All species fluctuated in numbers as the season progressed except for adults of Geocoris, which showed only a large early season fluctuation. Species occurring primarily late in the season were Zelus renardii, Collops granellus, Scymnus and Hyperaspis spp. Collops was represented largely by C. vittatus which occurred throughout the season. Orius tristicolor was the most abundant predator, followed by Nabis, Collops, Geocoris, Chrysopa, coccinellids and reduviids.

Strip-planting alfalfa in cotton (Wilbur Wuertz Farm):

At LaPalma, Arizona, cotton and alfalfa were interplanted at the rate of 48 rows of cotton and two rows of alfalfa for lygus bug control. Various treatments of a systemic insecticide, Temik, in the alfalfa strips were included in the test.

Based on preliminary greenhouse trials, rates of 10, 20, and 30 lbs. per acre were all effective in killing lygus bugs in alfalfa. A treatment of 10 lbs. per acre was made on certain alfalfa strips at the time of first squares on cotton. Approximately one month later rates of 20 and 30 lbs. per acre were applied to alfalfa strips as well as the 30 lb. rate on certain blocks of cotton.

Although results were inconsistent from field to field, there were good indications in one large field that the suppressive action on the population was taking place. However, the timing of the effective rates of Temik (20 and 30 lb. rates) was delayed beyond the optimum time and lygus populations in the cotton reached economic levels, requiring over-treatment with methyl parathion on July 16.

The common predators were abundant until the July 16 application of methyl parathion. After this time, only Orius spp. and Collops spp. were found in abundance.

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BIOLOGY AND CONTROL OF INSECTS AFFECTING COTTON IN ARIZONA

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Objectives

To study the ecology of important cotton insects.

To conduct field experiments for the purpose of developing practical and effective pest management programs.

Summary of Progress

I. Laboratory Investigations

Susceptibility of the Pink Bollworm to Sevin:

A study was initiated during the winter of 1970-71 to determine the susceptibility of the pink bollworm to Sevin. Various reports were received during the 1970 growing season that field control with Sevin was not being maintained at the expected level. Four cultures of pink bollworm were started in the laboratory from larvae collected at Safford, Phoenix, Wellton, and Sommerton. Standard laboratory procedures were followed in rearing and topical applications.

Results indicated that pink bollworm moths from all four areas fell into the susceptible category when compared with results obtained in 1966, a period before state-wide chemical control of the pink bollworm was necessary.

The Biology of *Nabis alternatus* (Parshley):

Laboratory studies were conducted at Tucson, Arizona on the biological characteristics affecting the potential rate of increase of populations of *Nabis alternatus* Parshley. In conducting these studies under laboratory conditions (28°C & 59% RH), it was found that the adults lived approximately 38 days. During this time the females laid eggs for approximately 30 days, laying an average of 281 eggs per female. Nearly 79% of the eggs hatched and the incubation period averaged 6.5 days. The average duration of the nymphal period was 16.1 days with a total nymphal mortality of 67.8%. These results indicate that nabids have the potential to increase rapidly when food is available.

Environmental Factors Affecting Diapause Termination in the Pink Bollworm:

These studies were designed to determine the influence of certain environmental factors, particularly temperature and moisture, on termination of diapause in pink bollworm larvae. Other factors considered were photoperiod and time that the larvae were in diapause as it affected their emergence pattern under conditions favorable for pupation.

Larvae with which the diapause termination studies were conducted were field-collected in late November 1970 near Tucson, Arizona. Bolls containing the larvae were placed on paper towelling in screen-wire trays. Larvae were collected from the paper towelling and stored in plastic petri dishes in an unheated, but cooled, greenhouse. Growth chambers were programmed to simulate the mid-month day of March, April, and May (means of 57°, 72°, and 78°F, respectively) and 100 larvae sample units were placed in each chamber under both wet and dry conditions. Similar larvae samples were placed in constant temperature boxes maintained at the mean temperatures of 57°, 72°, and 78°F.

Other studies were conducted at constant temperatures of 60°, 64°, 68°, and 72°F to further determine the effects of temperature and moisture on pupation. Additionally, moisture levels of 0%, 50%, and 100% RH and contact moisture were studied in relation to effects on pupation at a constant temperature of 72°F.

An adjunct to these studies involved another test concerned with the relationship of time spent in diapause to rate of pupation once subjected to conditions favorable to pupation. From the pool of larvae initially field collected, 100-larvae samples were randomly collected at two-week intervals, beginning December 19, and placed in a 72°F constant temperature growth chamber under wet conditions and 50-larvae samples under dry conditions. Observations were made daily and pupae, larval mortality and moths recorded. This series was continued through May 11 and included 11 test groups.

