MULTICOLORED ASIAN LADY BEETLE (HARMONIA AXYRIDIS) as a NUISANCE PEST in HOUSEHOLDS in OHIO

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Abstract The multicolored Asian lady beetle, *Harmonia axyridis*, was introduced into the United States to serve as a biological control agent and has now become well established in Ohio. To determine the nature and distribution of the nuisance problem in Ohio, we conducted a statewide survey during the summer of 2001. The survey results helped to delineate typical characteristics of homes that are infested by *H. axyridis*. The average house was 73 years old, two-story, wood- or vinyl-sided, and has lots of trees on at least three sides. The colors of the house and roof were not found to be a determining factor for an infestation problem. The data were used to map the progression of the infestation problem throughout the state over the past decade. The data showed that the problem originated in eastern and southern Ohio and has spread north and west in the past decade. The most irritating problems associated with an *H. axyridis* infestation are the foul odors the beetles emit and the stains resulting from their hemolymph when they reflex bleed. Biting and food contamination are also significant concerns. An associated health problem is emerging, as evidenced by the 13% of the respondents who reported dermal or respiratory allergic reaction to the beetles. The survey participants were asked to provide the date in the fall of 2001 when the beetles first arrived in significant numbers at their home. This information was graphed with local weather data to derive predictive events for the arrival of *H. axyridis* in any given locale. *H. axyridis* are prompted to search for overwintering sites on the first day over 18°C after a significant drop in temperature, usually to near freezing. Some survey participants also tracked the management methods used throughout the period of infestation in the fall of 2001. These data were used to develop case study reports on the efficacy of the different management techniques.

Key Words Lady beetle nuisance pest survey pesticides

INTRODUCTION

The multicolored Asian lady beetle, *Harmonia axyridis*, has been introduced many times into North America to serve as a biological control agent, first in 1916 in California, and as recently as 1985 in Connecticut (Tedders and Schaefer, 1994). The first established populations of *H. axyridis* were reported in Mississippi and Louisiana in 1988 (Chapin and Brou, 1991). Since that time *H. axyridis* has become a well-established predatory insect in many parts of the United States, including Ohio (Horn, 1996). By outcompeting native populations, *H. axyridis* has become the dominant species of lady beetles in Ohio, successfully managing populations of aphids, scale insects, and other soft-bodied insect pests on many types of plants and trees. However, the perceived successful release of non-native generalist predators such as *H. axyridis* for biological control has not been without controversy. In such introductions there have usually been long delays between release and establishment, displacement of other guild members, and negative non-target impacts (LaMana and Miller, 1996). And it is these non-target impacts that are the concern of homeowners across the state and region. While much heralded for their activity as a bio-control agent during the growing season, *H. axyridis* becomes a serious nuisance pest to homeowners during the fall, winter, and early spring.

Problems with *H. axyridis* begin during the fall when they aggregate in large numbers in search of an overwintering site. In their native lands *H. axyridis* would normally overwinter in cracks and crevices of cliff sides and rock outcroppings (Riddick, et al., 2000). In Ohio where

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such structures are relatively uncommon, the preferred overwintering site has become individual homes. This aggregation usually begins in early October. Large swarms can be found moving across the landscape and settling on or around individual homes. During the swarming period, homeowners report the inability to leave the house without being covered with beetles that oftentimes bite. When in the home in large numbers, *H. axyridis* causes much aggravation to the homeowner because these beetles often find their way into food and drink, disrupt activities such as sleeping and reading, and when disturbed will reflex bleed a yellow-orange, foul-smelling liquid that stains most surfaces. Additionally, *H. axyridis* has been shown to induce allergic reactions in some people (Yarbrough et al., 1999).

Once the weather turns consistently cold the beetles settle into their overwintering sites on or just inside the home. If they remain dormant throughout the winter, the beetles are less of a concern to the homeowner. However, during warm spells in the winter and spring the beetles become active and often find their way into the home and become a nuisance again.

For years very little was done to address the *H. axyridis* nuisance problem because of the desire to preserve it as a biological control agent. However, the nuisance problem has grown tremendously and now many homes throughout Ohio are being invaded each year. In order to assess the extent and nature of the *H. axyridis* nuisance problem in Ohio, a survey of residents was conducted along with an evaluation of selected insecticides for their toxicity against the beetle.

