Title: Integrated control of viburnum leaf beetle with minimally toxic methods

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Abstract: Viburnum leaf beetle continues to spread throughout the state and region, impacting production and landscape use of several popular species of shrubs (mainly cranberrybush and arrowwood viburnum). If left uncontrolled, this insect kills established shrubs within a few years owing to repeated defoliation by larvae and adults. We evaluated several newer control options that are less toxic than current control tactics, but were expected to provide adequate control. The treatments included horticultural oil applied to egg masses, insecticidal soap applied to larvae, and covering plants with a physical barrier (agricultural fabric) to exclude adults. Insecticidal soap provided excellent control of larvae, but the other treatments were largely ineffective. Experiments with biological control agents revealed that *Harmonia axyridis* adults released into test plots significantly reduced larval feeding damage, but had no impact on adult feeding or egg laying. Insecticidal soap is now demonstrated to be a viable alternative to synthetic, more persistent pesticides commonly used for control of viburnum leaf beetle, and should have less adverse impact on the environment.

Background and Justification: The viburnum leaf beetle (VLB), *Pyrrhlata viburni* (Paykull), is a leaf-feeding beetle from Eurasia that became established in the northeast in the mid 1990s, and has quickly spread to inhabit portions of all the New England states, New York, Pennsylvania, Ohio, and Washington. Both larvae and adults feed extensively on the foliage of many species of viburnum, killing the most susceptible species within a few years of their arrival. As a result, many nursery producers have stopped growing susceptible viburnums, even though they are still popular with consumers and with landscape architects, whose specifications for plant materials to be used in plantings dictate which species of plants are purchased.

We have evaluated a variety of pesticides for managing VLB in nurseries and landscapes (Weston et al. 2001, 2002), and found soil-applied imidacloprid to be the most effective control. Even though this product has low impact on non-target organisms when applied to soil, there is still a need for less toxic (and less expensive) management tactics for this pest, especially where leaching of pesticides from soil makes this product less desirable or highly restricted (e.g. Long Island).

Our recent research has shown that very good levels of control can be achieved with reduced risk pesticides and predatory insects. In field tests conducted in 2005, we achieved excellent control of VLB larvae using insecticidal soap; larval damage was reduced to levels comparable to that achieved with foliar applications of imidacloprid (Weston and Desurmont, unpublished). In addition, horticultural oil (2% and 4%) applied to egg-infested twigs of arrowwood viburnum 2 and 4 weeks before egg hatch showed that 2% oil had no efficacy, but 4% oil at either timing reduced egg hatch by 75-80%. Combined with soap application, we expect to achieve excellent control of VLB larvae.

Adult VLB are also capable of causing extensive damage to many viburnum species, although not as predictably as larvae. For example, adult feeding damage was very low in 2005, despite healthy larval populations and large numbers of adults after the onset of adult emergence, which we attribute to high adult mortality because of the abnormally hot and dry conditions for most of the summer. In a more typical year, however, feeding by adults can be substantial, which generally translates into large larval populations the following year because egg-laying seems to be highly correlated with adult foliage feeding (personal observation). Adults are not easily managed with reduced-risk pesticides, but a physical barrier (such as Agri-Bon fabric) should reduce feeding and egg-laying sbstantially.

Release of the predatory bug *Podisus maculiventris,* the spined soldier bug, has also looked promising in field trials, reducing defoliation by ca. 50% on small shrubs in field tests in 2005 (on larger shrubs, where larval populations were >3000, control was not effective) (Desurmont & Weston, unpublished). The presence of *Harmonia axyridis*, the multicolored Asian lady beetle, may significantly increase control exerted by *P. maculiventris*; on smaller shrubs, feeding damage was reduced by 90% when both predators were present (Desurmont and Weston, unpublished). Most shrubs in nursery production are fairly small, so releases of *P. maculiventris*, alone or in combination with *H. axyridis*, may be a potential control option for VLB. *P. maculiventris* also consumes adult VLB, so establishing populations on susceptible shrubs in spring may provide a degree of control against adults as well. Eggs of *P. maculiventris* are available commercially, but populations of the predator may potentially be augmented by baiting field plots with Soldier Bug Attractors, commercially available pheromone lures for *P. maculiventris*. When deployed in the spring, overwintering adult *P. maculiventris* might be drawn to field plots in sufficient numbers so that they and their offspring might seriously diminish populations of VLB soon after egg hatch (*P. maculiventris* adults become active in mid April, just 2 weeks before eggs of VLB start to hatch).

