Final Report
UC-ANR
2019 Field Research on Sorghum Forages for the California Dairy Industry

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Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is known for its inherent drought tolerance. The Sustainable Groundwater Management Act will drive producer decisions on what to and what not to plant based on restricted water allocations. Using technologies such as more drought tolerant crops, better water use efficient plants, and deficit irrigation strategies will become tools for farmers growing forages. These tools will have to be implemented to ensure a reliable source of good quality and nutritional forages in the future in California. The San Joaquin Valley of California is home to a multi-billion dollar dairy industry. Use of sorghum as a crop for silage has received mixed reviews. Some of the mixed reviews have been driven by poor hybrid choice for forage production, the introduction of sugarcane aphid (SCA) which introduced additional costs for control, and the lack of understanding of how to use forage sorghums in balanced ration to optimize milk production. Data herein represent forage trials planted at the Kearney Agricultural Research and Extension (KARE) Center, the Westside Research and Extension (WREC) Center and at the UC Davis Research Farm (UC Davis).

Methods and Materials

Seven seed companies provided a total of 49 hybrids, which included traditional forage sorghums and brown mid-rib (BMR) derivatives of both traditional and photoperiod sensitive (PS) sorghums. Hybrids were planted in a randomized block design in four row plots planted on 30-inch raised beds and were analyzed as a split-plot design. Irrigation was applied using a new linear irrigation system at Kearney and a combination of overhead sprinklers and flood irrigation at the Westside Center and at the Davis Farm. Fertility applications followed similar recommendation for forage sorghums for the region. The 2019 growing season was wetter than the previous year. Trials at Kearney, Westside and Davis were irrigated as needed and according to ET demands of the crop at the various locations. The new irrigation system at KARE began to under water the field plots approximately ¾ the way through the first planting and this problem was not determined until after the final harvest of the second planting AT KARE. Plants did not express signs of drought stress throughout either one of the plantings; however, yields were impacted in both trials at KARE.

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KARE received 7.9 inches of rain from January through the end of May and an additional 0.5 inches through the growing season. Though irrigation totals based on computer outputs indicated a total of approximately 18.84 and 17.71 inches of irrigation for KARE1 and KARE2, respectively, this was determined after the trial to have been severly underreported and totals could not be determined. Rainfall totals from January through May prior to planting at WREC were 7.41 inches, almost twice the amount of the year before. Summer rainfall was recorded as 0.32 inches throughout the growing season. An additional 10.5 inches was applied by overhead sprinkler system over the course of the season. Rainfall totals from January through June prior to planting at UC Davis were 23.8 inches, almost 3 times greater than the previous year. An additional 2.0 inches of rainfall fell throughout the growing season. The trial was irrigated to match ET demand. Trials were harvested approximately 100 days after planting.

Other cultural practices and study information:

Trial Location:	KARE Planting 1 and 2, Parlier
Cooperator:	UC-ANR
Previous Crop:	Winter forage (Oats)
Soil Type:	Hanford sandy loam
Plot Size:	Four, 30 inch rows by 20 ft
Replications:	3
Study Design:	Split-Plot
Planting Date:	May 2 and June 4, 2019
Planting Rate:	100,000 seed $acre^{-1}$
Seed Method:	Almaco 4 row plot planter
Fertilizer:	400 lbs urea ac^{-1} 46-0-0 applied pre-planting on May 31, 2019
Herbicide:	Dual Magnum at 1.3 pints per ac^{-1} as a pre-plant
Pesticide:	Sivanto 14 fl oz ac^{-1} with Latron 1956 at 5 oz ac^{-1} August 8, 2019
Irrigation:	Linear irrigation system – See narrative above
Silage Harvest Date:	Plots harvested with Wintersteiger Cibus S forage chopper on August 16 and September 13, 2019

Trial Location:	Westside Research and Extension Center, Five Points
Cooperator:	UC-ANR
Previous Crop:	Fallow
Soil Type:	Panoche clay loam
Plot Size:	Four, 30 inch rows by 17 ft
Replications:	3
Study Design:	Split-Plot
Planting Date:	June 12, 2019
Planting Rate:	100,000 seed $acre^{-1}$
Seed Method:	Almaco 4 row plot planter
Fertilizer:	100 lbs N $acre^{-1}$
Herbicide:	Dual Magnum 24 oz/ac as pre-emergent, Clarity 8oz and Prowl-H_20 at 32 oz ac^{-1} as needed
Pesticides:	3 applications of Sivanto Prime 14oz ac^{-1}
Irrigation:	Overhead irrigation system – see narrative for amounts
Silage Harvest Date:	September 27 and finished on October 1, 2019

Trial Location:	UC Davis Research Station, Davis
Cooperator:	UC-ANR
Previous Crop:	Safflower
Soil Type:	Yolo loam
Plot Size:	Four, 30 inch rows by 20 ft
Replications:	3
Study Design:	Split-Plot
Planting Date:	June 5, 2019
Planting Rate:	100,000 seed $acre^{-1}$
Seed Method:	Wintersteiger Self Propelled Drill Planter
Fertilizer:	A total of 100 lbs N was applied
Herbicide:	Dual Magnum as pre-plant
Irrigation:	See above narrative
Silage Harvest Date:	Plots harvested with Wintersteiger Cibus S forage chopper September 25-26, 2019

Data Collected:

1. Plant stands
2. Plant height (ft) at silage harvest
3. Lodging at silage harvest. Percent of fallen or significantly leaning plants per plot.
4. Moisture content at harvest.
5. Forage (silage) yield. The middle two rows of each plot were harvested with a Wintersteiger Cibus S forage chopper. Yields are reported at 65% moisture in tons/acre.
6. Nutrient analysis: Samples were collected from the forage chopper in the field, weighed and then placed in forced air Gruenberg oven (Model T35HV216, Williamsport, PA) at 50º C until dried. These sub-samples were sent to Dairyland Laboratory, Inc, Arcadia, WI for analysis.
7. Key Nutrient Analysis Definitions
    a. Crude Protein: 6.25 times % total nitrogen
    b. ADF: % acid detergent fiber; constituent of the cell wall includes cellulose and lignin; inversely related to energy availability
    c. NDF: neutral detergent fiber; cell wall fraction of the forage
    d. Lignin: percent estimated lignin present
    e. Starch: estimated starch content
    f. Fat: estimated fat content
    g. RFV: relative feed value is an index for comparing forages based on digestibility and intake potential. RFV is calculated from ADF and NDF. An RFV of 100 is considered the average score and represents alfalfa hay containing 41% ADF and 53% NDF on a dry matter digestibility.
    h. RFQ: relative feed quality is an index for comparing forages calculated from TDN and DMI. An RFQ of 100 is considered the average score and represents fully mature alfalfa.
    i. Milk lbs/ton: A projection of potential milk yield per ton for forage dry matter.

