THE EFFECT OF EARLY SEASON TERMINAL BUD AND SQUARE REMOVAL ON COTTON YIELDS IN NORTH CAROLINA

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Abstract

Field studies were conducted in northeastern North Carolina and southern Virginia to evaluate the effects of early season terminal bud and square removal on yield of cotton. Terminal buds were removed at 10%, 20%, and 30% on the 3rd or 5th of July at the test locations. No significant yield differences among terminal bud removal levels were observed when compared to the zero removal control. First position squares were removed as sequential groups at 4, 8, and 12 per row foot on three different dates (5 July, 9 July and 13 July) from three test locations in order to simulate the feeding pattern of tobacco budworm larvae. Yield results indicated that cotton plants fully compensated for the loss of early first position squares when compared to the zero removal control. Plant mapping data indicated that a greater percentage of fruit were set at second positions or at higher first positions in the plant fruiting profile when early first position squares were removed.

Introduction

Increasing difficulty in managing late season lepidoptera pests has led to a general consensus that cotton crop earliness must be achieved at any cost. Researchers have demonstrated many benefits of crop earliness such as reduced inputs (fertilization and irrigation), reduced late season insect complications, earlier and less problematic harvest, increased yield, and earlier crop destruction. However, the wholesale adoption and promotion of the earliness concept may mislead producers to intensively protect all early developing squares and ignore any compensatory capacity of the cotton plant.

Jenkins et al. (1990a & 1990b) demonstrated the importance of each fruiting position to the overall yield of several common cotton cultivars. This work emphasized the importance of fruiting positions which are low and close to the mainstem of a plant's fruiting profile. It is generally these positions that many researchers have recommended protecting from insects early in the season to ensure crop earliness and high yields (Brook et al. 1992, Danforth et al. 1990, Jenkins et al. 1990, Kerby and Keely 1993, Parvin et al. 1987, Parvin 1992). Though earliness is an important goal, thresholds should not be ignored or set so conservatively that insignificant second generation budworm populations receive insecticide applications. Brook et al. (1992), Kennedy et al. (1986), Mann et al. (1995), Turnipseed et al. (1992), Turnipseed et al. (1995) have demonstrated through natural and mechanical defruiting methods that cotton plants can sustain substantial loss of early season squares and terminals without suffering significant yield reductions. In addition, the compensatory capacity of cotton has been realized to the extent that researchers have suggested the removal of early squares through chemical means (ethephon application) as a method of reducing later season boll weevil problems (King et al. 1990, King et al. 1992, Namken & King 1991,Sheng & Hopper 1988).

The purpose of this study was to evaluate the ability of cotton plants to compensate (in terms of yield) for the loss of terminal buds and early season first position squares. The plants from square removal treatments were mapped to evaluate the redistribution of harvestable bolls.

Materials and Methods

Cotton terminal removal tests were conducted at the Central Crops Research Station in Clayton NC., Upper Coastal Plain Research Station in Rocky Mount NC., and the Tidewater Research Station in Plymouth NC. At each location, a RCB test with six replicates was established with plots represented by a single row containing a total of 50 plants which were spaced at two per row foot. Terminal removal treatments were 10%, 20%, 30% and a 0% untreated control (no terminals removed). Each terminal was removed just above the small subtending leaf from random plants within the single row plots. Terminal removal treatments were performed on 3 July at the Central Crops Research Station and the Upper Coastal Plain Research Station and on 5 July at the Tidewater Research Station (NC). These dates corresponded to the seasonal occurrence for each test location of the mid-season tobacco budworm moth flight and ovipositional period. The field tests located at both the Upper Coastal Plain and Tidewater Research Stations (NC) were irrigated while the test located at the Central Crops Research Station was under dryland production.

