Toxicity of Slide Dip Application of Five Insecticides to Apple Aphid and Spirea Aphid (Homoptera: Aphididae)[1,2]

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J. Entomol. Sci. 25(1): 10-15 (January 1990)

ABSTRACT A slide-dip bioassay using laboratory colonies revealed that apple aphid, *Aphis pomi* DeGeer, was more susceptible to esfenvalerate and methomyl, but less susceptible to azinphosmethyl than spirea aphid, *A. spiraecola* Patch. Susceptibility to endosulfan and chlorpyrifos was not significantly different between the two species. For *A. pomi*, order of insecticide toxicity was esfenvalerate > methomyl > endosulfan > chlorpyrifos > azinphosmethyl. For *A. spiraecola*, order of toxicity was esfenvalerate > methomyl > azinphosmethyl > chlorpyrifos > endosulfan. Knowledge of which species was present in a given apple orchard and the selective use of insecticides could result in more efficient aphid control while reducing toxicity to predators used in IPM programs.

KEY WORDS *Aphis pomi, Aphis spiraecola,* insecticide toxicity, apple.

Of the four aphid species commonly found on apple in the United States, apple aphid, *Aphis pomi* DeGeer is considered to be the most abundant and widespread (Baker and Turner 1916, Brunner and Howitt 1981). The spirea aphid, *A. spiraecola* Patch, also reported under the name *A. citricola* van der Goot (cf. Eastop and Blackman 1988), is a worldwide pest of citrus which has been found to colonize apple as a secondary host (Blackman and Eastop 1985). Pfeiffer et al. (1989) reported apple as a primary host of *A. spiraecola,* which was more abundant than *A. pomi* during the spring in Virginia, West Virginia and Maryland. The listing of multiple records for *A. pomi,* but only one record for *A. spiraecola* on apple by Leonard and Bissell (1970), led Pfeiffer et al. (1989) to interpret their findings as the possible result of a recent shift in aphid species composition on apple. In Israel, competitive displacement was suggested to account for the presence of spirea aphid on apple and recent absence of apple aphid, which had been common (Zehavi and Rosen 1987). The limited number of reports of *A. spiraecola* on apple may be due, at least partially, to misidentification because of its morphological similarity to *A. pomi* (Gillette 1910, Patch 1923) which makes field identification virtually impossible.

Numerous studies have been conducted on the chemical control of *A. pomi* on apple (Cutright 1953, Madsen and Bailey 1959, Forsythe 1985, 1987, Hamilton et al.

[1] Accepted for publication 6 July 1989.

[2] Published with the approval of the Director of the West Virginia Agricultural and Forestry Experiment Station as Scientific Article No. 2154. This research was supported with funds appropriated from the Hatch Act. This article reports the results only. Mention of a proprietary product does not constitute an endorsement or a recommendation for its use by West Virginia University or USDA.

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1986). Because of the recent findings of Pfeiffer et al. (1989) and the difficulty in distinquishing between apple aphid and spirea aphid in the field, there is some question as to which species was represented in past, especially most recent, chemical control research reported under *A. pomi.* There is a need to determine the specific management strategies, especially in terms of insecticides and rates of application required to control each species on apple.

The objective of this study was to determine the susceptibility of laboratory colonies of both species to various insecticides commonly used on apple.

Materials and Methods

During July and August 1986, leaves bearing viviparae of *Aphis* spp. were collected from an apple orchard in Ulster County, NY and Jefferson County, WV. *Aphis pomi* and *A. spiraecola* were identified from both of these collections using morphological characters described by Blackman and Eastop (1985). Reference specimens from these collections are located at the USDA Appalachian Fruit Research Station, Kearneysville, WV. Each species was reared separately on individually caged potted apple trees maintained in separate environmental chambers at the USDA Appalachian Fruit Research Station. Each colony was maintained at 20-24°C and 15:9 (L:D) photoperiod.

