Population Development and Insecticide Susceptibility of Apple Aphid and Spirea Aphid (Homoptera: Aphididae) on Apple[1,2]

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ABSTRACT Colonies of apple aphid, *Aphis pomi* DeGeer, and spirea aphid, *A. spiraecola* Patch, were confined separately in bottle cages on apple tree branches to compare population development and susceptibility to insecticides under field conditions. Spirea aphid populations were significantly larger than apple aphid populations eight days after introduction into bottle cages. After two and a half weeks there was a 24-fold and 40-fold increase in the population of apple aphid and spirea aphid, respectively. Apple aphid was more susceptible than spirea aphid to a low concentration of esfenvalerate and to normal field and 2X field concentrations of azinphosmethyl. There was no significant difference between the two aphid species in susceptibility to methomyl, chlorpyrifos and endosulfan. Mortality of apple aphid to the two phosphate insecticides, azinphosmethyl and chlorpyrifos, was similar; however, spirea aphid was more susceptible to chlorpyrifos than to azinphosmethyl. An increased rate of population development and a greater tolerance of azinphosmethyl, the most widely used insecticide for apple insect control, could be contributing factors in the virtually complete domination of spirea aphid over apple aphid in West Virginia apple orchards.

KEY WORDS *Aphis pomi, A. spiraecola,* population development, control, apple, apple aphid, spirea aphid.

The apple aphid, *Aphis pomi* DeGeer, is reported as the most important green aphid species on apple (Baker and Turner 1916, Brunner and Howitt 1981). The spirea aphid, *A. spiraecola* Patch, which is of similar morphology (Gillette 1910, Patch 1923) and indistinguishable under field conditions, was found to predominate over *A. pomi* during the spring in Virginia, West Virginia and Maryland (Pfeiffer et al. 1989). During 1990, Brown (unpublished) found that the green aphid species on apple consisted of over 95% and 80 - 90% *A. spiraecola* during the spring to early summer and later summer periods, respectively. Pfeiffer et al. (1989) interpreted their findings as the possible result of a recent shift in aphid species composition on apple, based on a listing by Leonard and Bissell (1970) of multiple records for *A. pomi,* but only one record

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for *A. spiraecola* on apple. Zehavi and Rosen (1987) suggested that competitive displacement occurred in Israel as an explanation for the presence of spirea aphid on apple and recent absence of apple aphid, which had been common.

Differences in insecticide susceptibility are factors that could contribute to the predominance of one species over another (Brown et al. 1988). In a laboratory slide-dip bioassay, Hogmire et al. (1990) found that apple aphid was more susceptible to esfenvalerate and methomyl, but less susceptible to azinphosmethyl than spirea aphid. Since slide-dip bioassays may not accurately reflect field efficacy (Dennehy et al. 1983), our first objective was to determine the insecticide susceptibility of both aphid species under orchard conditions where residual as well as contact efficacy would be represented. Our second objective was to compare population development of both species under field conditions as a second possible factor which could explain differences in aphid abundance.

Materials and Methods

This study was conducted in 1990 at the West Virginia University Plant Science Experiment Farm, Kearneysville, in a 0.4 ha block of four-yr-old 'Rome' apple trees on M-7A rootstock. The trees measured 2.74 m in height and 2.13 m in width and were planted at a spacing of 5.49 x 7.32 m. Two-liter plastic soda bottles (Royal Crown Cola, Winchester, VA) were modified for use as aphid cages (Alverson and English 1990). Three 10 x 14 cm sections of plastic were removed and replaced with No-See-Um Mosquito Netting (Recreation Equipment, Seattle, WA) which was attached with silicone caulk. Velcro strips were attached to three edges of one section of netting to serve as the cage door. The neck and shoulder of the bottles were slit on two opposing sides with a bandsaw to facilitate installation on tree branches. On 24 April, arthropods were removed, Safer's insecticidal soap (Safer Inc., Newton, MA) applied and bottle cages installed on two branch terminals on opposite sides of 55 trees. Gauze and duct tape were used to seal the neck of the bottle around the branch. The bottle cage was supported with string attached to the tree's central leader.

