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, MI were used for this test (Oakland Co, MI T2N R11E Sec 7 SE). These trees were between 12 and 26 years old and ranged in size from 7-24 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 ft 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 a metal tag during the last two weeks of April. Lawns in the neighborhood were well maintained, but very few had an irrigation system. The trees were grouped into 10 blocks of twenty trees based on the location in the neighborhood. Each treatment was replicated 10 times with each replicate 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 1.42g AI/inch DBH. The appropriate amount of Merit was mixed in 1.5 gal of water and poured around the base of the tree within 2 feet of the trunk on 4 May.
2) AceCap Trunk Injection (0.875 grams acephate per cap). A cap was placed every 4" around the base of the tree in a 3/8 inch diameter, 3/4 inch deep hole and sealed with a plastic cap on 4 May.
3) Onyx 32 oz Trunk and Limb Spray Once (bifenthrin 2 lb ai/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 3 Jun. Each tree received 6-9 gal of spray solution, depending on its size.
4) Onyx 32 oz Trunk and Limb Spray Twice (bifenthrin 2 lb ai/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 3 Jun and again on 24 Jun. Each tree received 6-9 gal of spray solution, depending on its size.
5) Onyx 16 oz Trunk and Limb Spray Once (bifenthrin 2 lb ai/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 3 Jun. Each tree received 6-9 gal of spray solution, depending on its size.
6) Onyx 16 oz Trunk and Limb Spray Twice (bifenthrin 2 lb ai/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 3 Jun and again on 24 Jun. Each tree received 6-9 gal of spray solution, depending on its size.
7) Onyx 12.8 oz Foliar Spray Twice (bifenthrin 2 lb ai/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 3 Jun and again on 24 Jun. Each tree received 16-20 gal of spray solution, depending on its size.

8) Onyx 6.4 oz Foliar Spray Twice (bifenthrin 2 lb ai/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 3 Jun and again on 24 Jun. Each tree received 16-20 gal of spray solution, depending on its size.
9) Mauget Imcide 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 with the total number of injection sites determined by the diameter at breast height (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 35psi. Trees with less than 12" DBH received four #3 plugs and trees with greater than 12" DBH received 8 #3 plugs. The amount of solution to be delivered was 4ml/inch DBH on trees with a DBH less than 12" and 8ml/inch DBH on tress greater than 12" DBH.
11) IMA-jet Trunk Injection (5% imidacloprid solution). Four ml of IMA-jet solution per inch of DBH were injected into trees with DBH less than 12 inches, while trees large 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 inches in diameter and 15mm deep into the sapwood. The injection pressure was set at 125 psi. The number of injection sites was determined by inches of DBH/2.
12) BotaniGard Foliar Spray (11.3% *Beauveria bassiana* Strain GHA) - BotaniGard was mixed at a concentration of 6 quarts/100 gal. The entire canopy, trunk and branches were sprayed with a commercial hydraulic sprayer on 3 Jun and again on 24 Jun. Each tree received 16-20 gal of spray solution, depending on its size.
13) Untreated Check

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

Branches from the upper 1/3 of the tree canopy were sampled between 22 Aug and 22 Nov. Three branches were removed from each tree by the arborists of the City of Troy. Branches selected for pruning were spaced as far apart as possible to maintain canopy balance. EAB galleries and larvae were counted after removing bark with a drawknife and chisel. Bark-scraping was done on site for 3 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 in an indoor environment. Also, as time passed, the cut branches began to dry out. To compensate for the difficulty in scraping dry branches, 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 weakened 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 over 200 relatively healthy green ash street trees of a similar size. In May of 2003, when we set-up our experiment and tagged trees, we eliminated 6 trees from the test; 5 that were heavily attacked by woodpeckers, and 1 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 9 or 10 replications in all treatments except for the Mauget Imicide treatment and the Onyx 32 oz trunk and limb spray-twice treatment; each with 7 replications.

From recent research by McCullough and Cappaert we now know that 50% or more of the live larvae found in our test trees this fall could be in their second year of development, and therefore were already within the ash trees when the trees were treated in spring of 2004. Insecticides applied as a foliar spray or as a trunk and limb spray are not expected to impact 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 2nd year EAB larvae as well as first year larvae. The active ingredients of the systemic insecticide treatments were 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 base 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 control treatment. Of these, the two Arborjet treatments had the lowest density of new galleries (0 - 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 - 100%), suggesting that they were efficacious against 2nd-year larvae as well as 1st-year larvae. Acecap trunk injections, containing acephate, gave 76% 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 - 74% 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%. Botanigard is also expected to provide better control in the second year of this test when there will be fewer 2nd-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% control of EAB larvae after 2 years of applying an imidacloprid soil drench to small-caliper trees (3 - 4" DBH), and at the Bay Point Country Club site a basal drench of Merit gave 40% control of EAB on ash trees of all sizes (Bay Pointe test results are available on emeraldashborer.info). In 2003, results from treatments with Merit as a soil injection varied from 0 to 80% 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 - 4" DBH) but is inconsistent in large trees (> 12" DBH) in the first year of treatment. This inconsistency on larger trees may become less of a problem after 2 or 3 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 2nd and 3rd 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. However, the first year of data 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 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 by finding a few trees that were heavily attacked by woodpeckers, and by the presence 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 because 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 $p<0.05$.