Evaluation of Insecticides for Control of Larvae of *Pyrrhalta Viburni*, a New Pest of Viburnums[1]

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Abstract

Pyrrhalta viburni (Paykull), a newly introduced pest of viburnums in the United States, causes extensive defoliation, and eventually death, of a number of species of *Viburnum* commonly used in managed landscapes and occurring in native habitats. We evaluated several foliar and systemic insecticides for their ability to control the larvae of this leaf-feeding pest. Several foliar insecticides (Conserve SC, Dursban, and Pyronyl Crop Spray) significantly reduced defoliation by larvae, but the most effective products were two systemic insecticides (Merit and Meridian) that were applied before egg hatch. The ability of the soil-applied systemic products to be translocated throughout the plant, to remain active for very long durations (a year or longer), and to have minimal impact on foliar-dwelling natural enemies make them well suited for managing this pest until more sustainable forms of control can be developed.

Index words: viburnum leaf beetle, pest control, insecticides, invasive pests.

Species used in this study: American cranberrybush viburnum 'Compactum' (*V. trilobum* Marsh.); Arrowwood viburnum (*Viburnum recognitum* Fernald, formerly known as *V. dentatum* L.); European cranberrybush viburnum 'Nanum' (*V. opulus* L.); Sargent viburnum 'Onondaga' (*V. sargentii* Koehne).

Chemicals used in this study: Conserve SC (spinosad), Spinosyn A & Spinosyn D; Dursban (chlorpyrifos), 0,0-diethyl 0-(3,5,6-trichloro-2-pyridinyl); Malathion 50% (malathion), diethyl (dimethoxythiophosphorylthio) succinate; Meridian (thiamethoxam), 4H-1,3,5-oxadiazin-4-imine, 3-[(2-chloro-5-thiazolyl) methyl]tetrahydro-5-methyl-N-nitro-; Merit 75 WP (imidacloprid), 1-[(6-chloro-3-pyridiyl)methyl]-N-nitro-2-imidazolidinimine; Novodor (*Bacillus thuringiensis* subsp. *tenebrionis*); Orthene Systemic Insect Control (acephate), O,S-dimethylacetylphosphoramidothioate; Pyronyl Crop Spray (pyrethrins + PBO), pyrethrins & piperonyl butoxide; Volck Oil Spray (horticultural oil), refined petroleum distillate.

Significance to the Nursery Industry

Control of viburnum leaf beetle is needed to protect susceptible species/cultivars because considerable damage or death of the plant will occur if left untreated. Viburnums are used widely in the landscape, and this new pest is expected to expand its range to cover a significant portion of the United States. Virtually no reports exist documenting efficacy of pesticides against this insect. Our results indicate that the most effective insecticide treatments for controlling larvae of viburnum leaf beetle are soil applications of Merit at 0.42 g/liter (5.6 oz/100 gal) or Meridian at 0.47 g/liter (6.3 oz/100 gal).

Introduction

Pyrrhalta viburni (Paykull), a newly introduced pest of viburnums in the United States from Canada, causes extensive defoliation to several popular viburnums used in the landscape as well as several species occurring in native habitats. This pest feeds only on viburnums, but not all species are equally susceptible. The most susceptible species — *V. trilobum*, *V. opulus*, *V. sargentii*, *V. rafinesquianum*, and *V. recognitum* — will die after 2–3 years of repeated infestation if left uncontrolled (11). Other viburnums are eaten only lightly by the beetle, or are left untouched. Most of the resistant viburnums are thicker-leaved accessions such as leatherleaf viburnum (*V. rhytidiophyllum* Hemsl.) or Koreanspice viburnum (*V. carlesii* Hemsl.) and its hybrids (e.g. Burkwood viburnum, *V.* x *burkwoodii* Burkw. & Skipw; and Judd viburnum, *V.* x *juddii* Rehd.) (11).

P. viburni is particularly damaging to susceptible plants because both the larvae and adults feed on the foliage, seriously depleting plant reserves. The insect has one generation per year, starting with larvae that emerge in mid-late spring from overwintering eggs. The larvae feed for 5–6 weeks on recently expanded leaves, leaving only major veins when populations are high. After they complete their development, the larvae drop to the soil and pupate in a small chamber several centimeters below the soil surface. Adults emerge several weeks later, and feed on the leaves of the same plants that served as hosts for the larvae. Adults continue to feed and lay eggs for the remainder of the summer and into early fall. The eggs laid by the adults, which can be seen primarily on the underside of young shoots, remain dormant until the following spring.

