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Center for Invasive Species and
Ecosystem Health

Hemlock Woolly Adelgid Management in Georgia

Elizabeth P. McCarty, *University of Georgia*
Lynne Womack, *Georgia Forestry Commission*

WHY ARE HEMLOCK TREES IMPORTANT?

Eastern hemlock^a is an evergreen tree species that is widely distributed in the eastern U.S., with ecological and cultural value in forests throughout this region (Figure 1). Carolina hemlock^b is another hemlock species in the eastern U.S., although it has a very isolated and limited distribution. Eastern hemlock is a foundation species, which means that many other organisms depend upon the forest environment that hemlocks create. There are no other shade tolerant, native conifers that can fill hemlock's ecological role. The forest will never be the same if hemlock is no longer present.

^a*Tsuga canadensis* (L.) Carrière (Pinaceae)

^b*Tsuga caroliniana* Engelmann (Pinaceae)

^c*Adelges tsugae* Annand (Hemiptera: Adelgidae)



Fig. 1: View of a hemlock canopy
from the forest floor.

Unfortunately these majestic trees are being eliminated from our forests by a small insect, the invasive hemlock woolly adelgid (HWA).^c HWA is native to Japan, China, and western North America but is invasive in the eastern U.S.¹ Hemlocks in the east are not resistant to HWA, and millions of the trees have died. The loss of hemlock alters landscapes and threatens this tree resource in forests and urban areas.

Eastern hemlock grows slowly and is shade tolerant, meaning that branches are not shaded out by taller trees, in other words, branches lower on the tree continue to have foliage even in deep shade. Hemlock's shade tolerance results in layers of foliage in the forest canopy, creating a deep shaded environment very distinctive of hemlock forests. Shade, temperature, moisture, stream flow rates, water quality, soil pH, and soil nutrients are affected by hemlock growing in the forest.²

WHAT IS HEMLOCK WOOLLY ADELGID?

HWA biology: Hemlock woolly adelgids are wool-covered soft-bodied insects that use their piercing sucking mouthparts to feed on fluids from hemlock trees. The wool is a waxy protective layer that covers the HWA.³ A HWA-infested branch has the appearance of tiny cotton balls adhered to the branch where the needles join the twig (Figure 2). These woolly masses are visible during the fall through early summer.



Fig. 2: HWA woolly masses on a twig.

HWA reproduces asexually, meaning that females reproduce without males, and each year there are two generations: a sistens and progrediens generation (Figure 3). The sistens generation is longer, starting in early-summer and ending in early-spring in the southeastern U.S. Crawlers are the first HWA instar (phase), and these are the only mobile phase of the insect. Sistens crawlers move along the branch looking for a place to settle, usually at the base of a hemlock needle. Once they settle, sistens are inactive and do not grow during the summer. In the fall, the sistens begin to grow again and begin producing the white wool, making HWA infestations very easy to detect. Progrediens have a much shorter generation, lasting from early spring to early summer. Progrediens crawlers begin producing wool once settled at the base of a needle (Figure 4). Each female HWA lays up to 175 eggs, all of which are protected in her woolly ovisac. With two generations each year of almost all reproducing females, pest populations grow rapidly.



Figure 3: Hemlock woolly adelgid lifecycle.

Liz Moss, Center for Invasive Species and Ecosystem Health, University of Georgia.

HWA Damage: Once HWA begins feeding on hemlock fluids, the carbohydrate reserves in the tree are reduced.⁴ The tree experiences decreased growth, impaired ability to move fluids, and other physiological symptoms.^{5,6} Signs of an infestation include the needles going from green to gray, branches dying, and an overall thinning in the canopy. Unfortunately, hemlocks in the southeast can die within 2 - 4 years after infestation, while trees in more northern areas tend to live longer.⁷ The rapid mortality occurs because temperatures in the southeast are not sufficiently cold enough to kill a majority of HWA during the winter.^{8,9}

Hemlock loss results in both ecological and economic damage. Once hemlock mortality has occurred, forest ecosystems are altered from arthropod's canopy habitat all the way down to stream conditions and the associated stream fauna.^{2,10,11} Wildlife, plant communities, and aquatic communities are all affected by the loss of this foundation species.^{10,11,12} There are also economic costs from hemlock mortality, including reduced property values, tree removal costs, reduced tourism, impacts to the nursery industry, and increased safety issues due to dead trees in the urban and rural landscape.^{13,14} However, effective HWA management can reduce these effects to some degree.

HOW IS HWA MANAGED?

There are numerous currently available and potential options for HWA management, including contact insecticides, systemic insecticides, and biological control, as well as genetic resistance and forest stand management strategies, which are still being developed.¹⁴ The management goal and nature of the site (landscape/ornamental versus forested) will drive which management options are best. However, the methods most practical and available for landowners will involve either contact or systemic insecticides.

Contact insecticides: Contact insecticides are sprayed directly on the hemlock foliage. All of the foliage must be covered with the spray to effectively suppress HWA. This is a management option best suited for small trees and shrubs in ornamental settings or Christmas trees. Contact insecticide sprays must be timed to intercept the crawler stage. Applications should be made twice a year to suppress crawlers of the progrediens and sistens generations. Once HWA is protected by wool, contact insecticide sprays will not be effective.

