EFFECTS OF SELECTED PESTICIDES ON POPULATIONS OF BENEFICIAL ARTHROPODS IN LOWER RIO GRANDE VALLEY COTTON

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Abstract

Comparative effects of early-season applications of azinphosmethyl, oxamyl, two rates of endosulfan, ULV malathion, and fipronil on populations of beneficial arthropods in cotton were examined in large-plot field studies. Two applications of each insecticide were applied to coincide with the normal timing of producer applications for control of overwintered boll weevils. Treatment effects were evaluated by sweep net and drop cloth samples, and collections by a tractor-mounted sampler. Few treatment effects could be statistically demonstrated after the 1st application because of generally low population levels of beneficial arthropods and absence of an untreated check. However, population trends suggested that applications reduced beneficial arthropod population levels temporarily. Analyses of second application effects indicated that all insecticides usually resulted in an immediate suppresion of beneficial populations, followed by a population recovery that appeared to be caused by immigration. Thus, choice of early-season insecticide appeared to have little influence on effects of these applications on beneficial arthropod populations. In addition, general disruption of the natural enemy complex in cotton was not achieved in field-sized treatment areas because of immigration of beneficial arthropods from surrounding areas.

Introduction

Following severe secondary pest problems in the cotton crop of the Lower Rio Grande Valley of Texas in 1995 (Summy *et al.* 1996), the Boll Weevil Eradication Program, cotton producers, and scientists expressed considerable interest in identifying alternate materials to replace ULV malathion in area-wide boll weevil suppression programs. However, comparative data regarding the effects of alternate materials on early-season beneficial arthropod populations are lacking. We examined the temporal effects of ULV malathion and four potential replacement insecticides on population dynamics of selected early-season beneficial arthropods.

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Materials and Methods

Four individual fields, ranging in size from 12.5 to 35.8 acres, in the vicinity of Monte Alto, TX were used as replicates. Chemical treatments randomly assigned within replicate fields included endosulfan (Phaser 3E; 0.375 and 0.5 lb. a.i./acre), azinphosmethyl (Guthion 2L; 0.25 lb. a.i./acre), oxamyl (Vydate 3.77 CLV; 0.25 lb. a.i./acre), and fipronil (Regent 2.5 EC; 0.05 lb. a.i./acre). Inclusion of fipronil was limited to three replicates because of acreage restrictions imposed by the experimental use permit. ULV malathion (technical material; 12 oz./acre) was included as an adjunct treatment, but because of drift concerns, the malathion plots were established in fields adjacent to the primary treatment fields. Untreated areas of the ULV malathion fields were subject to normal producer treatment regimes.

Plots in each field were established by dividing the row length of each field by the number of insecticide treatments and adjusting the results to yield plot widths that were approximate multiples of the aircraft swath width. Thus, plots in each field were approximately the same size except in field 2, where acreage constraints imposed by the experimental use permit resulted in the fipronil plot being about one-half the width of the other plots. ULV malathion plots in adjacent fields were at least 3 aircraft swaths wide.

All insecticide treatments were applied using a Cessna A188B aircraft operating at 120 mph and 5 ft above ground level. ULV malathion (12 oz./acre) was applied at a pressure of 40 psi using nine SS 8002FF nozzles and a 75 ft swath width. Other materials were applied at a pressure of 40 psi using 44 nozzles (SS 8002FF), resulting in an application rate of 3 gal of spray mixture per acre and a swath width of 60 ft. All treatments except the ULV malathion treatment associated with field 1 were applied perpendicular to the row.

Application of insecticide treatments was intended at matchhead square stage, followed by a second treatment 5-7 days later. However, windy conditions (>10 mph) frequently prevented completion of all scheduled applications on a given day. All treatments were applied to field 1 on 30 April and repeated on 7 May. Both rates of endosulfan were applied to fields 2 and 3 on 11 May and repeated on 16 May. Fipronil (field 2 only) and oxamyl (fields 2 and 3) were applied on 11 and 17 May. Initial applications of azinphosmethyl and ULV malathion were made to fields 2 and 3 on 8 May. Second applications of azinphosmethyl and ULV malathion were made on 16 and 14 May, respectively. All treatments were applied to field 4 on 7 and 14 May, except that the second application of oxamyl was made on 15 May.

