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INSECTICIDES AND BENEFICIAL INSECTS IN COTTON FIELDS

Beneficial insect populations are often reduced by insecticides applied for control of specific pest species. The seven insecticides evaluated in this progress report were found to affect adversely the populations of six of the common predators in cotton fields. Populations of some beneficial insects (though severely reduced) recovered rapidly in plots treated with organophosphate materials that have short residual properties—but failed to recover rapidly in plots treated with long-residual materials.

EVALUATING THE EFFECT of pesticidal chemicals on beneficial insects is one of the research responsibilities of University of California entomologists. This progress report summarizes studies conducted on cotton during the past three years during which more than 15 toxicants were evaluated for their effect on common beneficial species. The results obtained with seven toxicants are analyzed in this article.

A great many of the insects and insect-like species that frequent cotton fields are beneficial, since they prey upon the plant-feeding species. They are extremely helpful to the farmer in his battle to suppress and control the insects and mites that attack his crop. Each pest species is preyed upon by a number of predators and parasites which often prevent it from reaching more destructive status.

Modern insecticides have served an outstanding role in pest control. They have also served to remind us of the significance of the naturally occurring beneficial organisms. The pesticides may provide excellent control of target insects but they frequently destroy the natural enemies of these and other pest species. The result may be a resurgence of the target insects or outbreaks of otherwise innocuous species.

University of California entomologists are presently investigating the role of many beneficial insects and spiders in controlling pest species. A recent U.C. publication, "Predaceous and Parasitic Arthropods in California Cotton Fields," Agricultural Experiment Station Bulletin 820, summarizes the available information on beneficial species in cotton fields.

The predators given consideration in this article, and their known prey, are as follows: Minute pirate bugs, *Orius tristicolor* (White), prey on spider mites, thrips, small bollworms, and other larvae. Big-eyed bugs, *Geocoris pallens* Stal, prey on spider mites, lygus nymphs, leafhoppers, small bollworms, and other insects. Damsel bugs, *Nabis americoferus* Carayon, prey on lygus nymphs, leafhoppers, small caterpillars, etc. The alligatorlike larvae of the green lacewings, *Chrysopa* spp., prey on spider mites, bollworms, aphids and many other soft-bodied insects. Collops beetles, *Collops vitatus* (Say), prey voraciously on spider mites and on the eggs of bollworms and other moths. Araneid or true spiders, of which there are more than a dozen species, prey on many other insects. Some feed on lygus, others on bollworms, still others on spider mites.

Beneficial insects move from field to field in search of hosts. They are usually present when pests arrive, and can become numerous on pest populations that are below the economic level of infestation. At times they may become abundant in nearby crops or pasture areas on the same or similar host insects and may move into cotton fields in great abundance. If they are destroyed by a pesticide, populations of their prey will increase and may become very destructive.

Procedure

The insecticides used in these investigations were applied for control of the lygus bug, utilizing conventional equipment and dosages recommended by the

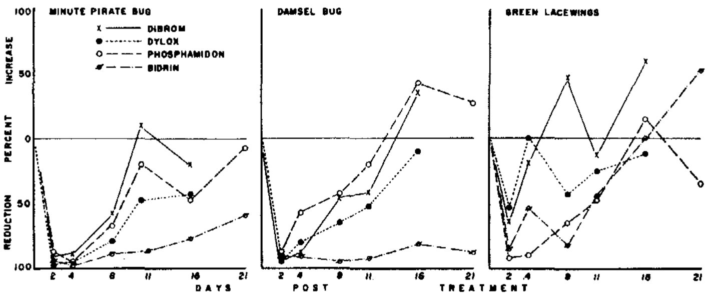

Fig. 1. Populations of minute pirate bugs, damsel bugs and green lacewings during August in experimental plots treated with four insecticides. Arvin, Kern County, 1963.

