# EFFECT OF INSECTICIDE TERMINATION AT VARYING HEAT UNITS AFTER CUTOUT ON YIELD, BOLL WEIGHT, FIBER QUALITY AND CARBON MOVEMENT

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## Abstract

COTMAN, a crop monitoring program for cotton, uses the concept of 350 heat units after anthesis of the last flower population at five nodes above white flower (NAWF=5) for termination of insecticide applications. It is hypothesized that terminating insecticide use 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. To test this hypothesis, a field study was conducted at Clarkedale to determine how removing unwanted fruit above NAWF=5 at different heat units impacted carbon movement, lint yield and boll weight and 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. Field experiments conducted from 1998 to 2000 have not shown a clear yield trend between treatments, however boll weight was usually increased the most when fruit was removed at NAWF=5 + 350 heat units. Results from 2000 indicated that boll weight of first position bolls at NAWF=5 were numericallyincreased when fruit was removed at NAWF=5 + 350 heat units, however yield and fiber quality were numerically reduced. Favorable late-season weather patterns in 2000, which extended the cotton growing season and filled upper bolls that normally fail to reach maturity, may be the reason for higher yields observed by the control. Due to these abnormal late-season weather patterns the past few years, additional field studies are needed to determine if removing fruit at NAWF=5 + 350 heat units provides a yield advantage.

## Introduction

Cotton is a perennial with an indeterminate growth habit and will continue to produce fruit as long as the season persists. However, these late-season bolls are often small in size, low in fiber quality, costly to protect and provide a good food source for insects. In the COTMAN crop monitoring program, (Cochran et al., 1998) a major aim is to identify the last effective boll population (Oosterhuis et al., 1999) and project a date for insecticide termination. Bagwell (1995) showed that bollworm *Helicoverpa zea* (Boddie) and boll weevil *Anthonomus grandis* Boheman damage to cotton bolls decreases dramatically at about 350 heat units after anthesis. 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. It has been speculated 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. This improvement in yield following fruit removal at 350 heat units may be explained by the differential movement of carbohydrates from upper-canopy leaves with square removed to bolls developing below the area of fruit removal (Kim and Oosterhuis, 1998). The objective of this field study was to investigate the effect of different times of upper-canopy square removal after physiological cutout (NAWF=5) on carbon movement, boll weight and quality of first position bolls at NAWF=5 and total lint yields.

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## Materials and Methods

Field experiments were conducted at Clarkedale in northeast Arkansas from 1998 to 2000 to test the effects of late-season fruit removal. Cotton (*Gossypium hirsutum L.*) cultivar Suregrow 125 was planted into a Dubbs-Dundee silt loam during early May each year. Rows were spaced 0.9m apart and plots were 4 rows wide with a plant density of 10 plants per meter. All plots received fertilizer and pesticide applications following the cotton production recommendations for Arkansas and were furrow irrigated as needed. The experiment was arranged in a randomized complete block design with four treatments and six replications.

Treatments:

- Control with no fruit removal
- Hand removal of all fruit above NAWF=5 at NAWF=5 plus 250 H.U.
- Hand removal of all fruit above NAWF=5 at NAWF=5 plus 350 H.U.
- Hand removal of all fruit above NAWF=5 at NAWF=5 plus 450 H.U.

Taggings of 20-30 white flowers per plot were made 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 for the various treatments. Three days following fruit removal, $^{14}C$ was used to label leaves for determining the amount of carbon eventually translocated to the first position bolls at NAWF=5. At final harvest, 10 tagged bolls at NAWF=5 were collected in order to determine boll weight and fiber quality. Lint yields were determined from mechanical harvest assuming a standard gin turnout of 38 percent.

## Results and Discussion

The following three-year study has investigated the impact that fruit removal at varying heat units after physiological cutout had on yield and quality of cotton in Arkansas. The data presented in this paper will summarize the results from the 2000 field study at Clarkedale and relate that data to trends from the previous years.

### Lint Yields

Results from 1998 to 2000 have shown no clear trends for increasing lint yields from the removal of late-season fruit. In 2000, lint yields were numerically increased when upper-canopy fruit (above NAWF=5) was removed at NAWF=5 plus 250 heat units (Fig. 1). The NAWF=5 plus 350 and 450 heat unit treatments represented the lowest numerical yields, which were even lower than the control treatment where no fruit was removed. These results contradict the concepts presented in COTMAN about insecticide termination at NAWF=5 plus 350 heat units and contradict the data from our 1998 field study which indicated that fruit removal at NAWF=5 plus 350 heat units increased lint yields. A possible explanation for these results might be that insect populations were low during the late-season with the weevil eradication program underway. Therefore, removing fruit earlier than 350 heat units increased the total amount of carbohydrate partitioned to lower bolls, without the concern of insects harming the bolls at NAWF=5 which would typically not be completely developed yet.

**Boll Weights at NAWF=5**

No significant differences occurred between treatments for increasing first position boll weight at NAWF=5. However, all fruit removal treatments resulted in numerically higher boll weights than the control treatment where no fruit was removed (Fig. 2). The control resulted in the lowest boll weights at NAWF=5 because carbohydrates were used to fill the unwanted upper-canopy fruit instead of being translocated to lower harvestable bolls still developing. Boll weight at NAWF=5 was increased the most where upper-canopy fruit was removed at NAWF=5 plus 350 heat units (Fig. 2). This boll data supports the results from past research by Kim and Oosterhuis (1998) which indicated that boll weight at NAWF=5 was increased the most when fruit was removed at 351 heat units after NAWF=5.