Arthropods were sampled using a tractor-mounted mechanical sampler (described elsewhere in these proceedings), sweep net, and drop cloth techniques. Four sample areas within each plot were established. Sample areas consisted of the center 10 of 20 outside rows on each end of each plot, and the center 10 of 20 rows in the center of each half of the remainder of each plot. Sample areas were 50 m in length except when plots were too short (e.g. fipronil plot in field 2), in which case sample areas were 25 m long. On each sample date, one mechanical sample, one sweep net sample, and two drop cloth samples were collected from each sample area. Rows sampled by the mechanical sampler were selected randomly without replacement. Mechanical samples taken from 25-m long sample areas were duplicated and subsequently combined. Sweep net samples (50 pendulum sweeps across the row per sample) were taken within a few rows of the mechanical samples. One drop cloth sample was taken on either side of each sample area using a standard 1-m² cloth supported on either side by a fiberglass rod. Sweep net and drop cloth samples were processed and recorded in the field. Mechanical samples were returned to the laboratory where larger pieces of plant debris were removed by a series of sieves and the contents of the sieves were examined under a dissecting microscope. Arthropods sampled included adults of the boll weevil (*Anthonomus grandis*), adults and nymphs of the minute pirate bug (*Orius* spp.), big-eyed bug (*Geocoris* spp.), and damsel bug (*Nabis* spp.), adults and larvae of the green lacewing (*Chrysoperla* spp.) and ladybeetles (primarily *Hippodamia* spp.), spiders, and lepidopterous larvae.

A pretreatment sample was usually collected from each field on the day before each insecticide application. When all treatments within a field were not applied on the same day, it was not possible to resample the untreated plots before treatment application. Thus, a few of the pretreatment samples were collected as many as four days before insecticide application. Plots were resampled at 24 and 72 h after each treatment application. Following the 72-h sampling of the last application, sampling was continued at weekly intervals until termination of the study. Pretreatment sweep net samples were not obtained from field 1 because plants were not tall enough for effective sampling. Also, irrigation prevented completion of sampling activities (sweep net samples were not obtained) in the oxamyl plot of field 4 at 72 h after treatment application.

The data were not analyzed by repeated measures analysis because of missing data and an unbalanced design (only three replications of the fipronil treatment). Data for individual arthropod taxa were examined in separate analyses for first and second applications by analysis of variance using the SAS procedure GLM (SAS Institute 1988). The initial model incorporated main effects of treatment (insecticide) and sampling time (pretreatment, 24, and 72 h after treatment), and a treatment by sampling time interaction. The interaction term was not significant in any analysis and consistently inflated the mean square error, and was therefore omitted from the final model. When significant differences in main effects were indicated, means were compared using the REGWQ option of PROC GLM (SAS Institute 1988).

Results and Discussion

At the time of initial treatment applications, mean plant heights ranged from 7.9 in. (field 1) to 10.2 in. (field 3), and populations of ≥1/3-grown squares ranged from an average of 0.71 to 0.88 per plant. Mean plant heights ranged from 9.1 in. (field 2) to 13.8 in. (field 3), and square populations from 1.51 (field 2) to 4.08 squares per plant (field 3) at the time of the second applications. Mean plant heights ranged from 11.0 in. (field 2) to 18.3 in. (field 3), and square populations from 2.73 (field 2) to 7.59 squares per plant (field 1) at the termination of the study.

Numbers of boll weevil adults, punctured squares, and lepidopterous larvae were too small to provide meaningful analyses. Beet armyworm larvae were present on most sample dates but never exceeded a mean of 1.29 larvae per sample. Typically, <0.1 larvae were collected per sample regardless of sampling method. Collections were primarily composed of first and second instars.

No significant differences in population levels of beneficial arthropods associated with the initial insecticide applications were observed among treatments or sample times when samples were collected by mechanical or drop cloth methods. Differences among sampling times in populations of pirate bug adults and lady beetle larvae were indicated by sweep net samples. Mean numbers of pirate bug adults were reduced from 0.51/pretreatment sample to 0.02/sample at 24 h after treatment, but levels rebounded to a mean of 0.26/sample by 72 h after treatment. Observed changes in lady beetle larval population were not caused by insecticide treatments because mean numbers per sample increased from 0.01 and 0.07 larvae in pretreatment and 24 h samples, respectively, to 0.42 larvae at 72 h after treatment.

