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PLANT RESPONSE TO DIFFERENT LEVELS OF PRE-BLOOM SQUARE REMOVAL AND IT'S RELEVANCE TO PLANT BUG MANAGEMENT

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Abstract

West Texas has historically relied on an aggressive management approach to early square feeding insects such as the cotton fleahopper and the western tarnished plant bug. This weather-limited production area purportedly does not have enough end-of-season heat units for the cotton plant to compensate for this early square loss. This study was initiated to evaluate the cotton plant's capacity to compensate for pre-bloom square loss in the Texas High Plains area and to determine if this value is the same as that currently utilized by the cotton management expert system, COTMAN. Four first position square retention treatments were evaluated ranging from 0-100%. Squares were removed manually from the first 9 fruiting nodes when they reached a diameter of 3/16 inch. The COTMAN computer model was used to track the plant's growth and development from first square to first flower and then to cutout, and to determine the timing for crop termination. Each of 100 plants per plot were mapped and each boll was removed from the plant and sorted according to main stem node number and position. Early square removal ranging from 20-40% resulted compensation. This compensation for early square removal was not primarily by adding fruiting nodes but rather by increasing boll retention at the 2nd and 3rd positions. This data suggests that the current early season threshold for western tarnished plant bug and fleahopper could be too aggressive when weather and high yield potential favor compensation.

Introduction

Cotton is the most economically feasible crop for much of west Texas, often planted on over 5 million acres. West Texas in general and the High Plains in particular are areas usually experiencing weather shortened growing seasons. This fact alone has led to an aggressive management approach to early square-feeding insects such as the cotton fleahopper and the western tarnished plant bug. How and how much a cotton plant compensates from early insect- induced square loss can vary with growing conditions and production practices. Planting date, row spacing, plant density, water management and variety planted are all possible complicating factors. Crop advisors and growers need to know the compensation capacity of cotton to make informed management decisions for square-feeding insects. The cotton management program, COTMAN, developed by the University of Arkansas, has been in the validation phase in Texas for the last five years, especially in the west Texas area. This expert system provides information on square retention and provides growth development curves from square map data collected from individual fields. One of the variables utilized by the model includes the cotton plant's compensation capacity for early-season square loss. Compensation values most widely followed across the cotton belt range between 19-30%. The objective of this study was to evaluate the cotton plant's capacity to compensate for pre-bloom square loss on the Texas High Plains and eventually relate this to early season insect control decision rules.

Materials and Methods

The study was conducted at the AG-CARES farm just north of Lamesa Texas. The experimental design was a randomized complete block design with four replications. Plot size was 13.1 feet by 5 rows and the cotton variety used was Paymaster 2326RR planted on May 8 and irrigated by a center pivot system equipped with LEPA nozzles. Each plot was hand thinned to 3 plants per foot. Three of the rows in each plot were designated for positional harvest, one row was designated for plant mapping only and the remaining row was reserved for bulk harvest.

The treatments consisted of 100 (untreated check), 70 percent retention, 60 and 0 percent retention of first position squares on fruiting nodes one through nine. For clarification, nodes one through nine refer to the fruiting sequence of first position squares and not the main stem node number. For example, fruiting node one could have occurred on main stem node four, five or six. Square removal was accomplished by pinching the designated square (Table 1) with jeweler forceps. In order to reduce damage to the adjacent fruiting site, squares were removed when they reached a diameter of 3/16 inch. Squares were removed from fruiting nodes on May 27 and July 9.

First, second and third position fruit were mapped weekly on ten plants per plot until physiological cutout was reached for all positions. This data was entered into the COTMAN computer model. Data was entered into the SQUAREMAN portion of the model until cutout and entered into the BOLLMAN component from first flower to cutout. The COTMAN computer model was utilized to track plant stress against a target development curve and to keep track of first through third position fruit shed.

