EFFECTS OF TRUNK-INJECTED ABAMECTIN ON THE ELM LEAF BEETLE[1]

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Abstract. Trunk-injected abamectin applied at the rate of 0.5 ml of 2% a.i. formulation for every 10 cm of trunk circumference effectively controlled the elm leaf beetle on Siberian elm. Treatments applied in May before hatching of first-generation larvae reduced defoliation levels in June and August. Foliage from treated trees remained toxic to elm leaf beetle larvae 83 days after treatment. Some phytotoxicity was observed around the treatment holes.

The elm leaf beetle, *Pyrrhalta luteola*, is a common defoliator of Siberian and American elms in the central United States (3). Frequently within the past ten years in Nebraska, defoliation of Siberian elms by the elm leaf beetle has been heavy, nearly 100% in many trees. Trees defoliated by elm leaf beetles are unsightly, and questions concerning the control of this pest are common.

Elm leaf beetles are often difficult to control because they commonly occur in large elms that are difficult to reach with sprays; and if a spray is applied to large trees, the risk of pesticide drift is great. Concerns about soil and groundwater contamination make soil treatments with insecticides undesirable in most situations.

Trunk injections of insecticides are another approach to elm leaf beetle control. The concerns with most injection methods include the damage to vascular tissue, the creation of wounds through which decay fungi and other organisms can enter the tree, the loss of stored nutrients in areas of the tree that are compartmentalized after wounding, and the breaching of previously formed compartment barriers by subsequent wounds (5,10,11).

But trunk injection methods have advantages over other application techniques in that by placing the pesticide within the tree they greatly reduce the risk of contaminating the environment, much smaller amounts of pesticides are usually used, and most treatments are easy to apply. As new trunk injection technology and materials are developed that are effective and less damaging to trees, the use of trunk injection methods to control tree pests will continue to increase.

The study reported here examined the efficacy of small-volume trunk injections of abamectin (avermectin B_1; AVID, Merck & Co., Inc.) for control of the elm leaf beetle on Siberian elm. Abamectin has been reported effective in controlling other beetle pests (2,6,7) and has been shown to move into leaf tissue when applied to the leaf surface (4). Our tests were conducted to determine whether abamectin could move through the trunk and be effective against a defoliating insect when applied as a trunk injection treatment.

Materials and Methods

Fifteen pairs of Siberian elms (*Ulmus pumila*) in street easements and wooded areas of Omaha, Nebraska, were used in the test. The trees ranged in diameter at 1.3 m from 9.7 to 103.4 cm, with paired trees located near each other and nearly equal in size. One randomly selected tree in each pair was injected with abamectin on May 17, 1990 before any elm leaf beetle larval feeding had occurred. The injection was made by pipetting 0.5 ml of 2% a.i. abamectin (AVID 0.15 EC) into holes drilled into the root flare or trunk near the ground. One hole was used for every 10 cm of trunk circumference measured at 1.3 m. Each hole was 5 mm in diameter and 2.5 cm deep. Holes were drilled at a slightly downward angle to hold the liquid and were spaced evenly around the trunk. Total volumes of the 2% abamectin applied per tree ranged from 1.5 to 16.0 ml for the smallest and largest treated trees, respectively.

Crown defoliation levels were recorded on June

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20 and August 6, 1990 to correspond to periods of heavy defoliation by first and second-generation larvae, respectively. Defoliation was rated on a scale of 0 to 9, with 0 meaning no detectable defoliation and 9 meaning defoliation near 100%. Differences in defoliation levels between treated and untreated trees were determined nonparametrically using the Wilcoxon rank-sum test (1,8).

To test the efficacy of the early-season treatment on second-generation larvae, second and third-instar larvae were collected on August 8 (83 days after treatment) from untreated trees in surrounding areas and placed in cages with foliage collected from the treated and untreated trees. For each test tree, three second and two third-instar larvae were placed with old foliage, and three second-instar larvae were placed with new foliage. New foliage consisted of the newest three leaves on a twig. These leaves were not present on the tree at the time of the injection except within buds. Old foliage consisted of leaves near the base of the current-year's shoot growth and were present and functional at the time of the injection. Larval survival was determined six days after placing the larvae on the foliage. The six-day period was used because insects feeding on abamectin-treated foliage typically stop feeding quickly, but take several days to die. Differences in larval survival were determined by a modified Student's t-test for means with unequal variances (1,8,9).

To obtain an indication of the amount of damage caused to the trees by the abamectin injections, four trees ranging in diameter from 4.6 to 7.4 cm in diameter and treated in a similar fashion with abamectin in 1988 were dug up in November 1990 and dissected, and the lengths of xylem stain above and below each of five treatment holes were measured. No holes were made at the time of treatment that were not injected with abamectin, so the effect of the abamectin on the length of stain could not be separated from the effect of the hole by itself.