Cotton square removal tests were conducted at the Farliss Farm in Bertie Co. NC., the Albemarle Beach Farm in Washington Co. NC., and the Tidewater Research Station in Suffolk Co., Holland, Va. At each location, a RCB test with six replicates and four treatments which consisted of three terminal removal levels and an untreated control (no square removal) was established. Plots were represented by 8 plants which were spaced at two per row foot. The three first position square removal treatments (4, 8 and 12

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:941-945 (1996)
National Cotton Council, Memphis TN

squares / row foot) were established by removing two squares per plant from each plot on 5 July. Two additional squares were removed from each of the plants in the 8 and 12 squares / row foot removal treatments on 9 July. A final two squares were removed from each plant in the 12 squares / row foot removal treatment on 13 July. First position squares (match head size or greater) were removed with surgical scissors from high to low sympodium in order to simulate the temporal and spatial feeding pattern of tobacco budworm larvae down the cotton plant fruiting profile. Each square removal treatment was considered to be equivalent to damage accumulated by larvae of a set age class. The first removal treatment (4 squares / row foot) was considered to simulate the damage caused by one 1st to 3rd instar TBW larvae per plant. The second square removal treatment (8 squares / row foot) was considered to simulate to the accumulated damage of one larvae surviving to the 4th instar. The final square removal treatment (12 squares / row foot) represented the accumulated damage of a single 5th instar larvae that completed 1st to 4th instar development on the early first position squares (located on higher sympodia) of a single cotton plant.

The square removal groups for the Albemarle Beach Farm and Tidewater Research Station (Va.) sites were as follows: 5 July, sympodia 11 and 10; 9 July, sympodia 9 and 8; and 13 July, sympodia 7 and 6 (Table 1). The removal groups for the Farliss Farm site were: 5 July, sympodia 13 and 12; 9 July, sympodia 11 and 10; and 13 July, sympodia 9 and 8 (Table 2). Removed squares and subsequent harvestable boll locations were evaluated through a standard plant mapping procedure. The mainstem branch positions were numbered from 0, 1, 2, 3, ..., X with the cotyledonary nodes designated as the number zero. Sympodial branch fruiting positions were numbered 1, 2, 3 ..., X with the first fruiting position designated as number one.

Delta & Pineland® 5690 was planted at the Tidewater Research Station, (NC.) on 27 April and the Central Crops Research Station on 26 April. Delta and Pineland 20 and 51 were planted at the Albemarle Beach Farm on 21 April and Farliss Farm on 27 April respectively. Delta & Pineland 50 was planted at the Tidewater Research Station (Va) on 5 May. DES 119 was planted at the Upper Coastal Plain Research Station on 22 May. All tests were planted on 38 inch row spacings with the exception of the test located at the Upper Coastal Plain Research Station test which was planted on 36 inch rows.

All cotton tests received the at plant insecticide Temik 15G® @ 0.75 lbs. ai./A, the herbicides Treflan 4EC® @ 0.75 lbs. ai./A applied PPI and Meturon 4L® @ 1.0 lb. ai./A applied preemergence for early season insect and weed pests. Each test was protected season long from caterpillar pests by over-spraying with either Karate 1EC® @ 0.04lbs. ai./A or Capture 2EC® @ 0.045 lbs. ai./A where aphid populations were stimulated from previous insecticide applications. The high rates of both Karate and Capture were used to mini-mize the number of applications but to assure no damage to fruiting forms would occur. All square removal test sites were under dryland production.

All cotton tests were hand picked and weighed to the nearest tenth of a pound. Yield differences among treatments in all test were evaluated by standard ANOVA (PROC GLM, SAS Institute, 1979). Significant treatment means were separated by LSD $P \leq 0.05$.

Results

No significant yield differences were observed among the three terminal removal treatments when compared to the untreated control at the Central Crops Research Station (Figure 1), the Upper Coastal Plain Research Station (Figure 2) , or the Tidewater Research Station (NC.) (Figure 3) respectively (F=0.34; df=3,15; P=0.7976), (F=0.14; df=3,15; P=0.9371), and (F=0.09; df=3,15; P=0.9617). Though no significant differences in yield were detected, the untreated control yielded 171.3 and 121.1 pounds / A more seed cotton than the 30% terminal removal treatment from the Central Crops and Upper Coastal Plain Research Stations respectivly. However, the untreated control yielded 80.7 pounds / A less seed cotton than the 30% terminal removal treatment at the Tidewater Research Station (NC.).

