EFFECTS ON PREDATOR POPULATIONS, INSECT DAMAGE, FRUITING CHARACTERISTICS, AND YIELD OF COTTON INTERPLANTED WITH CORN OR SORGHUM

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PREFACE

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CHAPTER I

INTRODUCTION

Early season chemical treatments for thrips and fleahoppers, or season long scheduled spraying for the boll weevil have resulted in the cotton bollworm, *Heliothis zea* (Boddie), and the tobacco budworm, *Heliothis virescens* (Fabricius), becoming major problems in the production of cotton in Oklahoma.

Several investigators, including Ewing and Ivy (1943), Ridgway et al. (1967), Lingren et al. (1968), and Dinkins et al. (1971), have reported that these early season treatments reduce the number of predators and parasites which attack the *Heliothis* complex. Also, an increase in insecticide resistance of the *Heliothis* complex in the cotton ecosystem has been reported by Lincoln et al. (1967), Graves et al. (1963), and Harris (1970), in response to the large amount of chemicals used in cotton insect control.

The magnitude of the problem of cotton insect control becomes very clear when it is noted that almost one-half of all insecticides used in control of agriculture pests is used on cotton (Agr. Econ. Rep. No. 179). This great volume of insecticides has resulted in pollution of the environment and increased costs to the producer. The above factors have led to research for new methods of control. Introducing or increasing natural populations of beneficial insects within or adjacent to the cotton ecosystem is one alternative to chemical control.

Robinson (1971) determined in strip-cropping studies that grain sorghum exhibited the greatest potential for furnishing a suitable habitat for the buildup of predators and parasites of the *Heliothis* complex. Robinson suggested that in more extensive studies, samples should be taken at various distances from the alternate crops to see if the numbers of insects increase or decrease on cotton rows as one moved away from the alternate crops.

DeLoach and Peters (1972), from their strip-planting studies, found obvious trends toward greater control in the more diversified habitat. They also determined that strip-planting caused a 35.4% reduction in the number of marked cabbage looper eggs surviving 72 hours.

The primary objectives of this study were to interplant corn and or sorghum with cotton and determine if there were any differences in predator numbers and or damage. The first growing season (1971) was devoted to determining if any linear differences in predator numbers and or damage existed. During the second growing season (1972) an effort was made to determine the best interplanting array based on predator numbers and or damage.

CHAPTER II

PREDATOR AND DESTRUCTIVE INSECTS IN COTTON

Whitcomb and Bell (1964) reported about 600 species of arthropods associated with cotton in Arkansas. van den Bosch and Hagen (1966) estimated 300 arthropod species may be found in California cotton fields. The *Heliothis* complex is partially or completely controlled by one or more predators or parasites at any one time. These beneficial insects help regulate the *Heliothis* complex.

Predators--Common predators and their benefits have been reported by several investigators, including Whitcomb (1967 a, b), Ridgway and Jones (1969), Lingren et al. (1968), and van den Bosch et al. (1969). Only five insect species plus spiders were recorded in sufficient numbers to be analyzed individually in this study. These five insects were lady beetles, primarily *Hippodamia* spp.; green lacewing adults, *Chrysopa* spp.; nabids, *Nabis* spp.; soft-winged flower beetles, *Collops* spp.; and hooded beetles (*Notoxus monodon* (Fabricius)). Nabids occurred in sufficient numbers to be analyzed only during the first summer. *Collops* beetles occured in sufficient numbers to be analyzed only during the second summer.

Destructive Insects--Thrips, primarily *Frankliniella* spp., are generally present each year on seedling cotton in Oklahoma. They injure the young seedlings by abrading foliage surfaces and sucking juices, thus causing malformed plants. On most occasions in Oklahoma, thrips control is not recommended. It has been found that the cotton plant will generally outgrow thrips damage (Young and Price, 1970). No data was taken on thrips populations.

The cotton fleahopper, Psallus seriatus (Reuter), and the black fleahopper complex, Spanogonicus albofasciatus (Reuter) and Rhinacloa forticornis (Reuter), occur in Oklahoma. Fleahoppers are considered to cause more economic damage than thrips in southwestern Oklahoma. This idea is based on the loss of early boll set due to loss of young squares and in some cases branches, as a result of fleahopper damage (Robinson, 1971). The growth stage of the cotton should be noted before control measures are applied for fleahoppers. It generally does not pay to control fleahoppers. Sometimes these early applications of insecticides on cotton initiate an early increase in the Heliothis population, due to killing of the predators and parasites.

The cotton bollworm, Heliothis zea (Boddie), and the tobacco budworm, Heliothis virescens (Fabricius), are responsible for a considerable amount of damage to cotton during most years in Oklahoma. These two species comprise a complex in which the bollworm is the dominant species early in the season; but both may be found together later in the season, with the budworm sometimes being the dominant species. Outbreaks of damage due to these two insects are generally not statewide, but are restricted to localized areas. A large amount of spraying for the Heliothis complex has resulted in resistance to the insecticides. Subsequently, this buildup in resistance and the killing of predators and parasites, sometimes results in a resurgence of the Heliothis complex after treatment.

The boll weevil, Anthonomus grandis (Boheman), feeds and over winters in Oklahoma. Severe damage in western Oklahoma may usually be circumvented by planting as early as is feasible. In some years when the population reaches levels that can cause economic damage, chemical control has often been utilized.

CHAPTER III

LINEAR EFFECTS IN PREDATOR POPULATIONS, INSECT DAMAGE, AND YIELD, ASSOCIATED WITH COTTON INTERPLANTED WITH CORN AND SORGHUM

Robinson (1971) conducted strip cropping tests at the Irrigation Research Station at Altus, Oklahoma. He stripped cotton with corn, sorghum, soybeans, peanuts, alfalfa, and no crop. Each plot consisted of 8 rows of cotton with 4 rows of one of the crops on each side. He determined that planting cotton and other crops in close association had an effect on the number of predators present in the immediate area. He also found that the sorghum treatment had the highest level of predators and highest yield, even though it had next to the highest per cent damaged squares. Robinson attributed the large populations of predators in the cotton next to the sorghum to the great number of aphids in the sorghum.

The purpose of this study was to determine the effects of interplanting cotton with corn and sorghum on predator populations, insect damage, and yield. The data were taken to emphasize linear effects as one moved away from the corn or sorghum.

Materials and Methods

During the 1971 cotton growing season a test was conducted on 20 acres of leased land, southwest of Tipton, Oklahoma. The test was planted in a randomized block design (Fig. 1). There were 3 blocks, each with 2 treatments, and each treatment was replicated twice in each block. Each treatment was divided into 2 plots based on whether it was north or south of the grain crops. Each treatment consisted of 12 rows of either corn or sorghum with 26 contiguous rows of Westburn 70 cotton, 260 feet long, on both sides. This resulted in 52 rows of cotton between the grain crops in different blocks. The rows were planted in 40 inch spacings. No fallowed rows or alleys were left unplanted.

The corn and sorghum were planted June 3, 1971, and the cotton was planted June 19, 1971. The test area was irrigated three times during the growing season.

All data on predator numbers and damaged squares were taken on rows 1, 5, 9, 13, 17, and 21, as one moved away from the corn or sorghum. Data were taken only on the west half of each plot. Predator numbers were determined by counts made on vacuum samples taken from 130 feet of each sampled row. The vacuum samples were taken on three dates: July 28, August 2, and August 23, 1971. The vacuum samples were taken with a modified D-VAC vacuum sweeper (Fig. 2).

The modifications on the D-VAC consisted of replacing the 2 cycle gasoline engine with a 3/4 horsepower (1725 RPM) electric motor powered by a portable generator. The power of the electric motor was transmitted to the shaft of the suction fan by means of a V-belt. This unit was then mounted on a platform on the back of a International cub tractor.

In the summer of 1970 a D-VAC vaccum sweeper was used to sample cotton and sorghum on the Cotton Research Station, Chickasha, Oklahoma. The vacuum sweeper was ran continuously for four hour periods. During this time it was necessary to clean the spark plug at least once to maintain maximum RPM of the suction fan. Therefore, the aforementioned modifications of the D-VAC vacuum sweeper were made so the suction fan would operate at a maximum and constant rate without periodic maintenance.

The tractor was driven down the two rows adjacent to the row to be sampled at approximately 3.5 MPH. The vacuum sweeper was aimed to suck the predators from the terminal portion of the cotton plants. The opening at the point of collection was 6.5 inches. The collecting net was removed from the vacuum sweeper in a way to prevent the predators from escaping. The net was then stuffed into a quart ice cream carton. The predators were killed by squirting a small amount of ethyl acetate into the carton. The samples were then taken to the laboratory where the insects and spiders were counted and recorded.

Heliothis damage was determined by collecting squares five times, from August 7 through September 10, at approximately weekly intervals. Fifty squares were collected from 130 feet of each sampled row in each plot on the five sampling dates. From this data, per cent *Heliothis* damaged squares was determined for each sampled row in each plot.

The cotton was machine harvested and yield taken on two rows 260 feet long. Therefore, the sampling units for yield were rows 1 and 2, 5 and 6, 9 and 10, 13 and 14, 17 and 18, and 21 and 22, in each plot.

Analysis of variances tables containing mean squares and significance levels are in the appendix. Analysis of variances were performed on the data by the Statistics Department of Oklahoma State

University utilizing the Statistical Analysis System.[1]

Results and Discussion

Predators--In analyzing the total number of predators, significant differences at the 5% level were found due to rows, dates, and row by date interaction (Table I). A marked reduction in total numbers occurred on August 23 on all rows except the first row next to the grain crops (Fig. 3 and Table II). This reduction in numbers is probably due to the cotton plants maturing and the increase in temperature during this period of the growing season. Another important contributing factor to this reduction was the sharp decline in the hooded beetle population from August 2 to August 23 (Fig. 7). No linear effects could be determined in conjunction with the total predator population.

Only four insects plus spiders occurred in sufficient numbers to be analyzed individually. These four were lady beetles, lacewing adults, nabids, and hooded beetles. The spiders and the insects, except the hooded beetles, tended to follow the expected pattern of being more numerous on the first row of cotton next to the grain crops. As one moved away from the grain crops their numbers decreased and tended to level off, with a few exceptions.

No significant difference in lady beetle and lacewing adult populations was found due to the grain crops. The analysis of variances for lady beetles and lacewing adults are given in Tables

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[1]The system was designed and implemented by Anthony James Barr and James Howard Goodnight, Department of Statistics, North Carolina State University, Raleigh, North Carolina.

III and IV, respectively.

Significant differences in lady beetle populations at the 1% level were found due to direction and row from the grain crops. A significant difference at the 5% level was found due to date, with several interactions being significant at either the 1% or 5% level.

No difference was found in lacewing adult populations due to direction from the grain crops. Significant differences at the 1% level were found in the lacewing adult populations due to row, date, and the row by date interaction.

The lady beetle and lacewing adult populations found on row 1 on August 23 increased approximately four-fold over the number found on row 1 on August 2 (Figs. 4 and 5). This increase can be attributed to a buildup of aphids and greenbugs in the sorghum in early August (Table V). The number of lady beetles declined as one moved away from the grain crop, but were still more numerous than the numbers found on August 2, up through row 13. Beyond row 13 fewer were found on August 23 than August 2. The numbers of lacewing adults found on August 23 declined from the first row, but were still greater on corresponding rows than the numbers found on the previous two sampling dates.

There was a difference at the 1% level of significance between direction from the grain crops, with more lady beetles found on the south side than the north side (Table VI).

