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# IR-4 Ornamental Horticulture Program
# Management of Borers, Beetles, and White Grubs:

**Ambrosia Beetles (*Xylosandrus crassiusculus, X. germanus*)**
**Banded Ash Clearwing Borer (*Podosesia aureocincta*)**
**Black Vine Weevil (*Otiorhynchus sulcatus*)**
**Bronze Birch Borer (*Agrilus anxius*)**
**Flat-headed Apple Tree Borer (*Chrysobothris femorata*)**
**European Elm Flea Weevil (*Orchestes alni*)**
**Flea Beetle (*Epitrix sp.*)**
**Japanese Beetle (*Popillia japonica*)**
**May/June Beetles (*Phyllophaga spp.*)**
**Peachtree Borer (*Synanthedon exitiosa*)**
**Redheaded (Cranberry) Flea Beetle (*Systena frontalis*)**
**Sri Lankan Weevil (*Myllocerus undatus*)**
**Strawberry Rootworm (*Paria fragariae ssp. fragariae*)**
**Viburnum Leaf Beetle (*Pyrrhalta viburni*)**

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## Abstract

Collectively, managing coleopteran insects can be challenging because the adult and larval stages may both cause damage and sometimes occur on different hosts or on different plant parts. While organophosphates, pyrethroids, and neonicotinoids can provide good to excellent control of coleopteran insects, not all products work equally well in all situations. Treatments for borers are very different than treatments targeting white grubs. Developing newer classes of chemistry are important to reduce the environmental consequences and to minimize the development of resistance. Starting with the 2004 Annual Workshop, screening a number of products to manage coleopteran insects became one of the high priority projects for entomology. From 2005 through 2016, 66 products representing 43 different active ingredients were tested for management of adult and larval stages of coleopteran insects. In addition,10 products representing 10 active ingredients were evaluated for lepidopteran clearwing borers in 2008 and 2009.These products represented both biological and chemical tools. Some products were already registered but more data were needed or they were considered standards to measure the level of efficacy achieved with other materials. Other products were in development but have not yet been registered with the EPA. While a number of coleopteran and lepidopteran species were tested, only enough experiments were able to be completed on the coleopteran species black vine weevil, Japanese beetle, oriental beetle, Sri Lankan weevil, and viburnum leaf beetles to recommend actions to register or amend labels for these pests.

## Introduction

Coleopeteran insects have represented some of the most pervasive invasive insects imported into the United States. While not all coleopteran insects causing damage are invasive, a large number impacting growers and landscapes originated outside the U.S. Collectively, managing coleopteran insects can be challenging because the adult and larval stages may both cause damage and sometimes occur on different hosts or on different plant parts. While organophosphates, pyrethroids, and neonicotinoids can provide good to excellent control of coleopteran insects, not all products work equally well in all situations. Treatments for borers are very different than treatments targeting white grubs. Developing newer classes of chemistry are important to reduce the environmental consequences and to minimize the development of resistance. At the 2004 Annual Workshop, screening a number of products to manage coleopteran insectsbecame one of the high priority projects for entomology. The following research was conducted between 2005 and 2016. Additional research for managing lepidopteran clearwing borers was conducted in 2008 and 2009.

## Materials and Methods

Fifty-seven insecticides were tested against six species of soil dwelling larvae, six species of borers, and five species of foliar feeding adults and larvae. However, not all products were tested against all species. Depending upon product characteristics, foliar, trunk spray, drench applications, soil incorporation or other application methods were made. A minimum of four plants (replicate treatments) were required with most researchers exceeding this minimum. Insect counts were recorded at timings suitable for each pest. Phytotoxicity when observed was recorded. The following protocols were used: 08-008, 09-017, 10-023, 12-006, 12-019, 13-006, and 16-007. For more detailed materials and methods, including application rates for various products, please visit http://ir4.rutgers.edu/ornamental/OrnamentalDrafts.cfm to view and download these protocols.

Products were supplied to researchers (See list of researchers in Appendix 1) by their respective manufacturers.

For all research data tables, product names have been updated where manufacturers have established trade names and tables have been rearranged by product alphanumeric order.

**Table 1. List of Products and Rates Tested from 2005 to 2016.**

| **Product** | **Active Ingredient(s)** | **Manufacturer** | **Application Method & Rate(s) –** *per 100 gal water unless otherwise specified* | | **# Trials** |
|---|---|---|---|---|---|
| A20520A / DPX-HGW86 / Mainspring | Cyantraniliprole | DuPont | Drench | 32 fl oz | 1 |
| | | | | 100 fl oz | 1 |
| | | | Foliar | 8 fl oz | 2 |
| | | | | 16 fl oz | 3 |
| | | | Trunk Spray | 32 fl oz | 1 |
| Acelepryn / DPX-E2Y45 1.67SC | Chlorantraniliprole | DuPont | Dipping bolt | 15.9 fl oz (47 g ai) | 1 |
| | | | | 32 fl oz | 1 |
| | | | | 64 fl oz (189.4 g ai) | 1 |
| | | | | 255 fl oz (754.4 g ai) | 1 |
| | | | Drench | 0.5 fl oz/inch DBH (14.8 ml) | 1 |
| | | | | 0.8 fl oz | 10 |
| | | | | 3.2 fl oz | 1 |
| | | | | 6.47 fl oz | 3 |

| Product | Active Ingredient(s) | Manufacturer | Application Method & Rate(s) – *per 100 gal water unless otherwise specified* | | # Trials |
|---|---|---|---|---|---|
| | | | | 8 fl oz | 1 |
| | | | | 11.5 fl oz | 1 |
| | | | | 8 fl oz | 1 |
| | | | | 16 fl oz | 2 |
| | | | | 23 fl oz | 1 |
| | | | | 32 fl oz | 2 |
| | | | | 46 fl oz | 1 |
| | | | | 47.9 fl oz | 1 |
| | | | | 100 fl oz | 1 |
| | | | Foliar | 2 fl oz | 1 |
| | | | | 4 fl oz | 1 |
| | | | | 8 fl oz | 1 |
| | | | | 10 fl oz | 11 |
| | | | | 16 fl oz | 2 |
| | | | | 47.9 fl oz | 1 |
| | | | Soil incorporation | 1 ppm | 1 |
| | | | | 2 ppm | 1 |
| | | | | 4 ppm | 1 |
| | | | | 5 ppm | 1 |
| | | | | 10 ppm | 1 |
| | | | | 20 ppm | 1 |
| | | | Trunk spray | 10 fl oz | 1 |
| | | | | 32 fl oz | 2 |
| Aloft | Clothianidin/Bifenthrin | Arysta | Foliar | 8 fl oz | 1 |
| | | | | 15 fl oz | 3 |
| | | | Trunk spray | 32 fl oz | 1 |
| Ammo 2.5 EC | Cypermethrin | Helena | Dipping bolt | 15 fl oz (66.3 g ai) | 1 |
| | | | | 32.7 fl oz (144.9 g ai) | 1 |
| Arena 50WDG | Clothianidin | Arysta | Drench | 1.28 oz | 1 |
| | | | | 1.9 g/inch DBH | 1 |
| | | | Soil incorporation | 49 mg/pot | 1 |
| Asana XL | Esfenvalerate | DuPont | Dipping bolt | 6.8 fl oz (8 g ai) | 1 |
| | | | | 65.4 fl oz (76.5 g ai) | 1 |
| | | | | 82 fl oz (95.9 g ai) | 1 |
| | | | | 131.3 fl oz (153.5 g ai) | 1 |
| AzaGuard | Azadirachtin | BioSafe | Foliar | 16 fl oz | 1 |
| Azatin XL | Azadirachtin | OHP | Dipping bolt | 256 fl oz | 1 |
| BAS 320i | Metaflumizone | BASF | Dipping bolt | 16 fl oz | 1 |
| | | | Drench | 12 fl oz | 1 |
| | | | | 16 fl oz | 5 |
| | | | | 50 ppm | 1 |
| | | | | 100 ppm | 1 |
| | | | Foliar | 4.5 fl oz | 1 |
| | | | | 16 fl oz | 7 |
| | | | Soil incorporation | 1 ppm | 1 |
| | | | | 2 ppm | 1 |
| | | | | 4 ppm | 1 |
| | | | | 25 ppm | 1 |
| | | | | 50 ppm | 1 |
| | | | | 100 ppm | 1 |

