SUBSURFACE DRIP IRRIGATION RESEARCH FOR CORN

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INTRODUCTION

The Ogallala or High Plains Aquifer is one of the largest freshwater sources of groundwater in the world. Much of the aquifer is used as the water supply for irrigated crop production and is experiencing overdraft due, in part, to irrigation. Additional efforts are needed to develop new and better water management techniques to conserve nonrenewable resources such as the Ogallala Aquifer. Drip irrigation is one technology that can make significant improvements in water management. However, it has traditionally been ignored as an irrigation method for crops such as corn because of its high initial investment cost. Times change and so do the constraints under which irrigators operate. Urban areas are increasingly distressed by high agricultural water use. Economics and water resource constraints may dictate the adoption schedule of this irrigation method, but the methodology needs to be available before the practice is adopted.

Kansas State University has taken the initiative to determine the methodology for successful application of subsurface drip irrigation for corn on the deep silt loam soils of western Kansas.

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This paper will discuss the engineering research efforts at KSU evaluating subsurface drip irrigation for corn. The overall objectives of the research were to conserve water, to protect groundwater quality, and to develop sound methodologies for drip-irrigated corn. The efforts have been broad, including evaluating the water requirement of drip-irrigated corn, the effect of drip irrigation frequency, the uniformity of irrigation for various length driplines, determining the optimum spacing of the driplines and nitrogen management for drip-irrigated corn.

SPACING AND LENGTH OF THE DRIPLINES

Increasing the spacing and/or length of dripline laterals would reduce the investment costs of drip irrigation. Soil type, dripline installation depth, and crop type are major factors which determine the maximum spacing. Hydraulic factors such as dripline size, flow, and land slope are determining factors in length of run.

Two studies have been conducted on the deep, silt-loam soils of western Kansas to determine the optimum dripline spacing (installed at a depth of 16-18 inches) for irrigated corn. The study at Garden City, Kansas has evaluated 4 spacings (30, 60, 90, and 120 inches) with corn planted perpendicular to the dripline lateral. At Colby, 3 spacings (60, 90, and 120 inches) were examined with corn planted parallel to the driplines. Yields were similar between sites even though row orientation was different (Table 1).

Table 1. Corn yields obtained with various dripline spacing treatments under full and reduced irrigation at Garden City and Colby, Kansas, 1989-91.

Spacing Trt.	Irrigation Trt.	Dripline Ratio in relation to 60-inch	Corn Yield (bu/a) Garden City 1989-91	Corn Yield (bu/a) Colby 1990-91
30-inch	Full Irrigation	2.00	230	---
60-inch	Full Irrigation	1.00	218	216
90-inch	Full Irrigation	0.67	208	204
90-inch	Reduced Irrigation (67%)	0.67	---	173
120-inch	Full Irrigation	0.50	194	194
120-inch	Reduced Irrigation (50%)	0.50	---	149

The results, when incorporated into an economic model, showed an advantage for the wider spacings in some years. However, the standard 60-inch spacing was best when averaged over all years for both sites.

Studies conducted at Colby and Garden City, Kansas have indicated that lateral lengths as long as 660 ft are acceptable on slopes up to 0.5% for drip tapes applying 0.25 gpm/100 ft. Calculations of the dripline hydraulics has indicated that a flow variation of approximately 15% exists between the head and the tail of the dripline laterals for the 660-ft driplines. However, corn yields were not appreciably different at different points along the lateral, even in 1991 when the study was deficit irrigated to replace only 75% of water use needs as estimated by a climatic- based ET model that has been used for furrow- and sprinkler-irrigation.

FREQUENCY OF DRIP IRRIGATION

Typically, a smaller volume of soil is wetted with drip irrigation as compared to other types of irrigation and as a result crop rooting may be limited. Crops may benefit from frequent irrigation under this condition. However, in a study conducted at Garden City, Kansas, corn yields were excellent regardless of whether a frequency of 1, 3, 5, or 7 days was used for the drip irrigation events. The results indicate there is little need to perform frequent drip irrigation events for fully-irrigated corn on the deep silt loam soils of western Kansas. There could be an advantage for more frequent events if the corn was managed at a deficit irrigation level or if fertigation was practiced.

WATER REQUIREMENT OF DRIP-IRRIGATED CORN

Studies were conducted at Colby and Garden City, Kansas to determine the water requirement of drip-irrigated corn. Results from both sites were similar. Careful management of subsurface drip irrigation systems reduced net irrigation needs by nearly 25%, while still maintaining top yields of 200 bu/a. Corn yields at Colby were highly linearly related to calculated crop water use, producing 19.6 bu/acre of grain for each inch of water used above a threshold of 12.8 inches (Figure 1). The relationship between corn yields and irrigation is nonlinear primarily because of excess drainage for the heavier irrigation amounts.

