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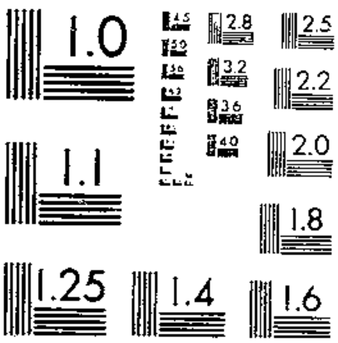

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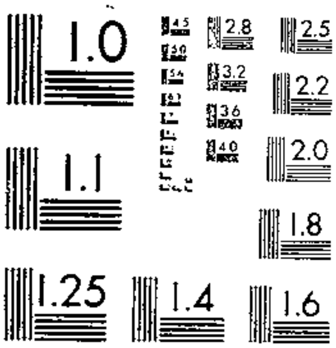

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Boll Weevil Populations as Affected by Removal of Shed Cotton Forms

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Boll Weevil Populations as Affected by Removal of Shed Cotton Forms

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One of the earliest methods investigated for control of the boll weevil (*Anthonomus grandis* Boh.), which proved impractical, was hand collection and removal from the soil surface of fruiting forms (squares, or flower buds, and bolls) containing eggs or larvae of this insect, shed from the cotton plant. This method was laborious and time-consuming, and many weevils emerged from the forms before removal was complete. Also, it was difficult, especially for inexperienced laborers, to find shed forms in grassy fields.

The recent development of vacuum devices for collecting legume seed from the soil surface suggested the possibility that a similar device for collecting shed cotton forms might prove to be a practical means of boll weevil control. Such a method should be most effective when shed squares containing eggs laid by overwintered females are on the soil surface, for at this time cotton plants are small and usually there are few weeds in the field.

To determine the feasibility of such a method of control, a preliminary study was conducted at Florence, S.C., during 1958 and 1959, to find out what percentage of the total number of shed forms on the soil surface would have to be removed; and at what intervals. Different removal rates and an insecticidal treatment of shed forms on the soil surface were included in the study.

PROCEDURE

In both years, 18 field cages arranged in randomized blocks, each covering one two-hundredths acre, were used. Two rows of cotton, each with 100 plants, were grown in each cage—an equivalent of 40,000 plants per acre.

In 1958, one pair of overwintered weevils was placed in each cage on May 22, and another pair on June 12. Shed forms were removed from the soil surface in the cages at weekly intervals until November 2 at rates of 100, 30, 20, and 10 percent, there being three cages (replicates) for each removal rate. In six cages no shed forms were removed; in three of these cages heptachlor granules were applied to the soil surface at the rate of 1 pound of toxicant per acre on June 26, and again on July 10.

The weevils introduced into four of the cages did not survive. In these cages populations were reestablished by adding the following

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number of squares containing eggs: 7 in a cage with a 30-percent removal rate; 8 in a cage with a 20-percent removal rate; 10 each in two cages where no forms were removed (one replicate with heptachlor granules, and one untreated replicate).

All squares 1 week or older on 20 to 50 plants selected at random in each cage were examined each week during the entire season for feeding and egg punctures, and the presence of adult weevils. The number of squares and the kinds of punctures were then calculated on an acre basis. All forms shed and removed from the soil surface were also examined for egg and feeding punctures. Shed not attributed to weevils was recorded as being for "other causes," which included damage from bollworms, *Heliothis* spp., noted in a few cages.

In 1959, one pair of overwintered weevils was placed in each cage on May 26 and another pair on June 17. Shed forms were removed from the cages every 5 days until November 2 at rates of 100, 90, 80, 70, and 50 percent, three replicates being provided for each removal rate. No shed forms were removed from three cages.

Examinations of forms, both shed and on the plants, were the same as those made in 1958, except that all forms on 30 plants in each cage were examined, and apparent causes of shed were determined only until August 26. In 1959, the number of removed shed forms from which boll weevils had emerged was recorded.

Yields were obtained by picking all of the cotton in each cage and converting the amounts to an acre basis.

