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EFFECTS OF INSECTICIDES ON INSIDIOUS FLOWER BUG AS MEASURED BY DIFFERENT METHODS

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Abstract

Laboratory-reared males, females and third instar nymphs of the insidious flower bug, Orius insidiosus, were exposed to residues of nine insecticides applied to cotton plants in the field, in potted plants in the greenhouse and glass petri dishes in the laboratory. Insects were exposed for 24-hours and then removed to determine mortality. Insecticides tested were spinosad, indoxacarb, imidacloprid, tebufenozide, methoxyfenozide, abamectin, emamectin benzoate, fipronil and λ-cyhalothrin. Differences were observed in mortality as measured by different methods. Spinosad, imidacloprid and indoxacarb induced significantly higher mortality with treated petri dishes than on treated cotton plants in the field or greenhouse. It is apparent that multiple testing methods should be used in evaluating the effects of pesticides on beneficial arthropods.

Introduction

An increasing number of scientists are evaluating the toxicity of new pesticide chemistries on beneficial arthropods. Although a considerable number of studies have been published, sometimes it is difficult to compare results among researchers. The variety of methods used in bioassays is as varied as the number of individuals conducting the work. Many researchers have used substrates such as glass vials, petri dishes or slides to test the toxicity of various insecticide residues to predatory or parasitic insects (Plapp and Bull 1978, Elzen et al. 1999). Others have used treated potted plants grown in the greenhouse (Brown and Shanks 1976, Pietrantonio and Benedict 1999), or plants grown in field plots (Snodgrass and Scott 1987, Young et al. 1997). In evaluating the effects of pesticides on any insect, the method used may have an effect on the final results. Confounding factors include solar radiation, rainfall, substrate treated, temperature, etc. Under field conditions, the effectiveness of a properly-applied insecticide may be diminished by high temperatures, sunlight and rainfall events. Similarly, the same tests may underestimate mortality caused by those insecticides that are systemic in the plant tissue, particularly on plant feeding insects. Therefore, it would be important to compare these effects as measured through various methodologies.

Predatory Heteroptera make up a large component of the key predators in cotton, with the insidious flower bug, *Orius insidiosus* (Say) being considered to be one of the most important (McGriff and Ruberson 1998). It is an important early season predator of thrips and spider mites and later is known to feed on bollworm and budworm eggs and small larvae. *O. insidiosus* is also considered to be omnivorous feeding on plant tissue. It is easily reared in the lab and can be handled with little mortality. Because of its importance as a biological control agent and omnivorous feeding habit, it was chosen for evaluation in this study.

Methods and Materials

O. insidiosus were collected from host plants (crimson clover, vetch and corn) early in the season of each year and used to start a lab colony maintained on green bean pods and *Heliocoverpa zea* eggs. *O. insidiosus* were reared at a 14:10 L:D photoperiod at 25° C in a Precision Scientific® model 818 illuminated incubator. Green bean pods were not only a source of food and moisture, but also served as a substrate into which females would readily oviposit. Green beans and *H. zea* eggs were replaced daily. Pods with *O. insidiosus* eggs were placed into separate containers to allow nymphs to hatch. Fresh bean pods and *H. zea* eggs were provided to nymphs as well.

Field Plots

Plots of SureGrow 125 cotton were planted at the University of Arkansas Northeast Research and Extension Center, Keiser, AR during the growing seasons of 2000 and 2001. Fertility and weed control recommendations outlined by the University of Arkansas Cooperative Extension Service were followed (Baldwin et al. 2001). No insecticides were applied to plots with the exception of the insecticide treatments outlined in this study in Table 1. Also, no in-furrow insecticides were applied at planting to insure insecticide-free plants. Plots were 4 rows by 25 feet long arranged in a RCB design with 4 replications. Insecticides were applied using a CO_2 powered backpack sprayer. The sprayer was calibrated to deliver 10 gpa at a pressure of 40 psi through 2-TX8 hollowcone nozzles per row. Water alone was applied to the untreated control plots. Only the center 2 rows of each plot were treated to give a buffer of 2 rows between each pair of treated rows. Treatments were applied early in the morning, just after sunrise, when wind conditions were negligible to avoid spray drift.

