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CHEMICAL, NATURAL, AND CULTURAL CONTROL OF *HYADAPHIS TATARICAE* (HOMOPTERA: APHIDIDAE) ON HONEYSUCKLE

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ABSTRACT

Hyadaphis tataricae is an aphid pest of honeysuckle relatively new to the Great Lakes and midwestern regions of North America. Feeding results in severly deformed terminals (witches' brooms). Studies were conducted on natural, chemical, and cultural control.

Foliar-applied systemic insecticides provided excellent knock-down and 3–4 weeks of residual control. Although diazinon also provided good knock-down, its residual activity was shorter. Malathion provided suppression but did not protect plants from injury. A tree and shrub soap wash did not provide control. Oxydemeton methyl provided best results of soil-applied systemics.

Of 385 aphidophagous predators collected, 85% were syrphid larvae. The remainder were Coccinellidae and Chrysopidae. About 140,000 aphids were examined microscopically without visual evidence of insect pathogens and with only one mummified (parasitized) individual. Dormant pruning of previously broomed terminals resulted in increased vegetative growth of the plants and larger early season aphid populations. There was no visible difference in pruned vs. unpruned plants at the end of the growing season.

Hyadaphis tataricae (Aizenberg) infests the terminals of tatarian honeysuckle, *Lonicera tatarica*, its cultivars, and some related species (Boisvert et al. 1981, Voegtlin 1982). An introduced species, the first North American record was from Quebec, Canada (Boisvert et al. 1981). The first United States record was from Lake Co., Illinois (Voegtlin 1981). Since 1979, it has spread rapidly throughout the Great Lakes states and upper Midwest. Although found for the first time in Wisconsin in 1979, within two years it had been recorded from 27 Wisconsin counties, primarily in the southern two-thirds of the state.

H. tataricae damages *Lonicera* by feeding on the terminal portions of the stems. Aphids first settle on the dorsal surface of developing leaves. Their feeding results in the leaf tightly folding dorsally along the midrib, with the aphids found within the folded leaves. Leaf growth stops shortly after feeding, but secondary vegetative bud development produces new terminals that are rapidly infested. The ultimate result is a profusion of short, weak terminal stems with very stunted leaves. In late summer, infested foliage dies prematurely. The following spring, the infested terminals are found to have been killed, with unsightly dead "witches' brooms"persisting.

Until the arrival of *H. tataricae*, *Lonicera tatarica* had been considered to be a low-maintenance landscape plant, capable of thriving under a variety of soil, light, and moisture conditions, and without major insect or pathogen problems. Although environmentalists have discouraged the use of the plant, primarily because it is rapidly invasive and highly competitive in prairie and woodland habitats, it has been extensively propagated by nurseries and widely used in landscaping. In some settings, tatarian

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honeysuckle has been used as a hedge surrounding homes or institutional grounds and removal and replacement would be very costly. Because of the severity and persistence of injury, we undertook an evaluation of chemical, natural, and cultural controls of *H. tataricae*.

METHODS AND MATERIALS

Chemical Control

Six chemical control tests of *H. tataricae* were conducted. Test 1 (1982) was a comparison of foliar sprays. Tests 2–4 (1983) were also tests of foliar sprays. Tests 5–6 (1983) were evaluations of soil-applied systemic insecticides. All studies were conducted on established landscape plants in various commercial settings in Madison, Wisconsin. At each study site except one, all plants were of the same cultivar, but cultivar names were not determined. All plants at all locations showed signs of prior infestation.

The following materials and rates were used in the foliar spray studies: acephate (Orthene 15.6% EC) at 14.8 ml/gal (22.2 ml/gal in Test 1), malathion (50% EC) at 9.9 ml/gal, oxydemeton methyl (MetaSystox-R 25% EC) at 7.4 ml/gal, diazinon (50% EC) at 19.7 ml/gal, dimethoate (Cygon 2E) at 19.7 ml/gal, and soap (ACCO Tree and Shrub Wash, Acme Chemical Co.) at 18.9 ml/gal. All foliar sprays were applied with a Hudson Industro sprayer to full coverage. Soil treatments will be described under the specific tests.

Samples were collected by removing terminals with pruning shears and immediately placing all terminals for a replicate in a labeled jar of 70% ethanol. Samples were returned to the lab for sorting and counting under a stereozoom microscope. During microscopic examination, all leaves were unfolded and all aphids washed from the plant material. Samples were then floated onto a gridded filter paper in a Buchner funnel and returned to the microscope for counting. Aphids which were dead at the time of field collecting were collapsed and shriveled, and were readily distinguished from aphids which were collected alive.