RESULTS

1958 Studies

Figures 1a and 1b, representing data from cages where no shed forms were removed, indicate the typical situation in the Coastal Plain of South Carolina. As Fye *et al.*[2] noted, most of the cotton is set in a period before the emerging first-generation weevils can cause serious damage, and subsequent population buildups virtually prevent further setting of squares. As the populations rise and no squares are available, migration ensues, with the alleviation of population pressure. This, in conjunction with the concurrent maturation of the bolls, permits the plants to resume squaring. The inability of the weevil to maintain high populations, with resultant high infestation levels during the period of low square production, is also evident. This failure occurs because the weevils destroy most of the squares before they are large enough to receive egg deposition.

Only two of the three replicates in the group from which no shed forms were removed (fig. 1a) had square production of consequence after August 14. In the third replicate, the weevils had eliminated almost all squares, and the infestation at that time was considered to be zero. Therefore, the infestations shown, which are the average of three replicates, must be considered conservative.

Figure 1b, representing the treated cages from which no shed forms were removed, indicates that the heptachlor granules failed to control the emerging weevils although a slight suppression was indicated.

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[2] Fye, R. E., Hopkins, A. R., and Walker, R.L. Field Experiments on Control of Overwintered Boll Weevils. Jour. Econ. Ent. 54(4): 622-624. 1961.

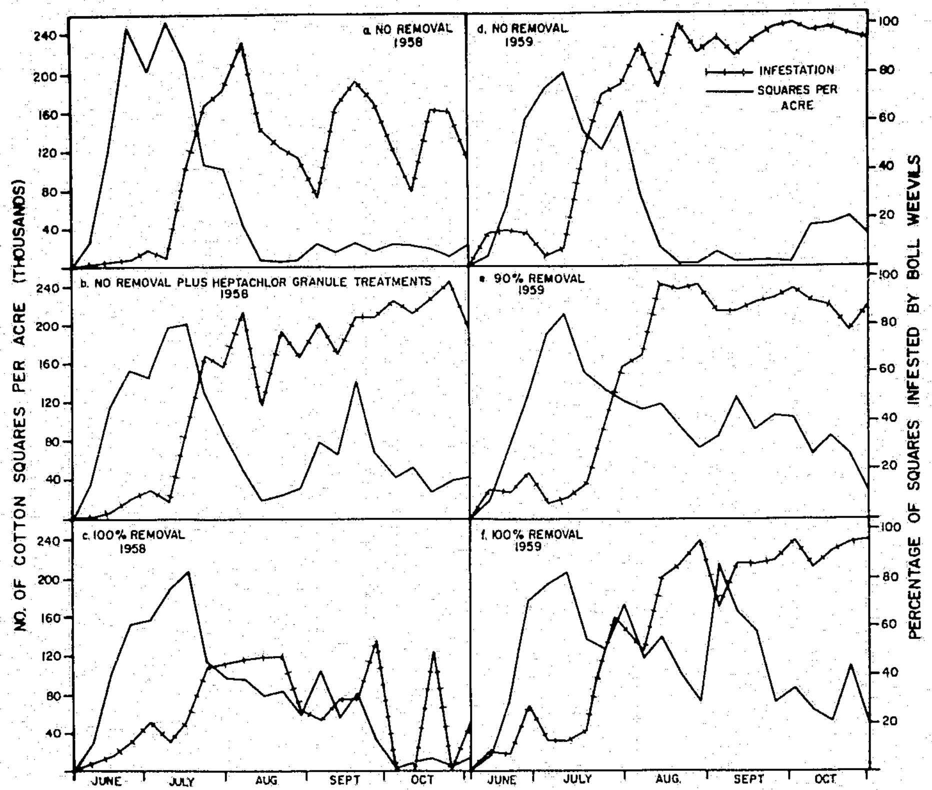

FIGURE 1.—Cotton squares per acre and boll weevil infestation under 90- and 100-percent removal of shed forms, and with no removal, Florence, S.C., 1958–59.

The cotton squared well throughout August, possibly because of this slight suppression, and this continued squaring provided the necessary medium for a high reproductive rate.

Figures 2a, 2b, and 2c, representing data from cages where 10, 20, and 30 percent of the shed forms were removed, are remarkably similar to figures 1a and 1b except for the higher infestation percentages.

