2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

FINAL IRRIGATION TIMING AND LATE SEASON CROP SUSCEPTIBILITY TO TARNISHED PLANT BUG (LYGUS LINEOLARIS PALISOT DE BEAUVOIS) – USING COTMAN TO MAKE CROP TERMINATION DECISIONS

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Abstract

Research to establish and validate end-of-season crop management guides for timing final furrow irrigation and for terminating insecticide applications for tarnished plant bug (*Lygus lineolaris* (Palisot de Beauvois)) is underway in Arkansas. In the first year of a planned 3-year study, we examined interactions of late season irrigation and insect control in a field trial on the University of Arkansas Cotton Branch Experiment Station in Marianna. Termination of insecticide and irrigation prior to physiological cutout (mean NAWF =5 (nodes above white flower))resulted in significant yield penalties compared to later termination dates. Extending insecticide sprays past 240 DD60 past physiological cutout (NAWF=5) or irrigation beyond 350 DD60s after NAWF=5 did not significantly improve yields. Late irrigations delayed boll opening. Results from this one season of research in the Central Eastern Arkansas indicate that the insect control termination guide in COTMAN that has been in use for heliothine caterpillars and boll weevils (NAWF=5 +350 DD60s) is more than sufficient for late season plant bug management, and timing of final furrow irrigation also may be appropriate at this same crop stage.

Introduction

The question of when a cotton crop is safe from late season insect pests has been the focus of intense research in the Midsouth for the last 20 years. Cotton Incorporated has supported research efforts that have yielded a simple crop monitoring procedure and crop termination rule that allow a decision maker to define the final stage of crop susceptibility for bollworms, tobacco budworms and boll weevil. This final stage is that point in the season when the crop is no longer susceptible to new infestations, when thresholds become irrelevant, and when additional insecticide applications are uneconomical (Pedigo et al 1986). The COTMAN™ system allows the user to determine the flowering date of the last effective boll population and to define when those bolls have reached the final stage of susceptibility. Extensive, large scale field research in the Midsouth has shown that at 350 heat units (DD60s) after physiological cutout (mean NAWF =5 (nodes above white flower)), the crop is safe from ***new*** infestations of bollworm, tobacco budworm, and boll weevil (O'Leary et al 1996, Harris et al. 1997, Cochran et al 1999, Danforth et al 2004). Teague et al. (2002) conducted on-farm studies in 2001 to evaluate late season crop susceptibility to tarnished plant bug and found that the 350 DD60 rule was adequate for crop protection from that insect. In those studies, plant bug injury did not affect yield with infestations beginning at cutout +150 DD60s. In studies conducted in Mississippi, Horn et al. (1999) examined the incidence and severity of plant bug feeding punctures in no-choice cage studies. Adult bugs were confined on bolls of different ages for 48 hrs. They determined that bolls which had accumulated 250 DD60s were relatively safe from tarnished plant bug injury.

There are on-going Cotton Incorporated funded research efforts focused on using crop monitoring with NAWF and COTMAN to time the final irrigation (Vories and Glover, 2000; Vories et al. 2001, 2002, 2003, 2004). In 2001, only two of the eight studies in 3 states (MO, AR, LA) had yield response to late irrigation. In the two cases where yield differences were significant, the differences for southeast Arkansas were observed later in the growing season (after 20 days or 470 DD60 after NAWF=5) than for northeast Arkansas (where no differences were observed with irrigation later than 11 days or 220 DD60 after NAWF=5). Eleven irrigation studies were conducted in five states (MO, AR, LA, TX) during the 2002 growing season to investigate the response to late-season irrigation. In the Midsouth, 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. The rest showed no yield or quality response to irrigation after cutout. In the trial at Marianna, AR in 2002, a significant benefit was observed if irrigation was extended from NAWF=5+ 250 to include an irrigation at NAWF=5+ 350, but no benefit was observed with final irrigation at NAWF=5 + 500 DD60s. When the test was repeated in 2003 and 2004, there was no yield penalty for termination of irrigation at 350 DD60s after NAWF=5. In limited insect scouting conducted at that study site in 2002, it was noted that pest insect population densities, particularly plant bug, were significantly higher where irrigation continued for 2 additional weeks with termination at 500 DD60s after cutout compare to final irrigations at NAWF=5+350 DD60s (T. G. Teague, unpublished).

Limiting late season irrigation may reduce lush fall crop growth that can make defoliation more difficult and costly, ultimately delaying harvest. Reducing late season lush growth also may reduce the movement of migrating insect pests such as plant bugs, stink bugs and bollworms/tobacco budworms into the field when they attracted to high quality food in rank growth. Movement of resident populations of insect pests out of the field may be encouraged by early irrigation termination. Just the presence of insect pests in rank cotton in late season may give the perception that they are damaging the crop even when their effect may be unimportant. The result is added anxiety in deciding to terminate insecticide applications. Timely irrigation termination may help growers feel confident in eliminating unnecessary and expensive late season insecticide sprays.

In the first year of a planned 3-year study, our focus was to address the following questions….Does the final stage of crop susceptibility (insecticide termination) and the timing for the final irrigation occur at a similar crop stage --- Cutout + 350 DD60s? Does prolonging irrigation delay the onset of final stage of crop susceptibility for plant bugs? Will earlier cessation of irrigation affect movement of insects into or out of a field and reduce the need (or perceived need) for late season insecticide inputs? Will prolonged irrigation and insecticide application produce higher yields?

Materials and Methods

The experiment was conducted on the University of Arkansas Cotton Branch Experiment Station in Marianna. The growing season in the study area is May through October. The latest possible cutout date for this production area – that date with a 50% or 85% probability of attaining 850 DD60s from cutout is August 14 and August 9, respectively (Danforth and O'Leary 1996).