No significant differences in seed cotton yields were detected from the ANOVA which compared the three first position square removal treatments and the untreated control at the Albemarle Beach Farm (Figures 4), the Farliss Farm (Figure 5), or the Tidewater Research Station (Va.) (Figure 6) test locations respectively (F=0.80; df=3,15; P=0.5105), (F=1.98; df=3,15; P=0.1605) and (F=2.94; df=3,15; P=0.0673). Though no significant differ-ences in seed cotton yield were detected, the untreated control (no squares removed) produced an average 186.5 pounds / A less seed cotton than the 12 squares/row foot removal treatment when data were pooled across test locations. The inequality in yield among the treatments can be contributed largely to the 30 to 40 percent average increase in numbers of second position harvestable bolls on sympodia from which first position bolls were removed (Tables 3 & 4).

Discussion

The results of these experiments showed that cotton had the capacity to compensate for the loss of a high percentage of terminal buds (30%) and early first position squares (12 squares / row foot) during late June through early July in NC. and Va. Terminal buds removed at 30% and first position squares removed at 12 / row foot represent a level of damage which is rarely observed in NC or Va. cotton fields. Our terminal bud removal test results were similar to the findings of Brook et al. (1992) and Mann et al.

(1995) in which cotton yields did not suffer from varying levels of terminal bud pruning.

The favorable yield response of cotton to high levels of early first position square removal supports similar findings by Turnipseed et al. (1995) in South Carolina. Our square removal studies assumed that early season TBW larvae feed in a downward vertical pattern within a cotton plant's fruiting profile and results in a reduction of first position squares. Though extensive damage from the early-to-mid-season TBW population is rare, this is generally the observation made in isolated fields in NC. and Va. during late June and early July. Growers who have achieved crop earliness generally possess a crop that has 6 to 8 first position squares per plant by July 4th and may observe early flowering of the first fruiting positions at this time. Many growers are often conscious of the condition of their crop at this time because of the yield implications placed on the early fruiting positions by many researchers, consultants, and agricultural chemical salesmen. Damage (flared and aborted squares) is often obvious on small plants which may cause alarm and result in unwarranted insecticide applications.

A great deal of uncertainty often faces growers because cotton plant canopies are very rarely closed during this portion of the season which prevents the movement of larvae between rows and limits to a certain extent any within row movement. These isolation factors (presence of food and limited interplant movement) tend to focus feeding damage on single plants. It is sometimes these badly damaged plants (often low in number) that cause alarm and unwarranted insecticide applications.

Although it is rare to observe early season square damage in NC. and Va. fields approach the levels represented by our more extreme test treatments, when observed its cause is most often insecticide related. As stated earlier, crop earliness should be our primary goal. However, the attempt at achieving crop earliness must not begin with early season unwarranted insecticide applications (generally for thrips or second generation TBW) which cause a reduction in beneficial arthropod populations (Bacheler 1992). J.R. Bradley Jr. (personal communication) refers to this as the "setting up" of a field which most often results in a season long insect pest management dilemma that is generally solved by multiple insecticide applications.

There is no doubt that the removal of a great number of early season first position squares will cause a marked delay in crop maturity. Our results indicate that cotton can rebound from the considerable loss of first position squares during late June and early July in NC. and Va. An economical approach would lead us to the conclusion that a mature crop stands to lose more than a less mature crop if a high proportion of early fruiting structures were damaged. The reason for this conclusion is that a mature crop has invested more photosynthate and accumulated heat units in its fruiting structures than a less mature crop. However, since we observed no significant differences in yield due to compensation in the form of greater numbers of second position bolls, the loss of early squares is considered negligible during this early portion of the season. Cotton plants routinely self prune a high percentage of early fruiting structures (squares and young bolls) as a response to both biotic and abiotic conditions. Since the loss of early fruiting structures is the norm, it is difficult to prove the need to apply insecticides for the second generation TBW and possibly should demand a reevaluation of current thresholds.

