VALIDATION OF THE INSECTICIDE TERMINATION COMPONENT OF COTMAN

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Abstract

The substantial cost of late-season insect control and the uncertainty producers have knowing when a crop is safe to terminate have necessitated the development of better end-of-season cotton management programs. One component of COTMAN, a computer aided cotton management program, is used to identify when insecticide use can be terminated based on crop development status. COTMAN therefore, has the potential of saving producers unnecessary late-season insect control costs. Studies to validate the insecticide termination component of COTMAN were conducted on nine grower fields from north Arkansas to south Arkansas. Results of the studies indicate that COTMAN rules are sufficient for timing insecticide termination for the control of fruit feeding insects. Even in fields expressing extremely pre-mature cutout, no yield advantage was obtained by extending insect control past cutout + 350 DD60's. Averaged across the state, insect control beyond cutout + 350 DD60's resulted $15.00 per acre more inputs with no yield increase.

Introduction

Inconsistent cotton yields and low prices have increased the importance of reducing cotton production costs. Knowing when to terminate crop inputs, especially expensive late season insecticides, continues to be one of the most difficult yet important decisions producers face. Defining when a boll is no longer susceptible to insect feeding is possible using heat unit accumulations (Bagwell and Tugwell, 1992; Bagwell, 1994). Showing a decline in boll weevil and bollworm damage to bolls at 350 DD60's after anthesis, their data suggest that insecticide termination could be timed based on heat unit accumulation past the last effective flower date. Therefore, the challenge is to identify the last boll population that warrants protection.

Accurate, in-season, measures of crop maturity are essential if end-of-season practices are to be more profitably managed. Ray and Richmond (1966) found that node of first fruiting branch was a good measure of maturity. This measurement however, occurs too early in the season to be used to manage end-of-season production practices. Recently, the proximity of first position white flowers to the plant terminal have been used to define crop maturity.

The occurrence of white flowers in the plant apex has long been recognized as a sign of the cessation of flowering, and commonly referred to as cutout. Kerby and Buxton (1981) reported that this phenomena resulted from a reduction in assimilates available for vegetative growth after flower initiation. Waddle (1973) suggested that counting the number of nodes above the last white bloom during the third week of blooming was a good indicator of maturity, and that it could be used to measure cutout. Waddle (1982) recognized that a white flower 3 inches down from the terminal marked the end of effective flowering. More recently, Bourland et al. (1992) defined the flowering date of the last effective boll population using numbers of nodes above the uppermost first position white flower (NAWF). In a study where first position white flowers were tagged and harvested at maturity, they found that NAWF = 5 represented the last flower population that significantly contributed to yield, and was the basis for defining cutout. Their work further suggested that cotton should have 8 – 10 NAWF at first flower and decline to cutout (NAWF = 5) by approximately 80 days after planting. Zhang et al. (1994 a; 1994 b) reported that, based on historical weather data, NAWF = 5 could be used to identify cutout only if there is a sufficient probability of that flower population developing into a harvestable boll of adequate quality. Their work indicated late season weather may dictate the date of the last effective boll population. Recognition of weather restraints resulted in cutout being defined as physiological, seasonal, or pre-mature (Oosterhuis et al. 1996). A crop has reached physiological cutout when its average NAWF = 5. Seasonal cutout is defined as the flowering date of the last effective boll population being determined by end-of-season weather constraints rather than by crop maturity. Pre-mature cutout is a type of physiological cutout in which excessive stress causes the crop to attain NAWF = 5 much earlier than desired.

The concepts of predictable nodal development, accurate identification of the last effective boll population, and recognition of weather restrictions have been combined to form one of the key components of COTMAN. COTMAN, a recently developed cotton management program, uses these criteria to time the termination of insecticide use. The use of COTMAN for determining when to terminate insecticide use has shown potential for increasing farm profitability (Cochran et al. 1994). The objective of this study was to validate the insecticide termination component of COTMAN in producer fields across Arkansas.

