General Report

ASH: *Fraxinus pennsylvanica* Marsh.
EMERALD ASH BORER;
Agrilus planipennis Fairmaire

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EAB tree trunk injections and sprays, 2004: Green ash street trees in a neighborhood in Troy, Mich., were used for this test (Oakland Co, Mich., T2N R11E Sec 7 SE). These trees were between 12 and 26 years old and ranged in size from 7 to 24 inches diameter at breast height (DBH). The mean DBH was 14 inches. All trees in this test were located between the street and the sidewalk. Trees were spaced a minimum of 50 feet apart. The tree canopies ranged from 15 to 30 feet in diameter, and in no case did they overlap. Tree trunks were measured and marked with metal tags during the last two weeks of April. Lawns in the neighborhood were well maintained, but very few had irrigation systems. The trees were grouped into 10 blocks of 20 trees on the basis of their location in the neighborhood. Each treatment was replicated 10 times, with each replication consisting of an individual tree. The treatments in the test consisted of:

1) **Merit soil drench** (75% imidacloprid). Merit 75WP was applied at a rate of 1.42 grams of active ingredient (ai)/inch DBH. The appropriate amount of Merit was mixed in 1.5 gallons of water and poured around the base of the tree within 2 feet of the trunk on May 4.
2) **AceCap trunk injection** (0.875 grams acephate per cap). Caps were placed every 4 inches around the base of the tree in holes 3/8 inch in diameter and 3/4 inch deep and sealed with plastic caps on May 4.
3) **Onyx 32 oz. Trunk and Limb Spray Once** (bifenthrin 2 lb a.i./gal.). Onyx was mixed at a concentration of 32 fl oz/100 gal. The trunk and larger branches were sprayed once with a commercial hydraulic sprayer on June 3. Each tree received 6 to 9 gallons of spray solution, depending on its size.
4) **Onyx 32 oz. Trunk and Limb Spray Twice** (bifenthrin 2 lb. a.i./gal.) Onyx was mixed at a concentration of 32 fl. oz./100 gal. The trunk and larger branches were sprayed with a commercial hydraulic sprayer on June 3 and again on June 24. Each tree received 6 to 9 gallons of spray solution, depending on its size.
5) **Onyx 16 oz. Trunk and Limb Spray Once** (bifenthrin 2 lb. a.i./gal.). Onyx was mixed at a concentration of 16 fl. oz./100 gal. The trunk and larger branches were sprayed with a commercial hydraulic sprayer on June 3. Each tree received 6to 9 gallons of spray solution, depending on its size.
6) **Onyx 16 oz. Trunk and Limb Spray Twice** (bifenthrin 2 lb. a.i./gal.). Onyx was mixed at a concentration of 16 fl. oz./100 gal. The trunk and larger branches were sprayed with a commercial hydraulic sprayer on June 3 and again on June 24. Each tree received 6 to 9 gal of spray solution, depending on its size.

7) **Onyx 12.8 oz. foliar Spray Twice** (bifenthrin 2 lb. a.i./gal.) Onyx was mixed at a concentration of 12.8 fl. oz./100 gal. The entire canopy, trunk and branches were sprayed with a commercial hydraulic sprayer on June 3 and again on June 24. Each tree received 16 to 20 gallons of spray solution, depending on its size.
8) **Onyx 6.4 oz. Foliar Spray Twice** (bifenthrin 2 lb. a.i./gal.). Onyx was mixed at a concentration of 6.4 fl. oz./100 gal. The entire canopy, trunk and branches were sprayed with a commercial hydraulic sprayer on June 3 and again on June 24. Each tree received 16 to 20 gallons of spray solution, depending on its size.
9) **Mauget Imicide trunk injection** (3 ml of 10% imidacloprid/capsule). Holes (11/64 inch) were drilled on the root flares to accommodate injection cups and were evenly spaced around the tree. The total number of injection sites depended on the tree size (DBH)/2).
10) **IMA-jet AAD-jet trunk injection** (5% imidacloprid with 5% ArborJet Aqueous Dilutant [AAD]). Imidacloprid was delivered via the Arborjet Tree IV system at a pressure of 35 pounds per square inch (psi). Trees smaller than 12 inches DBH received four #3 plugs and trees larger than 12 inches DBH received eight #3 plugs. The amount of solution to be delivered was 4 ml per inch DBH on trees with a DBH less than 12 and 8 ml per inch on trees with a DBH greater than 12 inches.
11) **IMA-jet trunk injection** (5% imidacloprid solution). Four ml of IMA-jet solution per inch of DBH were injected into trees with DBH smaller than 12 inches; trees larger than 12 inches received 8 ml per inch DBH. Injections were applied with an ArborJet Air Hydraulic VIPER (Volume Injection Pressure Enhanced Reservoir) apparatus. Injection holes were 9/32 inch in diameter and 15 mm deep into the sapwood. The injection pressure was set at 125 psi. The number of injection sites was determined by dividing inches of DBH by 2.
12) **BotaniGard foliar spray** (11.3% *Beauveria bassiana* strain GHA). BotaniGard was mixed at a concentration of 6 quarts per 100 gallons. The entire canopy, trunk and branches were sprayed with a commercial hydraulic sprayer on June 3 and again on june 24. Each tree received 16 to 20 gallons of spray solution, depending on its size.
13) **Untreated control**.

