WHY STEM INJECTION IS A POOR CHOICE

- **Highest cost of any treatment method** -- whether DIY or professional treatment
- **Shortest protection period** requiring annual re-application
- **Specialized equipment and extreme precision required** for proper application
- **Difficulty of calculating dosage –** complicated math
- **Unreliable effectiveness**, treatment failure reported
- **Damage to tree** – Accumulation of wounds that hemlocks don't heal the same way some other trees do, resulting in eventual death of tree due to girdling
- **Better choices available** – So many other treatment options are more reliable, more cost-effective, quicker and easier to apply, longer lasting, and less damaging to the tree. Note that the Imidacloprid and Dinotefuran product labels contain no set-back requirements from waterways when applying these products in the soil; and when proximity to streams is a concern, soil injecting Imidacloprid on the side away from the stream or careful application of Safari by basal trunk spray is a good alternative. Imidacloprid travels only a few inches from each soil injection point, and Safari applied to the tree trunk keeps it out of the soil and waterways entirely.

Cost Comparison for Treatment Products

Products for Soil Application or Basal Bark Spray (Safari only)	Size	Cost excl Tax	Avg Inches Treated	Residual Protection Period	Effective Cost per Inch per Year for Do-It-Yourself
Generic Imidacloprid 2F or 2L	Gallon contains 2 lb Imidacloprid	$82	1,208	5 years	$0.01
Generic Imidacloprid 75 WSP	4-Pack = 4 packets @1.6 oz	$38	181	5 years	$0.04
CoreTect Imidacloprid	Bottle = 250 tablets	$103	228	5 years	$0.23
Safari 20 SG	3 pound jug	$452	283	2 years	$0.80

Products for Stem Injection	Size	Cost excl Tax	Avg Inches Treated	Residual Protection Period	Effective Cost per Inch per Year for Do-It-Yourself
Imi-Jet or Arbor Jet Injectable Imidacloprid	Liter = 1,000 ml	$299	312	1year	$0.96
Pointer Injectable Imidacloprid	120 ml	$258	80	1 year	$3.23

Cost Comparison for Application Equipment

For Soil Application or Basal Trunk Spray (Safari only)	Soil Drench	no cost except mixing container
	Pump Sprayer	$20
	EZ-Ject Soil Injector	$730
	Nu-Arbor 1-Two Root Injector	$750

For Stem Injection	Mauget Injection Devices	$98
	ArborJet Injection Devices	$1,482
	Wedgle Direct-Inject Unit	$1,017

Cost Comparison for Professional Application

For Soil Application or Basal Trunk Spray (Safari only)	Imidacloprid (generic)	$0.40 per inch per year
	Safari 20 SG	$1.00 per inch per year

For Stem Injection	Injectable Imidacloprid	$12 to $25 per injection *or* per inch, with 1 injection for each 2 inches of trunk diameter

Note: The above cost figures are all averages as of 2024.

Comments and Cautions from Research Articles

The excerpts below are arranged in order of date of publication (starting with the earliest date), and the full articles are available on request. They deal with the effectiveness of stem injection compared to other methods, expense, time required for application, and damage to the tree and wound response. Some also describe the kinds of preparation and precision required to do stem injection, indicate that it's a method that should be used sparingly or only in special circumstances, and recommend that a skilled professional do the application.

The Hemlock Woolly Adelgid in Georgia, Georgia Forestry Commission, 2009.

p. 5

Stem injections: In this systemic treatment, imidacloprid is injected into the trunk of the tree. This application is normally recommended for trees growing in very rocky soils where soil treatments cannot be made. Stem injection treatments require specialized equipment and are usually made by professional arborists. The higher cost and tree wounding associated with stem injections should be considered before using this method.

Hemlock Woolly Adelgid, Mark S. McClure, Scott M. Salom, Kathleen S. Shields, December 1996.

p.16

Injecting or implanting chemical insecticides directly into the stem of infested hemlocks in mid-May can control HWA for up to six months. In both techniques the insecticide moves into and up the tree to where it is ingested by the adelgids. Introducing systemic insecticides into the roots of infested hemlocks in May is another alternative to protecting trees that cannot be sprayed thoroughly… Unlike stem injection and implantation, these soil treatments do not wound the tree.