Results and Discussion

Abamectin injection significantly reduced defoliation by first and second-generation elm leaf beetles on Siberian elm (Table 1) and reduced survival of larvae fed foliage from trees treated 83 days earlier (Table 2). The latter results indicate abamectin remained at efficacious levels in the leaves well into the feeding period of second-generation larvae. Even new foliage on treated trees was toxic to larvae, suggesting abamectin either moved from older leaves to newer ones as the newer ones were produced; that it moved into the very young, unexpanded leaves at levels high enough to be toxic after the leaves had expanded fully; or that some of the abamectin remained in the xylem for possibly several weeks and slowly moved from there into the new leaves as they expanded. In a few of the abamectin treated trees, an occasional one or two branches were defoliated in a tree that was otherwise completely free of noticeable defoliation. These branches typically originated low on the tree, and they illustrate the problem that can occur when lateral movement of the insecticide in the xylem does not occur quickly enough to provide a uniform distribution throughout the crown of the tree.

No trees showed signs of phytotoxicity in the leaves, and no noticeable injury from the abamectin treatment was outwardly apparent on the trunks of the undissected trees. Stain in the xylem of the dissected trees treated in 1988 had a length of 28.7 ± 8.7 cm (mean ± SE) above the injection hole and a length of 7.1 ± 1.8 cm below. However, since no holes were made that were not injected with the abamectin, it is not possible to know how much of the stain was caused by the abamectin compared to what would have happened from the hole by itself. In addition to the stain, one of the five

Table 1. Elm leaf beetle defoliation ratings for trees treated in May with trunk-injected abamectin and for untreated controls.

	Defoliation rating			
	June		August	
Treatment	Median	Range	Median	Range
Abamectin	0 a	0 - 1	0 a	0 - 1
Control	2 b	1 - 4	2 b	1 - 4

Defoliation rating scale: 0 (no detectable defoliation) to 9 (defoliation near 100%). Medians in the same column followed by different letters are significantly different ($p < 0.01$, determined nonparametrically using the Wilcoxon rank-sum test).

Table 2. Number of elm leaf beetle larvae surviving six days after feeding on leaves from abamectin-injected and untreated trees collected 83 days after treatment.

	Number of larvae surviving (mean ± SE)	
Treatment	Old foliage (5 larvae)	New foliage (3 larvae)
Abamectin	2.0 ± 0.6 a	1.4 ± 0.3 a
Control	4.8 ± 0.1 b	2.8 ± 0.1 b

New foliage: leaves that were not present at the time of treatment (except within buds). Old foliage: leaves that were expanded at the time of treatment. Means in the same column followed by different letters are significantly different ($p < 0.001$, t-test for means with unequal variances).

treatment holes also had a stem wound 27 cm in length associated with it; but the remaining treatment holes were free of any externally apparent injury and appeared to have sealed adequately.

Summary

The results of this study indicate that abamectin is able to move to and throughout the crown of Siberian elm from injection sites low on the trunk. When applied in May at the rate of 0.5 ml of 2% a.i. formulation per 10 cm of trunk circumference, the treatment reduced defoliation by the elm leaf beetle for at least 12 weeks and probably the entire growing season. The formulation of abamectin used in this test appeared to cause some injury to the trees beyond that which would have been caused by the drilled holes alone. It is not known whether the damage caused by the abamectin treatment was from the abamectin itself or from the inert ingredients that make up 98% of the product. Possibly a formulation could be produced that would be just as effective in controlling pests but would not have the damaging effects on trees.

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Résumé. L'injection d'abamectine appliquèe à raison de 0.5 ml d'une formulation à 2% par 10 cm de circonférence de tronc contrôle de façon effective le galéruque de l'orme sur l'orme de Sibérie. Les traitements appliqués en mai avant l'éclosions de la première génération de larves réduisent le degré de défoliation en juin et en août. Le feuillage des arbres traités conserve une toxicité pour les larves du galéruque de l'orme au cours des 83 jours suivants.

Zusammenfassung. Durch eine Stamminjektion von Abamectin in einer Konzentration von 0.5ml pro 2% a.i.; Lösung für alle 10 cm Stammumfang konnte der Ulmenblattkäfer auf der Sibirischen Ulme effektiv kontrolliert werden. Behandlungen im Mai, die vor der Schlüpfung der ersten Generation durchgeführt wurden, reduzierten die Entlaubungsgrade im Juni und August. Das Laub von behandelten Bäumen blieb für die Larven des Ulmenblattkäfers 83 Tage nach der Behandlung toxisch.