Drip Irrigation of Corn in Kansas

Danny H. Rogers[1], Harry L. Manges[2] and William E. Spurgeon[3]

Irrigation is a large consumer of both water and energy in the 31 western counties of Kansas which overlie the Ogallala aquifer. During the period 1978 to 1982, approximately 5,000 irrigators pumped water from 17,000 wells onto 2.7 million acres annually (Hay, 1978; Thomas, 1982). Wagner et al. (1982) estimated that 3.2 million acre feet of water were pumped for irrigation from the ground water in 1978, with a drop in the groundwater level of 3 feet from the previous year. Energy for pumping irrigation water was estimated at 16 trillion BTU in 1978 (Wagner et al., 1982). In general, withdrawals from the Ogallala aquifer exceed recharge, so conversation measures are needed to prolong the life of the aquifer.

According to Hall (1985), over 200,000 hectares are irrigated worldwide by the drip method. Corn was not a major drip irrigated crop for any country of the world in 1982 (Nakayama and Bucks, 1986). However, there are several drip irrigation systems being used to produce corn in Kansas.

Drip irrigation systems apply water to the soil much more efficiently than gravity and sprinkler systems, which are used extensively to irrigate row crops in Kansas. Water application efficiencies of 50 and 70 percent are estimated for gravity and sprinkler systems, respectively. Drip systems should have a water-application efficiency of 95 percent. Conversion to drip systems could reduce overdraft of the aquifer and reduce pumping costs per unit of land. It would free water and the energy required to pump it for a competing use. Farmers need to know the potential water and accompanying energy savings when converting from center pivot or gravity irrigation to drip irrigation before they can make an intelligent decision about conversion to drip irrigation. Water resource planners need to know the potential water savings and economics involved before developing policies to encourage conversion to drip irrigation.

Research is needed to determine the feasibility of corn production under drip irrigation in Kansas, both now and in the future. Research projects have been established at two sites in

---

[1]KSU Extension Agricultural Engineer, Manhattan, KS.

[2]Professor, KSU, Dept. of Agricultural Engineering, Manhattan, KS.

[3]KSU Research Agricultural Engineer, SW Research-Extension Center, Garden City, KS.

Kansas to investigate corn production under drip irrigation. These sites are at the Northwest Research-Extension Center and the Southwest Research-Extension Center of Kansas State University.

The drip irrigation project at Colby is headed by Freddie Lamm, Research Agricultural Engineer. The objectives of the drip irrigation project are 1) to determine the water requirement of corn grown with the drip irrigation; 2) to determine the optimum drip line spacing in terms of corn yield, water use and the corresponding economics and 3) to examine the feasibility of large scale adoption of drip irrigation for row crops in Kansas.

Phase 1 of the crop water use portion of the study was initiated in 1989. Irrigation levels ranged from no irrigation to 125% of calculated irrigation needs by 25% increments. Yield corresponding to the different irrigation levels are shown in Figure 1. The corn was grown on a modified ridge-till system. Two corn rows, 30 inches a part, were grown on flat bed with the drip line buried on-center between the two rows at a depth of 16 inches. Results for the 1989 growing season are given in Table 1.

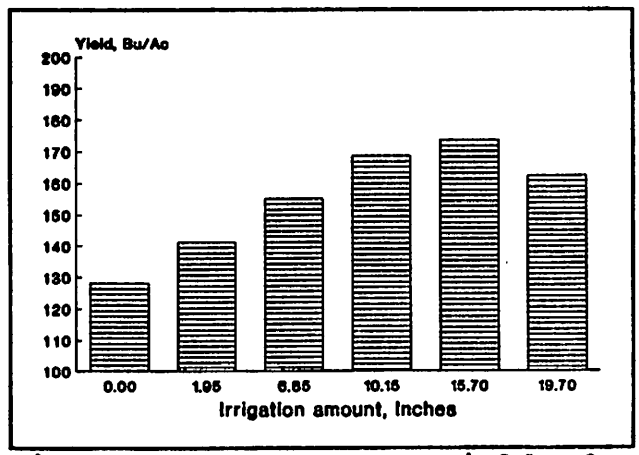

Figure 1. Average yield for irrigation amount treatments.

Table 1. Summary of corn yield and irrigation for a drip irrigation water use study, KSU Northwest Research-Extension Center, 1989.

ET Factor	Yield bu/ac	Irrigation inches
1.25 * ET	162.3	19.70
1.00 * ET	173.4	15.70
0.75 * ET	168.5	10.15
0.50 * ET	155.1	6.85
0.25 * ET	141.1	1.95
0.00 * ET	128.1	0.00

The drip lines for the drip line spacing portion of the study were installed in late summer and early fall of 1989 and are ready for the 1990 crop year. This study will have various drip line spacings, plant population, and irrigation water treatments.

A typical system for a farmer may consist of a drip line every 5 feet (a drip line every other row). Drip lines would be at least

300 feet long and longer depending on slope and how much uniformity the farmer is willing to give up in order to have longer drip lines (thus, fewer submains and reduced equipment cost). Drip line alone costs $275 an acre (on a 5 foot spacing) and the filter, mainline, submains, fittings and valves bring the equipment cost above $450 an acre. Drip line capacity varies but 0.25 gpm/100 feet is one example. in this case, a farmer could apply 1.15 inches in a 24 hr. set. Waterings every four days would mean a gross irrigation system capacity of 1.15/4 or 0.29 inches/day.