MATERIALS and METHODS

In May of 2001 a statewide survey of homeowners experiencing an *H. axyridis* nuisance problem was conducted. A toll-free number (The Ohio Lady Beetle Hotline) was set up so that individuals who had experienced an *H. axyridis* nuisance problem could call and request that a survey be sent to them. County Extension agents advertised the existence of the Hotline throughout the state. The survey was designed to gain a basic understanding of the kinds of houses that are infested by *H. axyridis* and the specific nature of the infestation experienced. All of the responses to the survey questions were entered into an Excel spreadsheet and summary statistics produced. In some cases to further refine the results, the data were grouped into three categories, whether the respondents reported having low (hundreds or less), medium (thousands), or high (millions to too-many-to-count) populations of beetles.

In a follow-up effort in the fall of 2001, the Ohio Lady Beetle Project (OLBP) participants were instructed to call the Hotline and report the date that the lady beetles arrived at their home in large numbers or swarms. Dates of arrival were received from 286 project participants. Daily temperature highs were then obtained from National Weather Service stations throughout the state. This weather data was used because *H. axyridis* flight appears to be temperature-dependent. The temperature data were then graphed against the arrival data for a given region in order to discern a pattern of predictive events. Regions were comprised of the resident county of the weather station and the counties immediately surrounding. Since all of the regional graphs were similar, a statewide graph was created using daily high temperature means and a summation of the arrival data.

The OLBP participants were also asked to record all mitigation activities they undertook against *H. axyridis* during the fall of 2001 and submit that information on data sheets provided by the project staff. Data sheets have been received from 41 people. The information from the data sheet was recorded, and a summary of treatment options was produced. Included in this information were the treatment method, cost, and efficacy.

The final portion of the project consisted of testing five pyrethroid insecticides on their residual effect and efficacy as a killing agent against *H. axyridis*, since pesticide application to the exterior of the home appeared as the most promising mitigation technique at the time. The beetles

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were collected from soybean fields located at the Snyder Farm of the Ohio Agricultural Research Development Center during August and September of 2001. Twenty-five petri-dish sized white vinyl siding disks were treated with insecticides on 27 Aug 2001. Insecticides tested were: Demand CS (9.7% lambda-cyhalothrin, rate of 0.634 ml/100 ml water); Talstar (7.9% bifenthrin, rate of 0.781 ml/100 ml); Tempo SC (11.8% cyfluthrin, 0.423 ml/ 100 ml); Suspend SC (4.75% deltamethrin, 1.16 ml/100 ml); and Demon EC (25% cypermethrin, 1 oz/gal or 0.78 ml/100 ml). Each treatment was replicated 5 times.

The disks were then placed outside during the day and exposed to natural sunlight for 21 days. Disks were brought in only at night, to conduct bioassays, and to avoid dew or rain events. Each disk was exposed to approximately 130 hours of daylight. On September 18, five beetles were placed on each insecticide-treated disk plus an untreated control for one hour. After exposure, the beetles were removed and placed on filter paper in petri dishes and provided with water. Beetles were evaluated at 6 time periods (16 hours, 24, 40, 48, 64, and 78 hours after treatment) and placed in 3 categories, alive, dead, or moribund. Data were analyzed using the analysis of variance function, and means were separated using Fisher's Protected LSD (SuperAnova, Abacus Concepts, 1991).

RESULTS

By the time that the survey results had begun to be tabulated in late August, nearly 1550 surveys had been sent and of those 1,148 returned. The survey respondents were initially asked when the beetles first became a problem in and around their home. A few respondents reported that their problem began in the late 1980s, but the majority of respondents reported dates in the 1990s. The map (Figure 1) shows how the problem has spread from a few counties in eastern and southeastern Ohio in the early 1990s to nearly half of the counties in Ohio. Although the map does not show the complete distribution of the *H. axyridis* nuisance problem, since the survey was not promoted equally in all counties, it is representative of the relative movement of *H. axyridis* throughout Ohio.

The survey respondents were then asked to describe their home. Over half (57%) of the respondents had two-story homes while 31% had a single story. On the exterior of the home, 54% had wood, 43% had vinyl, and 23% brick. However, the results did not indicate that either house or roof color was a determinant for an infestation problem. It has been reported elsewhere that *H. axyridis* has a preference for light colors (Nalepa et al., 2000). As Figure 2 shows, even when the data were broken down into the low, medium, and high population categories, the beetles equally invaded houses of light, medium, or dark color.

