

Final Report

University of California-ANR

2023 Field Research on Sorghum Grain hybrids for the California

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Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) holds the position as the fifth most globally important cereal crop, trailing behind rice, maize, wheat, and barley. States with the highest quantity of grain sorghum production in the US are Kansas, Texas, and Nebraska, with California having more limited production. Much of the grain sorghum production in the highest production states is under rain-fed conditions, while all California grain sorghum is produced under irrigation. Initially introduced for animal feed within the dairy and beef industries, sorghum's utilization has expanded over the years. It now encompasses the pet-food, pork, poultry, and bird seed industries, as well as the renewable fuels industry. Recently, it has gained traction in food systems, particularly in gluten-free markets due to its gluten-free characteristics, finding applications in food and beer production. California's Sustainable Groundwater Management Act anticipates idling approximately 500,000 acres of irrigated cropland by 2040. Sorghum, as an annual crop generally recognized to have significant adaptations for sustained productivity under at least moderate drought, emerges as a potential solution. It offers a sustainable crop rotation option with relatively few pest and disease management issues, and also is an option for farmers to still plant a drought-tolerant crop that can help mitigate soil loss and dust pollution that could otherwise occur if land was fallowed in low water availability years. The University of California Agriculture and Natural Resources (ANR) initiated sorghum grain hybrid evaluation trials in 2016. This report presents data from 2023 demonstration plots cultivated across two locations: the University of CA ANR Kearney Agricultural Research and Extension Center (KARE) and the University of CA ANR Westside Research and Extension Center (WSREC). Previous reports can be found at the sorghum website, <https://sorghum.ucdavis.edu/>

Methods and Materials

Three seed companies provided 13 commercial grain sorghum hybrids for inclusion in these studies. The hybrids were planted in a replicated randomized complete block design, with four 20-foot rows on 30-inch raised beds for each individual plot. The analysis followed a split-plot design, with hybrids as the main plot and locations as the sub-plot. Bird damage was significant at the KARE location. Final grain means were extrapolated from grain harvested from ten panicles previously protected with bags, Grain weight was average per panicle and multiplied by the total panicles in two rows. The Kearney Agricultural Research and Extension Center (KARE) received 12.8 inches of rain from January through the end of May. During the growing season from June to September, rainfall amounted to 0.6 inches. Prior to planting at the West Side Research and Extension Center (WSREC), rainfall from January through May totaled 7.4 inches, with total rainfall during the growing season (June-September) at 0.42

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inches. Sprinkler irrigation was used to establish the stand, with additional water applied through furrow irrigation approximately every 7 to 10 days at the KARE location and every 12 to 16 days at the WSREC location. The trial was irrigated to approximate evapotranspiration demand, and fertilizer applications followed recommendations for grain sorghums in the region, with some adjustments based on measured at-planting residual soil nitrate levels.

The following is a summary of the locations where trials were located.

Trial Location: KARE Planting, Parlier, CA
Cooperator: UC-ANR
Previous Crop: Winter forage (Oats, barley, wheat)
Soil Type: Hanford sandy loam
Plot Size: Four, 30 inch rows by 20 ft
Replications: 3
Planting Date: May 24, 2023
Planting Rate: 70,000 seed acre⁻¹
Seed Method: Almaco 4 row plot planter
Fertilizer: 200 lbs/ac 46-0-0 pre-planting; layby application 100 lbs/ac 46-0-0; 100 lbs/ac 11-52-0; 500 lbs/ac K2O pre-plant;
Herbicide: Dual Magnum at 1 1/3 pints per ac⁻¹ as a pre-plant; Gramoxone at 48 oz per ac⁻¹, Maestro 4 EC at .5 pint per ac⁻¹
Pesticide: Sivanto Prime at 14 fl oz per ac⁻¹
Irrigation: Furrow irrigation
Grain Harvest Date: Plots hand harvested on October 18, 2023

Trial Location: WSREC, Five Points, CA
Cooperator: UC-ANR
Previous Crop: Sorghum
Soil Type: Panoche clay loam
Plot Size: Four, 30 inch rows by 20 ft
Replications: 3
Planting Date: June 7, 2023
Planting Rate: 70,000 seed acre⁻¹
Seed Method: Almaco 4 row plot planter
Fertilizer: 250 lbs/ac 46-0-0; layby application 100 lbs/ac 46-0-0; 100 lbs/ac 11-52-0
Herbicide: Dual Magnum 24 oz/ac as pre-emergent, Clarity 8oz ac⁻¹ as a layby 3
Pesticide: one application of Sivanto Prime 14oz ac⁻¹
Irrigation: Sprinkler irrigation for establishment, all other irrigations by furrow
Grain Harvest Date: Plots harvested with Almaco SPC 40 Plot Combine on October 2-3, 2023.

