EFFECT OF VARIOUS LEVELS OF SIMULATED INSECT DAMAGE TO SQUARES ON YIELD OF STONEVILLE 213 COTTON

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Cotton is planted in United States, USSR, China, India, Mexico, Brazil and many other countries. The most important cotton growing country is the United States. In 1965 more than 53 million bales of cotton were produced in the world, while about 23 percent of them were produced in the United States. Cotton is especially important in the southern states of the United States. In Oklahoma 515 thousand acres of cotton were grown in 1973 and more than 20 percent of the income from the sale of crops were from cotton in 1964.

Farmers always have many problems when growing cotton. One of the major problems is insects which attack cotton squares. These insects include: bull weevil (Anthonomus grandis Boh.), pink bollworm (Pectinophora gossypiella Saund.), cotton bollworm (Heliothis zea Bod.), tobacco budworm (Heliothis virescens F.), cotton flea hopper (Psyllus seriatus Reut.), plant bugs (Lygus pratensis L., Lygus hesperus Knight, Adelphocoris rapidus Say., Adephocoris superbus Uhler., Leucopoecila albofasciata Reuter.), stink bugs (Chlorochroa ligate Say.) and some minor insects. They damage the squares by laying eggs in the squares, sucking the juice of the squares or directly feeding on the squares. Billions of dollars have been lost due to insect damage.

Many control methods have been developed to eliminate loss from these insects. One question in using control measures is how to get the

most complete control at the lowest possible cost. The first problem is deciding when to start controlling, i.e., how to tell when insect infestations are serious enough to warrant applying insecticides or other control methods.

A review of literature revealed that the loss of certain percentages of squares in the early stage of cotton growth would not cause loss of yield. The reasons are that cotton plants have the following characteristics:

(1) Shedding large numbers of squares naturally during the growing season. Some varieties of cotton which put on the most fruits also shed the most. Heavy blooming early in the season is not necessarily an indication of large yields. Experiments indicated that only approximately one-half of the total bloom may ordinarily be expected to produce mature fruit (Blackwell and Buie, 1924).

(2) Compensating the unnatural loss of squares within a certain limit. A normal cotton plant is stimulated by the squares and blooms lost from external damage to grow more and bigger fruits. The yield is not affected when the loss of squares is within its compensating ability.

These factors are important regarding the most economical use of control measures. This makes it desirable to have a better understanding of the reaction of cotton plant after the loss of squares.

In this experiment insect damaged squares were simulated by removing squares. The following information was expected:

(1) How many squares of Stoneville 213 cotton could be damaged by insects in a certain stage without reducing the yield.

(2) How late could this stage be.

It was hoped that this study would help to obtain more knowledge

of cotton plants and bring about a satisfactory control program.

CHAPTER II

LITERATURE REVIEW

One of the earliest investigations of the effect of square removal on cotton was made by Smith (1922) at Florida Agricultural Experimental Station. A so-called "Florida method" that involved stripping off all the early squares shortly after the last hibernating boll weevil (Anthonomus grandis Boh.) had emerged was developed to control the weevil. He reported that the removal of young squares was followed by a rapid increase in the height of the plants and this was followed by a profuse development of new squares. He concluded that the removal of all squares early in June would actually result in increasing the yield of cotton.

Similar work was done by King (1930). He reported that the axillary buds and bolls of Pima and upland cotton were usually developed too late to contribute materially to the yield under Arizona conditions. He found that the removal of the extra-axillary buds at frequent intervals resulted in more axillary buds being maintained by the plants and many of them continued development to maturity. The artificial removal of the extra-axillary buds caused the plants to grow much taller and to produce longer and more numerous fruiting branches than normally.

Ludwig (1931) reported that stripping the early squares from the plants and thus removing the competition of maturing fruit from the squares produced later permitted a greater percentage of the later ones

to mature. Eaton (1931) found that an increase of more than 24 percent in the yield of Acala cotton was obtained by stripping off all the bolls, blooms, and large squares on the eighth day of the flowering period. Hamner (1941) stated that a complete loss of young squares through six weeks after squaring began did not cause a statistically significant loss in yield of Cleveland 54 and D. & P.L. 4-8 cotton when the fruit was protected from the boll weevil and other insects and the disease infection was negligible. Hamner (1943) also simulated boll weevil infestations on Cleveland 54 cotton. The squares which were large enough for a weevil to puncture were removed at different levels. The highest average yield the first year of test was made by plants that had 10 percent of the squares removed the first week of square production, increased by 10 percent per week through the fifth week to 50 percent and held at that level for four weeks. Plants that had the percent of squares removed increased to 40 the fourth week and held at that level for five weeks exceeded the yield of the check for the two years of the study.

Effect of dusting schedules on the yield of cotton was studied by Gaines, Owen, and Wipprecht (1947, 1948). They reported that the loss of 50 percent of the squares from boll weevil during the first thirty days of the fruiting period did not reduce the yield. They stated that it was more profitable to apply insecticides at a tome when the weevils and bollworms were most injurious than to try to protect the fruit during the entire season. Mistric and Covington (1968) concluded that the increasing, constant, and fluctuating patterns of square removal averaging 45 percent per week for eight weeks did not reduce the yield of Coker 100 W cotton. Kincade, Laster, and Brazzel (1970) studied the effect of Heliothis damage on cotton yield. Because of the difficulty in

obtaining data from natural infestation, they simulated the damage by pulling 1 pinhead square and 3 small squares per larva off the plant the first week of damage and pulling 10 large squares off seven days later. In mid-season and late season simulated damage was based on 6 squares and 3 bolls per larva, and 8 squares and 3 bolls per larva respectively. They reported that the simulated Heliothis damage at the level of 1 larva/5 feet and 1 larva/2.5 feet did not cause a significant decrease in yield. They concluded that very little gain might be expected from protection of squares in early season from bollworm infestation, and relatively heavy infestation in med and late season were required for yield reduction.