Removal of 10, 20, and 30 percent of the shed forms was ineffective in preventing development of boll weevil populations sufficiently large to cause economic damage. In fact, there was substantial evidence that removal of these low percentages might have increased the population potential. Apparently this increase was attained by a subtle relaxation of weevil population pressure to a degree that enabled the cotton plant to maintain a constant supply of squares of sufficient size for oviposition by the weevil. Thus, higher population levels were sustained.

The immensity of the losses from shed forms caused by the boll weevil is shown in table 1. When 10, 20, and 30 percent of the shed forms were removed at weekly intervals, 90, 80, and 70 percent of the original groups still remained on the next removal date before deteriorating beyond recognition, resulting in another 9, 16, and 21 percent being removed, respectively. Thus removal of 10, 20, and 30 percent of shed forms actually represented the removal of 19, 36, and 51 percent of the total. The total number of forms shed per acre by August 29, a date after which a developing square did not have time to mature to a productive boll, indicates that a loss through shedding of about six to eight forms per plant occurred during the productive fruiting period.

The percentage of forms shed for different reasons through August 29 is also shown in table 1. Only 1.8 to 13.1 percent of the squares shed through August 29 were shed for other causes, compared with 34.9 to 70.4 percent of the bolls during the same period.

The number of shed forms containing eggs after August 29 showed considerable potential for the production of a large number of weevils that could overwinter. The potential was greater than that indicated by shed forms since weevils that can overwinter also develop in bolls that fail to shed.

The ineffectiveness of the removal of small percentages of shed forms is shown in the average infestations from June 12 through August 21 and November 3, and in yields of seed cotton per acre (table 2). However, differences were not significant in infestation or yield between removal levels. Since weevils were reintroduced in replicates of several treatments in which original introductions failed to establish populations, there was considerable variation in infestation between replicates within treatments, resulting in no significant difference even though the infestation at the 100-percent removal level was considerably lower than in all other treatments. Yields were affected for the same reason and yield data are shown with and without these replicates. Yields in replicates where the initial population survived were much lower than in those where later introductions were necessary. When introductions were made later, a heavy set of bolls occurred before population pressures of the boll weevil developed.

