EFFECT OF IRRIGATION TIMING ON COTTON YIELD AND EARLINESS

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Abstract

A study of the effects of irrigation timing (i.e., different initiation and termination times) for cotton was conducted at the University of Arkansas Northeast Research and Extension Center at Keiser during the 1999 growing season. Cotton (Gossypium hirsutum L. cv. Sure-Grow 125) was planted on May 10 at approximately 5 seeds per foot in 38-inch rows on a Sharkey silty clay. Nitrogen was applied at a rate of 98 lb N/acre, split between pre-square (50 lb N/acre) and early flower (23 lb N/acre) applications. No other fertilizers were required. Five irrigation treatments ranged from no irrigations to a total of four furrow irrigations. Highest seedcotton yields were observed for the Delay treatment (3 irrigations beginning July 21 and ending August 13), even though it was the first treatment to reach NAWF = 5 (cutout). NI (no irrigations) and NAWF5 (2 irrigations: July 9 and July 21) were the earliest treatments (based on mean maturity date and percent first harvest) and had the lowest total seedcotton yield. There was no significant yield increase associated with the final irrigation before FOB (August 13, 454 DD60 after NAWF = 5), even though there was less than 0.5 in. of rain during August. Observing this type of study over several years and locations will be required before new Extension recommendations can be made.

Introduction

Data from the Arkansas Agricultural Statistics Service (various years) suggest that yields of irrigated cotton (*Gossypium hirsutum* L.) for the past 15 years (1984 through 1998) have leveled off, averaging 838 lb lint/acre (Figure 1). While there has been a consistent increase (average of 202 lb lint/acre during that period) above dryland yields, many producers feel that the variability in irrigated cotton yield is unacceptably high. An example of that variability is in the three years 1992 through 1994. In 1992, average irrigated yields were third highest of the fifteen years (919 lb lint/acre); followed in 1993 by the lowest average irrigated yields of the period (657 lb lint/acre); followed in 1994 by the highest average irrigated yields of the period (951 lb lint/acre; Figure 1). Since stabilizing yields is often given as a principle reason for investing in irrigation, and 66% of the 1998 crop was irrigated (AASS, 1999), variability in irrigated yields is a major concern. While some evidence suggests that a shift in basic properties of the cultivars currently grown has made them more sensitive to environmental variability (Dr. Hal Lewis, personal communication), such a shift could take years to affect through the development of new cultivars. Short-term answers will probably have to come through improved management.

Water requirement for cotton varies throughout the season, with low use during the vegetative period and rapidly increasing needs during reproductive growth (Figure 2). The water requirement decreases late in the year as the first bolls mature and air temperatures cool. Current University of Arkansas Cooperative Extension Service (CES) recommendations are to begin monitoring the moisture status of the crop at planting (e.g., tensiometers, water balance calculations) and maintain well-watered conditions until bolls begin to open. In Arkansas, the capacity of a well and the number of acres to be covered very often limit irrigation frequency. Increasing the frequency in many cases would require additional wells or leaving a portion of the crop as dryland production. The factors most easily altered are the time and/or crop stage to begin watering the crop and the time and/or crop stage to stop watering the crop.

Due to factors such as cultivation, fertilization and preparing other crops on the farm, the first irrigation in cotton often comes later than recommended. Of course, the effect of such a delay will depend greatly on the weather conditions. Periods of drought are less likely early in the season, so rainfall will often prevent excessive stress from developing when an early irrigation is missed. It is generally believed that maintaining well-watered conditions until the first bolls open provides sufficient moisture to mature the remaining bolls. However, first open boll (FOB) alone is a poor indicator of the maturity status of the crop, addressing only the first fruit set and not the entire fruiting history. Increased in-season plant monitoring of cotton in recent years has led many producers to ask for an irrigation termination guide better tied to crop status.

Objective

The objective of this research is to determine the optimal initiation and termination timing for irrigation of cotton in Arkansas, in terms of both yield and earliness.