An acre of drip irrigation was installed at the KSU Southwest Research-Extension Center in order to study the effect of drip line spacing and plant population on corn performance. This project is headed by Bill Spurgeon. Drip lines were installed to a depth of 16 inches below the ground surface at spacings of 2.5, 5, 7.5 and 10 ft. Corn was planted in 30 inch rows perpendicular to the drip lines and thinned to populations of 38,000, 32,000, 26,000 and 20,000 plants/acre. All spacing treatments were irrigated to apply the same amount of water. Preliminary analysis show that deep percolation occurred near the drip lines under the wide spacings. Soil water data has not been completely analyzed.

June was very wet (6.7 inches) which diminished the effect of drip line spacing. This resulted in equal plant heights for the two narrow spacing treatments. There was some visible plant height decrease between drip lines for the wide spacings.

The first irrigation occurred on July 1. Plots were irrigated by replenishing ET (evapotranspiration - estimated crop water use) when the deficit reached 0.5 to 0.6 inches. Therefore the soil remained near field capacity throughout the summer. Thirteen inches of irrigation water was applied.

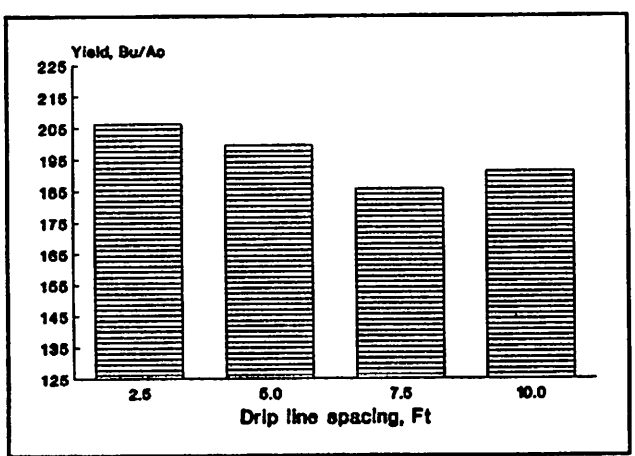

Figure 2. Average yield for spacing treatments.

Average yields for the spacing treatments ranged from 185 to 206 bu/ac (Figure 2). Although yields tended to be higher for narrow drip line spacing, they were not significantly different among all spacing treatments. We received 15.4 inches of rainfall during the growing season. We believe we were unable to show a significant difference among spacing treatments because of the wet year and because we only had two replications.

Population treatment yields were in the same range (184 to 204 bu/ac) as spacing treatments (Figure 3). Because we had sufficient

replication, we were able to show statistically significant results for plant population. Yields peaked at 32,000 plants/Ac.

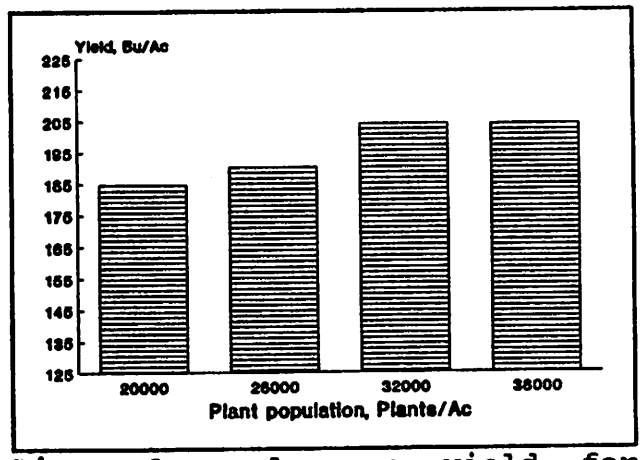

Figure 3. Average yield for population treatments.

Due to a wet year and limited replications, there was no difference in yield for the various spacing treatments even with a difference of 20 bu/ac between the 2.5 ft. and 7.5 ft. spacing treatments. Significant and greater differences are expected in a drier year. Reorganizing the study to obtain two more replications of spacing would help explain differences between spacing treatments. Plant population treatments also had a 20 bu/ac yield difference between 32,000 and 20,000 plants/ac. However, yields were different for population treatments. Results for the 1989 growing season are shown in Table 2.

Table 2. Summary of corn yield for spacing and plant population treatments, KSU Southwest Research-Extension Center, 1989.

Spacing feet	Yield bu/ac	Population plants/ac	Yield bu/ac
2.5	206.3	20,000	184.5
5.0	199.4	26,000	190.2
7.5	185.6	32,000	204.1
10.0	191.2	38,000	203.8

Since drip irrigation is new to Kansas for field crop production, records will be kept of any maintenance and operational problems encountered during the study. Recommendations on system operation and maintenance will result from these projects.

REFERENCES

Hall, B.J. 1985. History of drip/trickle irrigation. In: Drip/Trickle Irrigation in Action, Volume I. American Society of Agricultural Engineers Publication 10-85, St. Joseph, MI.

Hay, D.R. 1978. Kansas irrigation survey. Engineering Newsletter, Extension Engineering, Kansas State University, Manhattan.

Nakayama, F.S., and D.A. Bucks. 1986. Trickle irrigation for crop production. Elsevier Science Publishers, B.V. Amsterdam, the Netherlands.

Thomas, J.G. 1982. Kansas irrigation survey. Engineering Newsletter, Southwest Area Extension Office, Garden City, KS.

Wagner, J.P., C. Zarley, and H.L. Manges. 1982. Ogallala aquifer study in Kansas, energy. Kansas Water Office, Topeka.