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ESTIMATING THE COST OF DELAYING IRRIGATION FOR MID-SOUTH COTTON ON CLAY SOIL

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Abstract

Cotton producers often know that they need to irrigate sooner than they do, but have no idea of the cost of delaying irrigation. The objective of this research was to estimate the cost associated with delaying the first irrigation for cotton on clay soil. Cotton irrigation studies were conducted at the University of Arkansas Northeast Research and Extension Center at Keiser during the 2001 and 2002 growing seasons, with the cultivar 'PM 1218 BG/RR' planted on a Sharkey silty clay (Chromic Epiaquerts) precision graded to approximately 0.2% slope. All plots were four 38-inch rows by approximately 600 ft long, with all four rows harvested for yield determination. A four-row border area was left between each pair of plots. A well-watered treatment was irrigated at a 2-inch estimated soil water deficit (SWD) based on the Arkansas Irrigation Scheduler (Cahoon et al., 1990). Irrigations for two "delay" treatments were initiated on the date of the second irrigation or third irrigation of the well-watered treatment and then irrigated at a 2-inch estimated SWD. A nonirrigated check was also included. Irrigations were ceased when open bolls were observed. Highest yields in both years were observed for the well-watered treatment, and in 2002, yields and revenues associated with delaying irrigation were not significantly different than for no irrigation. The cost of delaying irrigation initiation ranged from $25/acre for delaying by one irrigation in 2001 to $122/acre for delaying by two irrigations in 2002. Continuing the study in additional environments will help to better define the importance of timeliness of the initial irrigation.

Introduction

Data from the National Agricultural Statistics Service (2002) suggest that yields of irrigated cotton (*Gossypium hirsutum* L.) in Arkansas for the past 18 years (1984 through 2001) have leveled off, averaging 838 lb lint/acre (Figure 1). While there has been a consistent increase (average of 214 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 principal reason for investing in irrigation, and an average of 66% of the Arkansas crop was irrigated over the last five years (1997-2001; NASS, 2002), variability in irrigated yields is a major concern. While some improvement could come through the development of new cultivars, such a shift could take years. 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. 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. 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. Later in the season, the plants are using water at a faster rate and the likelihood of drought is greater.

Producers often know that they need to irrigate sooner, but they have no idea of the cost of delaying irrigation. The risks associated with irrigating are well known to them, especially for furrow irrigation on a clayey soil, where the soil will not dry out for several days. Cultivation, pesticide application and fertilization may have to be delayed for several days after an irrigation until the soil dries sufficiently to support traffic without severe rutting or soil compaction. An estimate of the costs associated with waiting to irrigate would allow a more informed decision on what to do first.

Objective

The objective of this research was to estimate the cost associated with delaying the first irrigation for cotton on clay soil.

Methods and Materials

To investigate the effects of delaying irrigation, cotton irrigation studies were conducted at the University of Arkansas Northeast Research and Extension Center at Keiser during the 2001 and 2002 growing seasons. The cultivar 'PM 1218 BG/RR' was planted on May 29, 2001 and May 21, 2002 at approximately 5 seeds/ft in 38-inch rows on a Sharkey silty clay (Chromic Epiaquerts) precision graded to approximately 0.2% slope. Nitrogen was applied in single pre-flower applications at a rate of 128 lb N/acre in 2001 and 125 lb N/acre in 2002, and no other fertilizers were required. CES recommendations were followed for weed and insect control. All plots were four 38-inch rows by approximately 600 ft long, with all four rows harvested for yield determination. A four-row border area was left between each pair of plots. There were three furrow-irrigated treatments and a nonirrigated check (NI) (Table 1). A well-watered treatment (WW) was irrigated at a 2-inch estimated soil water deficit (SWD) based on the Arkansas Irrigation Scheduler (Cahoon et al., 1990). Irrigations for two "delay" treatments were initiated on the date of the second irrigation (Delay1) or third irrigation (Delay2) of the WW treatment and then irrigated at a 2-inch estimated SWD. Irrigations were ceased when open bolls were observed, according to CES recommendations.

