EVALUATION OF NON-INVASIVE TRUNK SPRAYS AND TRUNK-INJECTED EMAMECTIC BENZOATE

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ABSTRACT

In 2007, we continued to evaluate two neo-nicotinoid insecticides, imidacloprid and dinotefuron, applied as non-invasive trunk sprays to control emerald ash borer (EAB), *Agrilus planipennis* Fairmaire. Neo-nicotinoid products are widely used to protect landscape ash trees because they are relatively safe for humans and non-target species. These systemic products generally applied annually to the soil or via trunk injection and the insecticide is translocated to the canopy. Adult EAB, which must feed on ash leaves for at least two weeks and often longer before oviposition occurs, encounter the insecticide in the foliage. Although these products can be effective, concerns have arisen about the long-term effects of repeated wounding associated with trunk injection, the time required to apply or monitor trunk-injected products, and possible negative consequences of applying insecticides to soil at some sites.

Background. In 2006, we evaluated a non-invasive, efficient, and simple method of applying imidacloprid and dinotefuron to the trunk of ash shade trees. This application method involves mixing the insecticide with PentraBark™, a non-toxic, bark-penetrating surfactant (Agrichem, Medina, Ohio). The formulated solution was applied directly to the bark on the lower trunk of a tree with a common garden sprayer. PentraBark™, originally developed as an agricultural surfactant, has recently been used to carry fungicide products through the bark and into the xylem tissue of trees, through which the product is then translocated to the canopy. We sprayed the bark on the trunk of the trees from 20 cm to 1.6 m aboveground until it was wet.

In our 2006 study, we used a randomized block design with 6 to 12 trees per treatment, replicated at four sites; average DBH of trees ranged from 5 to 15.5 inches. Each block consisted of five trees treated with: 1) a non-invasive trunk spray of Macho® 2F (imidacloprid) + PentraBark™; 2) a non-invasive trunk spray of Safari® (dinotefuron) + PentraBark™; 3) a soil application of Merit® 75WP (imidacloprid) applied at the base of the tree with a Davey wand; 4) a trunk injection of Imicide® (imidacloprid) applied with Mauget capsules (e.g., a positive control); or 5) left as an untreated control.

Data from 2006 showed that the trunk sprays of imidacloprid + PentraBark™ and dinotefuron + PentraBark™ effectively moved the insecticides into the vascular tissue of trees and that the insecticides were translocated to the canopy. Dinotefuron, which is highly soluble in water, appeared to translocate relatively rapidly into the canopy. Residue levels peaked in mid-June, and then declined by roughly 40-50% over the next three weeks, suggesting that the product may break down relatively quickly. Residue levels in imidacloprid trees from trunk sprays and soil applications continued to increase from mid-June to July to August, suggesting that the product moved relatively slowly into the canopy or foliage. In contrast, foliar imidacloprid residues peaked in mid June in trees treated with the trunk injection (Mauget capsules). In bioassays, beetle mortality (control-corrected) after four days of exposure ranged from 27-55% among imidacloprid-treated trees and 56-77% on dinotefuron-treated trees. Larval density varied considerably among treatments and sites, but was generally lower on treated than untreated trees. Differences among treatments were statistically significant at one site, where larval density was roughly 50 to 75% lower on treated trees than on control trees.

2007 Study. In 2007, we continued to work with neo-nicotinoids trunk sprays to assess the consistency of results, determine whether adjusted application timing would enhance EAB control, and evaluate whether the PentraBark™ product improved efficacy of the insecticide products. In addition, we evaluated the efficacy of emamectin benzoate applied via trunk injection. Although emamectin benzoate is used in a variety of pesticide products, it is not yet registered for use on ornamental trees.

We established a total of 25 blocks at three different sites, each consisting of seven trees with an average DBH of 6.6 to 13.2 inches. The seven treatments represented in each block included: 1) untreated control; 2) trunk injection with Imicide® (10%, 3 ml Mauget capsules); 3) trunk injection with emamectin benzoate; 4) a non-invasive trunk spray of Macho® 2F (imidacloprid) + PentraBark™; 5) a non-invasive spray of Macho® 2 without PentraBark™; 6) a non-invasive trunk spray of Safari® (dinotefuron) + PentraBark™; and 7) a non-invasive trunk spray of Safari® without PentraBark™. Application rates for the Mauget trunk injections and trunk sprays were the same as those used in 2006 (McCullough et al. 2007). The emamectin benzoate was applied as a 4% solution with an Arborjet micro-injector. Application dates were May 4 for trunk sprays of Macho® 2F, May 22 for trunk injections of Imicide® (Mauget capsules) and emamectin benzoate, and May 31 for trunk sprays with Safari®.