Cultivar Stoneville 4892 RBG was seeded on 8 May at a seeding rate of 3 to 4 seeds/ft in rows spaced 38 inches apart. Temik 15G (aldicarb) was applied in furrow at planting at 3.5 lb formulation per acre. The soil was a Calloway silt loam. Furrow irrigation timing was based on University of Arkansas Irrigation Scheduler Program and was initiated at a 1 inch deficit until mid-July. The experiment was set up as a 4 * 5 factorial with insect control termination (4 factors) and irrigation termination (5 factors) arranged in a split plot with irrigation as main plots. Plots were 60 ft long, and 8 rows wide. Fifteen ft alleys separated plots. There were 3 replications. Tarnished plant bug numbers were low to moderately high through the season with weekly sprays needed on most of the cotton fields on the Experiment Station starting about the 2nd week of squaring. Plots were furrow irrigated on 14, 22, 30 July, 9, 14, 19 26 and 31 Aug; insecticide applications were made on 11, 18 June, 6, 16, 22, 28 July and 8, 17 and 24 August. Irrigation and insecticide termination dates and treatments are listed in Table 1. Plant bug numbers were monitored in all plots in Aug sampling using a 12 inch sweep net – 10 sweeps in the terminal portions of plants in rows 5 and 6 of each plot. Plants were monitored in each plot from the early squaring period through cutout using the Squaremap procedure in the COTMAN™ crop monitoring system (Danforth and O'Leary 1998). Two sets of five consecutive plants in the center rows were monitored weekly. Sampling included measurement of plant height, number of sympodia, and presence or absence of first position squares and bolls. After first flowers, NAWF also were monitored using the COTMAN Bollman sampling protocol. The Scoutmap procedure for COTMAN was performed the final week of August to measure retention and external feeding injury on fruiting forms. The procedure is similar to the Squaremap sampling routine except that retained 1st position fruiting forms with injury symptoms are identified during mapping. Sampling included measurement of number of squaring sympodia (pre-flower) and fruiting sympodia (1st position square has flowered), and presence or absence of first position squares and bolls and whether those fruiting forms had been injured by insect feeding. Additional assessments to evaluate treatment effects on crop maturity included Nodes above Cracked Boll (NACB) determinations which were made on 8 and 22 Sep. Ten plants were inspected per plot. Final plant mapping was performed following defoliation on 5 Oct using COTMAP (Bourland and Watson 1990). Ten plants in one row per plot were examined for node number of first (lowest) sympodial branch on the main axis, number of monopodia, and number of bolls on sympodia arising from monopodia. Bolls located on main stem sympodia (1st and 2nd position) were recorded, as well as bolls located on the outer positions on sympodial nodes (>2nd position). The highest sympodium with 2 nodal positions and number of bolls on sympodia located on secondary axillary positions were also noted. Plant height was measured as distance from soil to apex. Harvest aid chemicals for defoliation and boll opening were applied 22 Sept and 1 Oct; defoliation was initiated at NAWF=5+883 DD60s. Plots were machine harvested using a 2-row picker on 6 Oct – rows 3 and 4 of each plot were harvested. Fifty boll samples taken throughout consecutive plants were collected at harvest and submitted to the International Textile Center at Texas Tech University for HVI fiber quality determinations. All crop and insect monitoring and yield data were analyzed using AOV with mean separation using LSD.

Results

Rainfall accumulations in May, June, July, August, and September were 6.9, 6.8, 3.2, 0.45, and 0 inches, respectively (Fig. 1). Because of the low incidence of rainfall in Aug and Sep, irrigation termination treatments were not severely impacted by natural rainfall. Temperatures for the growing season were below average beginning in mid July. DD60 accumulations for 2004 compared to the fifty year average for the Marianna site are presented in Figure 2. COTMAN growth curves show that 1st squares appeared for all treatments just prior to the target date of 35 days after planting (Fig 3). Sympodial development was comparable to the COTMAN target development curve (TDC) through the season; plant structure at 1st flowers was slightly lower than the standard curve (8.5 sympodia compared to the TDC standard of 9.25). Plants in all treatments reached physiological cutout (mean NAWF=5) on 23-24 July, 76 to 77 days after planting. Neither irrigation nor insecticide termination timing affected days to cutout (Table 1). Effects of irrigation termination were not apparent on growth curves until after physiological cutout. At 93 DAP, a significantly lower (P>F 0.02) mean NAWF of 1.65 was observed for the first irrigation termination treatment (final irrigation was applied at NAWF=7.2) compared to later irrigation termination dates (NAWF means ranged from 2.2 to 2.6) (Fig 3).

Tarnished plant bug population densities were maintained at moderately low levels with insecticide applications until termination of sprays. As insecticide termination treatments were initiated, mean numbers of total bugs per 10 sweeps rose (Table 3). First position square shed recorded in the first COTMAN sample at 35 DAP was less than 4% in all treatments, but rose to 25% by the time of first flowers (Table 4). Differences in square shed levels between insecticide termination treatments became apparent by 29 July after the first insecticide termination date of 16 July. Boll shed levels were significantly higher by 4 Aug where insecticides had been terminated compared to sprayed treatments. By 23 Aug, few squares remained on plants, and boll retention levels were less than 50% for some treatments (Table 5). On that sampling date, there were significantly higher numbers of bolls with feeding injury in early insecticide termination plots compared to plants protected later in the season (Table 5). Small boll (1st position bolls located on the uppermost 3 fruiting sympodia) injury levels ranged from 37% to 3.7%. No irrigation or irrigation*insecticide effects were statistically significant.

Varying rates of boll opening in response to irrigation termination treatments lead to striking visual differences between plots in early Sep. These maturity differences are reflected in NACB measures (Fig 4). Mean NACB levels on 8 Sep ranged from 7.9 to 4.4 in late compared to early irrigation termination timing. By 22 Sep, mean NACB fell below 3.4 for the final irrigation termination treatment. Insecticide application timing did not affect NACB values, and there were no irrigation*insecticide interactions.

