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Crop Assurance Strategies for Irrigated Grain Sorghum Production

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Cover Page Footnote

Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022. Special appreciation to Jonathan Aguilar for reviewing this report for final publication. This research project received support from the U.S. Department of Agriculture Agricultural Research Service Ogallala Aquifer Program.

Crop Assurance Strategies for Irrigated Grain Sorghum Production

F.R. Lamm^{1,2}

Summary

This sprinkler-irrigated study was conducted from 2018 to 2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS, to evaluate four different water management strategies that could provide assurance of adequately-yielding grain sorghum. The grain sorghum was grown on sites with good initial soil water at planting (>70% of field capacity within the 8-ft deep silt loam profile). Strategies were 1) No seasonal irrigation; 2) Irrigation of 100% of ET minus Rain after the boot stage through remainder of season; 3) Irrigation of 100% of ET minus Rain up to a limit of 6 inches; and 4) Irrigation of 100% of ET minus Rain up to a limit of 3 inches. Cropping season rainfall ranged from 5.48 inches to 13.98 inches and irrigation ranged from 0 to 11 inches across strategies for the 4 years of the study. Yield increases due to irrigation varied across years, ranging from -3.6 bu/a to 21.2 bu/a, but averaged only 7.2 bu/a over the non-irrigated treatment. Average yields were 138, 143, 144, and 145 bu/a for the four respective water management strategies. Soil water extraction by the grain sorghum was greater in the drier years and increased with less applied irrigation. These results indicate that adequately-yielding grain sorghum can be produced on sites with good soil water profiles at planting with little (\approx 3 inches) or even no in-season irrigation.

Introduction

Grain sorghum is tolerant of crop water stress and can be an excellent crop when irrigation is restricted both in total amount and temporally within the season. Many Central Great Plains producers prefer to grow corn under fully irrigated conditions, but those opportunities are decreasing as time progresses. Some producers are already beginning to remediate deficit irrigation capacities (i.e., gpm/a) by splitting center pivot sprinkler land areas annually into multiple crops. Although grain sorghum is reasonably tolerant of crop water stress, it does need sufficient water to yield well, and sometimes irrigation is needed to assure an adequate crop that is profitable. A sprinkler-irrigated grain sorghum study was conducted from 2018 to 2021 at the K-State Northwest Research-Extension Center at Colby, KS, to evaluate four water management strategies ranging from non-irrigated in-season to full irrigation.

Experimental Procedures

Grain sorghum (Pioneer 86P20) was planted in late May or early June in all years at a seeding rate of approximately 140,000 seeds/a. Nitrogen fertilizer (UAN 32-0-0) was

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applied at a rate of 175 lb N/a in 2018 and 2019 and at a rate of 240 lb N/a in 2020 and 2021. Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to an 8-ft depth in 1-ft increments with neutron moderation techniques. Grain sorghum yield and yield components were determined by hand harvesting at physiological maturity. Crop water use was determined as the sum of the seasonal soil water change, irrigation, and rainfall. Crop water productivity was calculated as yield/crop water use. The water management strategies were:

1. No in-season irrigation
2. Irrigation only after boot stage to replace 100% ET – Rain
3. Irrigation only after boot stage to replace 100% ET – Rain, but capped at 6 inches
4. Irrigation only after boot stage to replace 100% ET – Rain, but capped at 3 inches.

Irrigation was scheduled only as needed as determined by the weather-based water budgets. Irrigation amounts were generally 1 inch per application.

Results and Discussion

Growing conditions were favorable for good grain sorghum production in all four years of the study. Precipitation during the grain sorghum growing period was 11.77, 13.98, 6.13, and 5.48 inches for 2018, 2019, 2020, and 2021, respectively. Irrigation requirements varied between years, but were greatest for 2021 (Table 1). The drier years (i.e., less precipitation) of 2020 and 2021 provided a more thorough testing of the water strategies.

Average grain sorghum yields were 143 bu/a during the study (Table 1) but varied between years (Figure 1). Yield differences between the irrigated strategies were very small with Treatment 4, where total irrigation was limited to 3 inches, having the greatest average yield. Irrigation appreciably increased yields over the non-irrigated treatment in only two of the four years (2018 and 2021). Crop water productivity was greatest for the non-irrigated treatment and decreased further with increased irrigation (Table 1 and Figure 1).

The study sites in each year had ample soil water at planting, averaging greater than 70% of field capacity for the 8-ft deep silt loam soil profile (Figure 2) and this later helped to buffer seasonal drought periods when they occurred. In all four years there were not appreciable differences in available soil water among treatments until approximately August 20 (i.e., Day of Year 232). These results suggest that starting the season with ample soil water within these deep silt loam profiles can minimize the need for in-season irrigation.

