IMPACT OF SYNTHETIC PYRETHROIDS ON BENEFICIAL INSECTS FROM COTTON GROWN IN THE SOUTHERN PIEDMONT


Abstract: During the growing seasons of 1979, 1980 and 1981, insect predators and parasites were sampled from cotton fields located in north Georgia treated weekly with synthetic pyrethroids applied at various rates: formulations of cypermethrin, 2 isomers of fluvalinate, flucythrinate, permethrin, and fenvalerate. In all three years entomophagous insect numbers were highest before insecticide application and again 7 d or more after insecticide treatments had ceased. No significant differences in the number of beneficial arthropods or the number of species occurred between insecticide treatments or among the three spray application systems with fenvalerate. Data from this study showed that the synthetic pyrethroids tested depressed, but did not entirely exclude predators and parasites from cotton.

Key Words: Synthetic pyrethroids, beneficial insects, cotton.

Predaceous and parasitic arthropods are effective in reducing populations of Heliothis spp. and other pest insects during early and mid-season stages of cotton (Smith and Stadelbacher 1978); however, late season declines in these natural enemy populations often necessitate using artificial, usually chemical, pest control methods. Resistance problems with many organophosphate and carbamate insecticides for control of cotton insect pests have stimulated research efforts at decreasing chemical selection pressure (Metcalf 1980). Synthetic pyrethroid compounds are insecticidally active at very low dosages (Elliott et al. 1978) and are currently being employed for late season pest insect control in cotton. While information on the efficacy of these synthetic pyrethroids is documented (All et al. 1977; Ruscoe 1977), field studies examining their deleterious impact on the beneficial arthropod fauna occurring in cotton grown on the southern piedmont is lacking. This paper reports the results of a 3-yr study on the effect of six synthetic pyrethroid insecticides and three spray application methods on the number of individuals and species number of predators and parasites commonly found in north Georgia cotton fields.

METHODS

During the growing seasons of 1979, 1980 and 1981, insect predators and parasites were collected from cotton (Coker 310) grown on the University of Georgia Plant Sciences Farm near Athens. The experiment was conducted in 6 row by 10 m long plots in randomized complete block design with 5 replicates. Conventional sprays were applied with 3 hollow cone nozzles per row in a final spray volume of 94.0 liter/ha. Electrostatic spraying used 9.4 liter/ha final spray...
volume and were applied by published methodology (Law and Mills 1980). The air blast sprayer utilized an automatic ULV mist blower mounted with a Beecomist spray head with a 60μm sleeve and calibrated at 9.4 liter/ha final volume. The mistblower was mounted on a high cycle sprayer and adjusted to cover 8 rows.

_Heliothis_ spp. infestations were detected by examining cotton squares or small bolls for damage or presence of larvae (100 squares/treatment/wk). Once _Heliothis_ spp. infestations reached 5%, each cotton plot was treated weekly with one of six synthetic pyrethroid insecticides: two formulations of cypermethrin (Ammo®, FMC Corp., and Cymbush®, ICI Corp.), two formulations of fluvinate (Mavrik®, Zocon Corp.), flucythrinate (Pay-Off®, American Cyanamid), permethrin (Pounce®, FMC Corp.), and fenvalerate (Pydrin®, Shell Chemical Co.). Each season arthropod samples were collected on 8 representative dates: 3 pre-insecticide (1 d prior to insecticide application), 3 post-insecticide (3 d after an insecticide application), one 7-d post-insecticide treatment and one 21-d post-insecticide treatment sample. All entomophagous arthropods were collected by sweep net (50 sweeps/treatment/sample), brought to the laboratory, counted and identified to genus or species.

To estimate the impact of these insecticides on predator and parasite numbers, a parameter termed “percent recovery” was calculated. Percent recovery represents the number of beneficial arthropods collected after an insecticide treatment expressed as a percentage of the total collected initially:

\[
\text{% recovery} = \frac{\text{no. collected after treatment}}{\text{no. collected before insecticides}} \times 100.
\]

Margalef’s diversity index (\(d = S - 1/\ln N\)), a measure of species richness, was also calculated to estimate the impact of these synthetic pyrethroids on beneficial arthropod species diversity, where \(S\) is the number of species and \(N\) is the number of individuals (Odum 1970).

