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DETERMINING THE OPTIMUM TIMING FOR THE FINAL DRIP IRRIGATION ON COTTON BASED ON CROP MONITORING: WEST TEXAS

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Abstract

Interest is growing in expanding the use of COTMAN to assist in end-of-season recommendations such as irrigation termination. Current recommendations in subsurface drip irrigated cotton are inadequate to determine the optimum timing to stop irrigation. This study was conducted to determine if crop based recommendations could be used for timing the final irrigation in subsurface drip irrigated cotton in West Texas. Treatments were made by shutting off the drip irrigation in an 8 acre zone at approximately 200, 400 and 600 Heat Units (HU) after cutout (based on 4 nodes above white flower). Evaluations included percent open boll, yield and fiber characteristics.

Continuing to irrigate the crop slowed boll opening and may have impacted the final yield of the crop. Shutting off the water too early can drastically affect yield. The 200 HU treatment had 536 and 369 lbs lint / acre less than the 400 HU and 600 HU treatments, respectively. Both the 400 HU and 600 HU treatments had increased lint and seed weights over the 200 HU treatment. The 600 HU treatment also had a higher seed weight than the 400 HU treatment.

With respect to fiber characteristics of the composite sample, micronaire was unaffected. The 400 HU treatment had higher fiber strength values than the 200 HU treatment, but the 600 HU treatment was not different from either of the other treatments. Of the fiber characteristics, fiber length was most affected by shutting the water off early. In the composite sample and all but the first harvest date, the 200 HU treatment had shorter fibers than both the 400 and 600 HU treatments.

No advantage was gained by watering subsurface drip irrigated cotton beyond the point of 400 HU past cutout. The COTMAN rules for HU accumulation appear to be beneficial in determining the final irrigation of subsurface drip irrigated cotton in West Texas. However, additional studies need to be conducted on when irrigation should cease in drip irrigated cotton that include the measurement of other factors in addition to HU accumulation since cutout.

Introduction

COTMAN has been under evaluation in Texas as a management tool for several years and is being incorporated as one of the tools in cotton production. Much of the research has focused on end-of-season management decisions, especially insecticide terminations. The expansion of research in Texas has proven valuable in adapting COTMAN to Texas. For example, COTMAN uses NAWF=5 for physiological cutout while Texas data has shown that NAWF=4 is a more reliable indicator of physiological cutout, especially in the western part of the state.

Interest is now growing in expanding the use of COTMAN to assist in other end-of-season recommendations. Growers are expanding the use of irrigation in west Texas, especially with the development of LEPA (Low Energy Precision Application) and subsurface drip irrigation systems. Water costs are a major input and any savings by increasing efficiency or limiting additional water inputs will accrue to the grower immediately. Current recommendations in subsurface drip irrigated cotton, concerning the timing of the final irrigation, are based on a variety of factors ranging from an educated guess involving firmness of bolls, percent open bolls and soil moisture considerations. Other methods for terminating irrigation on drip irrigated cotton relies on the calender and not on the maturity of the crop.

A recommendation that relates final irrigation to physiological cutout should provide a more reliable measure and fit with other management tactics such as insecticide termination and defoliation. This study was conducted to determine if the rules of COTMAN could be used to determine the final irrigation in subsurface drip irrigated cotton in West Texas.

Materials and Methods

The study was conducted in a growers field near Snyder, Texas. Due to certain constraints regarding the subsurface drip irrigation system, only one irrigation zone was used for each treatment. Each zone was 8 row acres of cotton. Thus, the design of this trial was non-randomized. Four sample sites were used in each treatment.

The variety FiberMax 989 was planted on 7 May, 2002 in a 2-1 skip-row pattern with 40-inch rows. The final plant stand was 3.1 plants per foot. Fertilizer was applied pre-plant, 267 lbs 11-26-0-3/A, and four post emergence applications of 57 lbs 32-0-0/A were made through the drip tape.

Scouting the field began on 6 June and the first squares were noticed on 19 June signaling the beginning of COTMAN data collection. Only one insecticide application was needed. Fury was applied on 15 July at a rate of 4 oz/A.

The field reached 4 nodes above white flower (NAWF) on 17 August. The first treatment was begun on 21 August with 126 Heat Units (HU) accumulated since cutout. Less than 5% of the bolls were open at this time. Water was shutoff for the second treatment on 3 September with 432 accumulated since cutout and approximately 15% of the bolls were open. On 14 September, water was shutoff of the third treatment. HU accumulation was 630 HU since cutout and approximately 20% of the bolls were open. The treatments will be referred to as the 200 HU, 400 HU and 600 HU treatments, respectively. One inch of rain fell on 29 August and 1 ½ inches fell on both 9 September and 14 September for a total of four inches during the experiment.