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Materials and Methods

In 1998, COTMAN demonstration fields were established in cooperation with local extension agents, consultants and producers in six counties in Arkansas: three fields in Mississippi County, one field in Poinsett County, one field in Crittenden County, one field in St. Francis County, one field in Jefferson County and two fields in Lincoln County. The experimental design was a randomized complete block with plots running the length of the field. Cultivar and date of planting were based on individual producer preferences and varied across locations (Table 1). All crop production practices were consistent within a field and were implemented independently by producers based on their normal production practices.

Measurements of NAWF were made as described by Bourland et al. (1992). Weekly NAWF measurements began at approximately first flower. NAWF counts were taken from ten plants at each of four sites per field. Data were collected approximately once per week until NAWF = 5 (cutout). Once a field reached cutout, heat unit accumulation was tracked using the following equation:

$$[(\text{Daily high temp.} + \text{Daily low temp.})/2] - 60$$

Treatments were established after the accumulation of 350 DD60's beyond cutout, and included treated and untreated plots at each location. Untreated plots received no insecticide applications after cutout + 350 DD60's. Insect control continued on treated plots after 350 DD60's had been accumulated beyond cutout. Insecticide applications in treated plots were based on producer and consultants prescribed thresholds, and were applied as often as the producer deemed necessary. Plot size was not consistent within locations and varied greatly across locations (Table 2). All other production practices were consistent across treatments within a location.

Harvest

Timing of defoliation and harvest initiation was determined by the producer and was consistent across plots within a location. Across locations, harvest area ranged from 0.25 acres to greater than seven acres per plot (Table 2). All plots were machine harvested using producer equipment, and seedcotton weights recorded. Data were converted to pounds of seedcotton per acre with lint yields calculated based on an assumption of 33.3% turnout. Yield data were analyzed over locations and within locations using analysis of variance statistical procedures. Mean yields of treated and untreated plots were compared and separated using Fisher's Protected LSD test at the 0.05 level of probability.

Results and Discussion

Date of cutout (NAWF = 5), days from planting to cutout and date of cutout + 350 DD60's varied across locations (Table 3). Cutout at the Finch, Stuckey and Wildy15 locations occurred 70, 49, and 64 days after planting, respectively. Extremely hot dry weather in conjunction with possible delays in irrigation caused crops at these locations to cutout much earlier than would be desired. This "stress induced" cutout was followed by a resurgence of crop growth later in the season, making end-of-season management much more difficult than for crops with a non-stressed induced cutout. The three locations having extremely early cutout were separated from the other locations and grouped as fields having pre-mature cutout. The six remaining locations reached cutout near 80 days after planting and prior to historical weather restrictions. Therefore, these fields were categorized as having physiological cutout. No field in this study expressed seasonal cutout.

Pre-Mature Cutout

Yields for treated and untreated plots at the Stuckey, Finch, and Wildy 89 locations are reported in Table 4. No yield advantage was observed in plots where insect control continued after cutout + 350 DD60's. Although not statistically different, yields tended to be slightly lower where insect control was terminated at cutout + 350 DD60's.

Average yields of locations having pre-mature cutout were significantly lower than yields of locations expressing a physiological cutout (Table 4). Reduced yields associated with pre-mature cutout indicated that problems caused by early season- stress could not be overcome.

Physiological Cutout

Insect control after cutout + 350 DD60's did not result in increased yield in fields having physiological cutout (Table 4). A yield increase of 84 pounds was observed in the untreated plots at the Kimbrell location. Across locations, plots receiving no insecticide after cutout + 350DD60's yielded 22 pounds more lint than did the plots sprayed full-season. These data support results obtained by Ungar et al. (1987). In their study, removal of large squares late in the season provided a 12% increase in grams of seedcotton/m^2 over control plots. Results of these studies indicate that late-season removal of fruit, which is not likely to be harvested, may allow more carbohydrates for the most economically important bolls.

Cost of Control

As is typical from north Arkansas to south Arkansas, cost of insect control late in the season varied across locations (Table 4). Cost of insect control after cutout + 350 DD60's ranged from a low of $5.34 at the Kimbrell location (Central Arkansas) to a high of $27.46 at the Tarlton location (Southeast Arkansas). Across locations, cost of insect control after cutout + 350 DD60's was $15.38 for no additional yield.