There are also some reports that indicated the negative reaction of cotton after square removal. Blackwell and Buie (1924) reported that stripping all squares from plants in different stages, from each plant had about 3 to 5 squares to blooming had just commenced, resulted in a stimulation of blooming, but fewer of these late blooms were matured.

Dunnam et al. (1943) did get a loss in yield where all week-old squares were removed for a nine week period, but the yield was not significantly reduced by removal of all squares during the first four weeks of the fruiting period.

Singhaseni (1973) found that the 20, 30, and 40 percent square removal in both the fifth and sixth weeks after squaring began and 100 percent square removal in the third week after squaring began caused an reduction in yield of Tamcot 788 cotton. But he also found that the removal of 100 percent squares from the plant in one of the first two weeks and 50 percent square removal in one of the first three weeks after squaring began did not reduce the yield.

In a summary, the cotton plants were simulated to grow more fruits after the removal of the early squares to compensate the loss. The final yield was not definitely increased. It could remain the same or be decreased. This is attributed to the variety of cotton, the size of the squares removed, the longevity of the removing period and also to different climate and soil conditions.

CHAPTER III

METHODS AND MATERIALS

Field experiments were conducted during the summer of 1973 at the Altus Irrigation Research Station, Altus, Oklahoma. The field size was 250 feet long and 91 rows wide. The total area was 1.74 acres.

Stoneville 213 cotton was planted on May 25, with 20 pounds seed per acre. The soil was fertilized with 200 lb./acre of 18-46-0 five days before planting. The plant density was 38649 plants per acre.

There were 28 treatments and one untreated control replicated five times with a completely randomized block design. Each plot was 50 feet long and 2 rows wide.

Four different levels, 10, 20, 30, and 40 percent of the total squares were removed by hand at weekly intervals from one to seven weeks after squaring began.

Squares were removed during the period beginning on July 9 and ending on August 20. In each plot the squares were removed only once, for the week and percentage indicated for that plot. Each week 10, 20, 30, and 40 percent of the squares were removed from four plots (Table I). Squares were not removed from the check plots. When picking ten percent of the squares, one square was picked at every interval of ten squares checked. When picking twenty percent of the squares, one square was picked at every interval of five squares checked. When picking thirty percent of the squares, the third square, the sixth square and the tenth

square were picked in every ten squares checked. The second square and the fifth square were picked in every five squares checked when picking forty percent of the squares. Squares removed ranged in size from as small as pinhead to as big as 2 or 3 cm in width. When picking the squares from the plants, only the squares were touched. Damage to any other part of the plant was avoided as much as possible. Squares were picked at equal intervals, so that the squares lost could be equally separated on the whole plant. Every branch had the same probability of losing its squares.

Insecticides were applied four times during the growing season to minimize insect injury. A Hahn Hi-cycle sprayer equipped with a 8-row boom was used. For the control of bollworms and flea hoppers, the plots were first sprayed with Methyl parathion on July 18 at 0.08 gallon per acre. On July 25 and August 3, 6-3 Methyl parathion-Toxaphene at 0.33 gallon per acre were sprayed. The sprayer was operated at 4 miles per hour with 40 lbs pressure in the first three applications. The last application was applied on August 16 with 4-4 Methyl parathion-Toxaphene at 0.37 gallon per acre. The sprayer system was operated at 4 miles per hour with 60 lbs pressure.

Cotton was manually harvested from the first row of each plot on December 1 to determine the yield. The cotton in burr per acre was calculated by using 261.36 multiplied times the cotton in burr per 50 feet.

An analysis of variance was used to determine if there was a significant difference due to treatments.

CHAPTER IV

RESULTS AND DISCUSSION

No diseases were found throughout the experiment. Insect damage was controlled by the applications of insecticides. Vigorous cotton plants were growing under favorable conditions. All the squares lost were removed by hand purposely according to the design of the experiment, except those lost from physiological shedding.

The average number of removed squares per plot and the average number of total squares per acre are presented in Table II. The number of squares lost per plot in this experiment ranged from 6.2 which was 10 percent of the total squares in the first week to 1321.2 which was 40 percent of the total squares in the seventh week.

From the data of the first week, it was found that 40 percent of the total squares removed obtained by averaging five replications had fewer number of squares per plot as compared to 30 percent of the total squares removed obtained by averaging another five replications. This is because the total number of squares in the five plots which had 40 percent of the squares removed was not the same as the other five plots which had 30 percent of the squares removed. The same thing happened in the second week, the fourth week, and the fifth week. Since the proportions of the removed squares to the total squares were guaranteed by the method used when picking squares, the difference of the total number of squares per plot had no influence on the analysis of the results.