Data were analyzed using the SAS statistical package.

Results

A summary of yield, agronomic traits and nutritional analyses are reported by types of forage sorghums grown in the all locations in Table 1. See Tables 2 and 3 for a comparison of the different hybrids agronomic, yield, and nutritional characteristics.

Table 1. Summary of key forage characteristics by type of forage grown at three locations, Kearney (2 planting dates), West Side, and Davis in 2019.

Sorghum Type[1]	% Lodging @ Harvest[2]	Tons/ac @65% Moist.[2]	% Crude Protein[2]	% ADF[2]	% NDF[2]	% Lignin[2]	% Starch	% Fat	Milk lbs/ton DM[2]	Relative Feed Quality (RFQ)[2]
BMR (21)	12.52	15.34 bc	10.39 b	34.86 d	52.11 d	3.56 d	7.28 a	2.36 a	2653.45 a	113.24 a
NonBMR (31)	8.73	17.11 ab	9.93 c	36.00 c	54.80 c	4.27 b	6.93 a	2.16 b	2578.92 b	99.25 b
PSBMR (4)	11.86	13.84 c	11.02 a	39.66 c	58.89 b	3.83 c	0.29 b	2.14 b	2300.79 c	99.30 b
PS (3)	4.14	17.81 a	9.69 c	40.75 a	61.93 a	4.74 a	1.09 b	1.96 c	2273.14 c	84.68 c
Trial Avg.	10.07	16.29	10.16	36.08	54.47	4.01	6.31	2.22	2571.4	103.53

[1]Number in parenthesis is the number of hybrids in each sorghum type. BMR = brown midrib; PS = Photoperiod sensitive.
[2]Means followed by the same letter are significantly different using LSD (P=0.01)

Similar to previous reports, lodging can be a major issue for forage sorghums; however, this year lodging was not as severe as in previous reports. Lodging ranged from 0.0 to 42.2% (Table 2). Though the photoperiod sensitive brown midrib hybrids (BMRs) lodged a bit more than the non BMR, no significant differences were detected (Table 1).

Lodging was significantly different between all four sites. The lowest lodging % occurred at both trials at KARE. These low numbers could be attributed to the fact that the irrigaton system delivering less water than required to meet ET, thus stunding the growth of the forages, which was observed in the height measurements (not reported here). The highest average lodging occurred at Davis (Table 2), which could have been attributed to the abundant water available for growth throughout the growing season. Plantings between May and the first week of June are good for forage production in the SJ valley and lodging issues can be managed avoided by excess nitrogen and irrigation applications.

Forage yields for the trials ranged from a high of 22.4 to 11.7 tons acre^{-1} with an average of 16.3 tons acre^{-1} over all locations and planting dates (Tables 2). The lowest average yields were observed at the second planting of KARE (Table 2). These low values reflect the problem we experienced with our irrigation system and is not reflected of normal years. Though it had the lowest average yields, forage from the second planting at KARE had high milk lbs ton^{-1} and relative forage quality numbers, suggesting a higher quality forage.

ADF and NDF were significantly higher in the photoperiod sensitive sorghums and they had lower lbs of milk per dry ton than the other two photoperiod insensitive forages (Table 1).

The top 10 hybrids were ranked in this study by taking those hybrids with the greatest yields and eliminating those hybrids that lodged by more than 10% (Table 4). Of these hybrids, yield ranged from a low of 18.0 tons acre^{-1} (Gayland Ward Seed 19038) to a high of 22.4 tons acre^{-1} (Dyna-Gro Fullgraze II).

For many producers, yield is the greatest factor in their selection of sorghum forages. Table 5 highlights the top yielding hybrids that produced more than 16.0 tons acre^{-1} of yield. The highest yielding forage sorghum was Dyna-Gro Fullgraze II at 22.4 tons acre^{-1} followed by Scott Seed Co 542/43 at 21.7 tons acre^{-1}.

Discussion

This was the ninth year that a wide range of forage sorghums (59), both commercial and experimental, were evaluated for both yield and quality parameters in large replicated trials (KARE, WREC and UC Davis). These sites saw above normal winter rainfall totals. This year was different than the other 8 years in that yields in both plantings at KARE were impacted by an issue with the new irrigation system that underreported the amount of irrigation being applied during the season. These reduced irrigations limited the yield potentials of the two trials thus lowering the average yields over the four locations. However, it is of interest to note that with good winter rainfall and good irrigation, WREC can still produce high yields (average 26.3 tons ac^{-1}). Davis yields were limited by too much winter rainfall and higher rates of lodging because of the increased growth within the plants. The Davis planting may have benefited with less applied irrigation during the growing season as the sorghum forages would have utilized stored water from the winter to optimize growth. Forage selection should be a combination of factors that optimize quality, yield and standability (lodging resistance) and will require additional management of feed rations to optimize the potential of these forage crops to be utilized as forages for dairy animals.

Table 2. 2019 comparisons of sorghum forage hybrids and locations for agronomic characteristics and yield at KARE, WREC, and UC Davis by seed company.

