Biological control of viburnum leaf beetle

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Background and Objectives

Viburnum leaf beetle, *Pyrrhalta viburni* (Paykull), is a relatively new landscape pest in New York State. As its common name suggests, this pest has a host range that is restricted to plants in the genus *Viburnum*. This insect is very destructive to its host plant because the larvae feed extensively on new foliage in the spring, and adults resulting from this first generation consume considerable portions of the second flush of foliage produced by the plant following spring defoliation. The first record of the insect in New York State was from a planting of native viburnums along the shore of Lake Ontario in 1996 (Rick Hoebeke, personal communication), and the species has spread quickly through counties bordering the lake. As of this past summer, the insect had been detected in 27 counties of New York State, and was found for the first time in in states bordering New York (1 county each in Pennsylvania and Vermont). Given the rapid spread of the insect and the extent of damage observed to date, it seems likely that viburnum leaf beetle will soon pose a serious threat to viburnums throughout the Northeast and beyond.

We have been evaluating pesticides for controlling viburnum leaf beetle, but there are several incentives for developing non-pesticidal methods. First, pesticide use invariably poses risks for non-target organisms, be they humans that apply the products or come in contact with treated plants, or beneficial insects that can be very effective control measures in their own right. Second, repeated pesticide use generally results in development of pesticide resistance, decreasing the efficacy of pesticides and requiring larger doses of the products to achieve the same level of control. Thirdly, pesticide use is being severely restricted or banned outright in many municipalities in New York State, which means that we *must* have alternative control methods if we are to keep this pest species in check.

One alternative method for management of insect pests is biological control. A variety of biological control agents can be used for insect control; these include pest-specific parasitoids, generalist predators, and pathogens (including viruses, bacteria, fungi, or nematodes). For this project, we sought to evaluate generalist predators and pathogenic nematodes for control of viburnum leaf beetle in the laboratory.

Materials and Methods

As candidate biocontrol agents, we chose only organisms that are commercially available in the U.S. Four predators were evaluated: 1) *Coleomagilla maculata*, a ladybird beetle (adults and larvae), 2) *Harmonia axyridis*, another ladybird beetle (adults only; larvae are not commercially available), 3) larvae of *Chrysoperla carnea* (green lacewing), and 4) *Orius insidiosis*, minute pirate bug (adults only; nymphs are too small). In addition, we evaluated a

species of parasitic nematode, *Heterorhabditis bacteriophora*, because it attacks insects in the soil; we reasoned that immature stages of viburnum leaf beetle might be susceptible to such an agent, either as larvae as they crawl into the soil to pupate, or as pupae in the soil. This nematode is often used against other chrysomelids.

Predatory efficiency was evaluated by placing a viburnum leaf containing larvae of *Pyrrhalta viburni* in petri dishes (9 cm diam) at two densities (1 or 4 larvae per dish) along with an individual predator. Larval *P. viburni* in all trials were 3rd instar except for the second trial with lacewing larvae; in this trial, we used 1st instar prey larvae because the small predators had a difficult time handling the larger (3rd instar) prey. Prey mortality and signs of predator attack were assessed at the following times following introduction: 4, 24, 48, and 96 h. The various combinations of predator and prey life stages can be seen in Table 1 (we were unable to try every predator with both larval stages of prey because of lack of prey larvae). Five replicates were conducted for each predator:prey combination and each prey density. For those predators that appeared most effective, we video-recorded interactions between predator and prey and quantified a number of parameters related to aggressiveness and attack efficiency of the predators. Because the emphasis of this portion of the project was on absolute as opposed to comparative predatory efficiency, results were not statistically analyzed (mortality of larvae not confined with predators was nil). Predators killing less than half of prey items were considered to be poor candidates for further study. Incidence of predation in the field was observed in Highland Park Arboretum in Rochester, N.Y. where population levels of *P. viburni* have been very high.

Efficacy of *H. bacteriophora* was assessed by placing a viburnum leaf with five3rd instar *P. viburni* larvae in a container (9 cm diam x 11 cm tall) containing soil medium dosed with nematodes. The target number of nematodes was 666 per container, which is equivalent to 1 million nematodes per square foot, the recommended application rate. Ten such containers were placed in a growth chamber at 22C under 15:9 L:D, and checked daily for adult emergence. Ten control containers, identical to the treatment containers except lacking nematodes, were placed beside the treatment containers and similarly monitored. Percent emergence was analyzed with ANOVA.

