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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. Five 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 in super compensation and increased yields. 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 factorial with four replications. Plot size was 45 feet by 8 rows and the cotton variety used was Paymaster 2326RR irrigated by a center pivot system equipped with LEPA nozzles. Two planting dates were utilized. The first planting date plots were planted for a second time following a severe hail storm on May 30, 2001. This was at the end of the area's optimal planting window. The last date to plant for insurance purposes is June 10 and the second planting (representing a late planting date) was accomplished on this date. Only data from the first planting date is presented here. Data was collected from the middle four rows of each plot. Twenty five plants in each row were marked with popsicle sticks at the two true leaf stage for a total of 100 plants per replication. This was to insure age uniformity of sampled plants.

The treatments consisted of 100 (untreated check), 80 percent retention, 70, 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 one through six on July 17 and the remainder of the squares were removed on July 24.

Ten of 25 plants located in the fourth row of each plot were mapped weekly until physiological cutout, four nodes above upper most white flower (NAWF), or until seasonal cutout (August 11), which ever came first. 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 position fruit shed.

Plots were defoliated at NAWF = 4 + 850 heat units with Ginstar (5oz./a) + Prep (21oz./a) on October 11 and harvested 7 days later. The marked plants were removed with pruning shears by cutting below the cotyledonary scar. Plants were then placed in cardboard boxes (50 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 place 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 cotton was ginned at the Texas Agricultural Experiment Station in Lubbock and fiber quality data was obtained through the International Textile Center in Lubbock. Eventually an economic value will be calculated by position utilizing this data.

Results

The growth development curves produced by the SQUAREMAN portion of COTMAN did not give any indication of any plant stress, as all treatment curves demonstrated a similar growth rate as the target growth development curve prior to bloom (Figure 1). Once treatments reached first-flower, they accelerated towards physiological cutout then again paralleled the target development curve. First flower occurred on July 27 (58 days after planting) for all treatments with the exception of the 0% retention treatment which was delayed a week. This represented the addition of only one more main stem node even though the COTMAN model assumes a node is produced every 2.7 days. The COTMAN model also assumes that first flower occurs within 60 days of planting. All but the most severe shed-simulation treatments bloomed 59 days after planting while flowering for the lowest retention treatment occurred 66 days following planting.

Plants within treatments reached physiological cutout (NAWF =5)between August 5 and 9 and accumulated the 850 heat units targeted for crop termination between September 21 and October 5 (Table 2). 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. With a late replant due to the earlier weather loss of the first planting, physiological cutout occurred very close to seasonal cutout. The more severe the square shed simulation, the closer physiological cutout was pushed toward seasonal cutout.

Originally for our area, physiological cutout was defined as NAWF =4. This was based on earlier results of tests validating the BOLLMAN component of COTMAN in the Texas High Plains. This is different than the criteria developed by the University of Arkansas for the COTMAN model where NAWF =5 is used. We have since been able to justify the use of NAWF =5 as the timing of physiological cutout but not before the completion of this study. Since all treatments reached seasonal cutout on or before the physiological cutout criteria used for this study, all treatments were terminated at the same time, October 11, with 836 heat units accumulated past seasonal cutout.

Early square removal resulted in super compensation as lint yield per acre was significantly higher in all treatments when compared to the untreated check, but were not different from each other (Table 3). The amount of lint harvested from first position bolls from the entire plant generally increased as square retention increased. The most severe reduction was in the 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. Also, as more first position squares were removed final yield contribution of positions 2, 3, and 4 increased. There was also significantly more lint obtained from vegetative branch bolls in the 0 retention treatment than all other square retention treatments. This indicated that early fruit loss compensation was accomplished by increasing the contribution off mainly positions 2, 3, and 4. This compensation was not the result of increasing the total number of harvested bolls per plant (Table 4). 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 position bolls, however, there were some differences between treatments for both second and third position bolls (Table 5). These differences were not always consistent with the square retention levels achieved earlier but there was a weak trend toward heavier bolls in second and third positions as square shed simulation was increased. The total number of nodes per plant in the 0% retention treatment was significantly greater than all other treatments, ranging from about 1 to 1.5 additional nodes at the top of the plant (Table 6). The other treatments did not differ from each other. This was based on observations made on August 16. Plants may have added more main stem nodes after this date but these would have been of no value to yield since seasonal cutout had occurred on August 11. Any additional bolls from these main stem nodes would have had little impact on the yield compensation observed in the square removal treatments.