This study was conducted during December 1987 to March 1988 at the West Virginia University Experiment Farm, Kearneysville, WV. Potted apple trees with each aphid species were obtained as needed from the USDA Station and transported to the WVU Experiment Farm. Chemicals evaluated for toxicity to each aphid species included esfenvalerate 1.9EC, methomyl 1.8L, endosulfan 50W, azinphos-methyl 50W and chlorpyrifos 50W. A slide-dip bioassay method, developed for assessing mite susceptibility to acaricides (Busvine 1980), was used in this study. Fifty early instar nymphs (5 replications of 10 aphids) of each species were used for each of four to eight concentrations per chemical and a distilled water control. Aphids were attached by the dorsum to double-sided cellophane tape affixed to glass microscope slides. Slides were immersed in stirred test suspensions of insecticides for 5 sec., allowed to air dry, and placed horizontally in a covered plastic box (42 × 28 × 13 cm) lined with moistened paper towel which was held in an environmental chamber at 21°C and a 16:8 (L:D) photoperiod. Mortality was determined after 24 hr based on lack of movement of antennae and legs upon probing with a camel's hair brush. Data obtained from tests with >20% control mortality were discarded and the test repeated. Mortality data were analyzed by probit analysis (Finney 1971), using a program written by M. Weiss (USDA-ARS, Yakima, WA). Paired LC_{50} values for each insecticide were considered significantly different based on lack of overlap of 95% fiducial limits.

Results

Mortality at various concentrations (ppm ai) of five insecticides revealed that *A. pomi* was more susceptible to esfenvalerate and methomyl, but less susceptible to azinphosmethyl than *A. spiraecola* (Fig. 1, Table 1). Susceptibility to endosulfan and chlorpyrifos was not significantly different between the two species (Table 1). Based on LC_{50} values (Table 1), esfenvalerate, methomyl and endosulfan were