| Product | Active Ingredient(s) | Manufacturer | Application Method & Rate(s) – *per 100 gal water unless otherwise specified* | | # Trials |
|---|---|---|---|---|---|
| | | | | 200 ppm | 1 |
| BeetleGONE | *Bacillus thuringiensis galleriae* str | Phyllom | Foliar | 16 lb | 1 |
| Bifenthrin 8% ME | Bifenthrin | | Dipping bolt | 36.3 fl oz (42.5 g ai) | 1 |
| | | | | 72.7 fl oz (85 g ai) | 1 |
| | | | | 145.4 fl oz (170 g ai) | 1 |
| Botanigard ES | *Beauveria bassiana* | BioWorks | Drench | 39 uL/pot | 1 |
| | | | Foliar | 32 fl oz | 1 |
| | | | Soil incorporation | 39 uL/pot | 1 |
| Botanigard WP | *Beauveria bassiana* | Laverlam | Drench | 18.7 mg/pot | 1 |
| | | | Soil incorporation | 18.7 mg/pot | 1 |
| Cal-Agri 50 1 % | Potassium phosphate | Cal-Agri Products | Drench | 128 fl oz | 1 |
| Celero 16WSG | Clothianidin | Valent | Dipping bolt | 8 oz | 1 |
| | | | | 8.6 oz (38.8 g ai) | 1 |
| | | | | 17.1 oz (77.6 g ai) | 1 |
| | | | | 37.5 oz (170 g ai) | 1 |
| | | | Drench | 0.5 oz | 3 |
| | | | | 1.2 oz | 2 |
| | | | | 4 oz | 2 |
| | | | | 12 oz | 1 |
| | | | | 16 oz | 1 |
| | | | | 20 oz | 1 |
| | | | | 4 oz/1320 pots | 1 |
| | | | Foliar | 4 oz | 8 |
| | | | | 6 oz | 2 |
| CoreTec | Imidacloprid | Bayer | Soil treatment | 3 tablets/inch trunk diameter | 1 |
| DEET | N, N-diethyl-m-toluamide | | Dipping bolt | 40 % | 2 |
| | | | | 90 % | 1 |
| Discus | Imidacloprid + cyfluthrin | OHP | Dipping bolt | 100 fl oz | 1 |
| | | | | 180 fl oz (83.3 + 19.8 g ai) | 2 |
| | | | | 364 fl oz (169.6 + 39.6 g ai) | 1 |
| | | | Drench | 10 fl oz | 2 |
| | | | | 13 fl oz | 1 |
| | | | | 1.5 fl oz/inch DBH (44 ml) | 2 |
| | | | Foliar | 50 fl oz | 2 |
| DuraGuard | Chlorpyrifos | Whitmire | Drench | 50 fl oz | 1 |
| Dursban 2E | Chlorpyrifos | Dow | Dipping bolt | 32 fl oz | 1 |
| Dursban Turf (4E) | Chlorpyrifos | Dow | Dipping bolt | 13.1 fl oz (92.8 g ai) | 1 |
| | | | Foliar | 16 oz | 1 |
| Dylox 80S | Trichlorfon | Bayer | Drench | 3.75 oz | 1 |
| Flagship 0.22G | Thiamethoxam | Syngenta | Top dress | 4.25 g/9 sq ft | 1 |
| | | | | 6 g/pot | 1 |
| Flagship 25WG | Thiamethoxam | Syngenta | Drench | 0.4 oz | 2 |
| | | | | 5 oz | 1 |
| | | | | 8 oz | 8 |

| Product | Active Ingredient(s) | Manufacturer | Application Method & Rate(s) – *per 100 gal water unless otherwise specified* | | # Trials |
|---|---|---|---|---|---|
| | | | | 17 oz | 1 |
| | | | | 24 oz | 1 |
| | | | | 0.18 oz per 1000 sq ft | 1 |
| | | | Foliar | 8 oz | 1 |
| | | | Top dress | 0.09 g /linear foot | 1 |
| | | | | 0.1 g/9 sq ft | 1 |
| | | | Trunk spray | 16 oz/acre | 1 |
| Hachi-Hachi 15SC | Tolfenpyrad | SePro | Foliar | 21 fl oz | 5 |
| | | | | 27 fl oz | 1 |
| | | | | 32 fl oz | 5 |
| Hexacide | Rosemary oil | EcoSmart | Drench | 1.5 qt | 1 |
| IKI-3106 | Cyclaniliprole | ISK | Foliar | 22 fl oz | 2 |
| | | | | 27 fl oz | 2 |
| Kontos | Spirotetramat | OHP | Spray | 3.4 fl oz | 1 |
| Lorsban 4E | Chlorpyrifos | Dow | Dipping bolt | 66.9 fl oz (474 g ai) | 1 |
| | | | | 108.3 fl oz (767.5 g ai) | 1 |
| Lynx | Pyrethrins | Laverlam | Foliar | 16 fl oz | 1 |
| Mach 2 2SC | Halofenozide | Dow | Drench | 2 lb ai/A | 1 |
| | | | | 2.9 fl oz per 1000 sq ft | 1 |
| Marathon | Imidacloprid | OHP | Drench | 20 g per 3000 sq ft | 1 |
| Marathon 1G | Imidacloprid | OHP | Soil incorporation | 0.1 g ai/gal | 1 |
| | | | | 7 g/pot | 1 |
| Marathon II 2F | Imidacloprid | OHP | Drench | 20 g/650 pots | 2 |
| | | | | 20 g/244 pots | 1 |
| MBI-203 DF | *Chromobacterium subtsugae* strain PRAA4-1T | Marrone | Foliar | 1 lb | 4 |
| | | | | 2 lb | 5 |
| | | | | 3 lb | 1 |
| Merit 75 | Imidacloprid | Bayer | Foliar | 10 tsp | 1 |
| | | | Drench | 6.4 oz | 1 |
| Met 52 | *Metarhizium anisopliae* | Novozymes | Drench | 58 oz | 2 |
| | | | Soil incorporation | 20 g / 4 gal media | 1 |
| *Metarhizium anisopliae* Strain F52 | *Metarhizium anisopliae* | Novozymes | Dipping bolt | 1.3 x $10^9$ | 1 |
| | | | | 3.9 x $10^8$ | 1 |
| | | | | 3.9 x $10^9$ | 1 |
| | | | Drench | 2.9 g/pot | 1 |
| | | | | 14.04 cfu/pot | 2 |
| | | | | 28.08 cfu/pot | 2 |
| | | | | 56.16 cfu/ pot | 1 |
| | | | Foliar | 29 fl oz | 3 |
| | | | Soil incorporation | 4.5 x$10^8$ spores/L | 1 |
| | | | | 2.9 g/pot | 1 |
| | | | | 6.25 g/pot | 1 |
| NEI 25925 | Acetamiprid | Cleary | Trunk spray | 4 ml/inch DBH | 1 |
| | | | | | |
| Onyx 2EC | Bifenthrin | FMC | Dipping bolt | 32 oz | 4 |
| | | | | 60 fl oz (212.3 g ai) | 5 |
| | | | Foliar | 6.4 fl oz | 2 |
| | | | | 12.8 fl oz | 7 |
| | | | | 32 fl oz | 1 |
| | | | Trunk spray | 6.4 fl oz | 3 |

| Product | Active Ingredient(s) | Manufacturer | Application Method & Rate(s) – *per 100 gal water unless otherwise specified* | | # Trials |
|---|---|---|---|---|---|
| | | | | 12.8 fl oz | 4 |
| | | | | 16 fl oz | 3 |
| | | | | 32 fl oz | 2 |
| | | | | 102 fl oz | 1 |
| Ornazin | Azadirachtin | SePro | Drench | 10 oz per 100 gal | 1 |
| Orthene | Acephate | Arysta | Drench | 12 oz per 100 gal | 1 |
| Permethrin 2.5 EC | Permethrin | Bonide Products | Foliar | 128 fl oz | 2 |
| Precise G & N | Acephate | Purcell Technologies | Soil incorporation | 6 g product/can | 1 |
| | | | Top Dress | 3 tsp per pot | 2 |
| Preferal | *Isaria fumosoroseus* | SEPro | Foliar | 1 lb | 1 |
| Proclaim | Emamectin benzoate | Syngenta | Dipping bolt | 256 fl oz | 1 |
| Safari 2G | Dinotefuran | Valent | Soil incorporation | 1.23 g/pot | 1 |
| | | | Top dress | 2.2 g/gal media | 3 |
| | | | | 60 g/plant | 1 |
| Safari 20SG | Dinotefuran | Valent | Drench | 12 g/inch DBH | 3 |
| | | | | 12 oz | 4 |
| | | | | 24 oz | 23 |
| | | | | 48 oz | 3 |
| | | | | 6 g/ft shrub height | 1 |
| | | | Foliar | 8 oz | 13 |
| | | | Soil incorporation | 24 oz | 1 |
| | | | Basal spray | 8 oz | 1 |
| | | | Trunk spray | 24 oz | 1 |
| Scimitar GC | Lambda-cyhalothrin | Syngenta | Drench | 60 fl oz | 1 |
| | | | Foliar | 5 fl oz (148 ml) | 2 |
| | | | Trunk spray | 5 fl oz | 1 |
| Sevin XLR 4F | Carbaryl | Bayer | Drench | 6 fl oz/1000 sq ft | 1 |
| Talstar 0.2G | Bifenthrin | FMC | Soil incorporation | 10 ppm | 1 |
| | | | | 25 ppm | 1 |
| | | | | 33.7 g / 4 gal media | 1 |
| Talstar F | Bifenthrin | FMC | Dipping bolt | 32 fl oz | 1 |
| | | | | 35 fl oz (41 g ai) | 1 |
| | | | | 115.7 fl oz (135.3 g ai) | 1 |
| | | | | 183 fl oz (214 g ai) | 1 |
| | | | Drench | 25 fl oz | 1 |
| | | | | 80 fl oz | 1 |
| | | | Foliar | 40 fl oz | 2 |
| | | | Trunk spray | 40 fl oz | 3 |
| Talstar One | Bifenthrin | FMC | Foliar | 21.7 fl oz | 1 |
| Tempo 2 | Cyfluthrin | Bayer | Dipping bolt | 32 fl oz | 1 |
| Thiodan 3EC | Endosulfan | UCPA | Dipping bolt | 15.6 fl oz (83 g ai) | 1 |
| TickEx EC | *Metarhizium anisopliae* | Novozymes | Drench | 21 fl oz | 1 |
| | | | | 29 fl oz | 1 |
| | | | Foliar | 29 fl oz | 5 |
| Tolfenpyrad 15EC | Tolfenpyrad | Nichino | Foliar | 14 fl oz | 1 |
| | | | | 21 fl oz | 5 |
| | | | Soil incorporation | 10 ppm | 1 |

