Estimating the Cost of Delaying Irrigation for Cotton on Clay Soil

Earl D. Vories, Robert E. Glover, Kelly J. Bryant, and Phil L. Tacker

RESEARCH PROBLEM

Yields of irrigated cotton in Arkansas for the past 18 years have leveled off, averaging 838 lb lint/acre. Cotton producers often know that they need to irrigate sooner than they do but 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 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 to be made on what to do first.

BACKGROUND INFORMATION

Data from the National Agricultural Statistics Service (2002) suggest that yields of irrigated cotton in Arkansas for the past 18 years (1984 through 2001) have leveled off, averaging 838 lb lint/acre (Fig. 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 eighteen 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; Fig. 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,

1 Professor, Department of Biological and Agricultural Engineering, University of Arkansas Northeast Research and Extension Center, Keiser; research specialist, University of Arkansas Northeast Research and Extension Center, Keiser; area extension specialist - farm management, Southeast Research and Extension Center, Monticello; and agricultural engineer, University of Arkansas Cooperative Extension Service, Little Rock, respectively.

147
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 is often applied 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 use water at a faster rate and the likelihood of drought is greater.

**RESEARCH DESCRIPTION**

To investigate the effects of delaying irrigation on cotton, a study was conducted at the Northeast Research and Extension Center at Keiser. The cultivar ‘PM 1218 BG/RR’ was planted on 21 May 2002 at approximately 5 seeds/ft in 38-in. rows on a Sharkey silty clay (Chromic Epiaquerts) precision graded to approximately 0.2% slope. Nitrogen was applied in a single pre-flower application at a rate of 125 lb N/acre, and no other fertilizers were required. CES recommendations were followed for weed and insect control. All plots were four 38-in. 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-in. 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-in. 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 17 October 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 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 a stand of 3.7 plants/ft (50,900 plants/acre). Heat unit data for the study period appeared fairly typical; however, August was a relatively wet month (data not included). In fact, a 1.7-in. rain followed one day after the final irrigation (23 August), 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. 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 52 DAP. Similarly, the COTMAN TDC has an effective flowering period (time between first flower and NAWF=5) of 20 days; however, only the WW treatment ever exceeded NAWF=5, a value normally associated with physiological cutout (Bourland et al., 1992).

Highest yields were observed for the well watered treatment (WW, Table 2). 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.
PRACTICAL APPLICATION

The cost of delaying irrigation initiation by one irrigation was $106/acre. The cost of delaying irrigation initiation by two irrigations was $121/acre. Although the difference was not statistically significant, delaying initiation of irrigation resulted in returns being insufficient to pay the cost of the irrigations (i.e., higher returns for NI than either Delay treatment). Continuing the study in additional environments will help to better identify conditions when timeliness of the initial irrigation is most critical.

ACKNOWLEDGMENTS

Research was supported by Arkansas cotton producers through Cotton Incorporated.

LITERATURE CITED


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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Date of first irrigation</th>
<th>Date of final irrigation</th>
<th>Total irrigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW</td>
<td>8 July</td>
<td>23 August</td>
<td>4</td>
</tr>
<tr>
<td>Delay1</td>
<td>26 July</td>
<td>23 August</td>
<td>3</td>
</tr>
<tr>
<td>Delay2</td>
<td>5 August</td>
<td>23 August</td>
<td>2</td>
</tr>
<tr>
<td>NI</td>
<td>none</td>
<td>none</td>
<td>0</td>
</tr>
</tbody>
</table>

* 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Lint yield*</th>
<th>Total revenue*</th>
<th>TVC*</th>
<th>Returns over TVC</th>
<th>Cost of delaying irrigation*</th>
<th>Total revenue⁴</th>
<th>Returns over TVC</th>
<th>Cost of delaying irrigation⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>WW</td>
<td>746 a</td>
<td>$388 a</td>
<td>$22</td>
<td>$366 a</td>
<td>$291 a</td>
<td>$269 a</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Delay1</td>
<td>535 b</td>
<td>$278 b</td>
<td>$18</td>
<td>$260 b</td>
<td>$106 a</td>
<td>$208 b</td>
<td>$190 b</td>
<td>$78 a</td>
</tr>
<tr>
<td>Delay2</td>
<td>497 b</td>
<td>$258 b</td>
<td>$14</td>
<td>$244 b</td>
<td>$121 a</td>
<td>$194 b</td>
<td>$180 b</td>
<td>$89 a</td>
</tr>
<tr>
<td>NI</td>
<td>522 b</td>
<td>$271 b</td>
<td>$0</td>
<td>$271 b</td>
<td>$94 a</td>
<td>$203 b</td>
<td>$203 b</td>
<td>$65 a</td>
</tr>
</tbody>
</table>

* 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).

⁴ Values within a column followed by the same letter not significantly different at alpha=0.05 level.

¹ Total revenue = lint yield times $0.52 per pound.

⁵ 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.

⁶ Includes nonirrigated treatment; WW not included in analyses of cost of delaying irrigation.

⁷ The tenant receives 75% of the lint yield and pays all of the TVC of irrigation.
Fig. 1. Arkansas state-averaged irrigated cotton yields and the associated increases above dryland yields for the years 1984 through 2001 (NASS, 2002).