Harvest was taken on four dates from 10 feet of row from four locations in each treatment. At the first and third harvest dates, percent open observations were made on adjacent rows. At the final harvest, 100 boll samples were taken on adjacent rows to each of the harvest locations to determine boll characteristics. All harvest samples were ginned at the Lubbock Research and Extension Center and fiber characteristics were determined at the Texas Tech International Textile Center.

All data was analyzed in ARM 6. The percent open data was transformed by using the arcsin of the square root of the percent. Lint characteristics were not analyzed for the fourth harvest due to the need to combine samples in order to make a large enough sample to gin.

Results

Throughout the harvest time, continuing to irrigate the crop tended to slow boll opening (Table 1). On 13 September, the 600 HU treatment had 7.24 percent fewer bolls open than the 400 HU treatment and the 200 HU treatment was not different from the other treatments. On 15 October, the 600 HU treatment had 19.49 percent fewer open bolls than the 200 HU treatment and the 400 HU treatment was not different from either of the other treatments.

Harvest was accomplished by hand pulling bolls that were open sufficiently to insert the index finger into the top of the boll. Only the third harvest date exhibited any significant differences (Table 2). The 200 HU treatment had 446 lbs/A and 339.83 lbs/A less lint than the 400 HU and 600 HU treatments, respectively. And the 600 HU treatment had 106.17 lbs/A less lint than the 400 HU treatment.

The accumulated yields were analyzed by adding the lint together from each of the harvest dates. Beginning at the second harvest date, lint yields began to show differences (Table 3). At 24 September, the 400 HU treatment had 84.3 and 118.4 lbs/A more lint than the 200 HU and 600 HU treatments, respectively. In the15 October harvest, the 400 HU treatment has 491.6 more lbs lint /A than the 200 HU treatment and 185.7 more lbs lint /A than the 600 HU treatment. By the final harvest the lint yields of the 400 HU treatment and the 600 HU treatment were no longer significantly different, but they both yielded more lint than the 200 HU treatment. Thus, lint yields were impacted severely by shutting the irrigation water off at 200 HU after cutout.

Percent open boll data was not taken at the time of the last harvest. If the 600 HU treatment still had closed bolls at the final harvest, and this was visually observed but not documented, this may explain the numerical difference between the lint yields of the 400 HU treatment and the 600 HU treatment.

One hundred bolls were harvest to determine the lint and seed weight per boll. As the length of irrigation increased at the end of the season, so did the weight of the lint and seed in the bolls (Table 4). Both the 400 HU and 600 HU treatments had increased lint and seed weights over the 200 HU treatment. And the 600 HU treatment also had a higher seed weight than the 400 HU treatment.

Lint quality was analyzed from each of the four harvest dates and the 100 boll harvest composite sample. However, due to the fact that so little lint was collected from the plots in the fourth harvest on 11 November, one composite sample was made for ginning, thus, this data was not able to be statistically analyzed.

The micronaire value was lower for the 200 HU treatment than the others in the 13 and 24 September harvests but not different in subsequent harvests or in the 100 boll harvest (Table 5).

Fiber strength was increased by continuing to irrigate the crop (Table 6). The 200 HU treatment had a lower value for fiber strength than one or both of the other treatments in each harvest date and the 100 boll composite sample. No differences were observed between the 400 and 600 HU treatments except in the first harvest, where the fiber strength was increased by continuing to water the crop.

Fiber length was also impacted by continuing to water the crop (Table 7). In each of the sampling dates that the data was analyzed, the 600 HU treatment had longer fiber than the 200 HU treatment. And the 400 HU treatment had longer fibers than the 200 HU treatment in the 2 nd and 3^{ed} harvest, and the composite sample. No statistical differences were detected in fiber strength between the 400 and 600 HU treatments.

Continuous rains fell from the third week of October through the first week of November slowing the cotton harvest and the grower would not have harvested the 400 HU portion of the field prior to the rainfall. However while shutting the water off earlier did not result in losses due to weathering in this trial, or in the rest of the field, it may be an important factor in hastening the termination of the crop.

Conclusions

Yields were drastically reduced by shutting the water off at 200 HU after cutout compared to stopping the irrigation at 400 HU and 600 HU after cutout. Other factors that were detrimental to the 200 HU treatment involve boll and lint characteristics. This makes it unlikely that a grower would benefit from shutting off the irrigation wells this early.