The levels of the nabid populations were unstable as you moved away from the grain crops on all three sampling dates (Fig. 6). The nabid populations exhibited a uniform pattern, decreasing steadily as the season progressed. These differences were significant at the

1% level (Table VII).

Hooded beetles were more numerous on the first sampling date than any other species recorded, averaging 6.9 per sampling unit. The hooded beetles were less numerous on the first row of cotton than on the other rows sampled on the first two sampling dates, with one exception (Fig. 7). Significant differences at the 1% level were found due to row, date, and row by date interaction (Table VIII).

The trend of the spider populations over the three sampling dates was similiar to that exhibited by the hooded beetles, resulting in a significant (1% level) decrease on the third sampling date (Fig. 8). Significant differences at the 1% level were found due to row and date. Differences at the 5% level of significance were found due to direction by row by date interaction (Table IX).

All of the predators, except nabids, exhibited significant differences due to row. Even though some decline or increase in numbers was recorded as one moved away from the grain crops, no linear relationship could be determined, inclusive of the three sampling dates. Snedecor and Cochran (1968) discuss the situation where main effects cause a decrease in some cases and an increase in others. They state that "This presumably accounts for the large" interaction "mean squares and warns that no useful overall statements can be made from the main effects".

I feel that Snedecor's and Cochran's statement is not fully applicable to the biological situation in this study. I believe the differences due to dates and rows are valid differences, even when they are associated with interactions. Robinson (1971), Burleigh (1973), and Pickle (1973), substantiate this belief.

On the third sampling date lacewing adult populations exhibited a row effect with no corresponding interaction. This difference was an average decrease of 0.73 lacewing adults per sampling unit as one moved away from the grain crops; but only 40% of this decrease could be attributed to linear effects.

On the third sampling date lady beetle populations, likewise, exhibited a row effect, but with interaction present. This difference was an average decrease of 1.23 lady beetles per sampling unit as one moved away from the grain crops. Of this decrease, 55% could be attributed to linear effects.

Fleahoppers--Significant differences at the 1% level were found due to row and date (Table X). No linear effects could be determined. A large increase was observed in the fleahopper population as the season progressed (Table XI). No data was taken on fleahopper damage because of the difficulty in differentiating between damage due to fleahoppers, other phytophagous insects, and or square shedding due to physiological causes.

Damage--There was no significant differences in per cent square damage between cotton grown next to corn and that grown next to sorghum; although, the cotton next to the corn had slightly more damaged squares. There was a significant difference at the 1% level among dates with the greatest mean damage occuring the last week in August (Table XII). The average per cent of damaged squares during this period was 4.6% (Table XIII). Two peaks in bollworm damage normally occur each cotton growing season in southwestern Oklahoma; the first in the latter part of July and the second the latter part of August (Jimenez 1971, Robinson 1971, and Pickle 1973). According to Nemec (1971) these peaks occur in direct response to the dark phase of the moon. Only the peak in late August was noted in this study due to the late planting of the cotton.

A significant difference in per cent square damage, at the 1% level, was found between the directions from the grain crops (Table XIV). The north side consistantly had a higher per cent of damaged squares than did the south side.

Differences in per cent square damage among the rows sampled were significant at the 1% level. Row 1 had the greatest per cent square damage with 4.5% and rows 17 and 21 had the lowest with 3.1% and 3.2%, respectively (Table XIII). The only significant differences (1% level) found between rows was that of row 1 being different from all of the other rows. The average decrease in per cent damaged squares per sampling unit as one moved away from the grain crops was 0.44%. Of this decrease, 89% was found to be due to linear effects. The major component of the linear effect, as seen in Table XV, is the data taken from the north side of the grain crops. This fact lends some credence to the theory that the bollworm adult seeks shelter from the wind when selecting oviposition sites. The study area was subjected to strong southerly winds, intermittently, throughout the growing season.

Yield--No significant difference in yield was found due to the grain crops. The yields taken from the south side of the grain crops produced an average of 5.3 pounds more stripper cotton per sampling unit than the average of the yields from the north side of the grain crops (Table XVI). This difference was not significant. There was a significant difference at the 5% level among the rows (Table XVII).

The yield decreased as one moved away from the grain crops and 78% of this decrease could be attributed to linear effects. The drop in yield amounted to 2.27 pounds of stripper cotton per sampling unit (two rows 260 feet long) as one moved away from the grain crops. As may be seen in Table XVI, the major component of the linear effect was the greater yield from the south side of the grain crops.

Conclusions

In view of the fact that the lady beetle and lacewing adult populations increased as a result of the aphid and greenbug populations in the sorghum, one must conclude that sorghum is a very suitable crop for interplanting with cotton. Even though the corn and sorghum sustained a severe infestation of fall armyworms (*Spodoptera frugiperda* (J. E. Smith)), they recovered and produced a crop. The sorghum produced nearly 5000 pounds of grain per acre and the corn produced 30 bushels per acre.

In most cases, the population of any of the recorded species was higher on row 1 than any of the other rows. In general, as the populations became larger, the fluctuation between rows increased. As the populations decreased the fluctuation between rows decreased and tended to level off.

In both cases where linear effects were determined, the populations were at their highest recorded peaks. This is an indication of overpopulation in rows adjacent to the grain crops, and an attempt on the insects part to alleviate the problem by moving from the area.

The predator population and the per cent *Heliothis* damage squares was greatest on the first row north of the grain crops. This is more than likely due to the insects seeking shelter from the strong south winds.

Robinson (1971) concluded that the sorghum plants, stripped with cotton, might protect the cotton from the strong southerly winds. Results of this study indicate just the opposite; with greater yield occurring on the south side of the grain crops. I do not think this yield difference is totally due to the difference in square damage north and south of the grain crops, because after the first row there are no great differences between corresponding rows (Table XV).

CHAPTER IV

EFFECTS ON PREDATOR POPULATIONS, INSECT DAMAGE, FRUITING CHARACTERISTICS, AND YIELD, ASSOCIATED WITH DIFFERENT INTERPLANTING ARRAYS OF COTTON AND SORGHUM

Based on the findings from the 1971 growing season, the 1972 growing season was devoted to determining the optimum number of rows of cotton to plant between four rows of sorghum, based on predator populations, insect damage, and yield. The method of sampling was changed from vacuum sampling to whole plant examination. The reason for the sampling change was two-fold. First, I felt that the whole plant examination would result in a more realistic estimate of the total number of predators in a given area; and secondly, to make the results compatible with other data taken by institutions conducting research under the Cooperative States Research Service.

Materials and Methods

During the 1972 cotton growing season a test was conducted on 20 acres of leased land, southwest of Tipton, Oklahoma. Four different arrays of interplanting were used in the study. They were as follows:

Array 1 - 4 rows of cotton alternated with 4 rows of sorghum
Array 2 - 12 rows of cotton alternated with 4 rows of sorghum

Array 3 - 24 rows of cotton alternated with 4 rows of sorghum
Array 4 - 96 rows of cotton alternated with 4 rows of sorghum

The study area was 1020 feet long and 293 feet wide. The area was divided into twelve plots 85 feet long and 88 rows wide (40 inch row spacing). Each array was replicated 3 times. The 12 replications were randomly assigned (Fig. 9).

The cotton variety used was Tamcot 788 and the sorghum was Pioneer 828. Both were planted May 23, 1972 and were irrigated three times during the growing season. The cotton was planted at a rate of 15 pounds/acre. A stand of approximately 28,488 plants per acre was obtained. No fallow rows or alleys were left unplanted.

Data were collected weekly by whole plant examination. Sampling was begun June 26, 1972 and continued on a weekly basis through August 21, 1972. Forty plants were selected at random from each plot each sampling date. The forty random plants were determined by computer generation. The number of observations taken from each unit in each plot is given in Figure 9.

Predator data were collected on the numbers of lady beetles, lacewing adults, Collops, hooded beetles, and spiders.

Damage was recorded as Heliothis damaged squares, boll weevil damaged squares, and damaged bolls.

Fruiting characteristics recorded were numbers of squares, blooms, and bolls. The first counts of blooms, bolls, boll weevil damaged squares, and damaged bolls were not made until the fourth sampling date.

The cotton was machine harvested and all rows in each plot were summed to one figure. From these figures, yield per acre for each type of planting array was calculated.

The data was statistically analyzed; but due to a large coefficient of variation (C. V.) on all of the analyses of variances, no statements concerning significant levels of differences are included in the results and discussion. The large C. V.'s are due to the substantial number of zeroes recorded in the raw data.

Results and Discussion

Predators--The seasonal trend of all predators combined varied between 30 and 40 thousand individuals per acre the first four samplings (Fig. 10). The number increased the fifth period and during the sixth and seventh periods reached a peak of approximately 60 thousand per acre. The number decreased from this peak to approximately 44 thousand per acre in the last two sampling periods.

The increase in total numbers of predators can be attributed to a distinct rise in the number of *Collops* in late July and early August (Fig. 11). This increase in the number of *Collops* was probably due to a 40 acre field of alfalfa, adjacent to and west of the study area, being cut during the last week in July. One other contributing factor to the increase in total predator numbers was that the peak in the spider population occurred during this same interval of the growing season (Fig. 11).

Figure 11 depicts the individual average numbers per acre of lady beetles, *Collops*, and spiders for each sampling period. The number of lady beetles remained relatively constant during the sampling periods; varying between 7 and 12 thousand per acre. There was not much difference in the average numbers per acre of lady beetles present in three of the four arrays; but array-type "24" was clearly not as suitable a habitat as the other three arrays (Table XVIII).

The numbers of spiders steadily increased up through sampling period 7 and then leveled off. The numbers of spiders during this time increased from 13 thousand per acre to 23 thousand per acre. The average numbers per acre of spiders in each array are given in Table XIX. Array-type "12" had the highest average number per acre; but there were no overwhelming differences between it and array-types "4" and "24".

The number of Collops was lowest on sampling period 2; and from this point began a gradual increase. The population reached a peak of approximately 21 thousand per acre on sampling period 6. The sharp increase, of approximately 10 thousand per acre, from the fifth to sixth sampling period was due to an influx of Collops from an adjacent alfalfa field which was cut during the week of July 24. The population declined very sharply two weeks after reaching its peak. This decline was possibly due to the Collops returning to the new growth on the alfalfa field. The average numbers per acre of Collops are given in Table XX. Array-type "24" was the only array which was clearly different from the other three arrays. The sharp decline in array-type "24" was probably due to the fact that none of the type "24" replications occurred on the west half of the study area; this being the area the Collops came to after leaving the cut alfalfa.

Figure 12 depicts the individual average numbers per acre of lacewing adults and hooded beetles for each sampling period. The number of hooded beetles was highest the first sampling period with approximately 14 thousand per acre present. The number decreased from this high during the remaining eight sampling periods. The numbers varied from period to period with no set pattern. The average numbers per acre of hooded beetles in each array-type are shown in Table XXI. The largest number of hooded beetles occurred in array-type "96", averaging about 8 thousand per acre each period. Array-type "12" was only slightly less.

The numbers of lacewing adults remained low during the first five sampling periods; never exceeding 1 thousand per acre. The number of lacewing adults increased greatly from period 5, to a peak of 7 thousand per acre on period 8. A decrease to 2 thousand per acre was noted on period 9. The average numbers per acre of lacewing adults in each array-type are given in Table XXII. The adult lacewing population was the lowest of all the populations observed, never exceeding 2.6 thousand per acre, averaged over the nine sampling periods. This 2.6 thousand per acre average occurred in array-type "12". In looking at the four array-type averages, it seems that there is a definite preference by the lacewing adults for a habitat which includes sorghum.