Hybrid Information[1]					Agronomic Measurements		
Hybid	**Company**	**Type**	**Maturity**	**BMR**	**% Lodging**	**Height (cm)**	**Ton ac-1 65% Moist**
FX19125-BMR	Dyna-Gro Seed	F	E	Y	23.8 d-g	222.3 i-l	20.4 a-e
Super Sile 30	Dyna-Gro Seed	F	ME	N	27.5 c-e	246.5 d-h	14.9 j-r
FX19133	Dyna-Gro Seed	F	Me	N	0.0 k	160.7 s-w	16.9 d- n
FX19178-BMR	Dyna-Gro Seed	F	M	Y	0.0 k	121.1 bc	14.1 k-r
F74FS72 BMR	Dyna-Gro Seed	F	M	Y	0.0 k	141.9 v-bb	16.0 d-r
Super Sile 20	Dyna-Gro Seed	F	ML	N	21.3 d-i	241.2 e-i	13.9 l-r
TopTon	Dyna-Gro Seed	F	ML	N	44.2 a	227.7 g-l	13.1 o-r
GX13692	Dyna-Gro Seed	F	ML	N	0.0 k	150.6 u-aa	15.9 f-r
Dual Purpose SCA	Dyna-Gro Seed	F	ML	N	0.0 k	130.0 a-c	18.2 a-l
DannyBoy II-BMR	Dyna-Gro Seed	F		Y	27.5 c-e	265.8 b-d	13.4 n-r
Fullgraze II	Dyna-Gro Seed	F	ML	N	0.0 k	280.7 a-c	22.4 a
Fullgraze II-BMR	Dyna-Gro Seed	F	ML	Y	43.0 ab	260.8 c-e	14.2 j-r
X033	Mojo Seed	F	M	N	0.0 k	157.8 t-x	15.1 i-r
X714	Mojo Seed	F	M	N	0.0 k	170.1 p-u	20.4 a-d
X1037	Richardson Seeds	F	E	Y	0.0 k	132.3 z-cc	13.9 l-r
NK300	Sorghum Partners	F	ME	N	9.6 h-k	152.0 u-aa	17.4 b-o
SP2774	Sorghum Partners	F	ME	Y	11.7 f-k	241.8 e-i	16.2 d-q
SS405	Sorghum Partners	F	MF	N	16.3 e-j	254.4 d-f	19.7 a-h
SP1615	Sorghum Partners	F	PS	N	10.8 g-k	281.2 a-c	19.4 a-i
SP3904 BD BMR	Sorghum Partners	F	ME	Y	0.0 k	135.1 y-bb	15.3 h-r
506/52	Scott Seed	F	PS	Y	0.0 k	180.8 o-s	13.7 m-r
Sorgdan Headless	Sorghum Partners	F	PS	N	1.4 k	225.9 h-l	16.1 d-r

Table 2. continued.

Hybrid Information[1]					Agronomic Measurements		
Hybid	**Company**	**Type**	**Maturity**	**BMR**	**% Lodging**	**Height (cm)**	**Ton ac-1 65% Moist**
SP4105	Sorghum Partners	F	PS	Y	7.9 i-j	183.4 o-r	13.3 n-r
SS506	Sorghum Partners	F	L	N	21.4 d-i	278.7 a-c	20.1 a-f
SP1880	Sorghum Partners	F	L	N	5.0 jk	284.1 ab	19.7 a-h
18096	Gayland Ward Seed	F	L	N	6.7 jk	136.9 x-bb	15.5 g-r
18116	Gayland Ward Seed	F	ML	Y	39.6 a-c	215.7 k-m	15.9 e-r
18118	Gayland Ward Seed	F	ML	Y	11.4 f-k	234.3 f-k	16.3 d-q
18180	Gayland Ward Seed	S	E	N	0.8 k	249.1 d-g	21.2 a-c
18181	Gayland Ward Seed	S	E	N	21.7 dh	252.2 d-f	17.5 b-o
18351	Gayland Ward Seed	F	ML	N	0.0 k	139.8 x-bb	14.4 j-r
18487	Gayland Ward Seed	F	L	N	28.6 c-e	218.0 j-l	12.8 p-r
19038	Gayland Ward Seed	F	L	N	0.0 k	151.6 u-aa	18.0 a-m
19040	Gayland Ward Seed	F	L	N	0.0 k	136.4 x-bb	13.7 m-r
19042	Gayland Ward Seed	F	L	N	0.0 k	178.8 o-t	15.3 h-r
19055	Gayland Ward Seed	F	ML	N	13.3 f-k	218.7 j-l	15.6 g-r
19102	Gayland Ward Seed	S	E	N	0.8 k	248.5 d-g	17.4 b-o
19153	Gayland Ward Seed	S	E	N	0.4 k	254.3 d-f	19.8 a-g
19154	Gayland Ward Seed	S	E	N	4.6 jk	253.5 d-f	18.7 a-j
19155	Gayland Ward Seed	F	ML	Y	30.4 b-d	192.0 n-p	11.7 r
19174	Gayland Ward Seed	F	ML	Y	0.0 k	195.4 m-o	16.3 d-q
19175	Gayland Ward Seed	F	ML	Y	25.0 d-f	188.8 n-q	15.0 i-r
19176	Gayland Ward Seed	F	ML	Y	3.3 jk	240.3 e-j	18.2 a-l
19177	Gayland Ward Seed	F	ML	Y	29.6 d-e	207.6 l-n	14.3 j-r
19178	Gayland Ward Seed	F	ML	Y	20.4 d-i	217.0 k-m	14.6 j-r
19179	Gayland Ward Seed	F	L	N	0.0 k	152.7 u-z	15.5 g-r

Table 2. continued.

