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2016 UCCE Delta Sorghum Seeding Rate Trial

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Sorghum is not a new crop to California, having been introduced in the late 1800s (http://sorghum.ucanr.edu/), but acreage has been limited in recent years. According to the Agricultural Commissioner's crop reports, San Joaquin County sorghum acreage reached only about 1700 acres in 2015, up from about 1100 acres in 2014. Crop reports for 2016 are not yet available, but observationally, acreage appeared to increase in 2016. Sorghum may be grown for grain or silage, and in the United States, it is used primarily for animal feed. Sorghum has similar growth habits as corn and is sometimes grown as a substitute for corn, given that sorghum is tolerant of drought and low-input conditions (http://sorghum.ucanr.edu/). In recent years, the University of California has augmented research efforts on growing grain and silage sorghum in California. The purpose of this trial was to better understand optimal seeding rates for grain sorghum grown in the Sacramento-San Joaquin River Delta – a unique agricultural region known for its fertile, organic soils, shallow groundwater, and cooler climate conditions.

Extension publications from Midwestern states provide a range of specifications for sorghum seeding rates. In Wisconsin, for example, a rate of 8-10 lbs/acre is recommended when soil fertility and moisture are considered good, planting is on 30 to 40-inch row spacing, and the seed has approximately 75 percent germination and 16,000 seeds/lb. This would result in a plant population of 100,000-120,000 plants/acre (http://corn.agronomy.wisc.edu/Crops/SorghumGrain.aspx). In Alabama, a seeding rate of 5 lbs/acre is recommended under good growing conditions, resulting in a plant population of approximately 60,000 plants/acre. Under heavily managed, irrigated systems, they suggest that a plant density of 100,000 plants/acre may be acceptable (http://www.aces.edu/pubs/docs/A/ANR-0502/index2.tmpl). Because of the variability in sorghum seed size, recommendations from Texas are expressed as 8 seeds/foot-row under full irrigation, on 40-inch row spacing (http://sanangelo.tamu.edu/extension/agronomy/agronomy-publications/grain-sorghum-production-in-west-central-texas/#planting). The number of sorghum seeds/lb is highly variable across varieties. For this reason, when determining seeding rates, growers should first determine their desired plant population. A worksheet at the end of this report provides equations for calculating seeding rate based on desired plant populations.

The trial was planted in the Sacramento-San Joaquin Delta, on Tyler Island in Sacramento County. The soil is a Rindge mucky silt loam with approximately 20 percent organic matter in the top 15 inches of soil. The Rindge series is a mucky peat soil down to about 60 inches, and approximately 55,600 acres in the Delta are described by the Rindge classification. The plot was planted on May 20, 2016 using a John Deere cone planter. Seed was planted approximately 2 inches deep. The trial was a white sorghum variety, Eureka Seeds 3292, which was the grower's variety. The variety has 16,000 seeds/lb and 85 percent germination, according to the label. Five seeding rate treatments (5, 6, 9, 12, and 15 lbs/acre) were replicated over four blocks positioned down the rows. The seeding rates are expressed as plant populations in Table 1. Each plot consisted of four rows (30-inch row spacing) that were 45 feet in length. The previous crop in the field was wheat. Subsurface irrigation by "spud ditch" sub-surface irrigation was employed twice. The field was fertilized at planting with 35 gallons/acre of 8-24-0 with ½ percent of zinc. The field was cultivated one time, and Maestro 4EC (8 oz/acre), AAtrex 4L (0.75 pint/acre), and Crosshair (4 oz/acre) were applied for post-emergence weed control in mid-June. The plot was harvested on November 14, 2016 using an Almaco research combine, harvesting the center two rows from the four-row plots.

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Trial results are presented as plant establishment characteristics (Table 1), plant maturity characteristics (Table 2), and yield (Figure 1). The tables and figure present mean values for the four replicates. Tukey's range test was the statistical method used to compare the means. Varieties were considered statistically different if their P value was less than 0.05, or 5 percent. Differences between treatments are indicated by different letters following the mean.

The estimated plant populations for the treatment seeding rates were calculated using the number of seeds/lb and percent germination for this variety. Stand counts were made as the number of plants/10-foot row length on June 1st and June 16th, and these counts were scaled up to plants/acre. Stand counts were as expected - higher counts for the higher seeding rates. Stand counts for all treatments decreased from June 1st to June 16th, but stand counts remained on target with the estimated plant population for the 5 and 6-lb seeding rates. Weeds were also counted in the month after planting and in the month before harvest (data not shown), but overall weed pressure was very low at this location.

Table 1. Plant establishment characteristics of the 2016 UCCE Delta sorghum seeding rate trial.

