EFFECT OF INSECTICIDE TERMINATION AT 250, 350, AND 450 HEAT UNITS ON CARBON PARTITIONING FROM UPPER CANOPY LEAVES TO THE DEVELOPING BOLL LOAD

R. S. Brown, D. M. Oosterhuis, Charles T. Allen and F. M. Bourland
University of Arkansas
Fayetteville, AR

Abstract

The crop monitoring program COTMAN uses the concept of 350 heat units after anthesis of the last effective flower population at NAWF=5 for termination of insecticide applications. It has been reported that terminating insecticides at 350 heat units after NAWF=5 results in a higher yield than when terminating at either lower or higher heat unit values, although evidence is lacking. It is hypothesized that insect damage to upper-canopy (above NAWF=5) squares results in improved partitioning of carbon to lower developing bolls. Two field studies were conducted to determine how removing upper-canopy fruit at different heat units affected yield, as well as boll weight and fiber quality of first position bolls at NAWF=5. Treatments consisted of a control with no fruit removal and hand removal of all upper-canopy fruit above NAWF=5 at 250, 350, and 450 heat units. The data from the 1998 season supported the COTMAN concept of insecticide termination at 350 heat units after NAWF=5. However, the results from the 1999 study did not support insecticide termination at NAWF=5 +350 H.U., in fact, yield and fiber quality were the highest when fruit was not removed. Futher field verification is required.

Introduction

Cotton (*Gossypium hirsutum* L.) is a perennial with an indeterminate growth habit and will continue to produce fruit as long as the season persists. However, late-season bolls are often small in size, low in fiber quality, provide a food source for insects, and are costly to protect with increasing insect pressure. A major aim in COTMAN (Cochran et al., 1998) is to identify the last effective boll population and project a date for insecticide termination. It has been shown that bollworm (*Helicoverpa zea*) and boll weevil (*Anthonomus grandis*) damage to cotton bolls decreases dramatically at about 350 heat units after anthesis (Bagwell, 1995). This finding was supported by Kim (1998) who showed increased resistance of the boll wall to penetration at NAWF=5 plus about 350 heat units. Oosterhuis et al., (1996) reported that terminating insecticides at 350 heat units after physiological cutout (NAWF=5) results in a higher yield than when terminating before or after this time. It is hypothesized that insect damage to upper canopy (above NAWF=5) squares results in improved partitioning of carbon to lower developing bolls (Kim and Oosterhuis, 1998). The objective of this study was to investigate the effect of different times of upper-canopy square removal after physiological cutout (NAWF=5) on subsequent boll weights of first position bolls at NAWF=5, fiber quality of those bolls, and total seedcotton yields.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:669-671 (2000)
National Cotton Council, Memphis TN

Materials and Methods

A field experiment was conducted at Rohwer in southeast Arkansas and at Clarkedale in northeast Arkansas in 1999. Cotton cultivar Suregrow 125 was planted in early May at each location. Rows were spaced 0.9 m apart and plots were 4 rows wide and 15m long with a plant density of 10 plants per meter. All plots received fertilizer and pesticide applications according to the cotton production recommendations for Arkansas. The field studies were furrow irrigated as needed. The experiment was arranged in a randomized complete block design with four treatments and three replications. Treatments consisted of a control with no fruit removal and a simulated upper canopy fruit damage (hand removal) of all upper-canopy squares at approximately 250, 350 and 450 heat units after NAWF=5. 20-30 white flowers per plot were tagged at the first fruiting position of the main-stem node at NAWF=5. Treatments were applied as sufficient heat units were accumulated after physiological cutout. At final harvest,10 tagged bolls at NAWF=5 were collected from each plot to determine boll weight and fiber quality. Seedcotton yields were determined from mechanically harvesting the middle two rows of each plot.

Results and Discussion

Boll Weight

No significant differences ($P \leq 0.05$) in first position boll weight at NAWF=5 occurred between square removal treatments. At Rohwer, boll weight at the NAWF=5 position showed the largest numerical increase when upper-canopy fruit was removed at NAWF=5 plus 250 and 350 heat units (Figure 1). Fruit removal at the earlier heat units allowed more time for assimilates to be partitioned to lower developing bolls than the 450 heat unit treatment in which carbohydrates continued to be used by young fruit eventually removed. The control (no square removal) resulted in lower boll weights at NAWF=5 because more carbohydrates were used to fill out the upper-canopy bolls (which were not harvested) instead of being translocated to lower harvestable bolls. At Clarkedale, first position boll weight at NAWF=5 was the greatest for the NAWF=5 plus 450 heat units treatment (Figure 2) which could be explained by late-season boll weevil pressure. When upper-canopy fruit, above NAWF=5, was removed at earlier heat units boll weevils were forced to feed on bolls at the NAWF=5 position damaging bolls which were not yet resistant to penetration.

