

## Using Imidacloprid & Dinotefuran for Control of Hemlock Woolly Adelgid (Mark Dalusky; UGA Forest Entomology; revised June 2011)

Mark Dalusky has provided the information below as a guideline for choosing and using the most appropriate HWA treatment product, based on multiple factors that should be considered in making the choice. The portion highlighted in yellow is his most recent update.

The neonicotinoids imidacloprid (Merit\*) and dinotefuran (Safari) provide excellent control of hemlock woolly adelgid (HWA) when applied as a soil drench or soil injection. Both products are loosely bound to soil particles but are sufficiently water-soluble to be absorbed by tree roots following soil application. Safari is much more water-soluble than Merit and less tightly bound to soil particles. This characteristic is beneficial by increasing accessibility of the active ingredient for root uptake but can be perceived as detrimental regarding potential water contamination through run-off and soil leaching. However, a NEPA risk assessment of dinotefuran (USFS-funded) did not identify water contamination by dinotefuran as a significant concern when applied for control of HWA. Imidacloprid can safely be used on streamside hemlocks as long as you avoid injecting into a scarped bank or into deep sand on the stream side of the tree. Dinotefuran will carry a streamside buffer zone requirement (25') when applied next to water on public forest land under a Special Local Need (SLN) label for most southern states. Check the SLN for your state! No buffer zone is required when treating hemlocks in ornamental landscapes, but direct contact with water is prohibited.

\*Merit is Bayer's original brand of imidacloprid, and there are now several generic brands. At present, there are no generic brands of Safari.

### Imidacloprid or Safari: how to decide?

**Cost:** Safari is more expensive than Imidacloprid.

**Location:** If immediately adjacent to free water (streams, spring seeps, wet meadows), use Imidacloprid unless tree health is severely compromised; Safari can be used near water in ornamental landscape settings.

#### **Tree health:**

- Use Imidacloprid on trees that are in reasonably good health (i.e., new growth and no significant needle loss). Use Safari on hemlocks where rapid control is required, i.e., trees with no new growth, badly thinning foliage, and dead or dying (usually lower) branches and especially on large diameter trees (> 20 inches DBH) with these symptoms. Imidacloprid may still work but very slowly.
- Remember that tree health determines how quickly and efficiently the hemlocks will mobilize the active ingredient to the sites of HWA feeding.
- Imidacloprid can be effective on trees in advanced stages of decline, **BUT** you can expect tree health to deteriorate further before improvement is seen. This may include loss of lower limbs. Do not expect to see new growth for about 2 years. Survival of hemlocks is uncertain following Imidacloprid application if trees are in advanced stages of decline (gray foliage, >50% needle loss, dead lower limbs).

**Presence of other pests:** Use Safari if scale or spider mites are a problem as treatment with imidacloprid may intensify these conditions. This decision is based on tolerance to their feeding symptoms. These scale and mite infestations often self-resolve, especially in a forested setting, though not always.

**Timing:** In the southern Appalachians, imidacloprid can be used any time of year when minimum soil moisture conditions exist. Use Safari if you need to treat later in the season (late spring/summer) when conditions have become relatively dry. Treatment during official drought conditions is not recommended.

### Updated comments on choosing Imidacloprid or Safari (Dalusky; June 2011)

In the early days, we depended very much on the information generated by Rich Cowles from Connecticut Ag. Exp. Station. He got very good results treating trees below 28inch DBH at the 1 gram rate of Imidacloprid and recommended 1.5 grams for trees 28 inches and greater. In our original study on Imidacloprid at Brigadoon, we saw trees in the 20-25 inch DBH range losing treatment efficacy in the third year post-treatment. This caused us to revise our recommendations downward to the 20-22 inch range. Another thing that most of us missed while relying on the Cowle's data was that Rich was basing his "successful treatment" on 85% control of HWA in the

larger trees. Most constituents in GA wanted recommendations based on 100% control, as you might expect. I am comfortable with the 22 inch DBH number regarding second year treatment. I think that there is a range from 22 to 25 inch DBH where you can safely choose to use the 1.5 gram rate without the subsequent year treatment. This depends mainly on the health of your tree at treatment and on its height. We can experience problems treating the upper crown on very tall trees (over 90 feet high).

The recommendation for Safari on infested trees really depends on whether or not the tree in question has ceased new growth and what stage of decline the foliage is in. These factors become even more limiting in larger trees. I think it is more accurate to say that trees exhibiting zero or minimal new growth will respond quicker to a Safari treatment than an Imidacloprid treatment, especially if the DBH is 20 inches or greater. That does not exclude treating smaller diameter trees with Safari, but our experience has been that sick trees below 20 inDBH have a pretty good chance of responding to an Imidacloprid treatment, while trees over 20 inches may not respond well. Personally, if a tree has current new growth, even if heavily colonized by HWA, I'll treat with Imidacloprid if I'm not concerned with a quick response. My biggest concern would be on very tall trees over 90' tall. I might target them with Safari as we have seen Imidacloprid fail on very tall trees with heavy loads of HWA.