The availability of effective control methods with lower environmental impact will allow nursery operators to manage viburnum leaf beetle with less risk to the environment and to employees.

Objectives:

1) Measure the efficacy of reduced-risk products as part of an integrated control system for VLB: a) oil sprays against eggs; b) inseciticidal soap against larvae; c) fabric barrier against adults; d) combinations of a, b, and c.

2) Measure the efficacy of *P. maculiventris* and *H. axyridis*, alone and in combination, against larvae of VLB.

3) Measure the ability of artificial pheromone of *P. maculiventris* to augment populations of the predator in field plots, thereby reducing feeding damage by VLB.

Procedures: All experiments were conducted at the Bluegrass Lane Turf Farm in Ithaca, NY, where we have established an extensive planting of various species of viburnum contained within a deer-proof enclosure. Objective 1 was carried out on existing plants of arrowwood viburnum that have been in the ground for 5 years and have been naturally infested with VLB (pre-existing infestation with eggs is necessary for this objective). These plants are ca. 5' tall, and spaced 5' apart. The treatments were: 1) untreated control, 2) 4% horticultural oil applied to twigs in late April (1 weeksbefore expected egg hatch), 3) insecticidal soap applied to plants one week after onset of egg hatch (to allow for completion of egg hatch), 4) Agri-Bon fabric applied to plants in mid-June (after larvae have completed development, but before adult emergence), 5) oil for eggs and soap for larvae, 6) oil for eggs and Agri-

Bon for adults, 7) soap for larvae and Agri-Bon for adults, 8) oil plus soap plus Agri-Bon, and 9) positive control (foliar application of Merit). Five replicates were used. Feeding damage was assessed visually following the larval feeding period (mid-June) and again after adult feeding ceases (early October). We have found the visual estimation of feeding damage to be very repeatable and consistent. Data were analyzed with randomized complete block ANOVA.

Objectives 2 and 3 were carried out with newly acquired specimens of arrowwood viburnum. These plants were set out in 5 widely-spaced areas within the fenced area, each grouping constituting a replicate. Plants were artificially infested with egg-infested twigs of susceptible viburnums (at a rate of 1000 eggs/plant). The plants within each replicate were subdivided into two groups (subplots) of 5 plants each. Subplots were separated by 30'; one was provided with pheromone lures, the other was. Lures (Soldier Bug Attractors, Sterling International, Spokane, WA) were placed three to a subplot so that each plant within the supblot was equally exposed to the lure. Within each subplot, 5 treatments were used: 1) untreated control, 2) *P. maculiventris* eggs deployed, 3) *H. axyridis* adults deployed, 4) both predators deployed, and 5) positive control (foliar application of Merit). [NOTE: *H. axyridis* is no longer commercially available, but overwintering adults were collected and stored under refrigeration until deployment in spring.] Feeding damage was assessed visually in mid June and early October, and plants were censused for predators at the time of egg hatch, 2 and 4 weeks after hatch, and monthly thereafter. Data were analyzed with split-plot ANOVA, using predator abundance as a covariate.

Results and discussion:

Defoliation by larvae and adults was greatly impacted by the soft control methods evaluated, particularly insecticidal soap against larvae (Fig. 1). Analysis of defoliation by larvae showed that all treatments that included insecticidal soap (except for the soap + Agri-Bon treatment) reduced defoliation to the same extent as a foliar application of Merit 75 WP. Factorial ANOVA of all treatments excluding Merit allowed us to tease out the separate effects of oil and soap, and revealed that soap was highly significant ($P = 0.015$, but that oil had no impact on defoliation by larvae ($P = 0.78$). The only aberrant observation was soap + Agri-Bon, which had larval defoliation comparable to the untreated control. This was no doubt due to migration of larvae to one of the replicates of this treatment from a neighboring shrub that was extremely heavily infested with viburnum leaf beetle and whose branches were in contact with the treated shrub. Because insecticidal soap has little or no residual activity, we suspect that larvae migrating to the treated shrub would have been able to cause extensive defoliation after resident larvae were killed by the soap treatment on the treated shrub.

