LEPA Irrigation Project Report

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Introduction:

A Low Energy Precision Application (LEPA) sprinkler system was installed at the Southwest Research-Extension Center in 1989. This report summarizes the results and procedures for 1989 and 1990.

Procedures:

Corn was planted in a circle on May 19. The late planting was due to a wet spring and high residue cover. The system was run around once to establish the tower tracks, used as a marker. The corn was planted from the even towers (ie towers 2, 4 and 6) out to the odd towers. A total of 200 lbs of nitrogen was applied in 50 lb increments through the system four different times during the growing season.

The flexible drop hose initially installed was replaced with pvc pipe in late June, 1990. Dual nozzles were installed in some locations at this time also. The dual nozzles allowed the amount of water applied to the research plots to be varied. Once the center pivot was out of the plots the desired application rate for the bulk corn could be applied.

Aluminum access tubes were installed for use with a neutron probe to determine soil moisture. Measurements were taken weekly to verify crop water use estimates and were used to calculate the change in soil water over the season.

The field was furrow diked to help prevent runoff. Dikes or deep ripping are used with LEPA systems to store water for infiltration and prevent excessive runoff.

Irrigation treatments of 0.4, 0.7, 1.0 and 1.3 times evapotranspiration (ET-estimated crop water use) were used. The rated flow was changed for the nozzles by the respective percentage. Irrigation frequencies of 3, 6 and 9 days were also used. Each treatment was replicated four times. A typical replication is shown in Figure 1.

The first three irrigations (June 15, 23 and 25) were used to apply 50 lbs of nitrogen for each irrigation. Each plot received the same total amount of water. Plots were then irrigated every 3, 6 or 9 days with the desired fraction of ET. We replenished the amount of water used during each time interval at the end of that interval. A final 50 lbs of nitrogen was applied July 25 during corn pollination.

Irrigation amounts for each plot varied by treatment and frequency. Application amounts

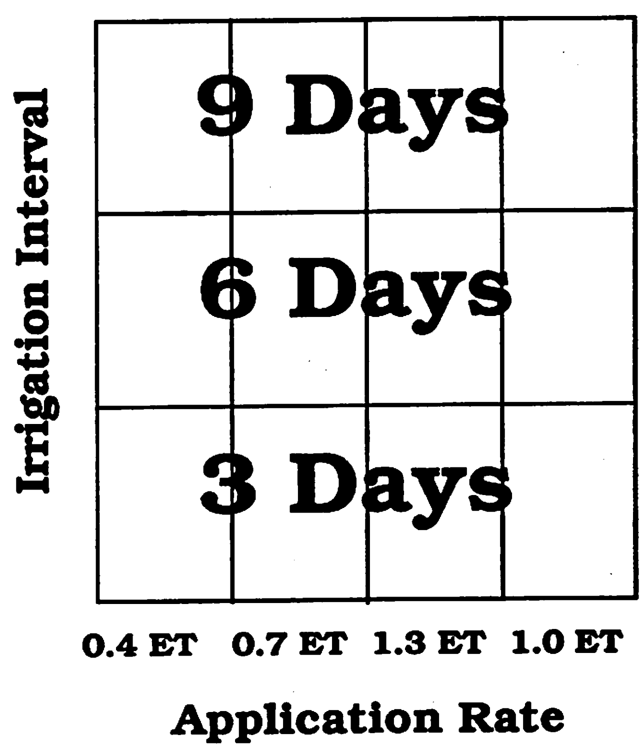

Figure 1. Amount and frequency plot for a typical replication.

ranged from 0.4 to 3.8 inches per irrigation event. The 3 day frequency was used to study the effects of high frequency applications. LEPA systems will probably require amounts less than one inch because of high runoff potential. The 9 day frequency results in very high water applications for LEPA but the plots were bordered to contain the water. Thus, the 9 day treatment resembles low frequency irrigation like furrow irrigation.

Forty feet of row were hand harvested from each plot on October 9. Yields were adjusted to 15.5 percent moisture and reported in bushels per acre.

Discussion:

This study was patterned after a study at Texas A & M conducted by Dr. Bill Lyle. The Texas study used the same amount and frequency treatments but added a 12 day frequency.

