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Working with Less Water for Corn Production

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Cover Page Footnote

The project was funded in part by the Kansas Corn Commission.

K-STATE Research and Extension

2021 SWREC AGRICULTURAL RESEARCH

Working with Less Water for Corn Production

A. Schlegel, F. Lamm, and D. O'Brien

Summary

Research was conducted at Colby and Tribune, KS, from 2018–2020 to evaluate irrigation strategies, hybrid maturity, and seeding rate on corn production. Irrigation strategies were a combination of irrigation frequency/timing (weekly or bi-weekly) applied pre- and post-silking, and irrigation amounts (1 and 1.5 inch/week). Hybrid maturities were 108- and 111-day hybrids planted at 25,000 and 30,000 seeds/a. Average irrigation amounts ranged from 7.33 to 12.50 in. at Colby and 8.41 to 13.44 in. at Tribune. At Colby, average corn yields were not affected by irrigation strategies or seeding rate but were 8 bu/a greater with the 108-day hybrid. At Tribune, average corn yields were greater with weekly post-silking irrigation and with the higher seeding rate but not affected by hybrid maturity. The water limitations in this study are relatively severe and these results might not replicate under less stressful irrigation regimes.

Introduction

As producers move to deficit irrigation strategies, evapotranspiration-based irrigation scheduling can be useful in alerting the producer to soil water conditions and can help the producer decide when to allocate their limited water supply. Institutional constraints (Local Enhanced Management Area (LEMAs)) will require producers to adjust and adapt their irrigation management. The objective of this study was to determine corn grain yield and yield component response, water use, and crop water use efficiency as affected by irrigation amounts and timing (4 treatments), 2 corn hybrids, and 2 plant populations.

Procedures

Research was initiated in 2018 at the Kansas State University Southwest Research-Extension Center near Tribune and at the Northwest Research-Extension Center near Colby on deep silt loam soils. For the purposes of this study the irrigation season was separated into the pre-silking and post-silking periods. The specific goal was not to mimic the actual pumping capacities of the wells but to manage total amount of applied irrigation that may be restricted by institutional constraints (e.g., LEMAs, water conservation areas). Overall, two well capacities were simulated for the peak irrigation need during any period.

Higher capacity well, equivalent to 505 gpm/125 acres

1. Apply as needed: 1.5 inches of irrigation weekly during the pre-silking period, and 1.5 inches every two weeks for the post-silking period.

2. Apply as needed: 1.5 inches of irrigation every two weeks during the pre-silking period, and 1.5 inches weekly for the post-silking period.

Lower capacity well, equivalent to 337 gpm/125 acres

3. Apply as needed: 1.0 inch of irrigation weekly during the pre-silking period, and 1.0 inch every two weeks for the post-silking period.
4. Apply as needed: 1.0 inch of irrigation every two weeks during the pre-silking period, and 1.0 inches weekly for the post-silking period.

The experimental design used irrigation treatment as the whole plot, with hybrid (108- and 111-day hybrids) and plant density (25,000 and 30,000 seeds/a) as subplots with 4 replications. Soil water was measured in the complete root zone with a neutron probe to help quantify periods of water stress and to determine crop water use. Weather data were measured using the automated Kansas Mesonet weather stations located on the research centers (https://mesonet.k-state.edu/). Corn grain yield was determined by harvesting a representative sample after physiological maturity, which enabled the determination of all corn yield components (grain yield, plant density, ears/plant, kernels/ear, and kernel mass).

Results and Discussion

Annual and average (2018–2020) corn yields for Colby are shown in Tables 1 and 3. Averaged across all treatments, corn yields were greater in 2019 (228 bu/a) than in 2018 (207 bu/a) and 2020 (201 bu/a). Average seasonal irrigation amounts were 10.00, 12.50, 7.33, and 9.33 inches for treatments 1, 2, 3, and 4, respectively. Averaged across years, there were no yield differences among irrigation treatments or plant population (Table 3). However, the 108-day hybrid yielded 8 bu/a more than the 111-day hybrid (216 vs. 208 bu/a) primarily due to increased number of kernels/ear. The number of kernels/ear decreased with increased seeding rate, but was compensated for by the greater plant density. Water use increased with increases in irrigation amounts while water use efficiency tended to decrease.

