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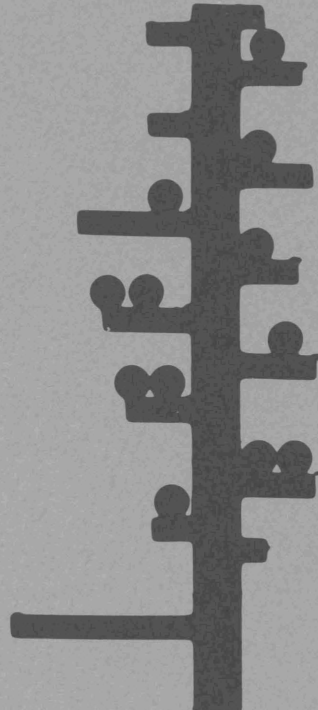
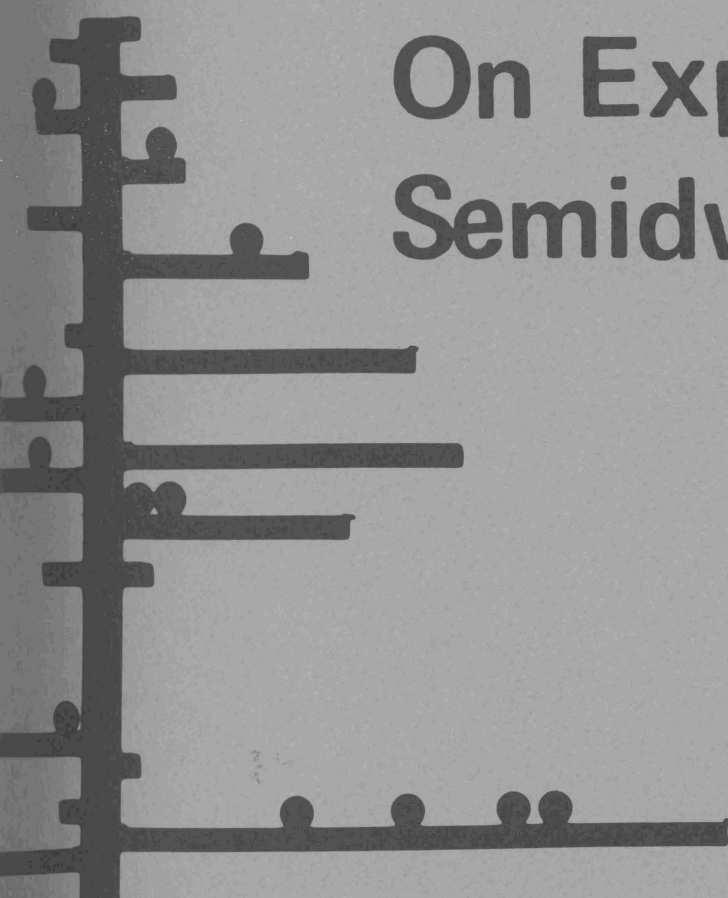


Bollworm Attack On Experimental Semidwarf Cottons



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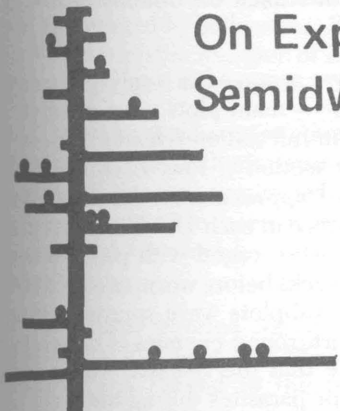
Contents

Summary

Investigations of bollworm, *Heliothis zea* (Boddie), attack on cottons differing in growth and fruiting characteristics were conducted in Texas, 1971-72. Numbers of fruits damaged on experimental semidwarf cottons were no greater than those on Deltapine 16; square damage tended to be less on the compact cotton types. As bollworms fed, they moved much less on the diminutive cottons in comparison to Deltapine 16. Studies showed that 9,000 worms per acre in three infestation periods did not produce severe effects on lint yields of the genotypes investigated. Delayed maturity, as a result of worm attack, occurred in Deltapine 16; maturity was unaffected in an experimental semidwarf cotton.

Bollworm Attack On Experimental Semidwarf Cottons



J. L. Baldwin, J. K. Walker,
J. R. Gannaway and G. A. Niles*

Insect problems associated with cotton production in much of the United States are many times a consequence of the extended production period required to produce an acceptable crop. Pest populations tend to increase as the growing season progresses, and insecticidal protection is often necessary. The development of experimental semidwarf determinate cottons by breeders of The Texas Agricultural Experiment Station offers a potential for reducing the production period. These strains produce their crop in a shorter time than many indeterminate varieties and, consequently, may escape a great deal of the late-season insect damage (Walker and Niles, 1971). However, it has been suggested that the problem of the bollworm, *Heliothis zea* (Boddie), may be greater on semidwarf plant types (Bradshaw, 1972). More damage was observed on a semidwarf strain than on Deltapine 16, possibly as a result of increased feeding efficiency of the pest on the diminutive cotton; that is, these genotypes possess short internodes on the fruiting branches with resulting close fruit placement. The distance of bollworm travel among fruit forms would seem to be reduced; consequently, more squares and bolls could be attacked in a given period of time.