Environmental Assessment: Conservation of Eastern Hemlock by Suppression of Hemlock Woolly Adelgid Infestations, Charles Meyers, August 2005.

p.10

Common activities of any HWA suppression program are:

1. Annual monitoring …
2. Annual identification and prioritization …
3. An on-the-ground evaluation of best suited treatment…
4. Treatment of each area using one or a combination of:
   a. Release of bio-control agent, i.e. predatory beetles
   b. Soil injection around selected individual hemlock trees
   c. Combination soil injection and predatory beetle release
   d. Individual stem injection above ground of imidacloprid using a pressurized injection system in the rare cases where (a) very high interest areas with highly valued trees are involved, and (b)neither beetle release or soil injection is available either because of inadequate beetle supply or site restrictions on soil injection.

Soil injection and stem injection of imidacloprid would be performed by (a) USDA Forest Service employees, (b) private contractors, or (c) both. Any such application would be made under the supervision of a certified pesticide applicator trained and approved to use pesticides safely in the forest.

p.18

Treatment would be repeated ... every year for stem injection.

p.85

The physical imprint left on the hemlock of stem injection will have a direct effect upon the wilderness, naturalness, and trammeling as this artificial interaction is abhorrent to the wilderness ecosystem.

Comparing Systemic Imidacloprid Application Methods for Controlling Hemlock Woolly Adelgid, Richard S. Cowles, Carole S.-J. Cheah, and Michael E. Montgomery, August 2010

p.1

Several studies have shown imidacloprid to have excellent activity for controlling hemlock woolly adelgid (HWA) in a landscape environment (Cowles and Cheah 2002, Doccola et al. 2003, Webb et al. 2003). This study was undertaken to determine which imidacloprid application method would provide the best control of HWA in forests. The methods compared were Kioritz soil injection with (1) placement near the trunk or (2) placement near the trunk and out to the drip line, (3) drench near the base of the trunk with Bayer Tree and Shrub Insect Control, and trunk injection with the (4) Arborjet, (5) Wedgle, and (6) Mauget systems. Along with the untreated check, these treatments were part of a 7 × 2 factorial design, including a comparison of fall vs. spring application timing.

p.3
p. 2

In contrast to the soil applications of imidacloprid, trunk injections did not result in significant reductions in adelgid populations, either in the 2003 or 2004 evaluations. Of the trunk injection methods, the Mauget system resulted in populations that were intermediate in value and not significantly different from either the untreated check or the soil application treatments.

p.3

Trunk injection methods were less effective for control of HWA than near-trunk soil placement of imidacloprid.

Hemlock Woolly Adelgid Strategy Session Summary, Clinch Coalition, March 2008

There are many methods of management and control of the HWA. Most chemical treatments involve the application of imidacloprid, the cost of which is coming down since the patent was lost a few years ago. Of the chemical control methods, soil injection of imidacloprid is the most effective strategy which can give 18-36 months of control. Foliar sprays of imidacloprid or oils are possible but are not as effective for big trees in wild settings and leave no residual impact so must be repeated more often. Stem injections of imidacloprid are the least desirable chemical option since they are four to six times as expensive as soil injection, only 50% as effective, and damage the tree.

Micro Injection Tool, Joseph J. Doccola, Eric J. Bristol, Samantha D. Sifleet, Joseph Lojko and Peter M. Wild, ArborJet Inc., April 2008

p.1

Injection capsules like these are applied at a rate based on the tree's diameter and the chemical treatment. This tree has more than 30 capsules attached—the manufacturer says that permanent damage is avoided if holes are limited to 1/2 inch deep. The capsules should be removed no more than three days after application. Photo courtesy of Tree Tech.

pp.2, 3

Recently, technicians working for the Massachusetts-based company ArborJet ran a study to evaluate the efficacy of micro-injected Imidacloprid. The study found that the insecticide does not provide a quick cure, but can help an infected tree resume growth after two injections over a year or more. Several other studies suggest that other Imidacloprid formulations can be effective too.