Hybrid Information[1]					Agronomic Measurements		
Hybid	**Company**	**Type**	**Maturity**	**BMR**	**% Lodging**	**Height (cm)**	**Ton ac-1 65% Moist**
19181	Gayland Ward Seed	F	L	Y	0.0 k	111.2 c	16.0 d-r
ADV XF033	Adavanta-Alta	F	M		0.0 k	163.0 r-v	16.5 d-q
ADV F7232	Adavanta-Alta	F	M	Y	0.0 k	139.5 w-bb	15.9 e-r
AF 7401	Adavanta-Alta	F	ML	Y	0.0 k	140.9 v-bb	14.7 j-r
AF 8301	Adavanta-Alta	F	M	N	22.1 d-h	154.7 u-y	16.5 d-q
FX19526 BMR	Dyna-Gro Seed	F	E	Y	0.8 k	130.6 z-cc	14.2 j-r
503/15	Scott Seed	F	ML	N	0.0 k	151.6 u-aa	18.4 a-k
522/42	Scott Seed	F	ML	N	24.2 d-g	168.3 q-u	14.5 j-r
557/65	Scott Seed	F	L	Y	0.0 k	124.2 bc	12.4 qr
506/51	Scott Seed	F	M	Y	25.0 d-f	171.7 p-u	15.6 g-r
506/54	Scott Seed	F	PS	Y	12.1 f-k	221.3 i-l	15.8 f-r
542/43	Scott Seed	F	L	N	2.1 k	292.5 a	21.7 ab
535/54	Scott Seed	F	PS	N	0.0 k	206.5 l-n	17.6 b-n
Means **CV**					**10.07** **169.5**	**196.3** **14.20**	**16.3** **34.0**
Location							
KARE1					**4.41 c**	**159.3 c**	**12.6 c**
KARE2					**0.00 d**	**120.2 d**	**6.6 d**
UC Davis					**23.64 a**	**236.4 b**	**19.6 b**
WREC					**12.22 b**	**269.2 a**	**26.3 a**

[1]Hybrid information provided by seed companies. Under type, F=Forage sorghum, D=Dual Forage/grain sorghum. Under Maturity, E=Early, F=Full, ME=Medium Early, MF=medium Full, M=Medium, ML=Medium Late, L=Late, PS=Photoperiod Sensitive.
[2]Means followed by the same letter do not significantly differ using LSD (P=0.05)

Table 3. 2019 comparisons of sorghum forage hybrids and locations for nutrient composition and calculations at KARE, WREC, and UC Davis by seed company.

Hybrid Information[1]					Nutrient Composition & Calculations[2]					
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% Crude Protein**	**% ADF**	**% NDF**	**% Lignin**	**% Starch**	**% Fat**
FX19125-BMR	Dyna-Gro Seed	F	E	Y	10.3 d-l	35.7 l-s	54.2 l-r	3.6 s-y	5.1 j-q	2.3 h-p
Super Sile 30	Dyna-Gro Seed	F	ME	N	10.1 h-n	37.0 h-n	56.4 g-l	4.4 c-h	6.1 i-n	2.0 w-bb
FX19133	Dyna-Gro Seed	F	Me	N	9.8 j-s	34.5 r-x	53.1 n-s	4.2 d-m	10.0 ef	2.2 h-r
FX19178-BMR	Dyna-Gro Seed	F	M	Y	11.4 ab	33.8 t-aa	51.0 s-x	3.7 q-w	8.8 e-h	2.4 b-i
F74FS72 BMR	Dyna-Gro Seed	F	M	Y	10.4 c-j	35.0 o-v	52.8 n-s	3.4 u-aa	6.4 h-m	2.5 a-e
Super Sile 20	Dyna-Gro Seed	F	ML	N	9.3 o-t	38.1 f-j	57.7 f-j	4.6 b-d	4.4 l-r	1.9 z-cc
TopTon	Dyna-Gro Seed	F	ML	N	9.7 j-t	36.4 j-q	54.7 l-o	4.0 j-s	4.6 k-r	2.2 k-s
GX13692	Dyna-Gro Seed	F	ML	N	10.0 i-r	33.2 w-aa	49.9 w-z	4.2 e-n	13.3 b-c	2.3 d-m
Dual Purpose SCA	Dyna-Gro Seed	F	ML	N	10.7 b-i	33.4 v-aa	50.3 t-y	4.2 f-o	14.1 b-c	2.2 h-q
DannyBoy II-BMR	Dyna-Gro Seed	F		Y	10.3 e-m	40.0 b-e	58.7 e-g	3.7 r-x	0.5 u	2.1 s-z
Fullgraze II	Dyna-Gro Seed	F	ML	N	8.1 v	37.7 f-k	59.0 d-f	4.4 c-h	2.7 q-u	2.1 s-z
Fullgraze II-BMR	Dyna-Gro Seed	F	ML	Y	9.2 q-t	37.3 g-l	56.2 h-m	3.8 p-u	4.4 l-r	2.2 h-r
X033	Mojo Seed	F	M	N	11.9 a	35.0 p-w	54.7 l-p	3.9 m-t	6.6 h-m	2.3 e-n
X714	Mojo Seed	F	M	N	10.4 d-l	34.3 r-z	52.7 o-s	4.3 d-l	10.4 ef	2.3 f-o
X1037	Richardson Seeds	F	E	Y	11.4 ab	32.6 z-bb	49.5 w-z	3.5 t-z	11.0 c-e	2.4 b-h
NK300	Sorghum Partners	F	ME	N	10.2 f-n	31.4 bc	48.0 z	4.0 i-r	15.5 b-c	2.4 c-k
SP2774	Sorghum Partners	F	ME	Y	10.1 h-n	37.3 g-l	56.0 i-m	4.1 i-q	5.4 i-p	2.0 x-bb
SS405	Sorghum Partners	F	MF	N	9.0 tu	36.9 h-n	56.4 g-l	4.5 b-g	5.8 i-o	2.0 t-aa
SP1615	Sorghum Partners	F	PS	N	9.6 k-t	41.0 a-c	63.2 a	4.8 ab	0.2 u	2.0 y-cc
SP3904 BD BMR	Sorghum Partners	F	ME	Y	10.3 d-l	35.6 l-s	52.2 r-v	3.2 y-aa	7.3 g-j	2.4 a-f

