EFFECTS OF EARLY SEASON INSECTICIDE APPLICATION ON COTTON FLEAHOPPER AND THRIPS AND ON SEVERAL PREDACEOUS ARTHROPOD POPULATIONS IN COTTON

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PREFACE

The need for assisting nations, to develop the capacity to keep their citizenry adequately fed is perhaps even greater importance when humanity is viewed from a total and long term perspective. As mankind becomes even more sensitive to the needs of all the people of the world, and is then confronted with the gross differences in resources between developed countries and developing countries, the need to share and to coordinate effort becomes evermore apparent. Such efforts by Governments, Agencies and individuals have led to my training in the United States of America for my Master's Degree in Entomology.

I am grateful to so many people who have been helpful during my studies and hereby express my deep appreciation to the following: Dr. Jerry H. Young who accepted to be my major advisor and effectively guided me through my classwork and my research work from which resulted this manuscript. Dr. Don Peters for his indulgence and patience as head of department of Entomology who coordinated very well my program here in the University. Dr. Richard Berberet and Dr. William A. Drew who served in my graduate committee, for their constructive assistance for correcting this thesis. Mrs. Judy Edmondson, for her devotion and excellence in typing this thesis. Mr. Bill Doerner, Mr. Edward Mishu, Mrs. Nongporn Kitbanroong for their great help in collecting my data. To all the faculty and staff members of the

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Finally to my father, mother and brothers and all my friends who gave me courage and faith and moral support through all my career.

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NOMENCLATURE

A.I.	Active Ingredient
g	gram
kg	kilogram
lb	pound
oz	ounce
A	acre
ha	hectare
m	meter
EC	Emulsibiable concentrate
ULV	ultra low volume
s.p	soluble powder

CHAPTER I

INTRODUCTION

In spite of competition from synthetic fibers, cotton holds a basic place in the world's textile industry. It is grown in many countries where it provides great revenue. The world's cotton production reached 65.6 million bales in 1979-1980 and was estimated at 66 million bales in 1980-1981. The five big producers were the United States of America, Soviet Socialist Republic, China, India and Pakistan.

Cotton is a plant which attracts large numbers of insect pests. These pests are a major limiting factor in cotton production. Hargraves (1948) listed 1,326 species of insects on cotton worldwide. The impact of pests has brought a great demand for modern pest control techniques including insecticides in cotton.

Kenaga and Allison (1969) found that insecticide use in the USA has increased from less than 30 to more than 200 chemical compounds during the past 30 years. Eichers et al. (1970); and Pimentel (1973) proclaimed from published statistics a use of 270 million pounds of insecticides each year on cropland in the USA alone. Of this amount, 47 percent was applied on cotton.

Despite the increased use of insecticides to control cotton pests, the loss caused by insect damage on cotton remains very substantial in many cotton producing states of the USA.

In Oklahoma, estimated reduction in cotton yield resulting from insect damage amounted to 7.0 percent in 1979-1980 and reached 14.5 percent in 1980-1981 (USDA, 1981). The cotton bollworm, Heliothis zea (Boddie), and tobacco budworm, Heliothis virescens (Fabricius), caused the most damage of 10 percent in 1980-1981. Other listed pests like the cotton fleahopper, Pseudatomoscelis seriatus (Reuter), and cotton thrips Frankliniella spp. were reported to cause 0.5 percent each group in yield reduction in 1980-1981.

The cotton fleahopper, P. seriatus (Hemiptera: Miridae) has been an important pest in isolated areas throughout the USA for a long time. It occurs as a serious pest on cotton in the eastern three-fourths of Texas and Arkansas, Louisiana and Mississippi. It is an occasional pest in Oklahoma, West Texas and other places in the United States.

In 1923, the cotton fleahopper, at that time a minor pest of cotton in Texas, caused some serious damage in that State (Reinhard, 1926). Folsom (1932) found that the cotton fleahopper was causing a peculiar disorder of the cotton plant, preventing the plant from producing blooms. He recommended a combined application of 8 pounds of sulfur and 4 pounds of calcium arsenate per acre as a control measure in case of a prevalence of cotton fleahoppers or bollweevils.

In 1946 in Oklahoma, a study conducted by the Agricultural Experiment Station showed that the fleahopper acting alone does not constitute a major pest problem. However, when conditions are favorable for population outbreak it may cause considerable damage (Charles 1946). Gaylor and Sterling (1976) stated that when reared on croton at 26.7°C for 10 weeks, the fleahopper could theoretically increase to over 13,000 females for each female at week one.

Cotton fleahoppers are early season to mid-season pests. Their injury on cotton is characterized by an excessive blasting and shedding of very small squares, a reduction of fruiting branches and tall whip-like growth of the main stem. Some infested plants may recover during the season but in heavy attack results in cotton yield reduction.

Thrips have been considered as economically important pests damaging crops in many parts of the world (Marsham 1796, Curtis 1860, Froggatt 1906). They were recognized as pests to seedling cotton in the 1920's in the USA (Newson et al. 1953). However, the amount of damage done by this insect has been highly controversial.

Eddy and Clark (1930) first found that infestation by onion thrips, *Thrips tabaci* Lindeman, caused seedling cotton plants to grow slowly and become malformed. Gaines (1934) conducted a study of thrips on seedling cotton and claimed that a fairly large number of thrips occurred each year. The thrips seemed to cause considerable damage. He studied the effects of thrips injury by tagging injured plants on the first of May for observation later in the season. He found that injured plants produced two or more main branches and sometimes some excessive vegetative branching. He concluded that injured plants yielded 56 percent less bolls than undamaged plants and set bolls at least 2 weeks later.

Dunnam and Clark (1937) used a similar method to study the effect of thrips on 40 varieties of cotton at Stoneville, Mississippi. They observed a 13.38 percent reduction in yield of seed cotton and that boll set was delayed 10 days to two weeks on the injured plants.

B. G. Hightower (1958), in a laboratory study on the effect of thrips Frankliniella Fusca (Hinds) infestation on cotton found a consistent reduction of 28 percent in height and 50 percent in weight of infested plants compared to check plants.

By contrast, many workers have advocated against the development of a specific program for thrips control. Gaines et al. 1948, Newson et al. (1953), Lincoln and Leigh (1957), Watson (1965) found that thrips control had no influence on rate of maturity or on total yield of seed cotton. Later, Walker et al. (1970), Young and Price (1970), Johnson et al. (1976) found that early routine spraying for fleahopper control was not economical in Oklahoma.

Nevertheless, insecticides as seed treatments and early season sprays have been used as a potential tool for thrips and fleahopper control programs. Reinhard (1926) found sulfur dust to be effective against fleahoppers in cotton. Ivy et al. (1947) stated that toxaphene gave a better control of the cotton fleahopper than DDT or benzene hexachloride. Gaines and Dean (1948) showed that chlordane and toxaphene or BHC + sulfur were less effective than parathion for fleahopper control.

Hanna (1958) found that several systemic insecticides including demeton, Thimet and Bayer applied as seed treatments adequately protected young cotton plant for 4 to 6 weeks after planting dates. Beckman (1970) stated that carbofuran, disulfoton and aldicarb applied in furrow applications at cotton planting reduced thrips on seedling cotton.

Consequently all the important classes of insecticides including the chlorinated hydrocarbons, the carbamates, the organophosphates, and the synthetic pyrethroids have been used for control of cotton thrips and fleahoppers in cotton. Incidentally some important considerations in pest management programs have led entomologists to take another look in pest control strategies other than chemical use alone.

The establishment of resistance in many species of insects to insecticides has been discovered. Parencia and Cowan (1960) Sterling and Plapp (1972) observed an increase in tolerance of fleahoppers to toxaphene, dieldrin and heptachlor. Moreover, most insecticides used in cotton pest control have a broad-spectrum activity and are toxic to non-target organisms including man. Many workers have found that insecticide applications to control fleahoppers and thrips often eliminate beneficial arthropods and lead to *Heliothis* complex outbreaks (Gaines 1942, Lindgreen and Ridgway 1967, Lukefahr et al. 1968, and Walker et al. 1970). In the same aspect, Dinkins et al. (1971) classified five insecticides tested in cotton fields into four groups according to their toxicity to predators:

1. High toxicity: fenthion (EC) and trichlorfon (EC)
2. Moderate toxicity: trichlorfon (ULV)
3. Low toxicity: dimethoate, disulfoton, fenthion ULV
4. Limited toxicity: trichlorfon 50% SP

They also found *Hippodamia convergens* Guérin Meneville and *Orius insidiosus* (Say) to be highly sensitive and the spider complex to be the less sensitive among nine groups of arthropod predators to all insecticides tested.

