

Kansas Agricultural Experiment Station Research Reports

Volume 8
Issue 8 *Western Kansas Agricultural Research*

Article 6

2022

Efficient Irrigation Technologies for Corn—A Comparison

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Recommended Citation

Lamm, F. R. and O'Brien, D. M. (2022) "Efficient Irrigation Technologies for Corn—A Comparison," *Kansas Agricultural Experiment Station Research Reports*: Vol. 8: Iss. 8. <https://doi.org/10.4148/2378-5977.8334>

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Efficient Irrigation Technologies for Corn—A Comparison

Abstract

This study was conducted from 2016–2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS. Two irrigation systems, subsurface drip irrigation (SDI) and mobile drip irrigation (MDI) were compared for two irrigation capacities equivalent to 0.25 in./day and 0.167 in./day. Irrigation amounts were similar for the two systems when comparing the equivalent capacities, averaging 13.3 and 11.4 inches per acre. When averaged over the six-year period, SDI and MDI corn grain yields were 242.5 and 239.2 bu/a, respectively. Although irrigation amounts for the two systems at an equivalent irrigation capacity were similar, total crop water use was less for SDI than for MDI. There was greater soil water depletion with MDI than with SDI. Crop water productivity was greater with SDI than with MDI. Both of these advanced irrigation systems are acceptable for corn production in the Central Great Plains.

Keywords

Irrigation, Irrigation efficiency, Irrigation technologies, Subsurface drip irrigation, mobile drip irrigation

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Cover Page Footnote

Sadly, Freddie Lamm passed away during the process of publishing this report, May 26, 2022. This research project received support from the Kansas Corn Commission.

Efficient Irrigation Technologies for Corn—A Comparison

F.R. Lamm¹ and D.M. O'Brien

Summary

This study was conducted from 2016–2021 at the Kansas State University Northwest Research-Extension Center near Colby, KS. Two irrigation systems, subsurface drip irrigation (SDI) and mobile drip irrigation (MDI) were compared for two irrigation capacities equivalent to 0.25 in./day and 0.167 in./day. Irrigation amounts were similar for the two systems when comparing the equivalent capacities, averaging 13.3 and 11.4 inches per acre. When averaged over the six-year period, SDI and MDI corn grain yields were 242.5 and 239.2 bu/a, respectively. Although irrigation amounts for the two systems at an equivalent irrigation capacity were similar, total crop water use was less for SDI than for MDI. There was greater soil water depletion with MDI than with SDI. Crop water productivity was greater with SDI than with MDI. Both of these advanced irrigation systems are acceptable for corn production in the Central Great Plains.

Introduction

Western Kansas producers are under pressure from both hydrologic and institutional constraints to reduce withdrawals from the declining Ogallala aquifer. By far, the predominant irrigation system in western Kansas is the center pivot sprinkler irrigation system, but some subsurface drip irrigation (SDI) systems are being installed and operated for row crop production. A major disadvantage of SDI systems is their high initial cost but there are some scenarios where the economics can compare favorably with center pivot sprinklers (Lamm et al., 2020). A newer technology attempting to obtain some of the benefits of SDI is mobile drip irrigation (MDI), where pressure-compensating driplines are installed on the center pivot irrigation system instead of the conventional irrigation sprinkler system package. The cost of MDI is considerably less than for SDI. The MDI driplines are pressure compensating which means that the emitter discharge (flowrate) is constant independent of length or distance from the inlet within operational parameters. This pressure-compensating feature allows for MDI to be simulated within an existing SDI research field for cropping comparisons of the two systems. From 2016 to 2021, a study was conducted at the K-State Northwest Research-Extension Center at Colby, KS, to compare SDI and MDI for corn production under two different irrigation capacities equivalent to 0.025 or 0.167 in./day.