Investigations were designed to study bollworm attack on semidwarf cottons and to develop information on economic damage thresholds for the bollworm on these genotypes.

Methods

1971 Study -- Bollworm Attack on Isolated Plants of Three Genotypes

Three cottons were examined in the present study.

Deltapine 16: This widely grown, commercial variety possesses an indeterminate fruiting habit in that it sets fruit throughout much of the season. Deltapine plants are large and produce extensive branching with long internodes.

DSR 1X6-56-66: The experimental cotton strain DSR 1X6-56-66 (hereafter identified as 1X6-56) displays an accelerated fruiting character which enables it to set and mature a large portion of fruit in a relatively short time. 1X6-56 is often referred to as a semidwarf genotype since its plants are small with short internodes and compact fruit placement.

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DSR 6-19-66-6M-10: Another experimental cotton strain, DSR 6-19-66-6M-10 (hereafter identified as 6M-10) combines a determinate fruiting habit with a semidwarf appearance. 6M-10 is very similar to 1X6-56; however, internode distance on the fruiting branches, although relatively short, is somewhat longer and fruit placement is not as compact as on 1X6-56. 1X6-56 and 6M-10, when grown in high-density plantings, have produced more lint and matured earlier than when grown in standard, single-drill culture on 38- to 40-inch beds (Niles, 1969).

The genotypes to be examined were planted April 27 in the conventional system, one drill per 40-inch bed. The plantings were arranged in a randomized block with six replications. Plants were thinned so that certain plants could be isolated from adjacent ones by approximately 8 feet. The isolated plants were checked periodically throughout June for bollworms and boll weevils, *Anthonomus grandis* Boheman. Very few pests were found, and their damage was insignificant. Each isolated cotton plant was confined in a 6′x6′x6′ plastic screen cage.

Third instar bollworms reared on an artificial diet were used for the experiment. One larva was released on the main-stem terminal of each test plant in the early evening of July 4. Younger larvae were not used because of their high mortality rate and limited damage, perhaps two or three small squares (Quaintance and Brues, 1905). Undamaged fruit counts were recorded on the day before release of larva. Beginning July 5, the plants were inspected twice daily, and new fruit damage was recorded. This procedure was followed with each plant until its respective bollworm had ceased feeding. The numbers of undamaged fruits remaining at the termination of each plant's bollworm infestation were recorded. Damaged fruits were tagged when initially discovered on the plants. Date of injury, including morning or afternoon inspection times, was recorded on each tag. The feeding trail of each bollworm was approximated using this procedure.

A second bollworm was released on each of the test plants on July 19. The methods and procedures used to determine the feeding trail of the bollworm were identical to those used for the July 4 infestation. These procedures subjected each test plant to two infestations by bollworms.

After the second bollworm infestation, the test plants were isolated until August 16 at which time they were defoliated, removed from the field and pictorially diagrammed to illustrate their general appearance and locations of damaged fruit. The bollworm feeding patterns and movements over the plants were reproduced from the data recorded on the plant identification tags. Measurements were taken of the internode lengths on the main stem and on each fruiting branch. From these data, the bollworm traveling distance (total distance crawled between damaged fruit locations) was calculated for each plant, providing a relative means of comparing bollworm movement on the three genotypes.

The relationship of bollworm numbers to damage on Deltapine 16 and 1X6-56 was examined. Deltapine 16 was planted May 1 in the conventional system, one drill per row on 40-inch beds. The 1X6-56 genotype was planted May 1 in two drills per 40-inch bed with drills 8 inches apart.

1972 Study -- Bollworm Attack on Cottons Planted in 6-Foot-Row Plots

The experiment was arranged in a split-plot design with three replications — main plots were genotypes, and subplots were worm-infestation releases. Each subplot contained a 6-foot section of row. Each subplot of Deltapine 16 contained approximately 24 plants. Approximately 48 plants were in each 1X6-56 subplot. The plants in the subplots were caged with plastic screen cages approximately 2 weeks before worm release. At the time of enclosure, the subplots were sprayed with an insecticide to destroy arthropod enemies of bollworms. There was no evidence that the released worms were attacked by predators or parasites during the study.

Infestations of worms were released in the subplots at different times. Four, early, third-instar worms per 6-foot subplot comprised an infestation (equivalent to approximately 9,000 worms per acre). The first bollworm release was made on nine subplots of each genotype on July 4. Six of the subplots of each genotype where the first infestation had been released were reinfested the second time on July 13. A third infestation was released on three subplots of each genotype on July 24. These subplots had experienced attack from the first and second infestations. Three subplots of each genotype served as controls. All of the plants in each subplot were examined daily; damage to fruits and the date and location of the damage on each plant were recorded. This permitted new damage to be recognized each day apart from previously damaged forms not yet shed from the plants. From these data the number of damaged fruits (new and old damaged fruits encountered at each daily examination) was associated with a population of approximately 9,000 worms per acre. Squares that were one-third grown or larger were recorded. Fruits were classified as bolls approximately 5 days after blooming. Damaged bolls, dried and shriveled, were not included in the counts.

After boll opening began, semiweekly records were made of the numbers of total bolls and open bolls. The experiment was harvested on September 15.