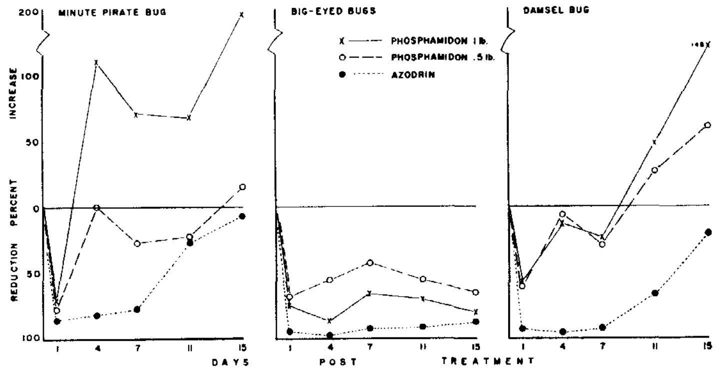

Fig. 3. Populations of minute pirate bugs, big-eyed bugs and damsel bugs during August in experimental plots treated with three insecticides, University of California West Side Field Station, 1964.

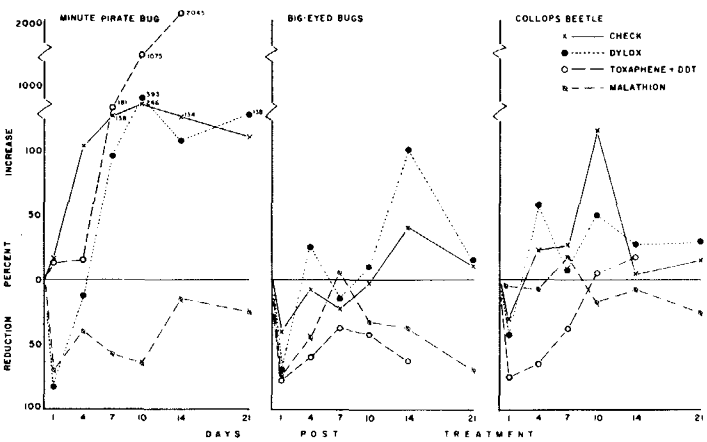

Fig. 2. Populations of minute pirate bugs, big-eyed bugs, and collops beetles during July and August in plots treated with three insecticides and in an untreated check, University of California West Side Field Station, 1963.

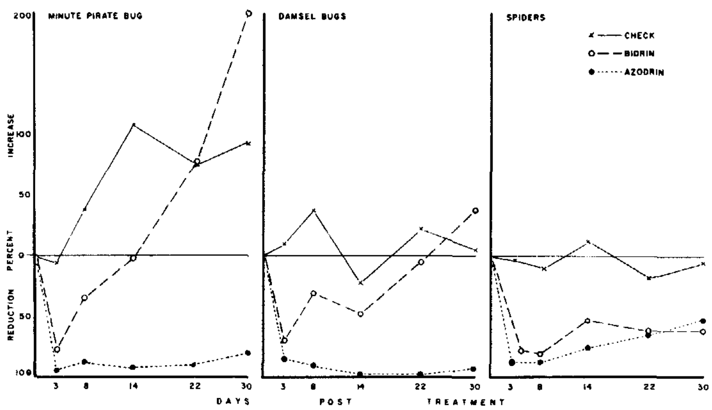

Fig. 4. Populations of minute pirate bugs, damsel bugs and spiders during August and early September in experimental plots treated with two insecticides and in an untreated check, University of California West Side Field Station, 1964.

University or the manufacturer. They were timed to coincide with applications made by the cotton grower.

The seven insecticides evaluated in this progress report and the rates per acre at which they were applied are: toxaphene + DDT, 2 lb + 1 lb; Azodrin, 0.5 lb; Bidrin, 0.5 lb; Dibrom, 0.5 lb; Dylox, 1.0 lb; malathion, 1.0 lb and phosphamidon at 0.5 and 1.0 lb. All of these materials are presently sold for use on cotton in California.