The Merit drench and Acecap treatments were applied on May 4, 2004 (treatments 1 & 2, respectively). All of the other trunk injection treatments (treatments 9-11) took place over a three-day period, May 26-28. The first trunk and foliage sprays of Onyx and BotaniGard (treatments 3-8, and 12) took place on June3 and were followed up by a second spray of Onyx or BotaniGard (treatments 4, 6-8, and 12) three weeks later (June 24).

Branches from the upper one-third of the tree canopy were sampled between August 22 and November 22. Three branches were removed from each tree by the Troy city arborists. Branches selected for pruning were spaced as far apart as possible to maintain canopy balance. After removing bark with a drawknife and chisel, EAB galleries and larvae were counted. Bark scraping was done on site for three weeks until the weather became unfavorable. The operation was then moved to Michigan State University's Tollgate Extension/Conference Center, where scraping could be done

indoors. As time passed, the cut branches began to dry out and became more difficult to scrape, so they were soaked in a large basin of water for two days and then stripped. Each of the branches was examined to determine how many old galleries, new galleries and live larvae were present. The surface area of each sampled branch was measured. Branches ranged from 2 to 10.5 inches in diameter, with a mean diameter of 5.1 inches. The branch lengths ranged from 27 to 87 inches, with a mean length of 44.2 inches. All of the gallery and larvae counts were converted to reflect counts per square meter of branch area. The average surface area sampled per tree was 0.434 m^2.

Results

Like bronze birch borer, the emerald ash borer seems to prefer to attack stressed trees. This behavior tends to lead to a clumped distribution of emerald ash borer in a stand of ash trees. We chose this subdivision for our test because it had more than 200 relatively healthy green ash street trees similar in size. In May 2003, when we set-up our experiment and tagged trees, we eliminated six trees from the test -- five that were heavily attacked by woodpeckers and one that was a different type of ash. Insecticide treatments were applied as previously described in May, June or early July. Old galleries, new galleries and live larvae were counted between late August and mid-November 2004.

The previous level of emerald ash borer infestation in trees at our test site before we made insecticide treatments in spring of 2004 was determined from counting the old galleries in each tree. These are galleries that were made in late summer and early fall of 2003. The density of old galleries in our test trees varied from 0 to 80/m^2 . In 185 of the 200 trees the density of old galleries was less than 25/m^2 . The remaining 15 trees, with more than 25 old galleries/m^2, were removed from the test because they may have been too severely damaged to adequately translocate systemic insecticides used in this test. This left us with nine or 10 replications in all treatments except for the Mauget Imicide treatment and the Onyx 32 oz. Trunk and Limb Spray Twice treatment, each of which had seven replications.

From recent research by McCullough and Cappaert we now know that some of the live larvae found in our test trees this fall could be in their second year of development and therefore were already in the ash trees when the trees were treated in spring 2004. Insecticides applied as a foliar spray or as a trunk and limb spray are not expected to affect EAB larvae already within the tree. In our test, the Onyx and BotaniGard treatments were applied as sprays. Any impact of these treatments is probably due to control of adult beetles or larvae that initiated galleries this year. All the remaining treatments, other than the control, are systemic insecticide treatments that could affect second-year as well as first-year EAB larvae. The active ingredient of the systemic insecticide treatments was either orthene (AceCaps) or imidacloprid (Merit 75 drench, Mauget Imicide, or Arborjet IMA-jet). The systemic insecticide treatments were applied as a type of trunk injection with the exception of Merit 75, which was applied as a drench around the bases of treated trees.