Defoliation by adults followed a similar pattern to that of larvae (Fig. 1). In many cases, defoliation was higher on shrubs shrouded with Agri-Bon, perhaps because adults emerging from beneath these shrubs were actually trapped by the fabric, allowing them to feed on the "protected" shrubs and preventing their dispersal, resulting in greater defoliation than on uncovered shrubs. Although the fabric barrier might prevent attack by adults immigrating from other locations, it does not seem to be a viable control option given that larvae would have to be eliminated prior to application of the fabric. In addition, the soap treatment was very effective by itself, so the added expense of purchasing and installing the fabric is probably not justified.

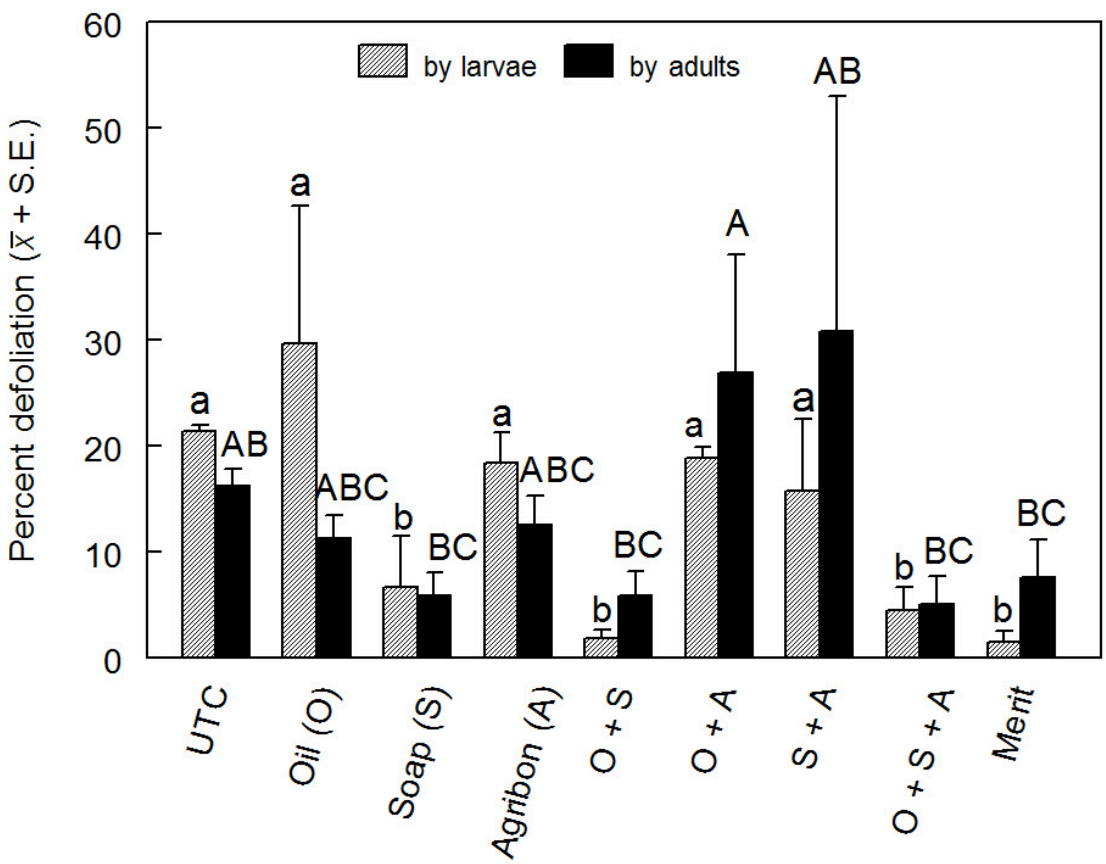

Figure 1. Defoliation of shrubs treated with the soft control treatments. Bars accompanied by the same letter are not significantly different as determined by ANOVA followed by lsd comparisons.