Effect of Square Removal in the First Week After Squaring Began on Stoneville 213 Cotton

The yield of burr cotton harvested from the plots of treatment 1-10, 1-20, 1-30, and 1-40 were 3101.82, 3622.97, 3270.14, and 3199.05 pounds per acre respectively (Table III). The check plots produced a yield of 3029.16 pounds per acre. The relationship between these four yields and the check yield is shown in Figure 1.

These four yields were all higher than the average yield of the check plots. This indicates that 10 to 40 percent square removal in the first week did not reduce the yield but on the contrary, it stimulated cotton plants to produce a higher yield than normally. The possible explanations of this phenomena are as follows:

(1) There were more than four hundred thousand squares per acre by the seventh week of squaring. The number of natural shedded squares was not included in this amount. Therefore, the total number of squares which cotton plants had produced by the seventh week should be much more than four hundred thousand. When 10 to 40 percent squares were picked in the first week, it was found that the total number of squares removed ranged only from 810.2 to 2456.1 squares per acre. This amount was only a very small part of the total squares which the cotton plants had produced during the whole fruiting season. This small loss of squares was easily recovered by later fruiting. The loss was not serious enough to cause any reduction of yield.

(2) In these four treatments, squares were picked in the first week after the plant had started squares. The cotton plants were stimulated to grow more and bigger fruits at the very beginning of fruiting period. The development of the cotton plants during the total fruiting

period that followed may have been affected by this early stimulation and hence increased the chance of obtaining a high yield.

These two reasons may also explain why the highest yield obtained in this experiment was from treatment 1-20.

Effect of Square Removal in the Second, Third, and Fourth Week After Squaring Began on Stoneville 213 Cotton

The yields higher than that of the check were 3193.296, 3476.088, 3175.524, and 3205.319 pounds per acre which were obtained from treatment 2-20, 2-30, 3-30, and 4-20 respectively. The lower yields as compared to the check were 2592.168, 2669.008, 2810.665, 2572.305, 2907.369, 2824.256, 2742.189, and 2850.392 pounds per acre which were from treatment 2-10, 2-40, 3-10, 3-40, 4-10, 4-30, and 4-40 resepctively. The relationships of the yields of treatments to check are shown in Figures 2, 3, and 4.

10 and 20 Percent Square Removal

It was found that 10 percent square removal in the second, third, and fourth week and 20 percent square removal in the third week reduced the yields. But when 20 percent of the squares were removed in the second week and the fourth week, it was found that it raised the yields again. Figure 8 and 9 show the effect of 10 and 20 percent square removal throughout the seven weeks. The flunctuation of these two curves along the check line indicates that the effects of 10 and 20 percent square removal during this stage on the cotton plant was at the edge of its compensating ability. At this time, environmental factors such as

temperature, rainfall, soil conditions, probably determine whether the plant could compensate the loss or not. If the environmental conditions are favorable, the plant might be able to tolerate the same amount of square loss which causes loss of yield under unfavorable environmental conditions.

30 Percent Square Removal

The average yields of plots which had 30 percent of the squares removed in the second week and the third week were higher than the average yield of the check plots, while the average yield of plots which had the same level of squares removed in the fourth week was lower than the check. Figure 10 shows the effect of 30 percent square removal throughout the experiment. When 30 percent of the squares were removed in the first three weeks, it was found that the yield increased, but when this was continued after the third week it was found that yields were reduced as compared to the check and never raised again. This indicates that the fourth week were the critical period for the 30 percent square removal. After this period, the 30 percent square loss could cause loss in yield.

40 Percent Square Removal

When 40 percent of the squares were removed in any of the second, third, or fourth week, it reduced yields. This would indicate that 40 percent loss of the total squares during this period would affect the fruiting ability of cotton plants. Figure 11 shows the effect of 40 percent square loss throughout the experiment. This indicates that square loss was not compensated by the later fruiting. The critical period for 40 percent square loss was from the first to the second week while the

critical period for 30 percent square loss was the third and the fourth week. Evidently, the increased level of square loss was responsible for this change of critical period. As the square loss decreased, the critical period moved ahead.

From the data obtained in these three weeks exhibited the different effects of the levels tested. The two lower levels had not shown a definite influence on yields, while the two higher levels had reduced the final yields.

Effect of Square Removal in the Fifth, Sixth, and Seventh Week After Squaring Began on Stoneville 213 Cotton

The 10 to 40 percent square removal during the last three weeks of testing generally resulted in low yields. The yields of burr cotton in pounds per acre were 2923.573 from treatment 5-10, 2762.575 from treatment 5-20, 2842.551 from treatment 5-30, 2639.736 from treatment 5-40, 3409.703 from treatment 6-10, 2803.347 from treatment 6-20, 2816.415 from treatment 6-30, 2686.781 from treatment 6-40, 2850.915 from treatment 7-10, 2981.595 from treatment 7-20, 2476.647 from treatment 7-30, and 2613.600 from treatment 7-40. During this period, all the treatments except treatment 6-10 had yields less than that of check as shown in Figures 5, 6, and 7. The lowest yield obtained in this experiment was made by treatment 7-30. This result indicated that the square removal of the levels tested during the late squaring period hurt the cotton plants. The square loss ranged from the minimum of 262.8 to the maximum of 1321.2 per plot. This square loss could not be overcome by the development of the late summer and early fall crop. The reasons are:

(1) Cotton plants were burdened with large number of squares in these three weeks. The levels of removed squares were still 10, 20, 30, and 40 percent but the actual numbers of the removed squares at this late stage were much more than at the early stage. The proportion of 10 percent squares at early stage and that at late stage to the total number of squares produced by the same plot were different. The latter was much larger than the early season removal. Therefore, strong compensating ability was needed to cover the loss.