Experimental Procedures

Corn was planted annually in late April or early May at a seeding rate of approximately 35,000 seeds/a. Initial fertilizer amounts of 125 lb N/a and 45 lb P₂O₅/a were preplant broadcast applied. Later at the first irrigation event, an additional 100 lb N/a

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was applied through the irrigation system (i.e., both the MDI and SDI system plots). Typical pesticide control procedures were used to minimize pests. Soil water was monitored periodically to a 8-ft depth in 1-ft increments with neutron moderation techniques. Corn 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 grain yield/crop water use. Mobile drip irrigation and SDI typically have some operational differences. Mobile drip irrigation typically applies a fixed amount of water, and the irrigation capacity determines the frequency of events. This fixed amount is usually in the range of 0.75 to 1.25 in. and this helps to minimize water evaporation losses from the soil. Subsurface drip irrigation, being subsurface, is less subject to soil water evaporation, so it can apply variable amounts of water on a shorter fixed frequency of events. In this study, irrigation was scheduled with a weather-based water budget only as needed. Thus irrigation treatments shown below were limited to the indicated criteria:

1. MDI with irrigation limited to 1 in./4 days
2. MDI with irrigation limited to 1 in./6 days
3. SDI with irrigation limited to 0.25 in./day
4. SDI with irrigation limited to 0.17 in./day

Results and Discussion

Growing conditions were favorable for good corn production in all 6 years (2016 to 2021). The greater irrigation capacity (treatments 1 and 3) averaged receiving 13.3 in. and the lesser irrigation capacity (treatments 2 and 4) averaged receiving 11.4 in. Irrigation requirements were greatest in 2021 (16 in. for greatest irrigation capacity) and least in 2019 (\approx 11.6 in. for greatest irrigation capacity). There were little to no differences in applied irrigation between MDI and SDI among years.

In five of the six years, corn grain yields were greater with SDI than for MDI (Figure 1). However in 2021, MDI yields were 16 to 25 bu/a greater than SDI for equivalent irrigation capacities. When averaged over both capacities and the entire six years, SDI had greater yields by only 3.3 bu/a, so both systems provided acceptable yields.

Although irrigation amounts were similar between equivalent irrigation capacities for the two irrigation systems, crop water use was always less for the SDI system (Figure 2), probably reflecting a slight reduction in evaporative losses when irrigation is applied subsurface.

Anecdotally, it was observed that crop senescence was slightly advanced in the MDI plots compared to the SDI plots in every year, but it was apparently never too early or too severe to greatly affect grain yield. Similarly, available soil water at harvest was less for the MDI plots compared to the SDI plots in every year (Figure 3).

Similar to corn grain yield, crop water productivity was greater for SDI in five of the six years and also for the overall period (Figure 4).

Acknowledgments

This research project received support from the Kansas Corn Commission.

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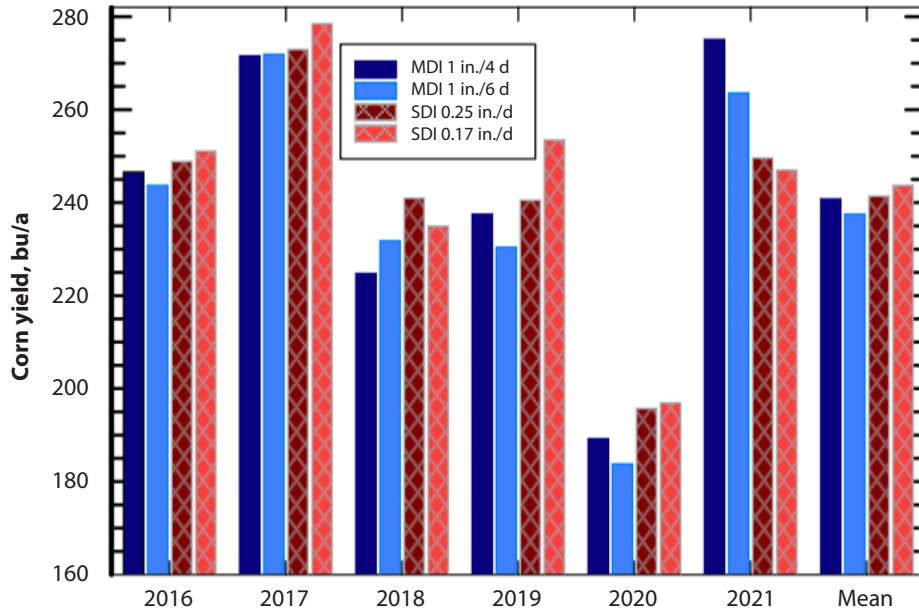