O. insidiosus were caged on plants as soon as sprays had dried (ca. 1-hour after application). Insects were caged on the plants for 24 hours and then removed to evaluate mortality. Cages were constructed from 11.5-cm hair clips that were bent to fit around 6-cm diameter polystyrene petri dishes. Each cage was constructed of either 2 petri dish bases or 2 petri dish tops so that the edges would meet forming an enclosure. Strips of foam were glued to the edges of each dish so that a seal would form when the cage was closed. A hole 3.2-cm in diameter was cut in each side of the cage and a piece of organdy cloth was glued over the opening to allow for air flow through the cage. Males, females and third instar nymphs were evaluated separately to determine the effects on gender and insect stage. Data were arcsine transformed and means from all bioassays were subjected to analysis of variance and separated by least significant difference test (LSD, $P \leq 0.05$). Detransformed means are reported.

Greenhouse

SureGrow 125 cotton was grown in pots in the greenhouse at the University of Arkansas Northeast Research and Extension Center, Keiser, AR. Potted plants were treated in a DeVries model SB8 spray chamber. The chamber was calibrated to deliver 11.5 gpa through a single TX8 hollowcone nozzle. Potted plants were treated individually with insecticide and then placed back into the greenhouse. *O. insidiosus* were caged on plants as soon as sprays had dried (ca. 1-hour after application). Insects were caged on the plants for 24 hours and then removed to evaluate mortality. Cages were the same as those used in the field study. Males, females and third instar nymphs were evaluated separately to determine the effects on gender and insect stage. Data were arcsine transformed and means from all bioassays were subjected to analysis of variance and separated by least significant difference test (LSD, $P \leq 0.05$). Detransformed means are reported.

Laboratory

Glass petri dishes 6-cm in diameter were treated with the insecticides listed in Table 1. Dishes were treated in the same spray chamber as the potted plants at the same rate. Individual *O. insidiosus* were placed in each dish as soon as sprays had dried (ca. 1-hour after application), which was then covered with a piece of parafilm to keep insects from escaping. Mortality was checked after 24 hours. Data were arcsine transformed and means from all bioassays were subjected to analysis of variance and separated by least significant difference test (LSD, $P \leq 0.05$). Detransformed means are reported.

Results and Conclusions

Abamectin, emamectin benzoate, fipronil and λ-cyhalothrin were consistently the most toxic of the tested insecticides to *O. insidiosus* as measured by all three methods during 2000 (Tables 1 - 3) and 2001 (Tables 4- 6). Mortality from λ-cyhalothrin ranged from 98.8% to 100%, fipronil 77% to 100%, emamectin benzoate 68% to 100% and abamectin 75% to 100%. No differences in mortality were observed between any of the three methods with abamectin, fipronil or λ-cyhalothrin.

In all instances, mortality induced by emamectin benzoate was significantly higher than that in the untreated control. In one instance, the mortality measured after treatment with this product using the petri dish bioassay was significantly lower than that in the field and greenhouse bioassays.

Differences in mortality measured between methods was most consistent with spinosad, imidacloprid and indoxacarb. In every instance, mortality was measured at a much higher level in the petri dish bioassay compared to both the field and greenhouse bioassays. This was most pronounced with spinosad. While no significant mortality was observed in the field and greenhouse bioassays, mortality was very high in the petri dish bioassay with spinosad. Mortality was also quite high in the petri dish bioassay with imidacloprid and indoxacarb, but the difference was not as great because mortality was ca. 50% in the field and greenhouse bioassays.

Overall, there were few differences in mortality as measured by the field and greenhouse bioassays. The majority of significant differences were between these two bioassays and the petri dish bioassay. It is apparent that in evaluating the effects of new insecticide chemistries on beneficial arthropods, multiple testing methods should be employed. However, if only one method is employed, using one that is most similar to that which would be encountered by the insect in the field should be the method of choice. Using inert substrates such as glass petri dishes or vials while often much less expensive and easier, may not give an accurate indication of what may be found under field conditions.

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Table 1. Percent mortality in *O. insidiosus* males measured by three methods in 2000.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		21.3 cAB	12.5 dB	26.3 cA
spinosad	0.089	18.8 cB	13.8 dB	98.8 aA
indoxacarb	0.11	21.3 cB	16.3 dB	100.0 aA
imidacloprid	0.047	53.8 bB	53.3 bB	100.0 aA
methoxyfenozide	0.25	23.8 cA	18.8 dA	25.0 cA
tebufenozide	0.25	23.8 cA	23.8 cA	20.0 cA
emamectin benzoate	0.009	100.0 aA	100.0 aA	78.8 bB
abamectin	0.018	98.8 aA	100.0 aA	100.0 aA
fipronil	0.05	100.0 aA	100.0 aA	100.0 aA
λ-cyhalothrin	0.025	100.0 aA	100.0 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).

