

USE OF SOIL AND TRUNK INJECTION OF SYSTEMIC INSECTICIDES TO CONTROL LACE BUG ON HAWTHORN

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Abstract. Several systemic insecticides are labeled for control of sucking insect pests of trees, and numerous application methods are available for arborists. A field trial was conducted to test 2 formulations of imidacloprid (Pointer 4% and Merit 75 WP systemic insecticides), a formulation of abamectin (Greyhound 1.9%, B1), and 2 different delivery systems. The delivery systems evaluated were the Kioritz soil injector and ArborSystem's Wedgle-tip tree injection system. The target pest in this field trial was hawthorn lace bug (*Corythucha cydoniae*) on hawthorn (*Crataegus viridis*) trees. The Kioritz is a handheld soil injector made for injecting fertilizer and systemic pesticides into the root zone of trees and shrubs with relatively small amounts of water. The Wedgle tip is an injection system that uses a blunt-edged tip inserted through a small hole through the bark, just to the edge of the sapwood. Wounding to the tree with the Wedgle tip is minimal. This study indicates that systemic insecticides applied through soil injection and trunk injection have potential for controlling sucking insects that feed on ornamental trees.

Key Words. Hawthorn lace bug (*Corythucha cydoniae*); hawthorn (*Crataegus viridis*); abamectin (*Streptomyces avermitilis*); imidacloprid; systemics.

Hawthorns (*Crataegus* spp.) are commonly used in urban landscapes as specimen and street trees. They are adapted to a wide variety of soil types and soil pH levels. Most hawthorns have a mature height of 6.5 to 8 m (20 to 25 ft) with vase-shaped crowns that provide moderate shading and allow ground covers to grow well under their canopy. Flower displays of white clusters in spring followed by persistent fruits add to the attractive qualities of this tree. The foliage is glossy medium green, turning red and purple in the fall (Dirr 1983; Gerhold et al. 1993).

Unfortunately, hawthorns are susceptible to attack by many sucking insect pests, including lace bugs (*Corythucha* spp.), mealybugs (*Phenacoccus aceris*), aphids (*Nearctaphis* spp., *Utamphorophora crataegi*, *Aphis pomi*, and *Eriosoma lanigerum*), and

leafhoppers (*Typhlocyba pomaria*) (Johnson and Lyons 1988). Lace bugs cause stippling of foliage and—in heavy infestations—yellowing and premature leaf drop. Insects, including lace bugs, have traditionally been suppressed by foliar applications of pesticides. Such applications have a number of disadvantages: Complete spray coverage can be difficult when treating large trees; heavy traffic areas must be treated during non-use hours; and drift can be a problem, especially when trees are on small lots or near boundaries. Risk, both real and imagined, to the environment is also a concern (Sclar and Cranshaw 1996).

By using systemic insecticides, the applicator can avoid or minimize some problems associated with spray application. New systemic insecticides and innovative delivery systems provide arborists with several choices. The systemic insecticides imidacloprid and abamectin are available and labeled for soil drenching and/or soil or trunk injection. Imidacloprid is formulated for use in landscapes as Merit and Pointer (4%). This systemic chloronicotinyl insecticide controls a number of insect pests, including adelgids, elm leaf beetle, lace bugs, leafminers, mealybugs, soft scales, whiteflies, and beetle grubs (Dotson 1994). Like acetylcholine, imidacloprid binds to the nicotinic acetylcholine receptor in the postsynaptic nerve. Unlike acetylcholine, imidacloprid is only slowly degraded by the insect, causing an often lethal nervous system disorder. Because imidacloprid has a different mode of action than carbamate and organophosphate insecticides, it is effective against pest populations that are resistant to those materials (Mullins 1993). The oral LD₅₀ in rats is 450 mg/kg for the technical material. The formulated products are less toxic and differ in their toxicity. Formulated products carry a warning or caution label (category II or III). As with abamectin, imidacloprid is most effective when ingested by the target (Mullins 1993).