Results

1971 -- Bollworm Attack on Isolated Plants

Damage from worm attack on the cotton genotypes is shown in Table 1. Bollworm damage to the three genotypes was similar during both infestations. Damage was no greater on the two modified semidwarf genotypes than on Deltapine 16.

The fruit counts taken after each of the infestations indicate that the bollworm releases did not have a great influence on the fruit loads of the plants. There was an obvious reduction in the number of squares on the two experimental cottons after the second infestation; however, this was due to the determinate fruiting habit of these cottons — the decline in number of squares from the prerelease count was greater than the number of squares damaged by bollworms. Both 1X6-56 and 6M-10 shed a considerable number of squares and small bolls during the second infestation.

The undamaged-square counts recorded at the termination of the second infestation indicate the advanced maturity of the two semidwarf cottons. Deltapine 16 probably would have been much more susceptible to natural bollworm attack because of its greater number of squares.

Bollworms traveled significantly greater distances on Deltapine 16 than on 1X6-56 and 6M-10 (Table 2). The difference was related to the contrasting plant morphologies — bollworms did not have to travel as far to obtain food on 1X6-56 and 6M-10 as on Deltapine 16. The semidwarf cottons fruited on short internodes and, during the first 3 weeks of fruiting, had more large squares than Deltapine 16. However, the reduced movement of bollworms on the semidwarf genotypes did not enable them to damage greater numbers of fruit (Table 1). Figures 1 and 2 are diagrams of one of the experimental plants of 6M-10 with locations and kinds of fruit damaged by two bollworm infestations. Travelling distances of the worm were figured from these diagrams.

This experiment was repeated with similar results. Bollworms destroyed similar amounts of fruits on the three cottons, and despite attack from two infestations, the isolated plants set and matured 15-30 bolls per plant.

1972 -- Threshold Studies

Bollworm attack on the genotypes is illustrated by the data from the subplots of Deltapine 16 and 1X6-56 where the first and second infestations were released (Table 3). Counts varied from day to day, but upper and lower limits of square damage are apparent. The number of old and newly damaged squares encountered daily in the 6-foot subplots of Deltapine 16 never exceeded 23, which, for the date, represented 17-percent square damage. Most daily counts ranged from 9 to 17 old and newly damaged squares per 6-foot subplot. The percentage of total squares damaged during this time ranged from 5 to 15 percent in most cases. Boll damage was never high since the worms attacked considerably more squares than bolls. Despite the loss of substantial numbers of squares to the released worms, boll counts progressively increased during the duration of the experiment. Numbers of damaged squares and percentage of square damage were less in the semidwarf cotton 1X6-56. There were more large squares on this compact cotton with each furnishing more food; consequently, fewer squares were eaten than on Deltapine 16.

Table 4 provides the results of the statistical analysis

TABLE 1. AVERAGE FRUIT DAMAGE PER PLANT FROM TWO RELEASES OF BOLLWORMS ON THREE COTTON GENOTYPES[1]

Date	Genotype	Fruit count before bollworm release			Bollworm damage				Fruit count after infestation		
		Squares	Blooms	Bolls	Squares	Blooms	Bolls	Total	Squares	Blooms	Bolls
July 4	Deltapine 16	32.0	1.1	3.3	9.3a	0.2a	1.6a	11.1a	27.1	1.6	6.8
First release	1X6-56	32.5	1.3	7.1	7.5a	0.8a	0.8a	9.1a	24.0	1.8	9.5
	6M-10	27.6	1.0	4.3	8.3a	1.0a	0.6a	10.0a	21.1	2.1	7.6
July 19	Deltapine 16	30.6	1.5	13.1	6.0a	1.1a	1.6a	8.8a	32.8	2.8	19.0
Second release	1X6-56	11.3	2.1	17.6	2.0a	1.1a	1.6a	4.8a	3.8	1.3	15.0
	6M-10	19.1	1.5	16.8	3.3a	1.0a	1.1a	5.3a	3.6	0.6	14.8
					Total damage for two releases						
July 4 & 19	Deltapine 16				15.3a	1.3a	3.3a	20.0a			
	1X6-56				9.5a	2.0a	2.5a	14.0a			
	6M-10				11.6a	2.0a	1.8a	15.5a			

[1]Means are compared vertically: those followed by the same letter are not significantly different at the 5% level of probability using Duncan's Multiple Range Test.

TABLE 2. AVERAGE DISTANCES TRAVELED PER PLANT BY SINGLE BOLLWORMS ON THREE COTTON GENOTYPES[1]

Release	Distance traveled, centimeters		
	Deltapine 16	1X6-56	6M-10
July 4	193a	72b	94b
July 19	172a	40b	55b

[1]Means are compared horizontally: those followed by the same letter are not significantly different at the 5% level of probability using Duncan's Multiple Range Test.

of the damaged fruit records for all worm releases. Square damage was significantly less in 1X6-56 where the first and second infestations and the first, second and third infestations were released. Total fruit damage appears to be excessive, but lint losses were surprisingly small.