pp.4, 5

"Treatment with stem-injected Imidacloprid did not provide a quick knockdown of the HWA, but required time (at least one year). In the year after a second treatment, we observed sufficiently high HWA mortality for hemlock to resume growth. We have a high degree of confidence that a repeat treatment increased the levels of Imidacloprid for the duration of efficacy observed. We recommend an increased dose for trees in the 30 to 59 cm size class and larger, and for an increased level of efficacy to extend the injection interval (to once every 2 years), and to limit the number of wounds a tree receives. The new rate recommendations are reflected on the IMA-jet label revised in 2006. (See the label for precise dosage guidelines)."

Potential Concerns for Tree Wound Response from Stem Injection, USDA Forest Service, Kevin T. Smith and Phillip A. Lewis, August 2010.

p. 1

Abstract: Stem injection of imidacloprid is an available component of management strategies for hem-lock woolly adelgid. Preliminary observations of similar treatments of maple and ash show that the injury sustained by injection warrants investigation of the wound response in eastern hemlock. Such investigations need adequate experimental controls to identify the role of phytoxicity of the active ingredient and the carrier formulation, delivery pressure, seasonality, and tree condition. External indicators such as bark cracks tend to underestimate the amount of cambial dieback. Evaluation of the wound response requires tree dissection. We suggest that the unintended consequences of treatment such as injection injury be considered and incorporated into the management decision process.

p. 2

The appeal of stem injection lies in the expectation of the delivery of effective doses into targeted tissues (such as branchlets in the case of HWA) throughout the tree translocation system with few or no non-target effects and a high degree of social acceptance. That appeal, coupled to the potential commercial profitability of the technique suggests that stem injection will continue to be considered as a treatment option for trees infested o threatened by HWA.

p. 2 The biological tradeoff with stem injection is that the tree is wounded in the course of treatment (Smith 1988). Although the size of the mechanical wound made during injection may be small, the treatment chemical and the application pressures can greatly increase the severity of wound-initiated discoloration and cambial dieback associated with an injection (Shigo et al. 1977). Please read the whole article.

Efficacy and Duration of Trunk-Injected Imidacloprid in the Management of HWA, Joseph J. Doccola, Eric J. Bristol, Samantha D. Sifleet, Joseph Lojko, and Peter M. Wild, January 2007

p. 12 Treatment with stem-injected imidacloprid did not provide a quick knockdown of the HWA; rather, it required time (i.e., at least 1 year). In the year after a second treatment, we observed sufficiently high HWA mortality for hemlock to resume growth.

p. 13 Wound response to stem injection is dependent on a number of factors, including the tree species, the time of year, the method of injection, and the chemical formulation. The pattern of Compartmentalization of Decay in Trees (CODIT) (Shigo 1977, 1979) responses are similar in hardwoods and conifers; however, there are qualitative differences, because their anatomy and physiology are quite distinct. It has been our observation that eastern hemlock is less susceptible to injection wound infections compared with the ring porous hardwoods (e.g., American elm [Ulmus Americana] is highly susceptible to bacterial wetwood infection). Wound closure, on the other hand, occurs at a slower rate in hemlock than in American elm.

p. 19 **Conclusions**: Treatment with stem-injected imidacloprid did not provide a quick knockdown of the HWA population; rather, our observation was that it required time (i.e., at least 1 year). In the year after treatment, we observed significantly greater HWA mortality in the IMA-jet trees (91.4.0%). However, we did not observe sufficient control of HWA for trees to recover until 1 year after the second treatment.

Southern Forest Futures Project, Chapter 16, USDA Forest Service, Donald A. Duerr and Paul A. Mistretta, May 2011.

p. 1 A number of suppression tactics show some promise for preventing the loss of significant numbers of hemlocks over the next 50 years. Treatment of trees with imidacloprid effectively controls hemlock woolly adelgids for several years (Cowles and others 2006). Distribution of the insecticide into tree crowns is more effective with soil drench or injection than with stem injection (Dilling and others 2010). Dinotefuran is also being used with success.

