Final Project Report to the NYS IPM Program, Agricultural IPM 2003-2004

Title:
Evaluation of hemlocks for resistance to hemlock woolly adelgid

Project Leader(s):
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Type of grant:
Pest-resistant crops; allelopaths

Project location(s):
Eastern U.S.

Abstract:
Test plots containing 40-42 specimens of various species of hemlock were established in Lasdon Park Arboretum near Somers, NY. A total of three plots were established in distinctly different microhabitats within the arboretum, and half of each plot was fertilized shortly after planting in order to measure growth response of the test species to fertilizer and the impact of fertilization on susceptibility to the hemlock woolly adelgid. Trees will be artificially infested with adelgids in mid spring, and the first data will be collected in the fall.

7. Background and justification:
Hemlock woolly adelgid (*Adelges tsugae* Annand) is a devastating pest of eastern hemlock (*Tsuga canadensis*) and has become firmly established in the forests of the eastern U.S. In New York, the insect is found throughout the southern Hudson River Valley and Long Island, and ranges as far north as Columbia County, just south of Albany. The insect itself is quite small, but has extremely long mouthparts that allow it to suck nutrients from the vascular system of its host, trees in the genus *Tsuga*. After several years of infestation, the pest is capable of killing mature trees. Several insecticides have been found to effectively control the pest, but their use is not feasible or desirable in many situations. Biological control has been explored, and a species of coccinelid (*Pseudoscymnus tsugae*) native to the home range of *A. tsugae* (eastern Asia) appears to offer potential. Field evaluation of this natural enemy, however, has not yet been completed, and challenges remain in rearing large enough quantities of the predator. In the meantime, hundreds of acres of hemlocks have been lost to the pest, and the character of the devastated landscapes will be drastically changed if the trees are not replaced. Replanting with susceptible hemlocks (*T. canadensis*) is doomed to failure because these trees will be equally susceptible to the adelgid, which is unlikely to be eradicated from the U.S., at least not in the foreseeable future. If these trees could be replanted with trees similar in botanical form and ecological characteristics to *T. canadensis* with the exception of susceptibility to *A. tsugae*, the original character of these landscapes may be at least partially restored. We propose to evaluate a number of species of hemlock for their susceptibility to *A. tsugae* in hopes of identifying species that might be suitable for replanting trees lost to this exotic pest. Anecdotal reports

exist claiming that western species of hemlock (e.g. *T. heterophylla* and *T. mertensiana*) are resistant to the adelgid, but no scientific reports exist in the literature. In addition, it is known that soil fertility impacts susceptibility of eastern hemlock to the adelgid (McClure 1991); fertilized trees are much more susceptible to the pest. It is not clear whether other species of hemlock are similarly affected.

If susceptible hemlocks could be replaced by resistant ones, then pesticide treatment for the pest in managed landscapes could be greatly reduced and areas once forested with susceptible hemlocks could be restored to a state similar to that existing before the adelgid arrived. The loss of mature hemlocks greatly changes the character of forests since these trees normally provide abundant shade and their roots help stabilize soil. The impact on watersheds following the loss of climax trees like hemlocks could be enormous. Knowing how fertility regimes impact susceptibility of hemlocks to the adelgid could also be very important. For example, if adelgids are found to reproduce more abundantly on trees that are merely tolerant of the pest (as opposed to being completely resistant), this would offer guidance to those wishing to reduce overall numbers of the pest as part of an overall pest management program. If soil fertility had little impact on adelgid numbers, however, then this factor could be largely ignored as far as pest management goes.

Objectives:

1) Evaluate several commercially available species of hemlock for resistance to hemlock woolly adelgid
2) Measure the impact of soil fertility on resistance of hemlocks to hemlock woolly adelgid, and
3) Project evaluation

Procedures:

Research plots. Plots containing representatives of the candidate species were established in fall of 2003 in three locations within Lasdon Park Arboretum, a park in the Westchester County Park system. The park is located in the Hudson Valley near Somers NY, in an area already colonized by *A. tsugae*. Each whole plot was divided into two subplots, one of which was left untreated and the other was fertilized with fertilizer to meet the needs of Objective 2. Each subplot contains contain three representatives of each of six test species (*T. canadensis*, *T. carolinensis*, *T. mertensiana*, *T. chinensis*, *T. sieboldii*, *T. diversifolia*) and 1-2 representatives of a seventh species, *T. heterophylla* (additional replicate specimens of this species died between the time trees were purchased and the time planting occurred). *T. canadensis* and *T. caroliniana* are native eastern hemlocks that are susceptible to the adelgid, *T. mertensiana* and *T. heterophylla* are western species that are reportedly tolerant, and *T. chinensis*, *T. sieboldii*, and *T. diversifolia* are Asian species that are reportedly resistant. In addition, an additional treatment of *T. canadensis* treated with an insecticide will be included so that growth habits of this species when not adversely affected by hemlock woolly adelgid can be compared to resistant species. Each whole plot is replicated in three locations in very different habitats within the arboretum.