Many other workers have reported selective or differential toxicity of insecticides to numerous entomophagous arthropods.

Plapp et al. (1978) stated that the common green lacewing Chrysopa carnea, a predator of the tobacco budworm was highly affected by most organophosphate insecticides and methomyl but much less affected by several organochlorines, pyrethroids and a formamidine. Wilkinson et al. (1979) found that the predators G. puntipes, H. convergens and Podisus maculiventris (Say) showed a survival of 42 to 82% to 2 pyrethroid insecticides and only 14 to 29% survival to 2 organophosphates (suprofos and profenofos) after exposure to maximum and minimum concentrations. Roach and Hopkins (1981) concluded that two or more spray treatments of the pyrethroids at rates of 0.11 and 0.056 kg AI/ha essentially destroyed most predator species in cotton fields. The present study was conducted in 1981 and aimed to determine the "optimal" rate, time and methods of applications of insecticides for control of fleahoppers and thrips. The effects of those insecticides on several beneficial arthropods populations were also studied during this research.

CHAPTER II

MATERIALS AND METHODS

The experiment was conducted with Westburn M. cultivar of cotton, a dryland short season variety in 1981 at the Oklahoma State University Research Station, Tipton, Oklahoma. Cotton was planted on May 12 on an area of 0.48ha at a rate of 28kg of cotton seed per ha. It was planted in a randomized complete block design with 4 replications. Plots were 33.55 meters long and 4 rows wide. The rows were separated by 1.01 meter. Eight treatments were tested.

First treatment was seed treatment with Orthene (acephate) at a rate of 90g per kg of cotton seed (8oz/5lbs). The second treatment was seed treatment with Orthene at a rate of 180g per kg (16oz/5lbs). The seeds were treated with Orthene in water and mixed thoroughly and left to dry in sunlight one day prior to planting.

The third, fourth and fifth treatments were hopper treatments. The cotton seed were mixed as evenly as possible with Orthene soluble powder just prior to planting. A rate of 90g per kg of cotton seed was applied to the third treatment. A rate of 180g per kg of seed was used for the fourth treatment. The fifth treatment had the highest rate of 224g per kg (20oz/5lbs) of cotton seed.

The sixth and seventh treatments were early foliar applications of Bidrin 8 water miscible (Dicrotophos) and Cygon 400 (dimethoate). Cygon 400 was applied at a rate of 220g A.I. per ha (.1 lb A.I./ha).

Bidrin was applied at a rate of 110g A.I. per ha (.1 lb A.I./ha). Cygon and Bidrin were applied 36 days after planting. A ground sprayer mounted on a John Deer Hi-cycle 600 tractor was used to apply foliar sprays.

The eighth treatment was a check which did not receive any insecticide treatment.

Sampling Procedures for Thrips

Sampling for thrips started on May 28, 2 weeks after cotton planting. The plots were sampled once a week for 5 consecutive weeks up to June 23. Twenty plants were taken at random from the four rows of each plot. Those plants were held in a Berlese funnel for 3 hours and the thrips collected in a 50ml jar containing alcohol. A dissecting microscope was used to identify and count the thrips collected. Their number per plot were then recorded. Following the Bidrin and Cygon spray, plant samples for thrips were taken in the middle two rows of each plot to avoid drift problem which could affect the thrips count.

D-Vac Sampling for Fleahoppers and Beneficial Arthropods

Weekly samples of cotton fleahoppers and selected beneficials arthropods were taken to determine the comparative effects of the test materials on non-target arthropods and on cotton fleahoppers. The beneficial arthropods identified and counted were:

1. Big-eyed bugs: Geocoris sp (Hemiptera: Lygaeidae)
2. Soft winged flower beetle: Collops sp (Coleoptera: Melyridae)

3. Hooded flower beetle. Notoxus monodon (Fabricius)

4. Lacewing adult and larva: Chrysopa spp (Neuroptera: Chrysopidae)

5. Lady beetle: Hippodamia sp (Coleoptera: Coccinellidae)

6. DAmsel bugs: Nabis spp (Hemiptera: Nabidae)

7. Some spiders primarily members of the family Oxyopidae, Salticidae, Thomiscidae, Mimetidae.

The samples were taken by a D-vac sampling machine. The arthropods were trapped in nets mounted on the coneshaped apparatus, removed along with the net and placed in quart containers and sprayed with ethyl acetate. Only the second and third row of each plot were sampled over their total length and alternately once a week. The samples from each plot were brought into the laboratory and the arthropods identified and counted using a dissecting microscope.

The D-Vac sampling lasted for one month, from June 29 to July 29.

Data from the experiment were analyzed using a statistical analysis system[1] of the F. test. Treatment means were separated by use of Duncan's multiple range test. Data were analyzed per rates of sampling for weekly results and over dates for seasonal results.

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[1]Statistical analysis system was designed and implemented by Dr. Young in Department of Entomology, Dr. Ronald W. McNew, Dr. Linda Wilson, Dr. Robert D. Morrison and other staffs of the STatistics Department of Oklahoma State University.

CHAPTER III

RESULTS AND DISCUSSION

Thrips

Table I and Figure 1 illustrate the fluctuation of thrips population during the period of sampling. The numbers of thrips per 20 plants were low for the entire sampling period and did not exceed 10 for 4 replicates.

On May 28, first day of sampling, the highest number of thrips obtained was 8.75 in Cygon plots which had not received treatment at that time. The lowest number of thrips (0.5) was observed on orthene seed treatment (90g/kg). The check treatments (Cygon plot, Bidrin and no treatment plots) had a higher population of thrips, compared to the Orthene seed treatments.

One week later, there were less thrips collected and the highest number of thrips was 4.5 on no insecticide treatment plots. On June 9 the number of thrips on Orthene hopper treatment (224g/kg) increased substantially to 7.25. The lowest average occurred on Orthene seed treatment (90g/kg).

On June 16, the number of thrips decreased for all the treatments. Only 2.25 thrips, the biggest population was obtained from Bidrin treatment plots. The plots assigned to Bidrin were not treated with Bidrin when the samples were taken on June 19.

The low number of thrips on June 16 could be attributed to the heavy rainfall during this week. A rainfall of 4.20 inches was recorded on June 15 one day before the sampling. On June 23, the number of thrips increased for most of the treatments, except for Bidrin and Orthene seed treatment (90g/kg).

On total seasonal average, the Cygon treatment had the highest number of thrips but only 4.0 thrips per 20 plants corresponding to 16.5 percent of all the treatments. The lowest number of thrips occurred on seed treatment (90g/kg), 1.85 thrips representing 7.47 percent of all treatments. The average number of thrips fluctuated substantially during the season. The thrips infestation found on Orthene seed treatments were not consistent with the amount of chemical used. It appeared from these results (Table I) that Orthene applied at a low rate at planting (90g/kg) gave a better control of thrips at higher rates (180 and 224 g/kg).

There was no significant difference at the 5% level between all the treatments for seasonal average.

Orthene seed treatments at rates of 90, 180, 224g per kilogram of seed did not give significant results despite the substantial difference in the rates of Orthene. Similarly Bidrin and Cygon as early foliar applications did not show any significant difference between the Orthene seed treatments. All the three insecticides: Orthene, Bidrin and Cygon have been recognized to be potent systemic insecticides and many workers have found systemic insecticides to be effective for early season pests. Hanna (1958) stated that several insecticides (demeton, thimet and Bayer applied as seed treatments adequately protected young cotton plants from thrips for a period of

4 to 6 weeks. Consequently, some significant results from Bidrin (110 g A.I./ha), Cygon (220g A.I./ha) and Orthene (90, 180, 224 g/kg) would be expected in heavy thrips infestation. The light infestation of thrips this year might have been caused by the rainy months of May and June of 1981. There was a rainfall of 6.70 inches recorded in May compared to a long term average of 3.72 inches and 7.96 inches in June compared to a long term average of 3.32 inches in Tipton where this research was conducted. Many thrips might have been washed out by rain as suggested by Harris et al. in 1936. Harris et al. found that driving rain and hail of two days washed about 70% of the population of *Thrips tabaci* Linds from an onion crop.

However, although the thrips results did not show any significant effectiveness of one insecticide to the other, they could be some important information concerning yearly predictions of thrips population near the research area in Oklahoma if the research is followed for several years.

Cotton Fleahoppers

Table II and Figure 2 and 3 show the fluctuations of cotton fleahopper under eight different treatments of insecticides. In general there was a substantial drop in fleahopper number for all the treatments after the first sampling day.