Abamectin is an avermectin insecticide that is a natural fermentation product of the soil bacterium *Streptomyces avermitilis* (Lankas and Grodon 1989). It is used to control insects and mites on a wide variety of crops and ornamentals. Abamectin interferes with the neural and neuromuscular transmissions by disrupting a specific type of synapsis that uses gamma-aminobutyric acid (GABA) as a transmitter. In mammals, these (GABAergic) synapses occur only in the brain and are protected by the blood-brain barrier, so toxicity only occurs at relatively high doses. However in insects, GABAergic synapsis occurs throughout the nervous system, making insects susceptible to abamectin at low doses. The oral LD₅₀ of abamectin in mice is 14 to 24 mg/kg for the technical material (Turner and Schaefer 1989). However, the formulated products are substantially less toxic, are classified as category II, and carry a warning label. For example, Agri-Mek and Avid (abamectin formulations) have toxicities of 300 mg/kg in rats. Humans are less sensitive than rodents to abamectin toxicity (Turner and Schaefer 1989). Like imidacloprid, abamectin is most effective when ingested by the target organism, making it a candidate for use as a systemic insecticide. Abamectin is labeled as a foliar spray for mite and leaf miner control on ornamental plants. Abamectin is also formulated for tree injection as a 1.9% emulsifiable concentrate under the trade name Greyhound.

The objective of this study was to test 2 formulations of imidacloprid (Pointer 4% and Merit 75 WP systemic insecticides), a formulation of abamectin (Greyhound 1.9%, B1), and two different delivery systems. The delivery systems evaluated were the Kioritz soil injector and ArborSystem's new trunk injection device with a Wedgle tip. The target pest in this field trial was hawthorn lace bug (*Corythucha cydoniae*) on hawthorn (*Crataegus viridis*) trees.

MATERIALS AND METHODS

A nursery in Sandy Spring, Maryland, was selected as the test site. Nursery field-grown trees of green hawthorn (*Crataegus viridis* 'Winter King') were established by the nursery in spring 1995. The soil type is a clay loam with a pH of 6.1. Nursery staff reported that the trees had been damaged by lace bugs in 1995 and 1996. Twelve trees—planted in 2 rows 1.8 m (6 ft) apart within rows and 3 m (10 ft) apart between

rows—were divided into 3 blocks with 4 trees in each treatment block. Treatments within a block were assigned randomly. A buffer zone of 3 m was maintained between each block and between soil-injected trees. On May 21, 1997, the trees were measured at 10 cm (4 in.) from ground and found to average 2.5 cm (1 in.) diameter \pm 0.75 cm. (0.25 in.). Trees ranged from 2.74 to 3.35 m (9 to 11 ft) \pm 0.3 m (1 ft) at the time of treatment. All treatments were made prior to eggs being laid by lace bug. Naturally occurring populations of hawthorn lace bug infested the trees as the season progressed.

Each treatment (Table 1) was applied to 1 tree in each block on May 21, 1997. Two different delivery devices were used to apply the systemic insecticides. A Kioritz soil injector (Wilber-Ellis Company, 1521 15th St. NW, Suite 5, Auburn, WA 98001) was used to inject imidacloprid (Merit 75 WP) into the soil. Fifty-seven grams (2 oz.) of Merit 75 WP were mixed with 887.1 mL (30 oz) of water and put in the Kioritz injector. The application equipment weighs 2.72 kg (6 lb). It is 114.3 cm (45 in.) long and holds 2.8 L (3 qt) of material. At the widest opening, the Kioritz system applies 5 mL (0.17 oz) of material with each injection. For each 2.5 cm (1 in.) of dbh, 29.5 mL of solution was applied by striking the Kioritz dispensing knob 6 times, resulting in 0.75 g of imidacloprid being applied.