Now for a general comment. Some people have problems with the arbitrary nature of the DBH cut-offs, and these suggested dosing rates per DBH are just that -- suggestions. If you had to calculate the perfect dose for each individual diameter out there, you can see where that would lead. The DBH ranges are to simplify applications and are based on sound research. They are designed to be biased towards never under-dosing any particular DBH tree. The monetarily important question is where and when do we go to the 1.5 gram rate of Imidacloprid with subsequent year treatment. There will never be a perfect menu-driven table that will deal with all of these potential problems. Whether to go to the next higher rate depends greatly on tree health at time of treatment including current adelgid load and new growth status, site conditions at the particular tree (good duff layer, soil moisture, rocks in soil, etc.), and height of the tree. If I come upon a hemlock that is 22 inch DBH with good current new growth on a good site, then I would probably use the 1.5g rate but not treat the second year. Conversely, if I had a 20 inch DBH tree that was over 90 feet tall, then I would go up to the 1.5g rate. If I had a big tree sitting on top of a large rock, I'd factor that into my dosing also.

See where I'm going with this? A very attuned applicator will notice all of this as he/she does the job and will factor these things in to dosing each tree. The tables are designed to be conservative and will work for the novice applicator even though there will be some over-dosing occurring near the lower end of each DBH range. Site and biotic factors that affect the residual of both Safari and Imidacloprid are so different here than in Connecticut that we are really in the dark regarding very big trees...say 30 inches DBH or greater. These trees would typically be over 100 feet tall, which also adds to the difficulty in getting an effective treatment.

## **Imidacloprid (Merit 75 WSP)**

**Soil condition:** Do not inject into saturated or frozen soils, shallow soils over rock, or extremely sandy soils particularly those lacking organic matter. Soils that puddle in your footsteps or from which you can squeeze free water out of a handful are too wet. Soil that clumps at all with hand pressure is OK.

**Injection depth:** Depth of injection is critical for effective treatment! Set injection depth in the 2-5 inch range. The majority of the feeder roots are within 6 inches of the soil surface. Deeper roots are mainly for water acquisition and anchorage. Leaf, twig and limb litter on the surface should be accounted for when calculating injection depth. If substantial, it may need to be kicked aside. Injecting too deep is inefficient and risks contaminating groundwater.

**Injection placement:** The majority of the feeder roots are within 2 feet of the trunk. Injecting in this zone is most efficient, but if necessary, soil injections can be effective when placed within the drip line of the tree. This can be useful for protecting trees that are located within stream buffer zones.

**Mixing and dosing:** Be sure that your injector is set to deliver 5 ml per pump. Suggested rates to inject are 0.5 to 1.5 grams active ingredient (AI) per inch DBH. At the mix rate of one 1.6 oz packet per 36 fl. oz. water, you deliver about 1 gram AI per ounce of solution, and you inject a fluid ounce (6 pumps) per injection hole. We

have ample research that 1 gram AI delivered in only 10 ml of water (0.33 oz or 2 pumps), applied to adequately moist soil, provides excellent results. For soils in this condition, we recommend that you reduce your mix volume of water by half. This solution will be twice the strength of your standard mix, so you should reduce the number of pumps per injection point by half (3 pumps) to achieve the same delivery as before. For marginally dry to dry soils, the current dosing (1 gram AI per fluid ounce) is good. I would also recommend that you follow the chart in ATTACHMENT I, which adjusts dosage according to diameter of the trees. This will save even more product and greatly increase the number of trees treated per one full injector. This becomes important when complying with the maximum allowable grams of AI per acre on the label. At UGA, we mix our solution to deliver 0.5 grams AI per pump. That makes the 0.5, the 1.0, and the 1.5 gram rates easy to hit. You use 1, 2 or 3 pumps per injection point. For the 0.75 gram rate, we simply pump once in half of the holes and twice in the other half.

**Timing:** Initially, the recommendation for time of year to inject was either in the spring or late fall. Now, as mentioned earlier, in the southern Appalachians we recommend using imidacloprid any time of year when minimum soil water conditions exist. Evapo-transpiration occurs year round in the South with peaks in the spring and fall. It is adequate to mobilize active ingredient in all but moderate to severe drought conditions. Research at UGA indicates that you can even inject into a very droughty soil and expect the active ingredient to still be effective up to 2 full years later when soil water conditions improve. Apparently, with proper injection technique, imidacloprid is well protected in the organic layer and will persist for several years under extreme drought conditions. That said, the optimum time of year for soil injection is still October through mid-June. This optimal period can be extended by good rains in June, and rains beginning earlier in September; but if time is the limiting factor, then the summer treatment option exists.

### **Things to Know about Imidacloprid:**

- Imidacloprid can take from 6 weeks to 12 months or longer to become effective. It might take several years to achieve complete control and show new growth, particularly in large diameter trees.
- Residual efficacy in the South can be as long as 3-5 years; in the North reported residual is as long as 7-8 years.
- Hemlocks should be examined for presence of HWA prior to retreatment as reinfestation by HWA might take several years.
- Limbs that are severely impacted at time of treatment may die even with successful treatment.
- Mite and scale infestations can occur particularly with over-dosing of hemlocks; these usually self-resolve but not always.
- Both insecticides dissolve much better in warm water than in cold.