The statistical analysis of the fruiting and yield performance of the two genotypes, 1X6-56 and Deltapine 16, are summarized in Table 5. 1X6-56 accumulated bolls much faster than Deltapine 16. At the last boll count on September 15, significantly fewer bolls were present in both genotypes where three infestations had been released. The other infestation releases did not differ significantly from the control subplots in numbers of bolls.

The rapid maturity of 1X6-56 is shown in Table 5 in its larger percentage of open bolls earlier in the season

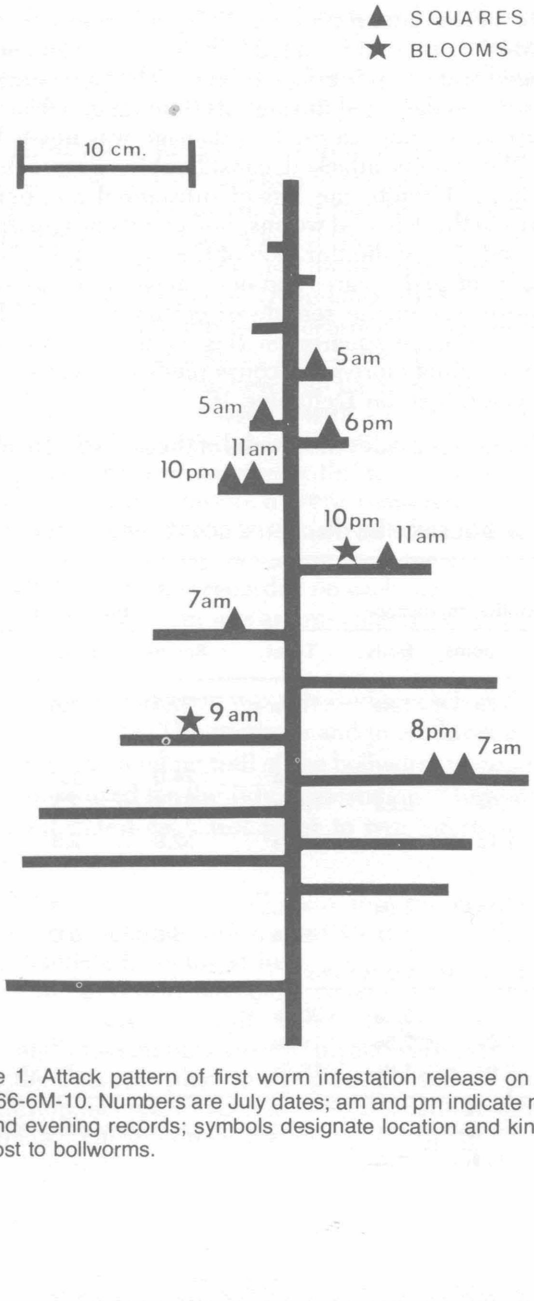

Figure 1. Attack pattern of first worm infestation release on DSR 6-19-66-6M-10. Numbers are July dates; am and pm indicate morning and evening records; symbols designate location and kinds of fruit lost to bollworms.

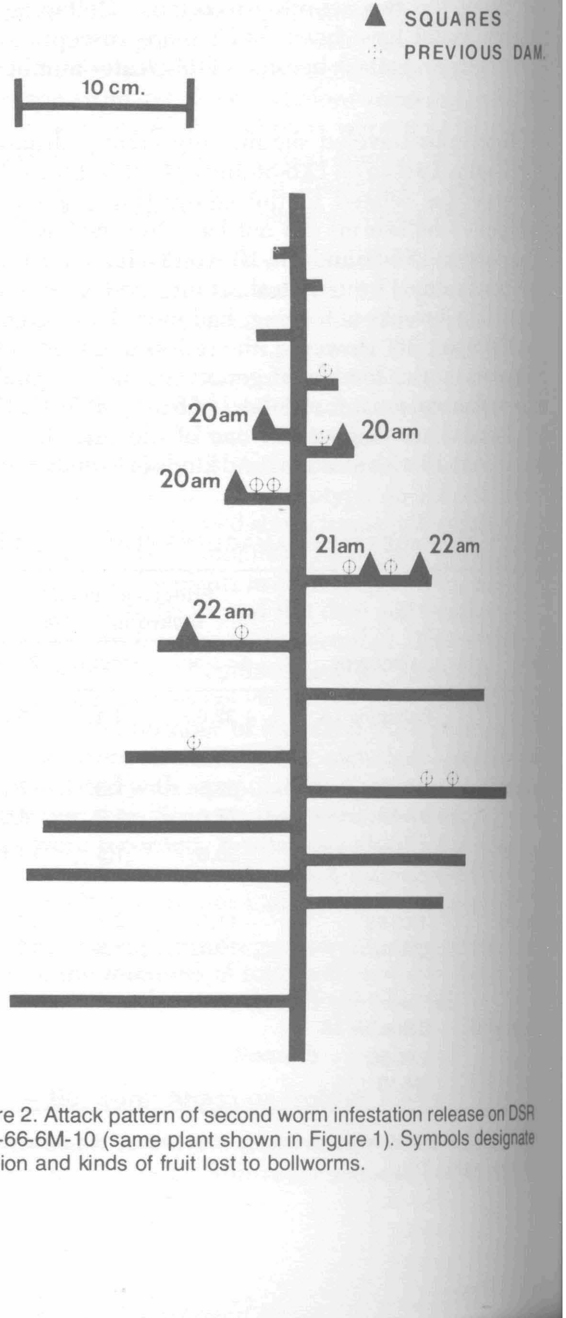

Figure 2. Attack pattern of second worm infestation release on DSR 6-19-66-6M-10 (same plant shown in Figure 1). Symbols designate location and kinds of fruit lost to bollworms.