The average numbers per acre of predators in each array-type are given in Figure 13. No great differences occurred among the different array-types. Array-type "96" exhibited the greatest number of predators on sampling period 6. This peak can be attributed to the aforementioned increase in the _Collops_ population, because two replicates of the array-type "96" occurred near the west end of the study area (Fig. 9).

Damage--The numbers per acre of _Heliothis_ damaged squares, boll weevil damaged squares, and damaged bolls are given in Figure 14. The _Heliothis_ damaged squares reached a maximum of approximately 3.6

thousand per acre the fourth sampling period. This was one week prior to the peak square production (Fig. 15). The numbers of Heliothis damaged squares declined from this high the remainder of the season, except for one small increase on sampling period 7.

The numbers of boll weevil damaged squares was less than 5 hundred per acre on the fourth sampling period; but increased sharply from this low to reach a high of 5.4 thousand per acre on period 9. From further observations made after sampling ended, the numbers of boll weevil damaged squares continued to increase for several weeks.

The numbers of damaged bolls per acre increased greatly from period 4 to period 5. The numbers then tended to stabilize, varying around 2 thousand per acre for the remainder of the sampling periods.

Table XXIII gives the per cent Heliothis and boll weevil damaged squares on each sampling date. Heliothis damaged squares reached a high of 1.65% on period 4. The per cent boll weevil damaged squares increased each sampling period and reached a high of 6.07% on period 9.

Array-types "12" and "96" averaged 1.24 thousand Heliothis damaged squares per acre each sampling period. This number was clearly less than the numbers found on the other two array-types (Table XXIV).

The average numbers of boll weevil damaged squares per acre for each array-type are given in Table XXV. An average of 2.88 thousand boll weevil damaged squares per acre were found on each sampling period in array-type "12". This was the largest average number of any of the array-types.

There seemed to be a pattern in the average numbers of damaged bolls per acre (Table XXVI). As the ratio of cotton to sorghum decreased there was a corresponding increase in damaged bolls. Array-type "96" had an average of 0.71 thousand damaged bolls per acre on each sampling period. Array-type "4" was highest with an average of 2.37 thousand damaged bolls per acre on each sampling period.

Plant Fruiting--The fruiting characteristics are presented in Figure 15. The fruiting cycle of the Tamcot 788 cotton, planted on May 23, 1972, reached peak squaring about July 24, 1972, with approximately 241 thousand squares per acre. The bloom counts were never indicative of the total boll-set. The number of blooms recorded never exceeded 20 thousand per acre during the sampling periods. Counts of bolls increased from a low of 11 thousand per acre on period 4 to a high of 216 thousand per acre on period 9. Boll counts more than likely continued to increase after August 21, 1972, which was the last sampling period. A corresponding increase in the number of bolls lagged three weeks behind the increase in number of squares.

The average numbers per acre of squares and bolls by array-type and period are given in Table XXVII and Table XXVIII, respectively. Array-type "12" produced the greatest number of squares and bolls. Array-type "4" produced considerably more squares in the early part of the season and less in the latter part than did the other array-types. This was due to the cotton in array-type "4" being subjected to more stress than the other array-types. Young cotton, when subjected to stress conditions, will restrict its vegetative growth and begin forming fruits at an earlier age than is normal. Further discussion concerning this stress will be associated with the discussion on yield.

Yield--Array-type "12" was the highest yielding array-type, producing 2619 pounds of stripper cotton per acre. This was approximately 500 pounds greater than the yield from array-type "24", which was the second highest producing array-type (Table XXIX). I believe this difference was mainly due to the location of the array-type "12" plots (Fig. 9). Two of the three plots (array-type "12") were on the east end of the study area, which was adjacent to the source of water for irrigation. The third plot was on the west end of the study area where the irrigation tail-water accumulated. Due to the low volume of the irrigation well it was necessary to run water down the rows an excessive amount of time, which resulted in plots 1, 2, and 12 receiving a better soaking than the other plots.

Array-type "4" produced the smallest amount of cotton. In looking at the number of bolls (Table XXVIII), one would have thought that array-type "4" would have been the second highest yielding array-type. I believe this inconsistancy was due to the aforementioned stress conditions prevalent in the array-type "4" plots. All of the array-type "4" plots exhibited the condition of "wilting down" during the day, while the other array-types showed no signs of stress. This condition was more than likely due to heat reflected by the sorghum or trapped between the sorghum, which was taller than the cotton. The sorghum may also have been sapping the moisture from the root area of the adjacent cotton rows.

Conclusions

In trying to determine the best interplanting array, it was found that a decision could not be made on the basis of predator numbers, damage, or yield, alone; but must be based on all three areas of the study.

Not one of the interplanting arrays exhibited a superior attractiveness to all of the predator species on a given sampling period. Some predator species found one array to be a more suitable habitat, while other species preferred another. In looking at the total numbers of predators in each array-type over all sampling periods, array-type "12" was found to contain slightly more predators than the other array-types.

Array-types "12" and "96" sustained the lowest numbers of *Heliothis* damaged squares. This could be due to the numbers of predators present, undesirable oviposition sites for the *Heliothis* adult, or environmental conditions.

The yield from array-type "12" was 495 pounds greater than the production from array-type "24", which was the second highest. This 495 pounds difference is somewhat suspect in light of the watering situation, which developed; but I would not contribute the total difference to this problem.

Therefore, from the above mentioned facts, I conclude array-type "12" to be the best interplanting array and with proper management produce approximately 1.5 bales of lint cotton per acre in the Tipton, Oklahoma area.

CHAPTER V

SUMMARY

In most cases the population of any of the recorded predators was higher on row 1 than any of the other rows. In both cases where linear effects were determined, the populations were at their highest levels. This is an indication of overpopulation in rows adjacent to the grain crops, and an attempt on the insects part to alleviate the problem by moving from the area.

Differences in both Heliothis damaged squares and yield were found to be related to linear effects. Heliothis damaged squares decreased 0.44% per sampling unit and yield decreased 2.27 pounds per sampling unit as one moved away from the grain crops.

Not one of the interplanting arrays exhibited a superior attractiveness to all of the predator species on a given sampling period. Some species found one array-type to be a more suitable habitat, while other species preferred another. The total numbers of predators in array-type "12", over all sampling periods, were slightly superior to the other array-types.

Array-types "12" and "96" sustained the lowest numbers of Heliothis damaged squares. Heliothis damage was at a low level in both 1971 and 1972. The high per cent damage for 1971 and 1972 was 4.5% and 1.65%, respectively.

Yield of stripper cotton from array-type "12" was nearly 500 pounds greater than the second highest array-type. Inclusive of all results, it appeared array-type "12" was the best interplanting array.

Array-type "4" is definitely not recommended as an interplanting array. This recommendation is based on the results of the study and also the stress conditions prevalent in this type planting array.

Other factors being equal, a most important aspect of interplanting, as a means of biological control, is the planting dates of the cotton and sorghum and also the varieties planted. The beginning of the decline in the greenbug, aphid, and fall armyworm populations should coincide with the early squaring of the cotton. Such a situation will result in the maximum number of predators leaving the sorghum and entering the cotton in search of food.

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APPENDIXES

TABLE I

ANALYSIS OF VARIANCES FOR TOTAL PREDATORS COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	332.5
Error A	10	123.0
Dir.[a]	1	99.2
Crop x Dir.	1	123.5
Error B	10	398.5
Row	5	139.9*
Crop x Row	5	27.4
Dir. x Row	5	36.1
Crop x Dir. x Row	5	35.1
Error C	100	49.1
Date	2	2755.1**
Crop x Date	2	109.4
Error D	20	399.3
Dir. x Date	2	205.8
Crop x Dir. x Date	2	81.2
Error E	20	140.3

TABLE I (Continued)

Source	df	Mean Squares
Row x Date	10	225.9**
Crop x Row x Date	10	71.1
Dir. x Row x Date	10	73.6
Crop x Dir. x Row x Date	10	33.5
Error F	200	43.0

[a]Direction

*Significant at the 0.05 level.

**Significant at the 0.01 level.

TABLE II

AVERAGE NUMBERS OF PREDATORS COLLECTED FROM 130 FEET OF COTTON ROW BY DATE AND ROW, TIPTON, OKLAHOMA, 1971

Row	Date			
	7-28	8-2	8-23	Mean
1	*16.8	16.2	17.7	16.9
5	18.7	11.7	9.3	13.2
9	21.3	16.9	7.9	15.3
13	17.5	14.8	8.1	13.4
17	17.3	17.4	6.7	13.8
21	17.2	18.3	8.3	14.6
Mean	18.1	15.9	9.7	

*Each figure is an average of 24 observations.

TABLE III

ANALYSIS OF VARIANCES FOR LADY BEETLES COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	57.8
Error A	10	25.3
Dir.[a]	1	156.5**
Crop x Dir.	1	28.0
Error B	10	22.3
Row	5	37.0**
Crop x Row	5	32.1**
Dir. x Row	5	16.8*
Crop x Dir. x Row	5	7.4
Error C	100	7.1
Date	2	70.9*
Crop x Date	2	105.6*
Error D	20	20.2
Dir. x Date	2	45.8
Crop x Dir. x Date	2	39.3
Error E	20	33.0

TABLE III (Continued)

Source	df	Mean Squares
Row x Date	10	35.5**
Crop x Row x Date	10	26.7**
Dir. x Row x Date	10	4.0
Crop x Dir. x Row x Date	10	6.1
Error F	200	7.4

[a]Direction

*Significant at the 0.05 level.

**Significant at the 0.01 level.

TABLE IV

ANALYSIS OF VARIANCES FOR LACEWING ADULTS COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	1.3
Error A	10	7.5
Dir.[a]	1	0.5
Crop x Dir.	1	0.2
Error B	10	0.7
Row	5	15.9**
Crop x Row	5	0.7
Dir. x Row	5	1.0
Crop x Dir. x Row	5	1.1
Error C	100	1.7
Date	2	76.4**
Crop x Date	2	0.6
Error D	20	2.3
Dir. x Date	2	8.4
Crop x Dir. x Date	2	16.6
Error E	20	5.7

TABLE IV (Continued)

Source	df	Mean Squares
Row x Date	10	7.9**
Crop x Row x Date	10	1.1
Dir. x Row x Date	10	0.6
Crop x Dir. x Row x Date	10	4.2
Error F	200	1.7

[a]Direction
**Significant at the 0.01 level.

TABLE V

AVERAGE NUMBERS OF PREDATORS COLLECTED FROM 130 FEET OF COTTON ROW IN EACH TREATMENT, TIPTON, OKLAHOMA, 1971

Predators	Treatment	
	Corn	Sorghum
Lady beetles	*2.7	3.5
Lacewing adults	0.9	1.0
Nabids	0.7	0.8
Hooded beetles	3.7	4.8
Spiders	4.5	4.3

*Each figure is an average of 216 observations.

TABLE VI

AVERAGE NUMBERS OF PREDATORS COLLECTED FROM 130 FEET OF COTTON ROW NORTH OR SOUTH OF THE GRAIN CROPS, TIPTON, OKLAHOMA, 1971

Predators	Direction	
	North	South
Lady beetles	*3.7	2.5
Lacewing adults	1.0	0.9
Nabids	0.8	0.7
Hooded beetles	3.4	5.1
Spiders	4.1	4.7

*Each figure is an average of 216 observations.