(2) These twelve treatments were having squares removed in the last three weeks of the experiment. It was almost the end period of squaring. There was not enough time for the plant to grow more even if it had such an ability.

CHAPTER V

SUMMARY AND CONCLUSION

There was no strong statistical evidence which showed that the average yield in the check plots was different from those in the plots from which squares were removed. The probability of having any two of the treatments with different yields was 85 percent. Although the differences were not great enough to be statistically significant, in this experiment slightly higher and slightly lower yields occurred in the damaged treatment than in the undamaged check.

From 10 to 40 percent of square damage occurred in the first week after cotton plants started putting on squares stimulated the plants to produce a higher yield. The reduction of yield appeared when 20 percent of the squares were attacked by insect pests after the fourth week, 30 percent of the squares were attacked after the third week, or 40 percent of the squares were attacked after the first week of squaring.

The fact that up to 40 percent of the square can be removed the first week of squaring indicates that early season insect control economic threshold should be reviewed. As has been indicated removal a higher percentage of squares from mid and late season is much more critical on a percent basis.

It is probable that the removal of 10-20 thousand squares per acre would not harm cotton at any period of development when grown under the conditions in this experiment. The removal of over a hundred thousand

squares per acre did not reduce the yield significantly.

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A P P E N D I X

TABLE I

TREATMENTS USED FOR DETERMINING THE EFFECT OF DIFFERENT LEVELS OF SQUARE REMOVAL IN DIFFERENT WEEKS ON THE YIELD OF STONEVILLE 213 COTTON

Treatment	Time of Square Removal	Percent of Square Removal
1-10	First Week (July 9)	10
1-20		20
1-30		30
1-40		40
2-10	Second Week (July 16)	10
2-20		20
2-30		30
2-40		40
3-10	Third Week (July 23)	10
3-20		20
3-30		30
3-40		40
4-10	Fourth Week (July 31)	10
4-20		20
4-30		30
4-40		40
5-10	Fifth Week (Aug. 6)	10
5-20		20
5-30		30
5-40		40
6-10	Sixth Week (Aug. 13)	10
6-20		20
6-30		30
6-40		40
7-10	Seventh Week (Aug. 20)	10
7-20		20
7-30		30
7-40		40
Check	-----	0

TABLE II

AVERAGE NUMBER OF SQUARES REMOVED PER PLOT IN EACH TREATMENT AND THE TOTAL SQUARES PER ACRE IN EACH TREATMENT

Treatment	Average No. of Removed Squares/Plot	Average No. of Squares/Acre
1-10	6.2	8102.2
1-20	13.0	8494.2
1-30	25.8	8187.1
1-40	19.2	6273.6
2-10	44.6	58,292.2
2-20	103.2	67,441.2
2-30	89.8	39,122.4
2-40	121.6	39,732.8
3-10	86.6	113,195.0
3-20	157.6	98,515.8
3-30	274.2	119,441.5
3-40	393.8	128,654.5
4-10	130.4	170,407.3
4-20	296.0	193,406.4
4-30	251.6	109,597.0
4-40	608.0	198,633.6
5-10	262.8	343,426.9
5-20	426.6	276,740.4
5-30	617.2	275,109.9
5-40	637.8	267,175.3
6-10	264.0	344.995.2
6-20	629.6	411,384.6
6-30	675.8	294,377.7
6-40	1134.4	370,608.5
7-10	336.8	440,130.2
7-20	626.0	409,028.4
7-30	950.4	422,598.1
7-40	1321.2	431,636.4
Check	0.0	----

TABLE III

AVERAGE YIELD OF STONEVILLE 213 COTTON IN EACH TREATMENT

Treatment	Average Yield of Burr Cotton lbs./50 ft. Row	Average Yield of Burr Cotton lbs./Acre
1-10	11.868	3102
1-20	13.862	3623
1-30	12.512	3270
1-40	12.240	3199
2-10	9.918	2592
2-20	12.218	3193
2-30	13.300	3476
2-40	10.212	2669
3-10	10.754	2811
3-20	9.842	2572
3-30	12.150	3176
3-40	11.124	2907
4-10	10.808	2824
4-20	12.264	3205
4-30	10.492	2742
4-40	10.906	2850
5-10	11.168	2924
5-20	10.570	2763
5-30	10.876	2843
5-40	10.000	2640
6-10	13.046	3410
6-20	10.726	2803
6-30	10.776	2816
6-40	10.280	2687
7-10	10.908	2851
7-20	11.408	2982
7-30	9.476	2477
7-40	10.000	2614
Check	11.590	3029