P. viburni is native to Europe, where its numbers are kept in control by several natural enemies (4, 5, 8). Unfortunately, when the pest made the transatlantic voyage to Canada, where it became established in 1979 (6), the natural enemies apparently did not come with it. Thus, the insect has been able to expand its range very rapidly since arriving in the United States in 1994, when it was first detected in Maine (1). In 1996, it was first seen in New York State (E. R. Hoebeke, personal communication), and by 2001, it had spread to half

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of the 52 counties in New York (unpublished data) and was found throughout the southern half of Maine (3). Given its continent-wide distribution in Europe, it seems likely that this insect will eventually become very widely distributed in the United States and be a persistent threat to those producing or managing susceptible viburnums in the landscape.

The only report in the literature documenting pesticidal efficacy against *P. viburni* reported that a formulation of *Bacillus thuringiensis* var. *san diego* (also known as *tenebrionis*) (*Btt*) caused 60% mortality of 3rd instar larvae (7). This degree of control would be unacceptable to nursery and landscape managers, however, and *Bt* is known to be more effective against younger instars. Therefore, we sought to assess the ability of *Btt* and several commercially available insecticides to limit damage of larval *P. viburni* to susceptible viburnums in field or nursery settings.

Materials and Methods

Trials were conducted in the spring of 1999 and 2000 in and near Rochester, NY, the area in the state most heavily infested by the beetle following its first detection in 1996 (E. R. Hoebeke, personal communication). The trial in 1999 was conducted with established viburnums in Highland Park Arboretum, Rochester, NY, that were naturally infested with *P. viburni*. Because no one species of viburnum had enough individuals to use for the entire experiment, we used four groupings of susceptible viburnums (one of *V. trilobum* 'Compactum', one of *V. opulus* 'Nanum', and two of *V. sargentii* 'Onondaga') that had six individuals in each group. Each grouping constituted a separate replicate, and each of the six shrubs in a replicate was assigned to one of six treatments. The trial in 2000 was conducted with potted arrowwood viburnums (cultivar unknown) [46 cm (18 in) tall, in #1200 pots] at a nursery in Penfield, NY. These plants were obtained free of insects from a nursery in Waterdown, Ontario, Canada. Twigs of viburnum infested with eggs of *P. viburni* were attached to the foliage of these plants on May 9 in order to infest them with larvae of *P. viburni*. We aimed for an infestation level of about 20 egg sites, or 100 larvae, per plant. Additional live larvae (10/plant) were transferred to each plant after egg hatch to augment larval populations. Four replicates were also used for the 2000 trial. These plants were randomized on landscape fabric, and watered as needed with overhead sprinkler irrigation.

Application of foliar insecticides in both years was made after larvae were seen on the foliage (May 13, 1999, and May 23, 2000). For the systemic treatments in 2000, application was made to the soil 3–4 wk before egg hatch to allow enough time for the pesticide to be taken up by the roots and translocated. Systemic products that were applied as a soil drench were applied at a rate of 1.9 liters (2 qt)/plant, and those applied as a 'sprench' were applied at a rate of 1.4 liters (1.5 qt)/plant. A 'sprench' application is defined by Bayer Chemical Corp. as a coarse spray applied to the main trunk of a shrub, resulting in application to the bark of the trunk and also to the soil. The products tested in 1999 (Table 1) were all labeled for use against *P. viburni* at that time. All of these products were used again in 2000 except for Volck Oil Spray (horticultural oil) (owing to complete lack of efficacy in 1999) and Dursban (chlorpyrifos) (because of impending cancellation of registration by EPA). For the 2000 trial, we added two common homeowner insecticides (Sevin (carbaryl) and Orthene (acephate)) as well as several rates and application methods of two systemic insecticides, Merit (imidacloprid) and Meridian (thiamethoxam).

Plants were rated on two dates during each year of the trial. For the 1999 trial, pesticidal efficacy was gauged 1 and 2 weeks after application by assigning test plants a numerical score of 1 to 5, with 1 indicating little or no damage, and 5 indicating severe or complete defoliation. Efficacy in 2000 was measured 1 and 2 weeks after application by estimating percent defoliation by two independent observers, and averaging the values. For the 2000 trial, the number of larvae were also censused on each plant on each rating date. Data for the 1999 trial were analyzed with two-way analysis of variance (since each grouping of viburnums constituted a discrete block), and means were compared with least significant differences (lsd) at $P = 0.05$ after transforming data with log $(x + 1)$. Data from the 2000 trial were analyzed with the Kruskal-Wallis test, a non-parametric method, because variances could not be made homogeneous. Each treatment was compared to the corresponding control at each of the two sampling times, and differences were judged significantly different at $P = 0.05$.

Table 1. List of products used in efficacy trials against larvae of *Pyrrhalta viburni* in 1999 and 2000.