TABLE VII

ANALYSIS OF VARIANCES FOR NABIDS COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	2.2
Error A	10	4.1
Dir.[a]	1	0.1
Crop x Dir.	1	0.8
Error B	10	1.3
Row	5	0.8
Crop x Row	5	0.8
Dir. x Row	5	0.8
Crop x Dir. x Row	5	1.1
Error C	100	1.0
Date	2	34.1**
Crop x Date	2	1.0
Error D	20	2.8
Dir. x Date	2	0.9
Crop x Dir. x Date	2	0.1
Error E	20	0.6

TABLE VII (Continued)

Source	df	Mean Squares
Row x Date	10	1.2
Crop x Row x Date	10	1.0
Dir. x Row x Date	10	1.2
Crop x Dir. x Row x Date	10	0.6
Error F	200	0.9

[a]Direction
**Significant at the 0.01 level.

TABLE VIII

ANALYSIS OF VARIANCES FOR HOODED BEETLES COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	120.3
Error A	10	87.3
Dir.[a]	1	320.3
Crop x Dir.	1	7.8
Error B	10	131.6
Row	5	62.8**
Crop x Row	5	2.6
Dir. x Row	5	12.0
Crop x Dir. x Row	5	8.8
Error C	100	15.7
Date	2	1718.9**
Crop x Date	2	57.5
Error D	20	206.9
Dir. x Date	2	60.7
Crop x Dir. x Date	2	14.1
Error E	20	129.1

TABLE VIII (Continued)

Source	df	Mean Squares
Row x Date	10	52.4**
Crop x Row x Date	10	10.4
Dir. x Row x Date	10	37.3
Crop x Dir. x Row x Date	10	9.9
Error F	200	13.4

[a]Direction
**Significant at the 0.01 level.

TABLE IX

ANALYSIS OF VARIANCES FOR SPIDERS COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	3.0
Error A	10	23.4
Dir.[a]	1	24.1
Crop x Dir.	1	48.0
Error B	10	47.6
Row	5	33.8**
Crop x Row	5	2.6
Dir. x Row	5	3.2
Crop x Dir. x Row	5	2.2
Error C	100	7.6
Date	2	651.6**
Crop x Date	2	14.5
Error D	20	30.9
Dir. x Date	2	3.0
Crop x Dir. x Date	2	6.0
Error E	20	12.0

TABLE IX (Continued)

Source	df	Mean Squares
Row x Date	10	11.3
Crop x Row x Date	10	12.5
Dir. x Row x Date	10	16.7*
Crop x Dir. x Row x Date	10	4.1
Error F	200	8.3

[a]Direction

*Significant at the 0.05 level.

**Significant at the 0.01 level.

TABLE X

ANALYSIS OF VARIANCES FOR FLEAHOPPERS COLLECTED FROM COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	431	
Crop	1	17.5
Error A	10	11.7
Dir.[a]	1	0.3
Crop x Dir.	1	16.7
Error B	10	22.9
Row	5	38.1**
Crop x Row	5	6.9
Dir. x Row	5	3.6
Crop x Dir. x Row	5	1.6
Error C	100	5.1
Date	2	421.6**
Crop x Date	2	25.9
Error D	20	17.3
Dir. x Date	2	13.0
Crop x Dir. x Date	2	3.5
Error E	20	4.6

TABLE X (Continued)

Source	df	Mean Squares
Row x Date	10	5.1
Crop x Row x Date	10	2.5
Dir. x Row x Date	10	2.8
Crop x Dir. x Row x Date	10	1.9
Error F	200	6.1

[a]Direction

**Significant at the 0.01 level

TABLE XI

AVERAGE NUMBERS OF FLEAHOPPERS COLLECTED FROM 130 FEET OF COTTON ROW BY DATE AND ROW, TIPTON, OKLAHOMA, 1971

Row	Date			
	7-28	8-2	8-23	Mean
1	*1.3	2.0	3.5	2.3
5	1.2	2.2	4.9	2.7
9	2.2	3.5	5.5	3.7
13	2.0	2.8	5.8	3.5
17	2.6	4.5	5.6	4.2
21	1.9	3.2	6.0	3.7
Mean	1.9	3.0	5.2	

*Each figure is an average of 24 observations.

TABLE XII

ANALYSIS OF VARIANCES FOR *HELIOTHIS* DAMAGED SQUARES ON COTTON, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected)	719	
Crop	1	9.8
Error A	10	4.8
Dir.[a]	1	26.5**
Crop x Dir.	1	0.8
Error B	10	2.1
Row	5	7.9**
Crop x Row	5	1.4
Dir. x Row	5	5.9**
Crop x Dir. x Row	5	2.7
Error C	100	2.1
Date	2	52.0**
Crop x Date	2	3.2
Error D	20	2.3
Dir. x Date	2	2.1
Crop x Dir. x Date	2	1.7
Error E	20	2.8

TABLE XII (Continued)

Source	df	Mean Squares
Row x Date	10	5.7**
Crop x Row x Date	10	3.8*
Dir. x Row x Date	10	2.6
Crop x Dir. x Row x Date	10	2.0
Error F	400	2.1

[a]Direction

*Significant at the 0.05 level.

**Significant at the 0.01 level.

TABLE XIII

AVERAGE PER CENT *HELIOTHIS* DAMAGED SQUARES ON COTTON BY ROW AND DATE, TIPTON, OKLAHOMA, 1971

Row	Date 8-7	8-19	8-25	8-31	9-10	Mean
1	*2.3	3.9	7.7	5.2	3.4	4.5[a]
5	2.1	2.6	3.9	4.1	3.6	3.2[b]
9	2.9	2.0	3.5	4.5	4.4	3.5[b]
13	1.6	2.5	5.3	4.7	3.4	3.5[b]
17	2.2	1.4	4.8	3.4	3.9	3.1[b]
21	2.1	1.3	2.6	5.7	4.3	3.2[b]
Mean	2.2[b]	2.3[b]	4.6[a]	4.6[a]	3.8[c]	

*Each figure is an average of 24 observations.

[a]Date means not significantly different at the 1% level followed by the same letter.

[b]Row means not significantly different at the 1% level followed by the same letter.

TABLE XIV

AVERAGE PER CENT *HELIOTHIS* DAMAGED SQUARES ON COTTON BY DATE AND DIRECTION, TIPTON, OKLAHOMA, 1971

Direction	Date					
	8-7	8-19	8-25	8-31	9-10	Mean
South	*2.2	1.6	4.1	4.1	3.6	3.1[a]
North	2.2	2.9	5.1	5.0	4.0	3.8[b]

*Each figure is an average of 60 observations.

[a]Direction means not significantly different at the 1% level followed by the same letter.

TABLE XV

AVERAGE PER CENT *HELIOTHIS* DAMAGED SQUARES ON COTTON BY ROW AND DIRECTION, TIPTON, OKLAHOMA, 1971

Row	Direction	
	North	South
1	*5.6	3.4
5	3.8	2.7
9	3.5	3.5
13	3.9	3.1
17	3.4	2.9
21	3.1	3.2

*Each figure is an average of 60 observations.

TABLE XVI

AVERAGE NUMBERS OF POUNDS OF STRIPPER COTTON HARVESTED FROM TWO ROWS 260 FEET LONG BY DIRECTION AND ROW, TIPTON, OKLAHOMA, 1971

Rows	Direction		
	North	South	Mean
1 and 2	*47.9	56.8	52.3
5 and 6	49.6	55.1	52.3
9 and 10	45.0	54.6	49.8
13 and 14	48.3	54.0	51.1
17 and 18	47.3	49.6	48.5
21 and 22	44.3	44.5	44.4
Mean	47.1	52.4	

*Each figure is an average of 12 observations.

TABLE XVII

ANALYSIS OF VARIANCES FOR POUNDS OF STRIPPER COTTON HARVESTED, TIPTON, OKLAHOMA, 1971

Source	df	Mean Squares
Total (Corrected	143	
Crop	1	91.8
Error	10	781.0
Dir.[a]	1	1040.1
Crop x Dir.	1	35.0
Error B	10	623.8
Row	5	222.0*
Crop x Row	5	8.0
Dir. x Row	5	79.0
Crop x Dir. x Row	5	36.6
Error C	100	77.3

[a]Direction

*Significant at the 0.05 level.

TABLE XVIII

AVERAGE NUMBERS IN THOUSANDS OF LADY BEETLES PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Array Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	**14.02	16.86	8.83	6.89	14.24	8.55	5.93	3.79	9.26	10.15
12	12.11	12.34	8.55	12.59	10.68	8.32	7.83	7.12	11.62	10.12
24	9.97	8.55	4.76	9.03	7.12	5.21	9.49	6.18	4.50	7.20
96	5.47	13.76	10.20	4.99	9.26	11.40	9.97	9.74	7.83	9.18

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XIX

AVERAGE NUMBERS IN THOUSANDS OF SPIDERS PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

	Period									
Type	1	2	3	4	5	6	7	8	9	Mean
*4	** 5.93	13.76	17.72	20.65	15.18	17.81	23.28	20.65	17.32	16.92
12	11.88	15.18	12.60	15.67	21.85	19.94	21.85	22.31	28.97	18.91
24	8.55	9.74	12.11	15.90	18.29	21.59	29.20	19.71	19.94	17.22
96	5.70	6.18	10.46	14.24	16.61	23.73	17.58	19.71	19.00	14.80

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XX

AVERAGE NUMBERS IN THOUSANDS OF COLLOPS PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	** 6.89	1.88	2.17	7.12	17.32	27.55	22.08	3.08	8.06	10.68
12	4.50	0.94	3.56	10.20	14.24	21.59	20.17	1.65	8.06	9.43
24	1.42	0.46	3.56	5.93	7.83	9.97	13.30	2.36	5.21	5.56
96	3.56	0.94	3.79	5.19	10.20	27.78	21.14	4.05	6.89	9.28

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXI

AVERAGE NUMBERS IN THOUSANDS OF HOODED BEETLES PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	**16.15	7.35	5.27	6.64	5.21	7.61	1.42	3.56	4.27	6.38
12	19.71	8.55	9.26	5.93	3.56	4.50	5.47	6.64	4.99	7.62
24	8.55	4.76	8.77	4.27	4.76	6.64	6.64	5.21	8.55	6.46
96	11.40	8.77	9.03	4.50	7.83	9.03	7.12	8.77	4.99	7.93

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXII

AVERAGE NUMBERS IN THOUSANDS OF LACEWING ADULTS PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	** 0.23	0.23	0.71	1.20	0.00	1.20	5.93	6.18	1.42	1.90
12	0.00	0.00	0.02	0.71	0.71	1.91	5.21	11.17	3.33	2.56
24	0.23	0.46	0.02	0.02	0.23	0.48	0.94	8.32	1.42	1.34
96	0.23	0.00	0.46	0.71	0.00	1.20	1.65	1.91	2.37	0.94

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXIII

PER CENT *HELIOTHIS* AND BOLL WEEVIL DAMAGED SQUARES ON COTTON BY PERIOD, TIPTON, OKLAHOMA, 1972

Period	% Bollworm Damaged Squares	% Boll Weevil Damaged Squares
1 (June 26)	.40	-
2	.38	-
3	1.50	-
4	1.65	.16
5 (July 24)	1.11	.39
6	.91	.61
7	1.31	1.00
8	.68	2.04
9 (Aug. 21)	1.12	6.07

TABLE XXIV

AVERAGE NUMBERS IN THOUSANDS OF HELIOTHIS DAMAGED SQUARES PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Type	Period 1	2	3	4	5	6	7	8	9	Mean
*4	** 0.24	0.48	4.75	6.17	2.85	2.37	0.24	0.48	0.95	2.05
12	0.00	0.00	2.37	2.14	0.95	1.42	1.90	1.19	1.19	1.24
24	0.00	0.48	1.90	3.09	3.80	1.90	3.80	1.19	0.95	1.90
96	0.00	0.24	1.42	3.09	3.09	0.95	0.95	0.48	0.95	1.24

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXV

AVERAGE NUMBERS IN THOUSANDS OF BOLL WEEVIL DAMAGED SQUARES PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972[a]

Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	-	-	-	** 0.24	1.42	0.24	0.95	1.90	4.56	1.55
12	-	-	-	0.24	0.71	0.95	0.71	4.27	10.45	2.88
24	-	-	-	0.24	0.00	1.90	1.90	3.09	5.22	2.05
96	-	-	-	0.71	1.66	1.42	1.66	0.71	2.37	1.42

[a]No data recorded on boll weevil damaged squares until the fourth sampling period.