Data Collected:

- Emergence (%) calculated by number of seed planted divided by stand counts
- Plants per acre
- Days to flowering

- Plant height (cm)
- Panicle length (cm)
- Panicle exertion (cm)
- Yield (bu ac⁻¹) at 13%
- 1000 seed weight (g)
- Data was analyzed using the R statistical package.

Results

Sugar cane aphid populations reached treatable levels only once during the year at both sites in 2023, with only one application of Sivanto made per season at each site and no observable impacts on ability to machine harvest or on yield. Some varieties were noticed to have reduced incidence of the aphids, suggesting some level of resistance to these pests.

Early Agronomic Data

When averaged across the two sites, no significant differences were observed for days to flowering among the 13 hybrids. However, at individual sites, some significant differences were noted across hybrids. Cultivars grown at the WSREC averaged a higher number of days to flowering (DTF) in 2023 compared to the same group of cultivars grown at KARE. DTF reflects differences in expected times to maturity among the grain sorghum hybrids. This year, it ranged from as early as 61 days to flowering to as late as 87 days for some hybrids at KARE. Plant heights were relatively taller in 2023 with an average of 116.76 cm across the two locations compared to 2022. Moreover, there were no significant differences in the averages across the two sites (Table 1).

Plant and Yield Data

There was no lodging recorded at any site this year. The average plant populations per acre (plants per acre) across the two sites were 87.60% higher than the previous year. WSREC had a much higher stand percentage, grain yield, and 1,000 seed weight compared to KARE. WSREC's average yield was 205.16 bu ac⁻¹, more than what was reported in previous years. Conversely, KARE had a much lower yield and 1000 seed weight. KARE's average yield was 111.32 bu ac⁻¹, still higher than previous years. The yields at KARE were affected by bird damage in the range of 20-40%, with DynaGro M59GN94 receiving the most bird damage. At the KARE site, due to observed potential for significant and persistent bird damage, ten panicles were protected by bird-proof mesh bags prior to grain maturity and then hand-harvested, with grains from these panicles used to calculate the final yield. Bird damage was minimal at the WSREC site. Due to differences in harvest and bird damage, we did not average the yield across the two locations. The highest yielding hybrids recorded at WSREC was S&W SP7715 at 303.75 bu ac⁻¹, while at KARE the highest yields were observed in S&W SPSD353 at 159.84 bu ac⁻¹ (Table 3 and 5).

Discussion

The grain sorghum performance trial was evaluated at only two sites, KARE and WSREC, compared to three locations in some previous years. The WSREC site has a deep, alluvial clay loam soil with high water holding capacity and no soil restrictive layers to limit rooting depth, while the KARE site is a sandy loam soil with low to moderate soil water holding capacity and some soil layers restricting most root development to the upper 3.5 to 4.5 feet.

This year, germination and emergence percentages were higher than observed in recent years at both sites, especially at WSREC, where emergence averaged approximately 93 percent of the planted seed rate. This was attributed to the quality of seeds and the high winter rains that replenished stored soil moisture, along with timely applied irrigations to support stand establishment. Despite the good emergence and stand survival at KARE, we were only able to estimate the yields from bagged, protected panicles due to the previously described bird damage. Certain varieties were highly preferred by birds or were at more desired grain maturity at the time of highest bird activity compared to others, resulting in reduced yields. Still, the yield estimates for some hybrids at KARE in 2023 indicated good potential for grain sorghum yields. High grain sorghum yields at WSREC and some indications of improved yield potentials at KARE over levels of prior years' confirms that, given the right conditions, sorghum has the potential to perform well in different soils in California.

