IMPROVING COTTON IRRIGATION SCHEDULING IN ARKANSAS

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RESEARCH PROBLEM

Timely irrigation of cotton has been shown to increase yields, but producers and researchers observe poor plant development even with irrigation under some conditions almost every year. Adequate moisture must be present when the cotton crop needs it, but saturated soil conditions deprive the roots of necessary oxygen. Published University of Arkansas recommendations do not include sufficient detail concerning irrigation management. Use of the Arkansas Irrigation Scheduler is recommended; however, the crop water-use function in the Scheduler was not experimentally developed.

BACKGROUND INFORMATION

Cotton was harvested from 950,000 acres in Arkansas in 2000, with over 69% of those acres irrigated (Arkansas Agricultural Statistics Service, 2001). Published University of Arkansas recommendations (Bonner, 1995) do not include much detail concerning irrigation management. While use of the Arkansas Irrigation Scheduler (Cahoon et al., 1990) is recommended, the crop water-use function (i.e., crop coefficient curve used to predict daily crop water use as a function of crop age) in the Scheduler was not experimentally developed. The original curve was adapted from Supak and Metzer (1977), based on older varieties and Texas High Plains conditions. Concerns that the curve caused an underestimation of early-season water use led to a modification in 1989. However, it was felt that the "new" curve was still not closely linked to the development of the cotton crop in Arkansas, so another curve was developed in 1991 and is still in use today. The current curve represented the best estimates of an agricul-

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tural engineer (Vories), a cotton physiologist (Oosterhuis), and a cotton breeder (Bourland), but was not experimentally verified. The objective of this research is to validate or develop a new crop coefficient curve for the Arkansas Irrigation Scheduler.

RESEARCH DESCRIPTION

A study was conducted at the University of Arkansas Northeast Research and Extension Center (NEREC) at Keiser on Sharkey-Steele complex soil to validate the crop water-use function for cotton in the Arkansas Irrigation Scheduler. Subsurface drip irrigation, with tubing placed approximately 12 inches below the original soil surface on a 38-inch spacing, was used to precisely control the water applied to plots and Watermark sensors were used to track soil moisture status. The study was designed as a randomized complete block split plot with four replications. Three levels of irrigation [nonirrigated, NI; 60% of estimated daily evapotranspiration (ET), Lo; 100% of estimated daily ET, Hi] were the whole-plot treatments and three varieties: Sure-Grow 747 (747), PSC 355 (355), and NuCOTN 33 B (33B) were the split-plot treatments. The study was planted on 18 May, 2001. COTMAN (Danforth and O'Leary, 1998) data were collected throughout the growing season and sequential hand harvests were conducted during the boll-opening period. Daily ET was estimated using the system of Cahoon et al. (1990) adapted for subsurface drip irrigation. The drip irrigation system began daily applications on July 3. The Watermark sensors were placed 8 inches below the surface of the soil bed, approximately 6 inches above the drip tape. Data were collected hourly from the sensors beginning 21 July. Lint yields were estimated assuming a 35% gin turnout.

RESULTS

Rainfall during the early part of the growing season was plentiful, with approximately 6 inches from planting through June 7 (Fig. 1). From that point until the end of August there were less than four additional inches. The crop in the drip-irrigated plots developed at a normal pace. Regression analysis indicated that the nodes above white flower (NAWF) on 17 July, 60 days after planting (DAP) or approximately first flower, averaged 8.6 and was not significantly affected by irrigation treatment or variety. That value (8.6) is slightly below the apogee of the COTMAN target development curve (TDC), i.e., 9.25. Days to NAWF=5 were significantly affected by the water treatments, but not by variety (Table 1). As expected, NI was the first treatment to reach NAWF=5 and Hi was the last. Similarly, the days to mean maturity based on sequential hand harvests followed the same trend, although the difference between the two irrigated treatments (Lo and Hi) was not significantly different.

The differences in maturity were not reflected in yield differences (Table 2). The irrigation treatment effect was not significant, while the variety effect was significant.

Variety effects were significant for micronaire and strength, but only fiber length had a significant irrigation treatment effect with NI shorter than the irrigated treatments. Larger differences among the irrigation treatments were expected and were observed in other NEREC cotton studies. The differences in water status of the plots were large, as indicated by the estimated soil water deficits (data not included) and supported by the soil moisture tension readings from the Watermark sensors (Fig. 2), and these differences were reflected in the maturity results (Table 1). The soil disturbances fairly near planting (installing the drip lines with a subsoil plow and then rebuilding the soil beds) may have influenced responses and reduced the observed differences among treatments. If so, the soil should be much less affected in 2002 after the system has been in place for a year.

PRACTICAL APPLICATION

A nonirrigated treatment was the first treatment to reach NAWF=5 and a treatment with daily applications of 100% of the estimated daily water use was the last. Days to mean maturity followed the same trend. The irrigation treatment effect was not significant, but the variety effect was significant. Only fiber length had a significant irrigation treatment effect, with lint from the nonirrigated treatment shorter than from the irrigated treatments. Soil disturbances associated with installing the irrigation system fairly near planting may have influenced responses and reduced the observed differences among irrigation treatments.