The ArborSystem (P.O. Box 34645, Omaha, NE 68134) SW100 injector with Wedgle tip was used to inject either imidacloprid (Pointer 4%) or abamectin (Greyhound) pesticide into the cambium of the trees. With this system, a metal punch was used to remove a small core of the bark and—in the case of these small trees—a small portion of the cambium and sapwood. The manufacturer recommends injecting trees with diameters greater than 7.5 cm (3 in.). The core was 8 mm (0.30 in) deep and 3 mm (0.10 in) wide. This injector system consisted of a metal injector on which a plastic bottle of the pesticide was fastened. The pesticide was injected into the tree through the Wedgle tip, which was 3 mm in diameter. A plastic cover sleeve (3 mm) was placed over the tip of the Wedgle injector tip. This plastic cover sleeve is called a WedgeChek. The Wedgle tip, covered by the plastic cover sleeve, was pushed into the cored hole and pushed through the plastic sleeve such that the tip of the needle was in the core cham-

ber. A shaft ring on the injector handle allowed the operator to adjust the amount of insecticide for each injection from 0.5 to 1 mL (0.016 to 0.033 oz). For this trial, we set the adjusting ring at 0.5 mL (0.016 oz), making 2 injection holes into each tree. After the injector levers were pulled and the chemical was injected into the chamber, the Wedgle tip was gently removed. The plastic sleeve cap remained, sealing the liquid chemical in the chamber and preventing it from leaking.

The weather at time of application (May 21, 1997) was sunny and dry, with a temperature of 22°C (71°F). The summer of 1997 experienced the longest drought period since 1977, and it did not rain at this nursery site from the time of application until early September 1997.

EVALUATION

Evaluation was conducted on October 1, 1997, by examination of the foliage of the trees. Because trees were relatively small with few leaves, treatments were evaluated by examining all of the leaves from each tree. Leaves with more than 5% of the leaf surface with leaf stippling injury were considered damaged leaves. The number of leaves on each tree and the number of damaged leaves on each tree were counted and the number of living lace bugs was recorded.

RESULTS AND DISCUSSION

The application of abamectin via trunk injection and imidacloprid via trunk and soil injection significantly reduced the percent of leaves damaged by lace bugs (Kruskal-Wallis test, $P < 0.02$) and the number of lace bugs (Kruskal-Wallis test, $P < 0.02$) ob-

served on the leaves of treated compared to untreated leaves (Table 2). Control was not influenced by chemical or method of application. No leaves were considered damaged nor were any living lace bugs observed on treated trees (Table 2). The imidacloprid applied by the Kioritz soil injector was an easy-to-use, efficient method to treat small numbers of trees without use of power soil injection equipment and large volumes of water. This is a good tool for arborists to treat small numbers of trees. In small residential lots where access is limited, the Kioritz applicator would be a good method for applying soil-injected systemic insecticides.

The ArborSystem with Wedgle tip would probably work best on larger diameter trees with thicker bark, causing less injury than the ones we used in our trial. In our trials, the trees were relatively young and the coring device provided by ArborSystem company created a hole that extended beyond the cambium into the sapwood. The chamber provided adequate room for injecting 0.5 mL of Pointer. The WedgeChek tip did keep the majority of liquid injected in the tree (a small amount of liquid seeped around the sealed edge). For this reason, we would strongly suggest that arborists use nitrile gloves when injecting into the trunk of the tree. The WedgeChek was difficult to keep in the hole when the Wedgle tip was withdrawn. This may have been because the trees were below the recommended diameter. This trunk-injection system compares favorably with other such systems and offers the slight advantage of not requiring a waiting period that the use of an injection capsule would require.

Trunk injection may be useful for situations in which quick control of a pest problem is desired, whereas the soil injection may provide a more long-term solution (Tattar et al. 1998). When imidacloprid was soil applied, 8 to 12 weeks were required to reach concentrations of 0.15 ppm in eastern hemlock (*Tsuga canadensis*), pin oak (*Quercus palustris*), and eastern white pine (*Pinus strobus*). This concentration was determined to be lethal in a bean aphid study (Elbert et al. 1991). Imidacloprid that was trunk injected reached lethal concentrations in *Q.*

Table 1. Hawthorn lace bug control treatments, rates, and methods of application.

Treatment	Amount of material	Method of application	Injection holes, number and depth
Merit 75 WP	30 mL	Soil injection, 15 cm deep in root zone	6 injection holes in root zone
Greyhound 1.9% (abamectin 1.9%, B1)	1 mL	Injected into trunk flair 5 cm from soil level	2 injection holes with WedgeChek plugs
Pointer (imidacloprid 4%)	1 mL	Injected into trunk flair 5 cm from soil level	2 injection holes with WedgeChek plugs
Control	untreated		

Table 2. Percentage of leaf damage and number of lace bugs after treatment.