On June 29, the population of fleahoppers was quite high for all treatments. The highest population of fleahoppers occurred on the early spray treatment with Cygon applied less than 2 weeks earlier. There was also a high number of fleahoppers (42.25 compared to 51.25 as highest) reported for Bidrin treatment. The lowest population of fleahoppers was found on Orthene seed treatment (180g/kg). The results showed that at higher rates, orthene was more effective against fleahoppers than that at lower rates.

Early foliar applications of Bidrin and Cygon had higher infestation rates of fleahopper than all the Orthene seed treatments. However, the comparatively low number of fleahoppers on the check treatment tended to prove that none of the insecticide treatments adversely affected the fleahopper population. There was no significant difference at the 5% level between all the 8 treatments.

The second week of sampling, July 8, the Cygon treatment still had the highest infestation of fleahoppers, an average of 16 fleahopper per 33.5 m. row long. The lowest infestation occurred on the Orthene hopper treatment (180g/kg). On July 16, the number of fleahoppers was low. Cygon treatment proved to be still less effective than all the other treatments and averaged 14.5 fleahoppers. The check treatment had also a low population (8.75). There was no significant difference at the 5% level. On July 22, very few fleahoppers were collected from all the treatments compared to other days of D-Vac sampling. This situation was attributed primarily to equipment failure resulting in a poor suction of the D-Vac machine. Only 6.75 fleahoppers were found in Orthene seed treatments (180g/kg) and 2.25 fleahoppers in orthene seed treatments (90g/kg). The no-control treatment averaged 4.5 fleahoppers inferior to the fleahopper number obtained from most insecticide treatments.

On July 29, last day of sampling, there was a small variation in fleahopper populations between treatments. The lowest infestation of fleahoppers was observed on check treatment. There was no significant difference between treatments. On total seasonal average, the no-control treatment had the lowest infestation. The Cygon treatment averaged the highest population of fleahoppers during the first 3 weeks and still maintained a higher population than most of the other insecticide treatments.

There was no significant difference between treatments at the 5% level, suggesting that none of the insecticides significantly affected the cotton fleahopper population.

However, Orthene, Bidrin and Cygon are insecticides recommended for control of many cotton pests including the cotton fleahopper P. seriatus. The dosages of application recommended for Bidrin and Cygon vary from 110 grams per hectare (.1 pound per acre) to .275 grams per hectare (.25 pounds per acre).

Effects of the Selected Insecticides on Beneficial Arthropods

Seven different groups of beneficial arthropods believed to be important predators of some cotton pests were evaluated for effects of the insecticides on their populations. The abundance of these beneficial arthropods varied much depending on the group of predators and days of sampling.

Big-Eyed Bugs, Geocoris spp.

The population of big-eyed bugs observed was low for all the treatments during the sampling period. Table III illustrates the fluctuation of big-eyed bug populations for all the treatments. The number of big-eyed bugs collected was no more than one for all treatments. No statistical conclusion was shown from these results since the numbers of big-eyed bugs were too low.

Big-eyed bugs are recognized to be predators on young bollworms (*Heliothis zea*), cotton leafworm larvae and cotton fleahoppers. Consequently their abundance in cotton fields could help in the control of cotton pests by their natural enemies.

Soft-Winged Flower Beetles, *Collops* spp.

Similar to the big-eyed bugs, Table IV shows that the number of soft-winged beetles collected was very low. No flower beetles *Collops* spp were collected from the orthene hopper treatment (180g/kg). The number of *Collops* spp on the check treatment was also very low. The number of *Collops* spp per 33.8 m. row was below 1 for all the insecticide treatments. No statistical conclusion was drawn because the average number of *Collops* spp was too small.

Collops spp are frequent in cotton field and are known to be common predators of eggs and small larvae of the cotton bollworm, some mirids like the cotton fleahopper and many small soft body insect pests in cotton. A safe usage of insecticides would preserve and increase *Collops* spp population in cotton fields.

Lacewing Larva and Adult - *Chrysopa* spp.

Table V shows that very few lacewings were present in the cottonfield. More adult lacewings than larvae were collected. However, it appeared that the number of lacewing adults increased as the season progressed. Most of the insecticide treatments had more lacewings than the check treatment (24 percent for Orthene hopper treatment at

224/kg and 13% for the check). No statistical conclusion was obtained from the results because of the small numbers of lacewings observed under the no insecticides treatment and the insecticide treatments.

Lacewings are predators of major importance. They prey as larvae and adults. The adults feed on bollworm eggs. The larvae feeds on thrips, bollworms, armyworms, and cabbage loopers. Some workers found that lacewings consume more thrips than do any other predators. Callan (1943) found that some lacewing species, consumed one or two cocoa thrips larvae daily, but in cages the larvae of chrysopid ate 14 larvae per day and when hungry ate one or two per minute for short periods. therefore, lacewings can be important for thrips control programs.

Hooded Flower Beetles - *Notoxus monodon*.

The results are illustrated on Table VI. The population of hooded flower beetles was higher than those of lacewings, *Collops* spp and big-eyed bugs. Higher numbers of hooded flower beetles were found on high rate Orthene treatment compared to a low number of flower beetles on lower dosage Orthene treatment at the beginning of the sampling period. The results suggest that there was an increase in hooded flower beetles during the season. The population reached its peak on January 16. However, the population of hooded beetles on the no insecticide treatment was lower than most of those insecticide treatments. Although there was no significant difference at the 5% level between insecticides, it appeared that the insecticide application did not reduce the hooded flower beetle population.

Lady Beetles: *Hippodamia* spp.

The results are illustrated on Table VII. The number of lady beetles decreased after the first week of sampling. The population of lady beetles was low on all treatments in general. The no-insecticide treatment averaged less lady beetles than most of the insecticide treatment suggesting that the insecticides were not harmful to the lady beetles. However, there was no significant difference between the insecticides. In addition, the small population of lady beetles collected did not provide enough information for attributing lady beetle population fluctuation to insecticide treatments.

Damsel Bugs: *Nabis* spp.

The results are shown on Table VIII. The damsel bugs were more abundant than any other insect predators sampled. The population of nabids reached their peak on June 16 and remained quite low at the end of June.

The no-insecticide treatment was not significantly different from the insecticide treatment at 5%. There was also no significant difference between insecticides. The results suggest that the insecticides did not adversely affect the population of damsel bugs. In fact, some insecticide treatments averaged more nabids than the no insecticide treatment. Bidrin had a total seasonal average of 5.30 nabids compared to 4.05 for the check treatment.

Spiders

The populations of spiders similar to nabids, sampled, reached their peaks on July 8 and 16 and remained low during the rest of the sampling period, (Table IX, Figure 4).

On July 8, there was a significant difference between treatments. The treatments fell into two main categories: 1) those with high populations of spiders (check with 25 spiders, Orthene seed treatment (90g/kg) with 23.75 and Cygon with 29 spiders).

2) Those with low population of spiders: Bidrin with 10.75, seed treatment with Orthene (180g/kg) with 14.25 spiders and Orthene hopper treatment (224g/kg) with 10. The former group of treatments suggests that they were not toxic to spiders. The second group would indicate more toxicity to spiders. However, there are many other environmental factors which could affect the number of spiders. In fact the results found on the following week were completely different from those of July 8. Although there was some significant difference at 5% level between treatments, the no-insecticide treatment had fewer spiders and was only significantly different from Bidrin treatment. There was no significant difference at the 5% level between insecticide treatments for the total seasonal average.

Total Beneficial Arthropods

Table X and Figures 5, 6 and 7 indicate the fluctuations in total beneficial arthropods collected during the season. There was significant differences at the 5% level on July 16. Bidrin treatment had the highest number of beneficial arthropods. Bidrin treatment was significantly different from all insecticide treatments and the no insecticide treatment, suggesting that Bidrin did not harm the beneficial arthropod populations.

However, on total seasonal average there was no significant difference among the insecticide treatments and the check. The check treatment averaged less beneficial predators than most of the insecticide treatments.

The results found in this research seem to indicate that Orthene applied at rates of 90, 180 and 224 grams per kg of seed for seed treatments does not significantly reduce thrips and cotton fleahopper populations 2 weeks after cotton planting. Incidentally, early foliar applications of Bidrin at 110g A.I. per hectare (.1 pound per acre) and Cygon 220g A.I. per hectare (.2 pound per acre) did not give better control of thrips and fleahopper populations. However, it should be pointed out that the populations of thrips and fleahoppers were below the economic damage levels described by Oklahoma Extension SErvice. Treatments for thrips control in Oklahoma should begin when the number of thrips per young cotton plant reaches three or more. For fleahoppers, treatments are recommended when insect numbers reach 40 or more per 100 terminals of cotton plant. Among the insecticides listed for the control of these two insects, Orthene is recommended to be applied at 110 to 220g per ha, Bidrin and Cygon at 110g per ha. When Orthene is used as seed treatments or as in furrow granule application at planting, the effective rate recommended is 310g per kg of seed. The non-reduction of thrips population by Orthene seed treatment could be caused in part by the low dosages of Orthene during the present experiment.