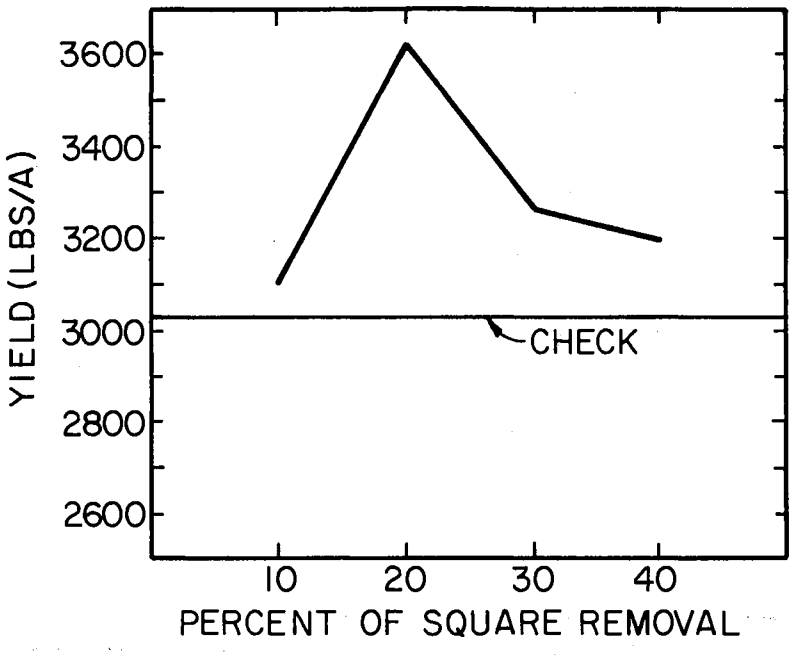

Figure 1. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the First Week

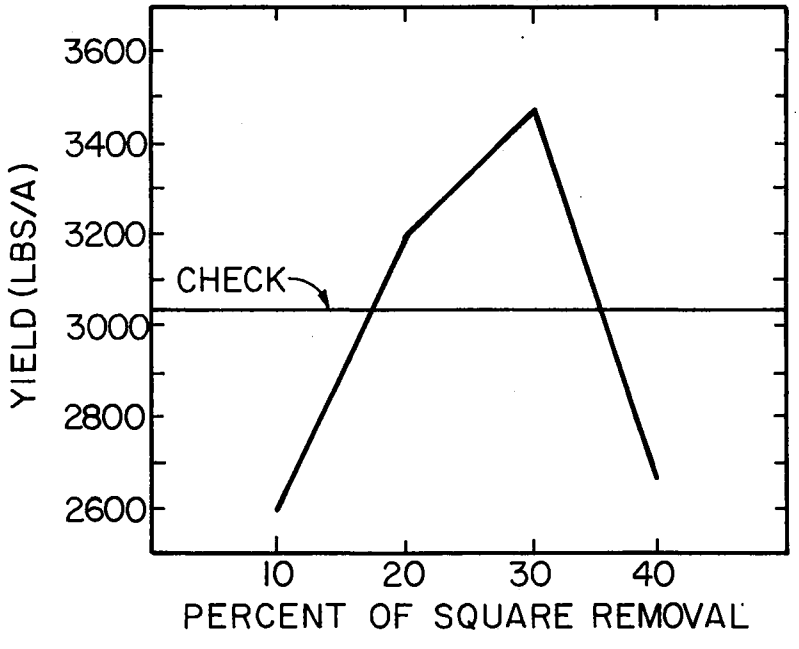

Figure 2. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Second Week

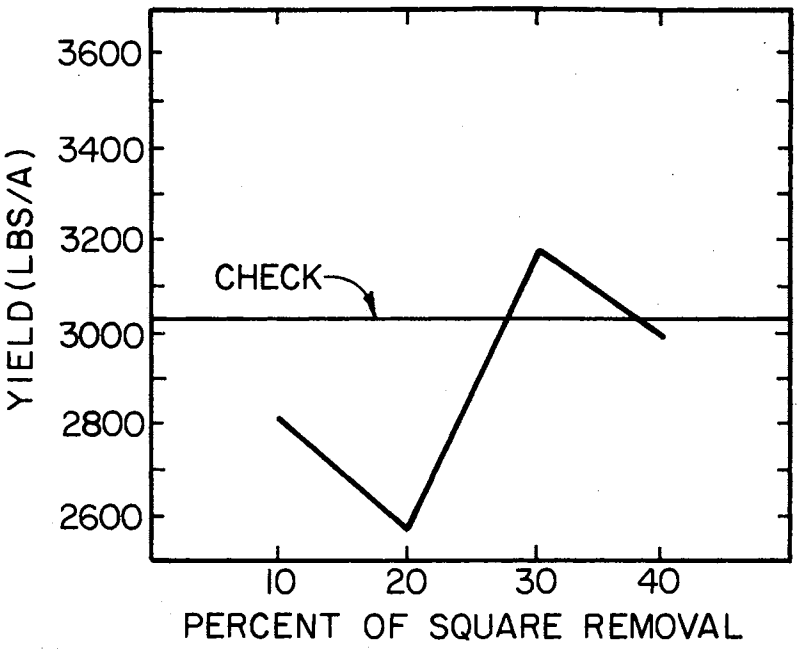

Figure 3. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Third Week

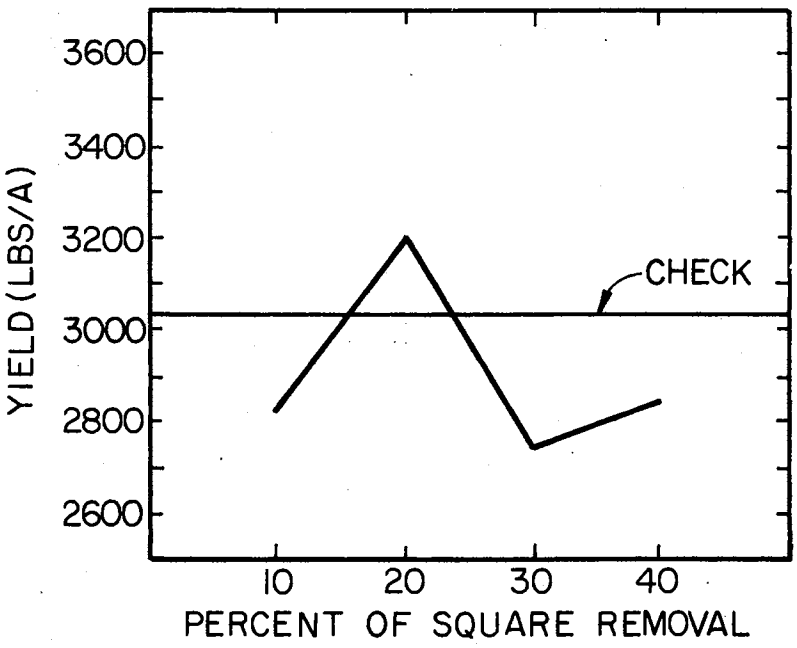