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]					
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% Crude Protein**	**% ADF**	**% NDF**	**% Lignin**	**% Starch**	**% Fat**
506/52	Scott Seed	F	PS	Y	11.3 ab	39.3 c-f	58.8 ef	3.9 m-t	0.2 u	2.1 p-y
Sorgdan Headless	Sorghum Partners	F	PS	N	9.3 o-t	41.3 ab	62.3 a-c	5.0 ab	1.0 tu	1.8 c-k
SP4105	Sorghum Partners	F	PS	Y	11.2 a-c	40.2 a-d	59.2 d-f	3.8 n-t	0.3 u	2.2 j-s
SS506	Sorghum Partners	F	L	N	9.6 k-t	37.7 f-k	58.3 e-i	4.5 b-g	3.7 n-t	2.0 y-bb
SP1880	Sorghum Partners	F	L	N	9.3 p-t	38.9 d-g	60.5 b-e	4.7 a-c	3.2 o-t	1.9 bc
18096	Gayland Ward Seed	F	L	N	11.0 b-f	34.7 q-x	52.4 p-t	4.0 k-s	7.8 f-i	2.4 b-g
18116	Gayland Ward Seed	F	ML	Y	9.4 n-t	33.5 u-aa	48.9 x-z	3.3 v-aa	9.5 e-g	2.4 a-e
18118	Gayland Ward Seed	F	ML	Y	9.5 m-t	36.6 i-p	53.1 n-s	3.1 a	2.6 q-u	2.5 a-e
18180	Gayland Ward Seed	S	E	N	9.1 st	36.5 i-p	55.0 l-o	4.5 b-g	6.6 h-m	2.1 r-z
18181	Gayland Ward Seed	S	E	N	9.6 k-t	38.2 e-i	58.5 e-h	4.4 d-j	2.6 q-u	1.9 a-c
18351	Gayland Ward Seed	F	ML	N	10.7 b-i	33.8 t-aa	50.1 u-z	4.1 h-r	11.3 c-e	2.3 d-l
18487	Gayland Ward Seed	F	L	N	9.4 m-t	35.0 o-v	52.9 n-s	3.7 q-v	5.0 j-q	2.2 h-r
19038	Gayland Ward Seed	F	L	N	11.1 b-e	36.5 i-p	55.8 j-m	4.1 g-p	4.7 j-r	2.3 g-o
19040	Gayland Ward Seed	F	L	N	11.4 ab	35.2 n-u	54.6 l-q	3.6 t-z	1.5 s-u	2.3 d-l
19042	Gayland Ward Seed	F	L	N	10.5 c-j	37.6 f-k	57.3 f-k	4.2 e-n	4.0 m-s	2.1 o-x
19055	Gayland Ward Seed	F	ML	N	9.2 r-t	35.0 p-w	53.2 n-s	3.9 l-t	5.0 j-q	2.2 i-r
19102	Gayland Ward Seed	S	E	N	10.0 i-r	41.8 a	62.8 ab	4.8 a-c	0.2 u	1.9 a-c
19153	Gayland Ward Seed	S	E	N	9.6 l-t	36.8 h-o	55.9 k-m	4.6 a-d	6.0 i-n	2.0 v-aa
19154	Gayland Ward Seed	S	E	N	9.3 q-t	36.8 h-o	54.7 l-p	4.4 c-i	5.1 j-q	2.1 r-z
19155	Gayland Ward Seed	F	ML	Y	10.2 f-n	33.5 u-aa	49.6 w-z	3.1 a	4.2 m-r	2.5 ab
19174	Gayland Ward Seed	F	ML	Y	10.9 b-h	36.6 i-p	55.1 k-m	3.1 a	1.5 s-u	2.4 b-g
19175	Gayland Ward Seed	F	ML	Y	10.2 g-n	32.2 ab	48.2 yz	3.2 zaa	10.7 de	2.6 a
19176	Gayland Ward Seed	F	ML	Y	9.4 n-t	38.6 d-h	58.7 e-g	4.5 b-e	2.8 p-u	2.0 u-aa

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]					
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% Crude Protein**	**% ADF**	**% NDF**	**% Lignin**	**% Starch**	**% Fat**
19177	Gayland Ward Seed	F	ML	Y	10.0 i-r	35.5 m-t	52.3 q-v	3.6 t-z	7.0 g-l	2.3 d-l
19178	Gayland Ward Seed	F	ML	Y	10.4 d-k	36.1 k-r	53.9 m-r	3.7 r-x	6.0 i-n	2.4 c-k
19179	Gayland Ward Seed	F	L	N	11.0 b-e	37.2 g-m	56.1 i-m	4.3 d-j	4.7 j-r	2.2 l-t
19181	Gayland Ward Seed	F	L	Y	10.0 i-q	30.0 c	44.5 a	3.9 l-t	18.8 a	2.4 c-i
ADV XF033	Adavanta-Alta	F	M		9.3 o-t	35.6 l-s	54.2 l-r	4.5 b-f	9.0 e-h	2.2 m-u
ADV F7232	Adavanta-Alta	F	M	Y	11.1 b-e	34.7 q-x	52.2 r-v	3.3 x-aa	7.2 g-k	2.5 a-d
AF 7401	Adavanta-Alta	F	ML	Y	11.0 b-g	34.7 q-x	51.5 s-w	3.3 w-aa	7.8 f-i	2.5 a-c
AF 8301	Adavanta-Alta	F	M	N	9.2 q-t	33.5 u-aa	50.2 t-z	4.5 b-f	15.0 b-c	2.2 n-w
FX19526 BMR	Dyna-Gro Seed	F	E	Y	10.9 b-h	32.9 x-bb	49.6 w-z	3.8 o-u	11.3 c-e	2.4 b-g
503/15	Scott Seed	F	ML	N	10.7 b-i	32.8 y-bb	50.0 v-z	4.2 e-n	13.6 bc	2.3 g-o
522/42	Scott Seed	F	ML	N	9.8 j-t	35.5 l-t	52.4 q-u	4.3 d-k	10.7 de	2.2 m-v
557/65	Scott Seed	F	L	Y	11.4 ab	35.3 n-u	53.3 o-s	3.8 o-u	6.1 i-n	2.2 i-r
506/51	Scott Seed	F	M	Y	10.7 b-i	34.1 s-z	50.3 t-y	3.8 o-t	10.1 ef	2.4 c-j
506/54	Scott Seed	F	PS	Y	11.1 a-d	39.4 c-f	59.0 d-f	3.9 m-t	0.2 u	2.2 n-v
542/43	Scott Seed	F	L	N	8.3 uv	39.3 c-f	61.2 a-d	4.5 b-f	1.4 s-u	2.1 p-y
535/54	Scott Seed	F	PS	N	10.1 h-p	40.1 a-d	60.3 c-e	4.4 c-h	2.1 r-u	2.1 q-z
Means **CV**					**10.16** **9.95**	**36.08** **6.15**	**54.47** **5.28**	**4.01** **12.05**	**6.31** **52.51**	**2.22** **8.49**
Location										
KARE1					**10.76 b**	**36.11 b**	**56.79 a**	**3.69 d**	**3.07 c**	**2.17 b**
KARE2					**12.94 a**	**34.60 c**	**55.68 b**	**3.83 c**	**0.40 d**	**2.18 b**
UC Davis					**8.76 c**	**36.85 a**	**52.54 c**	**4.37 a**	**12.15 a**	**2.19 b**
WREC					**8.16 d**	**36.76 a**	**52.82 c**	**4.17 b**	**9.74 b**	**2.34 a**

