Comparing Mobile Drip Irrigation to Low Elevation Spray Application in Corn

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Abstract. *Diminishing well capacities coupled with the desire to extend the usable life of the Ogallala aquifer have stimulated the quest for efficient irrigation application technologies. Mobile Drip Irrigation (MDI) which integrates drip line onto a center pivot or lateral move system has attracted attention lately. By applying water along crop rows, it hypothesized that MDI could eliminate water losses due to spray droplet evaporation, wind drift, and reduce soil evaporation due to reduced surface wetting. A study was conducted to compare grain yield, above ground biomass, and water productivity of MDI and LESA at two irrigation capacities 2.3 and 4.6 gpm/ac. The experimental design was arranged in a randomized complete block design with four replications. Preliminary results indicate grain yield was not significantly different between MDI and LESA due to the above normal rainfall received during the 2015 growing season.*

Introduction

Diminishing well capacities coupled with the desire to extend the usable life of the Ogallala aquifer have stimulated the quest for efficient irrigation application technologies. Mobile Drip Irrigation (MDI), which integrates driplines onto a mechanical irrigation system such as a center pivot, has attracted attention lately. By applying water along crop rows, it is hypothesized that MDI could eliminate water losses due to spray droplet evaporation, water evaporation from wetted canopy, and wind drift. MDI also may reduce soil evaporation due to limited surface wetting especially before canopy closure.

The idea of replacing center pivot sprinkler nozzles with driplines is not new (Olson and Rogers, 2007; Rawlins et al., 1974 and Phene et al., 1981). However, what is new is the advancement in precision positioning of the drip line and pressure compensated emitter technology. Such emitters eliminate the need for pressure regulators since they maintain constant flow over wide pressure range as long as the minimum threshold pressure is exceeded. Another advantage of MDI is that in areas where this technology could prove very useful, such as western Kansas, many producers already own center pivots; therefore the transition from sprinklers to MDI would be relatively easy.

To quantify the benefits of MDI, a study was conducted to compare grain yield, above ground biomass, and water productivity of MDI and LESA at two irrigation capacities 2.3 and 4.6 gpm/ac.

Procedures

Experimental Site

The study was conducted at the Kansas State University Southwest Research-Extension Center (38º01’20.87” N, 100º49’26.95’’ W, elevation of 2,910 feet above mean sea level) near Garden City, Kansas. The soil at the study site is a deep, well-drained Ulysses silt loam. The climate of the study area is semi-arid, and average annual rainfall is 18 inches. Two independent studies were conducted to compare MDI and in-canopy spray nozzles (LESA). Study 1 compared the two application technologies at high well capacity (600 gpm) and Study 2 compared the technologies at low well capacity (300 gpm). The two well capacities were intended to mimic a range of pumping capacities experienced by producers in southwest Kansas. The experimental design in each study was a randomized complete block with four replications (each span 135 feet long was a replication having MDI and in-canopy spray nozzles) as shown in Figure. 1.

Figure 1. Drip irrigation and spray nozzles in each span of four span 560 feet center pivot at the Kansas State University, Southwest Research and Extension Center near Garden City Kansas.

Agronomic Management

The experiment was conducted in a field that was previously under fallow. The corn hybrid planted in 2015 was DKC 61-89 GENVT2P, with a relative maturity of 111 days. Planting was done on May 18, 2015 at a seeding rate of 32,000 seeds per acre using a no-till planter, planting depth was 2 inches. Nitrogen fertilizer was applied preplant at a rate of 300 pounds of N per acre as urea 46-0-0. Weed control involved application of 3 qt/a of Lumax EZ (S-metolachlor, Atrazine, Mesotrione) and 2 oz/a of Sharpen (Saflufenacial) as pre-emergence herbicide and 32 oz/a of Mad Dog Plus (Glyphosate) and Prowl H2O (Pendimethalin) as post emergence herbicides. Harvesting was done by hand by taking two 40 feet corn rows in the center of each plot at physiological maturity. A detailed description of agronomic management is reported in Kisekka et al. (2016).

Irrigation Management

Irrigation was applied using a center pivot sprinkler system (Model: Valley 8000 Polyline, 4 Tower 560 feet, Valmont Industries, Inc., Valley, Nebraska). A 130 micron disc filter with a flow rating of 200 gpm was installed at the pump station also equipped with a Variable Frequency Drive (VFD). Irrigation treatments for the two studies are listed below:

Study 1: 600 gpm well capacity

1. MDI 4.6 gal/a irrigation capacity (1 inch every 4 days)
2. In-canopy spray nozzles and 4.6 gal/a irrigation capacity (1 inch every 4 days)

Study 2: 300 gpm well capacity

1. MDI and 2.3 gal/a irrigation capacity (1 inch every 8 days)
2. In-canopy spray nozzles and 2.3 gal/acre irrigation capacity (1 inch every 8 days)

Irrigation was triggered whenever available soil water reached 60% in the top 4.0 feet of the soil profile, but irrigation frequency was limited by irrigation capacity. Soil water measurements were taken weekly using a neutron probe (CPN 503DR, CPN International, Concord, California) at 1-foot depth increments from 1 to 8 feet deep. Each irrigation event applied 1.0 inch for all treatments scheduled to be irrigated on a given day. Nozzle flow rate was confirmed using the Spot-on device.