Table 1. Various agronomic and yield characteristics for grain sorghum hybrids averaged across 2 trial locations in California in 2023, University of CA ANR Kearney Agricultural Research and Extension Center, Parlier, and West Side Research and Extension Center, Five Points

Hybrid Information		Agronomic Measurements *			
Company	Hybrid	DTF ¹	Plants per ac	Height at harvest (cm)	1000 seed Weight (g)
S&W Seed	SWFS4901	61 e	64097 ab	104.29 cd	31.66 a
S&W Seed	SPSD353	72 bc	60250 bc	117.44 a-c	29.19 a-c
S&W Seed	SP 66M16	66 c-e	60830 bc	118.26 a-c	26.57 c-e
S&W Seed	SWGS4902	68 cd	52555 d	97.95 d	24.17 e
S&W Seed	SP7715	82 a	64605 ab	130.52 a	24.28 e
Scott Seed Co	X50415	80 a	61484 a-c	123.74 ab	23.98 e
Scott Seed Co	X50615	78 ab	51902 d	131.42 a	24.73 de
DYNAGRO	M59GB94	66 c-e	65694 ab	121.7 ab	26.04 c-e
DYNAGRO	M60GB31	63 de	65404 ab	115.4 a-c	24.23 e
DYNAGRO	M63GB78	69 cd	56402 cd	110.87 b-d	26.63 c-e
DYNAGRO	M67GB87	69 cd	60395 bc	122.41 ab	28.21 bc
DYNAGRO	M71GR91	69 cd	67944 a	118.69 a-c	27.8 b-d
DYNAGRO	M72GB71	67 c-e	61484 a-c	116.88 a-c	26.99 c-e
Mean		69.38	61323	116.76	26.81
CV (coefficients of variation-%)		7.74	9.42	12.27	10.39
Location Means					
KARE		68.48 a	57274 b	113.71 a	24.2 b
WREC		70.29 a	65372 a	119.81 a	29.41 a

*Means followed by the same letter do not significantly differ using LSD (alpha=0.05); ¹DTF=days to 50% flowering.

Table 2. Various agronomic characteristics for grain sorghum hybrids grown at the University of CA ANR Kearney Agricultural Research and Extension Center, Parlier, California in 2023.

Hybrid Information		Agronomic Measurements *			
Company	Hybrid	Height at harvest (cm)	DTF ¹	Exertion (cm)	Panicle Length (cm)
S&W Seed	SWFS4901	97.67 f-h	61 b	4.33 bc	29 a
S&W Seed	SPSD353	116.33 cd	67 b	11 ab	27.33 a-c
S&W Seed	SP 66M16	108.67 c-f	64 b	11 ab	28.33 a
S&W Seed	SWGS4902	86.67 h	66 b	13.67 a	22.67 de
S&W Seed	SP7715	132.33 ab	87 a	9.33 a-c	27.67 ab
Scott Seed Co	X50415	132.33 ab	82 a	1.33 c	22 e
Scott Seed Co	X50615	146 a	79 a	11 ab	24.33 b-e
DYNAGRO	M59GB94	113 c-e	69 b	8 a-c	24.33 b-e
DYNAGRO	M60GB31	106.33 d-g	63 b	14.33 a	22 e
DYNAGRO	M63GB78	100.67 e-h	61 b	9.67 a-c	26 a-d
DYNAGRO	M67GB87	118.67 b-d	70 b	10 a-c	23.67 c-e
DYNAGRO	M71GR91	118 b-d	65 b	14 a	23.33 de
DYNAGRO	M72GB71	122 bc	63 b	10 a-c	28.67 a
Mean		113.71	68.48	9.6	25.19
CV		7.98	7.88	55.54	8.89

*Means followed by the same letter do not significantly differ using LSD (alpha=0.05); ¹DTF=days to 50% flowering

Table 3 (continued). Various agronomic characteristics for grain sorghum hybrids grown at the University of CA ANR Kearney Agricultural Research and Extension Center, Parlier, California in 2023.