Figure 4. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Fourth Week

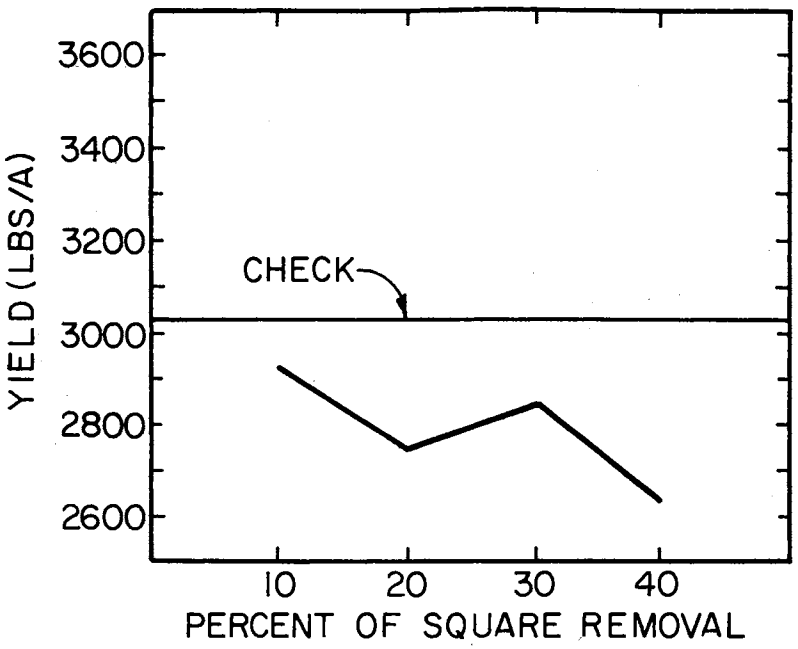

Figure 5. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Fifth Week

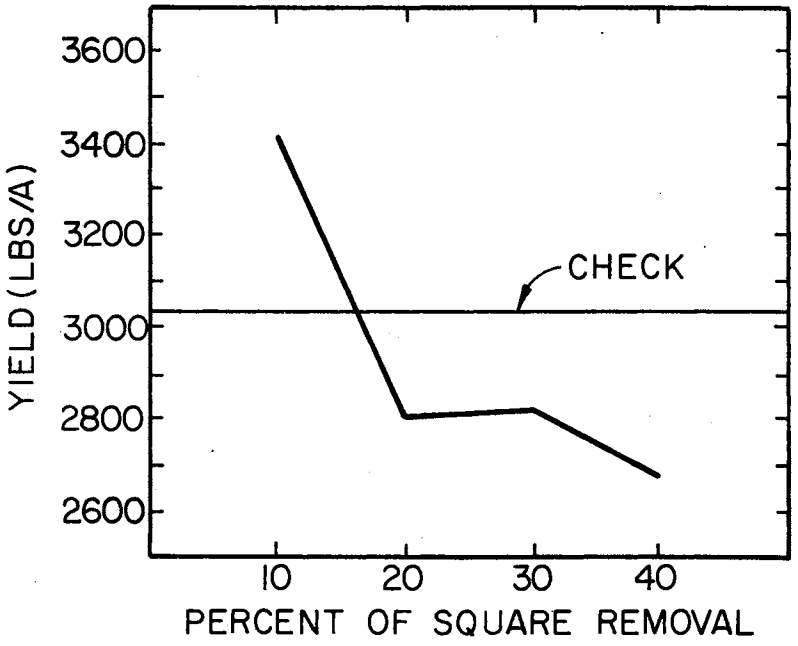

Figure 6. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Sixth Week

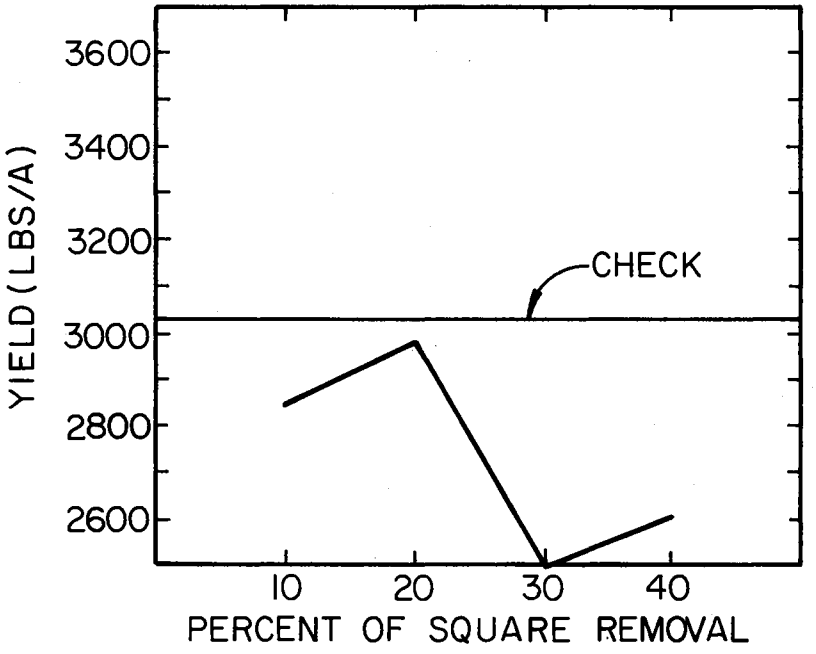

Figure 7. Average Yield of Burr Cotton (lbs/A) After Square Removal at Four Different Levels in the Seventh Week