Fiber Quality

Very little difference was noticed at either research location with respect to improved length, strength, length uniformity or micronaire of cotton fiber from first position NAWF=5 bolls (Table 1). The only significant difference was observed at the Rohwer location, in which micronaire increased ($P \leq 0.05$) in response to upper-canopy fruit removal at NAWF=5 plus 350 heat units over that of the control (Table 1).

Seedcotton Yield

In 1998, the highest yields were obtained when fruit was removed at NAWF=5 plus 350 heat units. However, the 1999 cotton season showed conflicting results in which the control (no upper-canopy fruit removed) numerically yielded the highest (Figure 3). The removal of upper-canopy fruit at NAWF=5 plus 350 heat units represented the lowest numerical yields of all treatments. The control probably yielded the highest due to the late fall and favorable growing conditions at the end of the season. Favorable conditions during the late, extended season allowed the upper-canopy bolls to mature and contribute to seedcotton yield from the control but not the other treatments in which fruit was removed.

Conclusions

The data from the 1998 season supported the COTMAN concept of insecticide termination at 350 heat units after NAWF=5. In 1999, there were no differences ($P \leq 0.05$) between treatments to increase boll weight or fiber quality of first position bolls at NAWF=5, or total seedcotton yield, with the exception of increased micronaire at Rohwer for the 350 heat unit treatment. The 1999 results were both unexpected and disappointing when compared to the excellent results obtained from insecticide termination at NAWF=5 + 350 H.U.'s in 1998. This was explained by the favorable late-season conditions necessary to mature the existing, pre mature upper-canopy fruit. Cotton being a perennial will continue to produce fruit as long as the season persists. In 1999, late-season growing conditions were favorable to mature upper-canopy bolls which aided in increased yields by the control. However, positive evidence did exist for increasing boll size at NAWF=5 following square removal at the Rohwer location.

References

Bagwell, R. D. 1995. Monitoring the cotton plant for insecticide effects and late-season termination. Ph.D. Dissertation, University of Arkansas, Fayetteville.

Cochran, M. J., N. P. Tugwell, F. M. Bourland, D. M. Oosterhuis and D. M. Danforth. 1998. COTMAN expert system. Version 5.0. D. M. Danforth and P. F. O'Leary (eds.) University Arkansas, Agric. Exp. Sta., Fayetteville. Published Cotton Incorporated, Raleigh, NC. p. 198.

Kim, M. 1998. Changes in the cotton fruit wall in relation to COTMAN insecticide termination rules. M.S. Thesis, Fayetteville, Arkansas.

Kim, M. and D. M. Oosterhuis. 1998. Effect of upper-canopy square removal before and after NAWF=5 plus 350 heat units on carbon partitioning from upper-canopy leaves to bolls lower in the canopy. *In* D.M. Oosterhuis (ed.) Proc. 1998 Cotton Research Meeting and Summaries. Agric. Exp. Sta., University of Arkansas. Special Report 188:174-176.

Oosterhuis, D.M., F. M. Bourland, N. P. Tugwell, and M. J. Cochran. 1996. Terminology and concepts related to COTMAN crop monitoring system. Agric. Exp. Sta., Univ. of Arkansas. Special Report. 174.

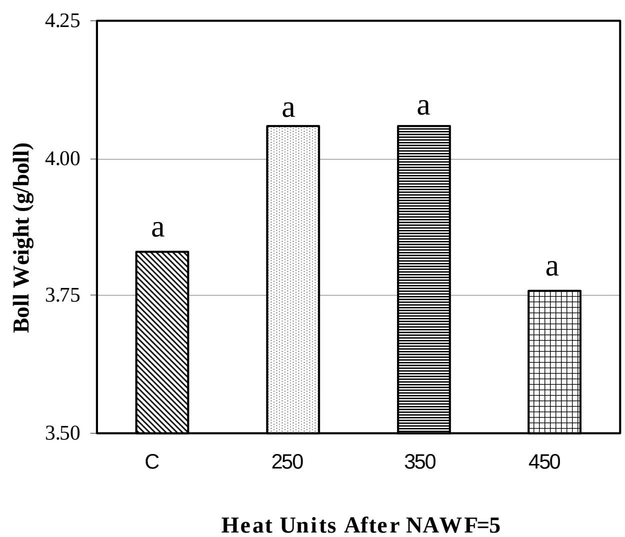

Figure 1. Mean boll weight of first position bolls at NAWF=5 for the control (C) treatment and the square removal treatments at 250, 350 and 450 heat units past NAWF=5. Rohwer, Arkansas, 1999. Bars followed by the same letter are not significantly different at $P \leq 0.05$.