Test 1. This study was a preliminary comparison of a contact insecticide (malathion), soap (ACCO Tree and Shrub Wash), and a systemic insecticide (acephate), and an untreated check. The two treatment blocks were located on opposite sides of a 10 m-wide driveway, with each block consisting of four plants, each 2 m apart, in a diamond configuration. The plants were first examined in April, before bud break, and all showed light aphid damage in the form of broomed terminals from the previous season. Examination of the persistent dead leaves in the damaged areas revealed the presence of shiny, black overwintering eggs. The first aphids were observed on 14 May, shortly after bud break, but with slight leaf folding already starting.

Malathion and acephate sprays were applied 18 May, 14 June, 9 July, 2 August, and 25 August. Soap sprays were applied 14 and 28 May, 14 and 28 June, 9 and 26 July, and 9 and 25 August. Two types of data were taken. The percent of damaged terminals was determined by counting the number of damaged and undamaged terminals on each of six major stems per plant. The number of aphids per terminal was determined by randomly removing terminals from each plant, placing them in 70% ethanol, and counting aphids under a stereozoom microscope in the lab. In early season, each sample consisted of six 10-cm terminals per plant; this was reduced to four 5-cm terminals later in the season when populations were large.

Test 2. This test evaluated four foliar applied materials, the systemics acephate, oxydemeton methyl, and dimethoate, and the contact insecticide diazinon. Plants were in a linear contiguous row at the back of a parking lot. Each treatment consisted of two replicates, each replicate consisting of two adjacent plants. There was a two-bush untreated buffer between each randomly assigned treatment. Insecticides were applied only after substantial population development. Application dates were 24 June and 19

July. Samples consisted of four 5-cm terminals per replicate. The first aphids were found on 3 May.

Test 3. In this test we compared three foliar applied systemic insecticides: acephate, oxydemeton methyl, and dimethoate. The plants were in a single row at the back of a parking lot. All bushes were separated by a space of 0.3 m or more and no buffers were used between treatments. Each treatment consisted of three single-plant replicates in a completely randomized design. Only one application was made, on 24 June; repopulation was very slow. Samples consisted of two 5-cm terminals per plant. The first aphids were found on 13 May.

Test 4. This was a comparison of acephate vs. diazinon. The test plants consisted of an old, densely intergrown hedgerow. The hedge was maintained at a height of about 1.5 m by bi-weekly pruning commencing 20 May. Each treatment consisted of three randomly assigned replicates, with each replicate consisting of 3.05 m of row. There was a 0.61-m untreated buffer between each treatment. Applications were applied 7 June and 7 July. Samples consisted of 10 5-cm terminals per replicate. The first aphids were found on 11 May.

Test 5. This test was an evaluation of 2% disulfoton granules applied to the soil. The test was conducted on two similar but separated beds, each consisting of a linear planting of six contiguous plants. One bed was treated and the second was the untreated check. The treatment was applied on 24 June as follows. Four equi-distant holes were cut with a golf-course cup- cutter just inside the drip line of each of the six plants. The holes were approximately 10–15 cm deep. To each hole, 113 g (1/4 lb) of 2% disulfoton granules were added, followed by 1 l water. After percolation, the soil was returned to the holes. Samples consisted of ten 5-cm terminals per treatment. The first aphids were seen on May 3.

Test 6. In this study we evaluated two soil-applied liquid systemics: acephate and oxydemeton methyl. Each treatment consisted of a cluster of four plants in a square pattern. The two clusters of plants were on opposite sides of a driveway. Each plant in the cluster was considered a replicate. No untreated checks were examined in this study. The treatments were applied in the following manner. Six equally spaced holes 10–15 cm deep were made with a golf-course cup-cutter just inside the drip line of each plant. One sixth of the total insecticide for each plant was mixed with 1 l water and placed in each hole. After percolation, the soil was returned to the hole. The first treatments of oxydemeton methyl and acephate were applied 7 June and 13 June, respectively. The second application of both materials was 4 July. The first application of acephate was at 60 ml/plant, but because of incomplete control, this rate was increased to 120 ml/plant for the second application. Oxydemeton methyl was applied at the rate of 72 ml/plant for both applications. Samples consisted of four 2-inch terminals/replicate. The first aphids were observed 13 May.

Natural Control

Weather. Weather conditions in 1982 vs. 1983 were quite different. This allowed us to observe the effects of weather on plant growth and aphid population numbers, especially as these factors influenced the need for insecticide applications.