| Product | Active Ingredient(s) | Manufacturer | Application Method & Rate(s) – *per 100 gal water unless otherwise specified* | | # Trials |
|---|---|---|---|---|---|
| | | | Trunk spray | 21 fl oz | 3 |
| | | | | 24 fl oz | 1 |
| TriStar 30SG | Acetamiprid | Cleary | Trunk spray | 4 oz/inch DBH | 1 |
| | | | Foliar | 8 g | 1 |
| TriStar 8.5 SL | Acetamiprid | Cleary | Foliar | 32 fl oz | 1 |
| TriStar 70WSP | Acetamiprid | Cleary | Foliar | 96 g (3.38 oz) | 6 |
| | | | | 8 oz | 2 |
| Venerate | *Burkholderia rinojensis* A*396* | Marrone | Foliar | 1 gal | 1 |
| Xpectro OD | Pythrerins + *Beauveria bassiana* | LAM | Foliar | 25.3 fl oz | 1 |
| | | | | 32 fl oz | 1 |
| XXpire / GF-2860 40WP | spinoteram/sulfoxaflor | Dow | Foliar | 2.75 | 1 |
| | | | | 3.5 oz | 3 |
| | | | | 7 oz | 1 |
| Xytect 2F | Imidacloprid | | Drench | 0.2 fl oz/inch DBH | 1 |

## Results: Foliar Feeding Beetles

### *Comparative Efficacy on Black Vine Weevil Adults (Otiorhynchus sulcatus)*

Black vine weevil (*Otiorhynchus sulcatus*) is a serious pest of ornamental nursery crops (field and container-grown), vineyards, strawberries and hops. Even though, it is suspected the black vine weevil(BVW)originated in northern Europe, it was first identified in North America in 1835 and became a notable pest in Missouri by 1871. It is found predominantly in the northern portions of the United States, but its range extends into Virginia and out to the pacific northwest.

Throughout Asia, Europe, and North America, black vine weeviladults feed on the foliage andlarvae feed on the roots dmaging a tremendousvariety of species, including azalea strawberry, begonia, blackberry, blueberry, and cranberry, cyclamen, euonymus, forsythia, fuchsia, hemlock, impatiens, primrose, rhododendron, sedum and yew (http://www.mortonarb.org/res/CLINIC_pests_BlackVineWeevil.pdf; http://www.entomology.umn.edu/cues/blackvw/blackvh.html).

IR-4 sponsored a single study on adult BVW and several studies on the larvae [See Comparative Efficacy on Black Vine Weevil (Otiorhynchus sulcatus)].

**Nielsen 2006**

In 2007, Nielsentested six products for their residual efficacy in controlling black vine weevil adults on foliage. Five products were applied to yew and one was applied to rhododendron. Foliage of Rhododendron or yew was sprayed August 13, 2007,and then adults were caged with treated leaves at 1, 3, 7, and 13 DAT.After exposure for 72 hours, the number of dead weevils was counted and any moribund adult was moved to untreated foliage and reevaluated 3-days later.

Only the standard Talstar and BAS 320i treatments provided any mortality of adult black vine weevils.Data were similar for all evaluation dates. (Table 2)

No phytotoxicity was observed.

**Table 2. Efficacy of several insecticides forblack vine weevil adults (*Otiorhynchus sulcatus*) on Yew (*Taxussp*.) or Rhododendron (*Rhododendron sp.*), Nielsen, 2007.**

| Treatment[z] | Rate (per 100 gal) | Plant Host | Percent Mortality after 3 day exposure[y] |
|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 oz | Yew | 0 |
| BAS 320i (metaflumizone) | 16 oz | Rhododendron | 100 |
| *Metarhizium* | 29 oz | Yew | 0 |
| Safari 20SG (dinotefuran) | 8 oz | Yew | 0 |
| Talstar F (bifenthrin) | 40 fl oz | Yew | 100 |
| Tolfenpyrad | 21 oz | Yew | 0 |
| Untreated | | Yew | 0 |

[z]Treatments were applied August 13, 2007 and evaluated through 13DAT. Four plants per treatment were used.

[y] Exposed 5 weevils/replicate in plastic cups with treated foliage.

### *Comparative Efficacy on Japanese Beetle Adults (Popillia japonica)*

The Japanese beetle (*Popillia japonica*) is a widespread and destructive exotic pest of turf, landscape, and ornamental plants in the United States. Outside of its native Japan, it is also found in China, Russia, Portugal, and Canada. Since the first detection in the US in a nursery near Riverton, New Jersey in 1916, it has spread to many states east of the Mississippi River, as well as parts of Wisconsin, Minnesota, Iowa, Missouri, Nebraska, Kansas, Arkansas and Oklahoma. Despite regulatory efforts, by 2002 it has become established in at least 30 states. Occasional introductions are made into western states such as California and Oregon when the adult beetles or larvae are shipped in commerce.

The Japanese beetle has a total host range of more than 400 plant species, including turf, ornamentals, fruits, and vegetables. Currently the Japanese beetle is the most widespread pest of turf and costs the turf and ornamental industry approximately $450 million each year in management alone (http://ohioline.osu.edu/hyg-fact/2000/2504.html, http://edis.ifas.ufl.edu/IN630).

IR-4 sponsored several studies on adult JB and a couple studies on the larvae [See Comparative Efficacy on Japanese Beetle Grubs (Popillia japonica)].

From 2006 to 2016, five researchers examined the efficacy of 17 products and unregistered materials for managing Japanese beetle adults. The products tested included Acelepryn, Aloft, BAS 320i, BotaniGard ES, Celero 16WSG, Flagship 25WG, IKI-3106, Onyx 2EC, Precise, Safari 2G, Safari 20SG, Scimitar, Talstar, TickEx EC, Tolfenpyrad, TriStar 70WP and Xpectro. In these experiments, the assessment typically made was percent leaf damaged by adult beetle feeding. Even though Reding (Table 12 and Table 13) and Adesso (Table ) were unable to achieve statistical separation in two experiments, in the nine experiments conducted by Alm, Braman, Davis, and Schultz, there were clear differences in efficacy. As the standard, bifenthrin in Onyx and Talstar, provided good to excellent control. Acelepryn performed well achieving greater than 95% control in five out of seven experiments. Aloft provided good to excellent control in two tests, and BAS 320i, in 2 of 3 tests.

**Table 3. Summary of Japanese Beetle Adult (*Popillia japonica*) Efficacy.**

| Treatment | Rose | Rose | Rose | Rose | Sargent Cherry | Sargent Cherry | Shamrock Linden | Black Pussy Willow | Willow |
|---|---|---|---|---|---|---|---|---|---|
| | **14 DAT** | **14 DAT** | **19 DAT** | **4 DAT** | **19 DAT** | **17 DAT** | **19 DAT** | **2 WAT** | **4 DAT** |
| | **Schultz 2007** | **Alm 2008** | **Braman 2008** | **Davis 2008** | **Alm 2006a** | **Alm 2007** | **Alm 2006b** | **Braman 2006** | **Braman 2007** |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | ++ | | | + | ++ | ++ | ++ | +/- | ++ |
| Aloft (clothianidin+bifenthrin) | | | ++ | + | | | | | |
| BAS 320i (metaflumizone) | ++ | - | ++ | | | | | | |
| Celero 16WSG (clothianidin) | ++ | | | | - | | + | - | +/- |
| Flagship 25WG (thiamethoxam) | | | | + | | | | - | |
| Onyx 2EC (bifenthrin) | | + | ++ | | ++ | ++ | + | | |
| Precise (acephate) | | | | | | | | - | |
| Safari 2G (dinotefuran) | | +/- | | +/- | | | | | |
| Safari 20SG (dinotefuran) | + | | +/- | +/- | - | | +/- | - | +/- |
| Scimitar (lambda-cyhalothrin) | | | | + | | | | + | |
| Talstar F (bifenthrin) | ++ | | ++ | | | | | | |
| TickEx (*Metarhizium anisopliae*) | - (by 28 DAT 100% control was achieved) | - | - | | | | | | - |
| Tolfenpyrad EC | ++ | | - | - | | | | | |
| TriStar 70WP (acetamiprid) | | | | | ++ | | ++ | +/- | + |

[1] Rating Scale: ++ = clearly statistically better than untreated and greater than 95% control; + = statistically better than untreated and between 85 and 95% control; +/- statistically better than untreated with control between 70 and 85%; - = statistically equivalent to untreated and/or efficacy less than 70%.

[2] Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

**Alm 2006**

In 2006, Alm ran two experiments to determine efficacy of five products to control Japanese beetle adults on foliage of Sargent cherry and shamrock linden. In both experiments, foliar applications were made and then a single terminal branch was selected from each plant with the top five treated leaves rated for percent Japanese beetle feeding damage on July 10, July 19, and July 31 (10, 19 and 31 DAT, respectively). The mean percent feeding damage was calculated for the top five leaves. An overall mean percent feeding damage was calculated from four replicates.

For Sargent cherry, there was no statistically significant Japanese beetle feeding damage to any of the treated trees at 10 DAT (Table 4), but by 19 and 31 DAT there was significantly more feeding damage on the untreated and the Safari treated trees than any of the other treatments. Acelepryn, Celero, Onyx, and TriStar 70WP significantly reduced feeding; however, Celero only provided approximately 50% control whereas the other treatments provided 95% control or better.