Treatment	Percentage of leaves damaged	Number of lace bugs
Merit	0.0 ± 0.0	0.0 ± 0.0
Greyhound	0.0 ± 0.0	0.0 ± 0.0
Pointer	0.0 ± 0.0	0.0 ± 0.0
Control	16.33 ± 4.91	409.67 ± 102.41

palustris and *T. canadensis* in 1 and 4 weeks, respectively (Tattar et al. 1998).

Differences in the percentages of leaf damage and abundance of lace bugs among treated and untreated trees were evaluated with a Kruskal-Wallis analysis of variance by ranks (Zar 1996). Our trials show that the tested systemic insecticides offer an attractive alternative to traditional spraying for control of sucking insects such as lace bugs. Acephate applied as foliar sprays also has a proven track record for controlling lace bug on several species of plants (Baldson et al. 1993). Soil or trunk injection of this systemic will be included in future trials. Our trials show that systemic insecticides offer an attractive alternative to traditional spraying for control of sap-sucking insects such as lace bugs.

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Résumé. Plusieurs insecticides systémiques reçoivent des certificats pour le contrôle des insectes suceurs dans les arbres. De nombreuses méthodes d'application sont maintenant disponibles pour les arboriculteurs. Un essai sur le terrain a été mené pour tester deux formulations d'imidaclopride (insecticides systémiques *Pointer* et *Merit 75 WP*) et une formulation d'abamectine (*Greyhound 1,9%, B1*) ainsi que deux systèmes d'application différents. Les applicateurs évalués étaient l'injecteur dans le sol *Kioritz* et le nouvel appareil d'injection dans le tronc de *ArborSystems* avec une aiguille *Wedgle*. L'insecte cible était la punaise réticulée de l'aubépine (*Corythucha cydoniae*) présente sur les aubépines (*Crataegus* spp.). Cette étude sur le terrain a indiqué que les insecticides systémiques appliqués par injection dans le sol et par injection dans le tronc avaient un potentiel de contrôle des insectes suceurs qui se nourrissent sur les arbres ornementaux.

Zusammenfassung. Verschiedene systemische Insektizide erhalten gerade ihre Zulassung zum Einsatz gegen saugende Insekten bei Bäumen. Zahlreiche Anwendungen sind nun für Arboristen erhältlich. Es wurden ein Feldversuch unternommen, bei dem zwei Formeln von imidacloprid (*Pointer* und *Merit 75 WP* syst. Insektizide), eine Formel von abamectin (*Greyhound 1.9%, B1*) und zwei verschiedene Ausbringungsarten getestet wurden. Die

bewerteten Ausbringungsarten waren der *Kioritz* Bodeninjektor und eine neue Vorrichtung zur Stamminjektion von *ArborSystems* mit einer keilförmigen Spitze. Die bekämpfte Krankheit war der Weißdornglanzkäfer (*Corythucha cydoniae*) auf Weißdorn-arten (*Crataegus* spp.). Diese Feldstudie zeigte, daß systemische Insektizide, die durch Boden und Stamminjektion appliziert wurden, ein großes Potential haben, saugende Insekten an Ziergehölzen zu bekämpfen.

Resumen. Varios insecticidas sistémicos están recibiendo etiquetas para controlar plagas de insectos chupadores de los árboles. Numerosos métodos de aplicación están ahora disponibles para los arboristas. Fue conducido un ensayo de campo para probar dos formulaciones de imidacloprid (insecticidas sistémicos *Pointer* y *Merit 75 WP*), una formulación de abamectin (*Greyhound 1.9%, B1*), y dos diferentes sistemas de liberación. Los sistemas de liberación evaluados fueron el inyector del suelo *Kioritz* y un nuevo aparato de inyección al tronco de *ArborSystems* con una extremidad *Wedgle*. La plaga objetivo fue la chinche de encaje (*Corythucha cydoniae*) de árboles de espino (*Crataegus* spp.). Este estudio de campo indica que los insecticidas sistémicos aplicados a través de inyección al suelo y al tronco tienen el potencial de controlar los insectos chupadores que se alimentan de árboles ornamentales.