# Hemlock Woolly Adelgid, *Adelges tsugae* (Annand)

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## What it is and How to Stop It

Hemlock woolly adelgid is a small aphid-like insect from Japan that has become a serious pest of eastern hemlock, *Tsuga canadensis*, in the eastern United States. Even though the adelgid is smaller than a period at the end of this sentence, it is easily recognized on the new growth by the presence of a dry, white woolly substance that covers its body and egg masses. Hemlocks are injured when the insects feed on the sap and inject toxic saliva into the tree. This dries out the needles turning them a grayish-green color. They then drop from the tree usually within a few months. Most buds are also killed, so little if any new growth is produced on infested branches. Death of major limbs usually occurs within two years and progresses from the bottom of the tree upwards, even though the infestation may be evenly distributed throughout the tree. Trees often die within four years, but some survive longer in a severely weakened condition with only a sparse amount of foliage at the very top of the crown. These weakened trees are unsightly and have little chance for recovery. They often fall victim to wood-boring insects, diseases and are easily damaged by the wind.

Hemlock woolly adelgid at this time, can not be managed in the forests. However, hemlocks growing in nurseries and ornamental landscapes can be saved by carefully monitoring for the presence of the adelgid. Implementing various cultural practices to enhance tree vigor, to discourage pest invasion, and by using mechanical and chemical measures as needed can bring the adelgid under control.

## Biology

The hemlock woolly adelgid is parthenogenetic. That means all individuals are female. It completes two generations of development each year. During March and April, adults of the overwintering generation lay about 100 eggs each in a cottony mass on the young twigs. Nymphs (called crawlers) hatch from these eggs during a period of several weeks from April to May. Within a few days, they either disperse from the tree or settle on the twigs near the base of the needles where they insert their piercing and sucking mouth parts. There they feed and remain throughout their development. The spring generation matures by mid-June. Some of the adults produced at this time have wings and are unable to reproduce on hemlocks. They leave the hemlock tree in search of spruce. There is no suitable spruce host in the eastern United States, so they soon die. Other adults produced at this same time are wingless and are able to reproduce on hemlock. In the middle of June these wingless adults lay about 100 eggs each in a cottony mass on the twigs. Crawlers,

which hatch in early July settle on the new growth and soon become dormant until the middle of October when feeding resumes. Nymphs feed and develop during the winter and mature in the spring.

## How to Monitor the Pest

It is important to detect infestations early, because the hemlock woolly adelgid can damage trees so quickly. Frequent visual inspection is the most effective means of determining whether or not a hemlock is infested. For most of the year the dry, white "wool" produced by the adelgid on the twigs is quite conspicuous. It is particularly noticeable in spring on the undersides of new growth. Further evidence of hemlock woolly adelgid infestation is the thinning or grayish-green (not red or yellow) color of the needles on some branches. Usually by the time these symptoms appear, the tattered "wool" of a previous adelgid generation is also present on the branches.

## Cultural Control Methods

*Reducing invasion by adelgids:* Birds, squirrels and deer are important dispersal agents. Thus any effort to discourage these animals from visiting hemlocks will reduce the risk of trees becoming infested. Care should be taken when moving plants, logs, firewood, or bark chips from infested areas into non-infested areas, especially from March to June when adelgid eggs and crawlers are present. Cleaning vehicles, clothing, etc. after visiting forests, recreational areas, parks or other properties with infested hemlocks is also advisable during this period. Hemlock woolly adelgid infestations often start in large mature hemlocks that intercept the wind or are especially attractive to birds and other wildlife. These trees serve as reservoirs for the adelgid and selective removal of them can retard the establishment of new infestations.

*Improving tree health:* The hemlock woolly adelgid infest and kill hemlocks of all sizes and ages, even in habitats with seemingly excellent growing conditions. Trees that grow in poor sites or experience stress from drought and other agents succumb to adelgid attack more quickly. Maintaining good growing conditions can play an important role in the survival of hemlock. The hemlock is a shallow rooted tree and is particularly prone to stress when there is little rain. Therefore, during periods of drought, trees should be watered as often as needed. Ensure that they receive 1 inch of water per week (including rainfall) over the area beneath the drip line of the crown. Water should be applied slowly so that the roots are well watered. Pruning may also be of some value in improving the health of hemlock. Remove dead and dying branches and limbs from hemlock will promote new growth by allowing more light to reach the foliage. It will reduce the likelihood of attack by insect pests and diseases. Although applying fertilizer may improve the growth and vigor of non-infested trees, fertilizing infested hemlocks with nitrogen enhances adelgid survival and reproduction. As a result, a fertilized hemlock becomes more heavily infested and more severely injured than an unfertilized one. Nitrogen fertilizer should not be applied to an infested hemlock. Fertilizing a tree after adelgids have been controlled may encourage growth and stimulate recovery. The potential risks and benefits of applying fertilizers which do not contain nitrogen to adelgid-infested hemlocks are unknown.

*Mechanically removing adelgids:* Eggs and crawlers are easily dislodged from trees by the wind and rain. Most of these individuals are unable to find their way back onto the tree and die. Therefore, intentionally dislodging eggs and crawlers by directing a strong stream of water at infested branches periodically during April through June may be of some value in reducing adelgid numbers. Clipping the more heavily-infested

twigs from hemlock branches will also reduce adelgid density on a given tree. However, extensive clipping may have undesirable effects on the general appearance and health of the tree.

