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J. P. Broeckelman
Kansas State University, jonnybr@ksu.edu

E. A. Adee
Kansas State University, eadee@ksu.edu

G. J. Kluitenberg
Kansas State University, gjk@ksu.edu

See next page for additional authors

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Authors

J. P. Broeckelman, E. A. Adee, G. J. Kluitenberg, and I. A. Ciampitti

Grain Sorghum Yield Response to Water Availability

J. Broeckelman, E. Adee, K. Roozeboom, G. Kluitenberg, and I.A. Ciampitti

Summary

Yield effects of irrigation on sorghum and corn were compared, but this report is merely focused on the sorghum phase of the crop rotation. Mean yield based on 12.5% grain moisture for irrigated sorghum was 168 bu/a, whereas dryland yield was 145 bu/a. The latter represents a yield improvement of 23 bu/a, an increase of approximately 2 bu/a per unit (in.) of water applied (considering a total of 11 in. of water applied in the irrigation block).

The irrigated sorghum used a mean of 7.8 in. more water than the dryland, which suggests that the dryland sorghum consumed 3.4 in. more water from the soil profile than the irrigated sorghum (this value assumes no water losses due to runoff or deep percolation and is calculated from total precipitation and irrigation as well as changes in profile water status). Water use efficiency, or WUE, was calculated as the ratio of yield to water use. A trend for superior WUE of 6.5 bu/in. was documented under dryland conditions, compared with 5.6 bu/in. for irrigated sorghum.

Introduction

Decreases in available irrigation water and increased water restrictions necessitate exploration of more economical ways to use available irrigation water. Under low-yielding environments (<80 bu/a grain sorghum), sorghum has a yield advantage over corn because of its lower input costs and superior WUE and heat tolerance. Sorghum's yield potential is not as high as corn's, however, so the goal of this study is to determine at what point in available water, both under dryland and irrigation management scenarios, it is better to plant sorghum rather than corn.

Procedures

In a randomized complete block design, grain sorghum was planted in dryland and fully irrigated blocks at the Topeka Unit of the Kansas River Valley Experiment Field. Within each block, three treatments of different grain sorghum hybrids were planted (Pioneer 84G62, Pioneer 85Y40, and DKS 53-67) with four replications. The plot size was 10 ft × 30 ft, and sorghum was planted in 30-in. rows (four rows per plot). The center two rows were harvested to determine final grain yield and its components.

Plant populations and fertility were based on yield goals of 170 bu/a for the fully irrigated and 130 bu/a for the dryland. Grain sorghum was planted on May 21 with seeding rates based on a goal of 90,000 plants/a in the irrigated block and of 60,000 plants/a in the dryland block. Fertilizer was applied based on recommendations for corn because sorghum fertilizer recommendations for the target yield were lower, and we wanted to eliminate variables that would cause different yields for corn vs. sorghum. Nitrogen (N) was applied preplant at 142 lb/a on both the dryland and the irrigated treatments and was supplemented with 80 lb/a N on the irrigated block (applied June 6). Phosphorus (P) and potassium (K) were applied preplant along with the N at 52 lb/a and 60 lb/a, respectively, for both water scenarios.

Because the study is considering crop production under limited irrigation, water usage was measured at diverse growth stages. After emergence, 6-ft aluminum tubes were installed in the center of each plot halfway between the center two rows. These tubes were used to take water content measurements throughout the growing season using a neutron probe at depths of 0.5, 1.5, 2.5, 3.5, and 4.5 ft. The moisture readings were taken at emergence, mid-vegetation, flowering, mid-reproductive phase, harvest, and 40 days after harvest.

Results

Both dryland and irrigated sorghum yielded very well because of high early-season rainfall amounts. Dryland sorghum yields were highly variable because of the non-uniform soils of the river bottom, which was also seen in the variability in neutron probe moisture readings.

The Pioneer 85Y40 hybrid yielded best of the three genotypes on both irrigated and dryland blocks, with yields of 178 bu/a and 150 bu/a, respectively (Tables 1 and 2). The second-best-yielding hybrid was Pioneer 84G62, with an irrigated yield of 165 bu/a and a dryland yield of 143 bu/a. DKS 53-67 yielded 162 bu/a on irrigated and 142 bu/a on dryland. Overall, irrigated sorghum yielded 168 bu/a (Table 1), whereas dryland sorghum yielded 145 bu/a. The irrigated averaged approximately 24 bu/a higher yield than the dryland block (Table 2).

Throughout the growing season, 11 in. of water was applied through irrigation. This can be calculated as an approximately 2-bu increase for every inch of water applied.

Although there were no significant differences between hybrids in terms of water use, differences in WUE for irrigated sorghum were significant (Table 1). The Pioneer 85Y40 hybrid had a WUE of 5.9 bu/in., whereas 84G62 and DKS 53-67 had similar values of 5.5 and 5.4 bu/in., respectively. For the dryland environment, no significant differences in yield, water use, or WUE were documented among the evaluated hybrids (Table 2).

Table 1. Sorghum water use, yield (12.5% grain moisture) and water use efficiency (WUE) parameters under the irrigated environment

Irrigated	Means		
Hybrid	Water use, in.	Yield, bu/a	WUE, bu/in.
85Y40	30.1 A[1]	177.6 A	5.9 A
84G62	30.2 A	166.3 B	5.5 B
DKS 53-67	29.7 A	160.8 B	5.4 B
P-value	0.4861	0.0334	0.0265

[1] Values with the same letters are not significantly different ($P > 0.05$).

Table 2. Sorghum water use, yield (12.5% grain moisture) and water use efficiency (WUE) parameters under the dryland environment

Dryland	Means		
Hybrid	Water use, in.	Yield, bu/a	WUE, bu/in.
85Y40	22.8 A[1]	149.7 A	6.6 A
84G62	22.0 A	142.6 A	6.5 A
DKS 53-67	21.7 A	141.6 A	6.5 A
P-value	0.1515	0.8087	0.9902

[1] Values with the same letters are not significantly different ($P > 0.05$).