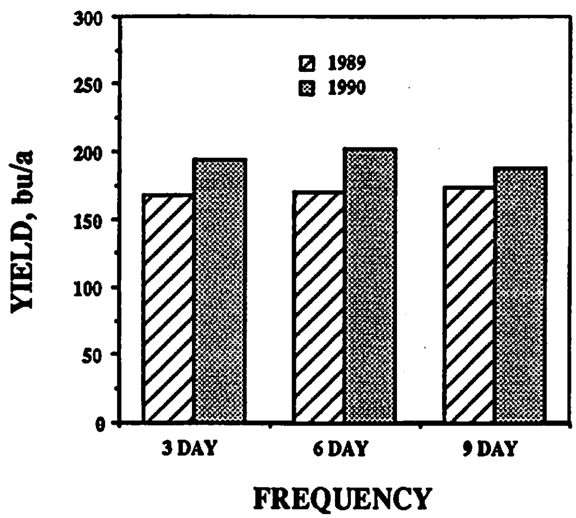

Figure 2. Average yield for frequency treatments.

This data (Figure 2) and the Texas data show that irrigation frequencies of 3, 6 and 9 days are not significantly different. The 12 day frequency yields were significantly lower than the 3, 6, and 9 day treatments. Yields for all treatments are given in Table 1. This data indicates no yield losses when high frequency irrigation is required, such as for a LEPA system.

Table1. Effect of irrigation frequency and amount on corn yield (bu/a), Southwest Research-Extension Center.

Fraction of ET	Irrig Inches	Irrigation Frequency Days 3	6	9	AVG
1989					
0.4	4.7	151.5	153.8	155.3	153.5
0.7	8.3	161.0	168.8	156.3	162.0
1.0	11.9	180.8	174.0	182.8	179.2
1.3	15.5	177.5	183.3	174.5	178.4
AVG		167.7	169.9	167.2	
1990					
0.4	11.0	149.1	155.4	162.0	155.5
0.7	16.6	185.6	204.3	185.3	191.7
1.0	22.2	220.5	217.0	200.3	212.6
1.3	27.8	222.6	231.4	204.0	219.3
AVG		194.5	202.0	187.9	

Figure 3 shows that yields level off for amounts greater than 1.0 ET. This presents a case for using irrigation scheduling to help the producer obtain optimum yield without wasting water. As expected, yields increase significantly with irrigation amounts up to 1.0 ET. There was a significant difference between yields for the two low ET treatments and the two high ET treatments.

The seasonal soil water change is given in Table 2. A negative value shows that water was

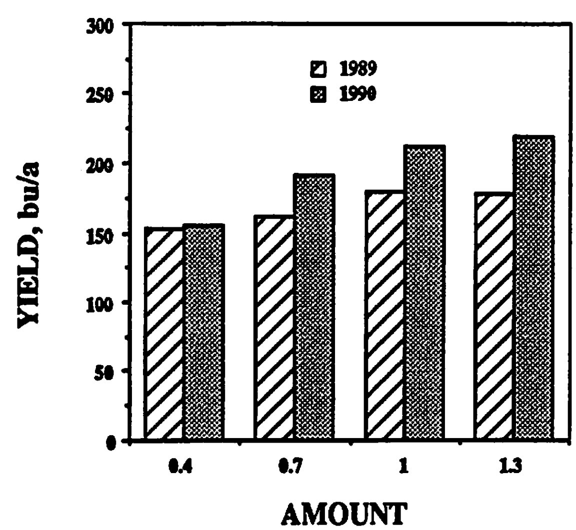

Figure 3. Average yield for amount treatments.

extracted from a 5 ft. profile between June 30 and September 22 (1989) and June 27 and October 3 (1990). Soil water was monitored in the 3 and 9 day treatments for each replication in 1990. In 1989 only one replication was monitored. In the under watered irrigation treatments, water was generally extracted from the soil profile to help meet the crop's water needs.

Table 2. Change in soil water content, in inches, for 5ft. of profile.

Fraction of ET	Irrig. Inches	Irrigation Frequency Days 3	6	9	AVG
1989					
0.4	4.8	-2.0*	-2.1	-1.9	-2.0
0.7	8.4	-0.5	-0.6	0.0	-0.4
1.0	11.9	0.4	-0.4	0.6	0.2
1.3	15.5	0.6	1.1	0.6	0.8
AVG		-0.4	-0.5	-0.2	
1990					
0.4	11.0	-4.8	-	-3.4	-4.1
0.7	16.6	-1.8	-	-2.5	-2.2
1.0	22.2	-0.8	-	-1.0	-0.9
1.3	27.8	-0.4	-	-0.8	-0.6
AVG		-2.0		-1.9	

* A negative value shows soil water was extracted from the profile by the crop.

