$.

Dry Matter and Forage Quality Report

Interval	Crop	Harvest	2016 Biomass	2016 CP	2016 ADF	2016 NDF	2016 TDN	2016 RFV	2017 Biomass	2017 CP	2017 ADF	2017 NDF	2017 TDN	2017 RFV
			Mg ha^{-1}	%				RFV	Mg ha^{-1}	%				RFV
30 day	Pearl Millet	H30	0.50b	14.6a	30.4b	56.5b	68.5a	107.8a	0.88b	11.4a	34.7b	61.2ab	63.5a	94.3a
		H60	2.53a	11.0b	31.7b	58.6b	67.4a	102.0a	4.02a	10.5b	38.6a	63.0a	59.7b	87.0b
		H90	0.93b	9.1b	37.7a	60.6a	60.4b	91.5b	1.09b	8.0c	39.0a	59.4b	59.0b	91.8a
		Total	3.96						6.00					
	Forage Sorghum	H30	1.06b	11.0	34.7b	62.1a	63.5a	92.8	1.83b	10.6a	35.8c	58.3a	62.6a	97.3b
		H60	3.53a	9.2	34.5b	60.6ab	64.0a	95.3	4.09a	10.1ab	40.2a	59.8a	57.5c	89.5c
		H90	0.80b	10.5	38.4a	57.8b	59.5b	95.3	0.61c	9.4b	37.9b	53.9b	60.2b	102.8a
		Total	5.38						6.53					
45 day	Pearl Millet	H45	1.57	14.8a	32.5b	60.4b	66.0a	98.0a	2.78	12.7a	36.8b	63.8a	61.5a	87.8
		H90	2.24	12.0b	35.9a	61.5a	62.6b	92.5b	2.86	6.0b	38.8a	60.3b	59.0b	90.5
		Total	3.81						5.64					
	Forage Sorghum	H45	2.65	5.8a	38.9b	63.9	59.0a	85.3a	4.59a	9.9a	38.9	62.1a	59.0	87.8b
		H90	2.34	6.5b	39.9a	62.1	57.9b	86.5b	2.46b	6.7b	38.2	57.2b	59.9	96.3a
		Total	4.99						7.05					
90 day	Millet	H90	6.29	5.1	38.0	64.5	59.9	85.5	9.87	4.3	39.3	59.8	58.6	90.8
	Sorghum	H90	11.05	4.4	38.6	62.0	59.5	88.5	15.51	4.2	39.9	58.3	57.9	92.5

Table 1. Pearl millet and forage sorghum DM and forage quality from three 30 d, two 45 d, and one 90 d harvest.
Columns with same letter are not different between harvest regimes within crop with $p<0.05$.

Fig. 5. Hand harvesting.

Fig. 6. Regrowth in 2016.