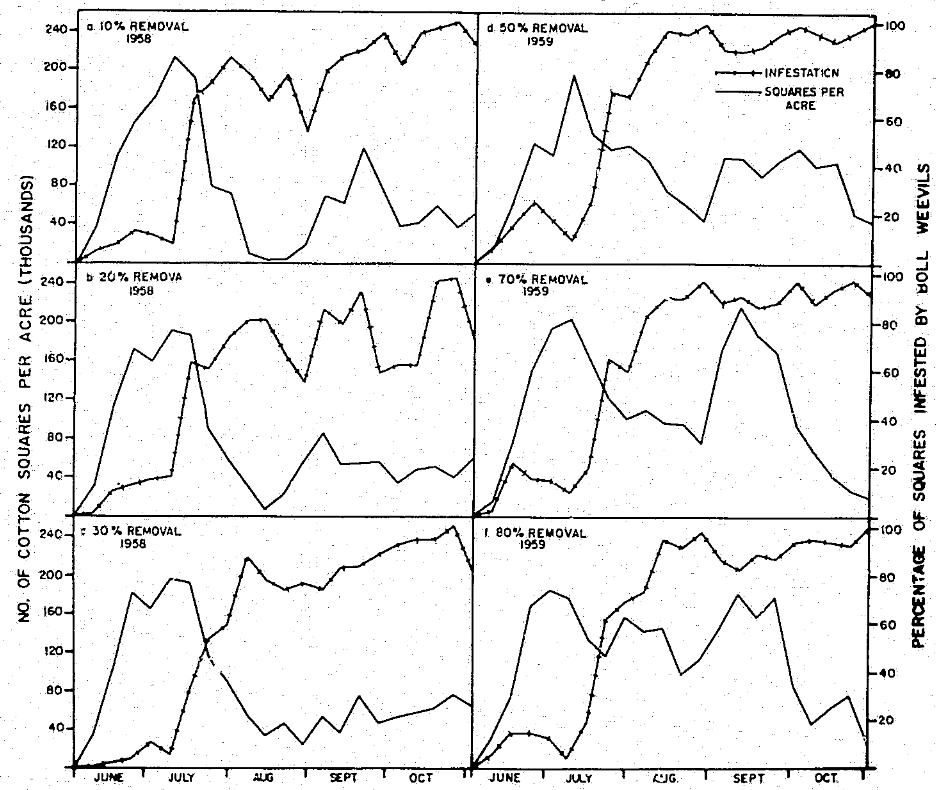

FIGURE 2.—Cotton squares per acre and boll weevil infestation under 10, 20, 30, 50, 70, and 80 percent removal of shed forms, Florence, S.C., 1958–59.

TABLE 1.—*Numbers of fruiting forms shed by cotton plants, and causes of shed*

Numbers of forms shed and removed, and causes of shed	Removal rates (percentages) in								
	1958[1]				1959[1]				
	10	20	30	100	50	70	80	90	100
Squares shed per acre[2]	189, 470	147, 500	147, 060	---------	388, 670	288, 460	360, 000	283, 130	--------
Squares removed per acre	36, 000	53, 100	75, 000	237, 600	291, 500	262, 500	345, 600	280, 300	367, 600
Percentage of squares shed owing to:									
Boll weevil feeding punctures	21. 8	16. 6	19. 9	7. 7	22. 6	16. 4	10. 0	10. 7	9. 6
Boll weevil egg punctures	72. 6	79. 5	74. 4	90. 5	72. 0	75. 1	80. 8	76. 5	76. 7
Other causes	5. 6	3. 9	5. 7	1. 8	5. 4	8. 5	9. 2	12. 8	13. 7
Bolls shed per acre[2]	117, 370	120, 000	139, 410	---------	150, 930	198, 570	164, 060	211, 620	--------
Bolls removed per acre	22, 300	43, 200	71, 100	103, 700	113, 200	180, 700	157, 500	209, 500	262, 700
Percentage of bolls shed owing to:									
Boll weevil feeding punctures	16. 6	12. 5	15. 7	22. 6	13. 1	11. 5	10. 9	10. 0	11. 9
Boll weevil egg punctures	25. 4	20. 1	33. 3	42. 5	16. 8	20. 8	20. 5	16. 0	17. 7
Other causes	58. 0	67. 4	51. 0	34. 9	70. 1	67. 7	68. 6	74. 0	70. 4

[1] Forms removed through August 29 in 1958 and August 26 in 1959.

[2] Numbers of shed squares and bolls computed on basis of 19-, 36-, and 51-percent removal in 10-, 20-, and 30-percent treatments in 1958, and 75, 91, 96, and 99 percent in the 50-, 70-, 80-, and 90-percent treatments in 1959.

TABLE 2.—*Average percentage of boll weevil infestation and cotton yield in cages in which shed forms were removed at different percentage rates, 1958–59*

Percent removed	Average infestation of squares						Yields (pound of seed cotton per acre)			
	1958		1959				1958		1959	
	June 12–Aug. 21	June 12–Nov. 3	June 12–Aug. 21	Significance [a] 5 percent	June 12–Nov. 3	Significance [a] 5 percent	3 replicates	2 replicates [b]	3 replicates	Significance [a] 5 percent
0 Untreated	36. 2	44. 7	47. 1	a	70. 0	a	1, 980	1, 670	548	b d
0 Treated	36. 8	58. 4					1, 480	1, 070		
10	44. 7	64. 8					1, 280			
20	43. 7	59. 2					1, 220	620		
30	36. 7	60. 6					1, 820	1, 340		
50			47. 4	a	69. 8	a			648	b d
70			42. 8	a b	66. 2	a b			1, 238	b c
80			42. 2	a b	66. 0	a b			1, 180	b c
90			39. 4	b	62. 9	b			1, 900	a
100	27. 9	25. 6	36. 6	b	61. 3	b	2, 480		2, 115	a

[a] Means followed by the same letters are not significantly different. Means followed by different letters are significantly different.
[b] Replicates in which original, introduced boll weevils survived.