For shamrock linden, all treatments provided statistically significant control of Japanese beetle feeding by the time trees were rated on10 and 19 DAT (Table 5). When trees were rated on 31 DAT, there was significant feeding damage on the Safari treated trees compared to the other treatments. With the exception of Safari at 31 DAT, all treatments provided 82% control or better based upon percent feeding damage.

No phytotoxicity was observed.

**Table 4.Efficacy of several insecticides for *Popillia japonica* on Sargent Cherry, *Prunus sargentii*, Alm, 2006a.**

| Treatment | Rate per 100 gal | Average Percent Leaf Damage [z] | | |
|---|---|---|---|---|
| | | 10 July 10 DAT | 19 July 19 DAT | 31 July 31 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 0.0 a (100%) | 1.0 bc (98%) | 2.0 c (98%) |
| Celero 16 WSG (clothianidin) | 6 oz | 0.0 a (100%) | 23.0 b (59%) | 40.0 b (50%) |
| Onyx 2EC (bifenthrin) | 12.8 fl oz | 0.0 a (100%) | 2.5 bc (95%) | 2.0 c (98%) |
| Safari 20SG (dinotefuran) + Capsil | 8 oz + 6 fl oz | 2.5 a (0%) | 49.0 a (12%) | 65.0 a (19%) |
| TriStar 70WP (acetamiprid) | 3.38 oz | 0.0 a (100%) | 0.0 c (100%) | 0.0 c (100%) |
| Untreated | | 2.5 a (0%) | 55.5 a (0%) | 80.5 a (0%) |

[z] Means in the same column followed by the same letter are not significantly different, ($P$ = 0.05, LSD test).

**Table 5. Efficacy of several insecticides for Japanese Beetle (*Popillia japonica*) on Shamrock Linden (*Tilia cordata*) 'Bailyei', Alm, 2006b.**

| Treatment | Rate per 100 gal | Average Percent Leaf Damage [z] | | |
|---|---|---|---|---|
| | | 10 July 10 DAT | 19 July 19 DAT | 31 July 31 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 0.5 b (93%) | 0.0 b (100%) | 3.5 c (96%) |
| Celero 16 WSG (clothianidin) | 6 oz | 0.5 b (93%) | 3.5 b (88%) | 14.5 c (82%) |
| Onyx 2EC (bifenthrin) | 12.8 fl oz | 0.0 b (100%) | 3.5 b (88%) | 11.0 c (86%) |
| Safari 20SG (dinotefuran) + Capsil | 8 oz + 6 fl oz | 2.0 b (71%) | 5.0 b (83%) | 41.0 b (48%) |
| TriStar 70WP (acetamiprid) | 3.38 oz | 0.0 b (100%) | 0.0 b (100%) | 0.0 c (100%) |
| Untreated | | 7.0 a (0%) | 29.5 a (0%) | 78.5 a (0%) |

[z] Means in the same column followed by the same letter are not significantly different, ($P$ = 0.05, LSD test).

**Alm 2007**

In 2007, Alm compared the efficacy of Acelepryn with Onyx to control Japanese beetle adults on foliage of Sargent cherry (Table 6). In this experiment, after foliar applications two terminal branches were selected from each plant, and ten treated leaves were rated for percent Japanese beetle feeding damage on July 18, July 27, and August 14 (8, 17 and 34 DAT, respectively). The mean percent feeding damage was calculated for these ten leaves. An overall mean percent feeding damage was calculated from five replicates.

In this experiment, Acelepryn and Onyx significantly reduced Japanese beetle adult feeding by 8 DAT. By 17 DAT, percent control was 91% or greater for all rates of both products. This level of management remained through 34 DAT, the last reading date.

No phytotoxicity was observed.

**Table 6. Efficacy of DPX-E2Y45 and Onyx for Japanese Beetle (*Popillia japonica*) on Sargent Cherry (*Prunus sargentii*), Alm, 2007.**

| Treatment | Rate per 100 gal | Average Percent Leaf Damage (% Control) [z] | | |
|---|---|---|---|---|
| | | 18 July<br>8 DAT | 27 July<br>17 DAT | 14 Aug<br>34 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 2 fl oz | 6.4 b (56%) | 2.3b (94%) | 3.3b (92%) |
| Acelepryn (DPX-E2Y45; chlorantraniliprole) | 4 fl oz | 4.4bc (69%) | 3.4 b (91%) | 4.2b (90%) |
| Acelepryn (DPX-E2Y45; chlorantraniliprole) | 8 fl oz | 2.0c (86%) | 0.7b (98%) | 1.6b (96%) |
| Onyx 2EC (bifenthrin) | 12.8 fl oz | 2.4bc (83%) | 1.9b (95%) | 2.0b (95%) |
| Untreated | | 14.4a (0%) | 39.0a (0%) | 41.3a (0%) |

[z] Means in the same column followed by the same letter are not significantly different, ($P$ = 0.05, LSD test).

**Alm 2008**

In 2008, Alm compared the efficacy of several insecticides to control Japanese beetle adults on foliage of *Rosa*. In this study, BAS 320i, Onyx and Tick-EX were sprayed to runoff while Safari 2G was broadcast on media and watered in. Treatments were evaluated 7 and 14 days after treatment (DAT) by rating percent Japanese beetle feeding damage on the entire plant. An overall mean percent feeding damage was calculated from seven replicates.

Onyx and Safari treatments significantly prevented feeding damage by Japanese beetle adults (Table 7). At 7 and 14 DAT, percent control was 94-96 % from Onyx and 84-86 % from Safari. BAS 320i and Tick-EX significantly reduced feeding damage but not at a commercially acceptable level.

No phytotoxicity was observed.

**Table 7. Efficacy of BAS 320i, Onyx, Safari and Tick-EX for Japanese Beetle (*Popillia japonica*) on *Rosa* sp., Alm, 2008.**

| Treatment | Rate per 100 gal | Average Percent Leaf Damage (% Control) [z] | |
|---|---|---|---|
| | | 7 DAT | 14 DAT |
| BAS 320i (metaflumizone) | 16 fl oz | 33.6 b (45) | 35.7 b (43) |
| Onyx 2EC (bifenthrin) | 6.4 fl oz | 2.7 c (96) | 3.7 c (94) |
| Safari 2G (dinotefuran) | 60 g/plant | 8.6 c (86) | 10.0 c (84) |
| Tick-EX EC[a] | 29 fl oz | 37.9 b (38) | 40.0 b (36) |
| Untreated | | 61.4 a (0) | 62.9 a (0) |

[a]*Metarhizium anisopliae* strain F52

[z] Means in the same column followed by the same letter are not significantly different, ($P$ = 0.05, LSD test).

**Braman 2006**

In 2006, Braman compared seven treatments for the impact on the number of Japanese beetles on black pussy willows and the percent defoliation. Plants were sprayed on June 13, 2006 and arranged in an area with historically heavy Japanese beetle populations in southeastern Spalding County, GA. Beetle density was recorded at one week, two weeks, and one month post application (1, 2, and 4 WAT, respectively).A final damage (% defoliation) assessment was made one month after application.All data were subjected to analysis of variance using the GLM procedure of SAS and means were separated using LSD.

In this test, the Japanese beetle pressure was high. Within one week beetle density varied by treatment, with Scimitar, Flagship, TriStar and Acelepryn providing significant reductions relative to the untreated control (Table 8).Celero, Safari and Precise were statistically similar to the untreated control 1 WAT. At two weeks post treatment all except Safari had significantly reduced beetle densities relative to the control. Defoliation was reduced in all treatments relative to the control and was least on plants treated with Scimitar, Precise, TriStar or Acelepryn.

Throughout the experiment, no phytotoxicity was observed. At the completion of the study, there was no discernable difference in growth among the treatments (data not shown).

**Braman 2007**

In 2007, Braman compared five treatments for efficacy on Japanese beetle adults on willow. In this experiment, 5 adult beetles were caged on treated foliage using nylon screen bags; at 1 and 4 days after exposure (6 and 9 DAT), the number of surviving beetles were counted, and at Day 4foliar feeding was estimated as percent feeding damage.Data were subjected to analysis of variance using the GLM procedure of SAS and mean separation is by LSD.

Beetle survival was high for all treatments one day after caging on the willows (Table 9). After 4 days, however, survival was significantly reduced in all but the Tick Ex cages. Fewest beetles survived in the Acelepryn treatment. TriStar and Acelepryn provided the best reduction in damage.

