REMOVAL OF COTTON FRUIT BY CHEMICAL AND PHYSICAL MEANS AT INSECTICIDE TERMINATION TO IMPROVE YIELDS

R. S. Brown, D. M. Oosterhuis, F. M. Bourland and D. L. Coker
University of Arkansas
Fayetteville, AR

Abstract

Past research has shown that removal of upper-canopy squares at nodes above white flower five plus 350 heat units (NAWF=5+350 H.U.) may divert carbohydrates to developing bolls with a resulting yield advantage. To test this hypothesis, a square removal project was performed in northeast Arkansas on an early-maturing Deltapine DP20B cultivar under irrigated conditions. This study evaluated 11 chemical and 2 physical methods of removing late-season upper-canopy squares. By removing this unwanted fruit, yields could potentially be increased from the translocation of additional carbohydrates to harvestable bolls still developing below the area of square removal. Results from the 2000 field study indicated that Roundup Ultra, when combined with Chlormequat (CCC), removed the most upper-canopy fruit of all treatments tested. However, the highest lint yields occurred in the control plots where no fruit was removed. The hand-square-removal and mechanical topping treatments, where all upper-canopy fruit was removed, represented the lowest lint yields and some of the smallest first position bolls at NAWF=5. Favorable late-season weather patterns in 2000, which extended the cotton growing season, may be the reason why fruit removal treatments yielded the lowest and control yields were the highest. More research is needed to determine if end-of-season fruit removal is a viable practice for enhancing lint yields in cotton.

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. Nodes above white flower (NAWF) is an integral concept used in the COTMAN crop monitoring program for basing end-of-season decisions. In COTMAN, a major aim is to identify the last effective boll population and project a date for insecticide termination (Cochran et al., 1998). 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 also 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 (Kim and Oosterhuis, 1998). The following objectives were developed in order to gain a better understanding of late-season fruit removal as a potential method for increasing lint yields. The first objective was to evaluate the efficiency of various chemicals for removing fruit above NAWF=5. The second objective was to determine if removing this upper-canopy fruit increased the weight and quality of first position bolls at the NAWF=5 main-stem node and total lint yields.

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Materials and Methods

Field studies were conducted from 1997 to 1999 at two locations in Arkansas to determine how various fruit removal techniques late in the cotton season affected lint yield and quality. Results from these studies showed conflicting results in terms of chemical efficacy at removing fruit and no clear yield trends (Brown et al., 1999, 2000). In 2000 a more extensive field study was conducted at Marianna in northeast Arkansas to further test the effects of late-season, upper-canopy fruit removal. This study evaluated some of the same chemicals and rates tested the previous years with additional rates and chemical combinations. Cotton (*Gossypium hirsutum L.)* cultivar Deltapine DP20B was planted on May 11, 2000 in a randomized complete block design with 14 treatments (listed below) and 6 replications. 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.

Treatments

*Control with no chemical or physical square removal
*Square removal by hand (all squares above NAWF=5)
*Mechanical topping (all plant material above NAWF=5)
*Chlormequat (CCC) @ 0.58L/ha + PHCA @ 0.58L/ha
*Chlormequat (CCC) @ 0.58L/ha
*Chlormequat (CCC) @ 0.58L/ha + Roundup Ultra @ 0.55kg a.i./ha
*Chlormequat (CCC) @ 1.6L/ha + PHCA @ 0.58L/ha
*Chlormequat (CCC) @ 1.16L/ha
*Ethephon (Prep) @ 0.22 kg a.i./ha
*Ethephon (Prep) @ 0.45 kg a.i./ha
*Cyclanilide (Finish) @ 0.06 kg a.i./ha
*Cyclanilide (Finish) @ 0.11 kg a.i./ha
*Jasmonate @ 300 ppm
*Jasmonate @ 600 ppm

At the NAWF=5 stage, 20-30 first position white flowers were tagged on the center two rows of each 4-row plot. Daily heat units [(max + min temp/2) – 60^0F] were accumulated from white flower until 350 heat units were reached. At this time (NAWF=5+350 H.U.) the square removal treatments were applied. One week after treatment application, first position square shed was determined for the 5 nodes above and below the tagged NAWF=5 position, as well as at the tagged position itself. 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 results summarize the efficacy of various chemicals for removing late-season fruit and also show what impact fruit removal had on lint yield and quality. Only the results from the 2000 field study at Marianna, Arkansas will be presented in this paper. However, results from the 1997 and 1998 seasons (Brown et al., 1999) and 1999 season (Brown et al., 2000) are presented in the previous two Proceedings of the Beltwide Cotton Conference.