TABLE 3. AVERAGE NUMBER OF BOLLWORMS AND DAMAGED AND UNDAMAGED FRUITS RECORDED IN 6-FOOT SUBPLOTS OF DELTAPINE 16

Date	Number released worms found	Total squares (damaged and undamaged)	Old and newly damaged squares	Damaged squares, % of total	Total bolls (damaged and undamaged)	Old and newly damaged bolls	Damaged bolls, % of total
Four larvae released per subplot per infestation First infestation released July 4; second infestation released July 13							
Deltapine 16							
7/5	3.6	141	14.0	9.9	10	0.0	0.0
7/6	3.3	140	8.0	5.7	12	0.0	0.0
7/7	3.3	136	11.0	8.0	13	0.3	2.3
7/8	3.6	130	20.0	15.3	16	2.0	12.5
7/10	3.0	139	21.0	15.1	19	3.0	15.7
7/11	2.6	135	23.0	17.0	20	3.0	15.0
7/12	1.3	141	17.0	12.0	27	3.0	11.1
7/13	0.3	136	12.0	8.8	27	1.0	3.7
7/14	3.6	147	11.0	7.4	33	0.0	0.0
7/15	3.6	140	14.0	10.0	33	1.0	3.0
7/17	3.0	120	16.0	13.3	37	1.0	2.7
7/18	3.0	128	14.0	10.9	42	1.0	2.3
7/19	2.3	106	16.0	15.0	44	1.0	2.2
7/20	1.3	115	14.0	12.1	53	1.0	1.8
7/21	1.3	107	11.0	10.2	56	1.0	1.7
7/22	1.0	94	13.0	13.8	59	1.0	1.6
7/24	0.6	96	3.0	3.1	80	1.0	1.2
1X6-56							
7/5	4.0	210	6.0	2.8	62	1.0	1.6
7/6	3.3	196	7.0	3.5	72	1.0	1.3
7/7	3.3	205	8.0	3.9	89	1.0	1.1
7/8	2.6	185	9.0	4.8	92	3.0	3.2
7/10	2.3	176	9.0	5.2	126	4.0	3.1
7/11	1.6	172	10.0	5.8	112	3.0	2.6
7/12	0.6	150	6.0	4.0	112	2.0	1.7
7/13	0.6	132	7.0	5.3	142	2.0	1.4
7/14	3.0	143	3.0	2.9	123	4.0	3.2
7/15	3.6	129	5.0	3.8	138	2.0	1.4
7/17	3.0	113	7.0	6.1	146	3.0	2.0
7/18	4.0	100	2.0	2.0	144	4.0	2.7
7/19	3.3	84	2.0	2.5	144	2.0	1.3
7/20	1.6	69	1.0	1.4	157	3.0	1.9
7/21	0.3	57	1.0	1.7	154	3.0	1.9
7/22	0.3	50	0.3	0.6	158	3.0	1.8
7/24	0.0	40	1.0	2.5	163	2.0	1.2

compared with Deltapine 16. The released bollworms significantly delayed maturity of Deltapine 16, but not 1X6-56. This may have been the result of the greater squaring rate of 1X6-56 early in the squaring period. Figures 3-6 are diagrams of plants in control subplots and in subplots where three infestations of bollworms were released. The delay in maturity (percent open bolls) recorded in Deltapine 16 can be explained by Figure 5; bolls tended to be set at distal locations on the fruiting branches (and, consequently, later). The feeding attack on 1X6-56, however, did not result in a delay (Figure 6).

The release of three infestations did not result in statistically significant reductions of lint yield; about 1,000 pounds of lint per acre were produced on both cottons (Table 5).

Discussion

The damage potential of bollworms is not increased by enhanced feeding efficiency on semidwarf cottons; however, reduced traveling distance for worms on these strains could lessen the efficiency of insecticidal treatments. Reduced exposure to the chemicals may result as

TABLE 4. TOTAL NUMBER OF COTTON FRUITS PER 6-FOOT SUBPLOTS DAMAGED BY DIFFERENT BOLLWORM RELEASES ON TWO COTTON GENOTYPES[1]

Genotype	Control	First infestation release	First and second infestation release	First, second and third infestation release
		Squares		
Deltapine 16	0a	46.3b	80.3c	79.3c
IX6-56	0a	22.6ab	28.0b*	26.3b*
		Blooms		
Deltapine 16	0a	3.3b	7.3bc	11.6c
IX6-56	0a	5.0ab	10.0bc	12.3c
		Bolls		
Deltapine 16	0a	5.6b	10.9b	23.6c
IX6-56	0a	8.6b	16.3c	31.6d
		Total fruit damage (not analyzed)		
Deltapine 16	0	55	98	114
IX6-56	0	36	54	70

[1]Means within genotypes are compared horizontally: those followed by the same letter are not significantly different at the 5% level of probability using Duncan's Multiple Range Test.