**Table 8. Efficacy of several insecticides for *Popillia japonica* on black pussy willows, *Salix gracilistyla* 'Melanostachys', Braman, 2006.**

| Treatment | Rate per 100 gal | Mean no. Beetles per plant [z] | | | Mean % defoliation 4 WAT |
|---|---|---|---|---|---|
| | | 1 WAT | 2 WAT | 4 WAT | |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 oz | 3.8 bc (83) | 6.3 cd (77) | 0.0 b (100) | 20.5 cd |
| Celero 16WSG (clothianidin) | 4 oz | 15.6 ab (28) | 16.1 bc (41) | 0.0 b (100) | 44.5 b |
| Flagship 25WG (thiamethoxam) | 8 oz | 5.9 bc (73) | 12.6 bcd (54) | 0.0 b (100) | 29.0 c |
| Precise (acephate) | 3 tsp/pot | 22.4 a (0) | 11.5 bcd (58) | 0.0 b (100) | 18.5 cd |
| Safari 20SG (dinotefuran) | 8 oz | 14.4 abc (34) | 21.1 ab (22) | 0.0 b (100) | 44.5 b |
| Scimitar (lambda-cyhalothrin) | 5 oz | 0.4 c (98) | 2.9 d (89) | 0.0 b (100) | 18.5 cd |
| Tristar 70WSP (acetamiprid) | 96 g | 1.3 bc (94) | 5.1 d (81) | 0.0 b (100) | 14.5 d |
| Untreated | | 21.8 a (0) | 27.1 a (0) | 0.3 a (0) | 61.0 a |

[z] Means followed by the same letter are not significantly different, P> 0.05

**Table 9. Efficacy of several insecticides for *Popillia japonica* adults feeding on willow leaves, *Salix hakuro nishiki*, Braman, 2007.**

| Treatment [z] | Rate | Survival (5 adult beetles caged on leaves)[y] | | Percent Damage Day 4 (9 DAT) |
|---|---|---|---|---|
| | | Day 1 (6 DAT) | Day 4 (9 DAT) | |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 oz/100 gal | 4.40 a | 1.56 c | 1.44 d |
| Celero 16WSG (clothianidin) | 4 oz/100 gal | 4.29 a | 2.30 bc | 21.10 b |
| Safari 20SG (dinotefuran) | 8 oz/100 gal | 4.56 a | 2.70 b | 17.20 bc |
| Tick Ex EC *(Metarhizium anisopliae)* | 29 oz/100 gal | 4.86 a | 4.40 a | 57.50 a |
| Tristar 70WSP (acetamiprid) | 96 g/100 gal | 4.50 a | 2.50 bc | 4.90 cd |
| Untreated | | 4.56 a | 4.40 a | 56.00 a |

[z] Treatments were applied on July 17, 2007.

[y] Means followed by the same letter are not significantly different, P> 0.05

**Braman 2008**

In 2008, Braman compared eight treatments for efficacy on Japanese beetle adults on rose. In this experiment, 5 adult beetles were caged on treated foliage using BugDorm insect rearing sleeves. At 7 and 19 days after treatment and caging (7 and 19 DAT), the number of surviving beetles were counted, and at Day 19total damage was recorded using a rating scale from 0 to 10, with 0= no damage and 10= 100% defoliation.Data were subjected to analysis of variance using the GLM procedure of SAS and means were separated using LSD.

Acelepryn, Aloft, BAS 320i,Onyx and Talstarprovided excellent control of Japanese beetle adults, based on number of survival at 7 and 19 DAT (Table 10). This resulted in virtually no defoliation on roses treated with these products. Safari provided significant but less effective control. Tolfenpyrad showed essentially similar beetle survival as the untreated but significantly reduced leaf feeding damage. Tick-Ex was non-effective, showing beetle survival and feeding damage similar to the untreated check.

**Table 10. Efficacy of several insecticides for *Popillia japonica*adults feeding on rose (*Rosa sp.*) 'Blushing', Braman, 2008.**

| Product | Rate per 100 gal | No. feeding beetles 7 DAT | No. living beetles 19 DAT | Leaf DamageRating[a] 19 DAT |
|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 0.4 c | 0 b | 0.1 c |
| Aloft (clothianidin+bifenthrin) | 8 fl oz | 0 c | 0 b | 0 c |
| BAS 320i (metaflumizone) | 16 fl oz | 0 c | 0 b | 0 c |
| Onyx (bifenthrin) | 12.8 fl oz | 0.2 c | 0 b | 0 c |
| Safari 20SG (dinotefuran) | 8 oz | 0.8 bc | 0.8 b | 1.0 c |
| Talstar One (bifenthrin) | 21.7 fl oz | 0 c | 0 b | 0 c |
| Tick-Ex (*Metarrizium anisophliae*) | 29 oz | 1.4 ab | 2.0 a | 4.8 a |
| Tolfenpyrad | 21 fl oz | 1.4 ab | 2.4 a | 3.6 b |
| Untreated | | 2.0 a | 2.2 a | 5.0 a |

[z] Means followed by the same letter are not significantly different, P> 0.05
[a]Rating: 1 = 10 % defoliation, 10 = 100 % defoliation.

**Davis 2009**

In 2009, Davis initiated an outdoor aseesment of products on the feeding of Japanese beetle adults. Container roses were positioned next to a planting of Linden where JB adults were present in previous years. At no time were there any differences between any of the treatments or the untreated check on any of the sample days while the plants were in the field.This is primarily due to the low numbers of JB adults in the area and the number of other suitable hosts nearby.

To enable usable data to be generated, treated leaves were placed into arenas and the amount of leaf tissue consumed by adult JB was measured. At 3 days after the arenas were set-up, the Acelepryn, Safari drench, Safari and Tolfenpyrad treatments were not significantly different from the untreated check. The number of adults left alive in the arenas was significantly different from the untreated check in the BAS 320i, Flagship drench and Scimitar treatments.The arenas were evaluated again the next day.Mortality had increased in all of the treatments.All of the treatments except for Safari and Tolfenpyrad were significantly different from the untreated check treatment.The 3 applications of BAS 320i, 3 applications of Scimitar and single drench application of Flagship were the superior treatments.Four days after the arenas were set-up, the untreated check had 35% of the foliage in the arena consumed.All of the treatments were significantly different from the untreated check with regards to amount of foliage consumed.The Flagship and Scimitar treatments protected the foliage the best.

**Table 11. Efficacy of several insecticides on Japanese beetle adults feeding on rose, Davis, 2009.**

| Treatment | Rate | Application Type | Lab assay 5 JB initial,after 3 days | % Skeletonized after 3 days | Lab assay 5 JB initial,after 4 days | % Skeletonized after 4 days |
|---|---|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz/100 gal | foliar | 2.86b | 9.29b | 1.57 ab | 9.29b |
| BAS 320i 22% liquid (metaflumizone) | 16 fl oz/100 gal | foliar | 1.72 a | 9.29b | 1.00 ab | 9.29b |
| Flagship 25WG (thiamethoxam) | 24 oz/100 gal - 43 oz soln/gal/media | drench | 1.57 a | 3.71 a | 1.00 ab | 2.86 a |
| Safari 20SG (dinotefuran) | 24 oz/100 gal - 4 oz soln/gal/media | drench | 2.86b | 6.43 a | 2.00bc | 7.86b |
| Safari 2G (dinotefuran) | 2.2 g/gal/media | top of potting soil | 3.72b | 5.00 ab | 3.00cd | 5.71 ab |
| Scimitar CS | 5 fl oz/100 gal | foliar | 1.72 a | 5.00 ab | 0.86 a | 5.00 ab |
| Tolfenpyrad 15EC & adjuvant (tolfenpyrad) | 21 fl oz/100 gal & 0.25% v/v | foliar | 4.00b | 17.86c | 3.71d | 19.29c |
| Untreated | | | 4.00 b | 26.43 c | 3.86 d | 35.00 d |

**Reding 2006**

In this experiment,four products (Acelepryn, Celero, Safari, and Tristar) were tested in a no choice feeding bioassay along with a greenhouse study. Leaves were collected 7 days after application, and stems were inserted into water soaked oasis cubes and placed into lidded containers with two Japanese beetle adults per leaf sample. Leaf area measurements were taken after 12 days of feeding. There was no mortality during the trial. Square centimeters consumed were compared using analysis of variance (ANOVA) with no differences found between treatments (Table 12).

In addition to running a bioassay, insect counts and feeding damage were recorded two weeks after Japanese beetles were observed feeding on test plants or 17 days after treatment (17 DAT). Insect counts did not prove to be a good source of efficacy data due to the continual flight of adults during the counting process. Percent of leaves damaged from feeding and leaves with more than 25% of the leaf eaten were compared using analysis of variance (ANOVA) with no differences found between treatments (Table 12).

Throughout the experiment, no phytotoxicity was observed. All plants were marketable at the completion of the study, and there was no discernable difference in growth among the treatments.

**Table 12. Efficacy of several insecticides for *Popillia japonica* adults on Hibiscus, *Hibiscus syriacus*, Reding, 2006.**

| Treatment | Rate (per 100 gal) | Mean leaf area removed in Feeding Bioassay | Feeding Data | |
|---|---|---|---|---|
| | | | % Leaves with Damage | % Leaves with >25% Leaf Area Removed |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 47.9 oz | 1.91 | 34.7 | 10.4 |
| Celero 16WSG (clothianidin) | 4 oz | 1.49 | 38.9 | 7.5 |
| Safari 20SG (dinotefuran) | 8 oz | 1.24 | 32.9 | 4.6 |
| Tristar 70WSP (acetamiprid) | 96 g | 1.17 | 34.6 | 5.7 |
| Untreated | | 0.88 | 36.2 | 5.0 |

**Reding 2007**

In this experiment, four products were tested to assess efficacy: Acelepryn, BAS 320i, Celero, and TickEx. Feeding damage on leaves was recorded in the field 7 and 14 days after first treatment and 14 days after second treatment for leaves. There were differences in severity of damage between treatments for leaf feeding (Table 13. Efficacy of several insecticides for *Popillia japonica* adults on Hibiscus, *Hibiscus syriacus*, Reding, 2007.Table 13) with BAS 320i, and Tick Ex demonstrating significantly higher damage than the untreated control. Acelepryn and Celero 16WSG were equivalent to the untreated control. Flower numbers were recorded (7 and 14 days after second treatment) rather than flower damage because when Japanese beetles feed on flowers they become so severely damaged that they fall from the plant and cannot be accurately counted. Comparing the difference in number of blooms was a more accurate method to evaluate efficacy. Some treatments had a larger number of hibiscus flowers than untreated plants but were not statistically significant (Table 13).