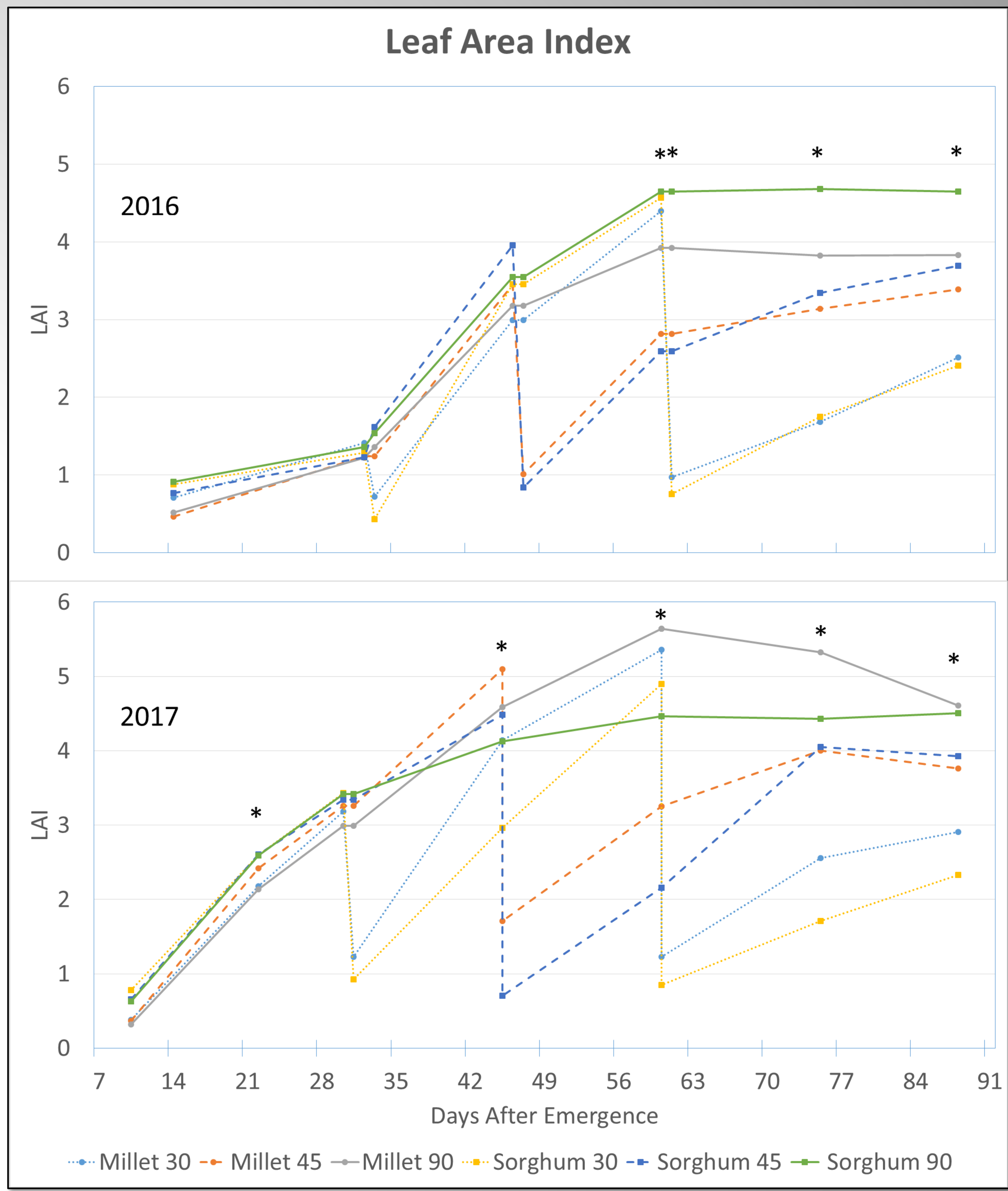

Fig. 7. Pearl millet and forage sorghum Leaf Area Index across the growing season for the three 30 d, two 45 d, and one 90 d harvest regimes.
* Represents sampling dates where LAI was different between crops within harvest regime with $p<0.05$.

RESULTS & DISCUSSION

- In 2016 pearl millet DM was different across harvest regimes with a p-value = 0.1, the 90 d harvest produced greater DM than the other harvest regimes was observed (Fig. 4).
- Total DM of forage sorghum was 48% greater in 2016 in the single, 90 d harvest than either of the other two harvest regimes and 46% greater in 2017. This is opposite of Stephenson and Posler (1984) who reported similar DM among varying harvest regimes (Fig. 4).
- As both crops aged and accumulated DM, forage quality trended toward lower quality in most scenarios in 2016 (Table 1).
- However, forage quality trended upward in both crops in the 30 d interval at the 90 d harvest and in the 45 d interval at the 90 d harvest in forage sorghum following the previous harvest in 2017 (Table 1).
- Leaf area index for both years and both crops had similar responses following the different harvests with a rapid regrowth occurring in both crops after the first 30 d harvest (Fig. 7).
- In 2017, pearl millet had a faster regrowth rate after a harvest compared to forage sorghum (Fig. 7).

CONCLUSIONS

Multiple harvest regimes for forage sorghum and pearl millet have potential in the Texas High Plains to give producers more flexibility. As the crops accumulate biomass, nutritive quality is lost. To conserve nutritive quality, frequent cuttings in a growing season is desired. Further research needs to be done to explore other cutting schedules and pearl millet crop establishment in the Texas High Plains.

ACKNOWLEDGEMENT

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