Similar results were obtained for each year, despite the difference in rainfall. We received 15.4 inches of rainfall during the 1989 growing season and 9.3 inches in 1990. The irrigation amounts applied were, 11.9 inches in 1989 and 22.2 in 1990 for the 1.0 ET treatment. This results in a total of 27.3 and 31.5 inches respectively for the 1.0 ET treatment.

Total water use is shown in Table 3, which includes seasonal soil water change, irrigation and rainfall amounts.

The total water use and irrigation water applied were used to calculate total water use efficiencies (TWUE) and irrigation water use efficiencies (IWUE). Both are shown in Table 4. Water use efficiency is defined as the corn yield divided by the appropriate water quantity (bu/a-in).

Table 3. Total water use (soil water extracted + irrigation + rainfall) in inches.

Fraction of ET	Irrig. Inches	Irrigation Frequency Days 3	6	9	AVG
1989					
0.4	4.8	22.2	22.3	22.1	22.2
0.7	8.4	24.3	24.4	23.8	24.2
1.0	11.9	26.9	27.7	26.7	27.1
1.3	15.5	30.3	29.8	30.3	30.1
AVG		25.9	26.1	25.7	
1990					
0.4	11.0	25.1	-	23.7	24.4
0.7	16.6	27.7	-	28.4	28.1
1.0	22.2	32.3	-	32.5	32.4
1.3	27.8	37.5	-	37.9	37.7
AVG		30.7		30.6	

Table 4. Irrigation water use efficiency (IWUE) and (total water use efficiency) (TWUE), bu/a-in.

Fraction of ET	Irrigation Frequency Days 3	6	9	AVG
1989				
0.4	31.6	32.0	32.4	32.0
	(6.8)	(6.9)	(7.0)	(6.9)
0.7	19.2	20.1	18.6	19.3
	(6.6)	(6.9)	(6.6)	(6.7)
1.0	15.2	14.6	15.4	15.1
	(6.7)	(6.3)	(6.8)	(6.6)
1.3	11.5	11.8	11.3	11.5
	(5.9)	(6.2)	(5.8)	(6.0)
AVG	19.4	19.6	19.4	
	(6.5)	(6.6)	(6.6)	
1990				
0.4	13.6	14.1	14.7	14.1
	(5.9)	-	(6.8)	(6.4)
0.7	11.2	12.3	11.2	11.6
	(6.7)	-	(6.5)	(6.6)
1.0	9.9	9.8	9.0	9.6
	(6.8)	-	(6.2)	(6.5)
1.3	8.0	8.3	7.3	7.9
	(5.9)	-	(5.4)	(5.7)
AVG	10.7	11.1	10.6	
	(6.3)	-	(6.2)	

The LEPA concept is to keep every other row dry to reduce evaporation losses. Slopes greater than 0.5 to 1.0 percent will produce significant runoff and reduced yield. Therefore, furrow diking is recommended for all LEPA systems. The plots were not furrow diked in 1989 because fields were too wet from excessive rainfall during June, which may be the reason yield was lower in 1989. Improved corn yields might have resulted from using the flat spray mode rather than the bubble mode.

There was only 0.42 inch of rainfall between June 1 and July 19 (1990). There was 3.06 inches of rain between July 19 and August 2. During a hot dry year like 1990 and using the above rainfall amounts, the soil profile (4 ft) would have approached 3 inches depletion for a system capacity of 5 gpm/ac at 100 percent efficiency. Over 4 inches would have been depleted in a 4 ft profile with a capacity of 4 gpm/ac. Both maximum depletion levels would have occurred around July 19, near or after pollination, the most critical growth stage. Assuming LEPA is 98 percent efficient and the soil holds at least 2 inches per ft in a 5 ft soil profile, fully irrigated corn may be possible with 5 gpm/ac or less. However, that would not leave any extra capacity for system repair.

The current cost to convert an existing system to LEPA is approximately $10,000. It is hard to justify conversion unless fuel costs are high and water is limiting (ie the producer is currently under irrigating). It is possible however, to pay off the difference in cost between spray heads and LEPA heads (approximately $5,000) for new installations in a 3 to 5 year period depending on fuel costs and corn prices.

Conclusions:

Irrigation frequency did not affect yields. Therefore, switching to a LEPA system and applying smaller amounts to minimize runoff should not affect yields adversely. Yield is significantly reduced by under irrigation and is not significantly increased by over irrigation.

LEPA is easier to justify when purchasing a new sprinkler because the cost difference is smaller (approximately $5,000). Converting an existing system to LEPA is much harder to justify unless water costs are high and the producer is currently under irrigating the crop.