No phytotoxicity was detected on any of the insecticide treated plants.

**Table 13. Efficacy of several insecticides for *Popillia japonica* adults on Hibiscus, *Hibiscus syriacus*, Reding, 2007.**

| Treatment[z] | Rate per 100 gal | Percent Leaves Damaged[y] | | | Mean Number of Blossoms | |
|---|---|---|---|---|---|---|
| | | 7 DAT | 14 DAT | 28 DAT | 21 DAT | 28 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 9.7 | 11.8a | 9.5a | 40.5 | 57.7 |
| BAS 320i (metaflumizone) | 4.5 oz | 13.4 | 21.1c | 16.8c | 68.4 | 79.4 |
| Celero 16 WSG (clothianidin) | 4 oz | 11.0 | 13.9ab | 12.6abc | 55.7 | 70.7 |
| Tick Ex EC *(Metarhizium anisopliae)* | 29 oz | 17.4 | 17.4bc | 14.7bc | 65.8 | 80.6 |
| Untreated | | 11.7 | 12.5a | 11.5ab | 47.8 | 58.5 |

[z]Treatments were applied as foliar sprays on 7/10/2007 and 7/30/2007

[y]Means within columns followed by the same letter are not significantly different ANOVA ($P$ = 0.05), means separated by LSD ($\alpha$ = 0.05).

**Schultz 2007**

In this experiment, Schultz examined Acelepryn, BAS 320i, bifenthrin, Celero, Metarhizium, Safari SG, and tolfenpyrad for their ability to control Japanese beetle adults on rose. Applications were made either June 25th or 28th as foliar sprays or drenches (Table 14). After foliage had dried (and one week after the Safari drench), 10 Japanese beetle adults were introduced into a mesh cage on a single branch.Mortality was assessed weekly (7, 14, and 21 DAT). After the 21 DAT counts, dead and remaining live beetles were removed, mesh bags were relocated on the plant, and new adults introduced. Mortality of the newly introduced beetles was taken for 7 and 14 days after introduction (28 and 35 DAT).

At 7 DAT all treatments, except Safari applied as a drench and Tick Ex, had significantly higher adult mortality for caged beetles than the untreated plants. At 7 DAT, Acelepryn and BAS320i had 100% mortality 7 DAT.By 14 DAT, Bifenthrin and Celero also exhibited 100% mortality. At 21 DAT, Safari and tolfenpyrad reached 100% mortality.

There was a high background population of beetles, and observations were taken on their feeding. Throughout the experiment roses treated with Acelepryn, bifenthrin, BAS 320i Celero, and Safari SG sustained no damage to the foliage regardless of adult beetle mortality. Foliage in the other treatments (*Metarhizium*, tolfenpyrad, and untreated check) did exhibit foliar damage.

**Addesso 2016**

In this experiment, Addesso examined BotaniGard ES, IKI-3106,  Tristar SL, and Xpectro OD applied as foliar sprays for their ability to control Japanese beetle adults on crape myrtle. Treatments were applied on Jul 15 and all, except Botanigard, reapplied on Jul 29. Adult Japanese beetles were released onto plants and a PEG lure was deployed at the center of the container pad to draw beetles into the plot from nearby fields. Beetles were free to migrate into and out of the plot at will.

Adult live counts were too low to analyze by day and were pooled across all observations for statistical analysis. No significant differences were observed in either live of dead beetles across treatments. Percent defoliation was recorded at DAT 3, 7, 14, 21 or 28. No differences in defoliation were observed due to large variation between treatment ratings.

No phytotoxicity was observed on any of the plants in any of the treatments.

**Table 14. Efficacy of several insecticides for *Popillia japonica* adults on 'Julia Child TM. Butter Gold' Rose, Schultz, 2007.**

| Treatment | Rate per 100 gal | Mean Number Dead Beetles per Cage (Corrected Percent Control) | | | | | |
|---|---|---|---|---|---|---|---|
| | | First Challenge (after foliar applications had dried) | | | | Second Challenge | |
| | | 0 DAT | 7 DAT | 14 DAT | 21 DAT | 28 DAT | 35 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Foliar – 10 fl oz | 3.6 b (34%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) | 8.3 b (81%) | 10.0 a (100%) |
| BAS 320i (metaflumizone) | Foliar – 16 oz | 1.1 c (8%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) | 1.5 c (6%) | 10.0 a (100%) |
| Celero 16WSG (clothianidin) | Foliar – 4 oz | 5.8 a (57%) | 9.8 a (98%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) |
| Onyx (bifenthrin) | Foliar – ** | 5.6 a (55%) | 6.9 b (68%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) |
| Safari 20SG (dinotefuran) | Drench – 24 oz | -- | 1.3 c (10%) | 9.5 a (94%) | 10.0 a (100%) | 10.0 a (100%) | 10.0 a (100%) |
| Tick Ex EC *(Metarhizium anisopliae)* | Foliar – 29 oz | 0.4 c (1%) | 0.5 c (2%) | 2.5 b (10%) | 9.1 a (74%) | 9.9 a (99%) | 9.9 a (99%) |
| Tolfenpyrad | Foliar – 14 oz | 2.1 bc (19%) | 7.4 b (73%) | 9.6 a (95%) | 10.0 a (100%) | 9.0 ab (89%) | 9.6 a (95%) |
| Untreated | | 0.3 c (0%) | 0.3 c (0%) | 1.7 c (0%) | 6.6 b (0%) | 1.0 c (0%) | 1.4 b (0%) |

** no rate provided in report so the high label rate of 12.8 fl oz per 100 gal was assumed.

**Table 15. Efficacy of several insecticides for *Popillia japonica* adults on 'Pink Velour' crape myrtle, *Lagerstroemia indica,* Addesso, 2016.**

| **Treatment** | **Rate per 100 gal** | **Number of Beetles** | | **Percent Leaf Damage** | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Live** | **Dead** | **Day 3** | **Day 7** | **Day 14** | **Day 21** | **Day 28** |
| BotaniGard ES (*Beauveria bassiana*) | 32 fl oz | 1 | 5 | 2.82 | 5.68 | 4.01 | 3.28 | 1.23 |
| IKI-3106 (cyclaniliprole) | 22 fl oz | 0 | 7 | 1.38 | 2.57 | 2.73 | 2.39 | 2.58 |
| IKI-3106 (cyclaniliprole) | 27 fl oz | 1 | 11 | 2.20 | 8.58 | 2.35 | 3.36 | 3.40 |
| Tristar 8.5 SL (acetamiprid) | 32 fl oz | 0 | 15 | 1.84 | 3.30 | 1.13 | 0.56 | 1.07 |
| Xpectro OD (Pythrerins + *Beauveria bassiana*) | 25.3 fl oz | 0 | 8 | 1.46 | 3.95 | 3.61 | 4.07 | 3.35 |
| Untreated | - | 0 | 5 | 2.53 | 2.69 | 2.58 | 2.58 | 1.20 |
| | | ns | ns | ns | ns | ns | ns | ns |

### *Comparative Efficacy on Viburnum Leaf Beetle (Pyrrhalta viburni)*

Viburnum leaf beetle is native to Europe and Asia and was first detected in North America in 1947 in Ontario, Canada. Since 1978 when breeding populations were discovered in the Ottawa/Hull region of Canada, viburnum leaf beetle has slowly spread south and was found in Maine in 1994 and in New York in 1996. Currently, it has been found as far south as Pennsylvania and Ohio. Viburnum leaf beetle feeds exclusively on viburnum species. The most susceptible include arrowwood viburnum (*V. dentatum*), European cranberry bush viburnum (*Viburnum opulus*), Rafinesque viburnum (*V. rafinesquianum*), and Sargent viburnum (*V. sargentii*). It will also feed on wayfaring tree viburnum (*V. lantana*), nannyberry viburnum (*V. lentago*), blackhaw viburnum (*V. prunifolium*) and several other species (http://creatures.ifas.ufl.edu/orn/beetles/viburnum_leaf_beetle.htm).

In the series of experiments presented here, most tested products reduced viburnum leaf beetle populations and feeding damage. The best consistently performing products in these three experiments were BAS 320i, Celero, and Safari. See the individual reports below for more information.

**Costa 2006**

In this experiment, Costa examined 5 products for efficacy of Viburnum leaf beetle larvae. Treatments were applied on May 16 to runoff using a handheld, pump sprayer with a second TriStar treatment made on June 13. The extent (percentage of affected leaves) and severity (percentage area affected on damaged leaves) of leaf feeding by larvae were assessed at 2, 7, 14, and 28 DAT by visually inspecting each plant and rating damage on a scale ranging from 1– 10.

By 2 DAT, no live larvae were detected outside of plants in the water control. By 14 DAT all insecticide treatments had significantly less feeding damage than the water-treated control (Table 16, Table 17). None of the treatments varied significantly from each other. The second application of Tristar was made according an industry-prescribed protocol and was not necessary for larval control. All chemical insecticide treatments provided effective control of VLB larvae.

No phytotoxicity was observed.