The insecticides were evaluated for their initial effect on the predator populations and for their effect over a two-to-six-week period. Adult and immature stages of the pest and beneficial insect species were collected with a D-Vac vacuum insect sampler before and on several occasions after the insecticide was applied. The field-collected samples were processed through modified Berlése funnels and the insects obtained were identified and counted under a microscope. Results are presented in the graphs.

The influence of seven insecticides on populations of the minute pirate bug was investigated in four experiments. In the first experiment Dibrom, Dylox, phosphamidon, and Bidrin were evaluated (fig. 1). The data show that all materials caused reductions of 90 to 95% in the minute pirate bug populations within 24 hours after application and that the populations remained depressed for at least four days. One material, Bidrin, suppressed the populations throughout the 21-day sampling period. In all other treatments the minute pirate bug populations began to increase after the fourth day, but with Dylox and phosphamidon they failed to reach the pre-treatment level even after 16 days. The more rapid recovery of populations in plots treated with Dibrom, Dylox and phosphamidon was apparently related to the short residual toxicity of these materials.

Experiment 2 measured the effects of Toxaphene + DDT, Dylox, and malathion on the minute pirate bug (fig. 2). One treatment, Toxaphene + DDT, had no apparent adverse effect and the population actually increased during the sampling period. This increase was apparently correlated with an increase in spider mite (*Tetranychus* spp.) abundance in the plots. Dylox and malathion were about equally destructive to minute pirate bug populations within the first 24 hours following treatment, but thereafter the numbers increased rapidly in the Dylox plots while they remained low in the malathion treatment throughout the 21-day sample period.

Experiment 3 measured the effect of two dosages of phosphamidon and one dosage of Azodrin on the minute pirate bug (fig. 3). All three materials caused sharp reductions in populations at first. Populations remained low in the Azodrin treatment throughout the seventh day after treatments, then increased to near the pre-treatment level by the end of the test period. Following the initial reductions by phosphamidon, the minute pirate bug populations returned to the pre-treatment level in the plots treated at 0.5 lb per acre and increased by more than 100% over the pre-treatment level in the plots treated at 1.0 lb per acre. The increase in the plots treated at 1.0 lb per acre appeared to be related to the rapid buildup of the Pacific spider mite (*Tetranychus pacificus* McG.).

Experiment 4 compares the effects of Bidrin and Azodrin on the minute pirate bug (fig. 4). Both materials reduced the populations drastically and they remained low in the Azodrin plots throughout the 30-day sample period. The populations in the Bidrin plots returned to the pre-treatment level in 14 days and increased greatly thereafter. This increase following the Bidrin treatment appeared related to an increase in spider mites (which became very abundant by the 22nd day).

Big-eyed bugs

The effect of five insecticides on big-eyed bugs was measured in two experiments. The first included Dylox, toxaphene + DDT, and malathion (fig. 2). The three insecticides cause an initial reduction of about 70% in the populations. The big-eyed bug populations in the check plots were also reduced to some extent. This insect is quite active and many adults undoubtedly moved into the treated areas where they may have been killed, or may have served to replace the bugs that were destroyed earlier by the treatment. The populations recovered in the Dylox plots in four days and exceeded the check through the 21-day sample period. The populations in the malathion treatment returned to their original levels by the seventh day, but declined thereafter through 21 days. In the toxaphene + DDT plots the big-eyed bug populations recovered to about 50% by seven days but remained depressed through the fourteenth day.

The second experiment compared the effect of phosphamidon at two dosages, and Azodrin at one dosage on big-eyed bugs (fig. 3). Azodrin initially reduced the population by 90% and continued to have a strong reducing effect through 15 days. Phosphamidon was not as severe as Azodrin in its initial effect, reducing the populations by about 65% at the 0.5- and 75% at the 1.0-lb dosages. The populations remained depressed throughout the test period.