At Tribune, corn yields (averaged across all treatments) were greater in 2018 (213 bu/a) than 2019 (194 bu/a) and 2020 (202 bu/a) (Table 2). Average seasonal irrigation amounts were 11.81, 10.65, 9.02, and 9.71 inches for treatments 1, 2, 3, and 4, respectively. Averaged across years, the irrigation treatments with weekly irrigation post-silking (treatment 2 at 211 bu/a and treatment 4 at 207 bu/a) produced the highest yields, primarily due to increased kernel mass (Table 4). Hybrid maturity had no effect on grain yield, while increasing the seeding rate from 25,000 to 30,000 seeds/a increased yields by 6 bu/a even though there was a decrease in the number of kernels/ear. Similar to Colby, water use increased with increased irrigation amounts but there were no significant differences in water use efficiency.

In this study with limited water allocations, there tended to be an advantage to shifting water to the post-silking period with these hybrids at these seeding rates. In general, the higher seeding rate (30,000/a) produced similar or greater yields. Averaged across the two locations, the shorter season hybrid obtained greater yields. The water limitations in this study are relatively severe and these results might not repeat under less stressful irrigation regimes.

Acknowledgment

The project was funded in part by the Kansas Corn Commission.

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Table 1. Grain yields by across years, Colby, KS, 2018–2020

Trt	in./wk	Frequency	Hybrid	Seed rate	Year			Average
					2018	2019	2020	
		Pre - Post		1000/a	bu/a			
1	1.5	wk - 2 wk	P0801	25	210	244	220	224
				30	232	250	209	230
			P1197	25	206	220	199	208
				30	230	210	196	212
2	1.5	2 wk - wk	P0801	25	196	234	214	215
				30	197	237	196	210
			P1197	25	211	215	201	209
				30	190	228	210	209
3	1.0	wk - 2 wk	P0801	25	192	218	183	198
				30	230	219	189	213
			P1197	25	178	239	218	212
				30	210	223	199	211
4	1.0	2 wk - wk	P0801	25	230	226	188	214
				30	210	244	220	224
			P1197	25	232	250	209	230
				30	206	220	199	208

Table 2. Grain yields by across years, Tribune, KS, 2018–2020

Trt	in./wk	Frequency	Hybrid	Seed rate	Year			Average
					2018	2019	2020	
		Pre - Post		1000/a	---------- bu/a ----------			
1	1.5	wk - 2 wk	P0801	25	204	189	206	199
				30	209	208	206	208
			P1197	25	203	193	203	200
				30	216	180	208	201
2	1.5	2 wk - wk	P0801	25	210	205	190	202
				30	225	211	207	214
			P1197	25	225	216	196	212
				30	223	220	206	216
3	1.0	wk - 2 wk	P0801	25	198	187	188	191
				30	196	198	204	199
			P1197	25	220	165	188	191
				30	197	158	196	183
4	1.0	2 wk - wk	P0801	25	218	185	203	202
				30	213	205	206	208
			P1197	25	220	187	209	205
				30	231	197	216	215

Table 3. Irrigation frequency, hybrid, and population on corn yield and yield components, Colby, KS, 2018–2020

Trt	in./wk	Frequency	Hybrid	Seed rate	Yield	WUE*	Plant pop.	Ear/ plant	1000 seed	Kernels	Water use
		Pre - Post		1000/a	bu/a	lb/a-in.	1000/a		oz	No./ear	in.
1	1.5	wk - 2 wk	P0801	25	224	501	26.1	0.96	11.66	692	25.10
				30	230	520	29.8	0.98	11.53	615	24.82
			P1197	25	208	476	26.4	0.98	12.29	593	24.58
				30	212	477	29.5	0.99	11.88	550	24.95
2	1.5	2 wk - wk	P0801	25	214	472	25.6	0.99	11.45	671	25.37
				30	215	469	29.3	0.98	11.25	598	25.67
			P1197	25	210	449	26.5	0.97	11.98	618	26.21
				30	209	455	29.5	0.98	12.22	535	25.80
3	1.0	wk - 2 wk	P0801	25	209	506	25.8	0.97	11.47	667	23.15
				30	211	506	29.1	0.97	11.36	596	23.29
			P1197	25	198	487	26.1	0.97	12.12	585	22.79
				30	213	510	29.5	0.99	11.78	557	23.34
4	1.0	2 wk - wk	P0801	25	212	503	25.8	1.00	11.56	647	23.72
				30	211	487	29.3	0.98	11.29	588	24.33
			P1197	25	203	471	26.4	0.97	12.23	583	24.09
				30	214	496	29.0	0.97	11.93	575	24.23
MEANS											
1					219	494 a	28.0	0.98	11.84	613	24.86 b
2					212	461 b	27.7	0.98	11.72	606	25.76 a
3					208	502 a	27.6	0.97	11.68	601	23.14 d
4					210	489 a	27.6	0.98	11.76	598	24.09 c
$LSD_{0.05}$					NS	19	NS	NS	NS	NS	0.47
			P0801		216 a	495	27.6	0.98	11.45 b	634 a	24.43
			P1197		208 b	478	27.9	0.97	12.05 a	575 b	24.50
			$LSD_{0.05}$		6	NS	NS	NS	0.16	15	NS
				25	210	483	26.1 b	0.98	11.85	632 a	24.37
				30	214	490	29.4 a	0.98	11.66	577 b	24.56
				$LSD_{0.05}$	NS	NS	0.3	NS	NS	15	NS