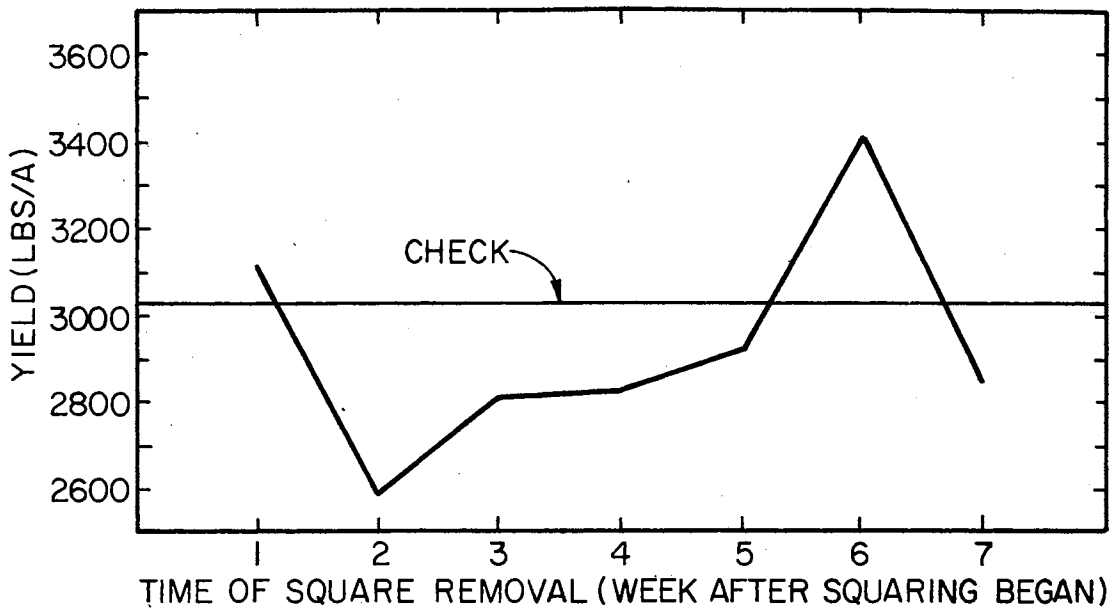

Figure 8. Average Yield of Burr Cotton (lbs/A) After 10 Percent Square Removal

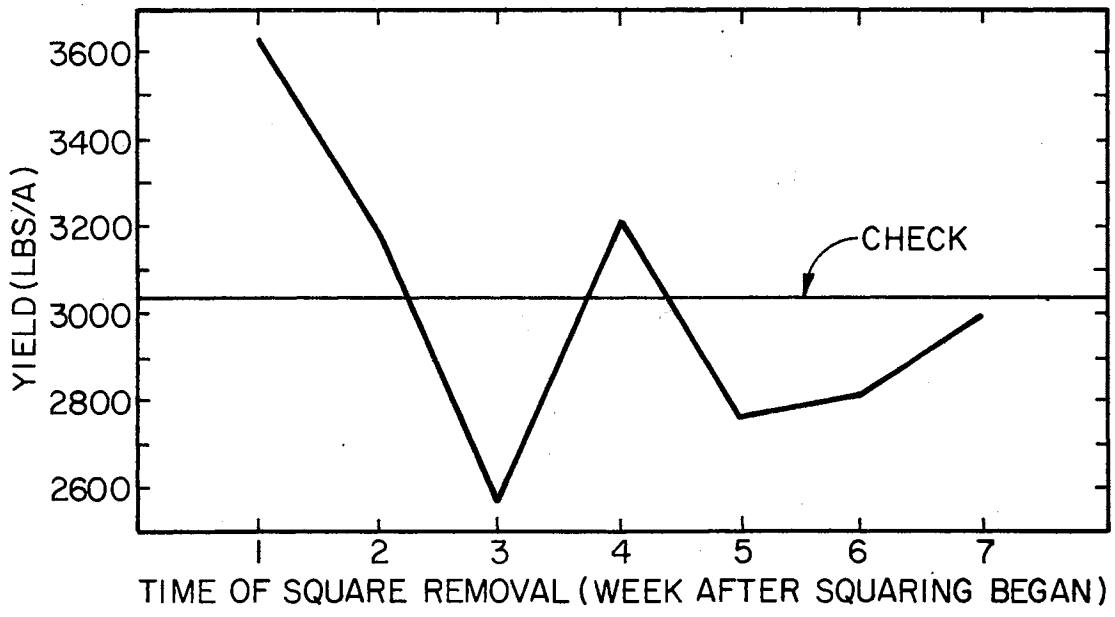

Figure 9. Average Yield of Burr Cotton (lbs/A) After 20 Percent Square Removal

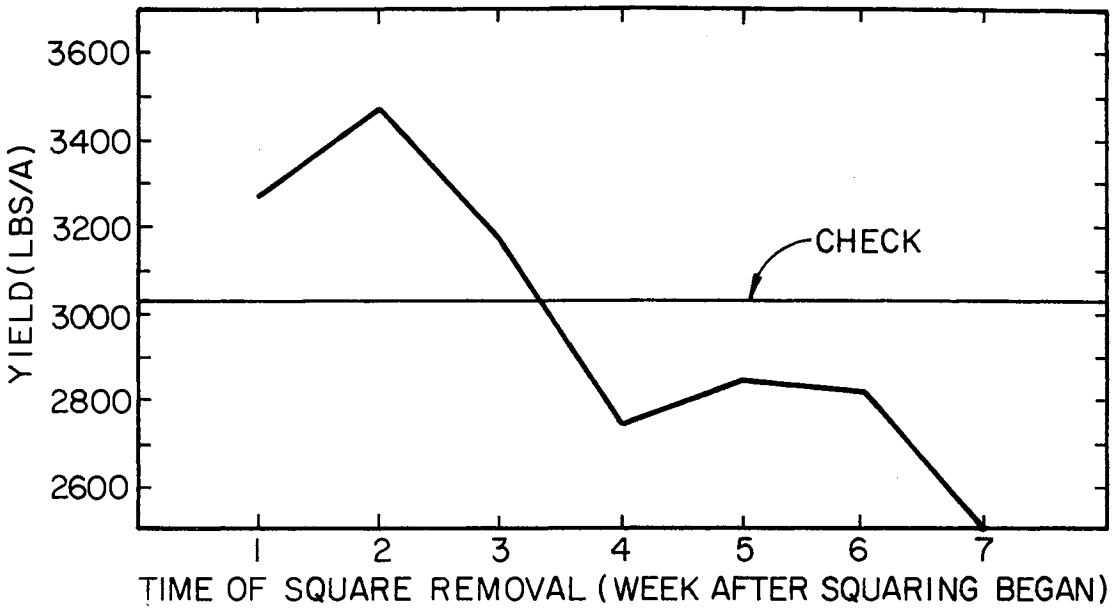