Nodes above white flower (NAWF) were counted weekly from 10 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. Seedcotton was harvested on October 8, 2001 and October 17, 2002 with a Case IH 1822 two-row cotton picker and seedcotton weights for each plot were determined with an instrumented boll buggy. An approximately 1-lb sample of seedcotton from each plot was ginned on a 10-saw laboratory gin without lint cleaners to determine gin turnout for lint yield calculations.

Costs for the inputs and operations were estimated with the Mississippi State Budget Generator (Spurlock and Laughlin, 1992). All inputs and thus all costs other than irrigation were the same for all treatments. Therefore, only the costs related to the different irrigation treatments were considered. For this analysis, the nonirrigated field had the same degree of precision grading as the irrigated fields and had water available; therefore, there were no differences in land and well preparation costs between the treatments and only the variable costs were considered.

Because so much cropland is rented rather than farmed by the owner, it was necessary to include the impact of rent payments. While in practice there are a seemingly infinite number of rental arrangements, this analysis assumed a 25% crop share rent for all treatments, with the farmer paying all costs of production. Furrow irrigation with disposable poly-tubing was used, with all costs based on Bryant et al. (2001). A price of $0.52/lb lint, the USDA farm program loan rate in effect, was assumed for both years and fiber quality was not considered.

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

Results and Discussion

Uniform emergence was observed, resulting in stands of 3.6 and 3.7 plants/ft (49,500 and 50,900 plants/acre) in 2001 and 2002, respectively. Heat-unit (DD60) and rainfall data for the study period are shown in Figures 2 and 3, respectively. While the heat unit data appeared fairly typical, it is obvious from Figure 3 that August 2002 was a relatively wet month. In fact, a 1.7-inch rain followed one day after the final irrigation (August 23), negating most of the effect of the irrigation. Such an untimely rainfall is a constant risk in the mid-South region and underscores the importance of adequate surface drainage.

Due to the relatively late planting and the corresponding warm temperatures, the crop developed at an accelerated rate in both years of the study. While the COTMAN (Danforth and O'Leary, 1998) target development curve (TDC) has first flower at 60 days after planting (DAP), flowers were observed at 53 and 52 DAP in 2001 and 2002, respectively. Similarly, the COTMAN TDC has an effective flowering period, or the time between first flower and NAWF=5, of 20 days. In 2001, the effective flowering period was 17 days for the WW treatment, but only an average of 9 days for the other treatments, which did not differ significantly (data not included). In 2002, only the WW treatment ever exceeded NAWF=5, a value normally associated with physiological cutout (Bourland et al., 1992).

In 2001, yields decreased with delaying irrigation and NI was significantly lower yielding than any irrigated treatment (Table 2). There was a consistent trend for lower yield for each delay in the first irrigation. Yields were lower in 2002 and yields for the delayed-irrigation treatments (Delay1, Delay2) were not significantly different than for NI. Vories and Glover (2000) reported their highest yield for a treatment matching the Delay1 treatment in this study. While they suggested compensation from later bolls may have affected yields in their study, the late planting in both years of this study made any yield compensation unlikely.

Since a constant price without premiums or discounts was used, the response for total revenue mirrored the response for yield (Table 2). Even though the differences were not always significant, the trend was for lower yields and lower returns with each delay in initiating irrigation. When yields were lower in 2002, and profit margins were already thinner, timely irrigation was even more important than in the previous year. Though the differences with NI were not significant, delaying initiation of irrigation in 2002 resulted in returns being insufficient to pay the cost of the irrigations.