Product	Application type, formulated rate	Applied dose[z]	Active ingredient	1999	2000
Control	—	—	—	x	x
Novodor	foliar[y], 1.3 ml/liter (1 tsp/gallon)	—	*B.t. tenebrionis*	x	x
Conserve SC	foliar, 0.53 ml/liter (0.4 tsp/gallon)	—	spinosad	x	x
Pyronyl Crop Spray	foliar, 11.8 ml/liter (3 tbsp/gallon)	—	pyrethrins + PBO	x	x
Volck Oil Spray	foliar, 5.3 ml/liter (4 tsp/gallon)	—	paraffinic oils	x	
Dursban 50 WP	foliar, 2.6 ml/liter (2 tsp/gallon)	—	chlorpyrifos	x	
Merit 75 WP	sprench[x], 0.37 g/liter (5 oz/100 gallons)	0.5 (0.019)	imidacloprid		x
Merit 75 WP	sprench, 0.74 g/liter (10 oz/100 gallons)	1.1 (0.038)	imidacloprid		x
Merit 75 WP	soil drench, 0.42 g/liter (5.6 oz/100 gallons)	0.8 (0.028)	imidacloprid		x
Meridian 25 WG	soil drench, 0.47 g/liter (6.3 oz/100 gallons)	0.9 (0.032)	thiamethoxam		x
Meridian 25 WG	soil drench, 0.63 g/liter (8.5 oz/100 gallons)	1.2 (0.042)	thiamethoxam		x
Meridian 25 WG	foliar, 0.30 g/liter (4 oz/100 gallons)	0.6 (0.021)	thiamethoxam		x

[z] g (oz) a.i./plant.

[y] All foliar applications were made to the point of runoff.

[x] 'Sprench' application is defined by Bayer Chemical Corp. as a coarse spray applied to the main trunk of a shrub, resulting in application to the bark of the trunk and also to the soil.

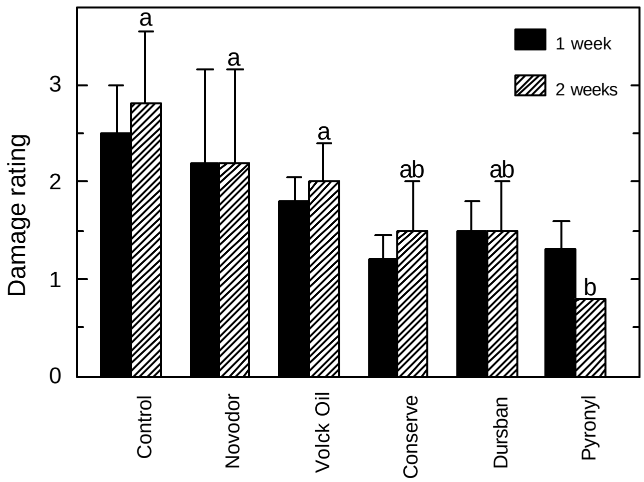

Fig. 1. **Damage ratings (1–5, 1 = little or no damage, 5 = extensive or complete defoliation) of viburnums infested by larval *Pyrrhalta viburni* following larvicide treatment in the spring of 1999. Error bars indicate standard errors. Means followed by the same letter are not significantly different as determined by lsd test ($P < 0.05$) following two-way analysis of variance of log-transformed data.**

Results and Discussion

No significant differences were detected 1 week after pesticide application in 1999 (Fig. 1). After 2 weeks, plants treated with Conserve SC (spinosad), Dursban, and Pyronyl (pyrethrins plus piperonyl butoxide) showed less damage than the control, but only Pyronyl was significantly different (F = 2.97, P = 0.49, df = 5, 14). Novodor (*Btt*) and Volck Oil Spray had no effect on larvae.

In the 2000 trial, the only products found to decrease damage were the three Merit treatments and the soil applications of Meridian (Fig. 2a). Lack of differences in damage between the control and the foliar insecticides probably resulted from the relatively low infestation levels achieved by our artificial infestation and the fact that the foliar products were applied after larvae had been given a chance to feed on the leaves. Note that even the control plants had a percentage defoliation of only 5–6%; in the 1999 trial with naturally infested shrubs, defoliation exceeded 90% for some control plants. It is clear from the larval counts recorded during the 2000 experiment, however, that most of the foliar insecticides were effective in killing larvae of *P. viburni*; all treated plants (except for Novodor and Conserve) had lower numbers of larvae than the control plants 1 week after pesticide application (Fig. 2b). This difference vanished by the 2nd week after application, probably because the larvae on the control plants had finished their development and had dropped to the soil to pupate. Interestingly, the Novodor-treated plants tended to have higher numbers of larvae than the control plants 2 wk after treatment. This is likely due to the documented ability of *Bt* toxin to delay larval development even if it does not kill them outright (9). Because of this delay, the larvae were able to feed for a longer period of time, resulting in slightly greater damage to the Novodor-treated plants than the controls 2 wk after pesticide application (Fig. 2a).

