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DETERMINING THE OPTIMUM TIMING FOR THE FINAL IRRIGATION ON MID-SOUTH COTTON

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Abstract

US Cotton growers are adopting COTMAN, a COTton MANagement system developed at the University of Arkansas, used to monitor crop development and aid in making end-of-season decisions. Currently, research-based decision guides have been developed to aid in identifying the last effective boll population and determining dates for safe termination of insect control and the application of defoliants based on physiological cutout, or NAWF=5. An area of cotton production that may benefit from COTMAN is the decision of when to stop irrigating the crop. The objective of this research was to investigate a crop-based recommendation for timing the final irrigation on cotton. Eleven irrigation studies were conducted in five states (Missouri, Arkansas, Mississippi, Louisiana and Texas) during the 2002 growing season to investigate the response to late-season irrigation. Irrigation treatments consisted of different irrigation termination times at each site, with the first termination treatment targeted for approximately NAWF=5. The Texas study dealt with drip irrigation and is reported elsewhere. Of the others, only five of the ten studies could be completed due to rain and only one of the five showed significant differences in cotton yield with later irrigation. In central-east Arkansas no significant yield differences were observed later than 16 days or 343 DD60 after NAWF=5. Only one of the studies (northeast Louisiana) was harvested twice, and while there was a trend for lower percent first harvest associated with later irrigation, the differences were not significant. Additional studies will be required to develop a meaningful recommendation.

Introduction

Cotton growers across the Cotton Belt are adopting COTMAN, a COTton MANagement system developed at the University of Arkansas, used to monitor crop development and aid in making end-of-season decisions (Danforth and O'Leary, 1998). The later-season portion of the system is based on monitoring the number of nodes above the uppermost first-position white flower (NAWF) on a plant. Research has shown that as the developing bolls require more of the plant resources, the development of new nodes slows and the first-position white flower "moves" progressively toward the plant apex. Bourland et al. (1992) found that a first-position white flower five nodes below the plant terminal represented the last effective flower population. Their work indicated that flowers set after NAWF=5 have a higher shed rate and lower mass, resulting in only a minor contribution to final yield. Based on their findings, NAWF=5 is generally accepted as physiological cutout.

The COTMAN system uses a target development curve (TDC) as a reference to compare with actual crop development. The TDC has flowering beginning at 60 days after planting (DAP) and NAWF=5 at 80 DAP. Comparisons of actual crop development to the TDC provide an indication of the maturity of the crop. Early-season stress often results in first flower at a relatively low NAWF value and physiological cutout occurring in less than 80 DAP.

Currently, research-based decision guides have been developed to aid in identifying the last effective boll population and determining dates for safe termination of insect control and the application of defoliants based on physiological cutout, or

NAWF=5. Research projects underway in several cotton-producing states are focused on ways to use the information from COTMAN to aid in management decisions regarding the crop (e.g., growth regulator applications). One area of cotton production that may benefit from COTMAN is the decision of when to stop irrigating the crop. Recommendations in Arkansas and other states concerning the timing of the final irrigation are often based on the appearance of the first open boll. Such recommendations ignore the maturity of later-maturing bolls and often reflect as much fear of promoting boll rot as providing for the water needs of the maturing bolls. A recommendation that relates the timing of the final irrigation to physiological cutout should better fit the needs of the crop and follows the approach taken with other management recommendations. Vories et al. (2001) reported on a study at three northeast Arkansas locations in 2000 and Vories et al. (2002) reported on another eight mid-South studies in 2001, but additional studies are needed to develop a meaningful recommendation.

Objective

The objective of this research was to investigate a crop-based recommendation for timing the final irrigation on cotton.

Methods and Materials

Eleven irrigation termination studies were conducted in five states during the 2002 growing season. For each study, NAWF data were collected weekly from early flower until NAWF<5. With the exception of irrigation termination, cultural practices followed Cooperative Extension Service (CES) recommendations for the area. Information about the crops in each of the mid-South studies is included in Table 1. For each site, the first termination treatment was targeted for approximately NAWF=5 (physiological cutout). An additional treatment was terminated with each subsequent irrigation. Fiber samples were submitted to Cotton Incorporated for high volume instrument (HVI) analyses but the results were not available at the time of this report. Fisher's protected least significant difference (LSD) was used to compare treatment means for significant ($p \bullet 0.05$) effects. Unless otherwise noted, cotton was planted on 38-inch rows and furrow irrigated. An assumed gin turnout of 35% was used to calculate lint yield at each location. A study in West Texas using drip irrigation was reported separately (Biles et al., 2003).

Southeast Missouri

A study with four replications was conducted at the Lee Farm of the University of Missouri Delta Experiment Station at Portageville. The soil was Tiptonville silt loam and the whole field was furrow irrigated until late in the season when the irrigation termination treatments were to be applied. At the end of the season, sprinkler irrigation was to be used to manage the treatments. Irrigation plots were to be 8 rows approximately 37 ft long. Two rows from the center of each plot were to be harvested for yield determination. However, excessive rainfall caused the treatments not to be applied.