*Planting resistant hemlock species:* Two Japanese hemlock species, *Tsuga diversifolia* and *T. sieboldii*, and two western North American hemlock species, *T. heterophylla* and *T. mertensiana*, are resistant to hemlock woolly adelgid. Although the adelgid infests these resistant species, it rarely reaches high enough densities to cause injury. Planting these resistant hemlocks may reduce the impact of the insect in the ornamental landscape. Of the four species, *T. heterophylla* is most similar to the eastern hemlock *Tsuga canadensis* in appearance, growth, form, and utility. However, the likelihood for long term success of these hemlocks in the eastern United States in unknown.

## Chemical Control Methods

*Deciding whether or not to use pesticides:* The use of chemical pesticides is an important component of any control program for hemlock woolly adelgid. Even though cultural control measures can significantly reduce adelgid numbers on hemlock, infested trees are usually unable to survive for more than a few years without the help of chemical pesticides. It is important to understand that hemlocks need to be protected from the adelgid as often as necessary until the danger has passed. This may be for a period of several years until all the unprotected hemlocks in the vicinity have died and can no longer serve as a source for re-infestation. Therefore, the initial decision on whether or not to use chemical control measures should take into account, the value of the trees relative to the anticipated cost of protecting them over the long term. It may be advisable to identify individual trees or groups of trees that have special value or significance on the property and to concentrate control efforts on those trees. This may be more successful than the overly ambitious approach of trying to save everything at first, only to lose it all when resources have been depleted a few years hence.

*What you need to know about pesticides:* Several pesticides are registered for control. Some can be used by homeowners, while others are only available to licensed commercial arborists. Each of these pesticides have a relatively short life in the environment, so treating a non-infested tree with pesticide, offers little or no protection from invasion by the insect. Hemlocks should be treated only when an adelgid infestation is known to be present. Before applying any pesticide, read the product label carefully. It will provide important information on safety, toxicity, methods, and rates of application.

*Applying pesticide sprays:* The most common and effective method for control on ornamental hemlocks is to thoroughly drench infested trees with horticultural oil, insecticidal soap, or any one of several petrochemical insecticides that are specifically labeled for this use. Oil and soap are used most often because they are highly effective in killing adelgids, and yet they are relatively safe to the applicator, beneficial insects, and the environment. Unlike the petrochemical insecticides which kill by contact or ingestion, the oil and soap selectively kill soft-bodied insects, such as adelgids, by "suffocation" rather than by poisoning. *It is essential that all parts of the infested hemlock be drenched thoroughly with insecticide.* This precludes control on very large trees (usually those greater than about 80 feet tall) and those in forest settings. A backpack or garden hose sprayer may be sufficient to drench trees less than 30 feet tall, but taller trees may require the services of a professional arborist using a hydraulic sprayer. Fortunately, it is unnecessary to target a particular life stage of the adelgid for control; all are equally susceptible. Therefore, pesticide sprays can be applied any time during the year, weather permitting. One thorough application each year may be

enough, if there are no other infested hemlocks within 100 yards from which adelgids could readily disperse. However, two spray treatments each year are usually necessary for most situations. If two applications each year are needed, an effective strategy is to spray in early April and again during the first half of June. Another option is to substitute a spray during the last half of September for the April treatment. Either of these schedules will target both adelgid generations and minimize the impact of immigration. It is advisable to spray as soon as a new infestation is detected because the hemlock woolly adelgid propagates and injures hemlocks so quickly. Then if necessary, adopt one of the maintenance schedules described above.

*Applying pesticides by soil injection and drenching:* Introducing a systemic insecticide known as imidacloprid into the roots of infested hemlocks in April to May is another alternative to protecting trees that can not be sprayed thoroughly. The soil beneath the tree's crown can either be drenched or injected with a hydraulic injection needle. The imidacloprid is then taken up by the roots and distributed throughout the tree where it can control hemlock woolly adelgid for one year or more. However, trees must have a healthy sap flow for these soil techniques to be effective. Therefore, if infested trees have already declined significantly, pesticide sprays may be the better option.

*Evaluating the effectiveness of chemical controls:* One of the most difficult tasks confronting the homeowner is to evaluate the effectiveness of efforts to control hemlock woolly adelgid. Unfortunately, the "wool" can persist on the twigs for several months after the adelgid has been killed. Therefore, the presence of "wool" is not necessarily indicative of living adelgid and an unsuccessful control effort. The simplest way to determine if further control measures are needed is to disregard the tattered, off-color "wool" on the older twigs, and to look for the production of fluffy, white "wool" only on the very youngest twigs.

## Biological Control Methods

*Hope on the horizon:* Several native insects, including beetles, flies, and lacewings, are occasional predators of the hemlock woolly adelgid in North America. Unfortunately, none of these has had a significant impact on adelgid populations or has shown much potential for biological control. In Japan, however, there are several effective natural enemies. Two species in particular, an oribatid mite (*Diapterobates humeralis*) and a ladybird beetle (*Pseudoscymnus tsugae*), are especially effective at locating and destroying infestations of the hemlock woolly adelgid in Japan. We are now evaluating the potential of these arthropods as biological control agents in the eastern United States in the hope that someday they can be part of an integrated program for managing the insect in our forests, nurseries and ornamental landscapes.