The effect of five insecticides on damsel bugs was measured in three experiments. The first experiment compared the effect of Dibrom, Dylox, phosphamidon and Bidrin (fig. 1). All of the materials reduced damsel bug numbers by 90% or more. The populations remained low in the Bidrin treatment throughout the 21-day test period. In plots treated with the other materials, populations recovered gradually. In the Dibrom and phosphamidon plots they exceeded the pre-treatment counts by the sixteenth day after treatment, while abundance in the Dylox plots remained slightly below the pre-treatment level.

The second experiment compared the effect of phosphamidon at two dosages and Azodrin at one dosage (fig. 3). Azodrin caused a 95% reduction one day after application and damsel bugs remained at near this point through seven days, then increased to near the pre-treatment level by 15 days after application. Phosphamidon at both dosages reduced the populations by 60%. The populations returned to near the pre-application level four days later, declined slightly on the seventh day, and then increased greatly through the fifteenth day.

The third experiment compared the effect of Bidrin and Azodrin (fig. 4). Bidrin reduced the damsel bug populations by 65% and Azodrin by 85% by the third day after application. Populations remained low in the Azodrin treatment for 30 days. In the Bidrin plots, the populations recovered to equal the pre-treatment count in 22 days.

Green lacewings, collops and spiders

The effects of four insecticides (Bidrin, Dibrom, Dylox and phosphamidon) on combined adult and larval green lacewing populations are summarized in fig. 1. Bidrin reduced the numbers of this insect by 93% and phosphamidon by 85% two days after application. The populations increased gradually and reached the pre-treatment level 16 days later. Dibrom and Dylox caused reductions in abundance of nearly 50% in 2 days. These materials had limited residual effects and the green lacewing numbers increased to or near the pre-treatment level in four days. During the remaining test period the populations showed a great deal of fluctuation.

The effect of three insecticides, Dylox, toxaphene + DDT and malathion, on populations of collops beetles is summarized in fig. 2. The combination of toxaphene + DDT proved to be the most destructive to this insect, initially causing a 75% reduction in the population. Thereafter the population increased, and reached the pre-treatment level in 10 days. Dylox reduced the collops population by 40% in one day. The numbers then increased to exceed the pre-treatment level for the remainder of the test period. The populations in the malathion plots remained nearly stable throughout the 21-day test period, indicating little effect by the material. A 120% increase was evident in the check at the 10-day evaluation followed by a return to the pre-treatment level by the fourteenth day.

The effects of Bidrin and Azodrin on populations of the Araneid (true) spiders are summarized in fig. 4. Spider abundance was reduced by more than 75% with both materials and the population levels remained below 50% of that in the untreated plots for the remainder of the test period. The populations in the untreated plots remained stable through the entire test period.

Each of the seven insecticides was detrimental to one or more of the six groups of beneficial organisms. Differences were evident between insecticides for each species and the predator species reacted differently to a particular insecticide. For example, the combination of toxaphene + DDT was not detrimental to the population of minute pirate bugs, but reduced big-eyed bug and collops beetle populations severely. All of the organophosphorus compounds reduced populations of minute pirate bug, big-eyed bugs and damsel bugs. Some of these populations recovered rapidly, particularly in treatments with insecticides such as phosphamidon, Dibrom, and Dylox which have a short residual effect. By contrast, the populations frequently failed to recover in plots treated with materials such as Azodrin and Bidrin which have longer residual effects. Populations of green lacewings were reduced by the materials tested, but showed good recovery ability, apparently as a result of the mobility of the adults. Spider populations which are often little affected by the organophosphorus materials were greatly reduced by the two materials tested and failed to recover by the end of the 30-day sampling period.

Evaluation of insecticides for their influence on beneficial insects and similar organisms is a continuing University program. New insecticides are being tested in the pesticide screening program, and new methods of use are being studied for the older materials, the objective being the development of effective pest control methods that utilize the naturally occurring beneficial insects, mites, and spiders.

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