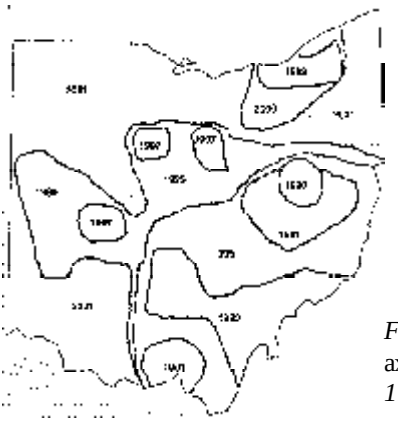

Figure 1. The progression of the Harmonia axyridis *infestation problem in Ohio from 1990 to 2001.*

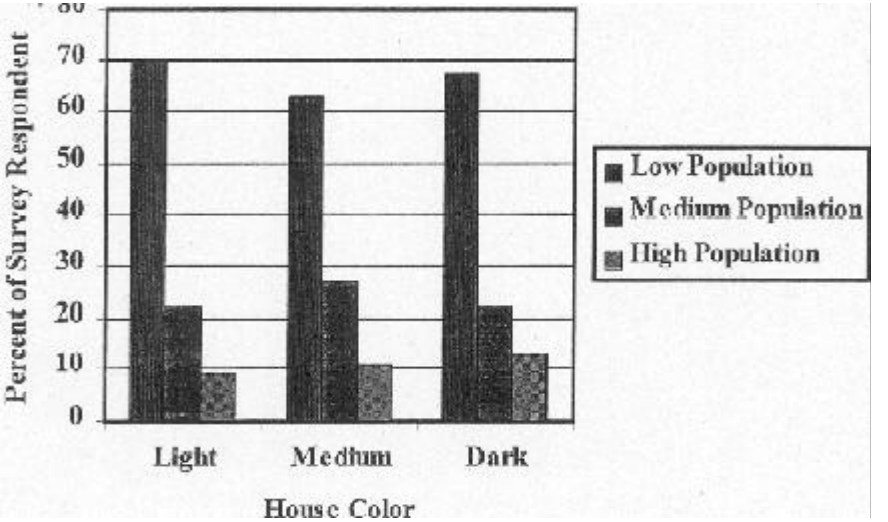

Figure 2. House color of survey respondents in each Harmonia axyridis *population size category.*

The average house age of the survey respondents was 53 years. The data did not indicate that house age was a determinant of an infestation problem. However, older houses were slightly more likely to experience high populations of lady beetles. The survey respondents were also asked to describe the landscape immediate surrounding their home in the four directions (N, S, E, and W). Figure 3 shows that having trees or a forest to any of the four cardinal directions was a good indicator of a *H. axyridis* infestation problem.

Questions were also designed to gain an understanding of the nature of the infestation problem experienced. The respondents were asked in what room and on what surface did the beetles most frequently appear. Most of the people experienced problems in their living rooms (58%), bedrooms (53%), and kitchens (46%) with the beetles appearing most frequently on the windows (86%) and ceilings (64%). When asked about the problems associated with an *H. axyridis* infes-

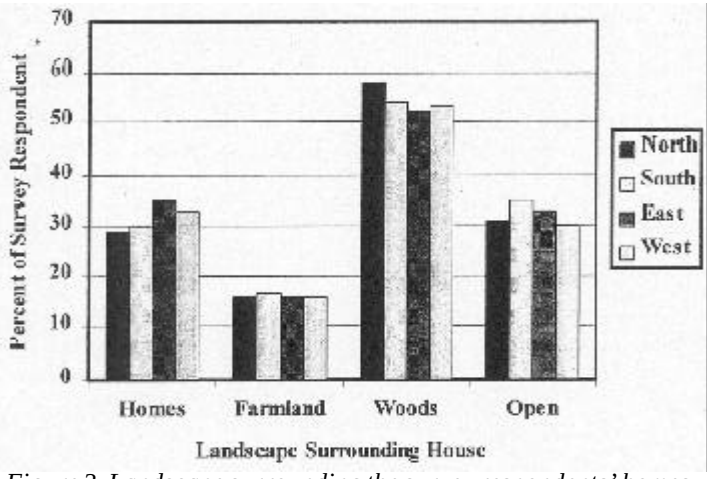

Figure 3. Landscape surrounding the survey respondents' homes in the four cardinal directions.

tation, the survey respondents most frequently mentioned that the beetles produced a foul odor (77%) and stained various surfaces (71%) throughout the house. However, a notable number also indicated that they were bitten by the beetles (42%) or that the beetles ended up falling into their food and drinks (41%).