In two of the replicates where all shed forms were removed, no egg punctures were found after August 21, and no adults after July 31. Thus, the infestation levels shown in figure 1c after these dates are somewhat misleading, representing the infestation in only one replicate but averaged for the three. The yields in the two replicates in which weevils were controlled were 2,860 and 3,600 pounds of seed cotton per acre. In the third replicate, where the infestation was not brought under control until the end of September, the yield was only 1,000 pounds per acre, resulting in no significant difference between this and other treatments. The yield in the same replicate was also reduced by bollworms. Although differences in infestation and yield were not significant, the data indicates that removal of all shed forms at weekly intervals provided considerable control of the boll weevil under conditions of this study.

1959 Studies

Since the studies in 1958 showed that weekly removal of 30 percent of the shed squares did not reduce weevil populations, and 100 percent removal resulted in considerable reduction, the studies in 1959 were directed at determining the lowest removal level at 5-day intervals between these extremes that would afford economic control.

Removal of 50 percent of the shed forms was not effective in controlling the boll weevil (fig. 2d). Since each form was present at the time of two removals at 5-day intervals before deteriorating beyond recognition, the actual removal was 75 percent. However, removal of forms with egg punctures actually remained near 50 percent since many of the weevils emerged from squares remaining in the cages before the subsequent removal (table 3). A total of 404,700 forms (squares and bolls) per acre were removed by August 26, and 539,600 forms per acre were shed. During this period the equivalent of 10,854 weevils per acre emerged. The effects of the early emergence of large numbers of weevils, and the subsequent high infestation levels during the main fruiting period of the plant were reflected in the average percentages of infestation through August 21 and November 3, and in the yield (table 2). The infestation was significantly higher than for the 90- and 100-percent removal levels, and the yield was significantly lower. These data show the ineffectiveness of a 50-percent removal of shed forms every 5 days.

TABLE 3.—*Total percentages of shed forms from which boll weevils had emerged into the cages prior to removal of forms every 5 days, June 19–August 26, 1959*

Percentage of forms removed	Percentage of emergence from:	
	Squares	Bolls
50	2. 5	3. 4
70	5. 7	4. 0
80	3. 1	3. 7
90	3. 4	3. 8
100	2. 3	1. 3

Seventy- and eighty-percent removals (actually 91- and 96-percent because of form presence at two removals) showed a marked similarity, and were more effective than the 50-percent removal level (figs. 2e and 2f). The total number of forms (squares and bolls) removed through August 26 (table 1) represents a shed of 487,030 forms per acre in cages with the 70-percent removal rate, and 524,060 for the 80-percent removal rate. Although this shed was less than in the cages with 100-percent removal (630,300), an earlier emergence of large populations and accompanying infestation levels in early July occurred. This is the critical portion of the fruiting period (*Fye et al.*).[2] The average infestation and yield data clearly indicate the middle position between the 50- and 100-percent removal levels. The slightly lower yield for the 80-percent removal rate compared with the 70-percent rate can probably be accounted for by losses caused by the bollworm.

Data from cages from which 90 (actually 99 percent because of form presence at two removals) and 100 percent of the fallen forms were removed, show considerable similarity (figs. 1e and 1f). The 494,750 forms (squares and bolls) shed per acre in the 90-percent-removal-rate cages does not approach the 630,300 removed at the rate of 100 percent, but it is suspected that the subtle relaxation of weevil pressure on tiny forming squares in the 100-percent-removal-rate cages, and ideal growing conditions for the cotton, may account for this difference and the differences in the numbers of squares produced with the 50-, 70-, and 80-percent removal rates.

Consideration of the average infestations and the yield (table 2) in the 90- and 100-percent-removal series reveals little difference in the two levels. The extended period of suppressed weevil populations during the early fruiting period (figs. 1e and 1f), which manifests itself as the lowered infestation percentage, further supports an earlier contention (Fye *et al.*)[2] that early boll set with subsequent boll protection should be an adequate control program for the boll weevil.

CONCLUSIONS

Thus, from this data, it may be concluded that any square removal in the field must be at the rate of 90 to 100 percent; removal must be accomplished at 5- or fewer-day intervals; and must be most efficient in the early and midfruiting period if control of the boll weevil is to be attained.

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[2] See footnote 2, p. 2.

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