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXVI

AVERAGE NUMBERS IN THOUSANDS OF DAMAGED BOLLS PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972[a]

Type	Period									
	1	2	3	4	5	6	7	8	9	Mean
*4	-	-	-	** 0.00	2.85	2.37	3.80	2.61	2.61	2.37
12	-	-	-	0.48	2.14	1.90	0.95	0.95	3.32	1.62
24	-	-	-	0.00	1.66	0.71	1.66	1.19	1.90	1.18
96	-	-	-	0.00	0.71	1.42	0.48	0.48	1.19	0.71

[a]No data recorded on damaged bolls until the fourth sampling period.

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXVII

AVERAGE NUMBERS IN THOUSANDS OF SQUARES PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972

Type	Period								
	1	2	3	4	5	6	7	8	9
*4	**19.00	85.24	195.37	261.85	249.51	164.28	80.72	61.73	55.08
12	11.89	77.40	174.00	212.47	274.91	215.08	176.14	154.07	132.95
24	14.96	63.39	173.06	212.00	214.14	159.53	129.38	150.75	97.10
96	9.97	70.51	155.26	188.73	225.53	187.78	135.08	119.17	71.70

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXVIII

AVERAGE NUMBERS IN THOUSANDS OF BOLLS PER ACRE ON COTTON BY TYPE AND PERIOD, TIPTON, OKLAHOMA, 1972[a]

Type	1	2	3	4	5	6	7	8	9
*4	-	-	-	** 20.42	70.03	152.41	193.24	193.24	197.76
12	-	-	-	9.97	66.46	136.50	194.19	231.70	254.02
24	-	-	-	13.77	62.20	111.34	190.63	192.06	201.79
96	-	-	-	8.07	50.33	153.12	168.56	194.19	211.05

[a]No data recorded on bolls until the fourth sampling period.

*Number of rows of cotton between 4 rows of sorghum.

**Each figure is an average of 120 observations.

TABLE XXIX

POUNDS OF STRIPPER COTTON HARVESTED PER PLOT AND CALCULATIONS TO CONVERT THE YIELD TO POUNDS PER ACRE, TIPTON, OKLAHOMA, 1972

Array Type	Plot	Lbs	Total Lbs/Type		Acreage In Each Type		Yield Lbs/Acre
	5	552					
4	8	436	1390	÷	.78	=	1781
	9	402					
	1	1009					
12	2	951	3066	÷	1.17	=	2619
	12	1106					
	3	1040					
24	4	978	2984	÷	1.41	=	2124
	6	966					
	7	986					
96	10	1002	3104	÷	1.56	=	1988
	11	1116					

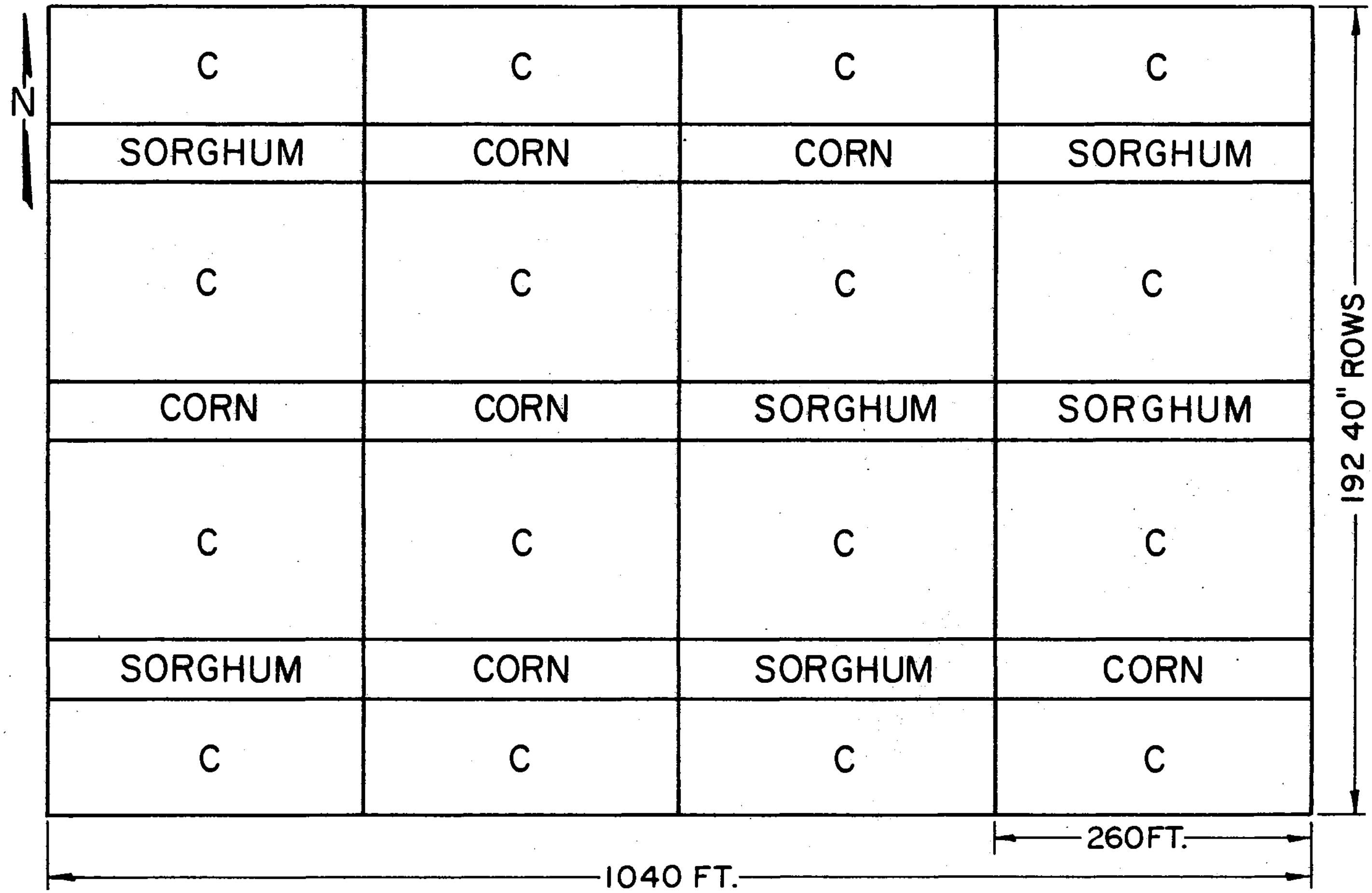

Figure 1. Field Plot Diagram, Tipton, Oklahoma, 1971

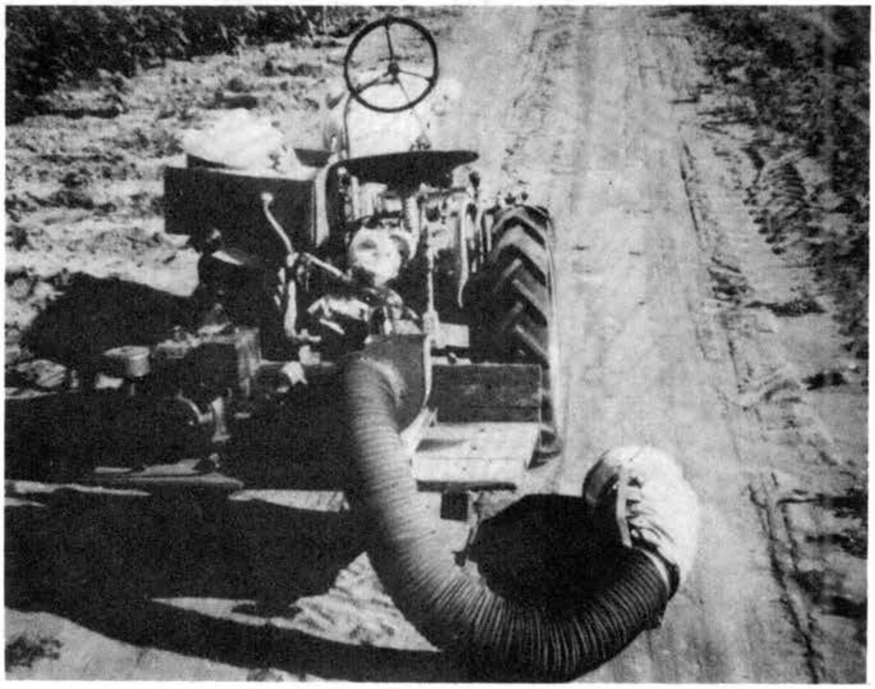

Figure 2. Modified D-VAC Sampling Unit, Tipton, Oklahoma, 1971

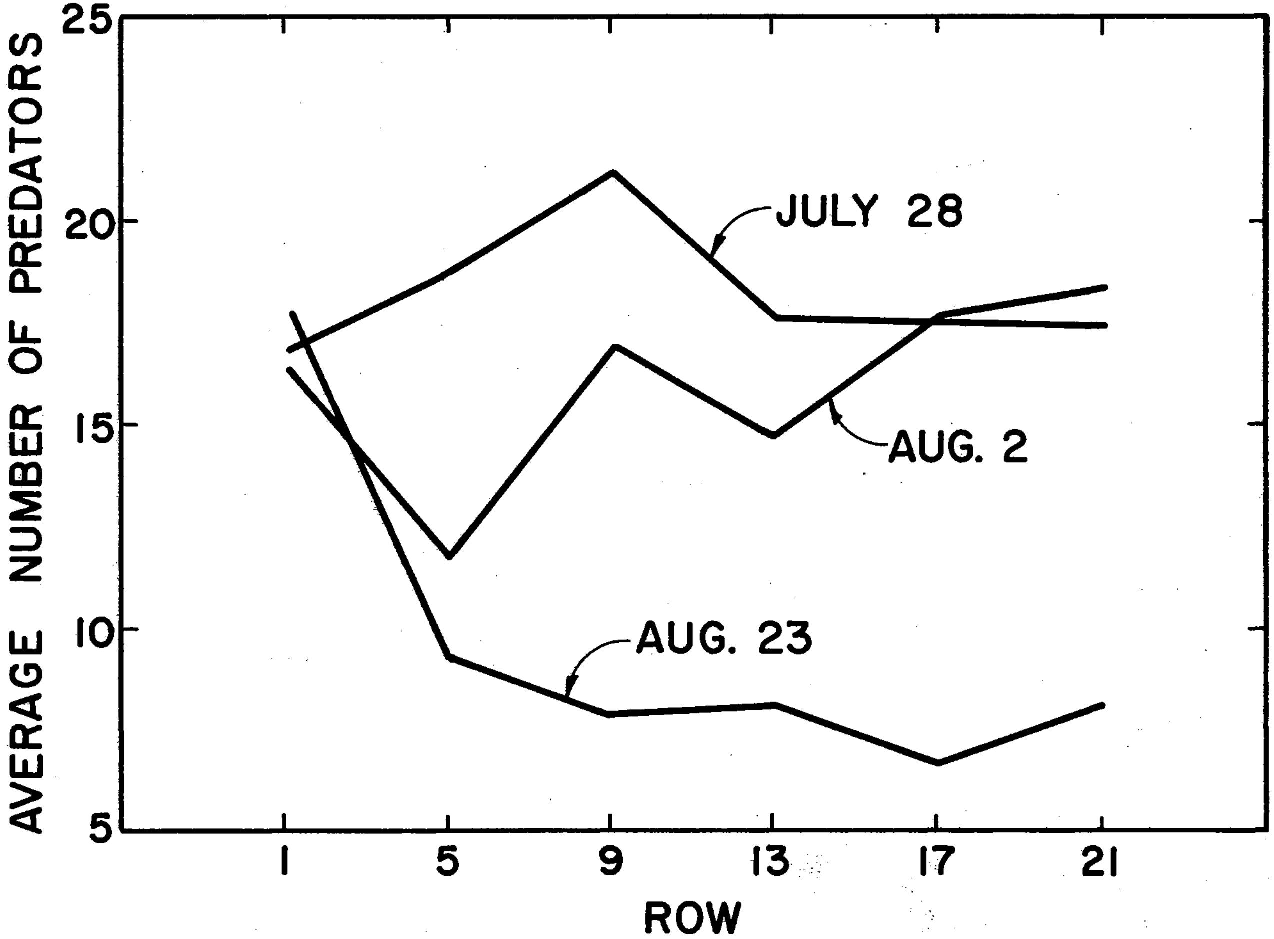

Figure 3. Average Numbers of Predators Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

