AN EXPANDED EVALUATION OF INSECTICIDAL TOXICITY TO COTTON FLEAHOPPERS

Juan. D. Lopez and Mohamed A. Latheef
USDA-ARS
College Station, TX

Abstract

An adult vial test was used to determine the contact toxicity of several technical insecticides comprised of synthetic pyrethroids, organophosphates, neonicotinoids and carbamates to cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter). Among the synthetic pyrethroids, bifenthrin was most toxic to cotton fleahopper with an LC_{50} (95% CLs) of 0.156 (0.135-0.179) µg/vial at 24 h. Among the organophosphates, dicrotophos with an LC_{50} of 0.189 (0.170-0.207) µg/vial was the most toxic compound to cotton fleahopper. The LC_{50}s of bifenthrin and dicrotophos were not significantly different from each other. Among the neonicotinoids, thiomethoxam with an LC_{50} of 0.385 (0.272-0.515) µg/vial was the most toxic insecticide to *P. seriatus.* Data presented herein provide a measure of acute potency of various selected insecticides against *P. seriatus.* Since field performance is dictated by use rate and exposure, the current study may be limited in application. However, baseline data may be useful for comparison should suspicion of tolerance to these insecticides develop in field populations.

Introduction

The cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter) (Hemiptera: Miridae) is an important pest of cotton during early stages of plant growth in south-central United States and caused an estimated crop loss of 0.126% with 6th place in the pest loss rankings in 2001 (Williams 2002). Fleahoppers feed on terminals of cotton plants and cause blasting and shedding of young squares, reduce fruiting branches, and produce whip-like growth (Reinhard 1926). Parker (1996) reported that fleahoppers caused extensive damage and subsequent lint loss in Texas where cotton was not protected with insecticide during the critical early fruiting stage. Traditional field tests that evaluate insecticides for control of cotton fleahopper are expensive and require spatial and temporal validation of the data to obtain meaningful results. Alternatively, a more rapid screening of insecticides may be obtained using adult vial test (AVT) procedures. Accordingly, Lopez and Latheef (2004) studied toxicity of technical dicrotophos, acephate, imidacloprid, thiamethoxam and indoxacarb to cotton fleahopper using the AVT. In this report, our objective was to evaluate the contact toxicity of several labeled insecticides to adult *P. seriatus* using AVT procedures.

Materials and Methods

Insects

Cotton fleahoppers were collected as diapausing eggs during 2003-2004 from woolly croton, *Croton capitatus* (Michaux) in the Brazos River Valley near College Station, TX, and were reared to adults following the methods described by Breene et al. (1989). Croton stems harvested in the winter were broken into small pieces and placed inside 39-oz coffee cans and refrigerated for storage. Periodically, the stems were soaked in tap water and shaken vigorously into a funnel placed over a large plastic container to collect the nymphs as they hatched. Young nymphs were transferred to a 2.4-gallon rectangular plastic Rubbermaid® container containing shredded paper that was placed snugly in position. The top of the container had inner portion removed and had a piece of organdy cloth over the top to seal the container. During the 1st week, fleahoppers were fed green beans and small pieces of potatoes placed inside the containers. During the 2nd week and thereafter, fleahoppers were fed green beans and potato pieces and artificial diet (Cohen 2000) placed over the organdy cloth. At the time of each test, fleahopper adults were collected from the containers using an aspirator.

Insecticides Technical insecticides were purchased from Chem Service, Inc. (West Chester, PA 19380, USA). In addition to insecticides tested previously, the synthetic pyrethroids (SPs) (esfenvalerate, bifenthrin, deltamethrin, lambda-cyhalothrin and zeta-cypermethrin), neonicotinoids (acetamiprid, thiamethoxam, imidacloprid and thiacloprid), organophosphates (dimethoate, methamidophos, methyl parathion and oxydemeton-methyl) and carbamates (methomyl and oxamyl) were evaluated in these tests.

Determination of contact toxicity

Adult vial test procedures were similar to those described earlier (Plapp et al. 1987; Snodgrass 1996). Briefly, stock solutions of technical grade insecticides were mixed in acetone (assay 99.5% min.). Various concentrations of insecticides were prepared from the stock solutions and stored in a refrigerator. At the time of each test, insecticide solutions were warmed to ambient temperature in the laboratory. One-half ml of each concentration was pipetted into a 20-ml scintillation vial. The vials were then placed on a hot dog roller (heating elements removed) and the roller was operated until the acetone completely evaporated leaving behind insecticidal residues inside the vials. Vials were tested during the same day they were prepared.