### **Dinotefuran (Safari 20SG)**

**Location:** Soil injection requirements are similar to imidacloprid, but there is a streamside buffer restriction for Safari on public forest lands in selected states. Check your state SLN label.

**Soil condition:** Safari is more effective than imidacloprid in dry soils and can reach lethal concentrations in foliage in as little as 3 weeks (usually 4-6). Reapplication is within 2 years, depending on reinfestation pressure in the area.

**Application method:** The basal trunk spray application technique is useful for wet or difficult sites (underlying rock, deep sand etc.). This technique is now in use and particularly effective for late spring/summer treatments. Safari trunk sprays provide rapid control; new growth can be expected the next year. Deliver the required amount of product (per inch DBH) in 1-3 ounces of water (per inch DBH); thoroughly wet the lower 4-5 feet of trunk avoiding excessive run-off; apply spray slowly at low pressure to achieve maximum effect; allow at least 3-4 hours drying time before predicted significant rainfall. (See ATTACHMENT II for mixing instructions.)

**Dosing:** Label rates range from 3-12 grams of product per inch DBH when applied via soil injection or as a basal drench. This equals 0.6 to 2.4 grams active ingredient per inch DBH; five grams of product per inch DBH will dissolve fully in as little as 1.5 ounces of water per inch DBH.

## **Factors that Affect Evapo-transpiration and Insecticide Uptake**

- **Rainfall and soil moisture:** A deluge might move the active ingredient out of the root mat before it has a chance to bind with the organic matter; adequate residence time in the organic layer is essential; drought can severely limit transpiration
- **Injection depth:** Chemical has to reside in the feeder-root zone for most effective uptake; deeper roots may absorb some but it is minimal compared to the feeder roots
- **Weather:** Long periods of cool, wet, and cloudy weather suppress photosynthesis and evapo-transpiration; this might delay treatment effect.

## **References**

R. S. Cowles 2009. Forest Ecology and Management, 257: 1026-1033. Optimizing dosage and preventing leaching of imidacloprid for management of hemlock woolly adelgid in forests.

C. R. Ford et al. 2007. Arboriculture and Urban Forestry, 33(6): 421-427. Use of water by eastern hemlock: implications for systemic insecticide application.

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## ATTACHMENT I

### Dbh- Adjusted Rates for Soil Injection of imidacloprid: 2010

(Adapted from R.S. Cowles 2009)

Soils ideally should have enough soil moisture in the organic layer to allow clumping when compressed by hand. If organic soils are extremely dry, they often become hydrophobic which may result in decreased availability of the active ingredient. If soils are moderately dry, you might consider doubling the amount of water in the finished solution and concurrently doubling the volume injected (twice the number of pumps OR twice the number of injection points). This will greatly increase the surface area of feeder root in contact with the active ingredient. Avoid treating saturated soils (puddling in your footprint or free water when squeezed by hand) or if a heavy soaking rain is imminent within 12 hours of application. Soils with heavy organic layers can accommodate rains of less than 1.0 inch with little negative impact on treatment. Soils with little or no organic content (deep sands) and thin soils over rock should be avoided. Depth of injection should be about 2-5 inches into the organic layer. This does not include the loose litter layer of recently fallen needles, leaves and twigs that are immediately on the surface. I generally kick this aside with my boot before injecting.

<b>Tree diameter (DBH inches)</b>	<b>Imidacloprid per inch DBH (grams active ingredient)</b>
< 11 inches	0.5 g
11 – 18 inches	0.75 g
19 - 22 inches	1.0 g
≥ 23 inches	1.5 g two successive years

The yearly per-acre amount of active ingredient is capped at 0.4 lbs ai/acre or 182 g ai. Using this rate chart, you could treat ten 19-inch DBH hemlocks per acre. Similarly, you could treat only four 30-inch DBH trees per acre. As an applicator, you can treat significantly more hemlocks per acre by following the above chart and not wasting the higher rates on smaller DBH trees.

## ATTACHMENT II

### Mixing Instructions for Safari 20SG for Basal Trunk Spray Application

A generic mix rate (regardless of tree DBH) is 12 oz (by weight) of Safari 20SG per 1 gallon of water. This mixture yields 2.66 gm of product per ounce of water. We suggest that this mix be limited to hemlocks < 15 inch DBH. The lower 5 feet of trunk is slowly sprayed at low pressure until run-off occurs. Dry hemlock bark can be very hard to wet, and run-off may occur rapidly before any substantial wicking occurs. A light application of water to initiate wicking action before spraying with insecticide can increase treatment efficacy. To dose your tree according to individual tree DBH, then follow the label recommendations for grams of product per inch DBH, and use the following amounts of water per inch DBH:

<b>Safari 20 SG</b>	<b>Minimum Amount of Water</b>
3-4 grams	1 ounce
5-7 grams	2 ounces
8-12 grams	3 ounces

Using this chart and the recommended rates, a 10-inch DBH hemlock would get 30 grams of product delivered in 10 ounces of water. A 30-inch DBH tree would get 210 grams of product delivered in 60 ounces of water.