Efficiency of Square Removal

No chemical treatment or chemical treatment combinations evaluated in 2000 were able to remove as much fruit as the physical removal treatments, which removed 100 percent of the upper-canopy fruit

(Table 1). When comparing the efficacy of the 11 chemicals tested, the 0.58L/ha rate of Chlormequat combined with Roundup Ultra at 0.55 kg a.i./ha was the most successful chemical for removing upper-canopy fruit, removing 70 percent of the first position fruit above NAWF=5 (Table 1). However, this treatment combination was not significantly different from the control. Chlormequat applied at 1.16L/ha in combination with PHCA at 0.58L/ha represented the least effective treatment for removing upper-canopy fruit and removed only 55.6 percent of first position squares and small bolls (Table 1). Unfortunately, the Chlormequt/Roundup combination, which effectively removed the most upper-canopy fruit, also removed a significantly greater percentage of first position bolls at the NAWF=5 position than the control. Prep applied at the 0.22 kg a.i./ha rate was the most detrimental chemical for adversely removing bolls at the NAWF=5 position (Table 1). No statistical differences occurred between treatments for adversely removing the harvestable bolls below NAWF=5.

Lint Yields

The highest numerical lint yields from the 2000 field study were observed in the control plots where no upper-canopy fruit was removed (Fig.1). This indicated that the upper-canopy fruit did develop and contribute to overall lint yields. In most years, upper-canopy fruit above NAWF=5 did not reach maturity due to high insect pressure, increased shed percentages and lack of heat units for fiber development. However, given the favorable late-season weather pattern in 2000 and extra insecticide use with boll weevil eradication in progress, the upper-canopy fruit was able to reach maturity and contribute to lint yields. The mechanical topping and hand-square-removal treatments, in which 100 percent of the upper-canopy fruit was removed, significantly reduced lint yields when compared to the control (Fig. 1). Jasmonate applied at 300 ppm and Finish applied at 0.11 kg a.i./ha resulted in the highest lint yields of the chemicals tested, however they were among the worst for removing upper-canopy fruit (Fig. 1, Table 1).

Boll Weights at NAWF=5

It was hypothesized that removal of upper-canopy fruit would increase boll weight of lower bolls from the improved partitioning of carbohydrates from the upper source leaves to lower sink bolls. Results from the 2000 field study failed to confirm this hypothesis. Instead, it was determined that the hand-square-removal treatment, where all upper-canopy fruit was removed, represented some of the lowest boll weights (Fig.2). The only logical explanation for this might be that the late-season regrowth noticed in these plots acted as a sink, thereby decreasing the amount of carbohydrate partitioned to lower developing bolls (data not shown). The largest bolls occurred where Chlormequat was applied at 0.58L/ha, however this was not significantly different from the control (Fig.2).

Fiber Quality

Bolls occurring above the NAWF=5 main-stem nodal position are generally known for providing below average fiber quality. It was hypothesized that removing this fruit would improve the fiber quality of lower, harvestable bolls. Unfortunately, late-season removal of upper-canopy fruit did not result in any significant differences among treatments in comparison to the control for improving length or strength of cotton fiber (Table 2). However, Prep applied at 0.45 kg a.i./ha significantly reduced fiber uniformity compared to the control and represented the lowest numerical fiber length (Table 2). The control treatment provided the highest micronaire values which were significantly greater than the mechanical topping, Prep @ 0.22 kg and 0.45 kg a.i./ha rates and Chlormequat at the 1.16L/ha rate (Table 2).

Summary

Late-season bolls are often small in size, low in fiber quality and costly to protect with increasing insect pressure. Based on this information coupled with decisions presented in COTMAN about terminating insecticide use at NAWF=5 plus 350 heat units, a field study was designed to test the effect of late-season fruit removal on lint yields. It was hypothesized that the weight of bolls lower in the canopy and subsequent lint yields would be enhanced following fruit removal from the improved partitioning of carbohydrates to lower bolls. Unfortunately, the 2000 square removal study did not support this hypothesis because treatments removing the most fruit tended to decrease lint yields the most. Favorable late-season weather patterns may have played a major part in the low yields where fruit was removed. The control treatment, where no fruit was removed, resulted in the highest yields and was among the treatments showing the highest weight and quality of first position bolls at the NAWF=5 position. Our field studies conducted over the past four years have not provided a clear trend for chemicals to effectively remove fruit and at the same time increase cotton yield and quality. Future research is needed to determine if late-season removal of upper-canopy fruit is a viable means for increasing lint yields in cotton. This research should investigate additional chemicals and/or chemical combinations at various labeled rates.

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Table 1. First position fruit shed percentages at the tagged NAWF=5 position, as well as above and below the tag one week after treatment applications. Marianna, Arkansas, 2000.