**RESULTS AND DISCUSSION**

Entomophagous insects collected were: (HEMIPTERA) _Geocoris punctipes_ (Say)⁶, _G. uliginosus_ (Say)⁶, _Pselliopus_ sp., _Sinea spinipes_ (Herrich-Schaeffer), _Zelus exsanguis_ (Stal), _Nabis roseipennis_ Reuter⁶, _Reduvius sp._, _Orius_ sp.; (NEUROPTERA) _Chrysopa_ sp.; (COLEOPTERA) _Lebia analis_ Dejean, _L. viridis_ Say, _Tachys_ sp., _Collops quadrimaculatus_ (Fabricius), _Notoxus_ sp., _Coleomegilla maculata_ lengi Timb.⁶, _Hippodamia convergens_ Guerin⁶, _Coccinella novemnotata_ Herbst⁶, _Cycloneda munda_ (Say)⁶; (DIPTERA) _Promachus rufigenus_ (Fabricius), _Eutheresia monohammi_ Townsend, _Eulasiona sp._, _Mericia ampelus_ (Walker), _Phorocera sp._; (HYMENOPTERA) _Apaneles_ spp., _Apidius_ sp., _Blacus_ sp., _Bracon_ sp., _Chelonius_ sp., _Micropilus_ spp., _Praon_ sp., _Rogas_ sp., _Zeus_ sp., _Agrothereutes_ sp., _Coccygomimus_ sp., _Epyris_ sp., _Myzium_ sp., _Dasymutilla_ sp., _Anoplins_ sp., _Polistes_ sp., _Cerceris_ spp., _Crabro_ sp., _Ectemnius_ sp., _Gorytes_ sp., _Liris_ sp., _Podalonia_ sp., _Tachysphex_ spp., _Tachythe_ sp.

⁶ Species or genera most commonly collected.
In all 3 yr, entomophagous insect numbers were highest prior to the first insecticide application and 7 d or more after insecticide treatments had ended. Table 1 lists the insecticides, application rates, number of individuals and number of species of beneficial insects collected from each treatment during the 3-yr study. Predator and parasite number declined rapidly following the commencement of chemical treatments and remained depressed throughout the insecticide stress period. Beneficial insect numbers measurably increased 7 d after insecticide treatments ceased, and after 21 d attained numbers similar to those collected prior to insecticide applications.

Differences in percent recovery of beneficial arthropods between treatments were not significant; however, we caution that the relatively small plot size used in this study may have been an important factor in restricting treatment difference. Figure 1 compares the 1979 - 1980 mean percent recovery and species diversity of beneficial arthropods from cotton treated with fluvalinate (0.1 lb AI/acre) and fenvalerate (0.1 lb AI/acre). Figure 1 also illustrates the general trend of percent recovery found throughout the study and the lack of any discernible divergence occurring between chemical treatments.

The effect of synthetic pyrethroids on the number of species of entomophagous arthropods was generally less inhibiting than that on the number of individuals (Table 1). The number of beneficial insect species was highest prior to synthetic pyrethroid applications and also 21 d after the last chemical treatment (Fig. 1). The number of predator and parasite species was typically depressed by insecticide treatments. Small fluctuations in the number of beneficial arthropod species throughout the season may indicate either that the rarer species inhabit microsites on the cotton plant which serve as effective refuges, or that these compounds exhibit differential mortality (Barrett 1968; Croft and Whalon 1982).

Infestations of bollworms, *Heliothis* spp., and boll weevils, *Anthonomus grandis* Boheman, were moderate to low during the test years. Seasonal damage by bollworms and boll weevils was 13.8% and 12.5%, respectively, in 1979 and was less than 6% in 1980 and 1981 for both species. All the pyrethroids provided significant control of bollworms and boll weevils at all rates as compared to controls. However, yield was increased only in 1979 in pyrethroid treatments as compared to controls.

Our data indicate that there were no differences in the impact of beneficial arthropod number and species diversity among pyrethroids tested. Although pyrethroids depressed beneficial arthropod populations, more importantly, they did not completely eliminate them.

ACKNOWLEDGMENTS

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Table 1. Insecticides, application rates, number of individuals and number of species of beneficial insects collected per sampling date from each treatment during 1979, 1980 and 1981. Means for 8 sampling dates and standard errors are shown.

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<td>9.5(2.0)</td>
<td>10.8(1.9)</td>
<td>5.4(0.4)</td>
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<td>0.20</td>
<td>7.6(2.4)</td>
<td>5.0(1.7)</td>
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<td>6.7(2.1)</td>
<td>4.8(1.2)</td>
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<td>6.2(2.2)</td>
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<td>3.7(1.2)</td>
<td>3.5(0.8)</td>
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<td>3.0(1.6)</td>
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<td>1.8(0.8)</td>
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<td>0.060</td>
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Fig. 1. (A) Mean percent seasonal recovery of beneficial arthropods from cotton treated with fluvalinate (0.1 kg AI/ha) and fenvalerate (0.1 kg AI/ha) (1979 and 1980); (B) Mean species diversity (Margalef’s index) of beneficial arthropods from cotton treated with fluvalinate (0.1 kg AI/ha) and fenvalerate (0.1 kg AI/ha) (1979 and 1980).
REFERENCES CITED