Results from final plant mapping indicated that no. of sympodia, no. of sympodia with 1st and 2nd position bolls, total bolls/plant and % boll retention of 2nd position bolls were significantly reduced with early irrigation termination prior to physiological cutout (Table 6). No differences in these measures were observed if irrigation was extended until NAWF+360 DD60s and NAWF + 580 DD60s. Final plant mapping results also indicate that early insecticide termination reduced mean no. of sympodia with 2nd position bolls, no. of sympodia with 1st and 2nd position bolls, % retention of 1st position bolls and 2nd position bolls and early boll retention (Table 7). No differences in these values were observed among insecticide termination treatments of NAWF=5 + 240 DD60s and at NAWF=5 + 450 DD60s. No significant interactions between irrigation and insecticide termination were observed for final plant mapping results.

Lint yield was significantly reduced when either insecticides or irrigation were terminated prior to physiological cutout (Fig 5 and 6). No significant irrigation * insecticide interactions were observed to affect yield. There was no yield penalty associated with terminating irrigation at 360 DD60s after cutout compared to 580 DD60s. No significant yield reduction was noted with insecticide termination made at NAWF =5+240 DD60s compared to extending sprays until DD60s levels had reached 460. HVI measures indicated significant differences in fiber quality among treatments. Micronaire was significantly increased with early insecticide termination (Fig 7). Fiber strength and elongation were significantly reduced if irrigation was terminated prior to cutout (Table 7).

Discussion

In an unusually cool summer with limited rainfall in August and September and with moderate levels of tarnished plant bugs, terminating irrigation and insecticides prior to physiological cutout resulted in lower yields. No yield or fiber quality penalty was observed with terminating insecticides at 240 DD60s or irrigation at 360 DD60s compared to extended applications. Late season irrigation tended to delay crop maturity as measured by NACB. Such visual cues of greater abundance of green bolls may act to delay defoliant applications by decision makers.

The plant bug pest pressure began in early squaring and was sustained through cutout. Late season sampling using the COTMAN Scoutmap procedure provided documentation that plant bug injury levels were elevated where insecticides were suspended too early. This sampling technique can provide a systematic method for monitoring boll retention as well as accounting for external boll injury. This method may over-estimate boll damage however, since the boll wall may not be completely penetrated by insect feeding. Inspection of internal injury using boll slicing techniques is a surer means of detecting potential economic damage.

Results from this 2004 research support insect control termination decision guides that have been in use for Heliothine caterpillars and boll weevils (cutout +350 DD60s). The current COTMAN recommendation for terminating insecticides for

TPB is to control the insect population until the last effective boll population has accumulated 350 DD60s. Research is on-going to produce a regionally accepted recommendation for irrigation termination.

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Acknowledgements

This project was funded in part through Cotton Incorporated Core Funds and the Arkansas State Support Committee. Special thanks to Claude Kennedy, Jimmy Hornbeck, Clayton Treat, and Kristen Edwards and the staff at the University of Arkansas Division of Agriculture Cotton Branch Experiment Station at Marianna their support and assistance.

Table 1. Mean number of days after planting and calendar dates at which plants reached physiological cutout (mean NAWF=5) in irrigation main effects and insecticide termination sub- plot effects (Marianna 2004).

Treatment [1]	Date of final application	Days after planting	Crop maturity status at final application	Mean date of physiological cutout [2]	Mean no. days to cutout [3]
Irrigation	14-Jul	67	NAWF = 7.2	23-Jul	76.3
	22-Jul	75	NAWF = 5.6	24-Jul	77.6
	30-Jul	83	NAWF = 5 + 100 DD60s	24-Jul	77.4
	18-Aug	103	NAWF = 5 + 360 DD60s	24-Jul	77.1
	31-Aug	115	NAWF = 5 + 580 DD60s	25-Jul	78.3
Insecticide	16-Jul	69	NAWF = 7.2	24-Jul	77.6
	21-Jul	74	NAWF = 5.6	24-Jul	77.5
	8-Aug	92	NAWF = 5 + 240 DD60s	24-Jul	77.0
	24-Aug	108	NAWF = 450 DD60s	24-Jul	77.2

[1] Furrow irrigation dates: 7/14, 7/22, 7/30, 8/9, 8/14, 8/19, 8/26, 8/31; insecticide applications were made on 6/11, 6/18, 7/6, 7/16, 7/22, 7/28, 8/8, 8/17, 8/24.
[2] Mean date at which treatments reached mean NAWF = 5.
[3] No significant main, subplot effects or interactions .

Table 2. Application timing, products and crop status at the time of final application in insecticide termination sub-plots. Late season decisions (after 21 July) for product and application timing were made by the commercial crop advisor employed by the Cotton Branch Station in Marianna 2004.

Application Date	Product (rate/acre)	Termination Treatment
11-Jun	Centric (1.55 oz)	
18-Jun	Centric (1.25 oz)	
06-Jul	Centric (1.25 oz)	
16-Jul	Trimax (1.5 oz)	Treatment 1 final spray (NAWF = 7.2)
21-Jul	Bidrin (8 oz)	Treatment 2 final spray (NAWF = 5.6)
28-Jul	Orthene/Fury/Zephyr (0.75 lbs + 4 oz + 5.9 oz)	
08-Aug	Trimax/Capture (1.5 oz + 5 oz)	Treatment 3 final spray (NAWF = 5 + 240 DD60s)
17-Aug	Bidrin/Trimax/Capture (8oz + 1.5 oz + 5 oz)	
24-Aug	Bidrin/Trimax/Capture (8oz + 1.5 oz + 5 oz)	Treatment 4 final spray (NAWF = 5 + 450 DD60s)

Table 3. Mean no. of tarnished plant bug nymphs and adults observed per 10 terminal sweeps on 3 dates in insecticide termination sub-plots.

