COMPARING SYSTEMIC IMIDACLOPRID APPLICATION METHODS FOR CONTROLLING HEMLOCK WOOLLY ADELGID

Richard S. Cowles[1], Carole S.-J. Cheah[1], and Michael E. Montgomery[2]

[1]Connecticut Agricultural Experiment Station
[2]Northeastern Research Station, USDA Forest Service

INTRODUCTION

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, which included a comparison of fall vs. spring application timing.

METHOD

Trees were chosen for this study based on the presence of moderate populations of HWA, the availability of lower branches from which adelgid populations could be observed, and a distance of at least 50 m between study trees. Six replicates were located at five sites in Connecticut: Shenipsit State Forest in Somers, Nathan Hale State Forest in Coventry, Tunxis State Forest in East Hartland, Sequassen Boy Scout Camp in New Hartford, and the Mashantucket Pequot Reservation in Ledyard, for a total of 84 study trees. Insecticides were applied between October 1–29, 2002, and between May 28 – June 6, 2003. The Kioritz-injected imidacloprid treatments used Merit 75W and 1 g of active ingredient per 2.5 cm DBH. Bayer Advanced Tree and Shrub Insect Control (68 ml of product per 2.5 cm DBH, providing 1 g a.i.) was diluted in 3.8 liters of water and drenched outwards from the trunk of the tree to a distance of 45 cm. Trunk injection applications were made of Mauget's Imicide (3 ml of 10% formulation per 15 cm circumference), Wedgle's Pointer (1 ml of 12% formulation every 10 cm circumference), and Arborjet's Imajet (6 ml of 5% formulation every 24 cm circumference) while following each manufacturer's recommended method. The targeted dosages for the Mauget, Wedgle, and Arborjet systems were 0.15, 0.09, and 0.1 g a.i./2.5 cm DBH, respectively. The application rate in the fall with the Wedgle System could not be confirmed, as there is no component to the application device that permits monitoring of active ingredient placement in the tree. Therefore, plugging of the needle orifice (a common occurrence) led to squeezing the handles without actually placing any product in the tree. Two modifications of the Wedgle method were required for successful springtime trunk injections. To prevent plugging of the needle orifice, a 7/64" hole was drilled into the center of the hole left by the bark corer. The injection plug was then inserted as before, and the needle inserted through the plug into the small diameter hole. Unlike the fall application, the application in the spring resulted in easily observable separation of the bark at the cambium layer where imidacloprid suspension was being deposited. Weighing the insecticide reservoir bottle before and after application with a portable electronic centigram balance allowed determination of the amount of product injected into each tree. Calibration marks on the Wedgle device were found to not correctly represent the volume of liquid being injected into the tree, so additional pressurizations (four per injection site) were used to compensate.

Cold temperatures during the winter resulted in HWA mortality at study sites in nearby untreated trees of 85-95%. Therefore, mortality was not evaluated for the overwintering generation but delayed until July 7-15, when following (progrediens) stage had developed. Mortality was also assessed in late November, 2003, and mid-December, 2004. In July, shoots with adelgids were brought back to the laboratory in a cooler and evaluated under a dissecting microscope. Adelgids were probed to determine whether there was movement of legs or mouthparts, and the numbers of living and dead adelgids were counted from a sample of 100 individuals per tree. In the November and December assessments, five shoots were cut from the lower canopy, and five shoots from a height of 20-30 feet. Adelgids were counted on each shoot, up to a total of ten adelgids per shoot. The total for the ten samples then constituted a 1-100 infestation rating.

We used an immunological method to measure imidacloprid residues (EnviroLogix, 2003) to compare with mortality data. Sap from hemlock branches was expressed from 20-50 cm long shoots on May 2-6, July 7-15, and August 20-27, 2003, using a hyperbaric chamber pressurized with nigrogen to ~200 p.s.i. with nitrogen. Sap collected with a pipette required no additional clean-up procedure before being tested with the EnviroLogix ELISA kit. Volumes of 250 – 700 µl were obtained for each sample with 100 µl required for imidacloprid determination. Sap samples were kept frozen once they were brought to the lab.

RESULTS AND DISCUSSION

Site variability and natural mortality affected adelgid survival and obscured insecticide treatment effects in the July assessment. Adelgid mortality ranged from an average of 64% for the Wedgle-treated trees to 80% for the Kioritz, near-trunk imidacloprid placement. Adelgids in the untreated check trees experienced 69% mortality.

November, 2003, and December, 2004, evaluations of adelgid populations determined that fall and spring application timing did not significantly differ. The November 2003 evaluations determined that soil applications resulted in an average population suppression of 79% relative to the untreated check. The Kioritz near-trunk placement of Merit in the fall of 2002 resulted in 100% mortality of adelgids as measured 13 months later. Suppression of adelgids with the soil applications improved further over the next year, resulting in an average of 98.5% reduction compared to the untreated check. Four of the six treatment combinations for soil application resulted in non-detectable HWA populations on the treated trees 18-26 months post-treatment.

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.

The ELISA assay of sap indicated that soil-based application of imidacloprid resulted in good mobilization and persistence in branches. With the Mauget system injections, a relatively short-lived, highly concentrated peak of imidacloprid was found in sap of some branches. Residues from the other two trunk injection methods were of low concentration.

The Mauget System allows visual monitoring of uptake of the formulated product into the tree—however, on many occasions the 3 ml capsules did not empty into the tree and had to be removed in spite of the lack of uptake. Capsules are pressurized, so any material not taken into the tree was lost onto the bark of the tree when the feeder tube was removed, making accurate measurement of uptake impossible. Uptake was very poor in the spring, and better, but variably successful, in the fall.

The Arborjet System provided the most complete feedback to operators regarding the movement of insecticide into the tree at the time of injection. Both the ability of the tree to accept the formulated product and the volume of product applied are easily monitored: the first through the pressure gauge attached to the injection needle, and the second through the injection reservoir calibrated in milliliters.

The imidacloprid test kits have proved to be an effective method for analysis of residues from hemlock sap. Concentrations can be quantified from 0.5 - 5 ppb, requiring considerable dilution and repeat testing for higher concentration samples. Non-specific binding results in values of imidacloprid from sap ranging up to 5 ppb, so at least a 1:10 dilution is required and quantitation of imidacloprid below 5 ppb is not possible with this method. The results have to be considered as semi-quantitative for imidacloprid because some of its metabolites are also detected (though to a lesser degree than the parent compound). It is adaptable for analysis of tissue (needle and twig) samples and the results can be read with a relatively inexpensive scanner and image measurement software.

SUMMARY

Trunk injection methods were less effective for control of HWA than near-trunk soil placement of imidacloprid. Efficacy of injections might be improved if the resulting short duration of mobilization in sap is timed to closely match peak feeding activity of adelgids (e.g., mid-April). The soil applications resulted in long-term moderate concentrations of imidacloprid in the sap, which may be responsible for the reliable, highly effective suppression of HWA populations. The ability of soil application of imidacloprid to provide multiple-year control of HWA must be balanced with the cost of this treatment and its potential to harm non-target aquatic organisms. Analyses of hemlock tissue foliage on untreated trees in this study determined that significant lateral and down-slope movement of imidacloprid can occur when imidacloprid is applied in water-saturated forest soil (data not shown). Insecticide treatment should be considered a stop-gap measure to preserve trees that are of exceptional value until such time that biological control becomes established.

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DISCLAIMER

Use of a product name does not imply endorsement of the product to the exclusion of others that may also be suitable.

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