Natural Enemies. During 1983, we evaluated natural enemy activity on plants not treated chemically. As terminals were collected from untreated check plants in the chemical treatment studies, all aphidophagous species were removed and counted. At the same time, additional, arbitrarily chosen larval predators were reared to adulthood for species identification. Larval rearing was accomplished in two ways. Some larvae were caged on aphid-infested terminals in the field with "no-see-um-proof" mosquito netting. These cages were periodically inspected until adult eclosion. Other larvae were brought to the lab and placed in lantern globes with bouquets of aphid-infested honeysuckle until pupation and adult eclosion. Additionally, observations of natural enemy activity and effectiveness were noted in the field. During routine microscopic counting of aphids from all studies, we examined for mortality from parasitoid and pathogen activity.

Cultural Control—Pruning

A study was conducted at two locations to determine if dormant pruning of previously broomed terminals would eliminate enough overwintering eggs to reduce the spring population size. One location was a park planting of a row of 20 slightly intergrown honeysuckle. Field examination of proportion and extent of broomed terminals indicated a uniform amount of damage during the previous season. The row was divided into thirds, with one end and the central portion pruned to remove all previous-season broomed terminals. The other end was left unpruned. The two ends represented the two treatments and the center was a pruned buffer between the two treatments. The second location was a vacant field near a residential area with wild seedling plants unevenly distributed over an area of approximately 0.5 hectare. Six plants were arbitrarily chosen for pruning; all others were left unpruned. Pruning at both locations was done 12 April, before egg hatch, and prunings were removed from the area. Samples, taken approximately weekly from 3 May to 24 June, consisted of ten 5-cm terminals for each group of pruned and unpruned plants. Samples were preserved in 70% ethanol in the field and microscopically counted in the lab. Observations were made on plant growth and degree of aphid damage.

RESULTS AND DISCUSSION

Chemical Control

Test 1. Acephate and malathion provided better aphid control than did the soap, as indicated in the first post-treatment sample (Table 1). There were no significant differences in aphid numbers in subsequent samples because of the low number of replicates. However, visual examination showed that the acephate-treated plants had much less damage than the other two treatments or the checks, and this was confirmed by the percent of damaged terminals for each treatment (Table 2). The acephate-treated plants had significantly fewer damaged terminals than all other treatments, and the degree of damage to each terminal was also less in the acephate treatments.

Test 2. Acephate, oxydemeton methyl, dimethoate, and diazinon all provided excellent knock-down acitivity of honeysuckle aphid (Table 3). However, after each application date the three systemic materials provided longer residual control than did diazinon.

Test 3. Acephate, oxydemeton methyl, and dimethoate all provided excellent knock-down activity at the rates used (Table 4). In this study, oxydemeton methyl apparently provided the longest residual activity, followed by acephate, and then dimethoate, although differences were not significant.

Test 4. Acephate and diazinon gave equal knock-down activity (Table 5). However, unlike test 2, acephate did not provide longer residual activity than diazinon in late summer. The long-term results of this test were somewhat confused by the regular pruning which the plants received throughout the growing season. Pruning removed a substantial part of the population (for example, compare Table 5 values for untreated check, on 16 June and 7 July dates).

Test 5. Table 6 shows the results of the evaluation of 2% disulfoton granules applied to the soil. Differences in population levels between treatments did not change appreciably after application.

Test 6. At the rates tested, oxydemeton methyl provided better control of *H. tataricae* than did the liquid formulation of acephate, when both were applied as soil treatments. In addition, marginal leaf burn was seen on the acephate plants after both the low and high-dosage treatments. The soluble powder formulation was not, however, included to determine if the phytotoxicity was caused by the acephate or its solvent-carrier.

Table 1. Results of a comparison of acephate, malathion, and a soap spray for control of *Hyadaphis tataricae*, Test 1, 1982. See text for treatment dates and sampling methods.

	Mean Number Aphids per Inch of Terminal[a]			
Material	24 June	9 July[b]	12 July	13 August
acephate	5 A	32 A	0 A	0 A
malathion	88 A	114 A	16 A	9 A
soap	294 B	37 A	29 A	13 A
check	287 B	34 A	24 A	16 A

[a]Values within a column followed by same letter are not significantly different ($P = 0.05$) as compared by Duncan's Multiple Range Test.
[b]Pre-treatment sample.

Table 2. Proportion of honeysuckle terminals damaged by *Hyadaphis tataricae* after treatments of acephate, malathion, and soap.