The application of *Harmonia axyridis* and *Podisus maculiventris* provided moderate levels of control of viburnum leaf beetle larvae (Fig. 2). Although the effect of the predators was not statistically different than the control, both predator species, when present alone, resulted in numerically less defoliation than the untreated control, an effect that was enhanced when both species were present together. To examine the effects of the predators alone, we excluded the Merit treatment and analyzed the remaining treatments with factorial ANOVA, which revealed that the presence of *H. axyridis* significantly reduced larval defoliation by roughly two-fold ($P = 0.039$). *P. maculiventris* had no significant effect on defoliation by larvae, likely because egg hatch of *P. maculiventris* eggs was quite low. The presence of Soldier Bug Attractors had no significant effect on either larval ($P = 0.6272$) or adult ($P = 0.5908$) defoliation, which we attribute to largely ineffective lures in the "attractors." (A lure from one of the Soldier Bug Attractors was placed in a trap for adult *P. maculiventris* during the spring emergence period, and resulted in zero trap catch compared to tens of adults trapped in traps baited with a lure from another source). Thus, we cannot rule out the efficacy of Soldier Bug Attractors as a potential control method, but the design of the lure or the formulation of the aggregation pheromone in Soldier Bug Attractors will need to be modified if this is to be effective.

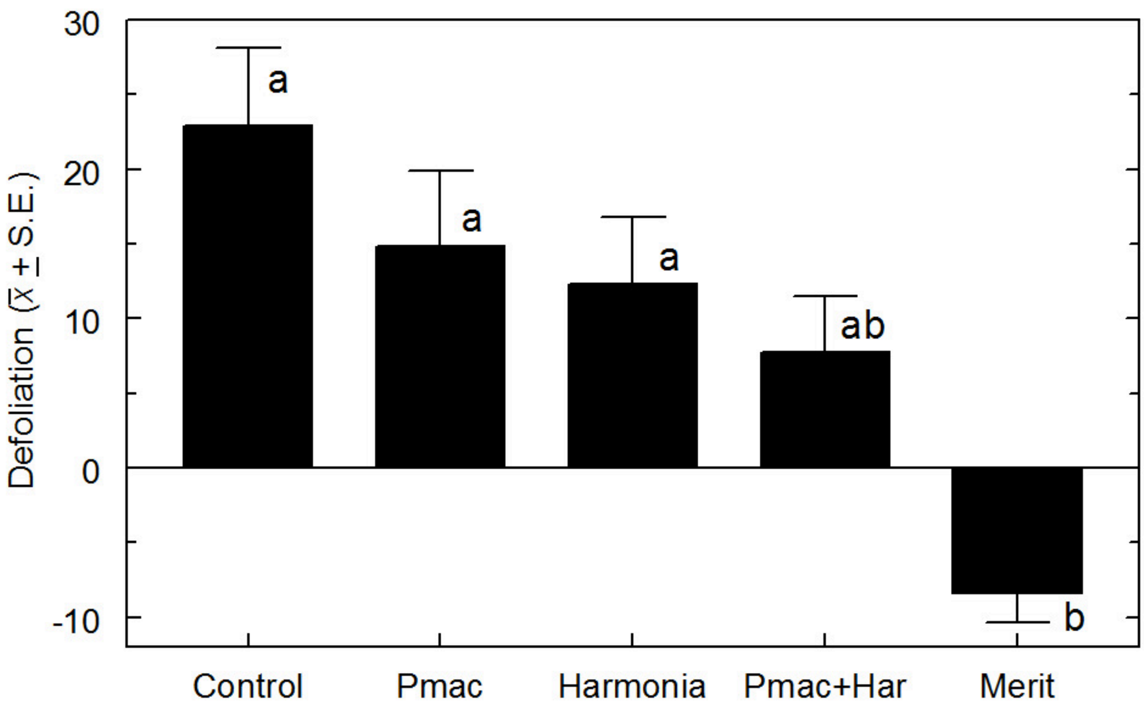

Figure 2. Defoliation by larvae as influenced by the presence of *P. maculiventris* (Pmac) and *H. axyridis* (Harmonia) in the field. Bars accompanied by the same letter are not statistically different as determined by ANOVA followed by lsd.

Implementing insecticidal soap treatments is simple and inexpensive, no doubt considerably less expensive than using Merit. (Note that Merit is the formulation of imidacloprid labeled for use in the landscape; the nursery equivalent is Marathon, which is virtually identical in composition to Merit). One disadvantage to using soap is that there is no residual efficacy, whereas soil applications of imidacloprid have efficacy for two or more years. In areas where pesticide residues, especially from soil-applied insecticides, are an issue, however, the efficacy of insecticidal soap may make it a very attractive alternative. Long Island is one such environmentally sensitive area where soap may have appeal. Applications of soap for control of viburnum leaf beetle larvae will require a bit more care than many other pesticides because the product has greatest efficacy when applied to young larvae, and because the product has little or no residual activity. However, other factors may outweigh these liabilities.