Contact insecticides that can be used to suppress HWA populations include horticultural oil, insecticidal soaps, organophosphates, carbamates, pyrethroids, and avermectins. Specific insecticides, their use sites, reentry time intervals, and trade names can be found in Table 1. These are broad-spectrum insecticides, so they can potentially kill any insect that comes in contact with the spray. Thus, care should be used when applying contact insecticides. Applicators should wear appropriate personal protective equipment (PPE), as specified on the insecticide label, and be mindful of site conditions, for example, wind speeds, pets, children, water resources, etc.



Figure 4: HWA just beginning to produce wool.



Table 1. Insecticides for adelgid suppression in different settings*

Active Ingredients	Activity	Selected Trade Names ^{&}	Use Sites [#]	R.E.I. [%] (hours)
carbaryl	contact	Sevin SL	FC	12
		Sevin T&O		
oxydemeton methyl	systemic	Harpoon	LFC	0
		MSR Spray Concentrate	C	10-18 days
bifenthrin	contact	OnyxPro	L	12
<i>tau</i> -fluvalinate	contact	Mavrik Aquaflow	L	12
bifenthrin + clothianidin	contact/systemic	Aloft LC, G, LC, SC	L	N/A
bifenthrin + imidacloprid	contact/systemic	Allectus SC	L	N/A
<i>lambda</i> -cyhalothrin + thiamethoxin	contact/systemic	Tandem	L	N/A
<i>zeta</i> -cypermethrin + bifenthrin + imidacloprid	contact/systemic	Triple Crown T&O	L	N/A
acetamiprid	contact	TriStar 8.5 SL	L	12
dinotefuran	contact/systemic	Safari 2G; 20 SG	L	12
		Zylam Liquid	L	12
		Transtect 70	LF	N/A
imidacloprid	contact/systemic	Xytect 75 WSP; 2F	L	12
		Merit	LF	N/A
		CoreTect	LF	N/A
thiamethoxam	contact/systemic	Flagship 25 WG	C	12
		Meridian 0.33G; 25 WG	L	N/A
abamectin	systemic	Aracinate TM	LF	N/A
chlorantraniliprole	contact/systemic	Acelepryn	L	N/A
azadirachtin	contact	Azatin O	L	4
		Tree-Azin	LF	Until dry
horticultural oil	contact	Ultra-Pure Oil	LC	4
insecticidal soap	contact	M-Pede	L	12

*Developed from Southeastern U.S. Pest Control Guide for Nursery Crops and Landscape Plantings.¹⁵

[&]Trade names are used for examples. No product endorsement is intended.

[#]C = Christmas trees, F = Forest, L = landscape. These indicate where it is legal to use a product.

[%]Re-entry interval is the time between applying a pesticide and being able to enter the treated area without personal protective equipment.

Systemic Insecticides: Systemic insecticides are more flexible products that last longer than contact insecticides and do not have to be timed to intercept a particular life stage. Once applied, the insecticide moves into the vascular system of hemlocks and goes to the canopy to protect the tree from within. Systemic insecticides are appropriate for landscape, forest, and Christmas tree farming settings and are most often the best choice for individual homeowners to use.

Systemic insecticides are applied to the soil around a tree (Figure 5) by burying a slow-release pellet (Figure 6), or to the tree trunk via spray or injection.^{14,16} Two neonicotinoid insecticides, imidacloprid and dinotefuran, are most often used for HWA suppression. Systemic insecticides are not immediately effective, because it takes time for the insecticide to move through the vascular system of the trees.

HWA mortality will take three months for imidacloprid and less than one month for dinotefuran.¹⁷ Imidacloprid can suppress HWA for up to seven years,¹⁸ and can be applied using optimized precise dosages, which is appropriate for larger-acreage management programs (see *Optimized Insecticide Dosage for Hemlock Woolly Adelgid Control in Hemlock Trees*).¹⁹ Dinotefuran will be effective for two years or less,²⁰ however, it is a good product to quickly suppress heavy HWA infestations. Imidacloprid is more appropriate for light to moderate HWA infestations.

As with contact insecticides, care should be taken when applying systemic insecticides, including wearing personal protection equipment, being mindful of the site conditions and following label instructions. Systemic insecticide soil applications should not be made within 10 feet of a stream channel.²¹



Figure 5: Soil drench insecticide application.



Figure 6: CoreTect slow-release imidacloprid pellet.



What is the role of the Georgia Forestry Commission and the University of Georgia?

Georgia Forestry Commission has been actively involved with HWA management since it was found in neighboring states in the early 2000's. Early work included following the initial spread of HWA in Georgia and working with U.S. Forest Service to delineate HWA Conservation Areas. GFC's role has now evolved into concentrating on biological control and working with private landowners to determine the best way to protect their hemlock trees. GFC continues biological control work with the help of three universities (University of Georgia, University of North Georgia and Young Harris College).

The University of Georgia is active with HWA research and extension. Scientists in the Warnell School of Forestry and Natural Resources and the Department of Entomology have been involved with numerous research projects on HWA biocontrol, insecticide control, and environmental safety of insecticide use in hemlock forests. UGA County Agents provide guidance and training for landowners and homeowners on hemlock treatment options and are a resource for the public.

GFC and UGA partner to help keep extension agents, homeowners, and other professionals up-to-date with the most current information on HWA control.



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Suggested Citation:

- McCarty, E. and L. Womack. 2019. Hemlock Woolly Adelgid Management in Georgia.
Georgia Forestry Commission and University of Georgia Warnell Outreach Publication WSNR-19-4.
8 Pages.

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