Material	*n*	*% Damage*[a]
acephate	99	19 A
malathion	91	65 B
soap	95	85 C
check	112	79 C

[a]Percentages followed by same letter are not significantly different when compared by paired χ^2 tests, $P < 0.05$.

Table 3. Results of comparison of foliar applied treatments of acephate, oxydemeton methyl, dimethoate, and diazinon for control of *Hyadaphis tataricae*, Test 2, 1983. Applications were made 24 June and 19 July.

	Mean No. Aphids/4 Terminals[a]				
Material	24 June[b]	27 June	19 July[b]	21 July	24 August
acephate	1265 A	0	670 B	0	9 A
oxydemeton methyl	1126 A	0	201 A	0	14 A
dimethoate	1447 A	0	927 B	0	0 A
diazinon	1550 A	0	2174 C	0	563 B
check	1239 A	1349	982 B	1359	80 A

[a]Means in column followed by same letter are not significantly different ($P = 0.05$) as compared by Duncan's Multiple Range Test. Post-treatment data were not normally distributed and were not compared statistically.
[b]Pre-treatment samples.

Table 4. Results of comparison of foliar applied treatments of three systemic insecticides for control of *Hyadaphis tataricae*, Test 3, 1983. Applications were made 24 June.

	Mean No. Aphids/4 Terminals[a]			
Material	24 June[b]	27 June	15 July	24 August
acephate	1417 A	0	8	60
oxydemeton methyl	918 A	0	0	0
dimethoate	790 A	0	168	176
check	907 A	294	437	272

[a]Means in column followed by same letter are not significantly different ($P = 0.05$) as compared by Duncan's Multiple Range Test. Post-treatment data were not normally distributed and were not compared statistically.
[b]Pre-treatment sample.

Table 5. Results of a comparison between the systemic insecticide acephate and the contact insecticide diazinon for control of *Hyadaphis tataricae*, Test 4, 1983.

	Mean No. Aphids/10 Terminals[a]						
Material	24 June[b]	2 June[b]	10 June	16 June	7 July[b]	11 July	24 August
acephate	121 A	305 A	0	5 A	293 A	0	112 A
diazinon	96 A	280 A	0	33 A	178 A	0	47 A
check	194 A	582 A	1019	1683 B	362 A	1253	645 B

[a]Means in column followed by same letter are not significantly different ($P = 0.05$) as compared by Duncan's Multiple Range Test. Post-treatment data were not normally distributed and were not compared statistically.
[b]Pre-treatment sample.

Table 6. Results of evaluation of 2% disulfoton granules applied to soil for control of *Hyadaphis tataricae*, Test 5, 1983.

	No. Aphids/10 Terminals		
Treatment	24 June[a]	27 June	8 July
disulfoton	5184	2938	2013
check	2502	1635	871
check, as proportion of disulfoton	0.48	0.56	0.43

[a]Pre-treatment sample.

Table 7. Results of a comparison of acephate and oxydemeton methyl as soil drenches for control of *Hyadaphis tataricae*, Test 6, 1983.

	Mean No. Aphids/4 Terminals[a]					
Treatment	2 June[b]	16 June	4 July[b]	8 July	15 July	24 August
acephate	214 A	232	179 A	18	143	39
oxydemeton methyl	398 A	0	13 B	0	0	0

[a]Means within column followed by the same letter are not significantly different ($P > 0.05$) as compared by two sample *t*-test (Ryan et al. 1976). Sample dates without significance indicators consisted of non-normally distributed data and were not compared statistically.
[b]Pre-treatment sample.

General Comments. *Hyadaphis tataricae* is readily controllable with insecticides currently available to both the landscape manager and the homeowner. Of the materials tested, the systemics oxydemeton methyl, acephate, and dimethoate provided rapid knock-down activity and continued to provide residual control for 3–6 weeks after treatment. These same three systemic insecticides were also evaluated by Nixon, et al. (1985), who found that all three materials reduced aphid damage to terminals, and that reinfestation occurred about 4 weeks after application. Of the contact insecticides we evaluated, diazinon provided good immediate control, even in folded leaves, but residual activity was shorter than the three systemic materials. Malathion suppressed populations but did not provide sufficient control to protect the plants from substantial brooming. The one commercial soap product evaluated likewise did not protect the plants from damage. The only soil application evaluated which provided adequate control without resulting in plant injury was oxydemeton methyl. The length of residual effectiveness of the materials tested was apparently dependent upon (1) material, (2) direct and indirect effects of weather, (3) initial population size, and (4) proximity of other local populations generating alates.