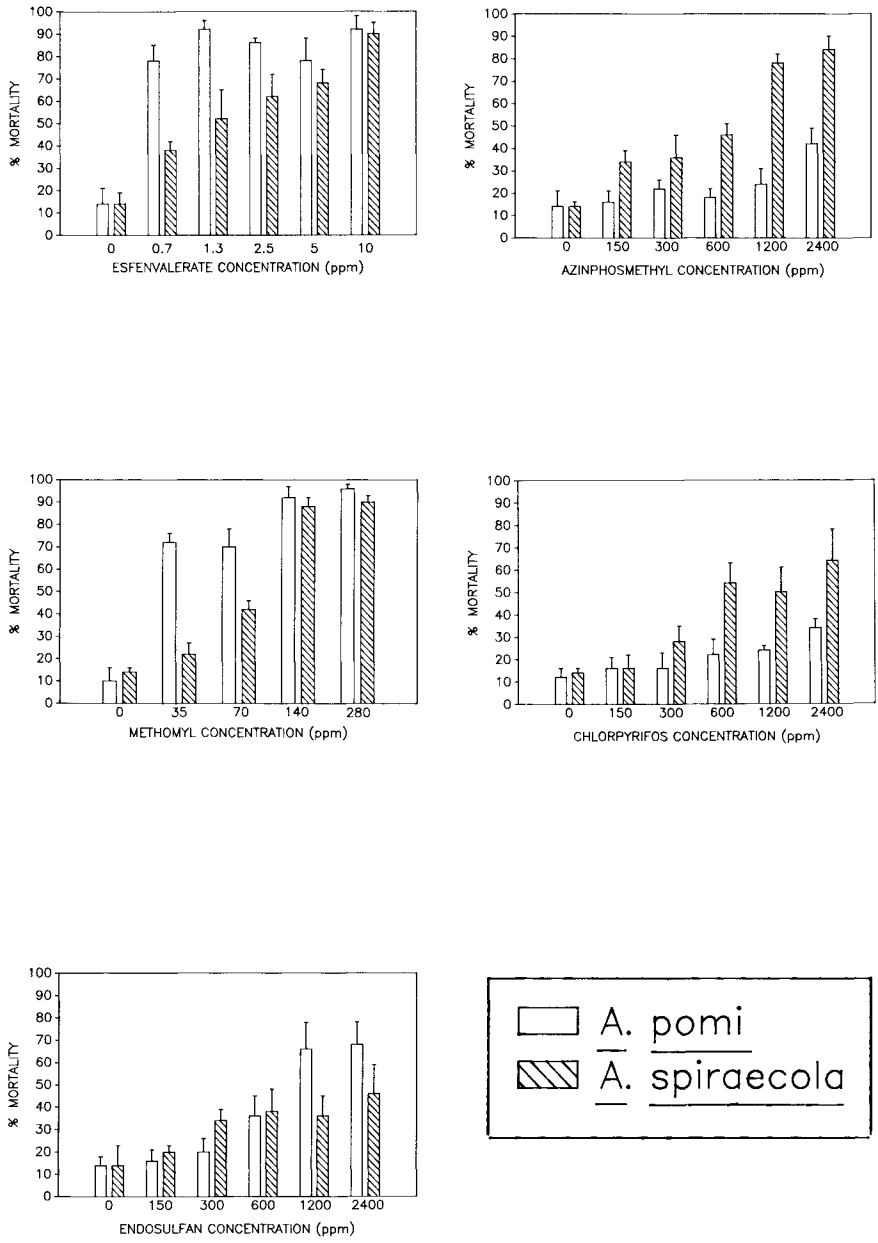

Fig. 1. Mean mortality (± SEM) of *A. pomi* and *A. spiraecola* lab colonies to slide dip application of various concentrations of five insecticides.

Table 1. Response of *A. pomi* (P) and *A. spiraecola* (S) lab colonies to slide dip application of five insecticides.

Insecticide	Species	n	LC_{50} (ppm)	95% FL	Slope ± SEM
Esfenvalerate 1.9EC	P	300	0.06*	0.02- 0.21	0.99 ± 0.10
	S	250	1.73*	0.90- 3.32	1.40 ± 0.13
Methomyl 1.8L	P	400	15.99*	10.75- 23.79	1.27 ± 0.04
	S	200	101*	86- 119	2.92 ± 0.10
Endosulfan 50W	P	250	1,338	765- 2,341	1.93 ± 0.11
	S	400	8,287	1,406-48,872	0.61 ± 0.08
Azinphosmethyl 50W	P	350	3,504*	2,010- 6,106	1.49 ± 0.06
	S	250	564*	337- 943	1.44 ± 0.13
Chlorpyrifos 50W	P	400	2,969	2,404- 3,667	1.57 ± 0.02
	S	250	1,286	610- 2,708	1.51 ± 0.12

* LC_{50} paired values are significantly different based on lack of overlap of 95% fiducial limits.

28.8x, 6.3x, and 6.2x more toxic, respectively, to *A. pomi* than *A. spiraecola.* Azinphosmethyl and chlorpyrifos were 6.2x and 2.3x more toxic, respectively, to *A. spiraecola.* Esfenvalerate was the most toxic insecticide, followed by methomyl, for both aphid species. Endosulfan, a chlorinated hydrocarbon, was more toxic than the organophosphates (azinphosmethyl and chlorpyrifos) against apple aphid but less toxic against spirea aphid. Azinphosmethyl was significantly more effective against spirea aphid than apple aphid, whereas the difference was not significant for chlorpyrifos.

Discussion

This study clearly demonstrates that differences exist between *A. pomi* and *A. spiraecola* in susceptibility to insecticides administered in a slide-dip bioassay. Whether or not these differences would be evident under field conditions has yet to be determined. Dennehy et al. (1983) found that slide-dip bioassays underestimated resistance levels in mites when compared to residual test methods and field efficacy data. Field use rates of esfenvalerate, methomyl, endosulfan, azinphosmethyl and chlorpyrifos would be equivalent to concentrations of 13, 139, 615, 308 and 385 ppm ai, respectively, which would not appear to result in a significant difference in control between the two aphid species (Fig. 1). The concentration of methomyl is for a reduced field rate typically used in combination with another insecticide, since methomyl is usually not applied alone.

Based on the results of this study, differences in control between the two aphid species might be expected at reduced application rates for esfenvalerate and methomyl, whereas above normal field rates would be required to reveal differences with endosulfan, azinphosmethyl and chlorpyrifos (Fig. 1). Although Brown et al. (1988) demonstrated that hypothetical differences in pesticide susceptibility could

influence the predominance of one species over the other, our lack of differences at typical field rates indicates that other factors are probably more important in influencing the abundance of either aphid species.

Following the introduction of chlorpyrifos 50W for apple insect control, it was frequently evaluated at a field application rate equivalent to a concentration of 615 ppm. In some cases good to excellent apple aphid suppression occurred (Hull et al. 1983, Hamilton et al. 1986, Swift et al. 1987), whereas in other instances control was poor or nonexistent (Hogmire and Walter 1985, Reissig et al. 1986, Hull 1987). Different results might be expected depending upon which species was predominant, as this study indicates that *A. spiraecola* would be more susceptible than *A. pomi* at this higher application rate (Fig. 1).