Acknowledgments

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Table 1. Irrigation amounts, grain sorghum yields, total crop water use, water productivity (WP) and available soil water (ASW) at planting and harvest in a sprinkler-irrigated study

Irrigation treatment	Irrigation	Yield	Water use	WP	ASW at planting	ASW at harvest
	inches	bu/a	inches	lb/acre-in.	----- inches/8 ft -----	
2018 crop year						
No irrigation	0.00	144.3	20.14	402	14.91	6.54
100% ET	8.00	153.7	24.37	354	16.07	11.48
100% ET to 6 in.	6.00	149.0	23.12	361	15.49	10.14
100% ET to 3 in.	3.00	152.3	21.68	394	15.45	8.54
Mean	4.25	149.8	22.33	378	15.48	9.17
2019 crop year						
No irrigation	1.00	144.2	19.69	410	16.89	12.18
100% ET	6.00	144.1	24.26	337	16.43	12.15
100% ET to 6 in.	6.00	147.8	23.18	358	16.68	13.49
100% ET to 3 in.	4.00	148.4	21.75	382	16.83	13.06
Mean	4.25	146.1	22.22	372	16.71	12.72
2020 crop year						
No irrigation	0.00	133.3	13.05	573	12.33	5.40
100% ET	8.00	124.5	16.54	423	13.76	11.35
100% ET to 6 in.	6.00	129.7	16.03	456	13.47	9.57
100% ET to 3 in.	3.00	129.8	14.96	487	13.76	7.93
Mean	4.25	129.3	15.15	485	13.33	8.56
2021 crop year						
No irrigation	0.00	131.2	15.46	476	16.16	6.18
100% ET	11.00	148.9	20.94	398	16.36	11.90
100% ET to 6 in.	6.00	152.4	18.33	466	16.35	9.50
100% ET to 3 in.	3.00	151.3	17.20	493	16.55	7.83
Mean	5.00	145.9	17.98	458	16.35	8.85
All four years						
No irrigation	0.25	138.3	17.09	465	15.07	7.57
100% ET	8.25	142.8	21.53	378	15.65	11.72
100% ET to 6 in.	6.00	144.7	20.16	410	15.50	10.67
100% ET to 3 in.	3.25	145.4	18.90	439	15.65	9.34
Mean	4.44	142.8	19.42	423	15.47	9.83