**Table 16. Efficacy of several insecticides for Viburnum Leaf Beetle (*Pyrrhalta viburni*) larval management on Arrowwood viburnum (*Viburnum dentatum*) – Defoliation Severity, Costa, 2006.**

| Treatment | Rate per 100 gal | Defoliation Severity Rating Relative Area[z] | | | |
|---|---|---|---|---|---|
| | | 2 DAT | 7 DAT | 14 DAT[y] | 28 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 16 fl oz | 2.2 | 3.0 | 3.8* | 2.8* |
| Celero 16WSG (clothianidin) | 4 oz | 2.6 | 3.4 | 3.4* | 3.0* |
| Permethrin 2.5EC | 128 fl oz | 2.4 | 3.0 | 3.8* | 3.2* |
| Safari 20SG (dinotefuran) | 8 oz | 2.8 | 3.4 | 3.8* | 3.4* |
| TriStar 70WSP (acetamiprid) + Cohere | 96 g + 0.125% | 2.8 | 3.4 | 4.2* | 3.4* |
| Untreated | | 2.8 | 5.6 | 6.2 | 7.0 |

[z]The severity of larval feeding post treatment as determined by qualitative rating of relative area affected on damaged leaves.Scale 1-10 is for 0 to 100%(1=0, 2=1-5, 3=6-15, 4=16-30, 5=31-50, 6=51-70, 7=71-85, 8=86-95, 9=96-99, 10=100% affected).

[y]An '*' indicates a significant difference between insecticide treatments and the water treated control (alpha = 0.05; one sided Dunnett's after GLM). There were no significant differences among insecticide treatments (P>0.05, GLM-ANOVA).

**Table 17. Efficacy of several insecticides for Viburnum Leaf Beetle (*Pyrrhalta viburni*) larval management on Arrowwood viburnum (*Viburnum dentatum*) – Defoliation Extent, Costa, 2006.**

| Treatment | Rate per 100 gal | Defoliation Extent Rating [z] | | | |
|---|---|---|---|---|---|
| | | 2 DAT | 7 DAT | 14 DAT [y] | 28 DAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 16 fl oz | 2.8 | 3.2 | 4.2* | 2.6* |
| Celero 16WSG (clothianidin) | 4 oz | 3.0 | 3.4 | 3.8* | 2.8* |
| Permethrin 2.5EC | 128 fl oz | 3.0 | 3.8 | 4.4* | 3.2* |
| Safari 20SG (dinotefuran) | 8 oz | 3.0 | 3.6 | 4.2* | 3.2* |
| TriStar 70WSP (acetamiprid) + Cohere | 96 g + 0.125% | 3.2 | 3.8 | 5.0* | 3.4* |
| Untreated | | 3.6 | 4.4 | 6.6 | 7.0 |

[z]The extent of larval feeding post treatment as determined by qualitative rating of percentage of affected leaves.Scale 1-10 is for 0 to 100%(1=0, 2=1-5, 3=6-15, 4=16-30, 5=31-50, 6=51-70, 7=71-85, 8=86-95, 9=96-99, 10=100% affected).

[y]An '*' indicates a significant difference between insecticide treatments and the water treated control (alpha = 0.05; one sided Dunnett's after GLM). There were no significant differences among insecticide treatments (P>0.05, GLM-ANOVA).

**Costa 2007**

In this experiment, Costa examined 8 products for efficacy of Viburnum leaf beetle larvae. All products except Safari 2G were applied as foliar sprays. Safari 2G was broadcast by hand around the plant base.

By 7 DAT, Viburnum plants treated with Acelepryn, BAS 320i, Celero, Permethrin, Safari, and Tolfenpyrad exhibited significantly less feeding damage than the untreated plants (Table 18). Throughout this experiment Met 52 was equivalent to the untreated. Safari 2G did reduce feeding damage at 14 DAT. While most products reduced severity of feeding, the extent of defoliation was only reduced by BAS 320i and Safari through 14 DAT (Table 19). By 28 DAT, these two products plus Celero, Permethrin and Tolfenpyrad reduced defoliation as compared to the untreated plants.

**Table 18. Efficacy of several insecticides for Viburnum Leaf Beetle (*Pyrrhalta viburni*) larval management on Arrowwood viburnum (Viburnum dentatum) – Defoliation Severity, Costa, 2007.**

| Treatment | Rate per 100 gal | Defoliation Severity Rating (±SE) Relative Area[z] | | | |
|---|---|---|---|---|---|
| | | Pre-Trt [y] | Week 1 [x] | Week 2 | Week 4 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 5.2 (0.2) | 4.6 (0.2)* | 4.6 (0.2)* | 4.4 (0.2)* |
| BAS 320i (metaflumizone) | 16 oz | 3.6 (0.4) | 4.2 (0.5)* | 4.4 (0.2)* | 4.2 (0.2)* |
| Celero 16WSG (clothianidin) | 4 oz | 4.2 (0.4) | 4.2 (0.2)* | 4.4 (0.2)* | 4.4 (0.2)* |
| *Metarhizium anisopliae* (Strain F52) | 29 oz | 4.6 (0.2) | 6.6 (0.5) | 6.4 (0.5) | 5.8 (0.4) |
| Permethrin 2.5EC | 128 fl oz | 4.0 (0.5) | 4.2 (0.2)* | 4.4 (0.2)* | 4.0 (0.3)* |
| Safari 2G (dinotefuran) | 2.2 g/gal potting media | 4.8 (0.6) | 5.5 (0.9) | 5.0 (0.4)* | 5.0 (0.6) |
| Safari 20SG (dinotefuran) | 8 oz | 4.0 (0.0) | 4.5 (0.3)* | 4.5 (0.3)* | 4.3 (0.5)* |
| Tolfenpyrad EC | 21 fl oz | 3.5 (0.3) | 4.0 (0.0)* | 4.3 (0.3)* | 4.5 (0.5) |
| Untreated | | 4.8 (0.6) | 6.2 (0.0) | 6.4 (0.5) | 5.8 (0.5) |

[z] The severity of larval feeding post treatment as determined by qualitative rating of relative area affected on damaged leaves. Scale 1-10 is for 0 to 100%(1=0, 2=1-5, 3=6-15, 4=16-30, 5=31-50, 6=51-70, 7=71-85, 8=86-95, 9=96-99, 10=100% affected).

[y] Pre-treatment (Pre-Trt) ratings were taken the day applications were made.

[x] An '*' indicates a significant difference between insecticide treatments and the water treated control (alpha = 0.05; one sided Dunnett's after GLM). There were no significant differences among insecticide treatments (P>0.05, GLM-ANOVA).

**Table 19. Efficacy of several insecticides for Viburnum Leaf Beetle (*Pyrrhalta viburni*) larval management on Arrowwood viburnum (Viburnum dentatum) – Defoliation Extent, Costa, 2007.**

| Treatment | Rate per 100 gal | Defoliation Extent Rating (±SE)[z] | | | |
|---|---|---|---|---|---|
| | | Pre-Trt [y] | Week 1 [x] | Week 2 | Week 4 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 5.8 (0.2) | 7.0 (0.6) | 6.6 (0.6) | 5.8 (0.6) |
| BAS 320i (metaflumizone) | 16 oz | 5.0 (0.6) | 4.8 (0.7)* | 4.8 (0.4)* | 4.2 (0.4)* |
| Celero 16WSG (clothianidin) | 4 oz | 5.0 (0.5) | 5.4 (0.7) | 6.0 (0.7) | 4.8 (0.6)* |
| *Metarhizium anisopliae* (Strain F52) | 29 oz | 5.4 (0.2) | 7.2 (0.6) | 7.4 (0.2) | 7.2 (0.4) |
| Permethrin | 128 fl oz | 5.4 (0.5) | 5.2 (0.7) | 5.6 (0.7) | 4.6 (0.4)* |
| Safari 2G (dinotefuran) | 2.2 g/gal potting media | 5.5 (0.7) | 6.3 (1.4) | 6.0 (0.9) | 5.8 (0.8) |
| Safari 20SG (dinotefuran) | 8 oz | 4.8 (0.5) | 5.0 (0.7)* | 4.8 (0.9)* | 4.3 (0.8)* |
| Tolfenpyrad EC | 21 fl oz | 4.5 (0.3) | 4.5 (0.7) | 5.3 (0.9) | 4.5 (0.7)* |
| Untreated | | 6.0 (0.6) | 7.4 (1.1) | 7.6 (0.8) | 7.0 (0.8) |

[z]The extent of larval feeding post treatment as determined by qualitative rating of percentage of affected leaves. Scale 1-10 is for 0 to 100%(1=0, 2=1-5, 3=6-15, 4=16-30, 5=31-50, 6=51-70, 7=71-85, 8=86-95, 9=96-99, 10=100% affected).

[y] Pre-treatment (Pre-Trt) ratings were taken the day applications were made.

[x] An '*' indicates a significant difference between insecticide treatments and the water treated control (alpha = 0.05; one sided Dunnett's after GLM). There were no significant differences among insecticide treatments (P>0.05, GLM-ANOVA).

**Holmes 2007**

During 2007, Holmes generated Viburnum leaf beetleefficacy data for chlorantraniliprole and thia methoxam. Several rate range experiments were conducted with Actara (the Canadian trade name for Flagship 25WG) and Rynoxapyr (the food use trade name for Acelepryn). The trade names within the US are used to summarize the information and in the data tables (Table 20- Table 23).

Four experiments were conducted simultaneously; two each for each product. Prior to application, each plant was assessed for a minimum level of hatched larvae. Crop tolerance and efficacy ratings were done at 7, 12, 35 and 61days after treatment on June 13, 2007. In the first experiment with Flagship (Table 20), all of the treatments had significantly less foliar damage than the untreated check through 35 DAT. At the final rating date, Conserve-treated plants exhibited the same amount of foliar feeding damage as the untreated plants, while all rates of Flagship were significantly lower than the untreated but not Conserve. In other words, control was beginning to break approximately 2 months after treatment. However in the second experiment (Table 21), Conserve and all three rates of Flagship provided excellent control through 2 months, albeit with a slightly lower infestation pressure.