Green beans, *Phaseolus* spp. purchased from local grocery stores were placed in a colander, washed in a sink and baking soda (household bicarbonate of soda) was sprinkled over them to neutralize any pesticide residues. Baking soda was completely washed off and the beans were dried by blowing air over them with an electric fan. Green beans were sliced into ½ to ¾ in. long pieces. Moisture on the cut ends was dried with a paper towel and one piece was placed inside each vial. Five to 10 adult fleahoppers were aspirated into each insecticide-treated vial and the mouth of the vial was closed with a ball of cotton. An untreated control treated only with acetone was maintained for all tests. Each test was replicated several times until a good fit of the data was obtained. Vials were kept in an environmental room maintained at 80º F, RH >60% and a photoperiod of 14:10 h L:D. Mortality was checked 24 h thereafter. Fleahoppers were considered dead when they could not right themselves after the test vials were emptied into a container.

Data Analysis

Dosage mortality equations [lethal concentrations (LCs)] and associated statistics were computed using POLO-PC (LeOra software 1987). Statistical differences between LCs were determined using the presence or absence of overlap in the 95% confidence limits (CLs).

Results and Discussion

Dosage mortality equations for all technical insecticides for 24 h responses provided good fit with significant χ^2 values (Table 1). The LC_{50} (95% CLs) of bifenthrin at 24 h was 0.156 (0.135-0.179) µg/vial. Bifenthrin was the most toxic SP to cotton fleahopper and based upon the lack of overlap in the 95% CLs, the LC_{50} of bifenthrin was significantly different from those of all other SPs LC_{50} values. The next most toxic insecticides (SPs) to cotton fleahopper were esfenvalerate and lambda-cyhalothrin with LC_{50}s of 0.692 (0.581-0.807) and 0.635 (0.504-0.763) µg/vial, respectively, and the LC_{50}s of these two insecticides were not significantly different from each other. Zeta-cypermethrin with an LC_{50} of 1.195 (1.021-1.356) µg/vial was the 3rd most toxic insecticide, followed by deltamethrin with an LC_{50} of 2.056 (1.690-2.451) µg/vial. Deltamethrin was the least toxic insecticide to *P. seriatus* in this study.

Among the organophosphates, dicrotophos with an LC_{50} of 0.189 (0.170-0.207) µg/vial was the most toxic insecticide to *P. seriatus*, followed by methamidophos with an LC_{50} of 0.456 (0.376-0.524) µg/vial. The toxicity of dimethoate and methyl parathion was comparable with LC_{50}s of 1.028 (0.797-1.261) and 0.931 (0.762-1.138) µg/vial, respectively, but dimethoate and methyl parathion were significantly less toxic than methamidophos. Acephate with an LC_{50} of 7.663 (5.930-9.080) µg/vial was significantly more toxic than oxydemeton-methyl with an LC_{50} of 8.725 (6.451-10.887) µg/vial which was the least toxic OP compound to cotton fleahopper tested in this study.

Among the neonicotinoids, thiamethoxam with an LC_{50} of 0.385 (0.272-0.515) µg/vial was the most toxic to cotton fleahopper and was significantly different from all other nicotinoids tested in this study. Imidacloprid with an LC_{50} of 0.658 (0.442-0.916) µg/vial was the next most toxic neonicotinoid followed by acetamiprid with an LC_{50} of 2.349 (1.528-3.393) µg/vial. The LC_{50} of acetamiprid was significantly different from that of imidacloprid. Thiacloprid was the least toxic insecticide with the highest LC_{50} of 22.361 (12.197-34.211) µg/vial.

Among the carbamate insecticides, methomyl with an LC_{50} of 0.413 (0.377-0.447) µg/vial was more toxic than oxamyl with an LC_{50} of 12.952 (10.022-15.793) µg/vial.

Data presented herein provide a measure of acute potency of various selected insecticides against *P. seriatus*. Since field performance is dictated by use rate and exposure, the current study may be limited in application. However, baseline data may be useful for comparison should suspicion of tolerance to these insecticides develop in field populations.

Disclaimer

Mention of a commercial or proprietary product does not constitute an endorsement for its use by the U. S. Department of Agriculture.

References

Breene, R. G., W. R. Martin, Jr., D. A. Dean and W. L. Sterling. 1989. Rearing methods for the cotton fleahopper. Southwest Entomol. 14: 249-253.

Cohen, A. C. 2000. New oligidic production of *Lygus hesperus* Knight and *L. lineolaris* (Palisot de Beauvois). J. Entomol. Sci. 35: 301-310.