*Differences between genotypes are compared vertically: an asterisk indicates that means differ significantly at the 5% level of probability using Duncan's Multiple Range Test.

a consequence of the decreased movement on the diminutive cottons. In areas where dependence on insecticide is heavy, semidwarf genotypes might aggravate an already difficult situation.

These threshold data demonstrate the ability of the cotton plant to withstand considerable damage to squares and yet produce high lint yields. For example, square damage in Deltapine 16 where two infestations of worms were released attained a level of 15 percent or greater on several dates. Cotton with 15 percent of the squares damaged by bollworms appeared to be suffering considerable injury; yet these studies showed that yield losses were not severe. The release of an additional infestation increased fruit loss, but lint production despite the worm attack should be viewed in perspective. Insecticide programs for bollworm control are expensive, and the organophosphate materials used today do not perform as well as did DDT in the 1950's. Ironically, insecticidal applications, through destruction of the bollworm-regulating populations of arthropods in cotton fields, increase by many times the number of bollworms to be killed. Further, late-season populations of the insecticidally resistant tobacco bollworm *Heliothis virescens* (F.) may develop in treated cotton.

TABLE 5. NUMBER OF BOLLS, PERCENT OF OPEN BOLLS AND LINT PRODUCTION IN GRAMS PER 6-FOOT SUBPLOTS IN TWO COTTON GENOTYPES SUBJECTED TO DIFFERENT BOLLWORM RELEASES[1]

Genotype	Control	First infestation release	First and second infestation release	First, second and third infestation release
		Number of bolls, July 14		
Deltapine 16	42	23	32	32
IX6-56	155a*	121b*	119b*	128b*
		Number of bolls, July 21		
Deltapine 16	110a	63b	54b	62b
1X6-56	199a*	160b*	151b*	144b*
		Number of bolls, August 14		
Deltapine 16	153	159	150	136
1X6-56	169a	160a	156a	129b
		Number of bolls, August 24		
Deltapine 16	153	151	153	142
1X6-56	159	160	152	125
		Number of bolls, September 15		
Deltapine 16	146a	139ab	130ab	122b
1X6-56	148a	138ab	139ab	122b
		Percent open bolls, August 31		
Deltapine 16	54a	33b	23b	33b
1X6-56	86*	79*	72*	79*
		Percent open bolls, September 4		
Deltapine 16	70a	52b	47b	46b
1X6-56	94	88*	87*	93*
		Grams of lint harvested		
Deltapine 16	265	249	233	237
1X6-56	251	246	238	215

200 grams per 6-foot cotton row = 960 pounds of lint per acre

[1]Means within genotypes are compared horizontally: those followed by the same letter are not significantly different at the 5% level of probability, using Duncan's Multiple Range Test.

*Differences between genotypes are compared vertically: an asterisk indicates that means differ significantly at the 5% level of probability using Duncan's Multiple Range Test.

The threshold research presented would not be expected to simulate every natural bollworm infestation. For example, the age structure of populations of bollworms attacking cotton is complex; these data represent only the effects of a population of fixed age. Nevertheless, this research provides understanding and support

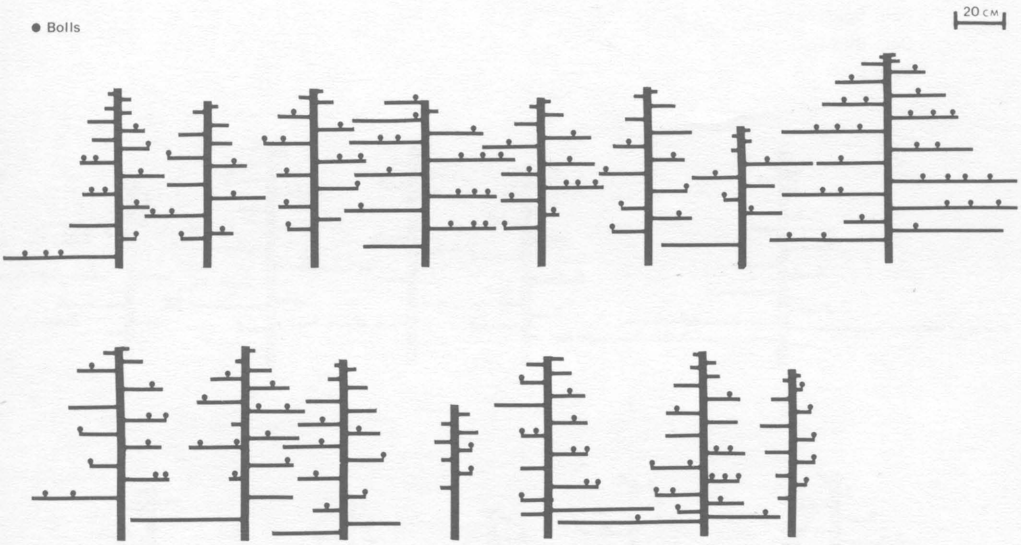

Figure 3. Diagrams of all plants in a 6-foot-row control subplot of Deltapine 16.

for the new outlook toward the bollworm problem that is emerging among many growers in Texas (Sterling and Haney, 1973).