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Table 1. First position square removal treatments at the Albemarle Beach Farm Washington Co., NC. and the Tidewater Research Station, Suffolk Co., Holland, Va. (Note 2 plants / row foot)

	First Position Square Removal Treatments		
Square Removal Dates	4 SQ's / row ft.	8 SQ's / row ft.	12 SQ's / row ft.
5 July	11 & 10	11 & 10	11 & 10
9 July	No Removal	9 & 8	9 & 8
13 July	No Removal	No Removal	7 & 6

Table 2. First position square removal treatments at the Farliss Farm Bertie Co., NC. (Note 2 plants / row foot)

	First Position Square Removal Treatments		
Square Removal Dates	4 SQ's / row ft.	8 SQ's / row ft.	2 SQ's / row ft.
5 July	13 & 12	13 & 12	13 & 12
9 July	No Removal	11 & 10	11 & 10
13 July	No Removal	No Removal	9 & 8

Table 3. The effect of the removal of 4, 8 and 12 first position squares per row foot on the percent harvestable first and second position bolls located on each sympodia at the Albemarle Beach Farm in Washington Co., NC. 1995.

	% Harvestable First & Second Position Bolls / Sympodium for each Square Removal Treatment							
	4 / row ft. Removed		8 / row ft. Removed		12 / row ft. Removed		UTC No Removal	
Sympodia	1st	2nd	1st	2nd	1st	2nd	1st	2nd
5	25	18.8	12.5	10.4	31.3	33.3	29.2	20.8
6	58.3	39.6	75	50	X	72.9	79.2	60.4
7	75	39.6	85.4	64.6	X	77.1	77.1	41.7
8	83.3	45.8	X	79.2	X	68.8	79.2	41.7
9	79.2	52.1	X	56.3	X	64.6	91.7	35.4
10	X	58.3	X	64.6	X	79.2	93.8	18.8
11	X	45.8	X	37.5	X	60.4	70.8	20.8
12	77.1	8.3	52.1	16.7	66.7	25	64.6	6.3
13	62.5	2.1	58.3	8.3	66.7	6.3	47.9	2.1
14	33.3	0	37.5	2.1	54.2	0	33.3	0
15	14.6	2.1	25	0	29.2	2.1	12.5	0
16	8.3	0	18.8	0	33.3	0	8.3	0
17	6.3	0	8.3	0	14.6	0	0	0
18	2.1	0	2.1	0	4.2	0	0	0

Table 4. The effect of the removal of 4, 8 and 12 first position squares per row foot on the percent harvestable first and second position bolls located on each sympodia at the Farliss Farm in Bertie Co., NC. 1995.

	% Harvestable First & Second Position Bolls / Sympodium for each Square Removal Treatment							
	4 / row ft. Removed		8 / row ft. Removed		12 / row ft. Removed		UTC No Removal	
Sympodia	1st	2nd	1st	2nd	1st	2nd	1st	2nd
6	29.2	14.6	33.3	18.8	31.3	4.2	31.3	2.1
7	58.3	12.5	60.4	18.8	58.3	31.3	54.2	14.6
8	66.7	35.4	77.1	31.3	X	60.4	72.9	16.7
9	75	31.3	66.7	35.4	X	72.9	52.1	6.3
10	70.1	43.8	X	75	X	79.2	93.8	20.8
11	68.8	25	X	56.3	X	58.3	64.6	12.5
12	X	29.2	X	20.8	X	35.4	56.3	8.3
13	X	8.3	X	10.4	X	18.8	62.5	4.2
14	33.3	2.1	41.7	6.3	52.1	2.1	29.2	2.1
15	25	0	37.5	0	45.8	0	22.9	2.1
16	16.7	0	8.3	2.1	33.3	0	8.3	2.1
17	2.1	0	8.3	0	18.8	0	6.3	0
18	0	0	8.3	0	4.2	0	6.2	0

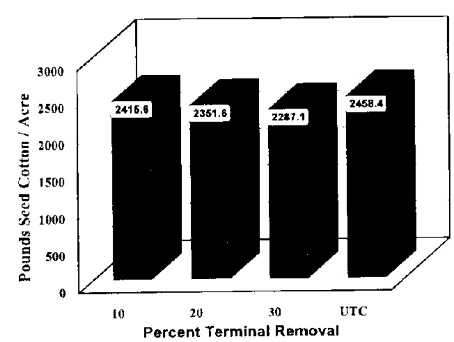

Figure 1. Yield comparison at the Clayton, NC site among three terminal removal treatments and an untreated control. No significant differences in yield were detected at $P < 0.05$.