Plots were defoliated at NAWF = 5 + 850 heat units with Ginstar (5oz./a) + Prep (21oz./a) on September 10, and harvested 7 days later. Every plant in the positional harvest rows was removed with pruning shears by cutting below the cotyledonary scar. Plants were then placed in cardboard boxes (approximately 60 plants per box) for transport to an enclosed facility. Each individual plant was mapped and each boll was removed from the plant and placed in paper sacks according to main stem node number and by combinations of the first three positions. The combinations were as follows: first position fruit only; first and second positions; first, second and third positions; first and third positions; second positions only; second and third positions and third positions only. For example, a first position fruit on main stem node five could be placed in one of four individual sacks depending on the presence or absence of second and third position fruit. Fourth and fifth position bolls and all vegetative bolls were placed in individual sacks regardless if an adjacent position was present or not. All bolls above main stem node 18 were placed in one sack. Each individual sack was weighed and then was combined with the corresponding sacks of each replication. The bulk harvest plots were hand harvested and the bolls were placed in paper sacks. The cotton was ginned at the Texas Agricultural Experiment Station in Lubbock and fiber quality data was obtained through the International Textile Center in Lubbock. The bulk harvest consisted of 152 plants per plot and the positional harvest consisted of 102 plants per plot. Plants in the positional harvest were eliminated due to extensive boll loss during transport and handling.

Results

The growth development curves produced by the SQUAREMAN portion of COTMAN did not give any indication of plant stress for first and second position fruit, as all treatment curves demonstrated a similar growth rate as the target growth development curve prior to bloom (Figure 1&2). However, the growth development curves for third position fruit across all treatments indicate stress as these curves diverge away from the target growth curve (Figure 3). This stress is most likely due to a lack of water to sustain third position fruit. Once treatments reached first-flower, they accelerated towards physiological cutout then again paralleled the target development curve which is normal for cotton grown in this region. Because of the square removal on the first nine fruiting sites, the 0% retention treatment reached first bloom after NAWF= 5. The removal of squares did not cause an increase in overall plant height, but a significant higher number of nodes did occur for the zero and 60 percent retention treatments. This difference was less than one node between treatments and had little effect on positional yield (Table 2). The total number of nodes per plant in the zero percent retention treatment was significantly greater than the 100 percent retention treatment, ranging less than one additional node at the top of the plant. The other treatments did not differ from each other. This was based on observations made on September, 10 a full month after seasonal cutout. Plants may have added one or two main stem nodes after this date but there would not have been enough heat units remaining to make a harvestable boll.

Plants within treatments reached physiological cutout (NAWF =5) between 79 and 82 days after planting for first position fruiting sites. Second position fruiting sites reached cutout between 80 and 83 days and third position sites reached cutout between 81 and 85 days after planting (Table 3). All treatments reached physiological cutout prior to August 11, the seasonal cutout date for Lamesa based on long term weather records and accepting a 50% probability of this being the correct decision.

Early square removal resulted in compensation as bulk lint yield per acre across all treatments was not significantly different from the untreated check (Table 4). Likewise, in the lint weight per acre for positional yield, none of the retention treatments were significantly different from the untreated check. The amount of lint harvested from first position bolls from the entire plant generally increased as square retention increased with no significant differences in the 60 and 70 percent retention treatments. The most severe reduction in first position lint yield was in the zero percent retention treatment where all first position squares were removed from the first 9 fruiting nodes. This was expected since few first position bolls were obtained outside this manipulated zone (Table 5). Also, as more first position squares were removed final yield contribution of second and third position fruit increased. There was also significantly more lint obtained from vegetative branch bolls in the zero retention treatment than all other square retention treatments. This indicated that early fruit loss compensation was accomplished by increasing the contribution off mainly second and third position fruit and vegetative fruit. This compensation was not the result of increasing the total number of harvested bolls per plant (Table 6). The number of harvested bolls per plant by position indicated that as the percent of first position bolls decreased, the percent retention of second and third position bolls increased. The average lint weight per boll by position did not differ for first and third position bolls, however, there were some differences between treatments for second position bolls (Table 7). These differences in lint weight are consistent with the differences in positional harvest yield.

The lint produced from only those fruiting positions in the zone of the plant in which first position squares were manipulated (table 1) represented 84.8% to 89.8% of the total lint harvested per acre for each treatment (Table 8). The 0 and 60% retention treatments were less than the other treatments. When comparing yield from this zone, there was no differences between treatments suggesting that compensation occurred within the square removal treatments.

