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The University of Tennessee
Agricultural Extension Service

SP503-G

Insects

The Hemlock Woolly Adelgid: A Threat to Hemlock in Tennessee

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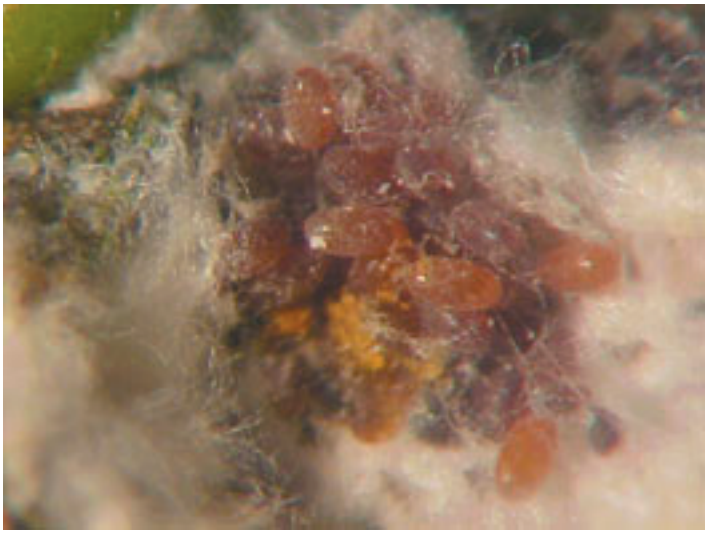
The hemlock woolly adelgid (HWA), a destructive aphid-like insect pest of eastern and Carolina hemlock, is originally from Asia. Its first discovery in the United States was in Oregon on western hemlock in the 1920s. It was not found in the East until the 1950s, when it was detected in Virginia. Since then it has spread throughout the East from New England to North Carolina (1995) and most recently to East Tennessee in 2002. The HWA is expanding its range an average of 15 miles per year.

The hemlocks found in Asia and the western and mountain hemlocks that occur in the western United States appear resistant to HWA. Conversely, the eastern and Carolina hemlock found in the East are highly susceptible. Nearly half the hemlock stands in the eastern forests are infested with this pest, which has caused extensive tree mortality, up to 80 percent, in the Middle Atlantic and southern New England states.

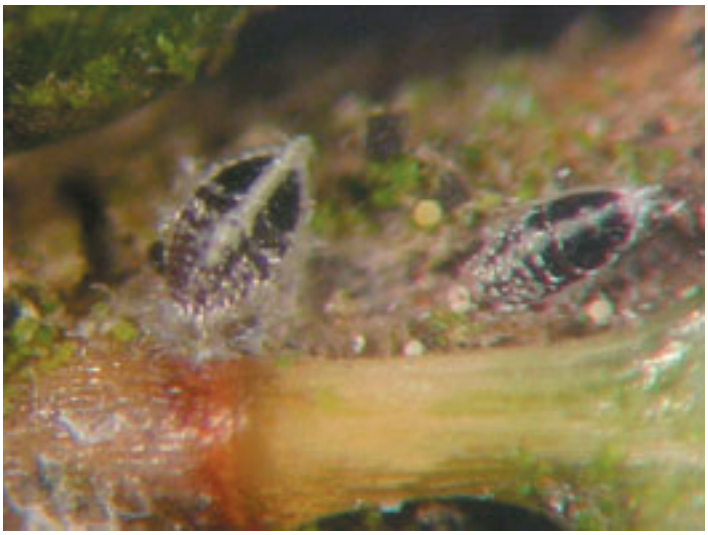
Damage Symptoms – HWA feeds on all ages of trees. The insects attach themselves to the base of the hemlock needles and feed from the new twig growth with piercing-sucking mouthparts. The first symptoms are needle yellowing and needle drop, followed by branch desiccation (drying) and a lack of vigor indicated by a thinning crown. Limb dieback may occur within two years of the initial infestation on seedlings and saplings. Heavily infested larger trees usually die within four years, although it may take longer than 10 years depending on proximity to other infested trees, tree size, the level of environmental stress and the quality of the growing site.

Identification and Life History – The most noticeable aspect of infested hemlocks is the white masses at the base of needles on the twigs. The adults are small (1/32 inch), oval and reddish purple, although covered with white, waxy tufts. This waxy material is produced from pores on their bodies. The HWA are all female and they overwinter within the waxy mass. In December through March, the adult adelgids lay egg sacs of up to 300 eggs each. Eggs are initially brownish-orange, but will darken as the eggs mature. After hatching in April-May, the flat reddish-brown crawlers without the protective covering actively seek a suitable site on the host plant to feed. After settling, this first generation molts and the nymphs become black with a white wax fringe around the edge and down the center of the back. The nymphs feed on twigs, usually near the base

White, waxy fluff covers the hemlock woolly adelgids on a twig.



Hemlock woolly adelgid egg mass.



Hemlock woolly adelgid nymphs are black with white, waxy fringes.

of needles. They soon extrude the white, fluffy "wool" that covers their bodies. About half of the resulting adults have two pairs of wings and will fly off in search of an alternate host of spruce on which to feed. Because no suitable spruce host occurs in North America, the adelgids will eventually die of starvation. The other half are wingless and remain on the tree, where they lay eggs in a fluffy mass on the hemlock.