Mechanical samples indicated differences among treatments associated with the second applications in populations of damsel bug nymphs and spiders, and differences among sampling times in populations of damsel bug adults, big-eyed adults and nymphs, lady beetle adults, and spiders. Although differences among treatments in populations of damsel bug nymphs were indicated (F=3.02; df=5, 61; P=0.017), multiple comparison procedures could not identify the source of those differences (mean number of damsel bugs ranged from 0.02/sample in the oxamyl treatment to 0.44/sample in the ULV malathion treatment). Spider population levels were higher in the ULV malathion treatment (5.48/sample) than in the azinphosmethyl treatment (1.46/sample), with levels of other treatments

being intermediate (F=2.51; df=5, 61; P=0.04). Examination of differences among sample times indicated that population levels of damsel bug adults (F=4.69; df=2, 61; P=0.01), big-eyed bug adults (F=17.25; df=2, 61; P<0.01), and lady beetle adults (F=12.49; df=2, 61; P<0.01) were reduced at 24 and 72 h after treatment compared with pretreatment samples. Although differences among sample times were indicated for big-eyed bug nymphs (F=3.17; df=2, 61; P=0.05), multiple comparison procedures did not indicate the source of those differences.

Sweep net samples indicated no differences among insecticide treatments, but differences among sampling times were detected for damsel bug adults, big-eyed bug adults and nymphs, lady beetle adults, and spiders. Population levels of damsel bug adults (F=8.63; df=2, 60; P<0.01), big-eyed bug adults (F=10.73; df=2, 60; P<0.01), lady beetle adults (F=10.57; df=2, 60; P<0.01), and spiders (F=7.39; df=2, 60; P<0.01) were reduced by insecticide treatments at 24 and 72 h after treatment application. Differences among sampling times in population levels of big-eyed bug nymphs were not caused by insecticide treatments because population levels increased from 0.03 and 0.02/sample in pretreatment and 24 h samples, respectively, to 0.12/sample in 72 h samples.

Drop cloth samples indicated differences among insecticide treatments in population levels of big-eyed bug nymphs (F=2.79; df=5, 61; P=0.04) and lady beetle larvae (F=3.45; df=5, 61; P<0.01), and differences among sampling times for populations of lady beetle adults (F=8.94; df=2, 61; P<0.01). The multiple comparison procedure did not identify differences among insecticides in numbers of big-eyed bug nymphs (mean number per sample ranged from 0.0 in the fipronil treatment to 0.80 in the high rate of endosulfan). Population levels of lady beetle larvae were higher in the oxamyl treatment (1.90/sample) than in the fipronil (0.58/sample), ULV malathion (0.43/sample), or azinphosmethyl (0.20/sample) treatments. Population levels in other insecticide treatments were intermediate. Differences among sampling times indicated for lady beetle larvae could not be identified by multiple comparison procedures.

Although significant differences in the impacts of the various insecticides on several beneficial arthropod taxa were detected, these differences were probably artifactual. Lack of significant treatment by sampling time interactions indicated that differences in population levels of beneficials observed among sampling times were similar among treatments. Therefore, where differences in population levels of a given taxa were detected among insecticides, those differences existed both before and after treatment application.

Power in our analyses was probably reduced by the generally low population levels of individual taxa, absence of an untreated check, and the differences in species composition among replications (figs. 1-4). Regardless, our data indicate no real evidence of differences among insecticides with respect to adverse impacts on beneficial arthropod populations. On the contrary, our data indicate a similar impact of all evaluated materials on affected taxa of beneficials, and that affected population levels of beneficial arthropods generally recovered quickly from the treatments (figs. 1-4), except between the first and second applications in field 1. In this experiment, recovery appeared to be heavily influenced by a pronounced immigration of beneficials, dominated by lady beetle adults, that began during the second week of May. Lack of available immigrants before this time was the most likely cause for failure of beneficial arthropod populations to measurably recover between the two applications in field 1.

Our data suggest that substitution of alternate insecticides for ULV malathion in area-wide control programs in cotton is unlikely to solve problems associated with disruption of natural enemy complexes. We also conclude it is unlikely that simulation of natural enemy disruption by insecticides can be accomplished in field-sized study arenas unless immigration of beneficials from surrounding areas can be prevented.

References

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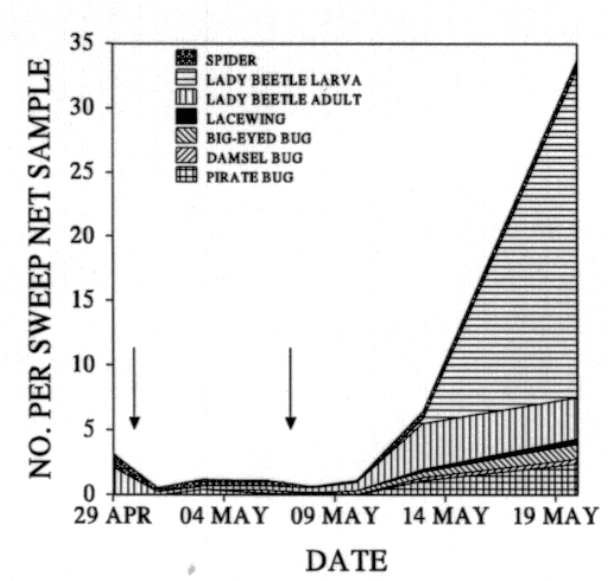

Figure 1. Changes in beneficial arthropod population levels in response to insecticide treatments, field 1. Widths of filled areas indicate the numbers of respective taxa; arrows indicate treatment applications.