Results from the test where the mid-month conditions for March, April, and May were simulated indicated that the mid-April day was most optimum from the standpoint of survival and in terms of percent pupation at periodic intervals after initiation of the test. Under constant conditions of 57°, 72°, and 78°F, the results showed that 57°F is about the threshold of development as practically none pupated over a 175 day period. Again 72°F was more favorable than a constant 78°F, under both wet and dry conditions.

Under the constant temperatures of 60°, 64°, 68°, and 72°F survival was greater at 68° and 72° than at 60° and 64°. Also the time required for all larvae that survived in each treatment to pupate was lengthened as the temperature was decreased. The companion set of treatments where larvae were held under dry conditions indicates that a constant 72°F is most favorable, 64° and 68° temp. were intermediate, and 60°F permitted practically no pupation. Even under the most favorable condition of 72°F, only 65% of the sample survived to pupate.

Where moisture levels were maintained at 0%, 50%, and 100% RH and contact moisture, survival was decreased with each decrease in moisture level and time for all surviving larvae to pupate was increased.

The study to determine the effects of time spent in diapause as it relates to pattern of pupation indicated that the rate of pupation increases the longer the larvae are maintained in diapause before being subjected to conditions favorable to pupation.

II. Field Investigations

Pink Bollworm Control with Lannate:

Objective: To determine the effectiveness of Lannate at two rates and two application schedules for control of the pink bollworm.

Procedure: An experiment was designed at the Cotton Research Center using a randomized complete block with three replications. Plot size was eight rows wide and 600 feet long. Each plot contained 0.367 acres and each treatment 1.101 acres.
Five treatments were included in the test:

Untreated check		
Lannate	0.25#/A.	at a 14 day schedule
Lannate	0.5 #/A.	at a 14 day schedule
Lannate	0.25#/A.	at a 7 day schedule
Lannate	0.5 #/A.	at a 7 day schedule

All treatments were applied with a Hahn Hi-boy high clearance sprayer using three nozzles per row to deliver nine gallons of water per acre.

Pre-treatment boll samples consisting of 25 bolls per plot were taken on August 23 to determine the initial population level. Boll samples were taken once a week for the remainder of the test. Leaf samples were also taken from the terminals to determine the infestation levels of the cotton leaf perforator.

Harvesting was done on November 4, with a two-row IHC. The four center rows of each plot were harvested and weighed to determine yield data.

Results and Discussion: The data from this experiment have not been subjected to statistical analysis at this time. However, it appears that significant control of both the pink bollworm and the cotton leaf perforator was obtained. Apparently no significant differences in yield were obtained. This is not surprising since previous data have shown that fairly high levels of pink bollworm infestations occurring late in the season will not appreciably reduce yields. These data are presented in Table 1.

Table 1. Infestation levels of pink bollworm and cotton leaf perforator, and yields from various treatments with Lannate insecticide. Phoenix, Arizona 1971.

Treatment Schedule	Rate lb./A	No. Appl.	% PBW 1/ Infestation Seasonal Mean	CLP Infestation 2/ on Last Sample Date - 10/13 Larvae - Horseshoe	lbs. Seed Cotton/A.
Check	-	0	45	5.57 - 3.00	2360
14-Day	0.25	4	16	0.00 - 0.13	2389
14-Day	0.50	4	15	0.06 - 0.10	2289
7-Day	0.25	7	7	0.00 - 0.20	2380
7-Day	0.50	7	7	0.00 - 0.10	2491

1/ Pink Bollworm
2/ Cotton Leaf Perforator/leaf

Bollworm Control:

Objective: To determine the effectiveness of three insecticides and two virus materials in the control of bollworm larvae.

Procedure: An experiment was conducted at the Cotton Research Center in Phoenix to determine the effectiveness of certain insecticides and viruses on bollworm larvae infesting Deltapine 16 cotton.

The test was set up as a randomized complete block with four replications. Plot size was eight rows wide except for check plots in replications I, II and III which were six rows wide. Row length was 600 feet. The six treatments are shown in Table 2.

Pre-treatment counts were taken to determine the optimum starting date. Each plot was sampled once each week after the initial application until the conclusion of the test. Infestation levels were determined by examination of 15 terminals from each end of the plot for the presence of larvae and eggs. Damage estimates were determined by counting the number of damaged squares in the top six inches of the terminals in 13 row feet and compared with the total number of squares in this sampling area.

Application dates were determined by need based on infestation levels. Four applications were applied to all treated plots except Biotrol which received only the last two applications. Application dates were as follows: July 27; August 5; August 10; and, August 23.

All treatments were applied with a Hahn Hi-boy high clearance sprayer using nine gallons of water per acre.

A sample was taken at the conclusion of the test to determine the percent of damaged bolls from both green unopened bolls and opened bolls from 6 1/2 row feet in each plot. Bolls were also sampled to determine the amount of pink bollworm infestation in each plot. The entire field was placed on a pink bollworm insecticide schedule on September 4 at the termination of the bollworm test.