The cost of delaying irrigation initiation by one irrigation was \$25/acre in 2001 and \$106/acre in 2002 (Table 2). The cost of delaying irrigation initiation by two irrigations was \$49/acre in 2001 and \$121/acre in 2002. The greater costs in 2002 corresponded to the lower yields and thus revenues, exacerbating the effect. Continuing the study in additional environments will help to better identify conditions when timeliness of the initial irrigation is most critical.

Conclusions

- Highest yields in both years were observed for the well-watered (WW) treatment, which was watered according to CES recommendations.
- In 2002, yields and revenues associated with delaying irrigation were not significantly different than for no irrigation.
- The cost of delaying irrigation initiation ranged from \$25/acre for delaying by one irrigation in 2001 to \$122/acre for delaying by two irrigations in 2002.
- Continuing the study in additional environments will help to better define the importance of timeliness of the initial irrigation.

Acknowledgment

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

Treatment*	Date of First Irrigation	Date of Final Irrigation	Total Irrigations
		2001	
WW	July 20	August 17	3
Delay1	August 1	August 17	2
Delay2	August 17	August 17	1
NI	none	none	0
		2002	
WW	July 8	August 23	4
Delay1	July 26	August 23	3
Delay2	August 5	August 23	2
NI	none	none	0

* Treatments were: well watered (WW), which was irrigated according to CES recommendations; Delay1 missed the first irrigation of WW; Delay2 missed the first and second irrigations of WW; and no irrigation (NI).

Table 2. Yield and economic comparisons for cotton irrigation study at NEREC, Keiser, Arkansas in 2001 and 2002.

						Under a 25%/75% share rent ###		
Treatment*	Lint Yield (lb/acre)	Total Revenue*** ($/acre)	TVC# ($/acre)	Returns over TVC ($/acre)	Cost of Delaying Irrigation## ($/acre)	Total Revenue*** ($/acre)	Returns over TVC ($/acre)	Cost of Delaying Irrigation## ($/acre)
			2001				2001	
WW	872 a**	$454 a	$18	$435 a		$340 a	$322 a	--
Delay 1	817 ab	$425 ab	$14	$411 a	$25 b	$319 ab	$305 a	$18 b
Delay 2	763 b	$397 b	$10	$387 a	$49 ab	$298 b	$288 a	$34 ab
NI	638 c	$332 c	$0	$332 b	$104 a	$249 c	$249 b	$73 a
			2002				2002	
WW	746 a	$388 a	$22	$366 a		$291 a	$269 a	--
Delay 1	535 b	$278 b	$18	$260 b	$106 a	$208 b	$190 b	$78 a
Delay 2	497 b	$258 b	$14	$244 b	$121 a	$194 b	$180 b	$89 a
NI	522 b	$271 b	$0	$271 b	$94 a	$203 b	$203 b	$65 a

*Treatments were: well watered (WW), which was irrigated according to CES recommendations; Delay1 missed the first irrigation of WW; Delay2 missed the first and second irrigations of WW; and no irrigation (NI).

** Values within a column and year followed by the same letter not significantly different at alpha=0.05 level.

*** Total Revenue = lint yield times $0.52 per pound.

\# TVC is the total variable cost associated with the irrigations and is equal to $5.75 per acre for poly-tubing plus $4.14 per irrigation.

\## Includes nonirrigated treatment; WW not included in analyses of cost of delaying irrigation.

\### The tenant receives 75% of the lint yield and pays all of the TVC of irrigation.