Some workers have used other systemic insecticides than orthene in seed treatments which have proven to be effective for thrips control. Davis and Cowan (1974) found that aldicarb applied in furrow at planting at 900g to 1350g per ha (0.8 to 3.2 pound per acre) gave an effective control for 5 to 9 weeks against thrips Frankliniella spp. and the cotton fleahopper P. seriatus.

The beneficial arthropod populations were not adversely affected by any of the insecticides. A quantitative classification of the arthropods per species appeared quite similar in all the treatments. Spiders, damsel bugs (Nabids) and hooded flower beetles were the most abundant groups encountered during the sampling period. They represented more than 90 percent of all the seven groups of beneficials sampled. The spiders were the most predominant group of beneficials. They represented 56% of total beneficials in check plots, 48% in Bidrin plots and 44% in Orthene hopper treatment (224g/kg) plots. The results confirmed the findings of Johnson et al. (1976). They found that spiders constituted 68% of seven groups of arthropod predators in no insecticide plots and 68.8% in insecticide plots. The present results also showed that lacewing and big-eyed bug populations were the less abundant group of all the predators collected. The lacewings and big-eyed bugs represented less than 1.5% of all predator populations for the total season and for all the treatments.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Three different organophosphates insecticides: Orthene (acephate), Bidrin (dicrotophos), Cygon (dimethoate) were used for early control of thrips and cotton fleahoppers P. seriatus. Their effects on seven beneficial arthropods were also studied.

Orthene as a seed treatment at rates of 90, 180, 224g per kg of cotton seed did not cause any reduction of thrips and cotton fleahoppers.

Bidrin and Cygon applied as foliar spray at 110g A.I. and 220g A.I. per ha respectively did not give a better control of thrips and fleahoppers when compared to the Orthene seed treatment. The insecticide treatments did not reduce the thrips and cotton fleahopper populations when compared to the non-insecticide treatment.

Both thrips and fleahopper populations were low for all treatments and were below the economic threshold described by the Okalhoma Extension Service.

The beneficial arthropods were not adversely affected by any of the insecticide treatments. There was also no selective toxicity detected among the three insecticides used. A total estimation of the predator population showed a very distinct predominance of spiders, nabids and hooded flower beetles. These predators represented more than 90% of all the beneficial arthropods sampled. The big-eyed bugs (Geocoris spp), lacewings (Collops spp) and ladybeetles (Hippodamia spp), were the less common species. The present research constitutes a good approach to the aspect of integrated pest control where all the available techniques are evaluated and consolidated into a unified program to manage pest populations so that economic damage is avoided and adverse side effects on the environment are minimized.

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APPENDIX

TABLE I

COTTON THRIPS SAMPLING COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of thrips per 20 plants						
		Dates of sampling					Seasonal Average	%
		5-28-81	6-04-81	6-09-81	6-16-81	6-23-81		
Seed treatment W.M. Orthene 75S soluble	90g/kg of seed (8oz/5lbs)	0.5*	2	1.75	0.75	4.25 *	1.85	7.47
Seed treatment W.M. Orthene 75S soluble	180g/kg of seed (16oz/5lbs)	2.25 ab	3.75	4.0	1	7 b	3.60	14.5
Orthene Hopper treatment W.M.	90g/kg of seed (8oz/5lbs)	5.0 abc	3.25	3.75	1	0.25 a	2.65	10.70
Orthene Hopper treatment W.M.	180g/kg of seed (16oz/5lbs)	5.5 abc	2.75	4.0	1	2.50 ab	3.15	12.72
Orthene Hopper treatment W.M.	224g/kg of weed (20oz/5lbs)	2.25 ab	4.0	7.25	1.25	2.75 ab	3.50	14.14
Cygon 400	220g AI/ha (.2lb AI/A)	8.75 bc	4.5	4.75	0.5	2.0 a	4.10	16.56
Bidrin	110g AI/ha (.1 lb AI/A)	6.5 bc	1.25	2.25	2.25	1.0 a	2.65	10.7
Check	No treatment	4.0abc	4.0	3.0	1.5	3.75ab	3.25	13.13
O.S.L.		0.090	0.80	0.58	0.77	0.09	0.38	

- W.M. = Westburn Mix
- 6-16-81 - Date of Bidrin and Cygon applications
- % = Percent of seasonal average

TABLE II

D. VAC SAMPLING FOR FLEAHOPPER CONTROL PROGRAM COTTON RESEARCH TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of fleahoppers per 33.5 meter row long						
		Dates of sampling					Seasonal	
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81	Average	%
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	40.25	7	7.25	2.25	13.75	14.1	13.04
Seed treatment W.M. Orthene 75S	180gkg of seed (16oz/51bs)	24	12.5	5.25	6.75	10.50	11.8	10.92
Hopper treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	31.25	8.75	10.25	5.75	9.25	13.05	12.07
Hopper treatment Orthene 75S	180g/kg of seed (16oz/51bs)	35	3.5	6.75	4.25	11.25	12.15	11.24
Hopper treatment Orthene 75S	224g/kg of seed (20oz/51bs)	27.75	9	6.25	6.00	8.25	11.5	10.64
Cygon 400	220g AI/ha (.21b AI/A)	51.25	16	14.50	6.50	11	19.85	18.36
Bidrin 8 miscible	110g AI/ha .1 lb AI/A	42.25	10.25	6.75	4.25	8.75	14.45	13.37
Check	0	27.75	7.25	8.75	4.5	7.75	11.2	10.36

- W.M. = Westburn Mix
- 6-16-81 - Date of Bidrin and Cygon applications
- % = Percent of seasonal average

TABLE III

D. VAC SAMPLING FOR BIG-EYED BUGS: GEOCORIS SPP. COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of big-eyed bugs per 33.5 m. row long						
		Dates of sampling					Seasonal Average	%
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81		
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	0.25	0	0.25	0	0.25	0.15	11.56
Seed treatment W.M. Orthene 75S	180g/kg of seed (16oz/51bs)	0.25	0	0.25	0	0	0.10	7.69
Hopper treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	1	0.25	0.75	0	0	0.40	30.77
Hopper treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	0.75	0	0	0	0	0.15	11.54
Hopper treatment W.M. Orthene 75S	224g/kg (20oz/51bs)	0	0.25	0	0	0	0.05	3.85
Cygon 400	220g AI/ha .21b AI/A	1	0	0	0	0	0.20	15.4
Bidrin 8 miscible	110g AI/ha .1 1b AI/A	0.75	0.25	0	0	.25	0.25	19.23
Check	0	0	0	0	0	0	0	0

- W.M. = Westburn Mix

- 6-16-81 Date of Bidrin and Cygon applications

- % = Percent of seasonal average

TABLE IV

D. VAC SAMPLING FOR COLLOPS: COLLOPS SPP. COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of collops per 33.5 m. row long						
		Dates of sampling					Seasonal Average	%
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81		
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	.75	0	.75	0	0	.30	13.64
Seed treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	.25	.25	.50	0	.25	.25	11.36
Hopper treatment Orthene 75S	90g/kg (8oz/51bs)	.25	0	1.75	0	.50	.50	22.72
Hopper treatment Orthene 75S	180g/kg (16oz/51bs)	0	0	0	0	0	0	0
Hopper treatment Orthene 75S	224g/kg (20oz/51bs)	.25	0	1.25	.25	.50	.45	20.45
Cygon 600	220g AI/ha (.21b AI/A)	.25	.25	1.25	0	0	.35	15.91
Bidrin 8 miscible	110g AI/ha (.1 lb AI/ha)	0	0.25	0.75	0	0	0.20	9.10
Check	0	0	0.25	0.25	0	0.25	0.15	6.82

- W.M. = Westburn Mix
- 6-16-81 Date of Bidrin and Cygon applications
- % = Percent of seasonal average