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]				
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% K**	**% S**	**Milk Lbs ton^{-1}**	**Rel. Feed Value**	**Rel. Forage Quality**
FX19125-BMR	Dyna-Gro Seed	F	E	Y	1.84 l-r	0.137 l-v	2605.9 g-o	105.07 j-p	109.35 e-k
Super Sile 30	Dyna-Gro Seed	F	ME	N	2.03 d-o	0.140 i-s	2487.5 n-s	100.00 p-u	93.55 p-u
FX19133	Dyna-Gro Seed	F	Me	N	1.84 l-r	0.131 p-y	2624.7 f-n	110.03 g-l	100.58 l-q
FX19178-BMR	Dyna-Gro Seed	F	M	Y	2.06 c-n	0.158 a-e	2695.0 d-j	114.95 d-i	114.78 b-f
F74FS72 BMR	Dyna-Gro Seed	F	M	Y	2.13 c-l	0.146 e-o	2637.8 e-m	109.79 h-m	114.19 b-g
Super Sile 20	Dyna-Gro Seed	F	ML	N	1.94 g-q	0.125 v-z	2479.8 o-s	96.33 q-x	90.32 s-w
TopTon	Dyna-Gro Seed	F	ML	N	2.03 d-o	0.138 l-u	2521.3 m-s	103.54 k-q	98.88 m-s
GX13692	Dyna-Gro Seed	F	ML	N	1.67 q-v	0.136 m-v	2768.0 a-e	119.35 c-e	110.71 d-j
Dual Purpose SCA	Dyna-Gro Seed	F	ML	N	1.78 m-s	0.143 g-q	2704.1 c-i	117.05 d-h	108.78 f-l
DannyBoy II-BMR	Dyna-Gro Seed	F		Y	2.48 ab	0.149 c-m	2319.0 u-x	92.06 w-aa	99.58 m-r
Fullgraze II	Dyna-Gro Seed	F	ML	N	1.40 u-w	0.112 z	2551.3 k-r	93.93 t-y	91.05 r-v
Fullgraze II-BMR	Dyna-Gro Seed	F	ML	Y	1.81 l-s	0.128 s-y	2567.2 i-r	99.23 p-w	103.95 i-n
X033	Mojo Seed	F	M	N	2.19 b-k	0.163 ab	2592.9 g-q	105.48 j-p	105.75 g-m
X714	Mojo Seed	F	M	N	1.68 q-u	0.142 h-r	2679.1 d-l	112.26 e-j	102.88 i-o
X1037	Richardson Seeds	F	E	Y	2.08 c-n	0.154 a-h	2779.8 a-d	120.86 b-d	120.45 ab
NK300	Sorghum Partners	F	ME	N	1.54 r-w	0.133 o-x	2836.8 a-c	127.20 b	113.50 b-h
SP2774	Sorghum Partners	F	ME	Y	2.20 b-k	0.136 m-v	2521.8 m-s	99.92 p-u	100.12 l-q
SS405	Sorghum Partners	F	MF	N	1.76 n-t	0.121 x-z	2522.7 m-s	99.51 p-v	91.04 s-v
SP1615	Sorghum Partners	F	PS	N	2.22 b-j	0.135 n-w	2267.3 v-x	84.81 ab	82.92 v-x
SP3904 BD BMR	Sorghum Partners	F	ME	Y	2.24 b-h	0.158 a-e	2602.2 g-p	110.10 g-l	117.07 b-f
506/52	Scott Seed	F	PS	Y	2.72 ab	0.157 a-f	2332.6 t-w	92.80 u-z	100.52 l-q