Sample date (DAP)	DD60s from NAWF =5	Days after Planting for insecticide termination (crop status)					
		69 (NAWF = 7.2)	74 (NAWF = 5.6)	92 (NAWF=5+240)	108 (NAWF=5+450)	*P>F*	*LSD_{05}*
3-Aug (87)	166	2.8	2.6	0.2	0.1	*0.02*	*2.4*
11-Aug (95)	293	5.0	4.7	0.2	0.0	*0.002*	*1.7*
17-Aug (101)	335	5.2	5.2	1.0	0.1	*0.04*	*2.1*
30-Aug (114)	563	0.3	0.4	0.6	0.3	*0.45*	

[1] Insecticide applications were terminated for each treatment on the indicated days.

Table 4. Results from COTMAN Squaremap plant monitoring through cutout in insecticide termination sub-plot treatments[2] showing shed rates from 1st position squares, bolls and total fruiting forms.

Category	Insecticide Termination Date	COTMAN sample date								
		15-Jun	22-Jun	29-Jun	07-Jul	14-Jul	23-Jul	29-Jul	04-Aug	10-Aug
% Square Shed	16-Jul	3.7	9.7	15.9	22.1	26.8	17.3	18.9	33.9	48.9
	21-Jul	3.1	8.2	13.1	19.8	25.7	17.9	19.3	26.3	43.3
	8-Aug	2.9	9.3	11.5	18.8	25.5	17.1	16.6	25.3	45.3
	24-Aug	3.8	9.8	14.3	21.4	24.2	16.8	9.8	23.6	37.6

	P>F	*0.76*	*0.84*	*0.34*	*0.7*	*0.4*	*0.92*	*0.001*	*0.05*	*0.07*
	LSD_{05}							*3.5*	*7.2*	
% Boll Shed	16-Jul					10.1	27.1	37.3	37.2	38.3
	21-Jul					7.0	28.0	37.1	37.2	36.5
	8-Aug					10.5	23.0	35.7	32.9	30.3
	24-Aug					11.1	28.5	34.8	31.5	32.1
	P>F					*0.23*	*0.27*	*0.23*	*0.02*	*0.001*
	LSD_{05}								*0.38*	*0.94*
% Total Shed	16-Jul	3.7	9.7	15.9	22.1	23.4	21.7	30.1	36.1	39.9
	21-Jul	3.1	8.2	13.1	19.8	22.0	22.5	30.3	33.9	37.6
	8-Aug	2.9	9.3	11.5	18.8	22.7	19.8	28.3	30.7	32.3
	24-Aug	3.8	9.8	14.3	21.4	21.5	22.3	25.6	29.3	32.6
	P>F	*0.76*	*0.84*	*0.34*	*0.71*	*0.56*	*0.63*	*0.009*	*0.01*	*0.001*
	LSD_{05}							*2.3*	0.27	*1.8*

[1]Irrigation main effects and Irrigation * Insecticide interactions were non-significant.

Table 5. Mean no. of sympodia, % square and boll shed, and % of fruiting forms with external bug feeding injury symptoms[1,2] determined 23 Aug (107 DAP, NAWF=5 + 431 DD60s) in insecticide termination treatments.

	Mean per plant for each insecticide termination sup-plot[3]					
Category	**NAWF = 7.2**	**NAWF = 5.6**	**NAWF = 5 + 240 DD60s**	**NAWF = 5 + 450 DD60s**	***P>F***	***LSD_{05}***
No. squaring sympodia	1.5	1.4	1.7	1.6	*0.6*	
No. fruiting (boll) sympodia	11.8	12.2	11.6	11.9	*0.22*	
Total sympodia	14.3	14.7	14.3	14.5	*0.62*	
% Square shed	93.8	80.9	88.5	93.1	*0.45*	
% Small boll shed	47.3	52.0	36.7	34.0	*0.13*	
% Total Boll Shed	49.1	53.4	45.8	44.0	*0.16*	
% Total Shed	54.4	57.3	50.3	50.0	*0.14*	
% Small (top 3) bolls w/ TPB injury	37.0	33.3	4.3	3.7	*0.003*	*9.7*
% Large bolls w/ TPB injury	32.9	22.2	13.7	12.8	*0.03*	*11.6*
% Total bolls w/ TPB injury	34.0	25.0	11.4	10.4	*0.006*	*7.8*
% Total fruiting forms w/ TPB injury	30.3	22.3	10.0	9.2	*0.004*	*6.3*

[1] Samples of 10 plants per plot using COTMAN Scoutmap procedures.
[2] External injury symptoms may not penetrate boll and cause economic damage.
[3] Irrigation main effects and Irrigation * Insecticide interactions were non-significant.

Table 6. Results from final end-of-season plant mapping following defoliation using COTMAP for irrigation termination main plot effects[1].

	Mean per plant for each irrigation termination treatment						
Category	**NAWF = 7.2**	**NAWF = 5.6**	**NAWF = 5 +100DD60s**	**NAWF = 5 +360DD60s**	**NAWF = 5 +580DD60s**	***P>F***	***LSD_{05}***
1st Sympodial Node	6.3	6.4	5.9	6.3	6.3	*0.32*	
No. Monopodia	1.6	1.9	1.4	1.7	1.7	*0.47*	
Highest Sympodia with 2 nodes	10.1	10.3	10.9	10.9	11.2	*0.23*	
Plant Height (inches)	40.1	40.9	41.2	42.4	42.0	*0.67*	
No. Effective Sympodia	9.9	9.4	10.2	10.6	10.9	*0.19*	
No. Sympodia	13.6	13.9	14.4	14.4	14.7	*0.04*	*0.65*
No. Sympodia with 1st Position Bolls	3.7	3.4	4.0	4.0	3.9	*0.2*	
No. Sympodia with 2nd Position Bolls	1.8	1.5	1.6	1.7	1.9	*0.16*	
No. Sympodia with 1st & 2nd Bolls	1.2	1.2	1.4	1.7	1.8	*0.008*	*0.34*
Total Bolls/Plant	10.9	9.8	11.5	13.1	12.9	*0.01*	*1.87*
% Total Bolls in 1st Position	45.2	47.7	47.3	44.5	44.8	*0.86*	
% Total Bolls in 2nd Position	28.1	27.4	25.8	26.6	28.8	*0.3*	