Northeast Arkansas

Three studies were conducted in Mississippi County in northeast Arkansas. One study with four replications was on the University of Arkansas Northeast Research and Extension Center (NEREC) at Keiser, on a field containing areas of Sharkey silty clay and Sharkey-Steele complex soils. Irrigation plots were four rows approximately 800 ft long, with four buffer rows between plots. Seedcotton weights were to be obtained from all four rows of each plot using an instrumented boll buggy. A second study with four replications was on Field 89 of Wildy Farms near Manila, with areas of Routon-Dundee-Crevasse complex and Amagon sandy loam soils. Irrigation plots were 18 rows approximately 1200 ft long. Seedcotton weights were to be determined from the center 12 rows of each plot using an instrumented boll buggy. A third study with four replications was on several fields under four similarly located center pivots with the same cultivar and similar (i.e., over a four-day period) planting dates. Irrigation plots were approximately 40 acres in size (one-fourth of a quarter-mile pivot), with each separate pivot functioning as a replication. However, as in the Missouri study less than 100 miles away, excessive rainfall interfered with the treatments for all three studies.

Central-East Arkansas

One study was conducted in Lee County in central-east Arkansas on the Cotton Branch Experiment Station (CBS) near Mariana. The experiment with five replications was on a Memphis silt loam. Irrigation plots were 4 rows approximately 800 ft long, with 4 buffer rows between plots. Seedcotton weights were determined from all 4 rows of each plot for one harvest using an instrumented boll buggy.

Southeast Arkansas

Two studies were conducted in Desha County in southeast Arkansas on the Steve Stevens Farm near Rohwer. One experiment with four replications was on the E Weaver field on a Hebert silt loam. Irrigation plots were 12 or 16 rows approximately 1200 ft long. Seedcotton weights were determined from the center 4 rows of each plot for one harvest using an instrumented boll buggy. The second experiment with four replications was on Barrett field on a Rilla silt loam. Irrigation plots were 16 rows approximately 500 ft long. Seedcotton weights were determined from the center 8 rows of each plot for one harvest using an instrumented boll buggy.

Western Mississippi
A study with four replications was conducted in Washington County, in west-central Mississippi on the L. Frankel farm, near Stoneville on a Dundee silty clay loam. Irrigation plots were 18 rows wide approximately 1300 feet long. Seedcotton weights were determined from the center 4 rows of each plot for one harvest using an instrumented boll buggy.

Northeast Louisiana
Irrigation termination experiments were conducted at two sites in northeast Louisiana. The first site was in Concordia Parish on the Noble Guedon Farm; however, frequent rainfall resulted in no termination treatments being applied. The second experimental site was in Tensas Parish at the Louisiana State University Northeast Research Station (NRS) near St. Joseph. Due to personnel changes, all of the Louisiana data were not available at the time of this report.

Results and Discussion

Southeast Missouri
The cotton crop did not reach NAWF=5 before the COTMAN last possible cutout date at 15% risk level for Portageville, MO of July 31 (69 DAP). Frequent rains eliminated the need for late-season irrigation and no treatments were applied.

Northeast Arkansas
While the NEREC field reached NAWF=5 on 77 DAP, 3 days earlier than the 80 DAP for the COTMAN TDC (Table 1), the other two fields took much longer (approximately 100 days). The differences were probably due to the differences in planting date. The NEREC field was planted more than two weeks after the other two fields and did not experience as much cool weather early in the season. However, frequent rains interfered with the treatments and none of the studies were harvested.

Central-East Arkansas
The CBS field reached NAWF=5 on 76 DAP (6 August), 4 days earlier than the 80 DAP for the COTMAN TDC (Table 1). The difference was probably due to the relatively late planting date (22 May) and thus warmer temperatures and not an indicator of a stressed crop. The crop received many of the rains that interfered with the studies to the north (SE Missouri, NE Arkansas) and no treatments near NAWF=5 could be applied. However, after the rain of 17 August it was dry enough for three treatments. The 17 August rainfall was treated as the final "effective" irrigation for the earliest treatment (Table 2). A significant yield increase was observed for one additional irrigation on 22 August (16 days and 343 DD60 after NAWF=5), but not for a second (Table 3).

Southeast Arkansas
Even though the planting dates differed by nine days, the fields reached NAWF=5 only one day apart, July 27 (89 DAP) and July 26 (97 DAP) for Stevens E Weaver and Stevens Barrett, respectively (Table 1). The longer time for Stevens Barrett resulted from early-season stress that delayed fruiting. The similar yields for the two fields (Table 3) suggest that the crop recovered from the early stress. A 1.25-inch rain occurred on 14 August, one day after an irrigation at E Weaver. Therefore, 14 August was considered the “effective” irrigation date and all calculations were based on that date. Final irrigations ranged from 14 August (18 days or 400 DD60 after NAWF=5 at E Weaver) to 5 September (40 days or 862 DD60 after NAWF=5 at E Weaver) (Table 2). Yield was not significantly affected by termination date at either location (Table 3).