Objective 1. Evaluate several commercially available species of hemlock for resistance to hemlock woolly adelgid. Adelgid-infested branches will be attached to several locations on each test tree in the spring of 2004 when adelgid immatures are active. Adelgid populations will be quantified by life stage (including eggs) on each tree at the end of the growing

season, and tree growth characteristics (e.g. growth rate, foliage color, height, dbh, circumference, etc.) will be measured.

Objective 2. Measure the impact of soil fertility on resistance of hemlocks to hemlock woolly adelgid. One subplot of each of the whole plots was treated on 11/21/2003 with 30-10-10 soluble ferilizer at a rate of 1.5 lbs. N/acre. The same variables will be monitored as under Objective 1.

Objective 3. Project evaluation. Plots have only recently been established; therefore, project evaluation has not yet taken place.

Results and discussion:

Data have not yet been collected because research plots were just recently established. Data were collected on the height of trees after planting (Fig. 1) in order to follow responses of the trees to infestation and fertilizer treatment over time. Because trees of uniform height across species were impossible to obtain, tree responses (when they are obtained) will be expressed on a percentage of starting height.

Samples of materials:

see attached photo of volunteers from Cornell Cooperative Extension/Westchester Co. and IPM program planting hemlocks for the research plots in Lasdon Park Arboretum.

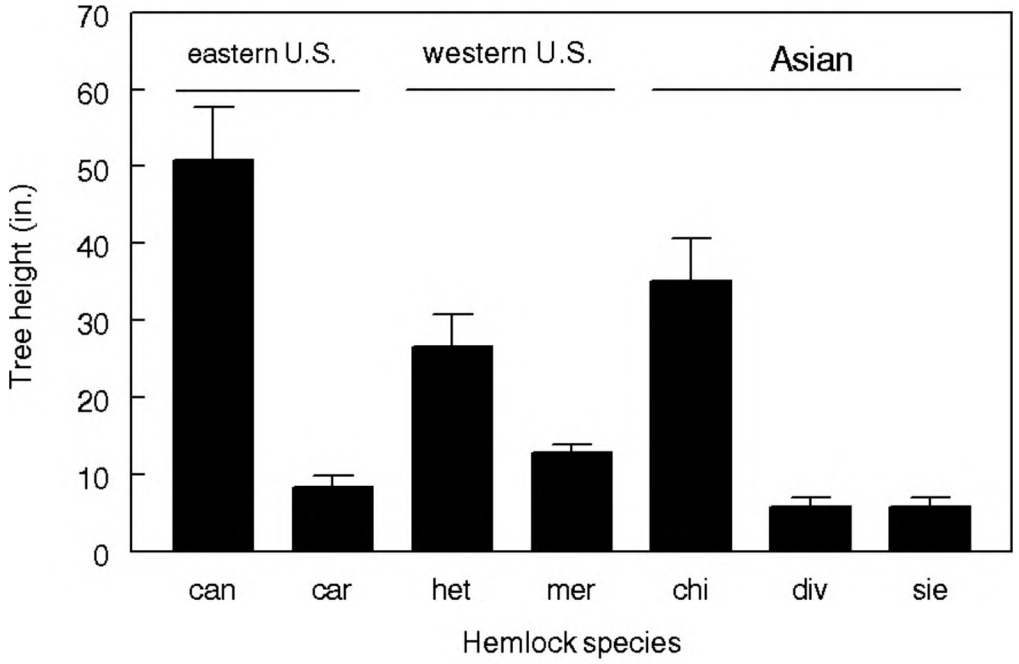

Figure 1. Height of hemlock trees in research plots shortly after planting (prior to fertilization or infestation by adelgids). Each bar represents a different species of *Tsuga*, as follows: can = *T. canadensis*, car = *T. caroliniana*, het = *T. heterophylla*, mer = *T. mertensiana*, chi = *T. chinensis*, div = *T. diversifolia*, sie = *T. sieboldii*. Height of bars represent mean $\pm$ standard deviation. Horizontal bars indicate native range of each species (i.e. eastern U.S., western U.S., Asia).