Results

Adult *Harmonia axyridis* paired with 3rd instar and larval *Chrysoperla carnea* paired with 1st instar *P. viburni* larvae exhibited efficacy at each of two prey densities, individually consuming 100% of single prey and 45-65% of four prey within 24 hours (Table 1). In direct observations, first instar *C. carnea*, despite a 65% greater duration of attacks than *H. axyridis*, seemed unable to kill 3rd instar *P. viburni* larvae. Post-attack mortality from inflicted injuries might occur, however. *H. axyridis* successfully killed and consumed large prey. Larval and adult *Coleomagilla maculata* and adult *Orius insidiosus* were ineffective predators of 3rd instar larvae; the only mortality with these two predators was 20% mortality observed with adult *C. maculata* paired with individual *P. viburni* larvae.

The nematode *Heterorhabditis bacteriophora* was highly efficacious against pupating *P. viburni*, reducing adult eclosion from 74% to 12% ($F_{1,18} = 21.4$; $P = 0.0002$). We suspect that efficacy might even be higher because mortality induced by the nematode was 100% in 8 of 10 experimental units and 80% in the ninth.

The only incidence of predation in the field was by *H. axyridis*. When present, it was

found at a density of approximately 1 *H. axyridis* (adult or larvae) per 100 *P. viburni* larvae. In all cases, *H. axyridis* was found on plants with populations of aphids, and were more often found in the vicinity of aphids than *P. viburni* larvae.

Discussion

These studies have revealed that two generalist predators and a pathogenic nematode offer potential as biocontrol agents for *P. viburni*. Although both predators (*H. axyridis* and *C. carnea*) are widely distributed in the northeastern U.S., it is not clear whether populations occurring in the wild would be sufficiently high to suppress *P. viburni* populations, especially when young *P. viburni* larvae are present (early to mid May). Thus, augmentation might be needed to elevate predator numbers to levels high enough to effect control. *H. axyridis* seems to prefer aphids over *P. viburni* larvae, so it is unclear whether predation on *P. viburni* will be substantial if large aphid populations are present. Augmentation with *C. carnea* larvae might also be effective in reducing numbers of *P. viburni*, but we have not seen lacewing larvae feeding on *P. viburni* in the field. This may be due to later emergence of lacewings; augmentation with commercially reared *C. carnea* in early May could possibly be an effective control strategy.

Biological control of *P. viburni* in the larval stage with *H. bacteriophora* seems most promising. Control in only one of the treated experimental units was low; it seems likely that the target dose was not achieved in this case. The level of control in the remaining experimental units was quite impressive, suggesting that this biocontrol agent is ready for evaluation in field trials. It would also be interesting to survey soils in western New York for the presence of this or other nematodes, and to evaluate other pathogens (e.g. *Metarhyzium* sp., *Bauveria* sp., etc.) for their potential in controlling *P. viburni*. An interesting phenomenon occurred this past year suggesting that a soil-dwelling pathogen may be effective in killing *P. viburni* in the soil; very few adults were seen this summer in many parts of Rochester in spite of large larval populations in the spring. It is unknown what was responsible for this dieoff, but we suspect a soilborne agent.

Soil-applied pathogens might be the most promising method for controlling the spread of *P. viburni* because they have very low non-target toxicity and can be easily applied to large areas. This is especially important for *P. viburni* because there are large areas of unmanaged landscapes containing suitable host material for *P. viburni* (e.g. arrowwood viburnum, or *Viburnum dentatum*) that can aid the spread of the insect. Controlling the front of the insect invasion as the insect moves into previously unoccupied territory might effectively halt the spread of the pest.

Table 1. Efficiency of several predators against larval *Pyrrhalta viburni* at two prey densities.

Predator	Predator Stage	Trial	Prey Density	Prey Stage	Mortality (%)
Harmonia axyridis	Adult	1	1	3rd instar	100.0
			4		65.0
		2	1	3rd instar	100.0
			4		45.0
Chrysoperla carnea	1st instar	1	1	3rd instar	0.0
			4		15.0
		2	1	1st instar	100.0
			4		62.5
Coleomagilla maculata	1st instar	1	1	3rd instar	0.0
			4		0.0
	Adult	1	1	3rd instar	20.0
			4		0.0
Orius insidiosus	Adult	1	1	3rd instar	0.0
			4		0.0