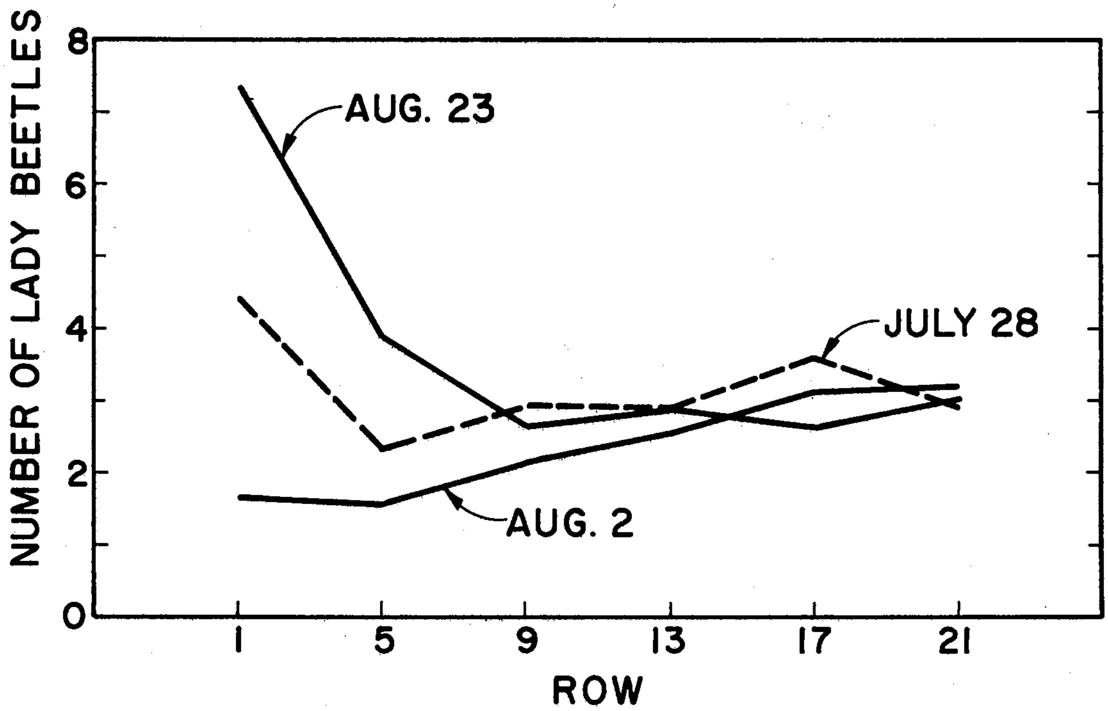

Figure 4. Average Numbers of Lady Beetles Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

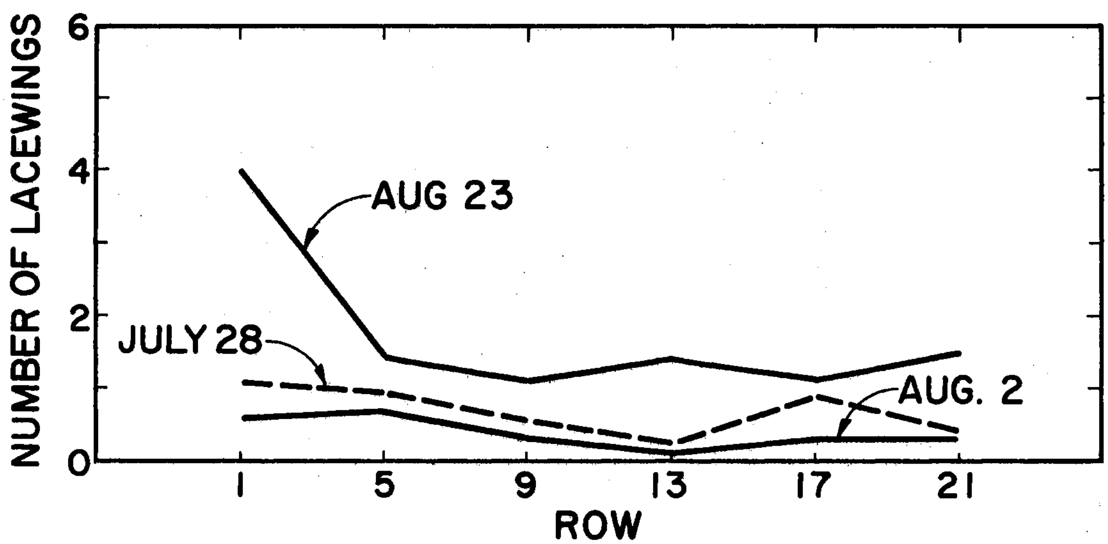

Figure 5. Average Numbers of Lacewing Adults Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

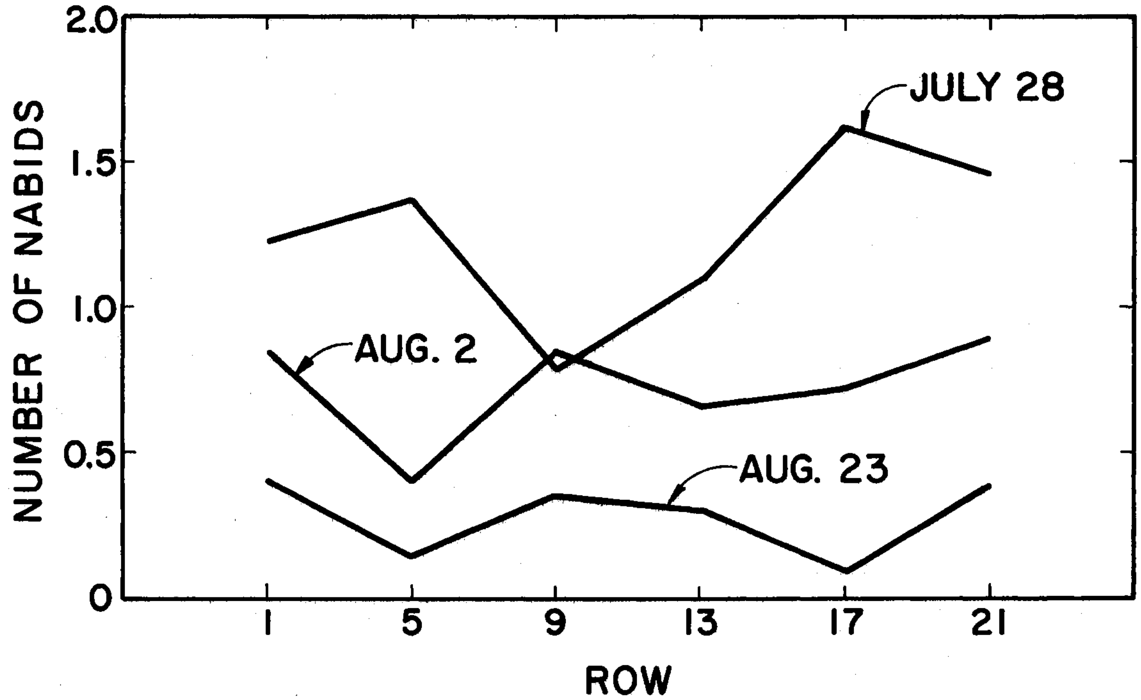

Figure 6. Average Numbers of Nabids Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

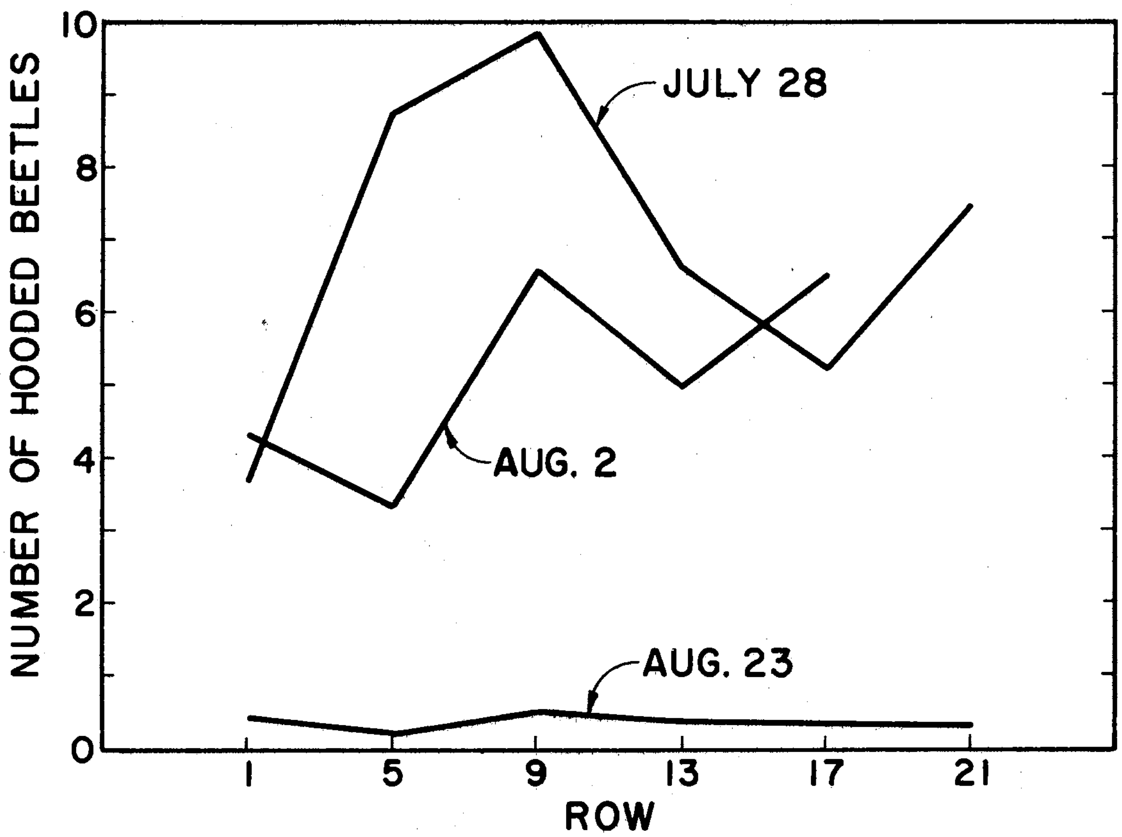

Figure 7. Average Numbers of Hooded Beetles Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

