

Kansas Agricultural Experiment Station Research Reports

Volume 7
Issue 7 *Southwest Research-Extension Reports*

Article 7

2021

Working with Less Water for Corn Production

A. Schlegel

Kansas State University, schlegel@ksu.edu

F. Lamm

Kansas State University, flamm@k-state.edu

D. O'Brien

Kansas State University, dobrien@ksu.edu

Follow this and additional works at: <https://newprairiepress.org/kaesrr>



Part of the [Agronomy and Crop Sciences Commons](#)

Recommended Citation

Schlegel, A.; Lamm, F.; and O'Brien, D. (2021) "Working with Less Water for Corn Production," *Kansas Agricultural Experiment Station Research Reports*: Vol. 7: Iss. 7. <https://doi.org/10.4148/2378-5977.8106>

This report is brought to you for free and open access by New Prairie Press. It has been accepted for inclusion in Kansas Agricultural Experiment Station Research Reports by an authorized administrator of New Prairie Press. Copyright 2021 Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Contents of this publication may be freely reproduced for educational purposes. All other rights reserved. Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. K-State Research and Extension is an equal opportunity provider and employer.



Working with Less Water for Corn Production

Abstract

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.

Keywords

deficit irrigation, water productivity, irrigation scheduling

Creative Commons License



This work is licensed under a [Creative Commons Attribution 4.0 License](https://creativecommons.org/licenses/by/4.0/).

Cover Page Footnote

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

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.

Brand names appearing in this publication are for product identification purposes only. No endorsement is intended, nor is criticism implied of similar products not mentioned. Persons using such products assume responsibility for their use in accordance with current label directions of the manufacturer.

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 $P = 0.05$.