Seeding Rate (lbs/acre)	Estimated Plant Population (# seeds/acre)	Stand Count 1-June (plants/acre)		Stand Count 16-June (plants/acre)	
5	80,000	82,756	e	79,489	e
6	96,000	106,712	d	96,258	d
9	144,000	149,396	c	130,667	c
12	192,000	196,436	b	161,156	b
15	240,000	248,267	a	190,338	a
Treatment P value		<0.0001		<0.0001	
Standard Error		4432		3748	

There were no differences in the number days to flowering among treatments; however, there were differences among treatments in the other maturity characteristics. The higher seeding rate plots had taller plants with longer panicle exsertion (the length of the stem from the top leaf to the bottom of the panicle), which may suggest that at these higher densities, plants were competing with each other and growing taller. Panicles were longest in the 5 lb seeding rate and statistically longer than the panicles in the 12-lb and 15-lb rates. There were no statistical differences in grain moisture at harvest.

The treatment yields do not provide a clear take-home message of the results, except perhaps to show that the highest seeding rate (15 lbs/acre) is not an optimum seeding rate. However, if the 9-lb treatment was ignored, there would be a trend for yield to decrease as the seeding rate increased. A possible explanation for the high yield of the 9-lb treatment is that there were three of these plots proximal to the sub-irrigation ditches, which were exterior to the experiment on both sides. The 9-lb treatment may have been inadvertently favored with better moisture conditions as a result of the experimental design. In hindsight, the experiment should have been blocked across the rows instead of down the rows to account for these field conditions which may have introduced variability in soil moisture. Blocking down the rows accounted for very little unexplained variability, and in future years, the experiment will be designed to account for the variability across the rows.

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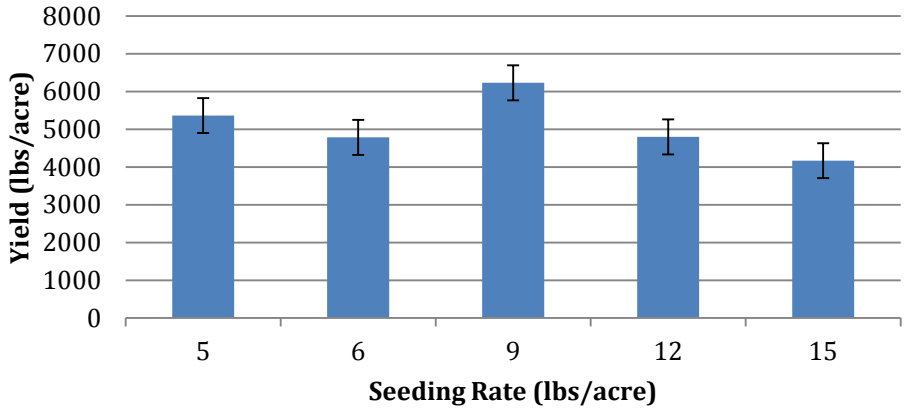
Table 2. Plant maturity characteristics of the 2016 UCCE sorghum seeding rate trial in the Delta.

Seeding Rate (lbs/acre)	Days to Flowering (# of days)	Plant Height (inches)	Panicle Length (inches)	Panicle Exsertion (inches)	Moisture (%)
5	71	53.1 b	11.8 a	6.2 c	18.2
6	71	52.3 b	11.0 abc	6.7 c	18.0
9	71	54.7 a	11.1 ab	7.4 bc	17.2
12	71	53.4 ab	10.6 bc	8.1 ab	17.8
15	71	53.7 ab	10.3 c	9.1 a	18.1
Treatment P value	0.9014	0.0003	<0.0001	<0.0001	0.0589
Standard Error	0.4	0.8	0.3	0.4	0.22

Figure 1. Yield at 13 percent moisture of the 2016 UCCE sorghum seeding rate trial in the Delta. There were no statistical differences among treatments (P = 0.1278).



In summary, it is important to study sorghum cultural practices in the Sacramento-San Joaquin Delta region because crop acreage appears to be increasing, and the Delta is a unique growing region of California. Sorghum seeding rates as a function of plant population were studied to assist growers with determining optimum rates for the Delta environment. While results are somewhat inconclusive, there appears to be a trend for the lower seeding rates to yield the highest. If this trend is shown in future years, then Delta growers could have higher productivity with lower seed costs.

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Sorghum Plant Population Worksheet

Jeff Dahlberg, Director, Kearney Agricultural Research and Extension Center

Calculating number of seeds per foot to get desired plant population per acre:

Table 1. Sorghum plant population in plants/ft-row for different row spacings.

	Desired plants per acre (X1000)					
	25	50	75	100	125	150
Row width	Average number of plants per foot of row					
7 inch	0.3	0.7	1.0	1.3	1.7	2.0
15 inch	0.7	1.4	2.2	2.9	3.6	4.3
20 inch	1.0	1.9	2.9	3.8	4.8	5.7
30 inch	1.4	2.9	4.3	5.7	7.2	8.6
40 inch	1.9	3.8	5.7	7.7	9.6	11.5

How do you calculate plant population and seeding rate?

Plant population per acre is equal to:

$$[43{,}560 \div (\text{row spacing in inches} \div 12)] \text{ X plants per foot of row}$$

Seeding rate per acre is equal to:

$$\frac{\text{Suggested plants per foot of row}}{\text{Percent germination X Percent expected emergence}}$$