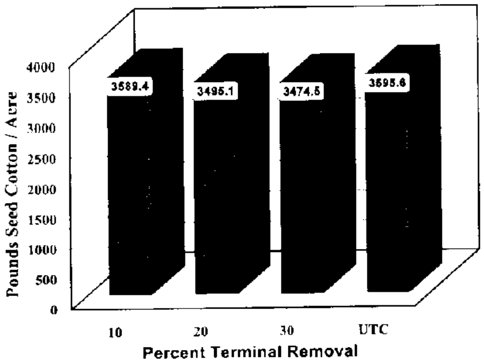

Figure 2. Yield comparison at the Rocky Mount, NC. site among three terminal removal treatments and an untreated control. No significant differences in yield were detected at $P \leq 0.05$.

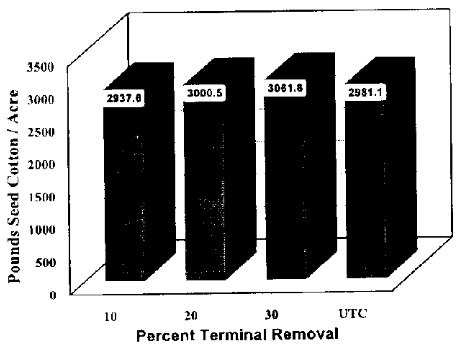

Figure 3. Yield comparison at the Tidewater Research Station in Plymouth, NC. site among three terminal removal treatments and an untreated control. No significant differences in yield were detected at $P < 0.05$.

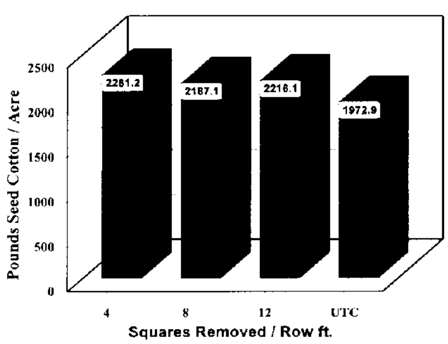

Figure 4. Yield comparison at the Farliss Farm Bertie Co., NC. site among three square removal treatments and an untreated control. No significant differences in yield were detected at $P \leq 0.05$.

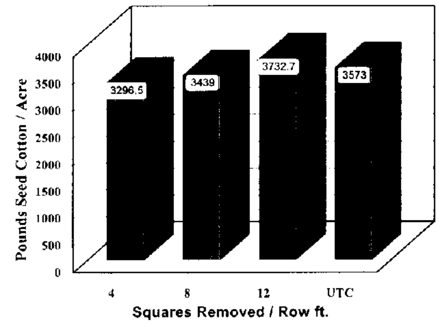

Figure 5. Yield comparison at the Albemarle Beach Farm Washington Co., NC. site among three square removal treatments and an untreated control. No significant differences in yield were detected at $P \leq 0.05$.

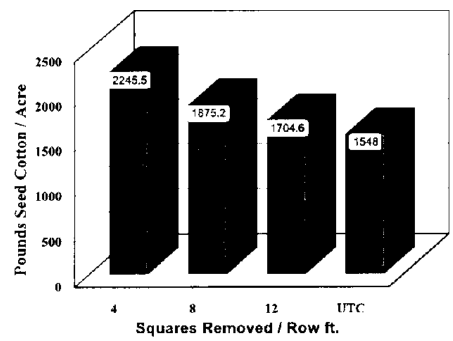

Figure 6. Yield comparison at the Tidewater Research Station in Suffolk Co. Holland Va. site among three square removal treatments and an untreated control. No significant differences in yield were detected at $P < 0.05$.