The second-generation crawlers emerge from the egg masses of up to 250 eggs each. The crawlers are dispersed via wind, birds and other animals. They move to the new growth and settle at the base of the needles to feed and molt into black nymphs with characteristic white fringes. These nymphs will remain at this site until maturity. The nymphs enter a period of dormancy in late summer before resuming feeding in the fall. In October or November, they molt and their bodies will begin to be covered with the white, cottony wax. Gradually maturing to adults by feeding throughout the fall and winter, these adults begin the yearly cycle again by laying eggs in April. Two adelgid generations per year allow for rapid buildup of this pest.

Control – Insecticidal soap and horticultural oil sprays can provide effective control of HWA even when the waxy covering is present. Relative to most other insecticides, insecticidal soaps and horticultural oils have fewer potential adverse effects to the user, with minimal harm to beneficial predators, parasites and the environment. Complete coverage is needed for effective control, so a high-pressure spray is necessary. A high level of control is possible with just one spray. Evaluate a week after spraying to see if a second spray is needed.

Horticultural oil may cause some phytotoxicity (leaf burn) when applied during the growing season, especially during hot, dry weather. For this reason, a 1 percent solution of horticultural oil is recommended from May through September, while a 2 percent solution can be used from October to April. Insecticidal soap sprays may occasionally cause some phytotoxicity on tender new foliage. It is best to not apply horticultural oil or insecticidal soap if the temperature exceeds 90 degrees F. or drops below 45 degrees F. Spraying trees with horticultural oil or insecticidal soap before trees are infected does not act as a deterrent to HWA infestation.

Imidacloprid can be used as a foliar spray, applied in the root zone as either a soil drench or soil probe injection, or injected directly into the tree trunk. Foliar imidacloprid sprays can be made on trees away from sources of water. Timing of imidacloprid sprays is best between mid-May and mid-June, and again between late July and October.

The root zone or trunk injection methods are much longer-lasting than the foliar application, and the level of control is generally better. One application to the root zone or the trunk can potentially provide a year or more of control.

After treatment, reinfestation by HWA should be a concern. Expect reinfestation to occur sooner if untreated HWA-infested hemlock trees are nearby. Even if reinfestation occurs within a year of a root or trunk treatment, higher pest levels that seriously reduce tree growth may not occur until the end of the second year.

Soil applications of imidacloprid by drenching or soil injection should be made between late August and early December or from mid-March to mid-June. It may take two to three months for the insecticide to move up into the foliage of a medium-sized tree. Moist soil prior to treatment and for seven to 10 days after treatment is needed to optimize uptake. Use rates are determined by the diameter of the tree trunk. It should be emphasized that trees heavily infested with HWA or those in poor vigor may not be as effectively treated as more vigorous trees. Imidacloprid is not labeled for use as a root zone application in forests.

The trunk injection methods are only available commercially for application by specially trained landscape professionals. The optimal timing of the imidacloprid trunk injections in the spring coincides with egg hatch and crawler attachment to new needles. The plant phenological state used to time these sprays is one week before through two weeks after leaf out. Tree injection for the fall is timed for September, about a month before partial leaf shed, to control this immature stage.

In landscape and nursery crop situations, it is practical to rely heavily on chemical control to eradicate this pest. In the forest situation, it is much more difficult and expensive to treat all the infested hemlock trees. Forest managers and park officials should make decisions on which trees to treat in forest settings based on tree stand values and land management objectives.

While chemical control can be a very useful tool, it is just one component of an integrated pest management (IPM) approach. IPM uses all available techniques to manage a pest so that economic damage and harmful environmental side effects are minimized. It is thus important to prevent the introduction of this pest into new areas. Inspect new landscape or nursery hemlock trees before planting or selling. Use care when moving plants, firewood and other outdoor items from infested areas, especially from March to June when HWA eggs and crawlers may be present. If possible, try to keep people out of infested areas, since HWA can be transferred on clothing. Animals may also help disperse this pest. Do not place birdfeeders in hemlock; and use noisemakers, fake owls or snakes to discourage birds from landing in infested trees.

Maintaining good growing conditions will enhance the survival of hemlocks. Water trees during periods of drought. While applying fertilizer may improve the growth and vigor of uninfested trees, fertilizing with nitrogen enhances HWA survival and reproduction. As a result, a fertilized hemlock becomes more heavily infested and more severely injured than an unfertilized one. Also avoid fertilizing lawn areas within the root zone of infested hemlock trees.

Infestations often start in large, mature hemlocks but can also start in other size trees. If these trees cannot be treated, their removal will retard the establishment of new infestations. Clipping heavily infested branches will reduce HWA numbers on individual trees, but extensive clipping may negatively affect the appearance and health of the tree. Removal of dead or dying branches will allow more light to reach the foliage and promote good tree health. Pruned branches should be properly discarded or destroyed so as to not spread the infestation to other areas. Since wind and rain will dislodge eggs and crawlers from the tree, washing the tree with a strong jet of water will also do the same. Do this periodically from April through June.

Consider not planting hemlock in or near an infested area. Although nothing can replace hemlock in a forest setting, there are a number of evergreens, including eastern white pine, Arizona cypress, Leyland cypress and eastern red cedar, available for landscape use.

Management of HWA by an imported predaceous lady beetle, *Pseudoscymnus tsugae*, is most effective using an IPM approach for forest stands that includes chemical control. This small black beetle feeds almost exclusively on HWA, although it probably will not prevent or eradicate HWA infestations. They are best used in forest situations to help maintain HWA populations at light to moderate levels, once established.

The commercial supply of *P. tsugae* should come closer to meeting the demand with the establishment of a rearing facility at the University of Tennessee in 2004. The use of chemical control can maintain hemlock stands until *P. tsugae* can become established or until better biological control agents can be discovered and introduced.

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