Figure 1. Corn grain yields (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

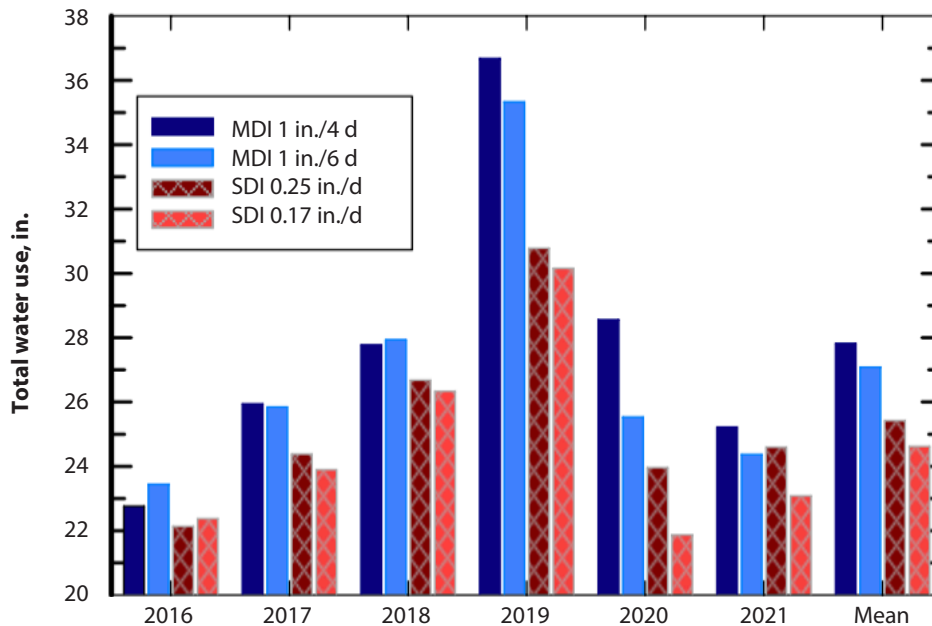


Figure 2. Crop water use for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