TABLE V

D. VAC SAMPLING FOR LACEWINGS ADULT AND LARVA: CHRYSOPA SPP. COTTON RESEARCH STATION TIPTON, OK. SUMMER 1981

Treatment	Rates	Average number of lacewing larvae and adults per 33.5 row long													
		Date of sampling													
		6-29-81		7-08-81		7-16-81		7-22-81		7-29-81		Seasonal Average		%	
		L	A	L	A	L	A	L	A	L	A	L	A	A	L
Seed treatment Orthene 75S	90g/kg of seed (8oz/51bs)	0	0	0	0.5	0.25	0.25	0	0.25	0	0.50	0.05	0.30	11.11	11.11
Seed treatment Orthene 75S	180g/kg (16oz/51bs)	0	0	0	0.5	0.25	0	0	0	0	0.75	0.05	0.25	9.26	11.11
Hopper treatment Orthene 75S	90g/kg (8oz/51bs)	0	0.25	0	0.25	0	0.50	0	0	0	0.75	0	0.35	12.96	0
Hopper treatment Orthene 75S	180g/kg (16oz/51bs)	0	0	0	0	0.25	0	0	0	0	0.25	0.05	0.05	1.85	11.11
Hopper treatment Orthene 75S	224g/kg (20oz/51bs)	0	0.25	0	0.75	0	0.50	0	0	0	2.75	0	0.65	24.07	0
Cygon 400	220g AI/ha (.21bs AI/A)	0	0	0.50	0.50	0	0.75	0	0	0	0.50	0.10	0.35	12.96	22.22
Bidrin	110g AI/ha (.1 lb AI/A)	0	0.25	0	0.50	0.50	0	0	0	0	1.25	0.10	0.40	14.81	22.22
Check	0	0	0	0	1	0.50	0.25	0	0	0	0.50	0.10	0.35	12.96	22.22

- L = Larvae - A = Adult

- W.M. = Westburn Mix

- 6-16-81 - Date of Bidrin and Cygon applications

- % = Percent of seasonal average

TABLE VI

D. VAC SAMPLING FOR HOODED FLOWER BEETLES: NOTOXUS MONODON (F.) COTTON RESEARCH STATION TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of hooded flower beetles per 33.5 m. row long						
		Dates of sampling					Seasonal Average	%
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81		
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	2.5	4.25	5.75	0.25	2	2.95	16.1
Seed treatment W.M. Orthene 75S	180g/kg of seed (16oz/51bs)	1.5	3.0	5.25	0.25	0.25	2	10.9
Hopper treatment W.M. Orthene 75S	90g/kg (8oz/51bs)	2.25	1	2.75	0.25	1	1.45	7.9
Hopper treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	0.75	0.50	2.25	0.25	0.50	0.85	4.6
Hopper treatment W.M. Orthene 75S	224g/kg (20oz/51bs)	3.25	2.75	6.25	2.75	1	3.20	17.5
Cygon 400 W.M.	220gAI/ha (.21b AI/A)	2.0	5.25	4.00	0.50	0	2.35	12.80
Bidrin W.M.	110g AI/ha (.1 1b/A)	2.75	5	10.50	0.25	0.75	3.85	21.1
Check W.M.	0	1.25	2.75	3.00	0.50	0.75	1.65	9.1

- W.M. = Westburn Mix
- 6-16-81 Date of Bidrin and Cygon applications
- % = Percent of seasonal average

TABLE VII

D. VAC SAMPLING FOR LADYBEETLES: HIPPODAMIA SPP. COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of lady beetle per 33.5 m. row long						
		Dates of sampling					Seasonal	
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81	Average	%
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	2	0.25	1.25	0	0	0.70	10.77
Seed treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	2	0.50	0	0	0	0.50	7.70
Hopper treatment W.M. Orthene 75S	90g/kg (8oz/51bs)	2.5	1	1.25	0	0	0.95	14.61
Hopper treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	1.25	0.25	0.75	0	0.25	0.50	7.70
Hopper treatment W.M. Orhtene 75S	224g/kg (20oz/51bs)	3	0.75	0.50	0	0.50	0.95	14.61
Cygon 400 W.M.	200g AI/ha .21b/ha	4.75	1	0.50	0	0	1.25	19.23
Bidrin W.M.	110g/AI/ha .1 lb AI/ha	3.00	0.75	0.50	0	0	0.85	13.08
Check	0	2.00	0.50	1.50	0	0	0.80	12.31

- W.M. = Westburn Mix
- 6-16-81 Date of Bidrin and Cygon treatment
- % = Percent of seasonal average

TABLE VIII

D. VAC SAMPLING FOR NABIDS: NABIS SPP. COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of nabids per 33.5 m. row long						
		Dates of sampling					Seasonal Average	%
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81		
Seed treatment W.M. Orthene 75S	90g/kg seed (8oz/51bs)	2	3.5	8	0.25	0.25	2.8	9.54
Seed treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	0.25	3.75	7.50	0.50	0	2.40	8.18
Hopper treatment Orthene 75S	90g/kg (8oz/51bs)	1.25	5.50	12.25	1	1	4.20	14.30
Hopper treatment Orthene 75S	180g/kg (16oz/51bs)	3.50	1.50	10	0.75	0.25	3.20	10.90
Hopper treatment Orthene 75S	224g/kg (20oz/51bs)	1	3.75	6.75	2.50	0.50	2.90	9.90
Cygon 400	220g/AI/ha (.21b AI/A)	2.25	9.75	9.75	0.25	0.50	4.50	15.32
Bidrin 8 miscible	110g AI/ha (.1 1b AI/A)	2.25	4.	19.50	0.25	0.50	5.30	18.06
Check	0	2.50	5.50	11.75	0.25	0.25	4.05	13.80

* Numbers followed by the same letter are not significantly different at .05 level

- W.M. = Westburn Mix

- 6-16-81 - Date of Bidrin and Cygon applications

- % = Percent of seasonal average

TABLE IX

D. VAC SAMPLING FOR SPIDERS
COTTON RESEARCH STATION.
TIPTON, OK. SUMMER 1981

Treatments	Rates	Average number of spiders per 33.5 m. row long						
		Dates of sampling					Seasonal	
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81	Average	%
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/5lbs)	3	23.75^{*}_{b}	17.25_{b}	1.5	1.25	9.25	13.22
Seed treatment W.M.	180g/kg (16oz/5lbs)	2.25	14.25_{c}	12.50_{b}	0.50	1	6.10	8.96
Hopper treatment Orthene 75S	90g/kg of seed (8oz/5lbs)	2.75	22.25_{b}	24.25_{ab}	1.75	3	10.80	15.87
Hopper treatment Orthene 75S	180g/kg (16oz/5lbs)	2.75	10.5_{c}	13_{b}	1.25	1.75	5.85	8.60
Hopper treatment Orthene 75S	224g/kg (20oz/5lbs)	1.25	10_{c}	14.50_{b}	5	2	6.55	9.62
Cygon 400	220g AI/ha (.2lb AI/A)	0.75	29_{a}	17_{b}	3	0.50	10.05	14.77
Bidrin 8 miscible	110g AI/ha (.1 lb AI/A)	0.75	10.75_{c}	34.75_{a}	3	1.50	10.15	14.91
Check	0	1	25_{ab}	16_{b}	2.50	2	9.30	13.67

* Numbers followed by the same letter are not significantly different at .05 level

- W.M. = Westburn Mix

- 6-16-81 - Date of Bidrin and Cygon applications

- % = Percent of seasonal average

TABLE X

D. VAC SAMPLING FOR TOTAL BENEFICIALS COTTON RESEARCH STATION. TIPTON, OK. SUMMER 1981

Treatments	Rates	Average of total beneficials per 33.5 m. row long						
		Dates of sampling					Seasonal Average	%
		6-29-81	7-08-81	7-16-81	7-22-81	7-29-81		
Seed treatment W.M. Orthene 75S	90g/kg of seed (8oz/51bs)	10.50	31.25	33.75 b *	2.25	4.25	16.50	12.80
Seed treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	6.25	22.25	26.25 b	1.25	2.25	11.65	9.04
Hopper treatment W.M. Orthene 75S	90g/kg (8oz/51bs)	10.25	30.25	43.50 b	3.0	6.25	18.65	14.48
Hopper treatment W.M. Orthene 75S	180g/kg (16oz/51bs)	9	12.75	26.25 b	2.25	3.00	10.65	8.26
Hopper treatment Orthene 75S	224g/kg (20oz/51bs)	9	18.25	29.75 b	10.50	6.25	14.75	11.46
Cygon 400	220gAI/ha .2 lb AI/A	11	46.25	33.25 b	3.75	1.50	19.15	14.86
Bidrin	110g AI/ha .1 lbs AI/A	9.75	21.50	66.50 a	3.50	4.25	21.10	16.37
Check	0	6.75	35.00	33.25 b	3.25	3.75	16.40	12.73