No distinct differences were detected between the 400 HU and 600 HU treatments. The only major difference is in boll opening. Bolls in the 400 HU treatment opened earlier than in the 600 HU treatment. Thus, either there is no advantage to watering subsurface drip irrigated cotton beyond the point of 400 HU past cutout or there are other factors that need so be considered.

The COTMAN rules for HU accumulation may be beneficial in determining the final irrigation of subsurface drip irrigated cotton in West Texas. However, additional studies need to be conducted on when irrigation should cease in drip irrigated cotton that include the measurement of other factors in addition to HU accumulation since cutout. Some of these factors may want to consider soil moisture in the root zone and boll maturity at various levels in the canopy.

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References

Earl Vories, Jeremy Greene, Steve Hague, Bobby Phipps, Lyle Pringle, William Robertson, Phil Tacker, and Tina Teague. 2002. Determining the Optimum Timing for the Final Irrigation on Mid-South Cotton. 2002 Proceedings Beltwide Cotton Conferences, January 7-10, 2003. Nashville, TN. National Cotton Council, Memphis TN.

Table 1. Percent open bolls of the various subsurface drip irrigation termination treatments.

Treatment	13 September	15 October
200 HU	20.05 ab*	94.83 a
400 HU	22.84 a	85.83 ab
600 HU	15.7 b	74.96 b
p-value	0.0379	0.0274

*Means followed by same letter are not significantly different (α = 0.05). Data was transformed using the arcsin square root of the percent for analysis. Data shown is the untransformed data.

Table 2. Lint yield of individual harvest dates of the various subsurface drip irrigation termination treatments.

Treatment	13 September	24 September	15 October	11 November
200 HU	186.8	243.5	261.5 c	51.8
400 HU	223.0	295.6	707.5 a	106.0
600 HU	139.7	256.5	601.3 b	115.3
p-value	0.0701	0.0726	0.0001	0.2887

*Means followed by same letter are not significantly different (α = 0.05).

Table 3. Accumulated lint yields of the individual harvest dates of the various subsurface drip irrigation termination treatments.

Treatment	13 September	24 September	15 October	Total
200 HU	186.8	430.3 b	691.8 c	743.7 b
400 HU	223.0	514.6 a	1183.2 a	1280.0 a
600 HU	139.7	396.2 b	997.5 b	1112.8 a
p-value	0.0701	0.0101	0.0003	0.0015

*Means followed by same letter are not significantly different (α = 0.05).

Table 4. Lint and Seed Weight per 100 bolls of the various subsurface drip irrigation termination treatments.

Treatment	Lint Weight per 100 Bolls (g)	Seed Weight per 100 Bolls (g)
200 HU	152.7 b*	259.0 c
400 HU	178.4 a	283.0 b
600 HU	183.1 a	309.5 a
p-value	0.0006	0.0053

*Means followed by same letter are not significantly different (α = 0.05).

Table 5. Micronaire of individual harvest dates of the various subsurface drip irrigation termination treatments.

Treatment	13 September	24 September	15 October	11 November	Composite Sample
200 HU	3.55 b*	3.53 b	3.85	4.30	3.80
400 HU	4.05 a	4.10 a	4.07	3.30	4.07
600 HU	4.10 a	4.08 a	4.28	3.60	4.00
p-value	0.0075	0.0174	0.1780		0.2531

*Means followed by same letter are not significantly different (α = 0.05).

Table 6. Fiber Strength of individual harvest dates of the various subsurface drip irrigation termination treatments.

Treatment	13 September	24 September	15 October	11 November	Composite Sample
200 HU	35.45 b*	35.88 b	32.52 b	31.60	32.63 b
400 HU	34.75 b	37.14 a	34.45 a	32.70	34.17 a
600 HU	37.10 a	36.60 ab	34.28 a	32.60	33.50 ab
p-value	0.0153	0.0201	0.0441		0.0433

*Means followed by same letter are not significantly different ($\alpha = 0.05$).

Table 7. Fiber Length of individual harvest dates of the various subsurface drip irrigation termination treatments.

Treatment	13 September	24 September	15 October	11 November	Composite Sample
200 HU	36.5 b	35.3 b	32.3 b	35.0	34.5 b
400 HU	37.5 ab	37.4 a	35.0 a	36.0	35.8 a
600 HU	38.5 a	37.5 a	35.3 a	35.0	36.0 a
p-value	0.0156	0.0001	0.0001		0.0444

*Means followed by same letter are not significantly different ($\alpha = 0.05$).