On 1 May, two adults and three nymphs of apple aphid and spirea aphid, from laboratory colonies, were introduced with a probe or camel's hair brush into separate cages on each tree. Aphid counts were taken on 9, 15 and 18 May. After removing bottle cages and counting aphids on 18 May, branches were sprayed with insecticides applied to runoff with a Century sprayer (Century Engineering Corporation, Cedar Rapids, IO) equipped with a handgun and operated at 14 kg/cm^2. Bottle cages were reinstalled following spray application. Each of ten insecticide treatments and an unsprayed control consisted of five single-tree plots in a randomized block design. Insecticides (and concentrations in ppm AI) included esfenvalerate 0.66EC (1.3), (13); azinphosmethyl 35W (308), (616); methomyl 1.8L (35), (140); chlorpyrifos 50W (385), (770); endosulfan 50W (615), (1230). Postspray counts were taken on 23 and 31 May, and percentage mortality was calculated for each date using prespray counts (18 May) for each treatment. A *t* test (SAS Institute 1985) was used to compare means of population abundance and mortality from insecticides between the two aphid species. Aphids were collected from each bottle cage on 31 May for identification to verify species. Reference specimens from this study are located at the USDA-ARS Appalachian Fruit Research Station, Kearneysville, WV.

Results

Aphis spiraecola populations were significantly larger than those of A. *pomi* eight days after introduction into bottle cages (Fig. 1). The greater abundance of spirea aphid populations continued for two and a half weeks, with the difference between the species increasing with time. There was a 24-fold increase in apple aphid and a 40-fold increase in spirea aphid after two and a half weeks.

Aphis pomi was more susceptible than A. *spiraecola* to esfenvalerate at a concentration of 1.3 ppm; however, no significant difference was detected at a normal field concentration of 13 ppm (Fig. 2). Mortality of spirea aphid thirteen days postspray was lower than on five days postspray due to reproduction of survivors. Azinphosmethyl was significantly more effective against apple aphid than spirea aphid at both the normal field concentration (308 ppm) and twice the field concentration (616 ppm). Although mortality of spirea aphid increased with the higher concentration of azinphosmethyl, it was still below 50%, whereas mortality of apple aphid was >95% at both concentrations. There was no significant difference between the two aphid species in susceptibility to methomyl, chlorpyrifos and endosulfan. Methomyl and endosulfan were the most effective insecticides against both species, providing 98-100% and 100% mortality, respectively. There was similar mortality of apple aphid to the two phosphate insecticides, azinphosmethyl and chlorpyrifos; however, spirea aphid was more susceptible to chlorpyrifos than to azinphosmethyl. In the unsprayed control the populations of both aphid species continued to increase following insecticide application by an average of 116% and 228% at five and thirteen days postspray, respectively. Aphids identified from each bottle cage at the conclusion of the study were found to be the correct species, except for one specimen which was questionable.

Discussion

This study demonstrates that a differential rate of population development occurred for A. *pomi* and A. *spiraecola* under orchard conditions in May when temperatures averaged 16° C. After two and a half weeks the population of spirea aphid was 66% greater than that of apple aphid.

Based on insecticide efficacy data acquired in this study, growers could expect to achieve equivalent control of both aphid species with normal field rates of all chemicals tested, except for azinphosmethyl. Excellent control of apple aphid could be expected at the normal field rate (308 ppm) of azinphosmethyl, whereas poor control of spirea aphid would likely occur, even at twice the field rate. These data are in contrast to that reported for a slide-dip bioassay with azinphosmethyl (Hogmire et al. 1990), in which greater mortality occurred with spirea aphid than with apple aphid at approximately the same concentrations. No explanation can be given for this apparent discrepancy other than a significantly greater susceptibility of apple aphid than spirea aphid to residual toxicity of azinphosmethyl.