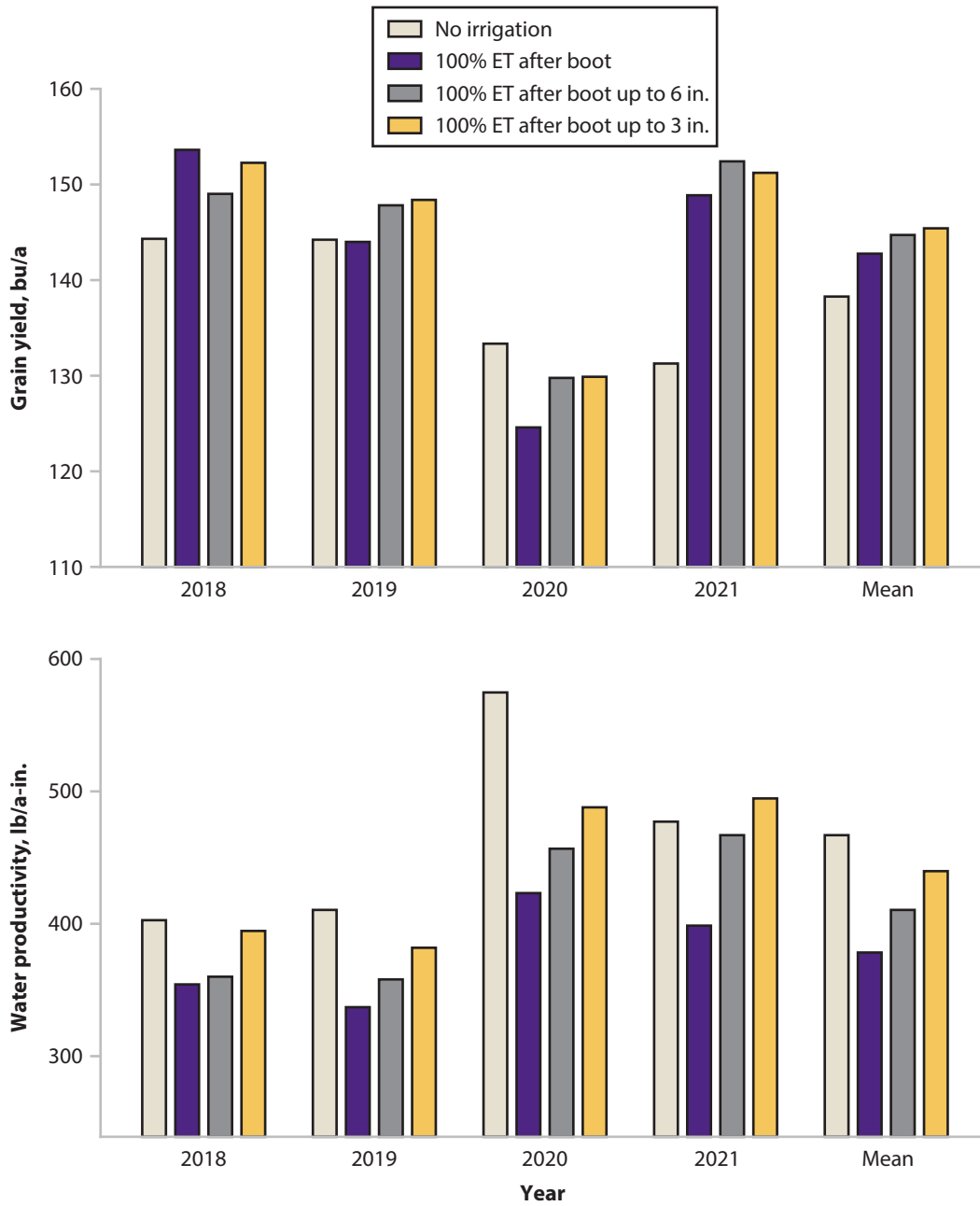


Figure 1. Grain sorghum yields (upper panel) and water productivity (lower panel) for 2018 through 2021 in a sprinkler-irrigated study examining four different water management strategies, Kansas State University Northwest Research-Extension Center, Colby, KS.

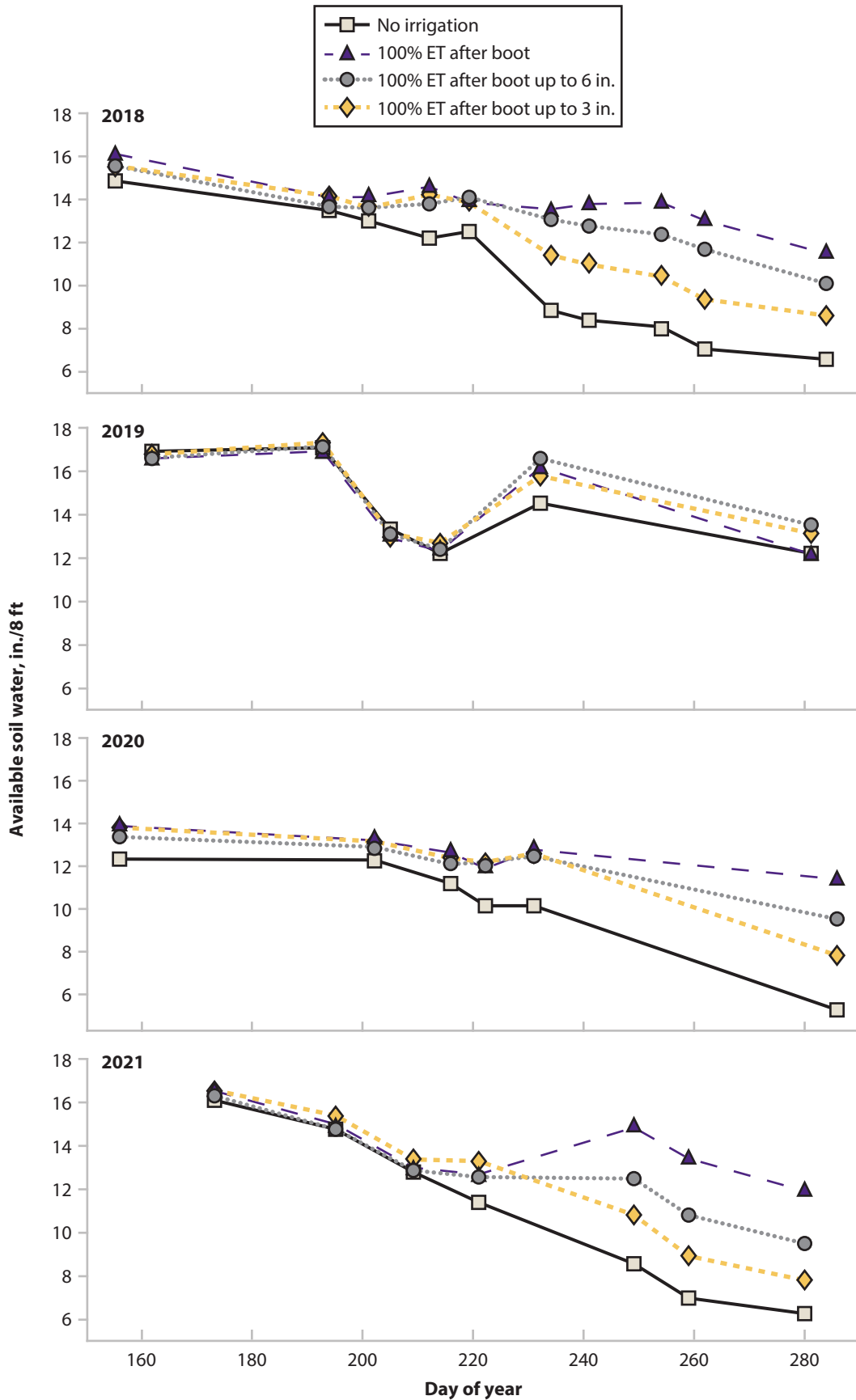


Figure 2. Seasonal progression of available soil water for four crop years as affected by water management strategy in a sprinkler-irrigated grain sorghum study, Kansas State University Northwest Research-Extension Center, Colby, KS.