The lint produced from only those fruiting positions in the zone of the plant in which first position squares were manipulated (Figure 2) represented 80.8% to 93.6% of the total lint harvested per acre for each treatment (Table 7). Only the 0 and 60% retention treatments were less than the untreated check and only the 0% treatment was less than all other square retention treatments in percent of lint produced within this zone. When comparing yield from the first 3 positions combined within this zone, the general trend was for higher yield contributions than the untreated check with the exception of the 0% retention treatment which was the same as the untreated check. This would indicate that most of the compensation for earlier square loss in the 60, 70, and 80% retention treatments took place within this manipulated zone while a larger contribution to compensation occurred outside this zone for the 0% retention treatment. As expected, the general trend for individual boll position contributions to overall yield was similar to that observed for the whole plant and increased in positions 2 and 3as first position square retention decreased.

There were some differences in the number of bolls harvested from combined positions 1-3 with the manipulated zone but there was no discernable trend in relation to differences due to treatment effect (Table 8). 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. Also, like the whole plant average lint weight per boll findings (Table 5), there were few discernable trends related to treatment effects (Table 9). There were generally lighter bolls in position 3 in the treatment where no first position squares were removed. There was significantly more lint harvested from bolls outside the manipulated zone when compared to the other treatments but no differences between these other treatments (Table 10). This was accomplished through the addition of 1.6 more bolls per plant which corresponds to the increase in vertical nodes resulting from the removal of all first position squares from fruiting nodes 1-9.

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. However, flowering was delayed approximately one week when all first position squares were removed prior to flowering in the other treatments. Early square removal did delay cutout 3-4 days in the more severe square removal treatments. This would have caused a delay of 10 to 12 days in crop termination, reflecting the loss of earliness so necessary in a weather-shorten growing area, especially when late replanting is forced by earlier weather losses. Early square removal resulted in super compensation in yields indicating that the current management practices stressing the importance of maximizing early square retention may be flawed. This compensation was in part from the addition of main stem nodes and fruiting branch positions, and to a very limited degree, the increase in boll weight in position 2. 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. Lint yields in this test were up into the 3 bale range indicating that even a later planting date can produce high yielding results when early squares are lost but inputs such as water (75% PET) are adequate. 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.

Because this was a high yielding system with generally adequate water, the importance of boll positions other than first position bolls to final yield is greater than where target yields are in the 1 - 1 1/2 bale range. Therefore, compensation as observed in this study may not be expressed in these lower yielding systems, especially during more typical years where heat unit accumulation is much lower in September and October than was the case in 2001 and in fact during the last 5 years in the Texas High Plains area.

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. 2001.

Target Percent Retention	Fruiting nodes of first position square removal	Actual Percent Retention 7/27[1/]
0%	1-9	4
60%	4, 6, 8 & 9	42
70%	6, 8 & 9	57
80%	8 & 9	69
100%	--	92

1/ Three days after last square removal.

Table 2. Date in which each treatment reached either physiological cutout (NAWF = 5) and the corresponding dates for attaining 850 heat units for crop termination in the COTMAN project at AG-CARES, Lamesa, Texas. 2001.

Percent Retention Treatment	NAWF = 5	NAWF = 5 + 850 HU	NAWF = 4 [1/]	NAWF = 4 + 850 HU
0 %	Aug. 8	Oct. 3	Aug. 14	Oct. 23
60 %	Aug. 9	Oct. 5	Aug. 15	Oct. 23
70 %	Aug. 5	Sept. 21	Aug. 12	Oct. 22
80 %	Aug. 5	Sept. 21	Aug. 11	Oct. 20
100 %	Aug. 6	Sept. 23	Aug. 11	Oct. 20

1/ All treatments reached the physiological cutout criteria on or after the seasonal cutout date of August 11 based on NAWF =4, therefore, the seasonal cutout criteria were applied to treatments for crop termination.