% Total Bolls in Outer Position	11.1	10.0	12.1	13.3	12.9	*0.62*	
% Total Bolls on Monopodia	12.4	12.0	11.4	13.0	10.4	*0.88*	
% Total Bolls on Extra – Axillary	3.3	2.9	3.3	2.6	3.0	*0.95*	
% Boll Retention - 1st Position	36.1	32.9	37.3	40.0	39.3	*0.12*	
% Boll Retention - 2nd Position	29.9	25.9	26.9	31.9	33.2	*0.009*	*3.81*
% Early Boll Retention	36.5	33.1	32.9	38.7	36.6	*0.43*	
Total Nodes/Plant	18.9	19.3	19.3	19.7	20.0	*0.19*	
Internode Length (inches)	2.1	2.1	2.1	2.2	2.1	*0.9*	

[1] means of 10 plants per plot

Table 7. Results from final end-of-season plant mapping following defoliation using COTMAP for insecticide termination sub-plot plot effects[1].

	Mean per plant for each insecticide termination treatment					
Category	**NAWF = 7.2**	**NAWF = 5.6**	**NAWF = 5 +240 DD60s**	**NAWF = 5 +450 DD60s**	**P>F**	**LSD05**
1st Sympodial Node	6.28	6.23	6.21	6.28	0.76	
No. Monopodia	1.57	1.54	1.73	1.69	0.38	
Highest Sympodia with 2 nodes	10.67	10.79	10.80	10.50	0.7	
Plant Height (inches)	41.06	41.40	41.97	40.83	0.37	
No. Effective Sympodia	9.89	10.09	10.47	10.29	0.26	
No. Sympodia	14.27	14.30	14.33	13.90	0.5	
No. Sympodia with 1st Position Bolls	3.49	3.60	3.95	4.07	0.08	
No. Sympodia with 2nd Position Bolls	1.58	1.63	1.90	1.60	0.14	
No. Sympodia with 1st & 2nd Bolls	1.25	1.20	1.73	1.74	0.0007	0.31
Total Bolls/Plant	10.41	10.72	12.81	12.69	0.002	1.49
% Total Bolls in 1st Position	46.28	45.04	45.36	46.95	0.9	
% Total Bolls in 2nd Position	27.39	26.84	28.65	26.52	0.650	
% Total Bolls in Outer Position	13.06	12.80	10.72	11.00	0.44	
% Total Bolls on Monopodia	10.99	12.23	12.25	11.85	0.9	
% Total Bolls on Extra – Axillary	2.29	3.09	3.02	3.68	0.24	
% Boll Retention - 1st Position	33.16	33.67	39.99	41.67	0.002	5.05
% Boll Retention - 2nd Position	26.49	26.33	33.78	31.64	0.0006	3.9
% Early Boll Retention	34.53	30.93	38.67	38.07	0.065	
Total Nodes/Plant	19.55	19.53	19.54	19.18	0.53	
Internode Length (inches)	2.10	2.12	2.15	2.13	0.37	

[1] means of 10 plants per plot

Table 8. Means for HVI classing data for 50 boll samples collected throughout consecutive plants on consecutive fruiting sites, Marianna AR 2004 – irrigation main effects.

Irrigation	**Micronaire**	**Length**	**Uniformity**	**Strength**	**Elongation**	**Leaf**
NAWF = 7.2	4.79	1.069	81.84	28.61	5.11	1.42
NAWF = 5.6	4.90	1.066	82.05	28.37	5.00	1.18
NAWF = 5 + 100 DD60s	4.74	1.071	81.89	28.06	5.11	1.33
NAWF = 5 + 360 DD60s	4.58	1.084	82.45	29.14	5.25	1.17
NAWF = 5 + 580 DD60s	4.83	1.068	82.55	27.69	5.56	1.25
P>F Irrigation(I)	*0.07*	*0.55*	*0.34*	*0.04*	*0.01*	*0.41*
Insecticide (B)	*0.001*	*0.59*	*0.24*	*0.28*	*0.27*	*0.83*
*I*B*	*0.55*	*0.964*	*0.889*	*0.8*	*0.11*	*0.06*

[i] Determinations made at International Textile Center, Texas Tech University, Lubbock.

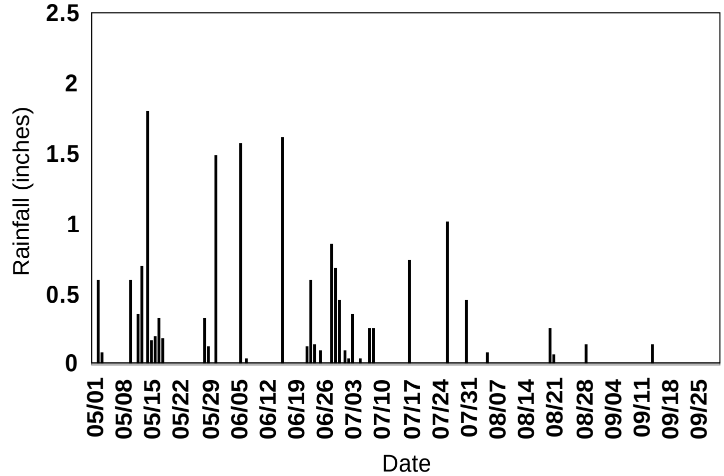

Figure 1. Rainfall accumulations for Cotton Branch Station summer 2004.