ACKNOWLEDGMENTS

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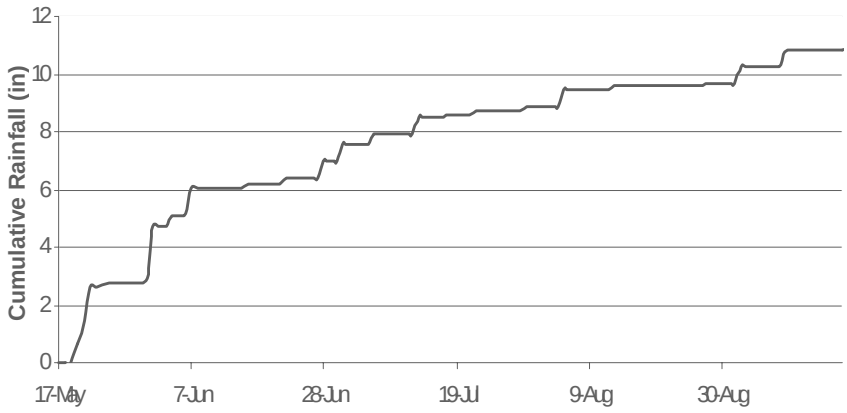

Fig. 1. Cumulative rainfall during the 2001 growing season at NEREC.

Table 1. Crop maturity parameters for drip irrigation study. Keiser, AR, 2001.

Irrigation treatment	Parameter value			
		Variety		
	747	355	33B	Avg.
		NAWF = 5 (DAP)		
Nil	73 a	77 a	76 a	75 c
Lo	79 a	80 a	82 a	80 b
Hi	84 a	82 a	85 a	84 a
Avg.	79 a	80 a	81 a	
		Mean maturity date (DAP)		
Nil	128 a	132 a	129 a	130 b
Lo	139 a	135 a	143 a	139 a
Hi	140 a	139 a	143 a	141 a
Avg.	136 a	135 a	138 a	

Table 2. Crop yield and quality for drip irrigation study. Keiser, AR, 2001.

Irrigation treatment	Parameter value			
		Variety		
	747	355	33B	Avg.
		Lint yield (lb/acre)		
Nl	1150 a	957 a	956 a	1021 a
Lo	1135 a	1068 a	1019 a	1074 a
Hi	1090 a	1008 a	867 a	988 a
Avg.	1125 a	1011 b	947 b	
		Micronaire		
Nl	4.68 a	4.70 a	4.32 a	4.57 a
Lo	4.32 a	4.65 a	4.28 a	4.42 a
Hi	4.55 a	4.52 a	4.38 a	4.48 a
Avg.	4.52 ab	4.62 a	4.32 b	
		Length (in.)		
Nl	1.14 a	1.13 a	1.15 a	1.14 b
Lo	1.19 a	1.20 a	1.19 a	1.19 a
Hi	1.17 a	1.19 a	1.18 a	1.18 a
Avg.	1.17 a	1.17 a	1.18 a	
		Strength (g/tex)		
Nl	27.9 a	30.8 a	30.3 a	29.6 a
Lo	26.5 a	29.4 a	29.7 a	28.5 a
Hi	26.6 a	29.2 a	28.9 a	28.2 a
Avg.	27.0 b	29.8 a	29.6 a	

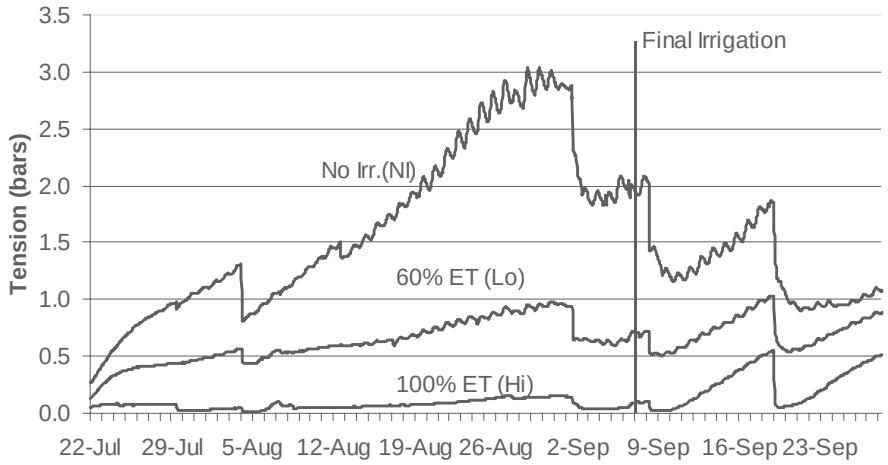

Fig. 2. Soil moisture tension in cotton drip irrigation study.