Methods and Materials

Since irrigation effects are so influenced by rainfall, cotton irrigation studies are being conducted in different growing seasons and locations. Findings from several such studies will be compared before new CES recommendations can be developed. The study in this report was conducted at the University of Arkansas Northeast Research and Extension Center at Keiser during the 1999 growing season. The

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cultivar 'Sure-Grow 125' was planted on May 10 at approximately 5 seeds per foot in 38-inch rows on a Sharkey silty clay (Vertic Haplaquepts). Nitrogen was applied at a rate of 98 lb N/acre, split between pre-square (50 lb N/acre) and early flower (23 lb N/acre) applications. No other fertilizers were required. U of A CES recommendations were followed for weed and insect control. All plots were four 38-inch rows by approximately 600 ft long, with the center two rows harvested. A four-row border area was left between each pair of plots. Five irrigation treatments were employed, including no irrigations (Table 1). Except as noted, plots were watered at a 2-inch estimated soil water deficit (SWD) based on the Cahoon et al. (1990) water balance method.

Nodes above white flower (NAWF) were counted weekly from 20 plants per plot beginning soon after all plots were flowering and continuing until the average NAWF for all plots was less than 5, indicating physiological cutout. The cotton was harvested twice with a two-row cotton picker. Seedcotton weights for each plot were determined for the first harvest (September 14) with an instrumented boll buggy and for the second harvest (October 4) with a cotton picker modified for plot harvesting. Sequential hand harvests were made weekly from a 10-ft section of both harvest rows, beginning the week following first open boll through the end of September for calculating days to mean maturity (i.e., the seedcotton-weighted average harvest day). At the time of harvest, ten whole plant samples were collected and mapped using COTMAP analysis (Bourland and Watson, 1990).

The study was designed as a randomized complete block with three replications. Fisher's least significant difference (LSD) was used to compare treatment means whenever significant (p values $\leq$ 0.05) treatment effects were observed.

Results and Discussion

The crop developed at a normal rate, with emergence @ 7 days (83 DD60) after planting resulting in a stand of 3.5 plants/ft (48,000 plants/acre); white flower @ 60 days (1079 DD60) after planting; and FOB @ 102 days (2055 DD60) after planting. Temperature and rainfall data for the study period are shown in Figure 3. Less than 2-in. total rainfall was recorded between June 27 and September 27.

Little difference was observed among the irrigated treatments. Total seedcotton yield was highest for the Delay treatment (Figure 4), even though the estimated SWD reached 3.8 in. by the first irrigation. The NAWF data (Figure 5) indicated that the Delay treatment was drought-stressed before the first irrigation on July 21 (i.e., the mean values dropped slightly below 5 and then increased after the irrigation). Studies have shown that the later bolls produced by the increase in NAWF (second growth) will not contribute significantly to yield (Benson et al., 1999); however, no other explanation could be found for the additional yield. Apparently conditions in this study were adequate to allow the crop to compensate for the premature cutout, particularly since the mean NAWF value of 4.9 suggests that many of the plants had not yet reached physiological cutout.

The treatment with the earliest irrigation termination (NAWF5) was associated with the lowest yield, not significantly different from the yield for the nonirrigated treatment (NI; Figure 4). Even though a four-row border area was left between each pair of plots, some lateral water movement into the nonirrigated plots may have occurred due to the cracking nature of the Vertic soil; therefore the yields reported for the NI treatment should not be considered representative of dryland conditions. The final irrigation for the 5+1Irr treatment was on August 3 (215 DD60 after NAWF = 5). There was no significant yield increase associated with the final irrigation before FOB (August 13, 454 DD60 after NAWF = 5), even though there was less than 0.5 in. of rain during August (Figure 3).

The NAWF data (Figure 5) suggested no differences in earliness among the treatments with irrigation starting July 9 (NAWF5, 5+1Irr and FOB, which all reached NAWF = 5 on July 26), with all three later than the NI treatment. Since the observations stop after NAWF < 5, late-season drought-stress effects would not be predicted. However, the two end-of-season earliness measures indicated that the NAWF5 treatment matured significantly earlier than the FOB treatment (Figure 6). While the appearance of the NAWF data for the Delay treatment suggest that it might be earlier than the other irrigated treatments, both end-of-season measures showed no significant differences among the FOB, 5+1Irr and Delay treatments. Both measures showed the last irrigation tended to delay the crop, though neither difference was significant.