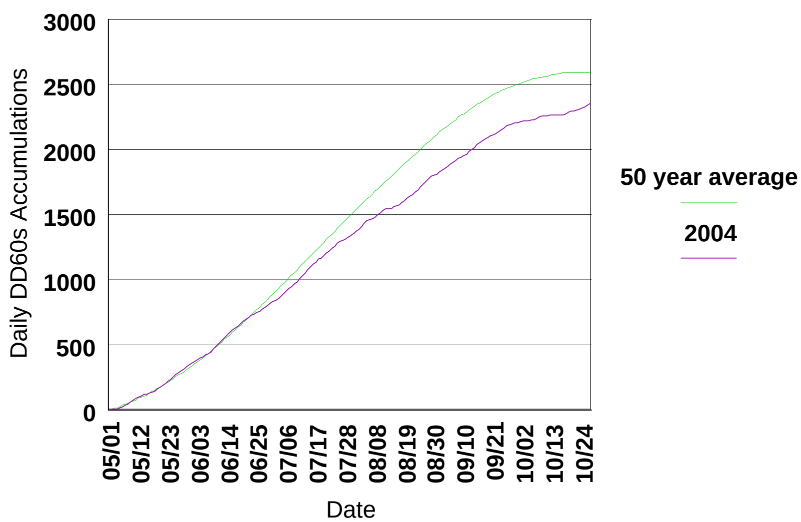

Figure 2. Daily DD60 accumulations for Marianna, AR compared to the 50 year average.

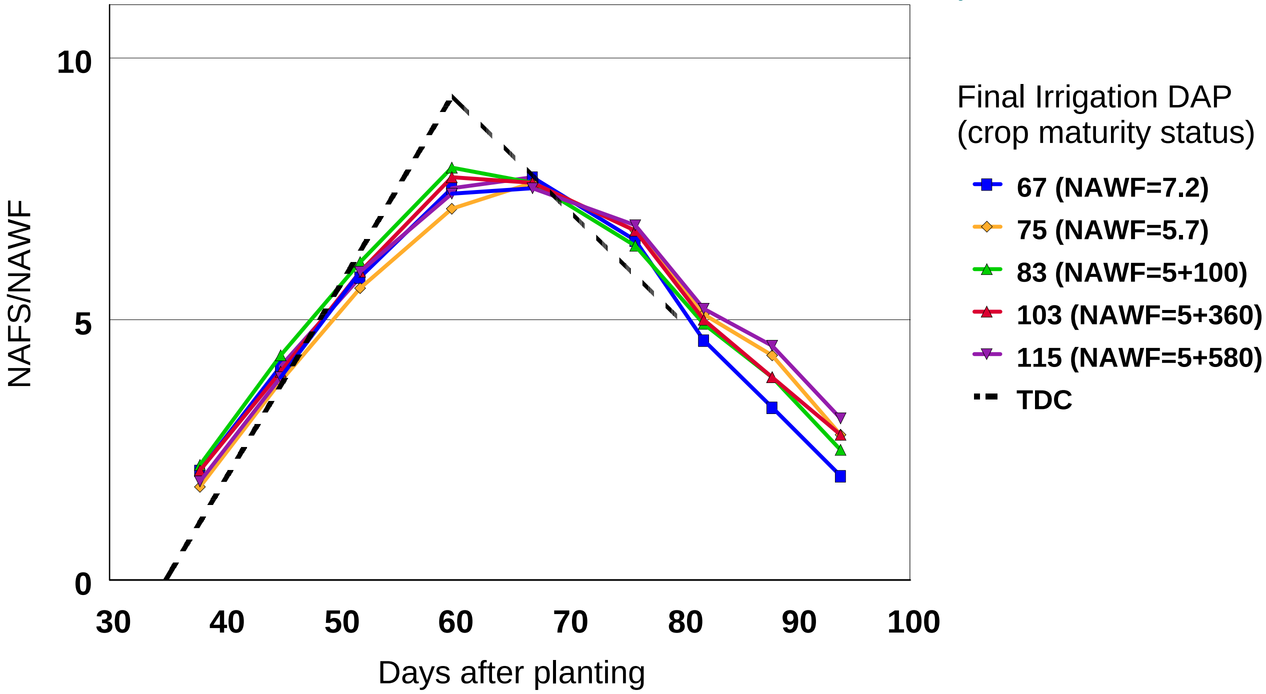

Figure 3. COTMAN target development curve (TDC) and crop growth curves of plants with different final dates of irrigation.