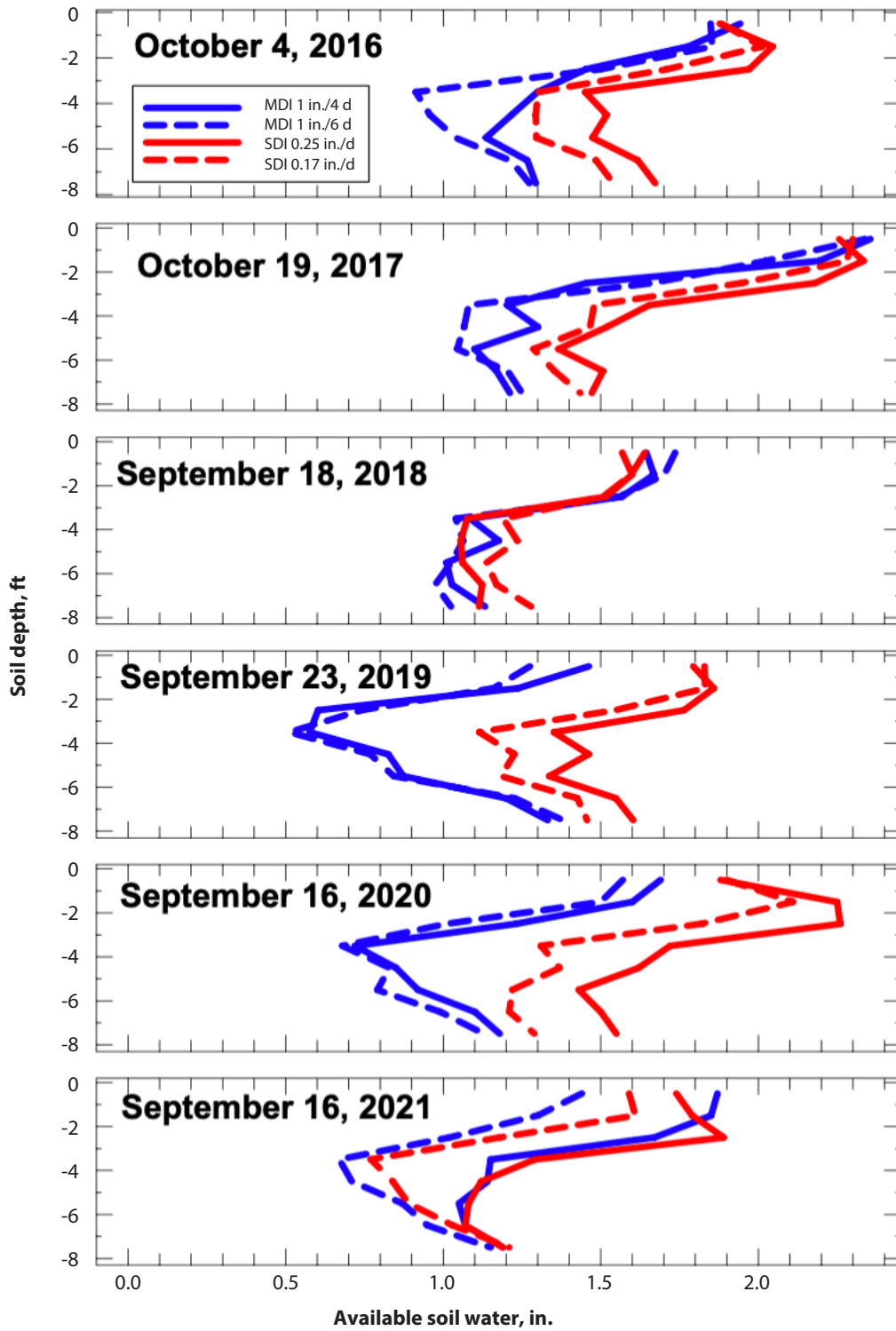


Figure 3. Available soil water within the 8-ft profiles for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.

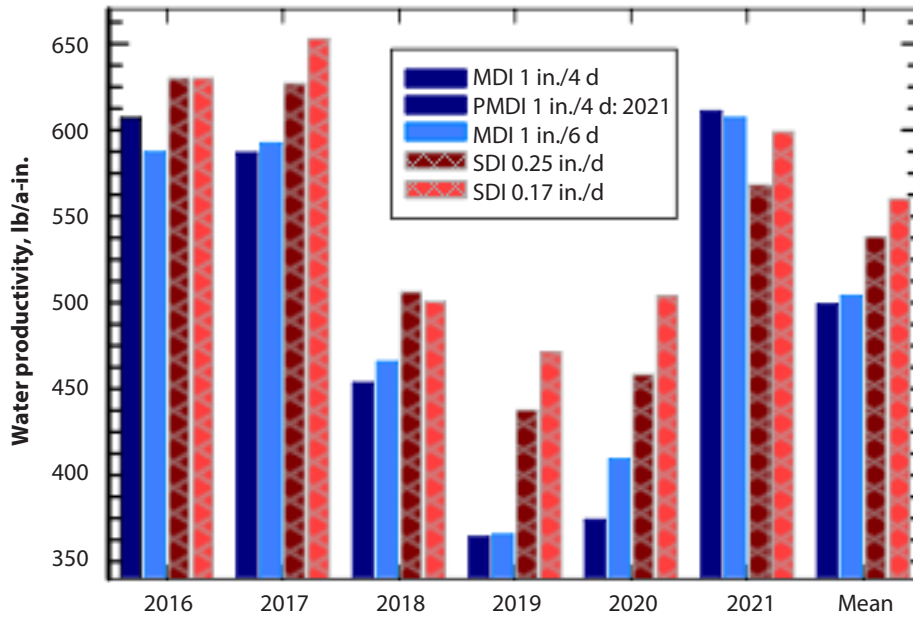


Figure 4. Crop water productivity for corn (2016–2021) for mobile drip irrigation (MDI) and subsurface drip irrigation (SDI) at two equivalent irrigation capacities, Colby, KS.