Conclusions

- Highest seedcotton yields were observed for the Delay treatment, even though it was the first treatment to reach NAWF = 5 (physiological cutout).
- NI and NAWF5 treatments were earliest (i.e., had the highest percent first harvest) and had the lowest total yield.
- There was no significant yield increase associated with the final irrigation before FOB (August 13, 454 DD60 after NAWF = 5), even though there was less than 0.5 in. of rain during August.
- Findings from several similar studies must be compared before new CES recommendations can be developed.

References

Arkansas Agricultural Statistics Service. 1999. Arkansas agricultural statistics 1998. U of A CES MP409-3.5M-8-99N.

Benson, N.R., W.C. Robertson and G.M. Lorenz. 1999. Validation of the insecticide termination component of COTMAN. p. 1133-1135 IN Proc. Beltwide Cotton Prod. Res. Conf., Orlando, FL. 3-7 Jan. 1999. Natl. Cotton Counc. Am., Memphis, TN.

Bourland, F.M. and C.E. Watson. 1990. COTMAP, a technique for evaluating structure and yield of cotton. Crop Sci. 30:224-226.

Cahoon, J., J. Ferguson, D. Edwards, and P. Tacker. 1990. A microcomputer-based irrigation scheduler for the humid mid-south region. Appl. Eng. Agric. 6:289-295.

Table 1. Irrigation treatments in cotton irrigation study at NEREC, Keiser, Arkansas.

Treatment	Initiation Key	Date	Termination Key	Date*	Total Irrigations
NI	none	--	none	--	0
NAWF5	2 in. SWD**	July 9	NAWF = 5	July 21	2
5+1Irr	2 in. SWD	July 9	one irr. after NAWF = 5	August 3	3
FOB	2 in. SWD	July 9	1st Open Boll	August 13	4
Delay	one irr. after 2 in. SWD	July 21	1st Open Boll	August 13	3

* Date of final irrigation.
** Soil water deficit estimated with Irrigation Scheduler program from Cahoon et al. (1990).

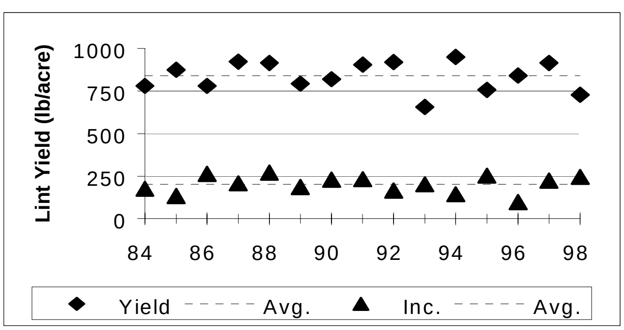

Figure 1. Arkansas state-average irrigated cotton yields and the associated increases above dryland yields for the years 1984 through 1998 (from Ark. Ag. Stat. Serv.)

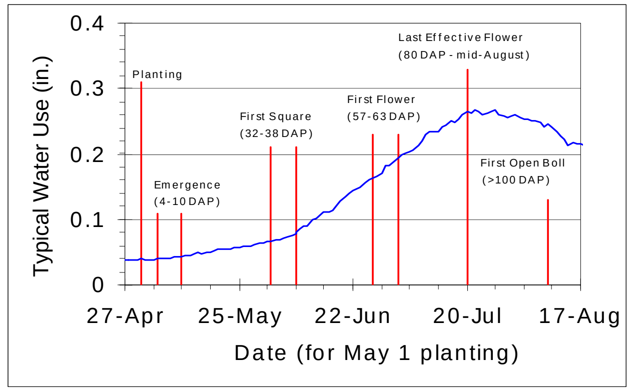

Figure 2. Estimated typical water use for cotton based on 30-year-mean maximum temperatures recorded at the University of Arkansas Northeast Research and Extension Center.