Data obtained in this study with azinphosmethyl and chlorpyrifos indicate that some recent aphid data acquired for these products in other studies were probably obtained using spirea aphid, rather than apple aphid as reported. For example, data reported by Forsythe (1988) and Hull (1988) revealed that azinphosmethyl provided virtually no control of apple aphid. We would expect this

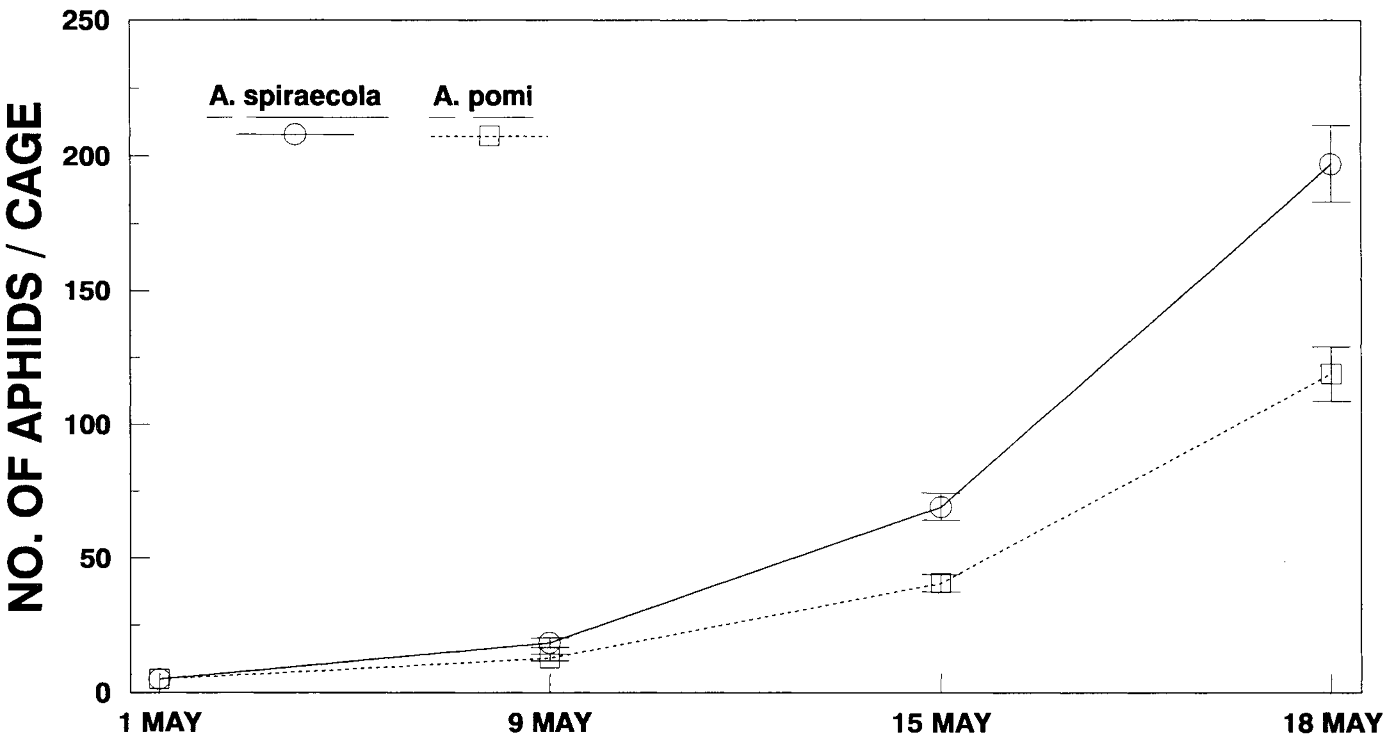

Fig. 1. Mean population development (± SEM) of *Aphis spiraecola* and *A. pomi* within bottle cages on 'Rome' apple branches for 17 days in Kearneysville, WV, 1990. *A. spiraecola* was significantly more abundant than *A. pomi* on 9, 15 and 18 May ($P < 0.01$; *t* test).

