TIMING DEFOLIATION BASED ON HEAT UNITS ACCUMULATED PAST CUTOUT

N. R. Benson
Univ. of Arkansas
Keiser, AR
W. C. Robertson
Univ. of Arkansas
Little Rock, AR
F. M. Bourland and E. D. Vories
Univ. of Arkansas
Keiser, AR

Abstract

COTMAN, a computer-aided cotton management program, was used to monitor approximately 80 acres of cotton in Mississippi county located in northeast Arkansas during the 1999 cropping season. Nodes-above-white-flower (NAWF) data, generated from COTMAN, was used to define the date of the last effective boll population (ie. Cutout or NAWF = 5). Heat unit (HU) accumulations were calculated beginning at the date of cutout by subtracting 60^0F from the average daily temperature. Replicated defoliation treatments were initiated in northeast Arkansas at approximately 650, 750, 850, and 950 HU's past cutout. Yield and fiber quality were compared in an effort to validate initial research efforts. No significant differences were observed in fiber micronaire, strength or length for plots defoliated at any of the four HU treatments. A greater percentage of seedcotton yield was obtained in the first harvest for plots defoliated at 948 HU's past cutout than for plots defoliated at 661 HU's past cutout. However, no yield penalty was recorded when defoliation was initiated at 763 (or more) HU's past cutout. Results of this study help to confirm that HU accumulations past cutout are an effective means of defining crop maturity. These results further indicate defoliation can be successfully timed based on HU accumulations beyond cutout.

Introduction

Defoliation marks the end of the production season and helps prepare the cotton crop for harvest. To be successful, defoliation must increase the chance of harvesting cotton of optimal yield and quality prior to the onset of adverse weather conditions. End-of-season management, including defoliation, should be based on crop development (last effective boll population) in relation to probable weather. Therefore, identifying the maturity of the latest boll population which has a high probability of being retained and developing into a boll of adequate yield and quality is required.

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Identifying which boll population should be used to define crop maturity is often the result of visual inspections of the "top crop". Percent open bolls, nodes above cracked boll and boll slicing have become standards used to determine crop maturity and trigger defoliation applications. Each of these measures, require a subjective identification of the last "effective" boll population. For these procedures, boll size is the most common criteria used to define the last effective boll population. Tharp (1960) however, reported that bolls reached their maximum size in as little as 18 days(after anthesis) even though actual maturity required 45 – 50 days. Furthermore, bolls set later in the season require longer to mature than bolls set early in the season (Morris, 1964). These reports would suggest that boll size may not be an accurate indicator of maturity. Determining crop maturity based on visual boll size of the top crop often causes defoliation to be delayed while waiting on "phantom" top bolls to mature.

Bourland et al. (1992) showed that a first position white flower five nodes below the terminal (NAWF = 5) signaed flowering of the last effective boll population (ie. Cutout). Their work indicated that flowers set above this critical position had a greater risk of being shed, and if retained, contributed little to total yield. Their study supported earlier work by Jenkins et al. (1990) who reported that less than 10% of total yield was obtained from the top five nodes. Benson et al. (1999) showed that NAWF = 5 represented the last boll population which warranted protection from fruit feeding insects. Their work suggested that any bolls set after NAWF = 5 did not significantly contribute to yield and were of little or no economic importance. Therefore, defining the maturity of the boll population identified at NAWF = 5 should aid in timing end-of-season management decisions, including defoliation.

The rate of boll maturity has been shown to be significantly correlated to temperature (Hesketh et al., 1968; Gipson and Ray, 1970). In a study in El Paso Texas, Young et al. (1980) showed an average of 950 HU's were required for a white flower to develop into an open boll. Wells (1991) suggested that HU's (based on 60^0 F minimum temperature) accumulated past the last effective flower population could be used to time cotton defoliation. Results of his study indicated that defoliation treatments my begin at 850 HU's beyond NAWF = 5 (cutout).

The objective of this study was to provide additional evaluation of the use of heat unit accumulation past cutout (NAWF = 5) as a means to initiate defoliation applications.

Materials and Methods

Cotton, cultivar Sure-Grow 501, was planted on an 80 acre, center pivot irrigated, field in northeast Arkansas on May 13,

1999. Production practices, including insect control, were based on University of Arkansas cotton production recommendations (Bonner, 1995). The field was monitored with the COTMAN, cotton management, program as described by Tugwell et al. (1998). Field reports generated from the COTMAN program were used to establish date of cutout.

Treatments were established after cutout (NAWF = 5) and included defoliation applied at approximately 650, 750, 850 and 950 HU's beyond cutout. Heat units were calculated by subtracting 60^0 F from the average daily temperature. Plots consisted of four-rows (38 inch centers) 25-feet long. Plots were arranged in a randomized complete block design and treatments replicated four times.

Prior to each defoliation treatment, percent open bolls and nodes above cracked boll counts were collected. Percent open bolls were determined by the percentage of open bolls to total number of bolls in a three foot section of one of the center two rows. The average number of nodes above cracked boll were collected by counting the number of nodes above the highest first position cracked boll (to the terminal) from each plant in the same three-foot section.

Defoliation treatments were applied with a CO_2 backpack sprayer calibrated to deliver 20 gal. per acre at 40 psi. All defoliation treatments consisted of 1/2 pint Def + 2 2/3 pints Prep per acre applied to all four rows. Fourteen-row feet (7 feet from each of the two center rows) were hand harvested approximately 14 days after each treatment. All plots received a second harvest on September 26, 1999. From each hand-harvested sample, seedcotton per acre were calculated and fiber properties were obtained after ginning.