The zero percent retention treatment had significant fewer bolls per plant within the manipulated zone but this difference was less than one boll and therefore had little impact towards compensation in this zone (Table 9). Like the whole plant findings (Table 4), the number of second and third position bolls harvested tended to increase as the number of first position bolls harvested decreased which again characterizes the role of second and third position fruit towards compensation. The trend in lint weight per boll within this zone (Table 10) parallels the trend in the corresponding positional yield per acre (Table 4). The zero and 60 percent retention treatments had a significantly higher yield outside the manipulated zone (Table 11). This increased yield within this zone is due to a higher percentage of the total yield and number of bolls per plant for these treatments.

Conclusions

The SQUAREMAN development curves from COTMAN did not show stress for any level of the square removal treatments prior to the appearance of first flower. Every treatment entered cutout before the seasonal date of August 11. However, as a trend, the more squares that were removed from the plant, the more time it took to reach cutout for all positions. In this region of Texas, a two day difference in reaching cutout can cause as much as a 14 day delay in reaching 850 heat units which is when we initiate crop termination. Early square removal resulted in compensation in yields indicating that the current management practices stressing the importance of maximizing early square retention may be flawed. This compensation was due in part to the increase in boll weight of second position fruit. But the majority of compensation appeared to be the result of increasing boll retention in positions 2 and 3. This data suggests that concern for early square retention may not be warranted until the 2nd or third week of squaring and that the plant's architecture or leaf area may not adequately support these earlier fruiting positions. Further studies will be needed to evaluate variable boll retention as a factor in early square loss compensation. Producers may be better off managing more for high boll retention rather than high early square retention. This could result in less insecticide usage for early season fleahoppers or *Lygus* bugs.

This report does not include the fiber quality data. The inclusion of economics associated with the various boll positions may alter somewhat the above conclusions.. The report also does not include the data from the second planting date which was June 10, an insurance deadline date which is very late. The data set also included another 70% treatment which will allow us to evaluate the Holman curve for early season square protection decisions versus the traditional more aggressive approach. This data will be provided in a later, comprehensive report.

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Table 1. Designated square removal for each target treatment and actual percent retention on main stem fruiting nodes 1-9 associated with the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Target Percent Retention	Fruiting nodes of first position square removal	Actual Percent Retention 7/24[1/]
100%	--	82.23
70%	6, 8 & 9	56.85
60%	4, 6, 8 & 9	49.08
0%	1-9	1

1/ Three days after last square removal.

Table 2. Comparison of mean number of nodes and plant height on September 10 between the various square retention treatments and by individual boll position and vegetative branch in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention Treatment	Number of Nodes	Plant Height
100 %	15.5 b	22.13 a
70 %	15.4 b	20.5 a
60 %	15.8 ab	21.5 a
0 %	16.1 a	22.13 a

1/ Means in a column followed by the same letter are not different (P=0.10, LSD).

Table 3. Number of days from planting in which each treatment reached cutout (NAWF = 5) in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention	Days to cutout (NAWF=5)		
Treatment1/	1st position fruit	2nd position fruit	3rd position fruit
100 %	79	80	84
70 %	80	81	84
60 %	81	83	81
0 %	82	83	85

1/ All treatments reached the physiological cutout criteria before the seasonal cutout date of August 11 based on NAWF =5, therefore, the physiological cutout criteria were applied to treatments for crop termination.

Table 4. Comparison of per acre lint yield in pounds between the various square retention treatments and by individual boll position and vegetative branch in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention Treatment	Bulk Yield lbs./a	Positional Yield lbs./a	Boll Position			
			1	2	3	V2/
100%	883.8 a	503.2 ab	405.18 a	95.60 c	17.38 c	3.8 b
70%	855.3 a	478.3 b	353.57 b	100.85 c	15.14 c	7.0 b
60%	845.8 a	540.4 a	352.67 b	144.21 b	32.41 b	5.3 b
0%	827.0 a	520.9 a	61.91 c	332.10 a	97.22 a	19.3 a

1/ Means in a column followed by the same letter are not different (P=0.10, LSD).
2/ V = all vegetative branch bolls.

