Corn Production with Alternative SDI Designs

P. D. Colaizzi, S. R. Evett, T. A. Howell

USDA Agricultural Research Service, Conservation and Production Research Laboratory, Soil and Water Management Research Unit, Bushland, Texas

Introduction

Subsurface drip irrigation (SDI) use is increasing in the Great Plains region of the United States. Drip laterals are commonly installed in alternate furrows (Figure 1) because installing laterals in every bed for low value crops is typically too expensive; however, crop germination can be difficult if preseason precipitation is inadequate. This has been problematic in the Texas Panhandle, where the Pullman clay loam soil tends to crack when relatively dry, and cracks impede movement of the wetting front from the SDI lateral to the seed bed. The wide bed, or twin row design (Figure 2) has been used successfully throughout the world for a wide variety of crops. This design has the same number of SDI laterals and plant rows per unit area as standard beds with laterals in alternate furrows, but the seed bed is much closer to the lateral, motivating the hypothesis that better crop establishment and yield would result.

Crop germination can also be influenced by lateral installation depth. Shallow laterals result in greater near-surface wetted soil areas compared with deeper laterals, which may result in more uniform seed germination (Figure 3). However, shallow laterals carry greater risk to mechanical (e.g., tillage operations) and animal (e.g., rodent) damage, engender greater soil water evaporation losses, and may reduce early season seed bed temperatures.

Procedure

We evaluated crop yield and plant population using the standard bed – alternate furrow and the wide bed – twin row designs at the USDA Agricultural Research Service Conservation and Production Research Laboratory in Bushland, Texas. For each bed design, lateral depths were installed at 6, 9, and 12 inches, and irrigation was applied at rates of 33, 66, and 100% of meeting the full crop water requirement (i.e., crop evapotranspiration), designated as I-33, I-66, and I-100, respectively. The crop was corn (Pioneer 33B54[1]) seeded at 32,000 plants ac^{-1} during the 2006, 2007, and 2008 seasons.

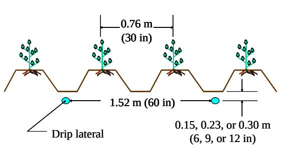

Figure 1. Standard bed design with SDI laterals in alternate furrows.

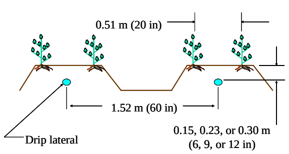

Figure 2. Wide bed – twin row design with SDI laterals centered in each bed.

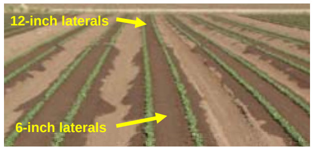

Figure 3. Influence of lateral depth on surface wetting pattern.

Results

Early season precipitation and growing conditions were favorable each year, making evaluation of crop response to alternative SDI designs difficult. Grain yield was most responsive to irrigation rate; nonetheless, some differences in grain yield and yield components were observed for bed design and lateral depths among irrigation rates (Table 1). Overall, the 9-inch lateral depth performed best for the standard bed design (except for the I-33 irrigation rate where grain yield for the 9- and 12-inch lateral depth were nearly equal), whereas the 12-inch lateral depth performed best for the wide bed design. The grain yield differences appeared most related to numerical differences in final plant population and kernel mass (I-66 and I-100 irrigation rates), or the number of kernels per ear (I-33 irrigation rate). The 12-inch lateral depth likely reduced evaporative losses of near-surface soil water, which was advantageous for the wide bed design. However, for the standard bed design, the 12-inch lateral depth resulted in reduced germination (and hence plant population) compared with shallower lateral depths.

Conclusions

A clear advantage in the standard vs. wide bed design could not be determined due to favorable early season precipitation and growing conditions, but also due to lack of statistical power caused by yield variability. The optimal lateral depth appeared to depend on the choice of bed design, where the 9- and 12-inch lateral depths performed best for the standard and wide bed designs, respectively. This was likely due to the relative influence of germination, soil water evaporation, and early season seed bed temperatures. In drier years, the deeper lateral depth for the wide bed design might reduce evaporative losses and improve yields, as seems to be the case here.

Table 1. Crop response to irrigation rate, bed geometry, and lateral depth.

Irrigation Rate	Bed Geometry	Irrigation Applied (inches)	Seasonal water use (inches)	Lateral Depth (inches)	Yield 15.5% wb (bu ac^{-1})	Plant Population (plants ac^{-1})	Kernel mass (g)	Kernels per ear
I-33	Standard	8.0	20.1	6	82.6 a	31,804 a	0.281 ab	247 b
				9	103.5 a	30,544 a	0.285 ab	305 ab
				12	103.7 a	30,004 a	0.275 ab	316 ab
	Wide	7.9	19.8	6	93.2 a	29,330 a	0.274 ab	300 ab
				9	91.9 a	29,734 a	0.266 b	321 ab
				12	111.6 a	29,510 a	0.303 a	335 a
I-66	Standard	14.4	26.2	6	237.0 ab	30,904 a	0.353 a	505 a
				9	246.2 a	31,309 a	0.354 a	513 a
				12	221.3 ab	30,724 a	0.350 a	482 a
	Wide	14.2	26.8	6	219.7 ab	29,240 a	0.342 a	514 a
				9	204.5 b	28,835 a	0.336 a	493 a
				12	233.6 ab	30,634 a	0.346 a	522 a
I-100	Standard	20.0	31.3	6	264.1 a	32,074 a	0.352 a	566 a
				9	266.2 a	32,883 a	0.355 a	541 a
				12	248.1 a	32,119 a	0.346 a	534 a
	Wide	20.3	33.6	6	245.8 a	29,510 a	0.358 a	564 a
				9	244.5 a	29,240 a	0.354 a	575 a
				12	253.3 a	30,859 a	0.358 a	549 a

Acknowledgements

This research was supported by the Ogallala Aquifer Program and USDA-ARS National Program 211, Water Availability and Watershed Management.

[1] Disclaimer

The mention of trade names of commercial products is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.