Lopez, J. D., Jr., and M. A. Latheef. 2004. Adult vial technique for evaluating insecticidal toxicity to cotton fleahopper. *In*: Proc. Beltwide Cotton Conf. Natl. Cotton Council., Am., Memphis, TN.

LeOra Software. 1987. POLO-PC. A user's guide to logit or probit analysis. LeOra software, Berkeley, CA.

Parker, R. D. 1996. Comparison of insecticides for control of fleahoppers on Texas Coastal Bend cotton. pp. 769-771. *In*: Proc. Beltwide Cotton Conf. Natl. Cotton Council., Am., Memphis, TN.

Plapp, F. W., G. M. McWhorter and W. H. Vance. 1987. Monitoring for pyrethroid resistance in the tobacco budworm in Texas. pp. 324-326. *In*: Proc. Beltwide Cotton Prod. Res. Conf., Natl. Cotton Council. Am., Memphis, TN.

Reinhard, H. J. 1926. Control of the cotton fleahopper in Texas. Circular No. 40. Tex. Agric. Exp. Stn., College Station, TX.

Snodgrass, G. L. 1996. Glass-vial bioassay to estimate insecticide resistance in adult tarnished plant bugs (Heteroptera: Miridae). J. Econ. Entomol. 89: 1053-1059.

Williams, M. R. 2002. Cotton insect losses – 2001. *In*: Proc. Beltwide Cotton Conf., Atlanta, GA. 8-12 Jan. 2002. Natl. Cotton Council. Am., Memphis, TN.

Table1. Lethal concentration (LC) (µg/vial) data (24 h) for contact toxicity of technical insecticides to cotton fleahopper when exposed to insecticides prepared in acetone and placed inside 20 ml scintillation vials [a/].

Insecticides	N*	χ^2 (df)	Slope ± SE	LC_{50}	95% CL	LC_{90}	95% CL
Synthetic Pyrethroids							
Esfenvalerate	336	1.46 (3)	2.80 ± 0.31	0.692	0.58-0.81	1.983	1.609-2.663
Bifenthrin	486	1.72 (3)	5.69 ± 0.886	0.156	0.135-0.171	0.262	0.242-0.299
Deltamethrin	483	1.99 (3)	2.50 ± 0.304	2.056	1.69-2.45	6.698	5.206-9.735
lambda-Cyhalothrin	322	2.02 (3)	3.27 ± 0.42	0.635	0.504-0.763	1.568	1.282-2.074
zeta-Cypermethrin	474	0.45 (3)	3.58 ± 0.44	1.195	1.021-1.356	2.722	2.326-3.414
Organophosphates							
Acephate	570	6.68 (4)	3.86 ± 0.443	7.663	5.93-9.08	16.46	13.24-25.65
Dicrotophos	491	6.08 (4)	7.14 ± 0.75	0.189	0.17-0.21	0.285	0.252-0.340
Dimethoate	441	0.91 (2)	2.00 ± 0.32	1.03	0.80-1.26	4.502	3.169-8.445
Methyl parathion	437	1.34 (3)	2.28 ± 0.28	0.931	0.76-1.14	3.393	2.493-5.409
Methamidaphos	332	0.21 (1)	5.76 ± 0.81	0.456	0.38-0.52	0.761	0.666-0.898
Oxydemeton-methyl	314	0.70 (2)	2.15 ± 0.300	8.725	6.45-10.89	34.35	26.35-51.50
Nicotinoids							
Acetamiprid	348	2.97 (3)	1.13 ± 0.15	2.349	1.528-3.393	31.99	18.314-76.441
Imidacloprid	393	6.51 (5)	2.10 ± 0.22	0.658	0.442-0.916	2.722	1.833-5.104
Thiacloprid	564	10.74 (5)	1.38 ± 0.153	22.361	12.20-34.21	190.93	102.121-743.6
Thiamethoxam	690	8.26 (5)	1.84 ± 0.173	0.385	0.272-0.515	1.921	1.275-3.865
Carbamates							
Methomyl	532	3.71 (4)	4.76 ± 0.50	0.413	0.377-0.447	0.767	0.682-0.903
Oxamyl	610	1.43 (4)	1.92 ± 0.21	12.952	10.02-15.79	60.269	47.969-82.438

[a/] Calculated using POLO-PC (LeOra Software 1987). LC values in the same column are not significantly different based upon the presence of overlap in the 95% confidence limits. N[*] = number of insects used.