They consider the bollworm to be largely a secondary insect, induced, in many instances, by applications of insecticides which disrupt the normal complex of predators and parasites. Consequently, it is a policy to use insecticides cautiously, thereby preserving the beneficial arthropods. Growers have found that many early July infestations of bollworms can be ignored, even though square damage may seem severe. Such tolerance of appreciable worm damage is feasible, however, only when insecticidal programs are not underway for control of the boll weevil.

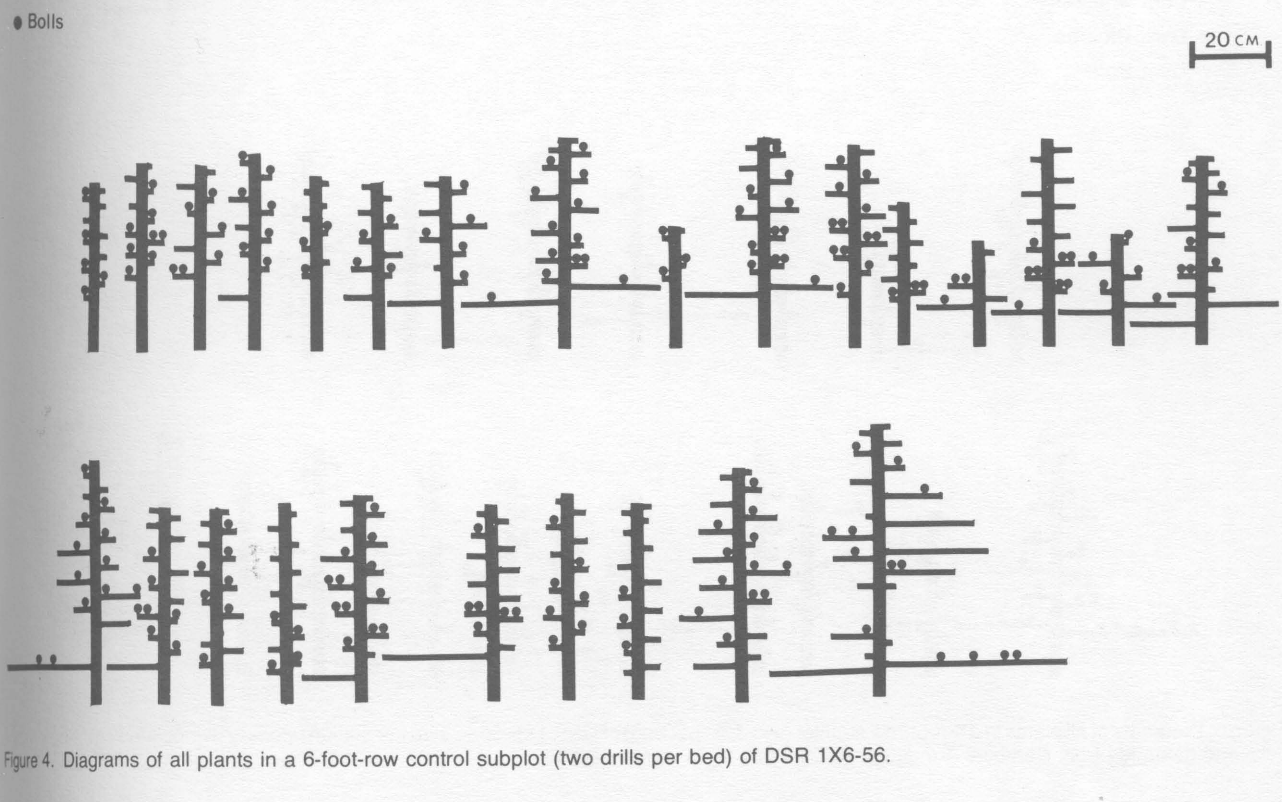

Figure 4. Diagrams of all plants in a 6-foot-row control subplot (two drills per bed) of DSR 1X6-56.