* Number followed by the same letter are not significantly different at 5% level

- W.M. = Westburn Mix
- 6-16-81 Date of Bidrin and Cygon applications
- % = Percent of seasonal average

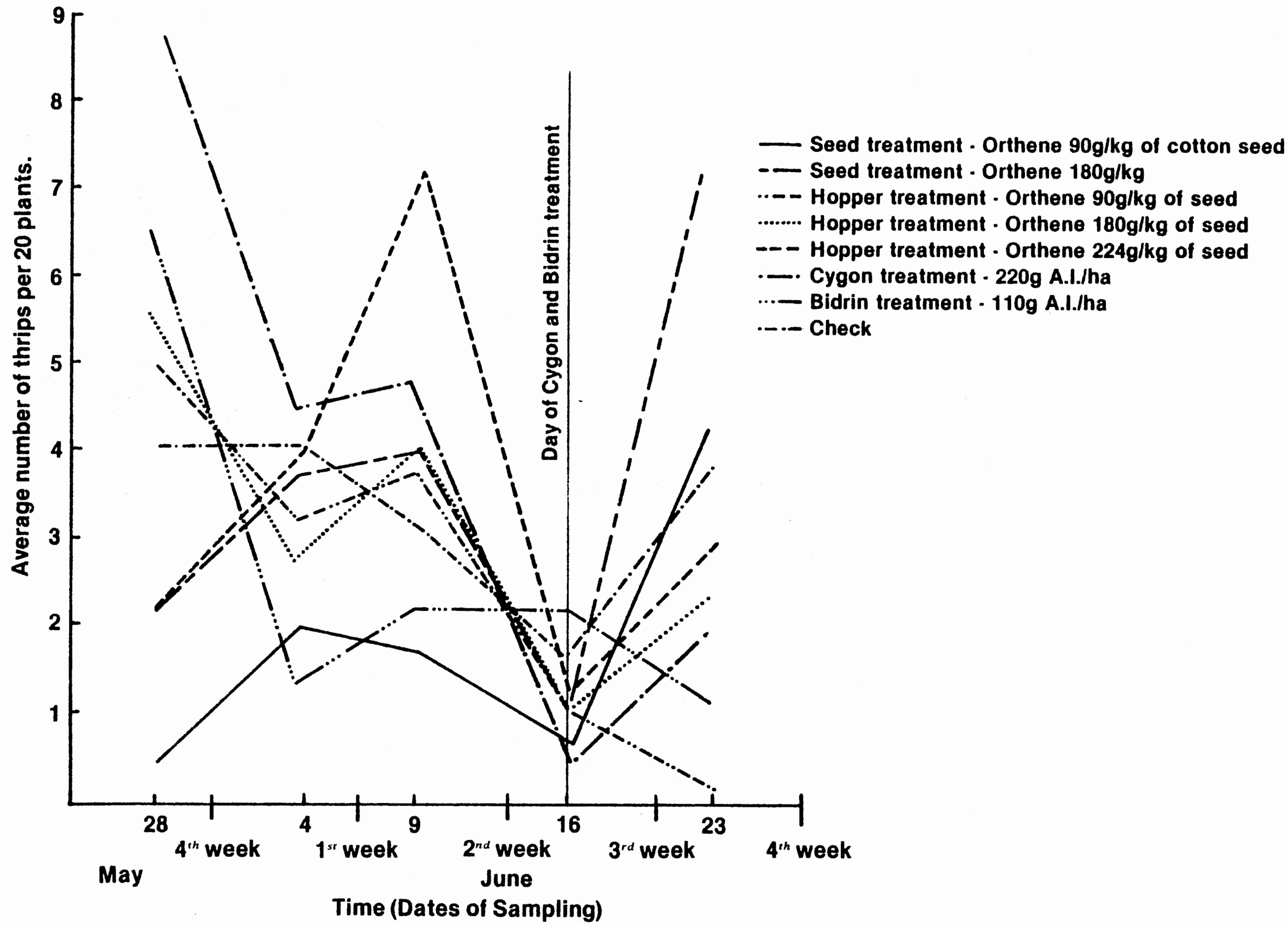

Figure 1. Population Trends of Thrips Under Different Insecticide Programs in Cotton in Tipton Cotton Research Station Summer 1981

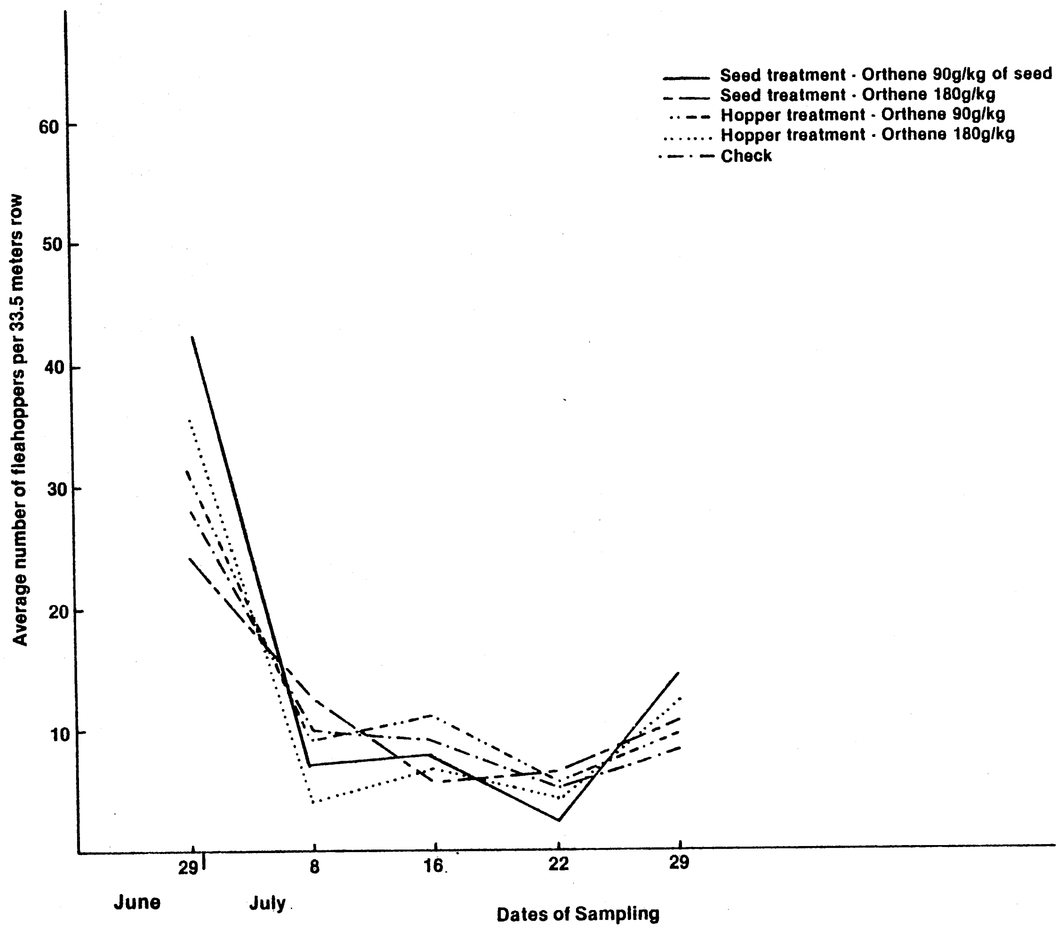

Figure 2. Population Trends of Fleahoppers Under Different Orthene Programs in Cotton in Tipton Cotton Research Station. Summer 1981