Results and Discussion

Rainfall

Rainfall during the 2015 growing season from May 1 to October 31 exceeded the long-term average in the same period from 1950 to 2013 as shown in Figure 2. The 2015 summer growing season rainfall exceeded the long-term average by 4.2 inches. Above normal rainfall in May of 2015 ensured sufficient soil water at corn planting. Also, above normal rainfall at tasselling in July and during grain fill in August contributed substantially to crop water needs.

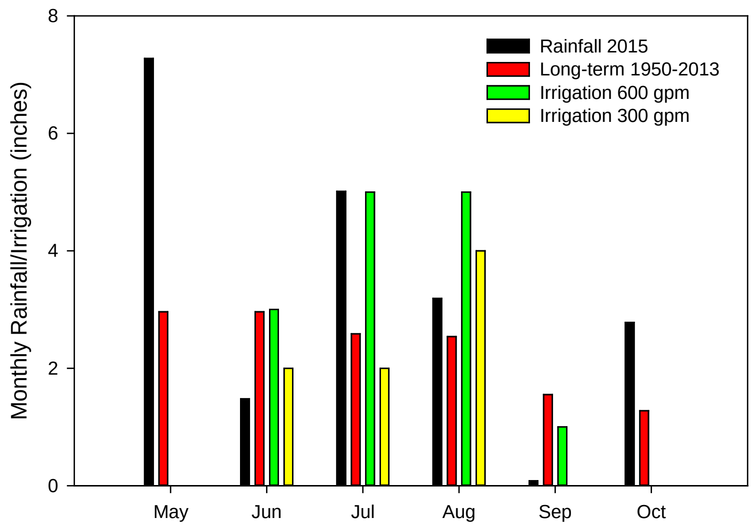

Figure 2. Growing season (May to October) rainfall for 2015 and long-term average, monthly irrigation applications for the 300 and 600 gpm studies at the Kansas State University Southwest Research-Extension Center, near Garden City, Kansas**.**

Yield
The effect of irrigation application method (MDI versus in-canopy spray nozzles) on yield at high (or 4.6 gpm/a) and low (2.3 gpm/a) well capacities was not statistically significant at the 5% level. The p-values were p = 0.37 and p = 0.67 for Study 1 and 2, respectively (Kisekka et al., 2016). In Study 1 (4.6 gpm/a), MDI and in-canopy spray nozzles produced yields of 247 and 255 bu/a, respectively. Under Study 2 (2.3 gpm/a) MDI and in-canopy spray nozzles produced yields of 243 and 220 bu/a, respectively. The lack of significant differences in yield could be attributed to the high rainfall received during the 2015 growing season (18 inches from May to October).

Crop Water Use
Crop water use under Study 1 was 29.8 and 29.0 inches for MDI and in-canopy spray nozzles respectively (Kisekka et al., 2016). Study 2 crop water use was 22.6 inches and 23.3 inches for MDI and in-canopy spray nozzles, respectively. The differences in seasonal crop water use (ETc) could be attributed to differences in irrigation application amounts between the two studies. Fourteen inches were applied in Study 1 while 8 inches were applied in Study 2. High irrigation amounts under Study 1 probably increased water losses in form of soil water evaporation and deep drainage. The effect of application method on water productivity and irrigation water use efficiency was also not significant at high and low well capacities (Figures 3 and 4). In Study 1, average water productivity of MDI and in-canopy spray nozzles was 8.3 and 8.9 bu/a/in, respectively. In Study 2, average water productivity of MDI and in-canopy spray nozzles was 10.7 and 9.5 bu/a/in, respectively. Irrigation water use efficiency was not significantly different in Studies 1 and 2 (Figure 4).