**Fiber Quality**

No significant differences were noticed with respect to improved length, strength, length uniformity and micronaire of cotton fiber from first position NAWF=5 bolls (Table 1). Fiber length and strength are usually determined more by genetics than the environment so no drastic changes were anticipated following the late-season fruit removal treatments. However, micronaire could have been slightly impacted from the removal of upper-canopy fruit and translocation of additional sugars. The 250 and 350 heat unit treatment did show numerically higher micronaire values, but they were not significantly different from the control (Table 1).

**$^{14}$C Translocation**

The following data were collected from a growthroom study in Fayetteville, AR in 1998. The data indicates that a greater amount of $^{14}$C was translocated to the boll at NAWF=5 when fruit was removed at 350 heat units (Table 2). This movement of $^{14}$C helps clarify why lower bolls are larger if upper-canopy fruit is removed, which consequently was observed from this study. A similar technique was used in the field in 2000 at Fayetteville to provide additional information on carbon movement to lower bolls following fruit removal at various heat units after NAWF=5. These data are still being analyzed, but should further help to explain late-season boll development following fruit removal.

**Summary**

Overall, the field experiments conducted form 1998 to 2000 have shown evidence of increased boll weight of NAWF=5 bolls following upper-canopy fruit removal, however there has not been a clear yield trend. The results from the 2000 field study were inconsistent with the field data from the 1998 season which supported the COTMAN concept of insecticide termination at 350 heat units after NAWF=5. This season showed no differences ($P \leq 0.05$) between treatments for increasing boll weight of first position bolls at NAWF=5, fiber quality of those bolls or total lint yields. However, boll weight was numerically increased by all fruit removal treatments in comparison to the control where no fruit was removed. This can be explained by improved translocation of carbohydrates from upper-canopy leaves where fruit was removed to lower developing bolls below the area of fruit removal. Previous field and growthroom studies have indicated that removing fruit, especially at 350 heat units after NAWF=5 is reached, can increase the amount of carbohydrate to lower bolls. It can be concluded that removing upper-canopy fruit increases translocation to lower developing bolls and will increase the size of the last effective boll population at NAWF=5. However, more research is needed to determine if yields can be consistently enhanced from removal of this fruit.

**References**


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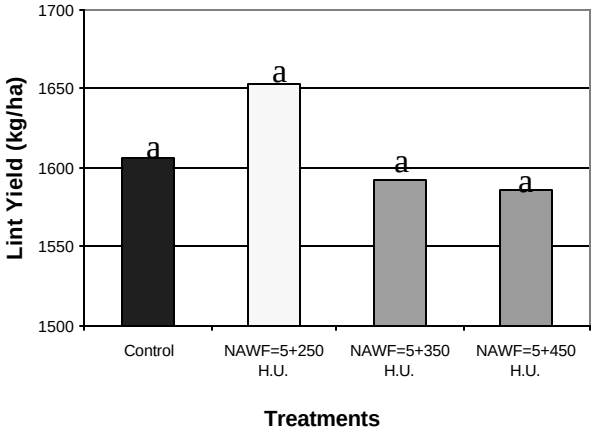


Figure 1. Effect of upper-canopy fruit removal at varying heat units after physiological cutout on lint yields. Clarkedale, Arkansas, 2000. Bars with the same letter are not significantly different ($P \leq 0.05$).

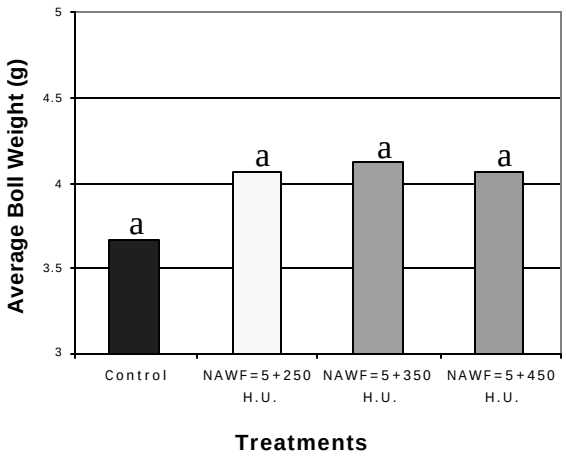


Figure 2. Effect of late-season upper-canopy fruit removal at varying heat units after physiological cutout on average weights of first position bolls at NAWF=5. Clarkedale, Arkansas, 2000. Bars with the same letter are not significantly different (P≤0.05).

Table 1. Fiber quality of first position bolls at NAWF=5 following removal of upper-canopy fruit at different heat units past physiological cutout. Clarkedale, AR, 2000.

| Treatment | Length | Strength | Uniformity | Micronaire |
|---|---|---|---|---|
| | in. | g/tex | % | |
| Control | 1.13a[2] | 28.3a | 84.9a | 3.9a |
| NAWF=5+250 H.U.[1] | 1.12a | 28.8a | 84.8a | 4.1a |
| NAWF=5+350 H.U. | 1.11a | 28.0a | 84.2a | 4.1a |
| NAWF=5+450 H.U. | 1.13a | 28.7a | 84.8a | 3.9a |

[1]Represent approximate heat unit values after cutout at which squares were removed.
[2]Treatment means within a column followed by the same letter are not significantly different at (P≤0.05).

Table 2. Translocation of $^{14}C$ from upper-canopy leaves to NAWF=5 bolls following upper-canopy fruit removal. Fayetteville, AR, 1998.

| Treatment | Boll Weight | $^{14}C$ Translocated |
|---|---|---|
| | g | % |
| NAWF=5+250 H.U.[1] | 3.3[2] | 1.8 |
| NAWF=5+350 H.U. | 3.8 | 75.4 |
| NAWF=5+450 H.U. | 2.8 | 44.4 |
| LSD (0.05) | 0.9 | 63.2 |

[1]Represent approximate heat unit values after cutout at which squares were removed.
[2]Treatment means within a column followed by the same letter are not significantly different at (P≤0.05).