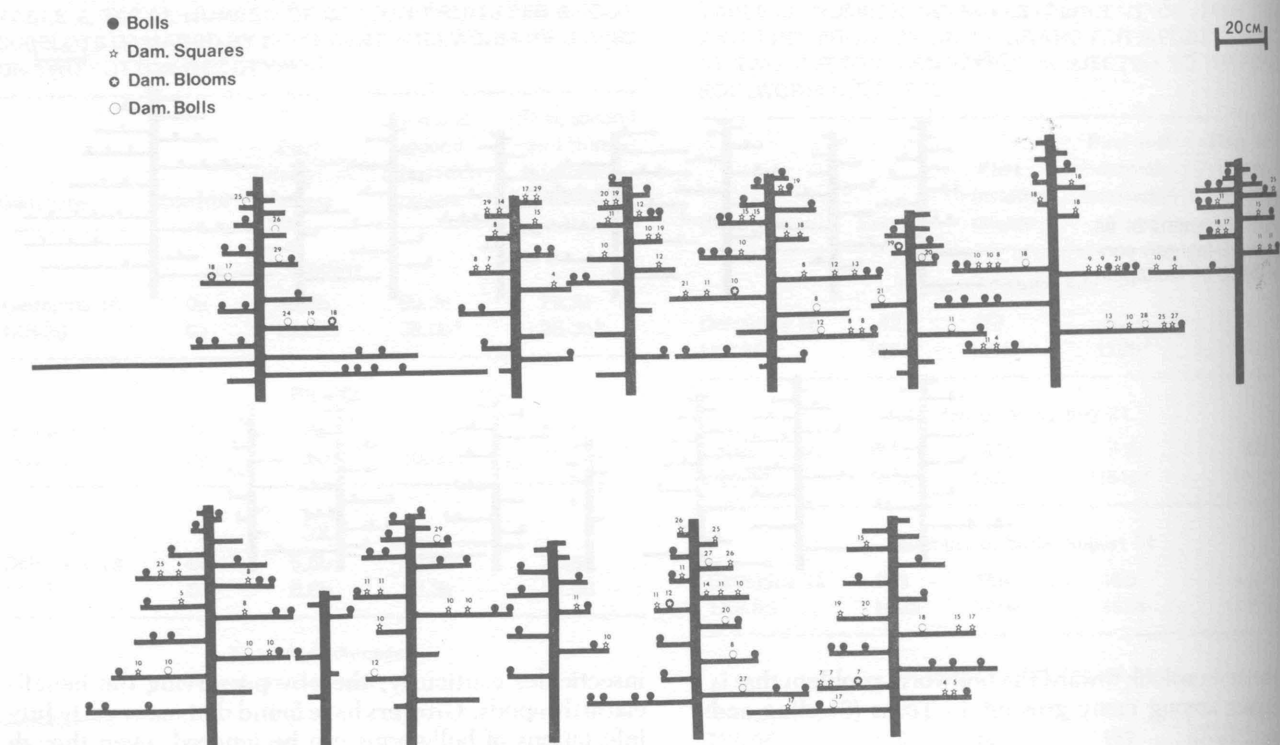

Figure 5. Diagrams of all plants in a 6-foot-row subplot of Deltapine — third infestation release. Symbols indicate undamaged bolls and damaged fruit. Numbers are dates in July when fruits were attacked.

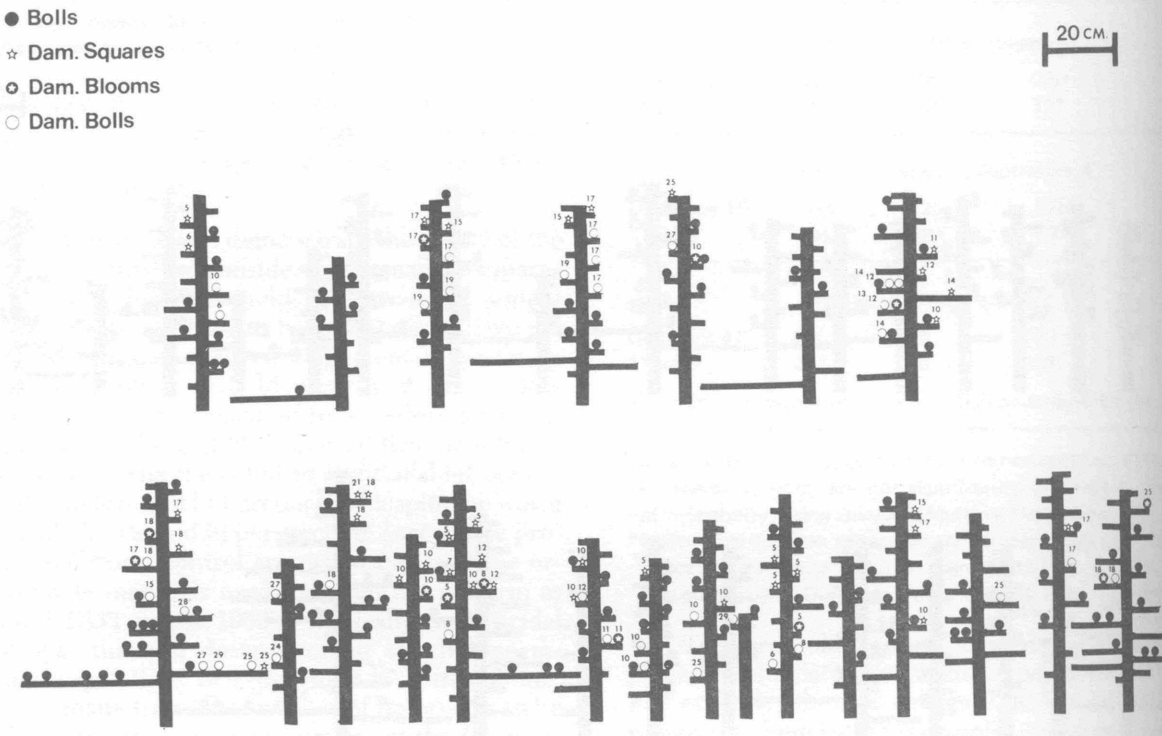

Figure 6. Diagrams of all plants in a 6-foot-row subplot (two drills per bed) of DSR 1X6-56 — third infestation release. Symbols indicate undamaged bolls and damaged fruit. Numbers are dates in July when fruits were attacked.

Acknowledgment

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