The respondents were also asked if they experienced an allergic reaction to the beetles. Overall 13% of the respondents reported having allergic reactions and 6% actually had that reaction confirmed by a doctor. Furthermore, the data do suggest a dose response when broken down into the high, medium, and low population categories (Figure 4). More of the respondents who reported allergic reactions also reported having high populations of beetles in their homes.

Finally, the respondents were asked what action they took against the lady beetles. The large majority of the respondents used vacuuming (90%) as their primary method of managing their *H. axyridis* infestation problem.Other methods used included applying pesticides (44%), sealing and caulking (34%), and trapping (7%). Six percent of the survey participants also reported that they took no action against the beetles. When asked how pleased they were with the results of the actions they took, only 1% of the group reported being satisfied.

The response from the participants regarding the date of arrival of the *H. axyridis* swarms at their location provided enough information to track the migration of the beetles to overwintering sites. There were three periods of migration, October 2-3, October 9-11, and October 20; the middle period was the most notable. When these data were graphed against high temperature means for the state, a predictive pattern of temperature declines was revealed. Figure 5 shows that during the days before each flight period the temperature dropped quickly. The low temperature for those days (September 30-October 1, October 7-9, and October 18-19) fell to near or below freezing. Then on the next day over 18°C the beetles began their migration.

While only a small number of participants have returned the data sheets detailing actions taken against the lady beetle, some of the information indicates a direction for research on better management techniques. The most popular and reportedly effective method of reducing the number of *H. axyridis* in the home was to apply a pesticide on the exterior of the house. The products used by homeowners most frequently contained the pesticides cyfluthrin, permethrin, or tralomethrin. Cyfluthrin also topped the list of chemicals applied by a pest-control company followed by lambda-cyhalothrin and the combination of deltamethrin plus cypermethrin. 58% of

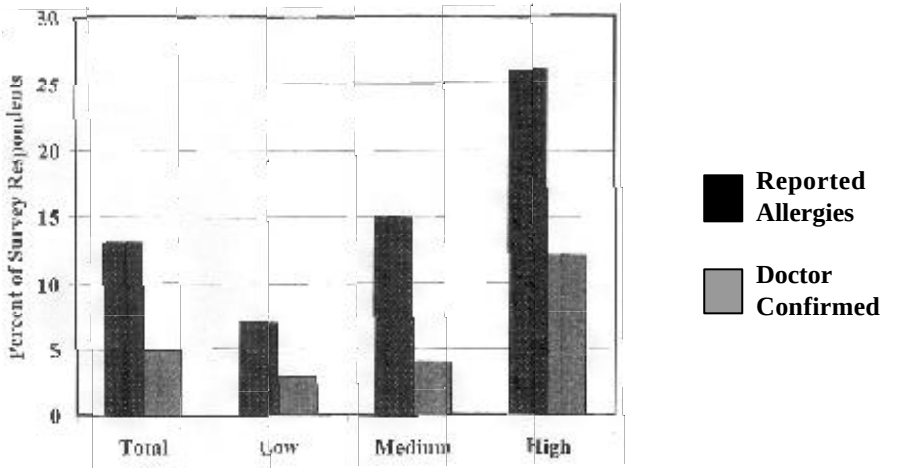

Figure 4. Percent of survey respondents reporting allergic reactions to Harmonia axyridis *and those reactions confirmed by a doctor in each population size category.*