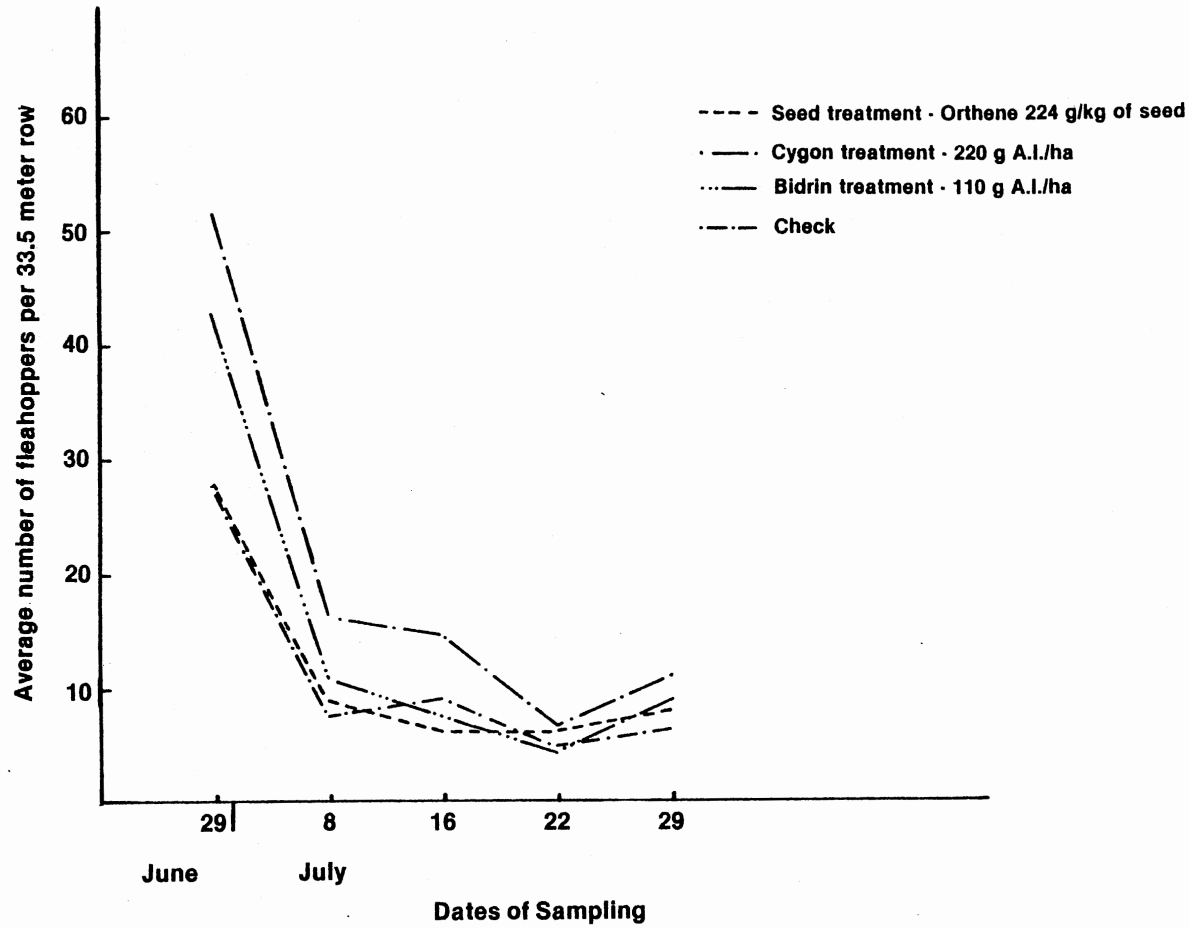

Figure 3. Population Trends of Fleahoppers Under Different Insecticide Programs in Cotton in Tipton Cotton Research Station. Summer 1981

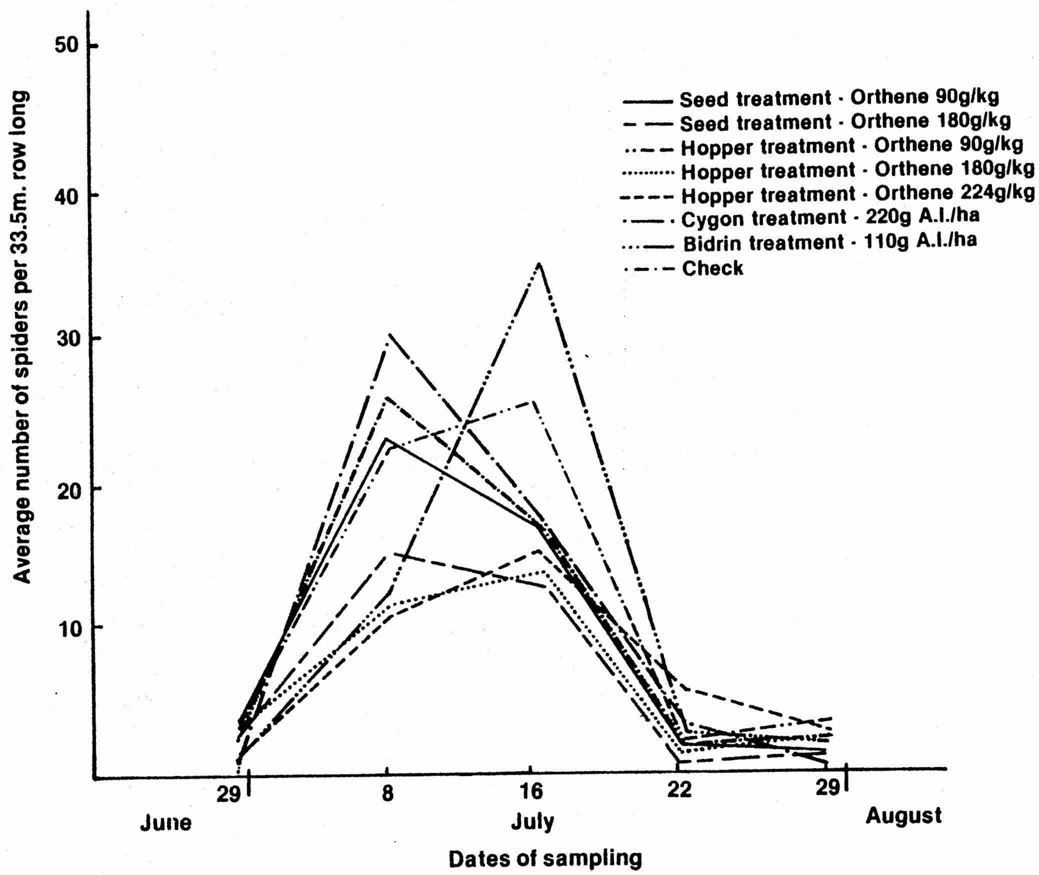

Figure 4. Population Trends of Spiders Under Different Insecticide Programs in Cotton in Tipton Cotton Research Station Summer 1981

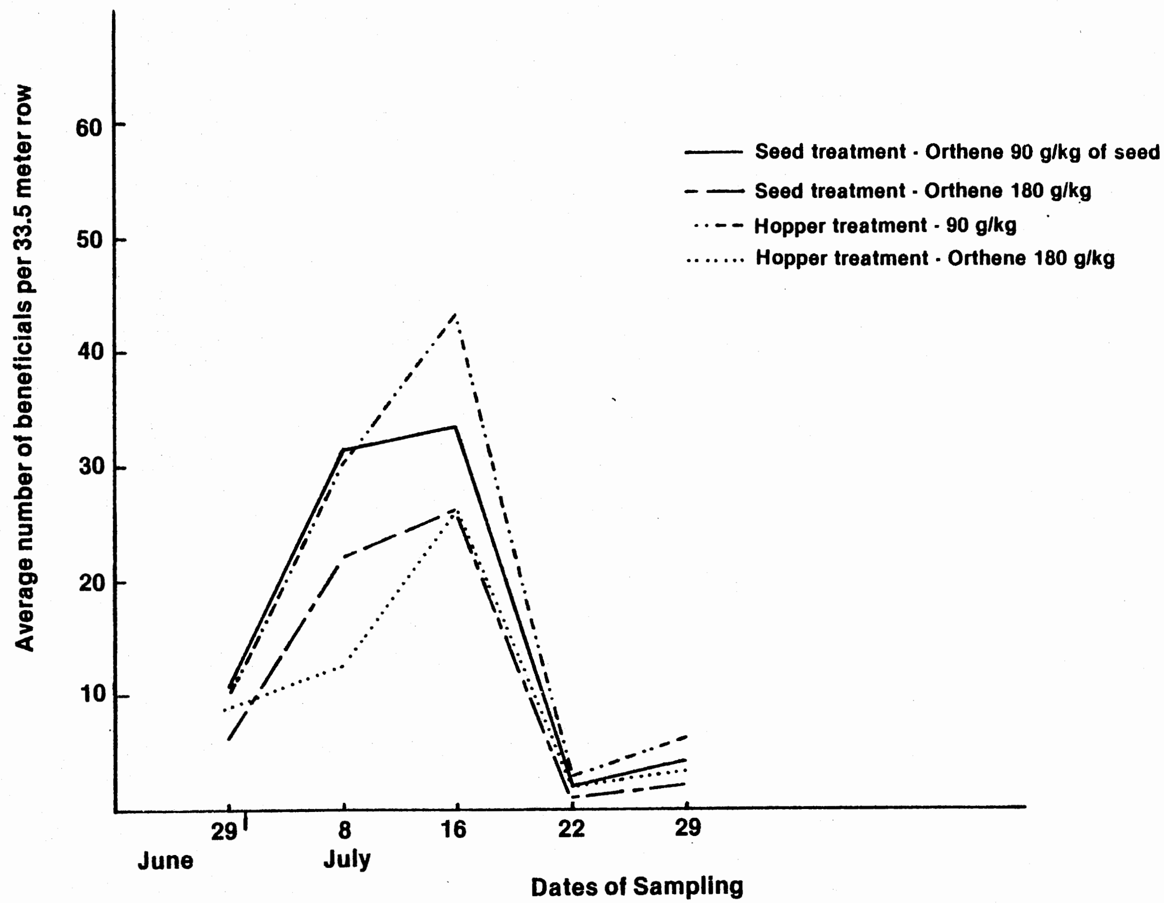

Figure 5. Population Trends of Beneficials Under Different Orthene Treatments in Cotton in Tipton Cotton Research Station. Summer 1981