The 25% reduction in irrigation needs translates into 35 to 55% savings when compared to sprinkler- and furrow-irrigation systems which typically are operating at 85 and 65% efficiency. Subsurface, drip irrigation is one technology that can make significant improvements in water use efficiency through better management of the water balance components.

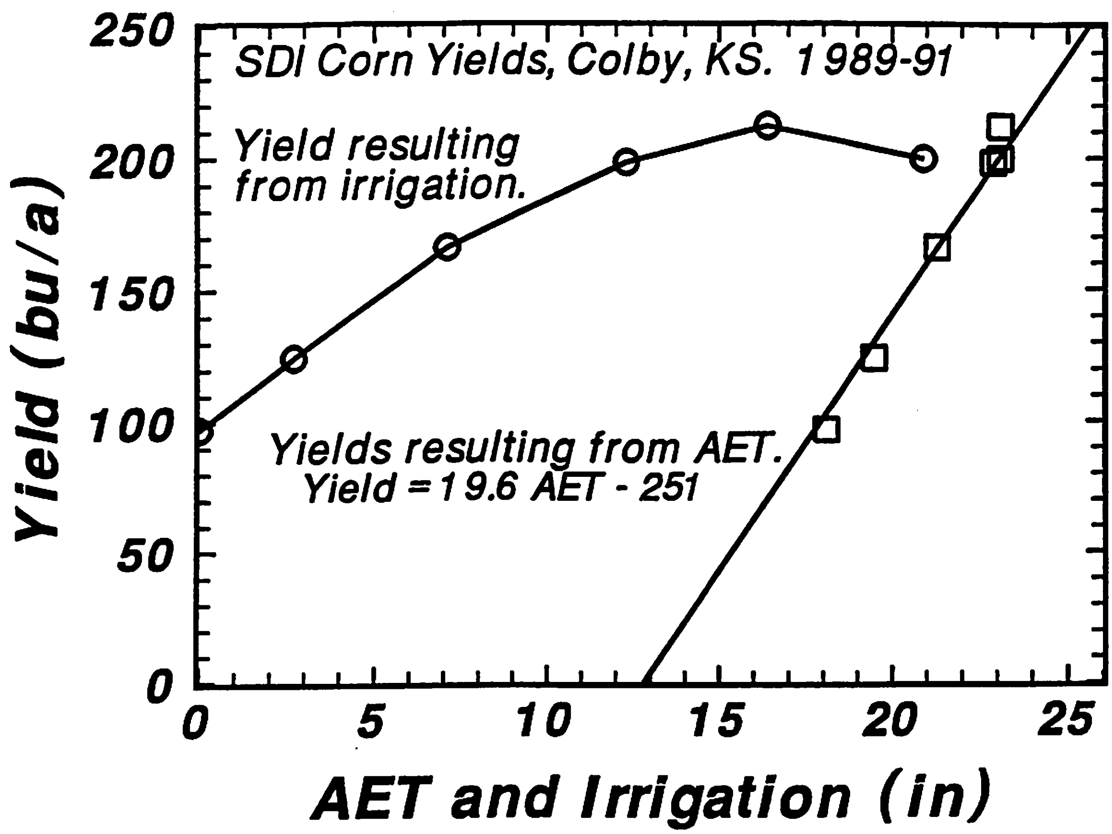

Figure 1. Corn yield as related to irrigation and calculated evapotranspiration (ET) in a drip irrigation study, KSU Northwest Research-Extension Ctr, Colby, KS.

NITROGEN FERTIGATION

Since drip-irrigation systems have a high degree of uniformity when designed properly and can apply small amounts of irrigation frequently, there are excellent opportunities to better manage nitrogen fertilization with these systems. Injecting small amounts of nitrogen solution into the irrigation water can spoonfeed the crop while minimizing the pool of nitrogen in the soil that could be available for percolation into the groundwater.

In a study conducted at Colby, Kansas, there was no difference in corn yields between preplant, surface-applied nitrogen and nitrogen injected into the driplines throughout the season. However, residual soil-nitrogen levels were higher where nitrogen was injected, suggesting similar corn yields might be obtained at lower amounts of injected nitrogen.

CONCLUDING STATEMENT

Subsurface drip irrigation for row crops in the Central Great Plains is an emerging, but technically sound technology. Changing economic factors and/or resource constraints could rapidly affect its adoption.