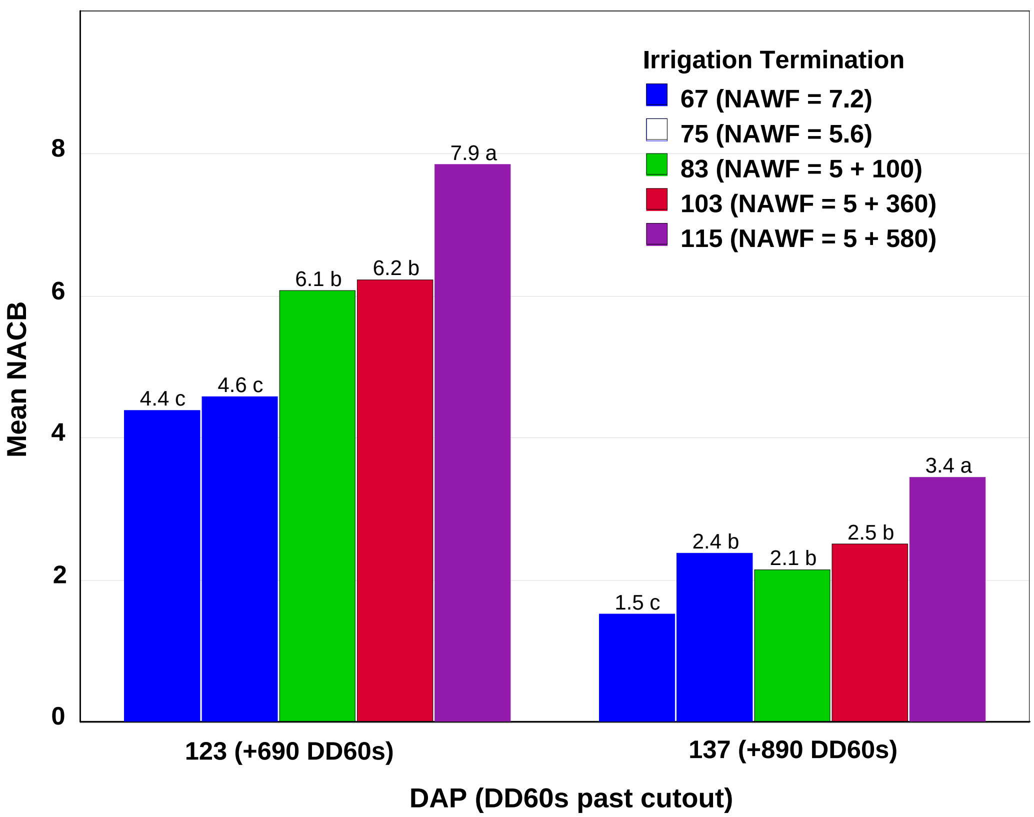

Figure 4. Mean number of nodes above cracked boll (NACB) values observed over 2 dates (123 and 137 days after planting (DAP)) for 5 irrigation termination timing treatments (irrigation main effects (P>F=0.001).

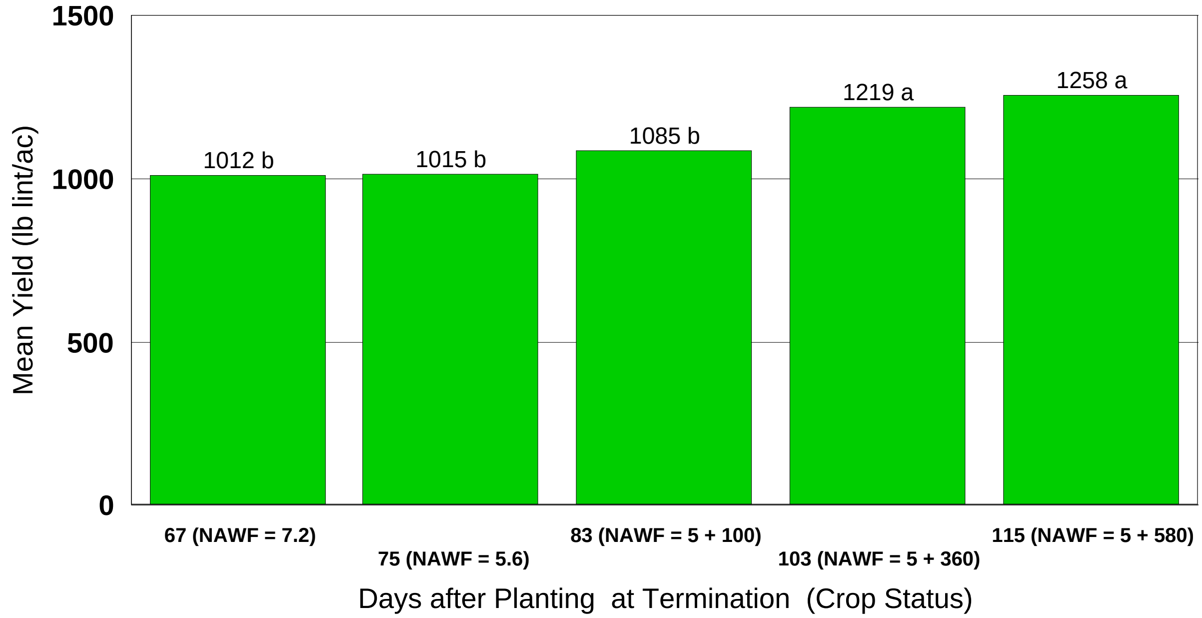

Figure 5. Mean lint yield following termination of irrigation at 5 different dates in 2004 (Irrigation main effects - P>F=0.001; LSD_{05} =131) (U of Arkansas Cotton Branch Experiment Station – Marianna).

