IMIDACLOPRID CONCENTRATION EFFECTS ON ADULT EMERALD ASH BORER: A GREENHOUSE STUDY

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ABSTRACT

Imidacloprid is the active ingredient of many widely used products applied to control the emerald ash borer (EAB), *Agrilus planipennis* Fairmaire, in valuable urban trees. Systemic treatment with imidacloprid is typically made in the spring to reduce the number of larvae that would otherwise be generated by oviposition during the summer. Substantial evidence suggests that imidacloprid suppresses larval density indirectly by its effects on survival and/or reproductive performance of adults interacting with treated foliage. This conclusion is based on findings from five years of research, in which we have observed: 1) far greater toxicity of imidacloprid on adult EAB than on larvae, 2) little evidence of larval mortality or growth suppression when treated trees are debarked, and 3) significant reductions in survival and feeding of adults exposed to treated foliage. In this study, we sought to more precisely quantify the effects of foliar imidacloprid on adult EAB survival and feeding. The results will suggests the relative importance of lethal and sublethal effects and define the residue range at which these effects occur.

The experiment. We planted bare-root green ash whips in 1-gallon pots in a greenhouse. To create a range of imidacloprid residue levels, we treated the pots at leaf flush with a soil drench of Bayer Advanced™ (1.5%) applied at rates that varied from minimal to very high. In Trial 1, there were seven replicates for each of six treatments, ranging from 0.8 to 2500 mg AI of imidacloprid in 5X increments. In Trial 2, there were 11 replicates of eight treatments, with 6.25 to 800 mg imidacloprid applied in 2X increments. When leaves were fully expanded (6-8 weeks post-planting), two leaves from each plant were collected. Leaf area was measured, and each leaf was placed in a petri dish with three EAB adults. Beetle survival in each dish was monitored for four days. Leaf area was then re-measured, and foliage was transferred to the USDA APHIS PPQ CPHST Otis lab for ELISA analysis.

Results. We found a linear relationship between log(treatment dose) and log(imidacloprid residue) in both trials (Figure 1). For Trial 1, mean leaf residues ranged from 0.75 ppm (for 0.8 mg/pot) to 141 ppm (for 2500 mg/pot). In Trial 2, leaves contained far lower residues for a given treatment dose. Mean leaf residues ranged from 0.03 ppm (for 6 mg/pot) to 25 ppm (for 800 mg/pot).

For both trials, we determined thresholds for leaf consumption and beetle survival. We found that beetle leaf consumption was significantly affected at lower residue levels than was four-day survival (Figures 2 and 3). In Trial 1, no feeding occurred at residues >3.5 ppm, and no beetles survived exposure to >33 ppm imidacloprid. In Trial 2, thresholds for feeding cessation and survival were 3.8 ppm and 40 ppm, respectively.

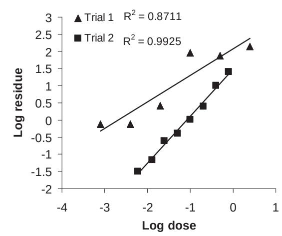

Figure 1. Relationship between treatment level (log(mg/pot) and leaf residue (log(ppm imidacloprid).

In a related experiment, we evaluated the fate of individual beetles exposed to the 25 ppm treatment in Trial 2 to determine whether beetles receiving a sublethal dose sufficient to inhibit feeding recover if removed to clean foliage. We found that, 48 hours after being removed from leaves containing imidacloprid and placed on clean foliage, half of the initially intoxicated beetles (unable to walk or feed) recovered.

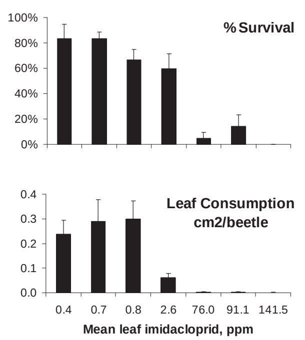

Figure 2. Emerald ash borer response to leaf residue, Trial 1. For treatments >2.6 ppm, survival differs from control. For treatments >0.8 ppm, leaf consumption differs from control.

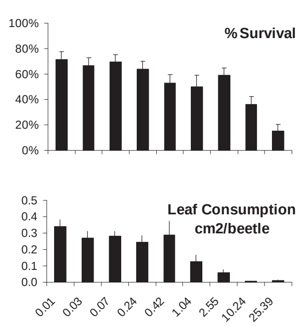

Figure 3. Emerald ash borer response to leaf residue, Trial 2. For treatments >10.2 ppm, survival differs from control. For treatments >0.42 ppm, leaf consumption differs from control.

To provide a basis for comparison between results of this greenhouse trial and actual imidacloprid treatment of trees, we compiled a summary of peak foliar imidacloprid residues observed in 2006 field trials. For two treatments (trunk injection of Imicide® via Mauget capsules and soil injection of Macho® 2F) used at three sites, mean residue levels in foliage ranged from 2.1 to 10.6 ppm (Table 1).

Discussion. In this experiment we found that imidacloprid strongly affects beetle feeding at levels well below those that cause mortality. Further, we established an approximate range of leaf imidacloprid concentration where lethal and sublethal effects are observed. In practice, the leaf residues that we found to inflict high EAB mortality are not typically achieved in field applications of imidacloprid. It appears likely that the benefits of treatments are primarily attributable to sublethal effects on EAB adults. Our experiment evaluates only one such effect: feeding inhibition. Other effects associated with feeding inhibition might be physiological (long-term mortality, reduced fecundity), behavioral (increased dispersal), and/or ecological (exposure of intoxicated beetles to predation or desiccation). A true understanding of the mechanism for imidacloprid efficacy will require investigation of these effects.

Table 1. Foliar imidacloprid residues. Values determined for July samples in 2006 MSU pesticide trials.

		Foliar Imidacloprid Residue, ppm	
Site	Treatment	Max	Mean
7L	Mauget	8.8	3.5
	Soil Merit	6.5	2.1
7s	Mauget	38.9	10.6
	Soil Merit	14.4	5.2
LA	Mauget	14.3	4.3
	Soil Merit	7.3	3.3