Table 5. Comparison of harvested bolls per plant from all positions on nodes 4-12 and on nodes 13 and higher plus vegetative bolls between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention Treatment	Nodes 4-12	Nodes 13+, Vegetative
100%	7.6 a	0.2 c
70%	7.4 a	0.2 c
60%	7.8 a	0.4 b
0%	7.1 b	0.9 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

Table 6. Comparison of number of harvested bolls per plant between the various square retention treatments and by individual boll position and vegetative branch in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention	Plant	Boll Position				
Treatment	Total	1	2	3	4	V[2/]
100%	5.5 a	4.2 a	1.1 d	0.2 c	0.0 c	0.0 b
70%	5.2 a	3.8 b	1.2 c	0.2 c	0.0 c	0.1 b
60%	5.7 a	3.7 b	1.6 b	0.4 b	0.1 b	0.1 b
0%	5.4 a	0.7 c	3.6 a	1.1 a	0.1 a	0.2 a

1/ Means in a column followed by the same letter are not different (P=0.10, LSD).
2/ V = all vegetative branch bolls.

Table 7. Comparison of lint weight (gm) per boll between the various square retention treatments and by individual boll positions 1-3 in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention		Boll Position		
Treatment	Plant Total	1	2	3
100%	1.62 a	1.64 a	1.57 ab	1.54 a
70%	1.60 a	1.64 a	1.48 b	1.61 a
60%	1.65 a	1.71 a	1.56 ab	1.48 a
0%	1.64 a	1.66 a	1.67 a	1.52 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

Table 8. Comparison of percent of total lint and pounds of lint produced per acre on nodes 4-12 between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

	Boll Position	
Percent Retention Treatment	Percent of total lint produced	Yield (lbs./a)
0%	89.8 a	451.3 a
60%	89.8 a	429.5 a
70%	87.8 b	474.5 a
100%	84.0 c	437 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

Table 9. Comparison of number of harvested bolls per plant from all positions on nodes 4-12 and by individual boll position between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention	Boll Position			
Treatment	1-3 Combined	1	2	3
100%	7.6 a	3.9 a	1.0 d	0.2 c
70%	7.4 a	3.6 b	1.2 c	0.2 c
60%	7.8 a	3.3 c	1.6 b	0.4 b
0%	7.1 b	0.1 d	3.4 a	1.1 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

Table 10. Comparison of lint weight (gm) per boll from all positions on nodes 4-12 and on nodes 13 and higher plus vegetative bolls between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention Treatment	Nodes 4-12 (gm)	Nodes 13+, Vegetative (gm)
100%	1.63 bc	1.59 a
70%	1.61 c	1.55 a
60%	1.66 a	1.60 a
0%	1.64 ab	1.63 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

Table 11. Comparison of percent of total lint, pounds of lint produced per acre and number of bolls harvested per plant from fruiting sites outside the zone encompassing positions 1-3 on nodes 4-12 between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2002.

Percent Retention Treatment	Percent of total lint produced	Lint Pounds per Acre	Number of Bolls per Plant
100%	10.2 a	51.8 c	0.25 c
70%	10.2 a	48.5 c	0.23 c
60%	12.2 b	65.8 b	0.40 b
0%	16.0 c	83.8 a	0.87 a

1/ Means in a column followed by the same letter are not different (P = 0.10, LSD).