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]				
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% K**	**% S**	**Milk Lbs ton^{-1}**	**Rel. Feed Value**	**Rel. Forage Quality**
Sorgdan Headless	Sorghum Partners	F	PS	N	2.23 b-h	0.128 r-y	2241.7 wx	85.50 z-bb	80.99 x
SP4105	Sorghum Partners	F	PS	Y	2.71 a	0.163 a-c	2201.1 wx	90.69 x-bb	95.84 n-t
SS506	Sorghum Partners	F	L	N	1.92 h-q	0.125 u-z	2464.9 p-t	95.20 r-y	89.95 t-w
SP1880	Sorghum Partners	F	L	N	2.00 f-p	0.129 q-y	2385.0 s-v	90.60 x-bb	84.03 v-x
18096	Gayland Ward Seed	F	L	N	1.98 f-q	0.151 a-k	2675.8 d-l	110.43 g-k	109.64 d-k
18116	Gayland Ward Seed	F	ML	Y	1.67 q-v	0.135 n-w	2720.3 c-g	120.30 b-d	117.04 b-f
18118	Gayland Ward Seed	F	ML	Y	1.86 l-r	0.135 n-w	2528.7 m-r	105.95 j-p	110.60 d-j
18180	Gayland Ward Seed	S	E	N	1.71 o-u	0.122 w-z	2514.7 m-s	102.68 m-q	91.15 r-v
18181	Gayland Ward Seed	S	E	N	2.10 c-m	0.129 q-y	2510.6 m-s	94.23 s-y	95.09 o-t
18351	Gayland Ward Seed	F	ML	N	1.85 l-r	0.153 a-j	2713.5 c-g	117.15 d-g	110.15 d-j
18487	Gayland Ward Seed	F	L	N	1.68 p-u	0.128 s-y	2746.4 b-f	108.62 i-n	111.37 c-i
19038	Gayland Ward Seed	F	L	N	2.21 b-j	0.153 a-i	2569.8 h-q	101.47 n-s	103.57 i-o
19040	Gayland Ward Seed	F	L	N	2.27 b-g	0.150 b-l	2597.4 g-q	105.07 k-p	110.85 d-i
19042	Gayland Ward Seed	F	L	N	2.35 b-d	0.143 f-p	2460.7 q-t	97.13 q-x	97.17 m-t
19055	Gayland Ward Seed	F	ML	N	1.49 s-w	0.125 u-z	2716.9 c-g	108.44 i-n	105.18 h-m
19102	Gayland Ward Seed	S	E	N	2.49 ab	0.139 j-t	2191.4 x	84.02 b	82.13 wx
19153	Gayland Ward Seed	S	E	N	1.78 m-s	0.131 p-y	2511.4 m-s	100.48 o-t	89.94 t-w
19154	Gayland Ward Seed	S	E	N	1.81 l-s	0.129 q-y	2549.6 l-r	102.79 l-q	95.89 o-t
19155	Gayland Ward Seed	F	ML	Y	1.88 k-q	0.147 e-o	2704.3 c-i	118.73 c-f	121.93 ab
19174	Gayland Ward Seed	F	ML	Y	2.37 bc	0.156 a-g	2557.5 j-r	102.31 n-r	114.27 b-g
19175	Gayland Ward Seed	F	ML	Y	1.70 p-u	0.144 f-p	2860.0 ab	125.79 bc	128.16 a
19176	Gayland Ward Seed	F	ML	Y	1.90 j-q	0.126 t-y	2430.3 r-u	93.68 t-y	88.63 t-x
19177	Gayland Ward Seed	F	ML	Y	1.83 l-r	0.139 j-t	2607.6 g-o	110.58 g-k	110.88 d-i

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]				
Hybrid	**Company**	**Type**	**Maturity**	**BMR**	**% K**	**% S**	**Milk Lbs ton^{-1}**	**Rel. Feed Value**	**Rel. Forage Quality**
19178	Gayland Ward Seed	F	ML	Y	2.08 c-n	0.145 e-o	2606.1 g-o	105.66 j-p	110.40 d-j
19179	Gayland Ward Seed	F	L	N	2.23 b-i	0.148 d-n	2540.8 l-r	99.59 p-u	102.06 j-p
19181	Gayland Ward Seed	F	L	Y	1.26 w	0.138 l-v	2904.9 a	139.50 ab	119.93 a-c
ADV XF033	Adavanta-Alta	F	M		1.67 q-v	0.125 u-z	2546.8 l-q	106.00 j-p	92.88 q-u
ADV F7232	Adavanta-Alta	F	M	Y	2.33 b-e	0.161 a-d	2679.3 d-l	111.77 f-j	118.08 b-d
AF 7401	Adavanta-Alta	F	ML	Y	2.27 b-f	0.164 a	2688.8 d-k	113.90 d-i	119.98 a-c
AF 8301	Adavanta-Alta	F	M	N	1.35 vw	0.119 yz	2707.8 c-h	118.18 d-f	99.83 m-q
FX19526 BMR	Dyna-Gro Seed	F	E	Y	1.90 i-q	0.156 a-g	2788.9 a-d	120.86 b-d	117.85 b-e
503/15	Scott Seed	F	ML	N	1.68 p-u	0.143 g-q	2758.6 b-f	119.80 cd	110.40 d-j
522/42	Scott Seed	F	ML	N	1.73 o-u	0.128 r-y	2540.9 l-r	109.64 i-m	101.34 k-q
557/65	Scott Seed	F	L	Y	2.23 b-i	0.161 a-d	2583.0 g-q	107.64 i-o	108.61 f-l
506/51	Scott Seed	F	M	Y	2.00 e-p	0.149 c-m	2717.6 c-g	118.16 d-f	115.25 b-f
506/54	Scott Seed	F	PS	Y	2.77 a	0.153 a-j	2330.0 u-x	92.19 v-z	100.16 l-q
542/43	Scott Seed	F	L	N	1.44 t-w	0.118 yz	2464.8 p-t	88.84 y-bb	86.17 u-x
535/54	Scott Seed	F	PS	N	2.36 b-d	0.141 h-s	2307.8 u-x	90.29 x-bb	89.80 t-w

Table 3. continued.

Hybrid Information[1]					Nutrient Composition & Calculations[2]				
Hybrid	Company	Type	Maturity	BMR	% K	% S	Milk Lbs ton^{-1}	Rel. Feed Value	Rel. Forage Quality
Means					**1.98**	**0.14**	**2574.4**	**105.56**	**103.53**
CV					**20.62**	**12.06**	**6.71**	**8.62**	**10.40**
Location									
KARE1					**2.19 b**	**0.14 b**	**2674.1 a**	**100.28 c**	**109.59 a**
KARE2					**2.31 a**	**0.18 a**	**2626.4 b**	**103.76 b**	**108.77 a**
UC Davis					**1.67 c**	**0.12 c**	**2499.4 c**	**109.81 a**	**96.75 b**
WREC					**1.75 c**	**0.11 d**	**2484.7 c**	**108.46 a**	**98.92 b**

[1]Hybrid information provided by seed companies. Under type, F=Forage sorghum, D=Dual Forage/grain sorghum. Under Maturity, E=Early, F=Full, ME=Medium Early, MF=medium Full, M=Medium, ML=Medium Late, L=Late, PS=Photoperiod Sensitive.
[2]Means followed by the same letter do not significantly differ using LSD (P=0.05)

Table 4. Top hybrids in the 2019 UC Sorghum Forage Trials based on yield and lodging[1].