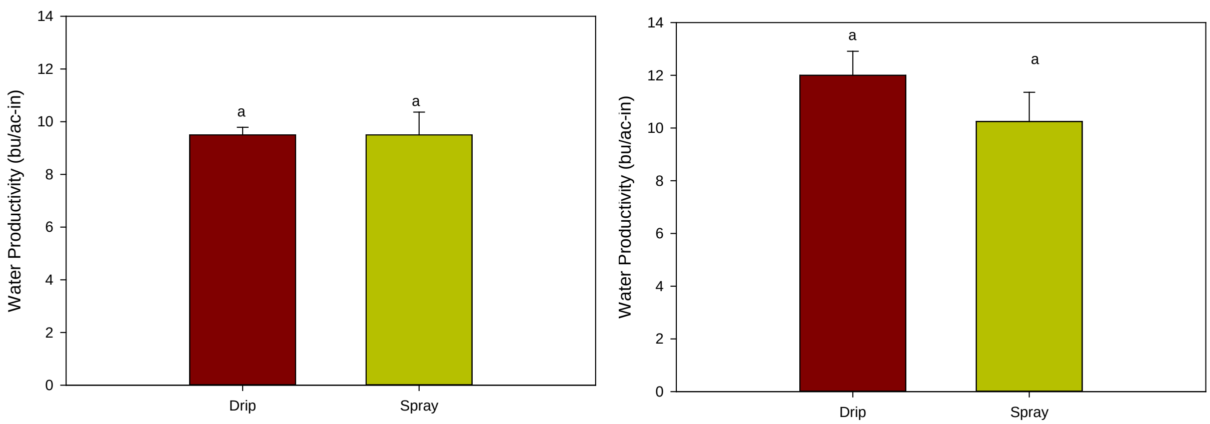

Figure 3. Water productivity of Mobile Drip Irrigation and in-canopy spray nozzles for well capacity of 600 gpm during the 2015 growing season at the Kansas State University SWREC, near Garden City, Kansas (Kisekka et al., 2016).

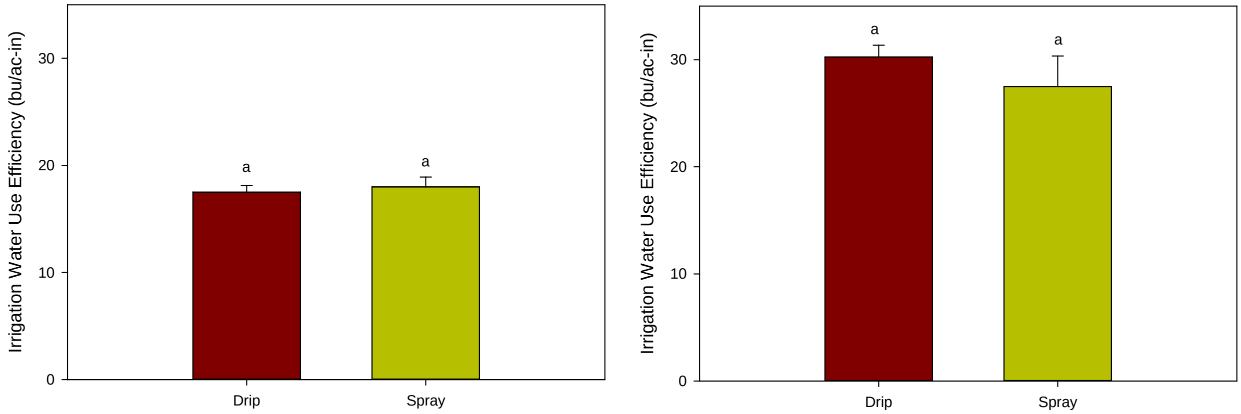

Figure 4. Irrigation water use efficiency of Mobile Drip Irrigation and spray nozzles for well capacity of 300 gpm during the 2015 growing season at the Kansas State University Southwest Research-Extension Center, near Garden City, Kansas (Kisekka et al., 2016).

Conclusion

Mobile Drip Irrigation was evaluated under high and low well capacities in corn. The effect of irrigation application method (MDI versus spray nozzles) on yield at high (600 gpm) and low (300 gpm) well capacities was not significant ($p > 0.05$) in 2015. The effect of application method on water productivity and irrigation water use efficiency was also not significant. The lack of significant differences could be attributed to the above normal rainfall received during the 2015 growing season. Water productivity and irrigation water use efficiency were higher under the 300 gpm study compared to the 600 gpm, implying that water was used more efficiently as the number of irrigation applications decreased. It is worth noting that plots under MDI did not have deep wheel tracks or rutting problems associated with sprinkler nozzles. More research is needed to confirm benefits of MDI.

Acknowledgments

The authors would like to thank Teeter Irrigation, Servi-Tech Inc., K-State Global Food Systems, U.S. Department of Agriculture Ogallala Aquifer Project, and Kansas Water Office for providing funding or material support for this project. The authors would also like to thank Mr. Dennis Tomsicek and Mr. Jaylen Koehn for their help in implementing this project and data collection and processing.

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