Results and Discussion

Cutout (NAWF = 5) was reached on July 27, 1999 (75 days after planting) (Figure 1.). HU accumulations were calculated from the date of cutout by subtracting 60^0 F from the daily average temperature. Unusually warm temperatures during July, August and September resulted in HU accumulations in excess of the 30 year average for northeast Arkansas (Table 1). During the period from cutout to the last defoliation treatment, HU's per day averaged nearly four above the 30-year average resulting in treatments being separated by only four and five days (Table 2). Actual HU's at time of defoliation application differed slightly from the targeted HU timing.

Fiber Properties

Although not significant, the earliest defoliation had the lowest micronaire value (Table 3). Micronaire values ranged from a high of 4.6 when defoliated at 837 HU's past cutout to a low of 4.3 when defoliation was applied at 661 HU's past cutout. Fiber length and strength were not effected when defoliation was initiated at any of the four HU levels. These data suggest that reductions in fiber quality are not likely when defoliation is initiated at cutout + 661 HU's

Yield

Defoliation timing had significant effects on yield and percent first harvest (Table 4). Seedcotton obtained in the first of two harvests (14 days after treatment) tended to increase as defoliation treatments were delayed. Plots defoliated at 837 and 948 HU's past cutout yielded 87.1 and 96.9% respectively, of total yield in the first harvest. Plots defoliated at 837 HU's past cutout had less than 26% open bolls at the time of treatment. This treatment however, resulted in the greatest numeric total yield. Plots treated at 948 HU's past cutout had 64.3% open bolls at the time of defoliation. Although this treatment more closely resembled standard practices for timing defoliation (ie. 60% open bolls), yields were not significantly different from the 837 or 763 HU treatments.

These data indicate that HU accumulation beyond the last effective boll population may be a more accurate measure of crop maturity than traditional percent open boll estimates. Timing defoliation on the accumulation of HU's past cutout may allow defoliation to be initiated earlier and improve the probability of harvesting prior to adverse weather.

Conclusions

Monitoring the maturity status of the last effective boll population (ie. HU's past cutout) appears to be an adequate tool for successfully timing defoliation. The range of HU treatments which had no significant effect on yield or fiber quality should provide cotton producers the flexibility and confidence to develop a defoliation schedule aimed at reducing end-of-season risk.

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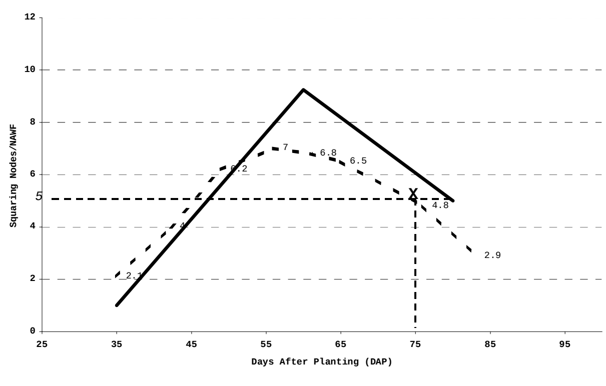

Figure 1. COTMAN output for 1999 defoliation test in northeast Arkansas.

Table 1. Mean temperatures and heat unit (DD60's) accumulations for northeast Arkansas in 1999 compared to 30 year averages.

Month	1999 Mean daily --Temperature--	1999 Mean daily --Heat unit--	30-year Mean daily --Heat unit--
June	79.1	19.1	18.3
July	84.4	24.4	21.2
August	81.3	21.3	18.7
September	74.7	14.7	12.2
July 27 - Sep. 8 (Cutout to last trt)	no data	22.2	18.5

Table 2. Heat units, % open bolls and nodes above cracked boll (NACB)
for plots (northeast Arkansas in 1999)at time of defoliation treatments.

Treatment	HU's (actual)	Treatment date	% open bolls [1]	NACB	Harvest Date
650	661	25 Aug	6.4	--	7 Sep
750	763	30 Aug	24.9	4.5	12 Sep
850	837	3 Sep	24.4	5.7	17 Sep
950	948	8 Sep	64.3	3.5	22 Sep
LSD (0.05)			21.2	NA[2]	

[1] % open derived from (open bolls/total bolls)*100 for a 3 row ft. sample.
[2] Data for NACB was not analyzed.

Table 3. Fiber properties[1] for plots (northeast Arkansas in 1999) defoliated at different heat units past NAWF = 5 (cutout).

HU's at Defoliation	Fiber micronaire	Fiber length	Fiber strength
661	4.3	1.2	33.9
763	4.5	1.2	33.4
837	4.6	1.2	33.3
948	4.5	1.2	34.3
Average	4.5	1.2	33.7
LSD (0.05)	NS	NS	NS

[1] Fiber properties determined from a weighted average of samples collected in the first and second harvest.

Table 4. Seedcotton yields for plots (northeast Arkansas in 1999) defoliated at different heat units past NAWF = 5 (cutout).

HU's at	---------Seedcotton yield (lb/a)----------			% First
Defoliation	1st harvest[1]	2nd harvest	Total	harvest
661	1377	252	1629	84.5
763	1475	449	1924	77.2
837	2390	385	2775	87.1
948	2689	76	2765	96.6
Average	1983	291	2273	86.3
LSD (0.05)	882	176	969	10.3

[1] Total seedcotton collected from 14 row ft. (7 feet from each of the center rows).