Note: WUE = water use efficiency. July 23 was the average silking date.
Average irrigation levels by treatment were 1 = 10.00 in., 2 = 12.50 in., 3 = 7.33 in., 4 = 9.33 in.
Irrigation Treatment
1 = 1.5 in. weekly pre-silk; every 2 weeks post-silk.
2 = 1.5 in. every 2 weeks pre-silk; weekly post-silk.
3 = 1.0 in. weekly pre-silk; every 2 weeks post-silk.
4 = 1.0 in. every 2 weeks pre-silk; weekly post-silk.
Means within a column with the same letter are not statistically different at $P = 0.05$.

Table 4. Irrigation frequency, hybrid, and population on corn yield and yield components, Tribune, KS, 2018–2020

Trt	in./wk	Frequency	Hybrid	Seed rate	Yield	WUE*	Plant pop.	Ear/ plant	1000 seed	Kernels	Water use
		Pre - Post		1000/a	bu/a	lb/a-in.	1000/a		oz	no./ear	in.
1	1.5	wk - 2 wk	P0801	25	199	411	22.5	1.01	12.27	640	27.21
				30	208	431	26.9	0.99	11.95	586	27.06
			P1197	25	200	410	23.6	1.02	12.92	575	27.38
				30	201	408	28.4	1.00	12.37	516	27.79
2	1.5	2 wk - wk	P0801	25	202	413	22.7	1.00	12.36	641	27.53
				30	214	430	26.9	1.00	12.03	596	28.09
			P1197	25	212	423	23.7	1.04	12.91	596	28.23
				30	216	426	28.3	1.02	12.67	531	28.57
3	1.0	wk - 2 wk	P0801	25	191	431	22.8	1.00	11.78	638	24.97
				30	199	454	27.4	0.98	11.68	570	24.62
			P1197	25	191	426	23.6	1.03	12.42	568	25.22
				30	183	407	28.4	0.99	11.87	489	25.37
4	1.0	2 wk - wk	P0801	25	202	448	22.9	1.00	12.14	651	25.28
				30	208	448	27.5	0.99	11.86	578	26.02
			P1197	25	205	443	23.9	1.05	12.91	570	26.24
				30	215	465	28.6	1.01	12.30	545	25.91
MEANS											
1					202 b	415	25.4	1.01	12.38 a	579	27.36 ab
2					211 a	423	25.4	1.02	12.49 a	591	28.11 a
3					191 c	430	25.6	1.00	11.94 b	566	25.04 c
4					207 ab	451	25.7	1.01	12.30 a	586	25.86 bc
$LSD_{0.05}$					9	26	0.5	0.01	0.26	22	1.64
			P0801		203	433	25.0 b	1.00 b	12.01 b	613 a	26.35 b
			P1197		203	426	26.1 a	1.02 a	12.55 a	548 b	26.84 a
			$LSD_{0.05}$		4	10	0.3	0.01	0.12	11	0.32
				25	200 b	425	23.2 b	1.02 a	12.46 a	610 a	26.51
				30	206 a	434	27.8 a	1.00 b	12.09 b	551 b	26.68
				$LSD_{0.05}$	4	10	0.3	0.01	0.12	11	0.32

Note: WUE = water use efficiency. July 21 was the average silking date.
Average irrigation levels by treatment were 1 = 11.61 in., 2 = 13.44 in., 3 = 8.41 in., 4 = 9.79 in.
Irrigation Treatment
1 = 1.5 in. weekly pre-silk; every 2 weeks post-silk.
2 = 1.5 in. every 2 weeks pre-silk; weekly post-silk.
3 = 1.0 in. weekly pre-silk; every 2 weeks post-silk.
4 = 1.0 in. every 2 weeks pre-silk; weekly post-silk.
Means within a column with the same letter are not statistically different at $P = 0.05$.