Weather

Weather conditions had substantially different effects on aphid population numbers in 1982 vs. 1983. In 1982, a cool, moist spring was followed by a "normal" summer of temperature and rainfall. Honeysuckle plants grew throughout much of the summer. Aphid populations rapidly built to high numbers in June, and then gradually tapered off as the summer progressed. In 1983, a dry spring was followed by a very hot, dry summer. All treatment plots were unirrigated and there was very little plant growth. Aphid populations were slower to develop, and never reached the levels of 1982. The result in 1983 was that fewer treatments were necessary to control populations, and the extent of brooming was considerably less on untreated plants than the previous year.

Natural Enemies

From 404 5-cm terminals examined, 385 aphidophagous predators were recovered (Table 8). The majority of these (85%) were syrphid larvae. Of 33 predators raised to adult stage for species identification, six were *Allograpta obliqua* Say (Syrphidae), 22 were *Adalia bipunctata* (L.) (Coccinellidae) and five were *Chrysopa plorabunda* Fitch (Chrysopidae). These numbers do not reflect relative abundance. In addition to the coccinellids reared, many adults were seen during observation of infested plants through

Table 8. Aphidophagous predators recovered from 404 honeysuckle terminals infested with *Hyadaphis tatricae*, Madison, WI, 1983.

Sample Period	Total Number Terminals Examined	Total Predators[a] CA	CL	SL	LA	LL	All Species
2–10 June	130	2	4	0	1	0	7
16–27 June	138	2	37	209	0	0	248
7–11 July	70	1	1	21	0	1	24
15–21 July	22	1	4	24	0	0	29
24 August	44	0	2	75	0	0	77
Total	404	6	48	329	1	1	385

[a]CA = coccinellid adults, CL = coccinellid larvae, SL = syrphid larvae, LA = lacewing adults, LL = lacewing larvae.

the two years of this study. Occasionally *Coleopmegilla maculata* (DeGeer) could be seen on the plants very early in the season, but apparently not feeding on aphids. They were never observed on the plants after early June. However, adults of *Adalia bipunctata* (L.), the reared species, were frequently seen in spring and summer feeding on the aphids.

These predators were not effective at regulating *Hyadaphis tataricae* at subdamaging levels. The reasons for this are two-fold. First, although aphids were first seen on plants by mid-May, predator populations did not start to increase until mid-June (Table 8). Substantial leaf stunting and brooming had already begun by the time predator populations started to build. Secondly, very few predators were found within the tightly folded leaves, where the majority of the aphid population was located. Adult predators and the larger larvae were unable to enter these folded leaves for feeding or oviposition. Most predators were found within the loosely folded larger leaves, or foraging on those aphids on stems or petioles.

Approximately 140,000 aphids were examined microscopically during this study. No aphids showing obvious symptoms of disease were found. Similarly, only one mummified aphid with emergence hole, indicating parasitism, was seen.

Pruning

The results of the dormant pruning study are shown in Table 9. At the park location, there was earlier and more rapid buildup of aphids on pruned than unpruned plants. This was unexpected and may relate to the colonization behavior of the aphid and differences in structure between vegetative and reproductive terminals. The unpruned plants at this location were highly florific with the majority of terminals ending in flower buds. The terminal leaves of these stems were flat and perpendicular to the stem (Fig. 1). The terminal leaves of vegetative stems were more parallel, forming a more enclosed bud area (Fig. 1). Throughout this study, we observed that vegetatively growing stems were more frequently colonized than stems terminating in a flower bud. By pruning, we removed flower buds and promoted the development of vegetative stems, thereby increasing the number of more suitable colonization sites.

The data from the vacant field location do not show distinct differences. This may have partially resulted from the sampling of dissimilar wild seedling plants.

In both locations, the extent of brooming by the end of the season was similar on pruned and unpruned plants. The dormant removal of old, damaged terminals will improve the appearance of the plant and remove a portion of the overwintering population. But by itself, pruning is not an effective management technique for preventing plant injury.

Table 9. The effects of dormant pruning of honeysuckle on spring population development of *Hyadaphis tataricae*, Madison, Wisc., 1983.

	No. Aphids/10 Terminals			
	Park		Field	
	Pruned	Unpruned	Pruned	Unpruned
May 3	0	0	0	0
11	0	0	0	0
13	0	0	0	4
16	0	0	0	0
22	0	0	0	0
26	19	0	0	2
June 2	164	0	0	0
10	33	8	6	406
16	484	60	146	113
24	1369	240	129	226

Fig. 1. Flowering terminal (right) as compared to vegetative terminal (left) of honeysuckle.

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