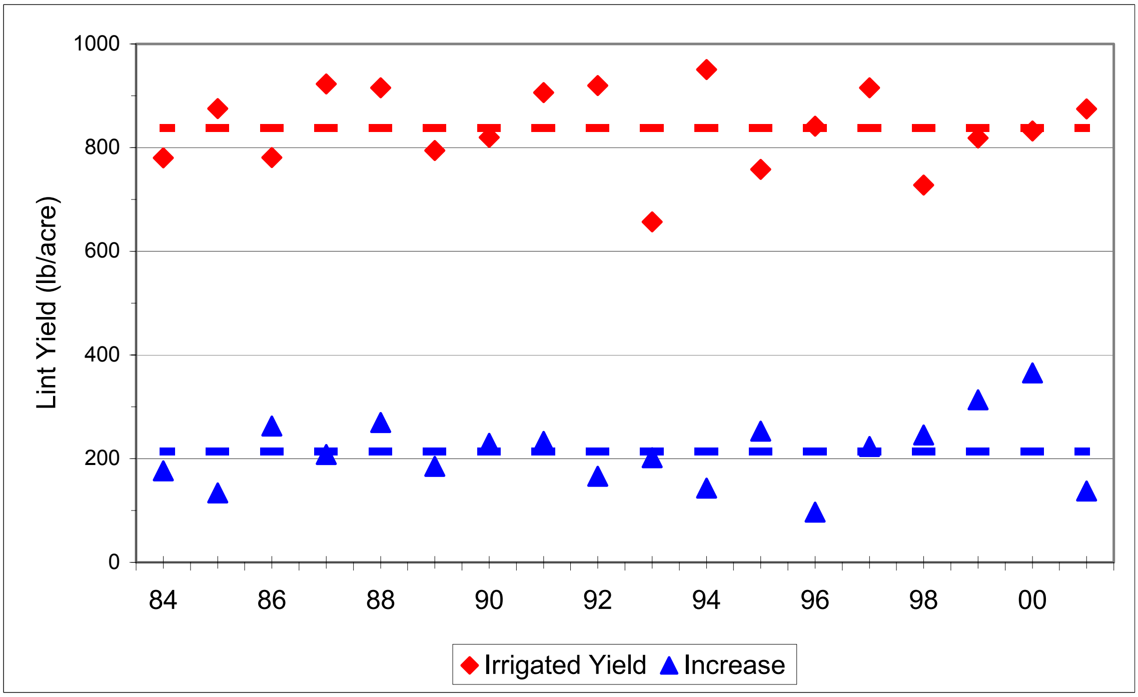

Figure 1. Arkansas state-average irrigated cotton yields and the associated increases above dryland yields for the years 1984 through 2001 (NASS, 2002).