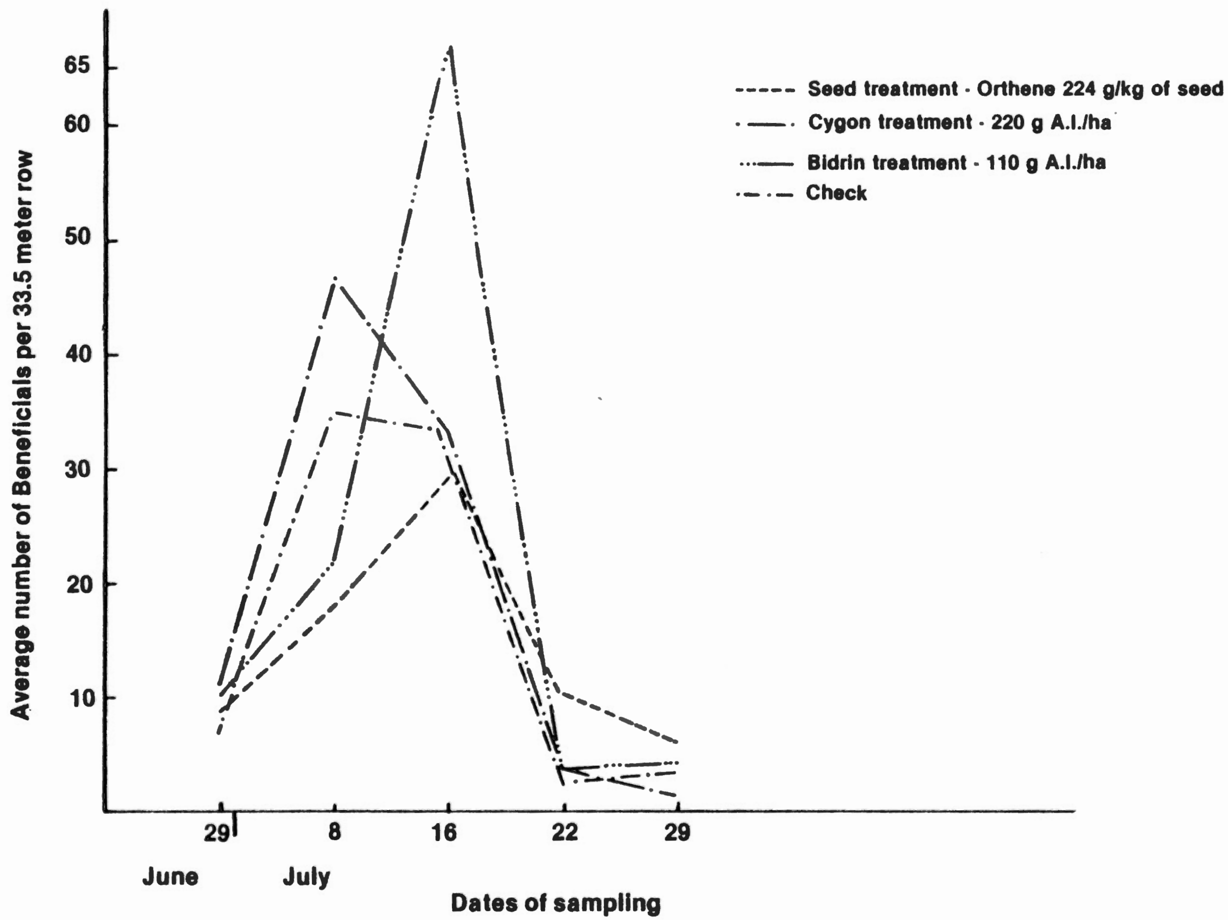

Figure 6. Population of Beneficials Under Different Insecticide Programs in Cotton in Tipton Cotton Research Station Summer 1981

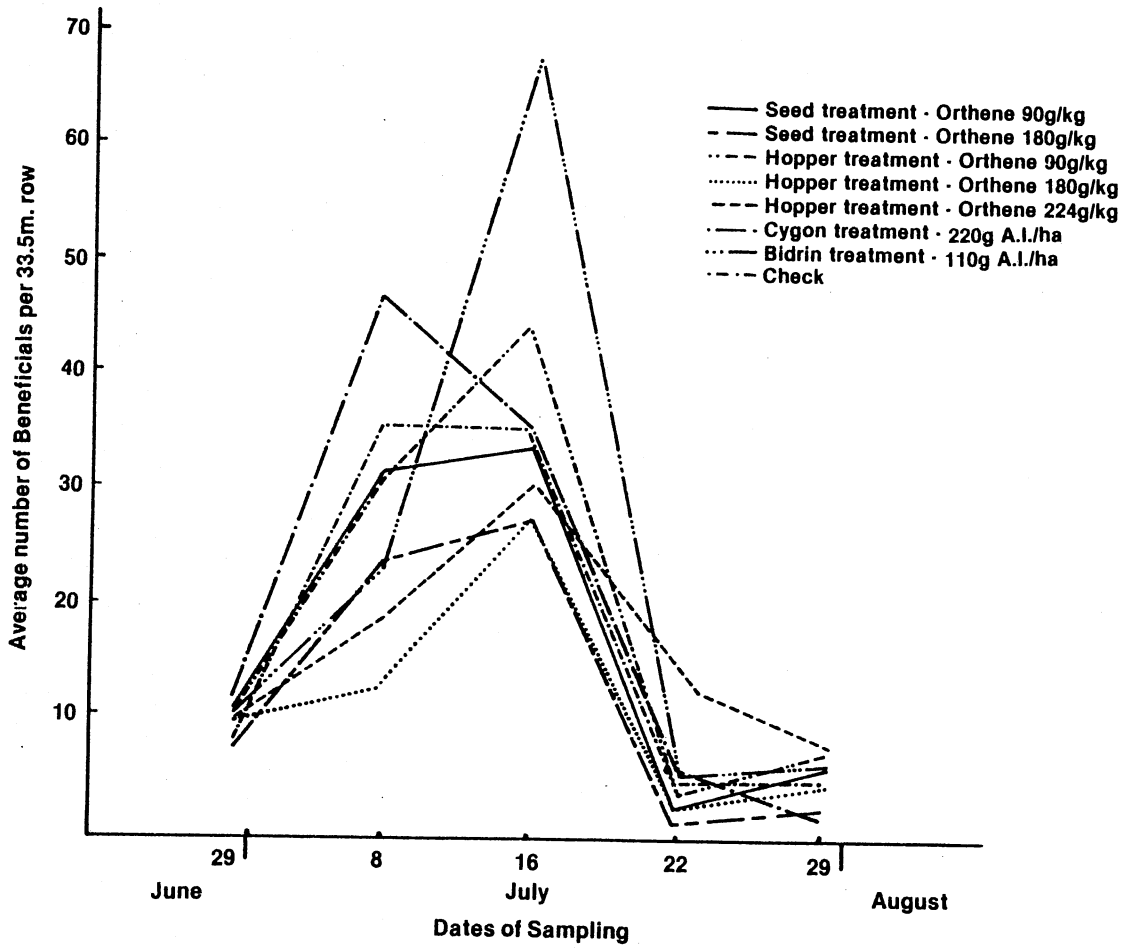

Figure 7. Population Trends of Beneficials Under Insecticide Programs in Cotton in Tipton Cotton Research Station. Summer 1981

VITA

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Master of Science

Thesis: EFFECTS OF EARLY SEASON INSECTICIDE APPLICATION ON COTTON FLEAHOPPER AND THRIPS AND ON SEVERAL PREDACEOUS ARTHROPOD POPULATIONS IN COTTON

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