Western Mississippi
Fairly Cool temperatures in May caused the cotton crop to start off slow and appear stressed. First bloom occurred 74 DAP with a NAWF approaching 9. The crop reached NAWF=5 at 93 DAP (Table 1). Final irrigation for one treatment occurred on 31 July (3 days or 69 DD60 before NAWF=5; Table 2). Due to 3.5 inches of rainfall occurring from 15 August to 26 August no other final irrigations treatments were implemented. The rainfall of 26 August (33 days or 719 DD60 after NAWF=5) was considered the last “effective” irrigation date for a second treatment. No significant yield differences were found between the two termination dates.

Northeast Louisiana
Three irrigation termination treatments at NRS ranged from near NAWF=5 to two additional irrigations (Table 2). Yield was not significantly affected by termination date (Table 3). The plots were harvested twice and while there was a trend for lower percent first harvest associated with later irrigation, the differences were not significant (data not included).

Conclusions

Rainfall interrupted the studies in southeast Missouri, northeast Arkansas, and one of the studies in northeast Louisiana and also affected the studies in southeast Arkansas and western Mississippi. Of the five mid-South studies that were completed, only one showed significant differences in cotton yield with later irrigation. In the case where yield differences were significant in central-east Arkansas, no significant yield difference was observed later than 16 days or 343 DD60 after NAWF=5.

Only one of the studies (northeast Louisiana) was harvested twice, and while there was a trend for lower percent first harvest associated with later irrigation, the differences were not significant. Additional studies will be required to develop a meaningful recommendation.

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Table 1. Cultivar and significant dates for each site from the 2002 cotton irrigation termination studies.

Location	Cultivar	Planting Date	NAWF=5 Date	NAWF=5 DAP	Harvest
Lee Farm	PM 1218 BG/RR	23 May	31 Jul**	69	--
NEREC	SG 747	16 May	1 Aug	77	--
Wildy 89	DP 451 B/RR	24 Apr	3 Aug	101	--
Wildy Pivot*	SG 215 BG/RR	30 Apr	6 Aug	98	--
CBS	PM 1218 BG/RR	22 May	6 Aug	76	8 Oct
Stevens E Weaver	ST 4892 BR	29 Apr	27 Jul	89	2 Nov
Stevens Barrett	DP 451 B/RR	20 Apr	26 Jul	97	30 Sep
Stoneville	ST 4691 B	2 May	3 Aug	93	18 Oct
Guedon	DP 458 B/RR	15 Apr	***	***	--
NRS	DP 451 B/RR	***	***	***	***

* several fields under four center pivots with common variety and planting date
** COTMAN latest possible cutout date for Portageville, MO at 15% risk level
*** some Louisiana data were not available in time for inclusion in this report

Table 2. Timing of the final irrigation in the 2002 cotton irrigation termination studies.

	Final Irrigation			
Treatment	Date	Days after planting	Days after* NAWF=5	DD60 after* NAWF=5
		CBS		
1	17 Aug**	87	11	228
2	22 Aug	92	16	343
3	29 Aug	99	23	480
		Stevens E Weaver		
1	14 Aug***	107	18	400
2	22 Aug	115	26	569
3	28 Aug	121	32	688
4	5 Sep	129	40	862
		Stevens Barrett		
1	14 Aug	116	19	424
2	21 Sep	123	26	568
3	28 Sep	130	33	710
4	4 Sep	137	40	845
		Stoneville		
1	31 Jul	90	-3	-69
2	26 Aug**	116	22	512
		NRS		
1	****	****	~NAWF=5	****
2	****	****	Tmt 1 + 1 irr.	****
3	****	****	Tmt 1 + 2 irr.	****

* negative values signify that the final irrigation was made before a field-average NAWF=5

** date represents last of several days with rain, used as "effective" irrigation date

*** date changed by one day to account for rain on day following irrigation

**** some Loisiana data were not available in time for inclusion in this report

Table 3. Lint yield, assuming 35% gin turnout, from the 2002 cotton irrigation termination studies.

Treatment	Lint Yield, lb/acre
CBS	
1	1150
2	1234
3	1281
$LSD_{(0.05)}$	61
Stevens E Weaver	
1	1097
2	1105
3	1096
4	1117
$LSD_{(0.05)}$	n.s.
Stevens Barrett	
1	1087
2	1088
3	1066
4	1085
$LSD_{(0.05)}$	n.s.
Stoneville	
1	956
2	954
$LSD_{(0.05)}$	n.s.
NRS	
1	982
2	980
3	1001
$LSD_{(0.05)}$	n.s.