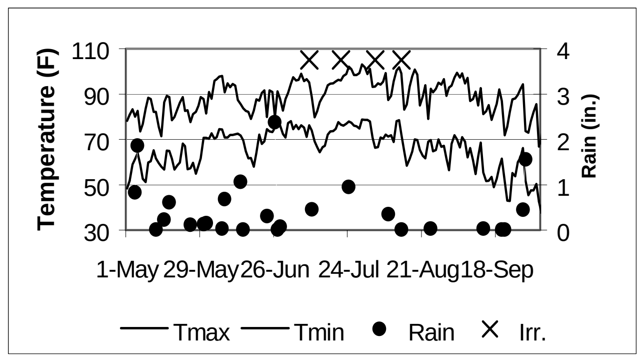

Figure 3. Temperature and rainfall observations at the University of Arkansas Northeast Research and Extension Center during the 1999 cotton growing season.

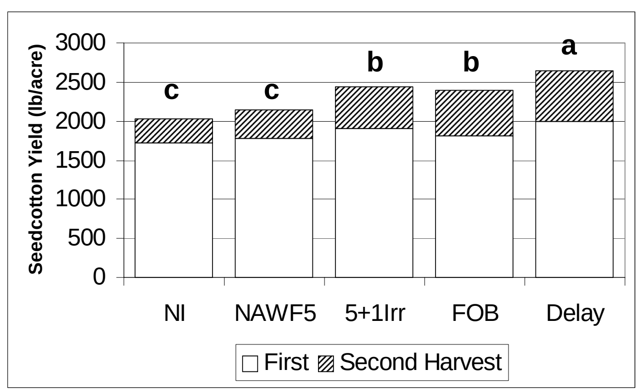

Figure 4. Seedcotton yields from two mechanical harvests of 1999 cotton irrigation study at the University of Arkansas Northeast Research and Extension Center (treatments with the same letter above the column did not differ significantly in total seedcotton yield).

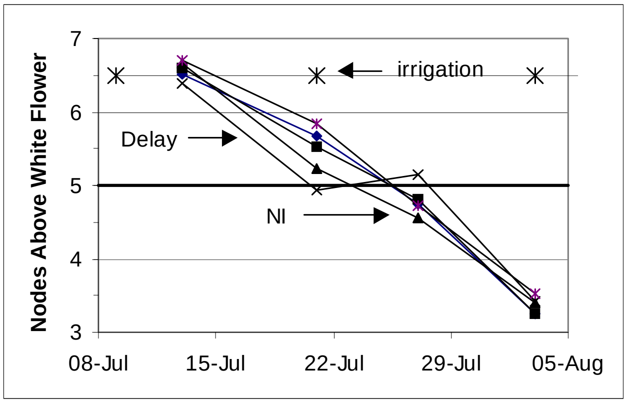

Figure 5. Nodes above white flower (NAWF) observations in 1999 cotton irrigation study at the University of Arkansas Northeast Research and Extension Center.

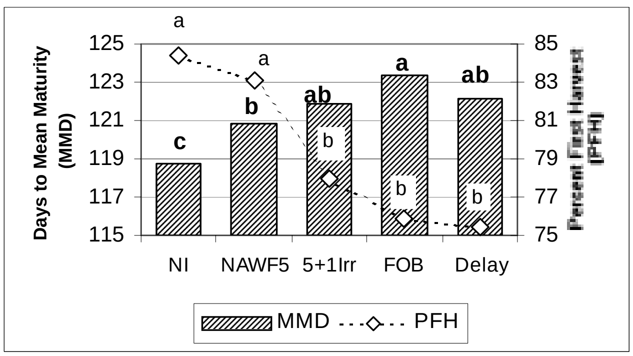

Figure 6. Days to mean maturity and percent first harvest for 1999 cotton irrigation study at the University of Arkansas Northeast Research and Extension Center (treatments with the same letter above the column/point did not differ significantly).