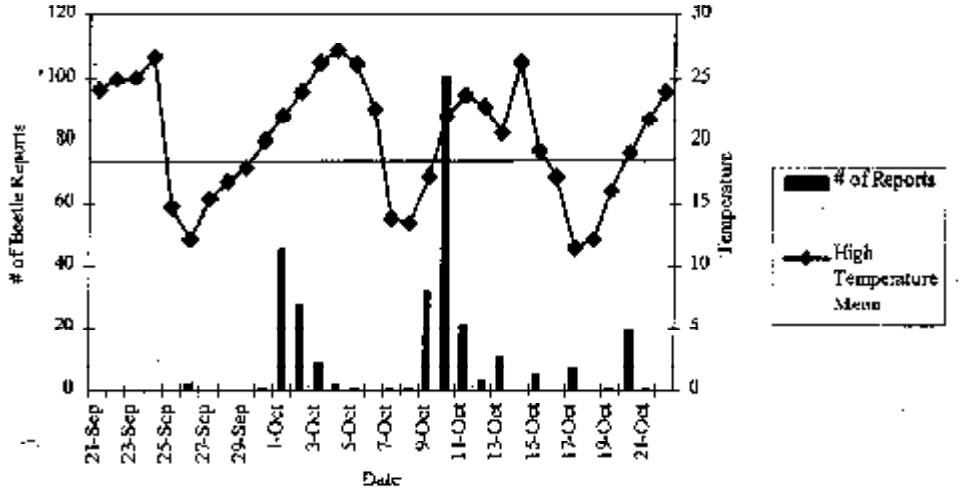

Figure 5. Temperature effects on Harmonia axyridis *migration activity.*

the respondents reported applying the pesticides after the first swarm of *H. axyridis* arrived. The other respondents applied their pesticides anywhere from one week before and up to the day of arrival. The respondents were also to rate the efficacy of the treatment. All of the treatments that were applied by a professional were rated as significantly reducing the number of beetles that got into the home. The homeowner-applied pesticides were rated slightly less effective. Cyfluthrin, Deltamethrin + Cypermethrin, lambda-Cyhalothrin, and Permethrin were consistently rated as effective chemicals. Furthermore, the timing of the application of the chemical does not appear to affect its efficacy. Pesticides applied shortly after the lady beetles arrived received nearly as high ratings for efficacy as those that were applied before the beetles appeared.

Homeowners also reported using other methods to exclude *H. axyridis* from their homes. Caulking to seal gaps and holes and screening any large openings such as vents were other popular mitigation techniques. Most reported caulking around windows and doors in addition to filling in any other visible cracks. This method alone was not viewed as successful in keeping the beetles out of the home. However, when used in conjunction with other methods, especially exterior pesticide sprays, the survey respondents indicated a significant reduction in the number of beetles entering the home. Camphor cakes or oil, vanilla candles, and bay leaves were other exclusion methods used by some homeowners. The camphor cakes or oil and bay leaves were placed around the windows, usually between the screen and the window on the exterior side. The candles were used with the intent of keeping *H. axyridis* out of the room in which they were burned. Most of the research participant indicated that the botanicals had no observable effect on their *H. axyridis* population. However, a few people with only a moderate infestation problem reported that camphor worked well for them.

Most of the data sheets also indicated that people relied heavily on vacuuming, usually numerous times per day, to manage their *H. axyridis* population. Some people even indicated that they purchased a vacuum or shop vac just for this purpose. This method did not eliminate *H. axyridis* from the home but did provide some help. It should be noted that all beetles vacuumed were disposed of, not released outside.

Very few people tried trapping devices to help manage their *H. axyridis* problem. The few who used sticky traps (both white and yellow) found them to be ineffective. Black light traps were also suggested. A few people constructed homemade versions and also found them to be

useless. The final method employed by some homeowners was to apply a pesticide on the interior of the home, usually around the windows and doors. Most of these chemicals were applied by the homeowner, who commonly used permethrin. The professionally applied chemicals included chlorpyrifos and chlorpyrifos with permethrin. All of the homeowners who applied pesticides to the interior of their home also applied them to the exterior. And all of these people found this combination of treatments to be successful.

The results from the long-term efficacy test of the five pyrethroid pesticides showed some clear differences. Table 1 shows the percent of beetles that are dead or moribund in each treatment after 78 hours. All treatments provided some level of control. The lambda-cyhalothrin and deltamethrin treatments were the best, with over 95% of the beetles either dead or dying. The bifenthrin treatment was next with 84% and statistically the same as the deltamethrin treatment. Cyfluthrin and cypermethrin killed only about 50% of the beetles at this time.

The number of dead or moribund individuals at the various times is presented in Figure 6. At the 16-hour reading, over 80% of the beetles were dead or dying in all the treatments. However over time some beetles recovered and were alive 40 to 48 hours after exposure, particularly in the Demon and Tempo treatments. After 48 hours, those beetles that were classified as dead or dying remained in that condition.