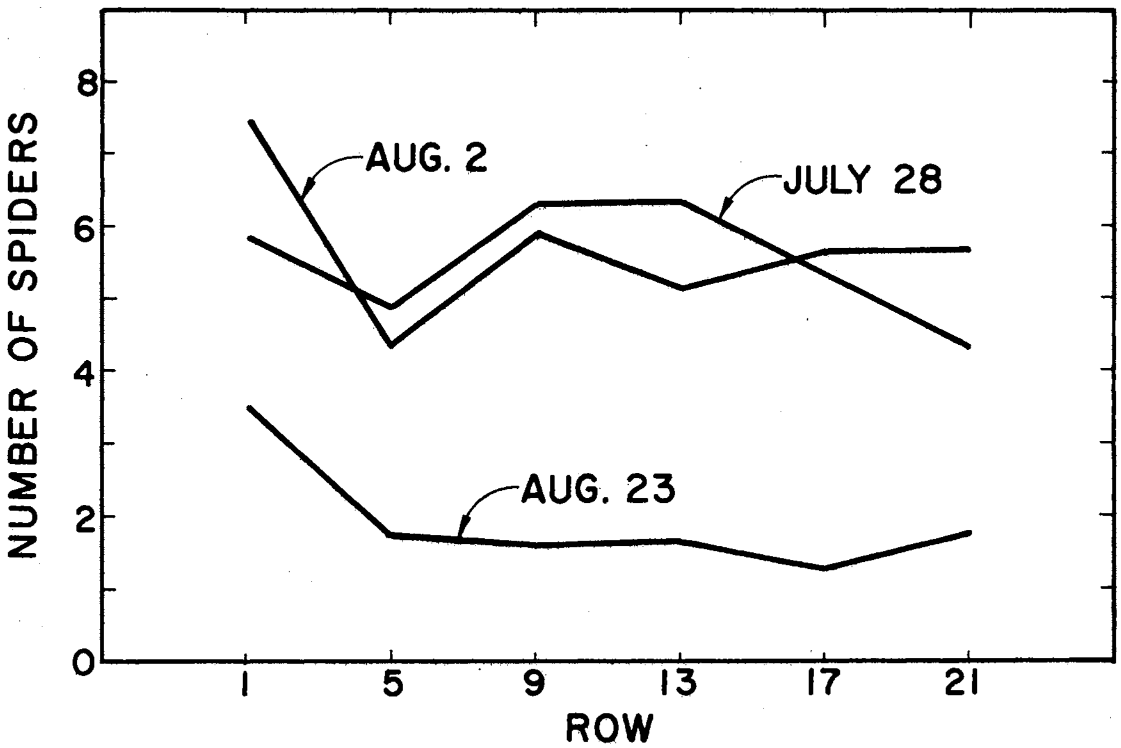

Figure 8. Average Numbers of Spiders Collected from 130 Feet of Each Sampled Cotton Row on Three Sampling Dates, Tipton, Oklahoma, 1971.[a]

[a]Each Point is Based on 24 Observations.

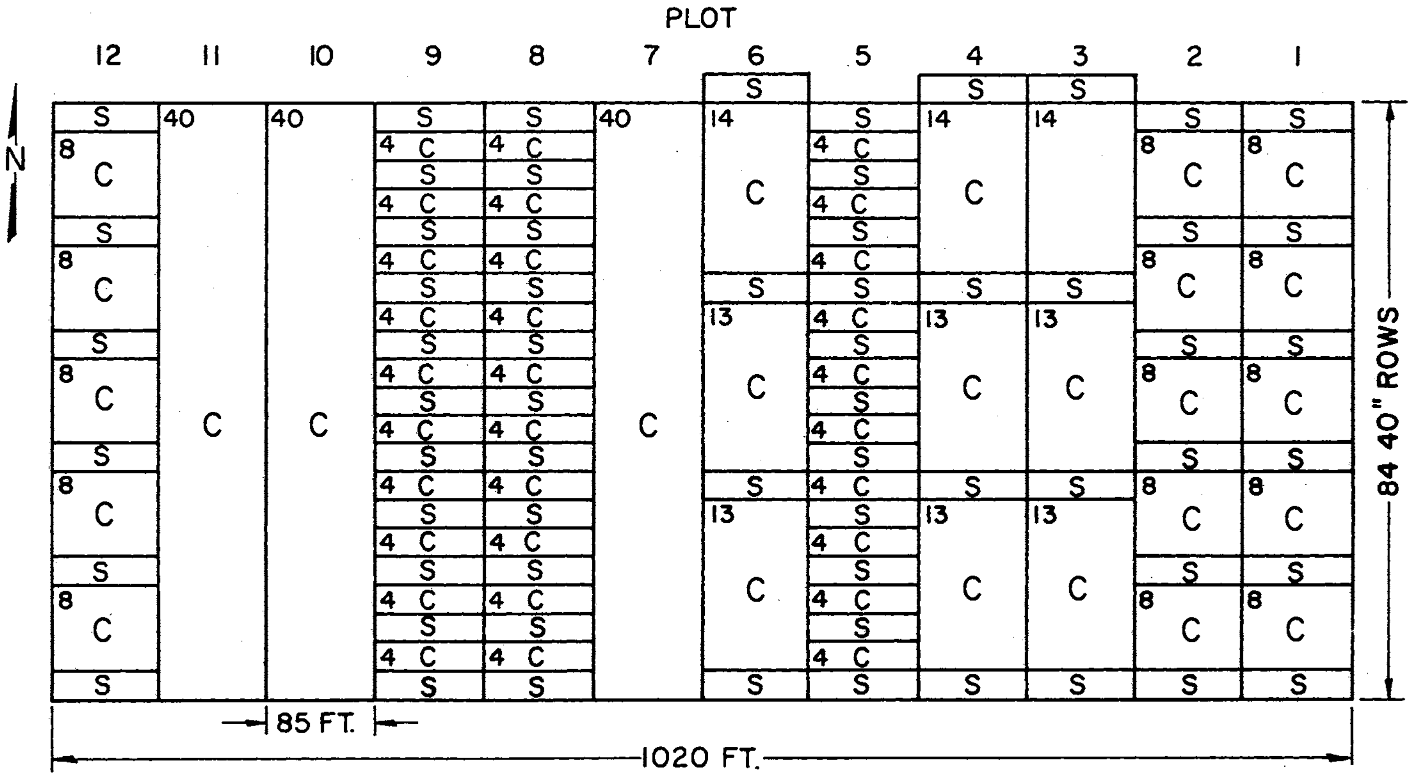

Figure 9. Field Plot Diagram, Tipton, Oklahoma, 1972.

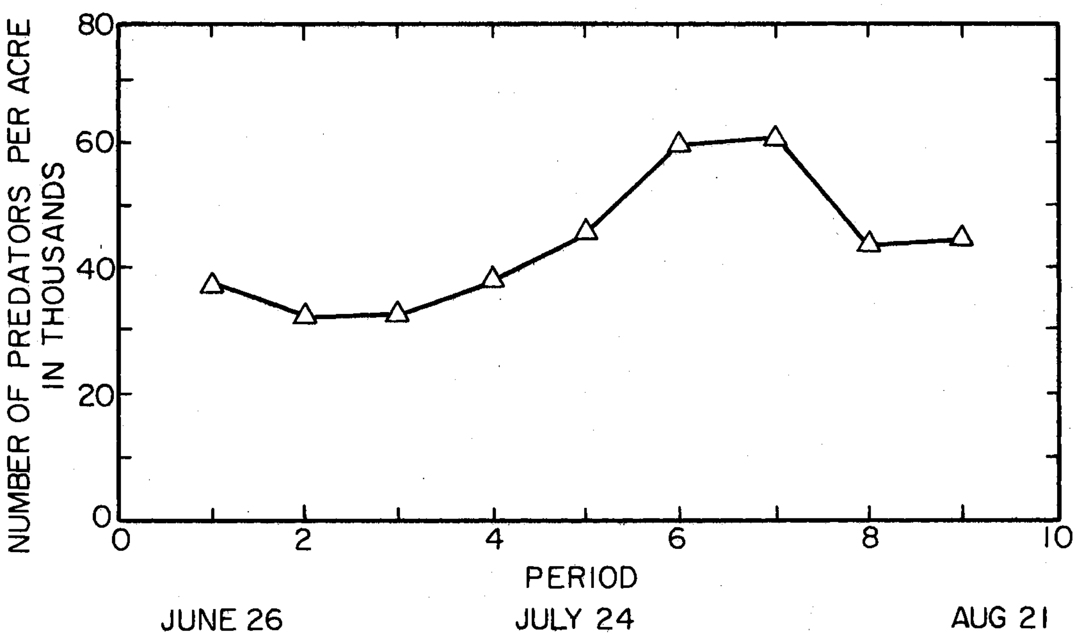

Figure 10. Total Numbers in Thousands of Predators Per Acre on Cotton on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[a]

[a]Each Point is Based on 480 Observations.

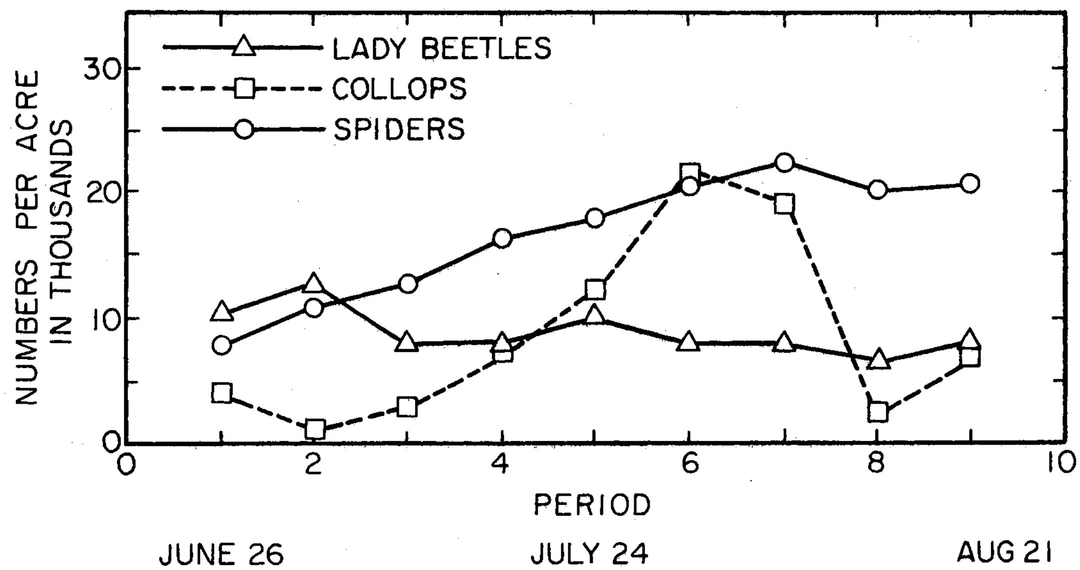

Figure 11. Average Numbers in Thousands of Lady Beetles, _Collops_, and Spiders Per Acre on Cotton on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[a]

[a]Each Point is Based on 480 Observations.