Hybrid	Company	Type	Maturity	BMR	% Lodging	Ton ac^{-1} 65% Moist	% Crude Protein	NDF	Milk Lbs ton^{-1}	Rel. Forage Quality
Fullgraze II	Dyna-Gro Seed	F	ML	N	0.0	22.4	8.1	59.0	2551.3	91.05
542/43	Scott Seed	F	L	N	2.1	21.7	8.3	61.2	2464.8	86.17
18180	Gayland Ward Seed	S	E	N	0.8	21.2	9.1	55.0	2514.7	91.15
X714	Mojo Seed	F	M	N	0.0	20.4	10.4	52.7	2679.1	102.88
19153	Gayland Ward Seed	S	E	N	0.4	19.8	9.6	55.9	2511.4	89.94
SP1880	Sorghum Partners	F	L	N	5.0	19.7	9.3	60.5	2385.0	84.03
19154	Gayland Ward Seed	S	E	N	4.6	18.7	9.3	54.7	2549.6	95.89
503/15	Scott Seed	F	ML	N	0.0	18.4	10.7	50.0	2758.6	110.40
Dual Purpose SCA	Dyna-Gro Seed	F	ML	N	0.0	18.2	10.7	50.3	2704.1	108.78
19176	Gayland Ward Seed	F	ML	Y	3.3	18.2	9.4	58.7	2430.3	88.63
19038	Gayland Ward Seed	F	L	N	0.0	18.0	11.1	55.8	2569.8	103.57

[1]The top hybrid list was derived by taking those hybrids with the highest yields and eliminating those hybrids that lodged by more than 10%.

Table 5. Top yielding hybrids that yielded over 20.0 tons acre^{-1} averaged over the UC Forage Trials in 2019.

Hybrid	Company	Type	Maturity	BMR	% Lodging	Ton ac^{-1} 65% Moist	% Crude Protein	NDF	Milk Lbs ton^{-1}	Rel. Forage Quality
Fullgraze II	Dyna-Gro Seed	F	ML	N	0.0	22.4	8.1	59.0	2551.3	91.05
542/43	Scott Seed	F	L	N	2.1	21.7	8.3	61.2	2464.8	86.17
18180	Gayland Ward Seed	S	E	N	0.8	21.2	9.1	55.0	2514.7	91.15
FX19125-BMR	Dyna-Gro Seed	F	E	Y	23.8	20.4	10.3	54.2	2605.9	109.35
X714	Mojo Seed	F	M	N	0.0	20.4	10.4	52.7	2679.1	102.88
SS506	Sorghum Partners	F	L	N	21.4	20.1	9.6	58.3	2464.9	89.95
19153	Gayland Ward Seed	S	E	N	0.4	19.8	9.6	55.9	2511.4	89.94
SS405	Sorghum Partners	F	MF	N	16.3	19.7	9.0	56.4	2522.7	91.04
SP1880	Sorghum Partners	F	L	N	5.0	19.7	9.3	60.5	2385.0	84.03
SP1615	Sorghum Partners	F	PS	N	10.8	19.4	9.6	63.2	2267.3	82.92
19154	Gayland Ward Seed	S	E	N	4.6	18.7	9.3	54.7	2549.6	95.89
503/15	Scott Seed	F	ML	N	0.0	18.4	10.7	50.0	2758.6	110.40
Dual Purpose SCA	Dyna-Gro Seed	F	ML	N	0.0	18.2	10.7	50.3	2704.1	108.78
19176	Gayland Ward Seed	F	ML	Y	3.3	18.2	9.4	58.7	2430.3	88.63
19038	Gayland Ward Seed	F	L	N	0.0	18.0	11.1	55.8	2569.8	103.57
535/54	Scott Seed	F	PS	N	0.0	17.6	10.1	60.3	2307.8	89.80
18181	Gayland Ward Seed	S	E	N	21.7	17.5	9.6	58.5	2510.6	95.09
NK300	Sorghum Partners	F	ME	N	9.6	17.4	10.2	48.0	2836.8	113.50
19102	Gayland Ward Seed	S	E	N	0.8	17.4	10.0	62.8	2191.4	82.13
FX19133	Dyna-Gro Seed	F	Me	N	0.0	16.9	9.8	53.1	2624.7	100.58
ADV XF033	Adavanta-Alta	F	M		0.0	16.5	9.3	54.2	2546.8	92.88
AF 8301	Adavanta-Alta	F	M	N	22.1	16.5	9.2	50.2	2707.8	99.83
18118	Gayland Ward Seed	F	ML	Y	11.4	16.3	9.5	53.1	2528.7	110.60

Table 5. continued.

Hybrid	Company	Type	Maturity	BMR	% Lodging	Ton ac-1 65% Moist	% Crude Protein	NDF	Milk Lbs ton-1	Rel. Forage Quality
19174	Gayland Ward Seed	F	ML	Y	0.0	16.3	10.9	55.1	2557.5	114.27
SP2774	Sorghum Partners	F	ME	Y	11.7	16.2	10.1	56.0	2521.8	100.12
Sorgdan Headless	Sorghum Partners	F	PS	N	1.4	16.1	9.3	62.3	2241.7	80.99
F74FS72 BMR	Dyna-Gro Seed	F	M	Y	0.0	16.0	10.4	52.8	2637.8	114.19
19181	Gayland Ward Seed	F	L	Y	0.0	16.0	10.0	44.5	2904.9	119.93

[1]Hybrid information provided by seed companies. Under type, F=Forage sorghum, D=Dual Forage/grain sorghum. Under Maturity, E=Early, F=Full, ME=Medium Early, MF=medium Full, M=Medium, ML=Medium Late, L=Late, PS=Photoperiod Sensitive.