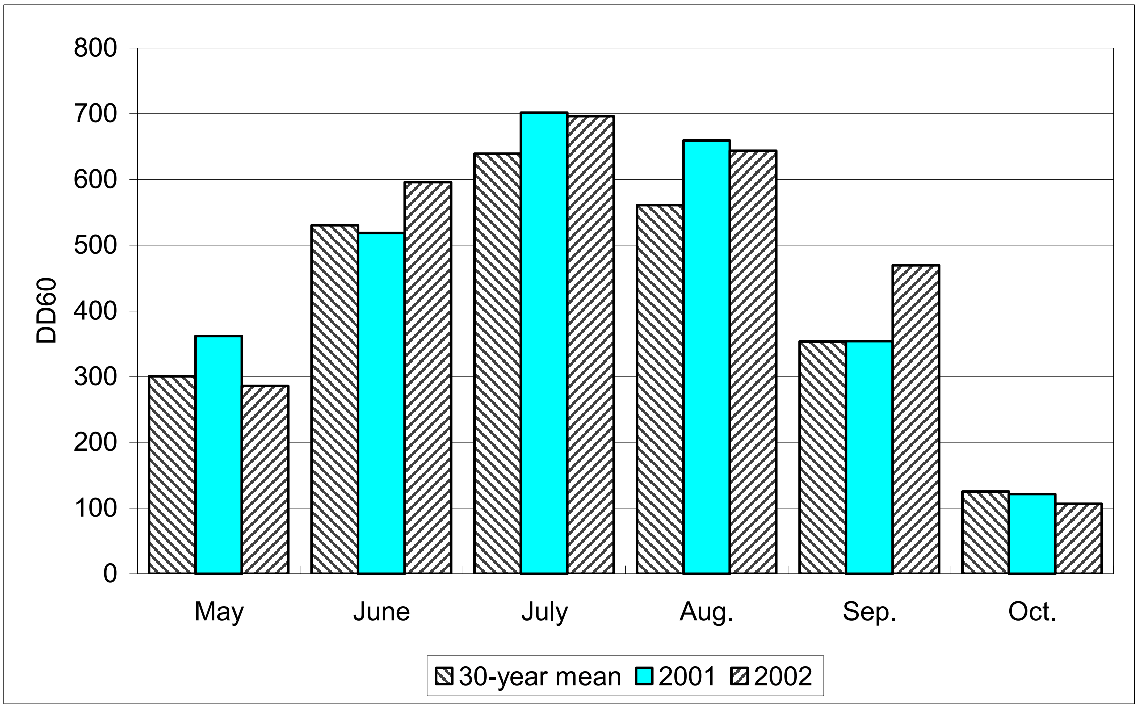

Figure 2. Monthly DD60 observations at the University of Arkansas Northeast Research and Extension Center during the 2001 and 2002 cotton growing seasons and 30-year (1963-1992) mean values.

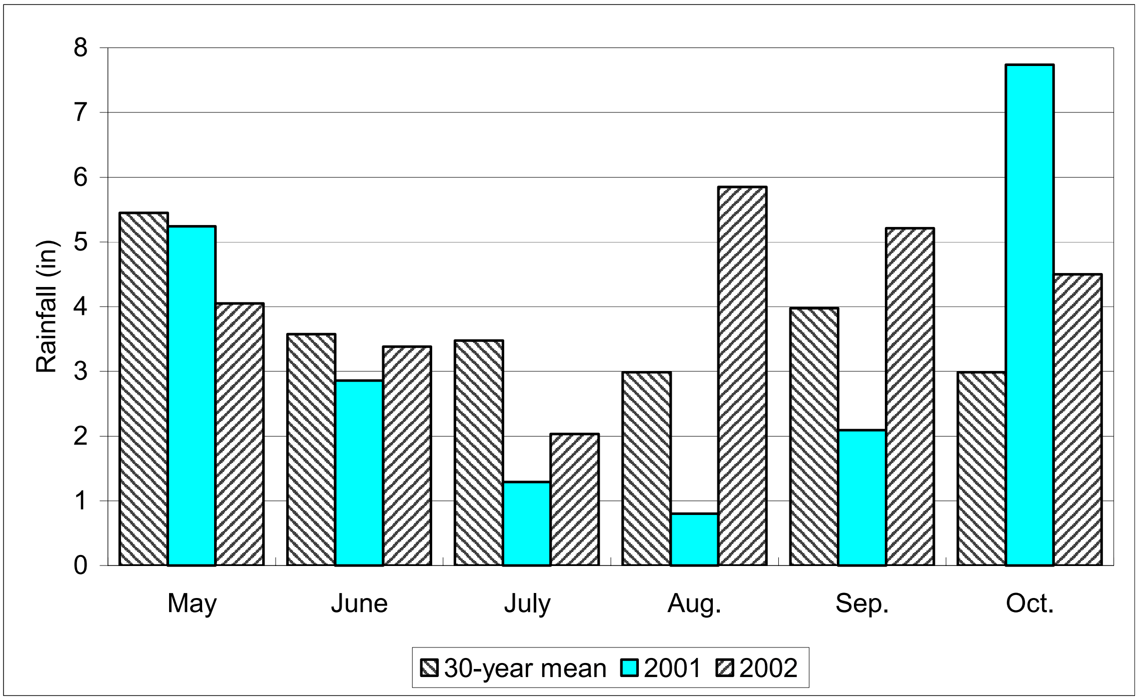

Figure 3. Monthly rainfall observations at the University of Arkansas Northeast Research and Extension Center during the 2001 and 2002 cotton growing seasons and 30-year (1963-1992) mean values.