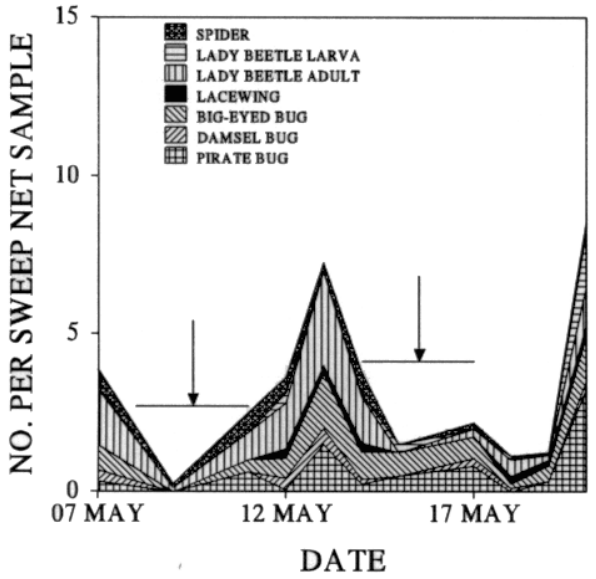

Figure 2. Changes in beneficial arthropod population levels in response to insecticide treatments, field 2. Widths of filled areas indicate the numbers of respective taxa; arrows indicate treatment applications.

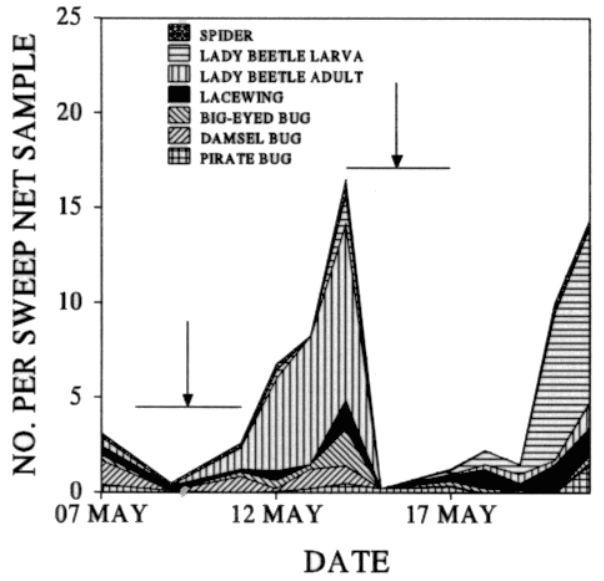

Figure 3. Changes in beneficial arthropod population levels in response to insecticide treatments, field 3. Widths of filled areas indicate the numbers of respective taxa; arrows indicate treatment applications.

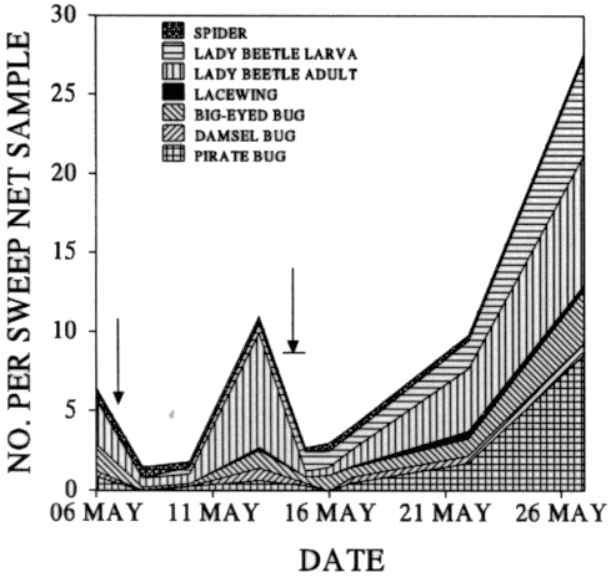

Figure 4. Changes in beneficial arthropod population levels in response to insecticide treatments, field 4. Widths of filled areas indicate the numbers of respective taxa; arrows indicate treatment applications.