Knowledge of which aphid species was present at time of treatment could result in more efficient use of insecticides for aphid control. For example, if *A. pomi* was predominant, excellent control would appear to be possible at much less than typical field use rates with esfenvalerate and methomyl. This could be of benefit to integrated pest management programs by reducing the detrimental effects of these compounds to predators.

References Cited

Baker, A. C., and W. F. Turner. 1916. Morphology and biology of the green apple aphis. J. Agric. Res. 5: 388-396.

Blackman, R. L., and V. F. Eastop. 1985. Aphids on the World's Crops: A Identification Guide. Wiley, N. Y. 466 pp.

Brown, M. W., H. W. Hogmire, and J. J. Schmitt. 1988. Simulation of the interaction between the apple aphid and spirea aphid. Proc. 64th Annual Cumberland-Shenandoah Fruit Workers' Conference. November 17-18. Harpers Ferry, WV.

Brunner, J. F., and A. J. Howitt. 1981. Tree Fruit Insects. North Central Regional Ext. Publ. 63. Mich. State Univ. Coop. Ext. Ser. 60 pp.

Busvine, J. R. 1980. Revised method for spider mites and their eggs, pp. 49-53. *In,* Recommended methods for measurement of pest resistance to pesticides. FAO Plant Prod. Prot. Pap. 21.

Cutright, G. C. 1953. Controlling *Anuraphis roseus* and *Aphis pomi.* J. Econ. Entomol. 46: 379-381.

Dennehy, T. J., J. Granett, and T. F. Leigh. 1983. Relevance of slide-dip and residual bioassay comparisons to detection of resistance in spider mites. J. Econ. Entomol. 76: 1225-1230.

Eastop, V. F., and R. L. Blackman. 1988. The identity of *Aphis citricola* van der Goot. Syst. Entomol. 13: 157-160.

Finney, D. J. 1971. Probit Analysis. 3rd edition. Cambridge University Press. London, England.

Forsythe, H. Y. 1985. Apple, aphid control, 1984. Insect. and Acar. Tests 10: 1.

Forsythe, H. Y. 1987. Apple, aphid control, 1986. Insect. and Acar. Tests 12: 11.

Gillette, C. P. 1910. Plant louse notes, family Aphididae. J. Econ. Entomol. 3: 404.

Hamilton, G. C., E. Herman, and F. C. Swift. 1986. Apple, all season insecticide test, 1985. Insect. and Acar. Tests 11: 20-24.

Hogmire, H. W., and S. Walter. 1985. Apple, insecticide evaluation, 1984. Insect. and Acar. Tests 10: 5-8.

Hull, L. A. 1987. Apple, concentrate airblast insecticide test, 1986. Insect. and Acar. Tests 12: 28-30.

Hull, L. A., E. H. Beers, and R. L. Meagher, Jr. 1983. Apple, concentrate airblast insecticide test, 1982. Insect. and Acar. Tests 8: 19-21.

Leonard, M. D., and T. L. Bissell. 1970. A list of the aphids of District of Columbia, Maryland and Virginia. Univ. Md. Exp. Stn. MP 770. 129 pp.

Madsen, H. F., and J. B. Bailey. 1959. Control of the apple aphid and the rosy apple aphid with new spray chemicals. J. Econ. Entomol. 52: 493-496.

Patch, E. M. 1923. The summer food plants of the green apple aphid. Maine Agric. Exp. Stn. Bull. 393: 45-68.

Pfeiffer, D. G., M. W. Brown, and M. W. Varn. 1989. Incidence of spirea aphid (Homoptera: Aphididae) in apple orchards in Virginia, West Virginia, and Maryland. J. Entomol. Sci. 24: 145-149.

Reissig, H., D. H. Dunham, and H. E. Hebding. 1986. Apple, preliminary insecticides test, 1985. Insect. and Acar. Tests 11: 65-66.

Swift, F. C., E. J. Herman, and V. Starner. 1987. Apple, all season insecticide test, 1986. Insect. and Acar. Tests 12: 49-52.

Zehavi, A., and D. Rosen. 1987. Population trends of the spirea aphid. *Aphis citricola* van der Goot, in a citrus grove in Israel. J. Appl. Entomol. 104: 271-277.