Increasing Water Use Efficiency for Sustainable Cotton Production

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RESEARCH PROBLEM

Irrigation management is of paramount importance to maximize yield potential in cotton. Lint quality and quantity including lint length, micronaire, strength, length uniformity, leaf grade and even color are all affected by water management. With irrigation costs as high as $70 per acre, there is a critical need to optimize water use for sustainable cotton production in Arkansas. Research has shown the importance of irrigation initiation and some guidelines have been developed for irrigation termination. But there is an urgent need to develop tools and Extension recommendations for farmers to help them trigger irrigations.

BACKGROUND INFORMATION

Irrigation scheduling is based on information on soil moisture conditions and crop evapotranspiration. Atmometers and check-book irrigation schedulers such as the Arkansas Irrigation Scheduler can be used to estimate crop evapotranspiration and used to schedule irrigation. Using soil moisture information from sensors installed in the field is another approach to sense the soil water balance. Ocampo (2007) conducted a study to compare different approaches, including the atmometers, a weather station, and the Arkansas Irrigation Scheduler. His results showed that the user-friendly atmometers provide similar estimates of evapotranspiration than those obtained with a weather station, which use the modified Penman equation. The objective of this study was to evaluate the yield response of a current cotton cultivar under different irrigation scheduling regimes, with emphasis on atmometers and soil moisture sensors.

RESEARCH DESCRIPTION

A 2.6-acre field located at the Lon Mann Cotton Research Station (LMCRS) in Marianna, Ark. was selected to conduct a test involving different furrow-irrigation scheduling regimes. The soil at the location is classified as a Memphis silt

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loam (fine silty-mixed, thermic, Typic Hapludalfs). The field was disked in the fall of 2012 after harvesting soybeans. Two additional studies were established with collaborating farmers but in soils of silty-clay texture.

Stoneville 5458 cotton was planted on 5 June, at a rate of 44.324 seeds per acre. Cotton plants began emerging 10 June. Plants were fertilized and disease and insect control was done according to University of Arkansas Cooperative Extension Service recommendations. The same cotton variety was planted at the two demonstration sites.

At LMCRS, plots consisted of 6 rows 38-in in width and approximately 600 ft in length. Irrigation treatments included 2, 3, and 4 inch deficits. Treatments were arranged in a randomized strip design and were replicated 3 times. Plots with collaborating farmers consisted of 24 rows 38-in in width by 300-500 ft in length. Atmometers were used to determine the time of the first irrigation event (The Etgage Company, Loveland, Colo.). Irrigation scheduling calculations were based on actual Evapotranspiration measurements (ETc) and rainfall. Irrigation was terminated following current COTMAN™ protocols (Oosterhuis and Bourland, 2008).

Plots were instrumented with watermark sensors (The Irrometer Company, Riverside, Calif.) installed at 6- and 12-inch depth and were periodically read with a portable reader. Soil moisture was periodically measured at random locations in the testing area using a ML 3 Theta probe (Dynamax Inc., Houston, Texas). The whole plots were harvested using a 4-row cotton picker, with total weight measured manually using a portable scale system.

RESULTS AND DISCUSSION

The response of seed cotton yield to varying irrigation regimes was significant ($P \leq 0.1$). There was a significant difference among irrigation treatments, with higher yields observed when a 2 inch deficit was used (Fig. 1). Yields obtained with a 2-inch irrigation regime were 387 and 530 lb/acre of seed cotton higher than the 3- and 4-inch irrigation regimes, respectively.

Table 1 shows the number of gallons used under each irrigation regime and the number of associated irrigation events. In order to maximize yields, under the conditions of this study, more than 471,000 gallons were needed compared to 297,759 and 214,075 for irrigation regimes equivalent to 3 and 4 inches deficit respectively.

Table 2 shows seed cotton yields of the irrigation demonstration tests established on silty clay soils. There was no significant yield difference between a 2- and a 3-inch irrigation deficit in Site 1. At site 2, however, seed cotton yields were significantly higher for the 3-inch irrigation regime than the rest of the treatments.

PRACTICAL APPLICATION

The objective of these tests was to characterize the seed cotton yield response of current cotton cultivars to varying irrigation regimes when grown in a silt loam
and a silty clay soil. Preliminary results show that an irrigation deficit of 2 inches appears to be appropriate for a silt loam and a 3-inch deficit will be appropriate when growing cotton in clayey soils.

ACKNOWLEDGMENTS

Financial support provided by the Arkansas Cotton State Support Committee is appreciated.

LITERATURE CITED


Table 1. Water used and number of irrigations according to treatment at the Lon Mann Cotton Research Station.

<table>
<thead>
<tr>
<th>Irrigation regime</th>
<th>2 inch</th>
<th>3 inch</th>
<th>4 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water use, Gallons</td>
<td>471465</td>
<td>297759</td>
<td>214075</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2. Water used and number of irrigations according to treatment at the Lon Mann Cotton Research Station.

<table>
<thead>
<tr>
<th>Irrigation regime</th>
<th>Dryland</th>
<th>2 inch</th>
<th>3 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1 Irrigations</td>
<td>2140 b†</td>
<td>2567a</td>
<td>2625a</td>
</tr>
<tr>
<td>Site 2 Irrigations</td>
<td>2352c</td>
<td>2840b</td>
<td>3205a</td>
</tr>
</tbody>
</table>

†Numbers within a row with the same letter are not significantly different ($P \leq 0.10$).
Fig. 1. Seed cotton yield response to varying irrigation regimes in a silt loam at the Lon Mann Cotton Research Station, near Marianna. Numbers followed by the same letter are not statistically significant ($P < 0.1$).