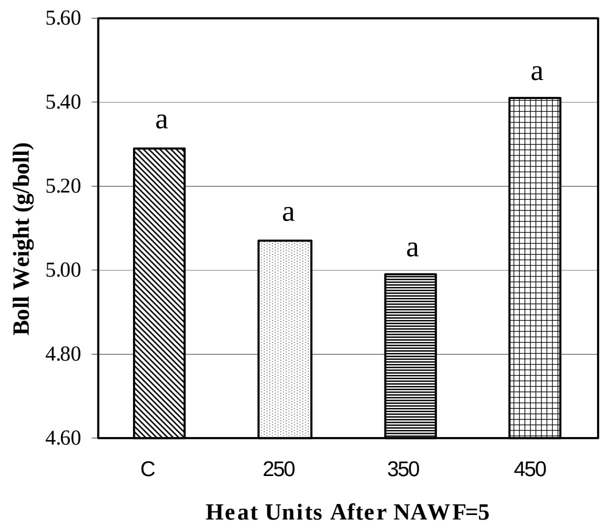

Figure 2. Mean boll weight of first position bolls at NAWF=5 for the control (C) treatment and the square removal treatments at 250, 350 and 450 heat units past NAWF=5. Clarkedale, Arkansas, 1999. Bars followed by the same letter are not significantly different at $P \leq 0.05$.

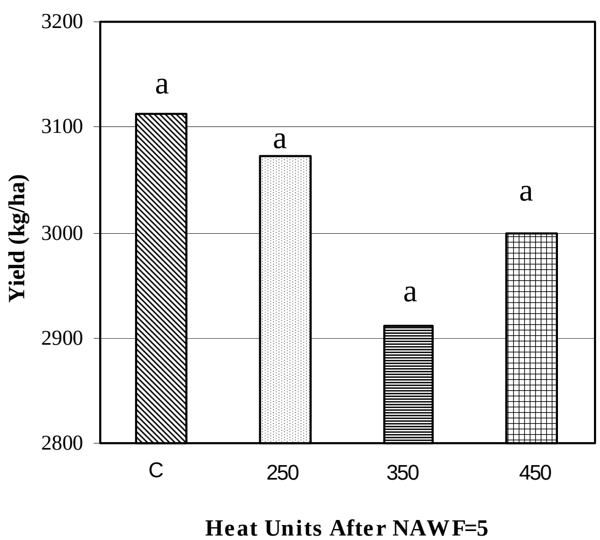

Figure 3. Means for total seedcotton yield, after square removal above NAWF=5, for the 250, 350 and 450 heat unit and control (C) treatments. Clarkedale, Arkansas, 1999. Bars followed by the same letter are not significantly different at $P \leq 0.05$.

Table 1. Mean fiber quality (length, strength, length uniformity and micronaire) values of first position bolls at NAWF=5 for the control treatment and square removal treatments at 250, 350 and 450 heat units (H.U.) past cutout. Rohwer and Clarkedale, Arkansas, 1999.

Treatment	Location	Length in.	Strength g/tex	Uniformity %	Micronaire unitless
Control	Rohwer	1.21a[1]	32.0a	87.6a	4.9a
250 H.U.[2]	Rohwer	1.20a	31.9a	87.2a	4.9a
350 H.U.	Rohwer	1.19a	32.1a	86.7a	5.0a
450 H.U.	Rohwer	1.21a	32.7a	86.7a	5.0a
Control	Clarkedale	1.10a	30.2a	85.3a	5.4b
250 H.U.	Clarkedale	1.11a	30.2a	85.1a	5.7ab
350 H.U.	Clarkedale	1.10a	29.5a	85.2a	5.8a
450 H.U.	Clarkedale	1.10a	30.1a	85.2a	5.8a

[1]Treatment means within a column followed by the same letter are not significantly different at $P \leq 0.05$.
[2]250, 350 and 450 H.U. treatments represent the number of accumulated heat units past physiological cutout (NAWF=5).