Figure 10. Average Yield of Burr Cotton (lbs/A) After 30 Percent Square Removal

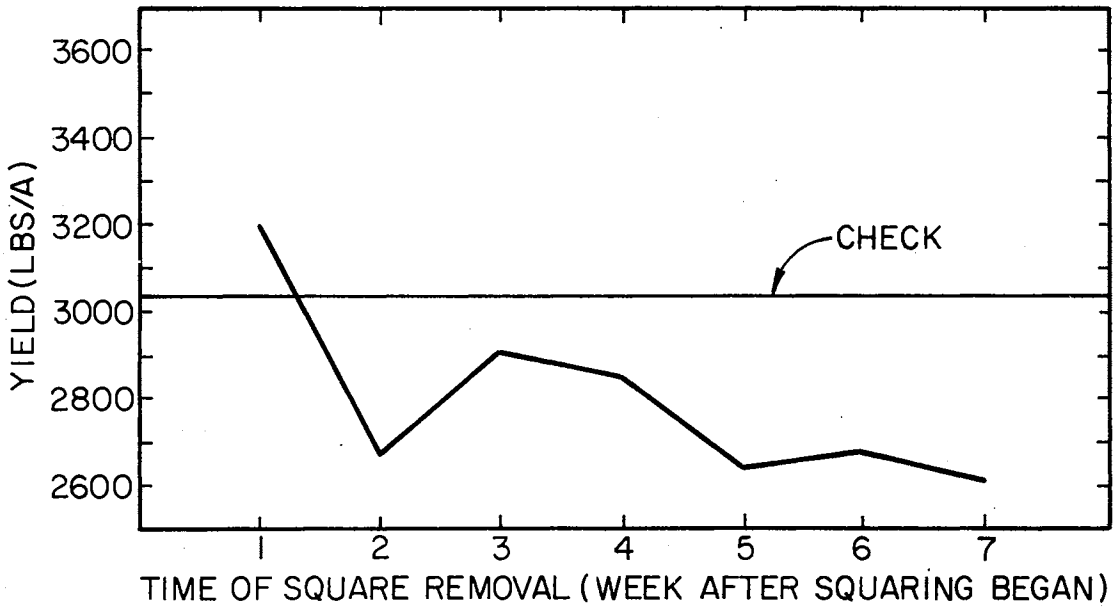

Figure 11. Average Yield of Burr Cotton (lbs/A) After 40 Percent Square Removal

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