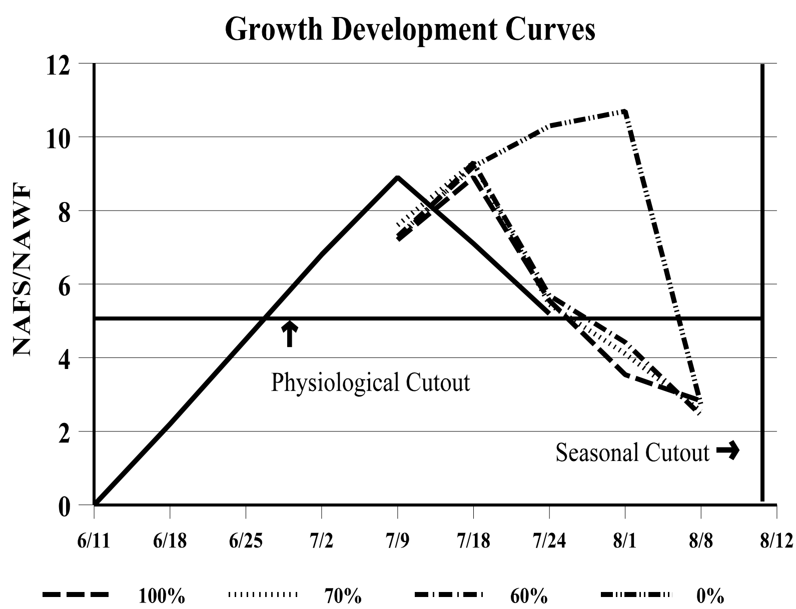

Figure 1. Comparison of first position growth development curves resulting from the various square retention treatments to the target development curve in the COTMAN test conducted at the AG-CARES farm at Lamesa Texas. 2002.

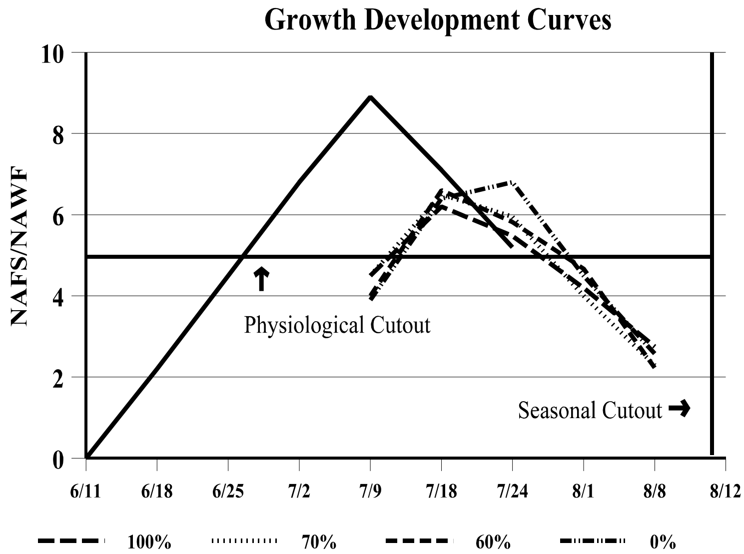

Figure 2. Comparison of second position growth development curves resulting from the various square retention treatments to the target development curve in the COTMAN test conducted at the AG-CARES farm at Lamesa Texas.

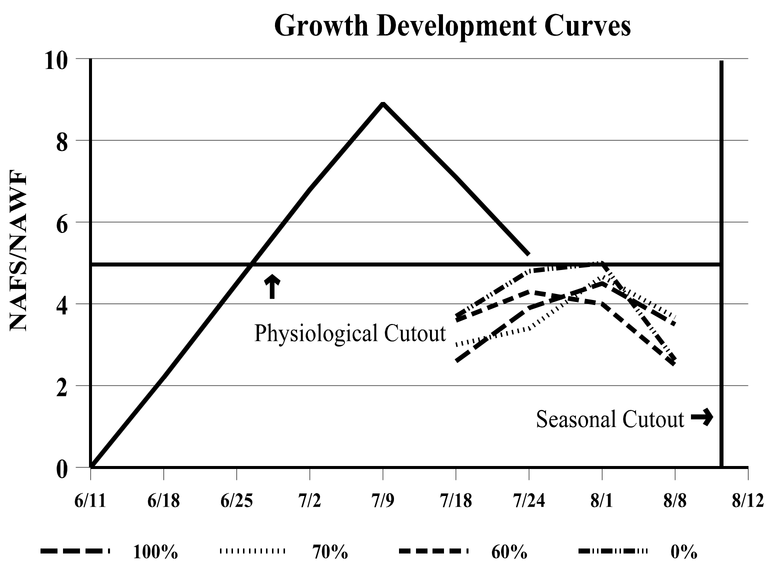

Figure 3. Comparison of third position growth development curves resulting from the various square retention treatments to the target development curve in the COTMAN test conducted at the AG-CARES farm at Lamesa Texas.