Table 3. 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. 2001.

Percent Retention	Boll Position						
Treatment	Plant Total	1	2	3	4	5	V[2/]
0%	1514 a[1/]	187 e	845 a	364 a	42 a	1 a	72 a
60%	1466 a	778 d	543 b	106 b	11 b	1 a	25 b
70%	1446 a	907 c	411 c	92 b	6 b	1 a	26 b
80%	1512 a	1047 a	357 c	78 b	4 b	1 a	25 b
100%	1299 b	975 b	254 d	36 c	5 b	0 a	29 b

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

Table 4. 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. 2001.

Percent Retention		Boll Position					
Treatment	Plant Total	1	2	3	4	5	V[2/]
0%	8.5 a[1/]	1.0 d	4.6 a	2.2 a	0.3 a	0.0 a	0.4 a
60%	8.2 a	4.3 c	3.1 b	0.6 b	0.1 b	0.0 a	0.2 a
70%	8.1 a	5.0 b	2.4 c	0.4 bc	0.0 c	0.0 a	0.2 a
80%	8.1 a	5.6 a	2.0 d	0.3 cd	0.0 c	0.0 a	0.1 a
100%	7.6 a	5.6 a	1.7e	0.2 d	0.0 c	0.0 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 5. 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. 2001.

Percent Retention		Boll Position		
Treatment	Plant Total	1	2	3
0%	1.82 a[1/]	1.95 a	1.88 a	1.70 c
60%	1.86 a	1.89 a	1.79 ab	1.95 bc
70%	1.84 a	1.85 a	1.75 b	2.10 b
80%	1.92 a	1.90 a	1.80 ab	2.55 a
100%	1.74 a	1.79 a	1.55 c	1.80 c

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

Table 6. Comparison of total number of main stem nodes per plant between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2001. on August 16, 2001.

Percent Retention Treatment	Number of Nodes
0%	17.33 a[1/]
60%	16.40 b
70%	15.70 b
80%	16.10 b
100%	15.90 b

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

Table 7. Comparison of percent of total lint and pounds of lint produced per acre from combined positions 1-3 on nodes 5-13 and by individual boll position between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2001. on August 16, 2001.

Percent Retention Treatment	Percent of total lint produced	Boll Position 1-3 Combined	1	2	3
0%	80.8 c[1/]	1221 b	60 d	811 a	363 a
60%	91.1 b	1342 ab	706 c	529 b	105 b
70%	91.8 ab	1325 ab	838 b	406 c	92 b
80%	93.0 ab	1406 a	988 a	350 d	77 b
100%	93.6 a	1217 b	935 a	251 e	36 c

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

Table 8. Comparison of number of harvested bolls per plant from combined positions 1-3 on nodes 5-13 and by individual boll position between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2001. on August 16, 2001.

Percent Retention	**Boll Position**			
Treatment	**1-3 Combined**	**1**	**2**	**3**
0%	6.9 c[1/]	0.4 d	4.4 a	2.2 a
60%	7.5 ab	3.8 c	3.1 b	0.6 b
70%	7.4 ab	4.6 b	2.3 c	0.4 bc
80%	7.6 a	5.3 a	2.0 d	0.3 cd
100%	7.1 bc	5.3 a	1.6 e	0.2 d

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

Table 9. Comparison of lint weight (gm) per boll from combined positions 1-3 on nodes 5-13 and by individual boll position between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2001. on August 16, 2001.

Percent Retention	**Boll Position**			
Treatment	**1-3 Combined**	**1**	**2**	**3**
0%	1.8 b[1/]	1.2 b	1.8 bc	1.7 b
60%	1.9 a	1.9 a	1.7 c	1.9 ab
70%	1.8 b	1.9 a	1.9 b	2.2 ab
80%	1.9 a	1.9 a	2.0 a	2.4 a
100%	1.8 b	1.8 a	1.7	1.1 c

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

Table 10. 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 5-13 between the various square retention treatments in the COTMAN project at AG-CARES, Lamesa, Texas. 2001. on August 16, 2001.