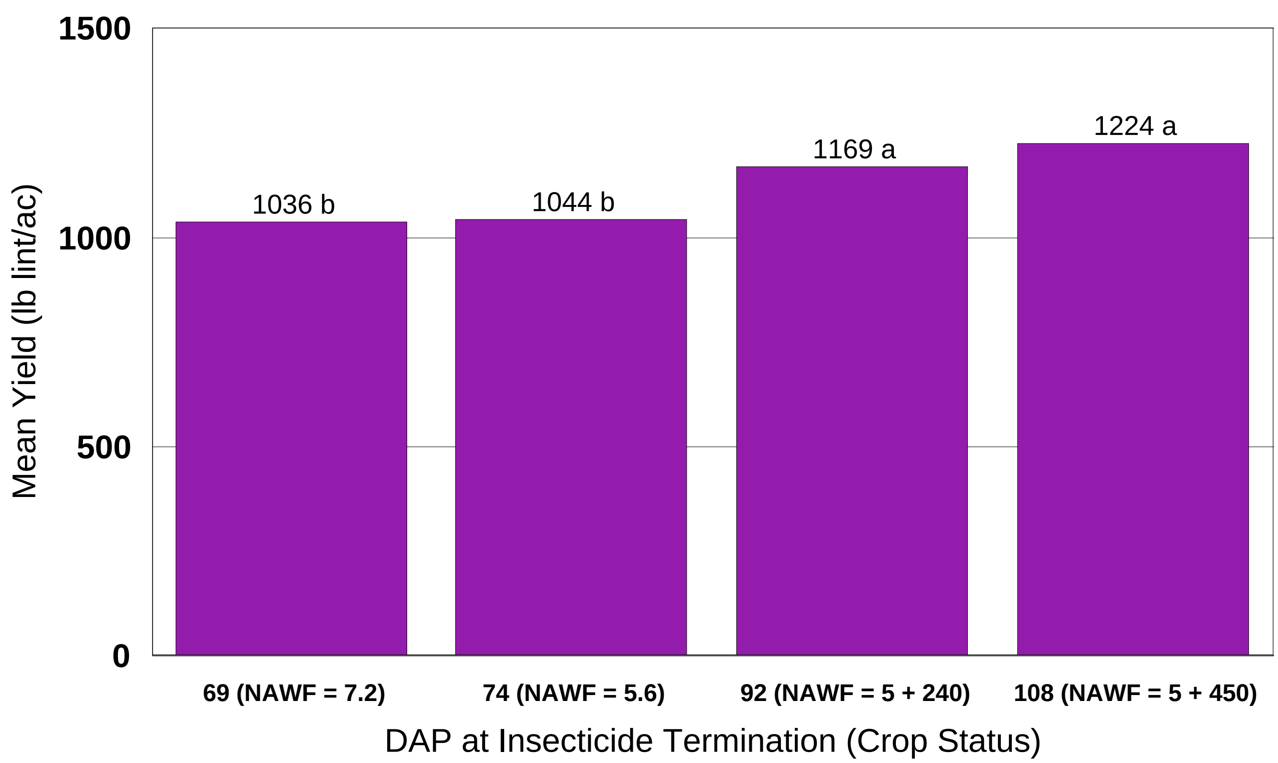

Figure 6. Mean lint yield following termination of insecticide applications for tarnished plant bug at 4 different dates in 2004 (Insecticide subplot effects - P>F=0.01; LSD_{05} =112) (U of Arkansas Cotton Branch Experiment Station – Marianna).

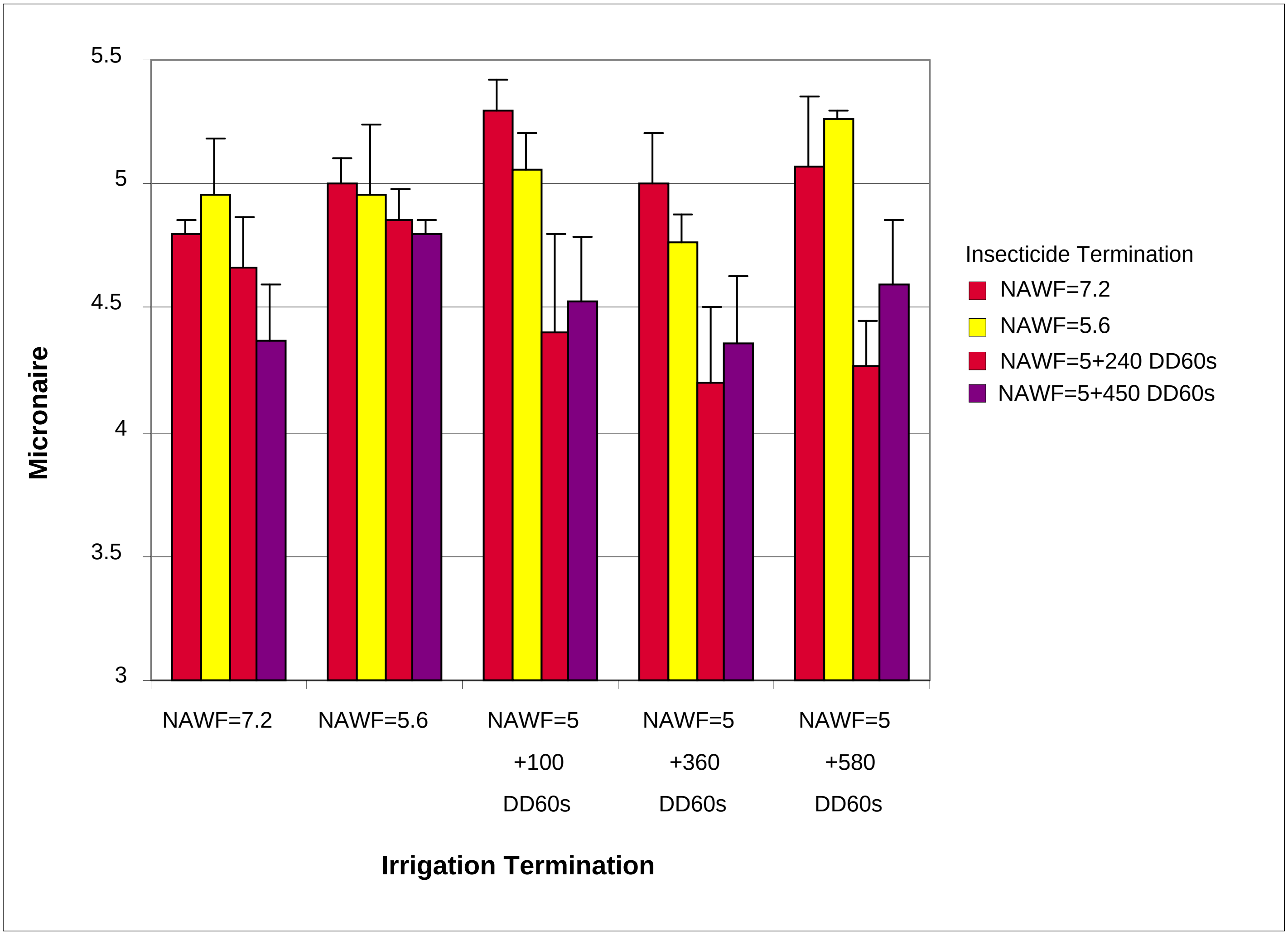

Figure 7. Mean values for micronaire (+SE) measured from 50- boll samples taken from consecutive plants and fruiting sites just prior to harvest (Irrigation main effects P>F 0.07; Insecticide sub-plot effects P>F 0.0001; Irrigation*Insecticide interactions P>F 0.548). Samples were analyzed at International Textile Center, Texas Tech University, Lubbock.