Table 2. Percent mortality in *O. insidiosus* females measured by three methods in 2000.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		15.0 dA	8.8 eA	11.3 dA
spinosad	0.089	20.0 dB	15.0 eB	92.5 aA
indoxacarb	0.11	28.8 cdB	18.8 deB	92.5 aA
imidacloprid	0.047	52.5 bB	46.3 bB	100.0 aA
methoxyfenozide	0.25	20.0 dA	21.3 deA	23.8 dA
tebufenozide	0.25	27.5 cdA	28.8 cdA	21.3 dA
emamectin benzoate	0.009	100.0 aA	100.0 aA	90.0 aA
abamectin	0.018	97.5 aA	100.0 aA	87.5 abA
fipronil	0.05	96.3 aA	98.8 aA	96.3 aA
λ-cyhalothrin	0.025	100.0 aA	100.0 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).

Table 3. Percent mortality in *O. insidiosus* nymphs measured by three methods in 2000.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		20.0 dA	12.5 deA	25.0 bcA
spinosad	0.089	21.3 dB	25.0 cdB	91.3 aA
indoxacarb	0.11	23.8 dB	25.0 cdB	100.0 aA
imidacloprid	0.047	52.5 cB	51.3 bB	100.0 aA
methoxyfenozide	0.25	26.3 dA	32.5 cA	27.5 bcA
tebufenozide	0.25	20.0 dA	26.3 cdA	15.0 cA
emamectin benzoate	0.009	100.0 aA	100.0 aA	97.5 aA
abamectin	0.018	97.5 aA	98.8 aA	100.0 aA
fipronil	0.05	80.0 bB	95.0 aA	100.0 aA
λ-cyhalothrin	0.025	100.0 aA	100.0 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).

Table 4. Percent mortality in *O. insidiosus* males measured by three methods in 2001.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		12.5 dA	7.5 eA	16.3 cA
spinosad	0.089	13.8 dB	15.0 eB	78.8 bA
indoxacarb	0.11	47.5 cB	53.3 bcB	97.5 abA
imidacloprid	0.047	51.3 cB	47.5 bcB	96.3 abA
methoxyfenozide	0.25	7.5 dA	12.5 eA	11.3 cA
tebufenozide	0.25	18.8 dA	22.5 deA	10.0 cA
emamectin benzoate	0.009	68.8 bcB	90.0 aA	97.5 abA
abamectin	0.018	90.0 aA	95.0 aA	86.3 abA
fipronil	0.05	93.8 aA	91.3 aA	98.8 abA
λ-cyhalothrin	0.025	100.0 aA	100.0 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).

Table 5. Percent mortality in *O. insidiosus* females measured by three methods in 2001.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		16.3 gA	8.8 eA	15.0 dA
spinosad	0.089	12.5 gB	11.3 eB	67.5 bcA
indoxacarb	0.11	18.8 fgB	26.3 cdeB	88.8 abA
imidacloprid	0.047	58.8 cdeB	48.8 bcB	95.0 aA
methoxyfenozide	0.25	20.0 fgAB	31.3 b-eA	5.0 dB
tebufenozide	0.25	22.5 fgA	20.0 deA	12.5 dA
emamectin benzoate	0.009	82.5 abcA	91.3 aA	81.3 abcA
abamectin	0.018	85.0 abA	91.3 aA	75.0 abcA
fipronil	0.05	78.8 a-dA	86.3 aA	77.5 abcA
λ-cyhalothrin	0.025	100.0 aA	98.8 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).

Table 6. Percent mortality in *O. insidiosus* nymphs measured by three methods in 2001.

Insecticide	Rate lb ai/acre	Field	Greenhouse	Petri Dish
untreated		13.8 cA	17.0 cdA	12.5 cA
spinosad	0.089	16.3 cB	26.3 cdB	85.0 abA
indoxacarb	0.11	27.5 cB	40.0 bcB	93.8 abA
imidacloprid	0.047	77.5 abA	48.8 bB	97.5 abA
methoxyfenozide	0.25	22.5 cA	31.3 bcA	17.5 cA
tebufenozide	0.25	17.5 cA	18.8 cdA	25.0 cA
emamectin benzoate	0.009	90.0 aA	95.0 aA	100.0 aA
abamectin	0.018	87.5 aA	90.0 aA	96.3 abA
fipronil	0.05	95.0 aA	90.0 aA	100.0 aA
λ-cyhalothrin	0.025	100.0 aA	100.0 aA	100.0 aA

Means within a column followed by the same lower case letter and means within a row followed by the same upper case letter do not significantly differ ($P \leq 0.05$, LSD).