Hemlock Woolly Adelgid Suppression in Frederick County, Catoctin Mountains & Monocacy NRA in 2004 -2011, Tom Lupp, Regional Entomologist, February 2012.

p. 5 Stem injections are performed using the Arborjet Tree I.V. System™. The imidacloprid is formulated in an Arborjet product called IMA-jet® at 5% active ingredient. The procedure involves measurement of the tree to determine insecticide dose in milliliters, based on inches of DBH. Based on dose and diameter, holes are drilled into the root flares of the tree (minimum of 4) and then fitted with plastic arborplugs™ which have self healing rubber centers. The insecticide is measured and poured in to the I.V. bottle which is connected to a set of needles (4) via plastic tubing. Once sealed, the I.V. bottle is pressurized with a bicycle pump to about 60PSI. The needles are inserted into the plugs and then a main valve and each of the needle valves are turned on allowing the pressurized insecticide to flow into the tree.

Stem injections can be done at most times of the year but work best in spring (March-May) and fall (Sept.-Nov.) when trees are actively moving fluids. The main limitations to treatment are soil temperatures below 40°F or hot dry conditions. Insecticide uptake is better earlier in the day and slows down by mid afternoon. Changes in design to the I.V. bottles and the needles have greatly increased productivity. Using the early equipment (2004 & 2005) a good day was 10 to 12 trees using 6 I.V. bottles. Using new equipment (2008 to date) we have been averaging about 25 trees per day using 8 to 10 I.V. bottles.

p. 8 In the fall of 2003 about 10 trees were treated using the Arborjet viper gun ™. This was done as an experiment to see how the equipment would work. This method is similar to the I.V. system using the Arbor plugs and a hand held injection gun to deliver the insecticide. Although very portable, this method was not practical for use on hemlock with high dose volumes and slow uptake.

Homeowner Options – How Do I Save My Hemlocks? Mark Warren, 2012.

p. 3

Stem (trunk) injection with imidacloprid – This application is typically reserved for sensitive areas: trees near surface water or saturated soil or located on rocky or sandy soil. A low-pressure stem injector is needed, because this application can potentially wound a tree by damaging its tissue – thereby weakening the tree in a time of adelgid-induced stress. Because of the potential harm to the tree and the fact that the chemical and equipment needed for this procedure is specialized, it might be prudent to hire professionals to inject. That said, Bayer has a product on the shelf called Merit Interjectible. A hole must be drilled into the trunk to specification, and a capsule with a measured dose of pesticide is tapped in. Professional stem injection costs from $12 to $25 per injection and the number of injections depends upon tree size. One company charges $15 X inches of trunk diameter at breast height. Though not as effective as soil injection, it is the necessary option for special-case trees.

Imi-Jet Product Label, ArborJet, Inc.

p. 1

BASIC INJECTION PROCEDURE: For insect control, this product must be placed into the tree's sapwood, the conductive tissue that moves water to the canopy. Make applications around the base of the tree. Inject into tree roots exposing them by careful excavation or, alternatively into the trunk flare or tissue immediately above the trunk flare, locating the injection site in the first few xylem (i.e., sapwood) elements. Drill holes through the bark and into the sapwood a minimum of 3/8" deep. When using the Arborjet Arborplug, drill a minimum of 5/8" deep into the sapwood.

p. 5

CALCULATING APPLICATION RATE: The dosages and number of application sites are based on tree diameter. To determine the application/dose rate per tree:

1) Measure the tree diameter in inches at chest height (54" from ground) to find the Diameter at Breast Height (DBH). (If measuring tree circumference, divide circumference by 3 to obtain the DBH in inches.)
2) Calculate the number of injection sites by dividing the DBH in inches by 2.
3) Multiply the tree DBH by the dosage rate (see table below for appropriate dosage rate) to calculate the total dose in milliliters per tree.
4) Divide the total dose by the number of injection sites to determine required dosage per injection site.