Conclusions

These data support the use of COTMAN rules for timing insecticide termination late in the season. Even under conditions of pre-mature cutout, it appears that control of fruit feeding insects after cutout + 350 DD60's does not improve farm profitability. Significant yield responses should not be expected as a result of controlling fruit feeding insects beyond cutout + 350 DD60's. Results of this study showed an average insect control cost of greater than $15.00 for plots treated after cutout + 360 DD60's. These plots however, had no statistical yield advantage over the untreated plots. As was evident in the pre-mature cutout fields, COTMAN appears to be capable of detecting crop stress well before the end of the season. Although COTMAN's contribution to end-of-season management was obvious in this study, the ability to detect early season stress may prove even more valuable.

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Table 1. Planting dates and cultivars used in 1998 test sites.

Location*	County	Cultivar	Planting Date
Edwards	Mississippi	Stoneville BXN 47	April 24
Wildy 15	Mississippi	Deltapine 5111	May 6
Wildy 89	Mississippi	Stoneville BXN 47	May 17
Finch	Poinsett	Stoneville BXN 47	April 25
Stuckey	Crittenden	Stoneville BXN 47	May 14
Gandy	St. Francis	Stoneville 474	May 7
Kimbrell	Jefferson	Stoneville BXN 47	May 8
Tarlton	Lincoln	Deltapine NuCotton 33B	May 5
Mizell #3	Lincoln	Stoneville 474	May 9

* Arranged from north to south Arkansas

Table 2. Plot size, harvest area and number of replications in1998 test sites.

Location	Treated* (ac)	Untreated** (ac)	Harvested (ac)	Reps (no.)
Edwards	7.40	7.40	7.40	2
Wildy 15	6.75	6.75	6.75	3
Wildy 89	2.25	2.25	2.25	7
Finch	8.85	4.40	1.47	5
Stuckey	8.00	8.00	1.60	3
Gandy	2.50	2.50	0.20	3
Kimbrell	3.00	1.80	0.40	4
Tarlton	2.50	2.50	0.25	4
Mizell #3	2.00	2.00	0.40	4

* Plots where insects were controlled after cutout + 350 DD60's
** Plots where insect control was terminated at cutout + 350 DD60's

Table 3. Date of cutout, days from planting to cutout, and date of cutout + 350 DD60's for all locations.

Location	Cutout Date	Days to Cutout	Date of 350 DD60's
Pre-Mature Cutout[1]			
Wildy 89	July 20	64	August 5
Finch	July 4	70	July 22
Stuckey	July 1	49	July 17
Physiological Cutout[2]			
Edwards	Jul 22	89	August 8
Wildy 15	July 25	80	August 11
Gandy	August 9	88	August 20
Kimbrell	July 30	83	August 14
Tarlton	July 21	73	August 6
Mizell #3	July 23	79	August 8

1. Pre-mature cutout defined as early cutout due to excess stress.
2. Physiological cutout defined as crop reaching NAWF = 5 without end of season weather restraints (NAWF = 5 prior to the latest possible cutout date).

Table 4. Yield of treatments and cost of applications made after cutout + 350 DD60's

Location	Lint TRT [1]	Yield TRT [2]	LSD	Late No. [3]	Insecticide Cost[4]
Pre-Mature[5] Cutout					
Wildy 89	437	450	50	2	$16.15
Finch	486	494	11	2	$12.29
Stuckey	499	508	84	1	$12.33
Average	474	484			$13.59
Physiological Cutout					
Edwards	768	739	639	2	$13.95
Wildy 15	896	866	103	2	$16.15
Gandy	788	793	322	1	$10.30
Kimbrell	938*	854*	56	1	$ 5.34
Tartlton	735	747	41	2	$27.46
Mizell #3	1,028	904	251	2	$24.46
Average	859	817			$16.28
Avg. All Locations	696	675		27.9	$15.38

1. Insect control terminated at cutout + 350 DD60's
2. Insect control applied full season
3. Number of insecticide treatments made after cutout + 350 DD60's
4. Total cost of insecticide (including cost of application) applied after cutout + 350 DD60's
5. When averaged across treatments, means for pre-mature cutout fields (479 lbs) were significantly less than physiological cutout fields (838 lbs).
   * Significantly different at the 0.05 level of probability