Percent Retention Treatment	**Percent of total lint produced**	**Lint Pounds per Acre**	**Number of Bolls per Plant**
0%	19.2	293 a[1/]	1.6 a
60%	8.9	131 b	0.7 b
70%	8.2	120 b	0.7 b
80%	7.0	105 b	0.6 b
100%	6.4	83 b	0.6 b

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

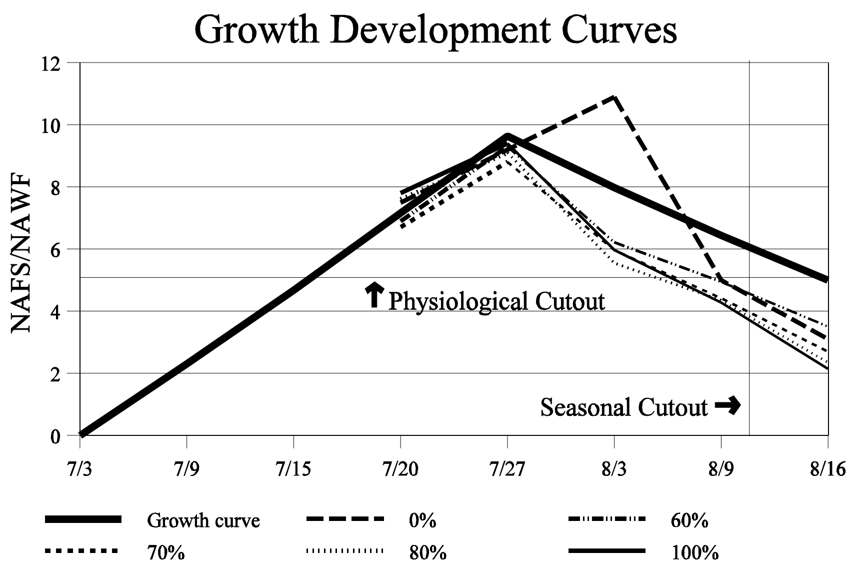

Figure 1. Comparison of growth development curves resulting from the various square retention treatments to the target development curve in the COTMAN test conducted at the AG-CARES farm at Lamesa Texas. 2001.

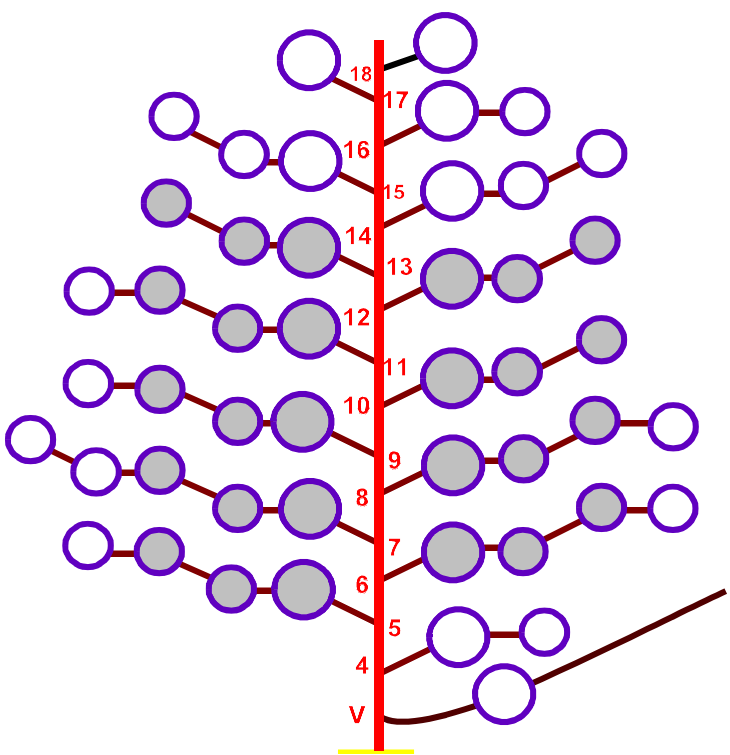

Figure 2. Diagram depicting the zone (nodes 5-13) in which 1st position squares were manipulated in the COTMAN test conducted at the AG-CARES farm at Lamesa Texas. 2001. Darkened bolls represent those nodes and positions included in the zone.