Treatment	NAWF=5	Above	Below
	------------Shed %------------		
Control	3.1c[1]	61.4bcd	17.4a
Hand Square Removal	19.9abc	100.0a	19.9a
Mechanical Topping	7.4bc	100.0a	21.9a
CCC(0.58L/ha) + PHCA(0.58L/ha)	6.3bc	68.1bc	21.4a
CCC(0.58L/ha)	19.9abc	58.3cd	24.4a
CCC(0.58L/ha) + R.Ultra(0.55kg/ha)	27.0ab	70.1b	18.0a
CCC(1.16L/ha) + PHCA(0.58L/ha)	18.8abc	55.6d	20.5a
CCC(1.16L/ha)	15.6abc	60.6bcd	19.6a
Prep(0.22kg a.i./ha)	30.1a	68.1bc	17.4a
Prep(0.45kg a.i./ha)	13.6abc	66.8bcd	21.8a
Finish(0.06kg a.i./ha)	20.8abc	61.8bcd	17.6a
Finish(0.11kg a.i./ha)	13.6abc	57.6cd	16.8a
Jasmonate (300ppm)	17.6abc	60.6bcd	16.3a
Jasmonate (600ppm)	11.4abc	62.0bcd	18.1a

[1]Treatment means within a column followed by the same letter are not significantly different at P≤0.05.

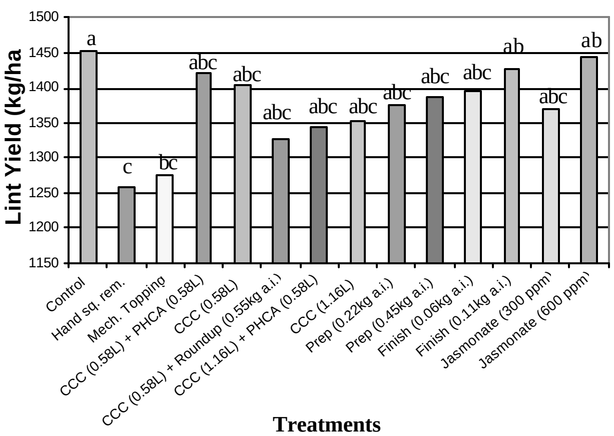

Figure 1. Effect of late-season fruit removal by chemical and physical means on lint yield. Marianna, AR, 2000. Bars with the same letter are not significantly different at P≤0.05.

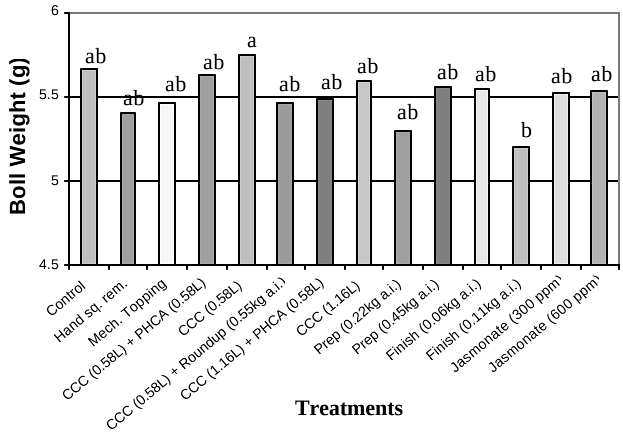

Figure 2. Effect of late-season fruit removal by chemical and physical means on boll weight of first position bolls at NAWF=5. Marianna, AR, 2000. Bars with the same letter are not significantly different at P≤0.05.

Table 2. Effect of late-season fruit removal on length, uniformity, strength and micronaire of first position NAWF=5 bolls. Marianna, Arkansas, 2000.

Treatment	Len.	Unif.	Stren.	Mic.
	in.	%	g/tex	
Control	1.09ab[1]	84.9ab	27.1ab	5.45a
Hand Square Removal	1.09ab	84.6ab	27.1ab	5.45a
Mechanical Topping	1.09ab	84.2bc	26.7ab	5.12e
CCC(0.58L/ha) + PHCA(0.58L/ha)	1.09ab	85.0ab	26.9ab	5.33abcd
CCC(0.58L/ha)	1.09ab	85.0a	27.0ab	5.37abcd
CCC(0.58L/ha) + R.Ultra(0.55kg)	1.08ab	85.0a	26.9ab	5.40abc
CCC(1.16L/ha) + PHCA(0.58L/ha)	1.09ab	85.2a	27.0ab	5.30abcd
CCC(1.16L/ha)	1.09ab	85.1a	27.2a	5.27bcde
Prep(0.22kg a.i./ha)	1.10ab	84.7ab	27.2a	5.25cde
Prep(0.45kg a.i./ha)	1.07b	83.8c	27.1ab	5.23de
Finish(0.06kg a.i./ha)	1.08ab	84.8ab	26.6ab	5.40abc
Finish(0.11kg a.i./ha)	1.08ab	84.9ab	26.2b	5.42ab
Jasmonate (300ppm)	1.10a	84.8ab	26.9ab	5.30abcd
Jasmonate (600ppm)	1.09ab	85.1a	27.4a	5.40abc

[1]Treatment means within a column followed by the same letter are not significantly different at P≤0.05.