Harvesting was done with a two-row IHC picker on November 5, 1971. The four center rows of each plot were harvested and weighed to determine yield results.

Results and Discussion: Table 2 presents a summary of egg and larval counts, square damage, and yields in the various treatments. Samples taken from August 3 through August 30 probably hold the greatest significance since the test was initiated on July 28, with the last application for bollworm control made on August 23. Based on these counts it appears that, in general, all treatments were effective in reducing the larval population when compared to the untreated check. The counts probably do not give a true indication of the performance of Biotrol VHZ since the material was not available for the first two applications.

Square damage in the plant terminal was also used to evaluate treatment effectiveness. All treatments resulted in reduced square damage when compared with the untreated check. The Viron H and Biotrol VHZ treatments resulted in slightly more square damage than did the conventional insecticide treatments. This follows the expected pattern since the larvae which ultimately die from the virus continue to feed for some time before dying.

The yield data have not been statistically analyzed. Although yield differences are shown it would be difficult to assign the differences to treatment effects based on the other sample data.

Table 2. Effect of various insecticide treatments on the bollworm, *Heliothis zea*. Phoenix, Arizona 1971.

Treatment	Rate lb./A.	Mean August Infestations/100 T.[1/] Eggs - Larvae	Mean % Square Damage	lb. Seed Cotton/A.
Check	-	18.0 - 8.0	6.58	1694
Methyl Parathion	1.00	12.0 - 2.0	1.77	1994
Lannate	0.50	12.3 - 4.5	1.92	2048
Galecron	0.75	18.8 - 2.8	1.64	2243
Viron H	1.00	16.8 - 2.8	2.95	1785
Biotrol VHZ	1.00	12.7 - 5.7	3.86	1689

1/ The pre-treatment terminal (T.) count across the entire test plot revealed an average of five eggs and 28 young larvae per 100 terminals.

Control of Cotton Leaf Perforator:

Objectives: To evaluate effectiveness of Lannate against the cotton leaf perforator.

To obtain information relative to the effectiveness of Lannate on the pink bollworm.

Methods: The experiment was a modified randomized complete block design with three replications. Plots were eight-rows wide and 244 feet long. Applications were made with a Hahn high-clearance spray machine, using three nozzles per row and delivering nine gallons total spray per acre. Applications were made, on the average, on 5.5- and 11-day schedules using Lannate at 0.5 lb. per acre.

The cotton on which the experiment was conducted was rank and growing well at the time the test was initiated on August 25. No pink bollworm control had been exercised and pre-treatment samples showed 100% of the bolls infested.

Temik had been applied to the cotton on June 19 at the rate of 15 lbs/A. It was evident that effectiveness against the cotton leaf perforator was beginning to diminish.

Sampling consisted of moving into each plot at least 25 yards and pulling 10 leaves at random for determining degree of cotton leaf perforator infestation to include leaves showing mines, fourth and fifth stage larvae and the horseshoe stage. Ten half-grown bolls were pulled in each plot and examined for presence of pink bollworm larvae.

Results and Discussion: Results of this experiment indicated that the cotton leaf perforator can be controlled with Lannate at 0.5 lb/acre with an application interval of at least 11 days.

The pink bollworm was not controlled in this plot of cotton and at the time the test was initiated 100% of the bolls were infested. This test indicated that under severe population pressure, the pink bollworm cannot be controlled at the longer application interval. However, at the 5.5 day interval, the data indicated that adequate control was being achieved. Observations of the long-interval sample collected on September 15 where 90% of the bolls were infested revealed the probable reason for lack of any apparent control in this treatment. Most of the larvae found in the bolls were first instar, indicating an application interval slightly in excess of that required to give good control.

Because no attempt was made during the earlier part of the growing season to control the pink bollworm, severe damage had occurred by the time this test was initiated. Therefore, yield data were not taken in this test.

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BIOLOGICAL CONTROL INVESTIGATIONS

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Objectives

To determine the feasibility of using native and introduced parasites and predators to control insects damaging cotton.

Summary of Progress

In February 1971 CIRB made funds available for a 112-acre pink bollworm, *Pectinophora gossypiella* (Saunders), control test with *Bracon kirkpatricki* (Wilkinson) and *Chelonus blackburni* (Cameron). In the ensuing months weekly production of both species was scaled up to about 250,000 of the former and 50,000 of the latter with the intent of keeping constant pressure on the pink bollworm population from first cotton bloom until the end of August. Beginning June 10 and continuing to September 2 a total of 2,019,000 *B. kirkpatricki* and 283,000 *C. blackburni* were released on a semiweekly basis. During this period the release fields received one insecticide treatment for lygus bugs on July 27 and one treatment for pink bollworm control on 75 acres in the parasite release area on September 5. In the non-release area (200 acres) four insecticide applications were made for pink bollworm control and one application for