Foliage residues. Translocation of insecticides to leaves in the canopy was evaluated by collecting composite foliage samples from eight locations in each tree in mid-June, early July, late July, and mid-August. Foliage samples were individually bagged and frozen for eventual residue analysis with ELISA (imidacloprid, dinotefuron) or MS/HPLC (emamectin benzoate). Analysis of foliage samples is in progress.

Adult EAB bioassays. Bioassays were conducted in mid-June, early July and late July, to assess survival of EAB beetles caged with leaves from each study tree. On each date, two leaves were collected from opposite sides of each tree and three beetles were placed on each leaf for four days. In the 15 June bioassay, no EAB survived on leaves from emamectin benzoate-treated trees. Beetle survival on trees treated with Safari® (dinotefuron) dropped to less than 15% by Day 4. Beetle survival on leaves from trees treated with Mauget capsules and Macho® 2F (no PentraBark™) was also significantly lower than survival on control trees. In the early

July and late July bioassays, we again observed 100% mortality of EAB on the emamectin benzoate-bearing leaves. Beetle survival was generally lower on other treated trees than on controls in July bioassays; however, at least, 40% of the beetles survived on the imidacloprid- and dinotefuron-treated trees.

Larval density. We assessed larval density in late September by felling and debarking areas on the trunk and canopy of trees. We felled three blocks of trees at the 7-L site and four blocks of trees at the IS site (49 total trees) to estimate larval density in 2007. The remaining blocks of trees will be re-treated and monitored through 2008.

At the 7-L site, we removed bark from at least 9 to 12 bark windows (each ≥ 500 cm^2 in area) per tree on the 21 trees that were felled. At the IS site, we examined at least 32 windows per tree on the 28 trees that were felled. All seven trees treated with emamectin benzoate, however, were completely debarked. Larval density, stage, and viability were recorded and standardized per m^2 of phloem.

Larval density varied considerably within and among treatments, as expected. The untreated control trees at the 7-L site and the IS site averaged 132 and 68 EAB per m^2, respectively. Trees treated with imidacloprid applied either as a trunk injection (Mauget capsules) or as a trunk spray had an average of 14 to 62 EAB per m^2 at the 7-L site and 14 to 75 EAB per m^2 at the IS site. The trees sprayed with dinotefuron had an average of 41 to 51 EAB per m^2 at both sites.

The efficacy of the emamectin benzoate, however, was striking. When we completely debarked the seven emamectin benzoate trees, we found only eight live larvae, equivalent to 0.19 larvae per m^2. There were no more than three live larvae on any of the trees, and two of the trees had zero live larvae. Overall, emamectin benzoate provided greater than 99% control of EAB. We recovered a total of 81 dead EAB larvae on the seven trees, most of which were late instars. Results from the larval sampling and the adult bioassays indicate that emamectin benzoate probably acts primarily on adult EAB and/or neonate larvae; otherwise, we would have expected to find hundreds of dead late stage larvae on the trees. Moreover, because emamectin benzoate affected adults and neonate larvae, the trees sustained little injury.

We plan to continue this project to evaluate product persistence, application rates, application timing, and other factors. The remainder of the trees treated in 2007 will be held and either re-treated or monitored in 2008. The notable control provided by the emamectin benzoate may provide a new tool, both for urban ash tree protection and perhaps for use in an integrated EAB management strategy. We expect to work with industry representatives and state regulatory officials to consider special registration for emamectin benzoate, perhaps as early as 2008.

REFERENCE

McCullough, D.G., D.A. Cappaert, T.M. Poland, P. Lewis, and J. Molongoski. 2007. Evaluation of neo-nicotinoid insectidies applied as non-invasive trunk sprays. Pp. 52-54 *in:* V. Mastro, D. Lance, R. Reardon, and G. Parra (compilers), *Proceedings of the Emerald Ash Borer Research and Technology Development Meeting,* October 31-November 1, 2006. Cincinnati, Ohio. USDA Forest Service, FHTET Publ. 2007-04.