Hybrid Information		Agronomic Measurements *		
Company	Hybrid	Plants per ac	Yield (bu/ ac ⁻¹)	1000 Seed Weight (g)
S&W Seed	SWFS4901	59378 ab	100.12 cd	30.64 a
S&W Seed	SPSD353	50668 cd	159.84 a	24.38 b
S&W Seed	SP 66M16	52265 bc	114.41 a-d	24.28 b
S&W Seed	SWGS4902	48055 cd	87.64 cd	24.77 b
S&W Seed	SP7715	60830 a	109.39 a-d	19.36 c
Scott Seed Co	X50415	61702 a	153.34 ab	19.43 c
Scott Seed Co	X50615	44135 d	123.11 a-c	19.39 c
DYNAGRO	M59GB94	63008 a	64.88 d	23.72 b
DYNAGRO	M60GB31	61121 a	102.59 b-d	23.53 b
DYNAGRO	M63GB78	52700 bc	97.31 cd	24.9 b
DYNAGRO	M67GB87	58798 ab	107.6 b-d	24.92 b
DYNAGRO	M71GR91	65041 a	125.12 a-c	25.33 b
DYNAGRO	M72GB71	61121 a	128 a-c	24.64 b
Mean		57274	111.32	24.2
CV		7.48	27.45	9.09

*Means followed by the same letter do not significantly differ using LSD (alpha=0.05)

Table 4. Various agronomic characteristics for grain sorghum hybrids grown at the University of CA ANR West Side Research and Extension Center, Five Points, California in 2023.

Hybrid Information		Agronomic Measurements *			
Company	Hybrid	DTF ¹	Height at harvest (cm)	Exertion (cm)	Panicle Length (cm)
S&W Seed	SWFS4901	61d	110.92 a	**	**
S&W Seed	SPSD353	76 a	118.54 a	**	**
S&W Seed	SP 66M16	69 bc	127.85 a	**	**
S&W Seed	SWGS4902	71 bc	109.22 a	**	**
S&W Seed	SP7715	77 a	128.7 a	**	**
Scott Seed Co	X50415	79 a	115.15 a	**	**
Scott Seed Co	X50615	76 a	116.84 a	**	**
DYNAGRO	M59GB94	63 d	130.39 a	**	**
DYNAGRO	M60GB31	63 d	124.46 a	**	**
DYNAGRO	M63GB78	77 a	121.08 a	**	**
DYNAGRO	M67GB87	68 c	126.16 a	**	**
DYNAGRO	M71GR91	72 b	119.38 a	**	**
DYNAGRO	M72GB71	71 b	111.76 a	**	**
Mean		70.29	119.81	**	**
CV		2.62	11.84	**	**

*Means followed by the same letter do not significantly differ using LSD (alpha=0.05), ¹DTF=days to 50% flowering. **These parameters were NOT collected in the trial at the WSREC si

Table 5 (continued). Various agronomic characteristics for grain sorghum hybrids grown at the University of CA-ANR West Side Research and Extension Center, Five Points, California in 2023.

Hybrid Information		Agronomic Measurements *		
Company	Hybrid	Plants per acre	Yield (bu/ac ⁻¹ @ 13% moisture)	1000 Seed Weight (g)
S&W Seed	SWFS4901	68815 a-c	184.29 cd	32.67 a-c
S&W Seed	SPSD353	69832 ab	201.45 c	34.00 a
S&W Seed	SP 66M16	69396 a-c	193.31 c	28.87 de
S&W Seed	SWGS4902	57056 d	235.11 b	23.57 g
S&W Seed	SP7715	68380 a-c	303.75 a	29.20 c-e
Scott Seed Co	X50415	61266 a-d	228.73 b	28.53 d-f
Scott Seed Co	X50615	59669 cd	224.06 b	30.07 b-e
DYNAGRO	M59GB94	68380 a-c	199.42 c	28.37 ef
DYNAGRO	M60GB31	69686 a-c	185.49 cd	24.93 fg
DYNAGRO	M63GB78	60105 b-d	197.9 c	28.37 ef
DYNAGRO	M67GB87	61992 a-d	160.87 e	31.50 a-e
DYNAGRO	M71GR91	70848 a	163.26 de	30.27 a-e
DYNAGRO	M72GB71	61847 a-d	198.91 c	29.33 c-e
Mean		65372.49	205.16	29.41
CV		9.22	6.52	7.58

*Means followed by the same letter do not significantly differ using LSD (alpha=0.05)