DISCUSSION

The multicolored Asian lady beetle has become a significant problem for many Ohio residents. The results of our survey indicate that the *H. axyridis* infestation problem, while originating in eastern and southern Ohio, has spread throughout many parts of the state in the past decade. The average type of house experiencing a *H. axyridis* infestation problem is 73 years old, two-story, wood or vinyl-sided and has lots of trees on at least three sides of the house. The colors of the house and roof are not a determining factor for an infestation problem. When *H. axyridis* invade a home they are found in rooms throughout the house but most frequently in the living room and bedrooms and usually on the windows and ceiling. The most irritating problems associated with a *H. axyridis* infestation are the foul odors the beetles emit and the stains resulting from their hemolymph when they reflex bleed. However, biting and food contamination are also significant concerns. An associated health problem is emerging as evidenced by the 13% of the respondents reporting dermal or respiratory allergic reaction to the beetles. Vacuuming is the primary management option utilized by the survey respondents to deal with the beetles. Others have also tried pesticides but nearly everyone has been dissatisfied with the results of the methods they have used.

Table 1. The percent *Harmonia axyridis* beetles dead or dying exposed for 1 hour to 5 pyrethroid-treated and weathered (about 3 weeks) vinyl siding. Observations are for 78 hours after exposure.

Treatment	% dead or moribund 78 hours after exposure
Demand (9.7% lambda-cyhalothrin)	96 a
Suspend (4.57% deltamethrin)	95 ab
Talstar (7.9% bifenthrin)	84 b
Tempo (11.8% cyfluthrin)	55 c
Demon (25% cypermethrin)	40 c
Check (water)	0 d

Means followed by the same letter are not significantly different (Fischer's PLSD P<0.01).

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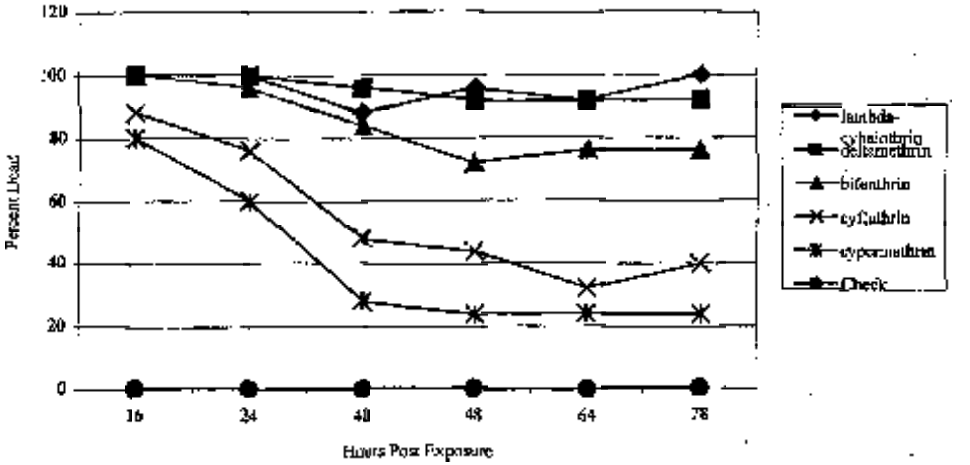

Figure 6. The number of Harmonia axyridis *dead or dying to the 5 different insecticides at 6 times post exposure.*

Graphing the reported arrival dates of the beetles against the temperature highs shows a predictive weather pattern for the initiation of migration. While needing further research, it appears that *H. axyridis* are prompted to search for overwintering sites on the first day over 18°C after a significant drop in temperature, usually to near freezing. The most effective mitigation treatment reported was the application of pesticides to the exterior of the home. Combining this treatment with others such as vacuuming, caulking, or screening only increased their success. While the importance of pesticides as a tool to combat an *H. axyridis* infestation was evidenced by the treatment reports, the efficacy test on these chemicals shows the choice of pesticide is important. Our results suggest that one application to the exterior of a vinyl-sided house with lambda-cyhalothrin, deltamethrin, or bifenthrin should give at least 3 weeks of protection and may provide seasonal control of *H. axyridis.*

The work of the Ohio Lady Beetle Program indicates the need for much more research. The issues surrounding *H. axyridis* are complicated at best. Research needs to commence to help find options for homeowners to keep *H. axyridis* from infesting their homes while at the same time preserving the beetle for its valuable biocontrol function.

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