It is clear that the soil application of Merit and Meridian offered excellent protection from larvae of *P. viburni* since no larvae were found on these plants at either rating time, and the amount of leaf tissue consumed was miniscule. The foliar application of Meridian did not result in the same protection from damage as the Merit treatments or the Meridian soil treatments because it was applied after larval emergence, whereas the other systemic treatments were applied in advance of egg hatch, and thus were able to protect the plants from the moment larvae emerged. A foliar application of Meridian is likely to be quite effective, however, if applied at or just before the time of egg hatch because it was quite effective in killing larvae (Fig. 2b) and is known to move translaminarly across the leaf cuticle quite readily (2). Aside from commendable efficacy, the soil-applied systemic treatments have several other attributes that make them desirable insecticides. First, since they are soil-applied, they pose less of a threat to natural enemies and other non-target organisms in the foliage of treated plants. Exposure to non-target organisms is further reduced because these products can be applied to the plants at a time when few arthropods are active. Although the products need to be applied in advance of an infestation because they require several weeks for uptake, this does give pest managers greater latitude in their pesticide application programs. These products have a very long

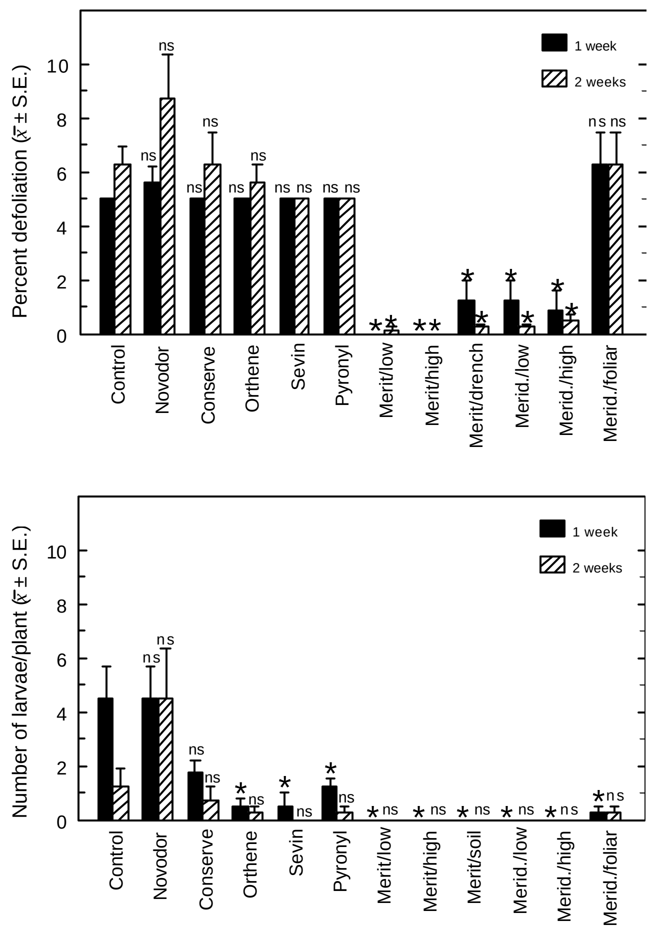

Fig. 2. **a) Percent defoliation by larvae and b) number of larvae of *P. viburni* present on arrowwood viburnums treated with a number of insecticides in 2000. Error bars indicate standard errors. Bars accompanied by asterisks are significantly different from the control treatment at the corresponding sampling time as determined by Kruskal-Wallis test (P<0.05).**

residual life in the plant and, thus, can be applied at a time when other landscape/nursery activities are minimal. Toxic residues of imidacloprid in woody plants have been found one year after application (10), and we have thus far (one year after treatment) seen no infestation by *P. viburni* in the plants treated with the systemic products in the 2000 trial (light to moderate infestation has been seen in the plants from that trial that were not treated with systemic insecticides).

The results of this research will be helpful in the short run for nursery operators and landscape managers faced with the task of managing a new pest on widely used landscape plants. In the long run, and in certain locations at the present time, alternatives to insecticides will be needed to manage this pest. Avoiding the most susceptible viburnum accessions, wherever possible, will reduce the need for pesticide application for this pest. We are currently investigating the mechanism by which resistant viburnums deter feeding by *P. viburni*, with the ultimate goal of transferring the genes coding for resistance (through conventional breeding or molecular techniques) to plants having desired horticultural traits but currently lacking resistance to the beetle. Biological control is another potential avenue for more sustainable control, especially in areas where the use of insecticides is precluded or undesirable. Importation from Europe of parasitoids specific to *P. viburni* is one appealing option, and augmentation of predators and pathogens is another. Preliminary work we have conducted has revealed that these natural enemies may indeed be useful tools in the management of this new threat to the landscape.

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