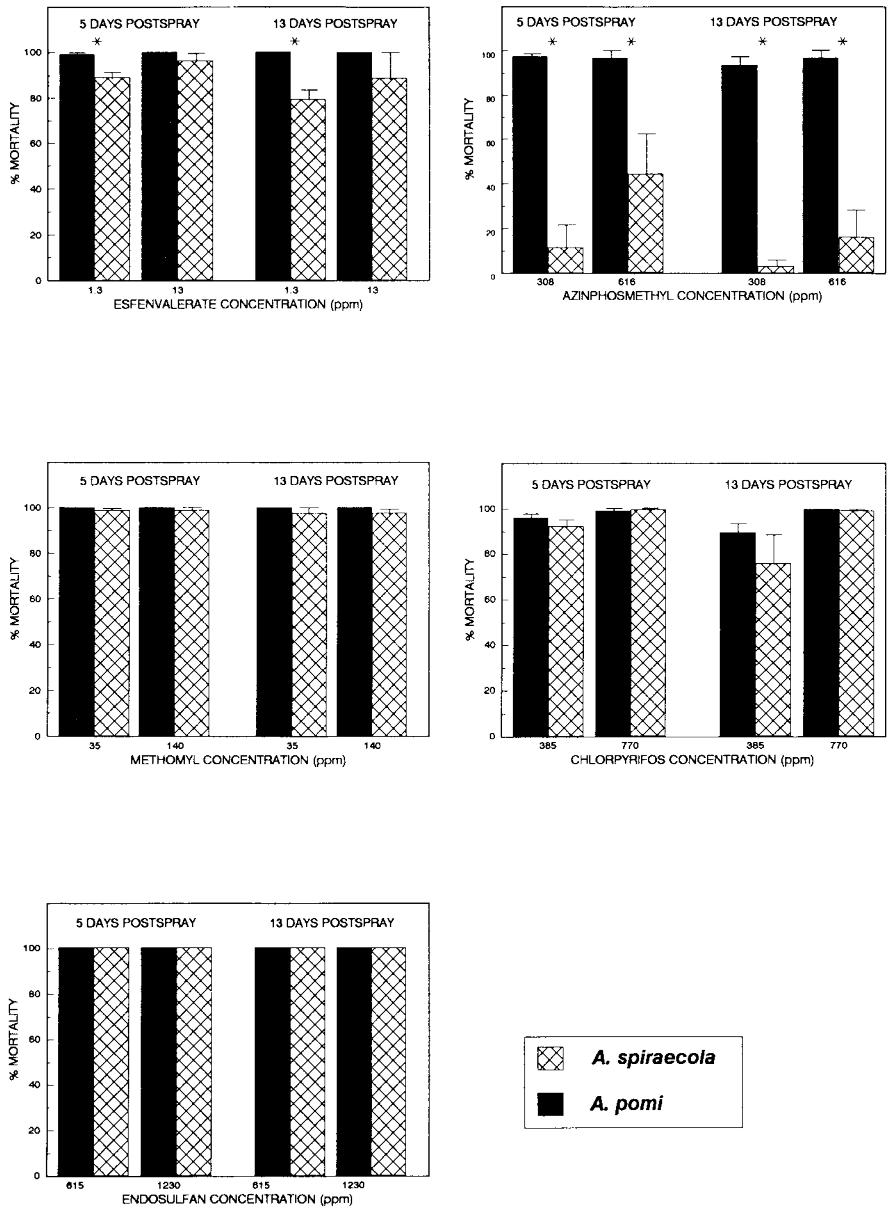

Fig. 2. Mean mortality (±SEM) of *Aphis spiraecola* and *A. pomi* to application of two concentrations of five insecticides while caged on 'Rome' apple branches in Kearneysville, WV, 1990. Asterisks indicate that *A. pomi* was significantly more susceptible than *A. spiraecola* ($P < 0.01$; *t* test).

to occur with spirea aphid, but not with apple aphid which was highly susceptible in our study. Other data reported for apple aphid indicate that chlorpyrifos was more efficacious than azinphosmethyl (Hamilton et al. 1986, Weires 1987). Our data support this difference for spirea aphid, but not for apple aphid which was equally susceptible to both compounds. The presence of spirea aphid in test plots of above researchers must at least be suspected, if not verified, as it is listed with apple aphid in later reports (Hull 1989, Weires and Lawson 1989).

A survey conducted by Brown during 1990 (unpublished) found very few *A. pomi* in West Virginia apple orchards. If we assume that *A. pomi* was more abundant in the past, we are led to ask what changes could have occurred to explain the current dominance of spirea aphid on apple? The greater tolerance of spirea aphid to azinphosmethyl, the most widely used insecticide for apple insect control, and its increased rate of population development could be important contributing factors in explaining the current aphid situation in West Virginia apple orchards.

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