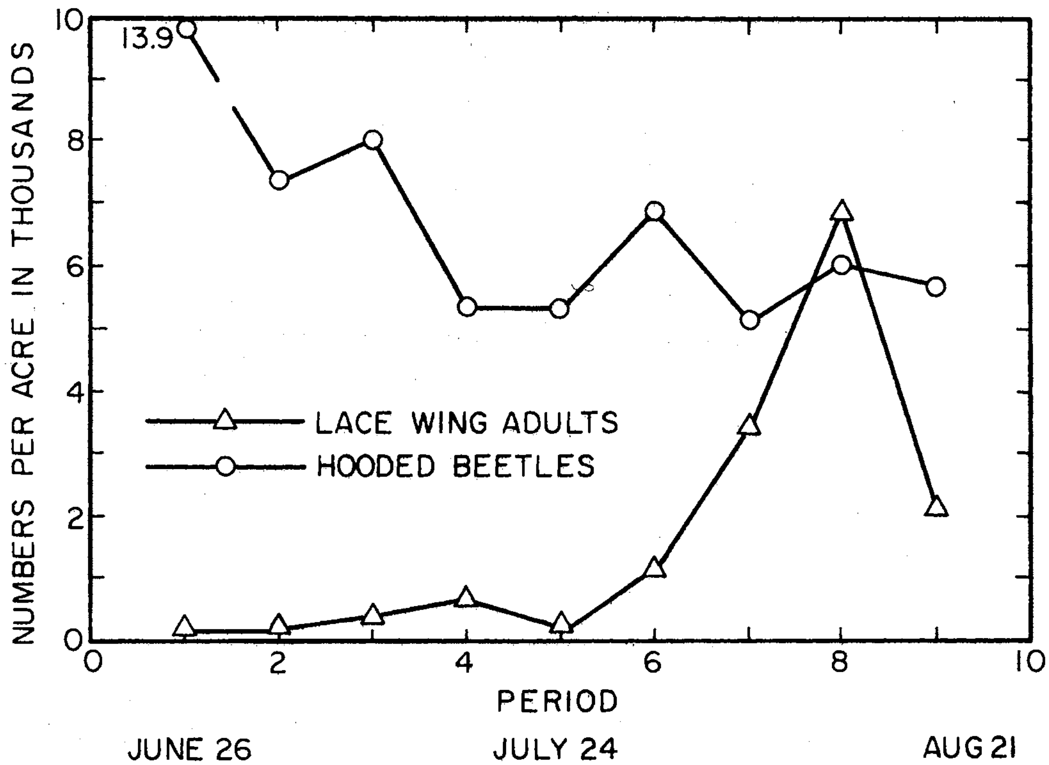

Figure 12. Average Numbers in Thousands of Lacewing Adults and Hooded Beetles Per Acre on Cotton on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[a]

[a]Each Point is Based on 480 Observations.

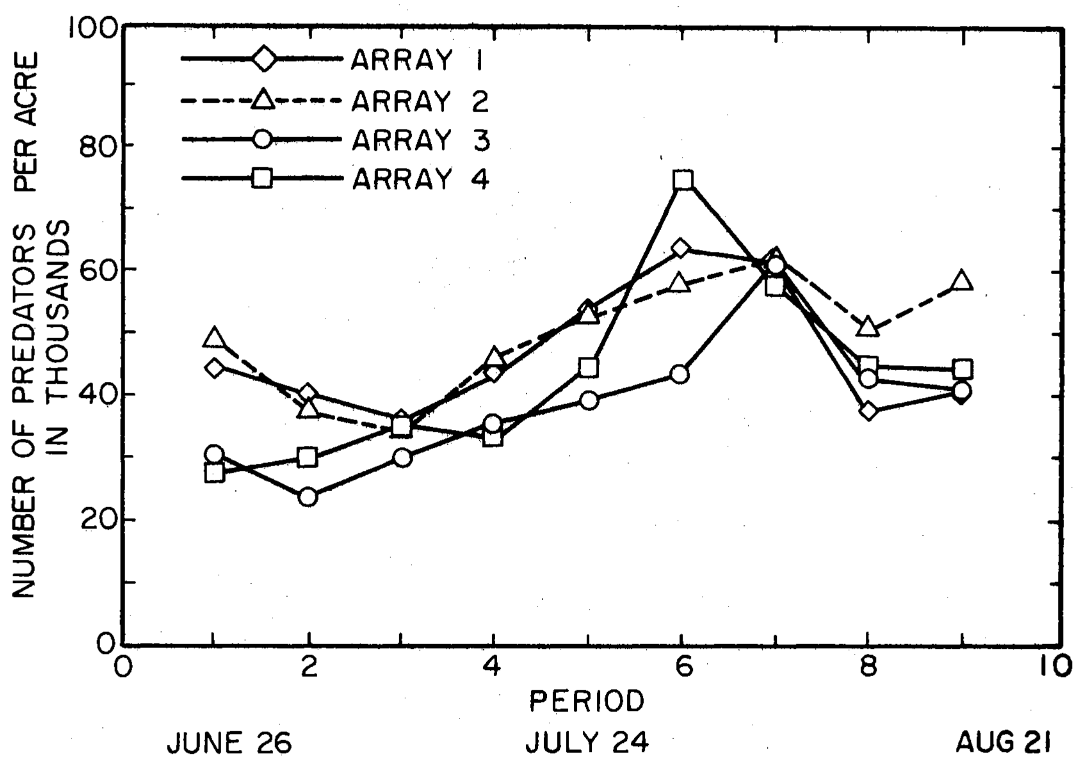

Figure 13. Average Numbers in Thousands of Predators Per Acre on Cotton in Each Planting Array on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[a]

[a]Each Point is Based on 120 Observations.

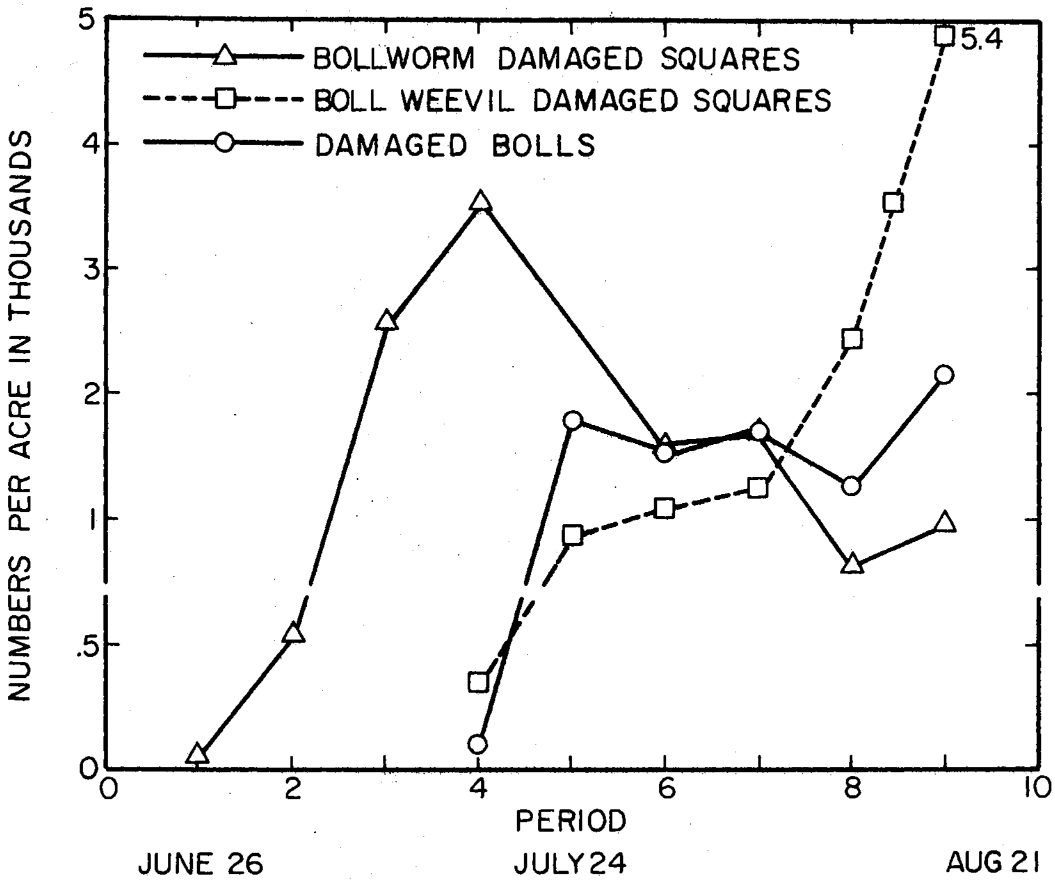

Figure 14. Average Numbers in Thousands of *Heliothis* Damaged Squares, Boll Weevil Damaged Squares, and Damaged Bolls Per Acre on Cotton on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[ab]

[a]Each Point is Based on 480 Observations.

[b]No Data Recorded on Boll Weevil Damaged Squares and Damaged Bolls until the Fourth Sampling Period.

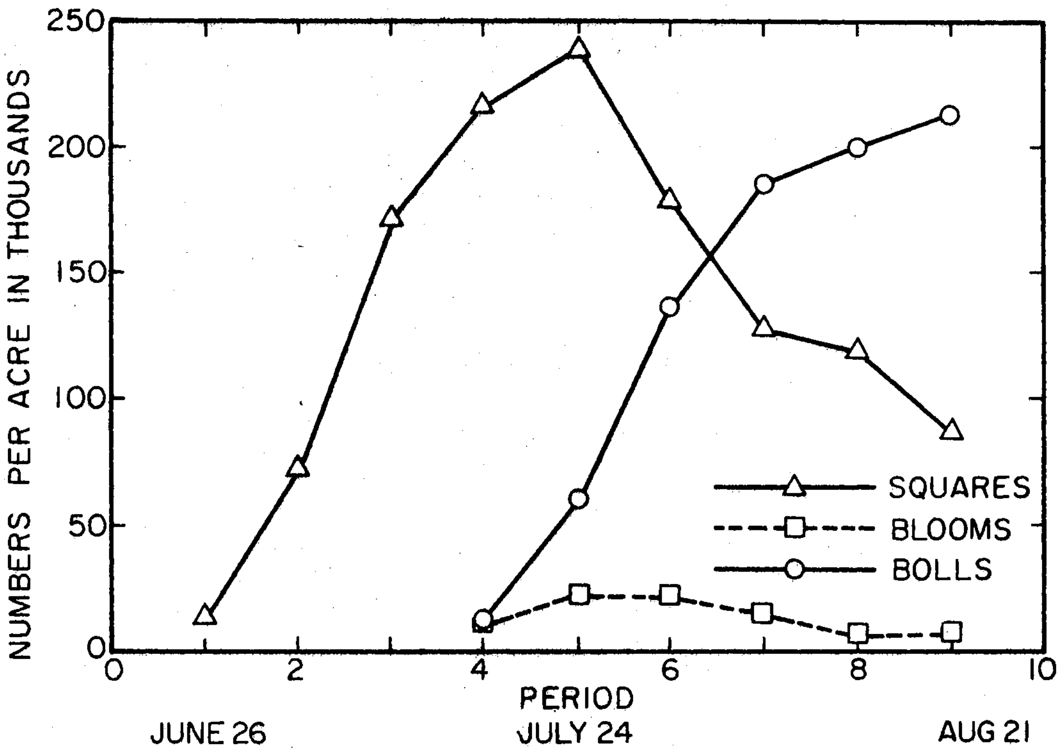

Figure 15. Average Numbers in Thousands of Squares, Blooms, and Bolls Per Acre on Cotton on Nine Weekly Sampling Dates, Tipton, Oklahoma, 1972.[a]

[a]Each Point is Based on 480 Observations.

VITA

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