Treatment means were separated by ANOVA LSD at $P < 0.05$. Six treatments had a density of new galleries significantly less than the untreated control. Of these, the two Arborjet treatments had the lowest density of new galleries (0 to 1.2/m^2), followed by Acecap (3.5), Onyx 32 oz. Trunk and Limb Once (3.8), Onyx 12.8 oz. Foliar Spray

Twice (4.1), and Onyx 16 oz. Trunk and Limb Twice (4.2). The remaining treatments were not different from the control. The ranking of treatments by density of live larvae and the associated data analysis were very similar to the results for new galleries.

The Arborjet trunk injection treatments with imidacloprid provided a high level of control (92 to 100 percent), suggesting that they were efficacious against second-year as well as first-year larvae. Acecap trunk injections, containing acephate, gave 76 percent control. This gives homeowners an option for treating ash trees with a product they can purchase at a local garden center. The best Onyx treatments reduced the density of new galleries by 71 to 74 percent in this test. Onyx treatments are expected to yield a higher level of control next year, when there are fewer 2nd-year larvae. Botanigard reduced the density of new galleries by 53 percent. Botanigard is also expected to provide better control in the second year of this test when there will be fewer second-year larvae.

The Merit 75 drench treatment did not provide any detectable level of control of EAB larvae. This is in contrast to our results from two other test sites in 2004. At the Westland test site, we got 100 percent control of EAB larvae after two years of applying an imidacloprid soil drench to small-caliper trees (3 to 4 inches DBH), and at the Bay Point Country Club site, a basal drench of Merit gave 40 percent control of EAB on ash trees of all sizes (Bay Pointe test results are available at www.emeraldashborer.info). In 2003, results from treatments with Merit as a soil injection varied from 0 to 80 percent control depending on the test site (McCullough and Smitley 2003). When the results of imidacloprid soil drenches and soil injections are considered for all test sites last year and this year, it suggests that imidacloprid applied as a soil drench or soil injection provides good control of emerald ash borer in small-caliper trees (3 to 4 inches DBH) but is inconsistent in large trees (> 12 inches DBH) in the first year of treatment. This inconsistency on larger trees may become less of a problem after two or three years of soil drenches or soil injections because of the potential for imidacloprid to persist in soil and in trees for more than a year. We will know more about this after the second and third year of our tests at Troy and Bay Pointe Country Club.

The results from the first year of this test look promising and suggest that we may be able to protect relatively healthy ash trees from emerald ash borer with annual insecticide treatments. The first year of data, however, should be considered preliminary. After a second year of the same treatments, we will have a better idea of how well these products protect ash trees. This test supports the concept that many arborists have put forward: to start treating for EAB when it is first detected in a subdivision. At our test site in Troy, we knew EAB was present because we found a few trees that were heavily attacked by woodpeckers and a of few bark splits on upper branches of some trees. There were very few dead branches and no exit holes visible on the lower trunks last spring, yet these trees contained an average of 3.5 galleries/m^2. Last spring was a good time to initiate insecticide treatments -- the density of galleries in the control trees doubled, increasing from 6.8/m^2 last year to 14.7/m^2 this year.

Treatment	New galleries/m^2	Larvae/m^2
Arborjet 5% IMA-jet	0.0 *	0.0 *
Arborjet 5% IMA-jet & AAD-jet	1.2 *	0.5 *
Acecap	3.5 *	2.8 *
Onyx 32 oz. trunk & limb once	3.8 *	1.9 *
Onyx 12.8 oz. foliar spray twice	4.1 *	3.1 *
Onyx 16 oz. trunk & limb twice	4.2 *	2.6 *
BotaniGard	6.9	4.7
Onyx 6.4 oz. foliar spray twice	8.0	6.1
Mauget Imicide	8.3	6.2
Onyx 16 oz. trunk & limb once	11.6	8.7
Onyx 32 oz. trunk & limb twice	11.8	8.9
Merit soil drench	12.8	10.0
Untreated control	14.7	10.1

* Indicates significant difference from the untreated control by Tukey's LSD at $p<0.05$.