In both experiments testing Acelepryn (Table 22 and Table 23), Acelepryn at all three tested rates provided great efficacy equivalent to Conserve through 2 months.

None of the treatments resulted in any phytotoxicity symptoms.

**Table 20. Foliar damage due to Viburnum Leaf Beetle on *Viburnum trilobum* treated with thiamethoxam (ACTARA 25WG) Experiment 1, Holmes, 2007 a**

| Treatment | Rate | Foliar Damage (Percent) | | | |
|---|---|---|---|---|---|
| | | 7 DAT | 12 DAT | 35 DAT | 61 DAT |
| Conserve | 50 ml /1000L | 5.8 b | 7.5 b | 5.0 b | 10.0 ab |
| Flagship (Actara) 25 WG (thiamethoxam) | 0.28 kg/ha | 6.3 b | 6.3 b | 21.3 a | 8.0 b |
| | 0.56 kg/ha | 6.3 b | 5.5 b | 5.0 b | 5.5 b |
| | 1.12 kg/ha | 4.5 b | 5.0 b | 5.0 b | 4.3 b |
| Untreated | | 16.3 a | 18.8 a | 23.8 a | 21.3 a |

Initial application occurred on June 13, 2007.
Means followed by same letter do not significantly differ (p = 0.05, Tukey.s HSD).

**Table 21. Foliar damage due to Viburnum Leaf Beetle on *Viburnum trilobum* treated with thiamethoxam (ACTARA 25WG) Experiment 2, Holmes, 2007 b**

| Treatment | Rate | Foliar Damage (Percent) | | | |
|---|---|---|---|---|---|
| | | 7 DAT | 12 DAT | 35 DAT | 61 DAT |
| Conserve | 50 ml /1000L | 1.5 b | 1.3 b | 2.8 b | 0.5 b |
| Flagship (Actara) 25 WG (thiamethoxam) | 0.28 kg/ha | 1.0 b | 1.3 b | 2.0 b | 0.5 b |
| | 0.56 kg/ha | 2.0 b | 1.5 b | 2.8 b | 0.5 b |
| | 1.12 kg/ha | 1.0 b | 1.0 b | 2.0 b | 0.5 b |
| Untreated | | 8.8 a | 10.0 a | 12.5 a | 6.8 a |

Initial application occurred on June 13, 2007.
Means followed by same letter do not significantly differ (p = 0.05, Tukey's HSD).

**Table 22. Foliar damage due to Viburnum Leaf Beetle on *Viburnum trilobum* treated with Rynaxapyr (DPX 2EY45 20SC) Experiment 1, Holmes, 2007 a**

| Treatment | Rate | Foliar Damage (Percent) | | | |
|---|---|---|---|---|---|
| | | 8 DAT | 13 DAT | 36 DAT | 62 DAT |
| Conserve | 50 ml /1000L | 5.8 b | 5.0 b | 5.0 b | 2.8 b |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.28 kg/ha | 7.0 b | 7.5 b | 8.8 b | 8.8 b |
| | 0.56 kg/ha | 5.3 b | 5.5 b | 5.0 b | 2.0 b |
| | 1.12 kg/ha | 4.5 b | 5.0 b | 5.0 b | 3.5 b |
| Untreated | | 21.3 a | 35.0 a | 83.8 a | 22.5 a |

Initial application occurred on June 13, 2007.
Means followed by same letter do not significantly differ (p = 0.05, Tukey's HSD).

**Table 23. Foliar damage due to Viburnum Leaf Beetle on *Viburnum trilobum* treated with Rynaxapyr (DPX 2EY45 20SC) Experiment 2, Holmes, 2007 b**

| Treatment | Rate | Foliar Damage (Percent) | | | |
|---|---|---|---|---|---|
| | | 8 DAT | 13 DAT | 36 DAT | 62 DAT |
| Conserve | 50 ml /1000L | 1.5 b | 1.3 b | 1.5 b | 3.5 b |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.28 kg/ha | 1.3 b | 1.3 b | 2.8 b | 8.0 b |
| | 0.56 kg/ha | 1.3 b | 1.5 b | 2.3 b | 2.8 b |
| | 1.12 kg/ha | 1.3 b | 1.3 b | 1.3 b | 1.8 b |
| Untreated | | 3.5 a | 8.8 a | 21.3 a | 28.8 a |

Initial application occurred on June 13, 2007.
Means followed by same letter do not significantly differ (p = 0.05, Tukey's HSD).

**Isaacson 2007**

To generate efficacy data for chlorantraniliprole andthia methoxamto manageViburnum leaf beetle Isaacson ran several rate range experiments with Actara (the Canadian trade name for Flagship 25WG) and Rynoxapyr (the food use trade name for Acelepryn). The trade names within the US are used to summarize the information and in the data tables (Table 24 - Table 27).

All three rates for Flagship provided good to excellent control throughout both experiments equivalent to Conserve SC (Table 24 and Table 25). All three rates of Aceleprynalso provided good to excellent efficacy throughout the experiments. (Table 26 and Table 27).

No phytotoxicity was oberserved.

**Table 24 Summary of Damage ratings (0 – 10) for *Viburnum opulus nanum* infested with VLB, treated with thiamethoxam (ACTARA 25WG) Experiment 1, Isaacson, 2007 a**

| Treatment | Rate | May-22-2007 | May-29-2007 | Jun-5-2007 | Jun-12-2007 | Jun-20-2007 | Jun-27-2007 | July-4-2007 | July-25-2007 | Aug-15-2007 | Aug-29-2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flagship (Actara) 25 WG (thiamethoxam) | 0.28 kg/ha | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.50 | 0.00 | 0.25 | 0.58 |
| | 0.56 kg/ha | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.25 | 0.08 | 0.00 | 0.00 | 0.20 |
| | 1.12 kg/ha | 0.42 | 0.42 | 0.42 | 0.42 | 0.42 | 0.33 | 0.25 | 0.00 | 0.00 | 0.17 |
| Conserve SC (spinosad) | | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.33 | 0.00 | 0.00 | 0.33 |
| Untreated | | 0.67 | 2.17 | 2.58 | 2.58 | 2.58 | 2.58 | 2.17 | 1.83 | 2.42 | 3.25 |

**Table 25 Summary of Damage ratings (0 – 10) for *Viburnum opulus nanum* infested with VLB, treated with thiamethoxam (ACTARA 25WG) Experiment 2, Isaacson, 2007 b**

| Treatment | Rate | May-22-2007 | May-29-2007 | Jun-5-2007 | Jun-12-2007 | Jun-20-2007 | Jun-27-2007 | July-4-2007 | July-25-2007 | Aug-15-2007 | Aug-29-2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Flagship (Actara) 25 WG (thiamethoxam) | 0.28 kg/ha | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.42 | 0.00 | 0.25 | 0.50 |
| | 0.56 kg/ha | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.42 | 0.08 | 0.00 | 0.00 | 0.25 |
| | 1.12 kg/ha | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.50 | 0.08 | 0.00 | 0.00 | 0.17 |
| Conserve SC (spinosad) | | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.58 | 0.25 | 0.00 | 0.00 | 0.33 |
| Untreated | | 0.67 | 2.17 | 2.58 | 2.58 | 2.58 | 2.58 | 2.17 | 1.83 | 2.42 | 3.25 |

**Table 26 Summary of Damage ratings (0 – 10) for *Viburnum opulus nanum* infested with VLB, treated with Rynaxapyr (DPX 2EY45 20SC) Experiment 1, Isaacson, 2007 a**

| Treatment | Rate | May-22-2007 | May-29-2007 | Jun-5-2007 | Jun-12-2007 | Jun-20-2007 | Jun-27-2007 | July-4-2007 | July-25-2007 | Aug-15-2007 | Aug-29-2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 31.25 ml/L | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.50 | 0.25 | 0.00 | 0.08 | 0.17 |
| | 62.5 ml/L | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.17 | 0.00 | 0.08 | 0.33 |
| | 125 ml/L | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.17 | 0.00 | 0.00 | 0.50 |
| Conserve SC (spinosad) | | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.33 | 0.00 | 0.00 | 0.33 |
| Untreated | | 0.67 | 2.17 | 2.58 | 2.58 | 2.58 | 2.58 | 2.17 | 1.83 | 2.42 | 3.25 |

**Table 27 Summary of Damage ratings (0 – 10) for *Viburnum opulus nanum* infested with VLB, treated withRynaxapyr (DPX 2EY45 20SC) Experiment 2, Isaacson, 2007 b**

| Treatment | Rate | May-22-2007 | May-29-2007 | Jun-5-2007 | Jun-12-2007 | Jun-20-2007 | Jun-27-2007 | July-4-2007 | July-25-2007 | Aug-15-2007 | Aug-29-2007 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 31.25 ml/L | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.50 | 0.17 | 0.00 | 0.00 | 0.25 |
| | 62.5 ml/L | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.50 | 0.08 | 0.00 | 0.00 | 0.25 |
| | 125 ml/L | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.42 | 0.08 | 0.00 | 0.00 | 0.17 |
| Conserve SC (spinosad) | | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.58 | 0.25 | 0.00 | 0.00 | 0.33 |
| Untreated | | 0.58 | 1.83 | 2.83 | 2.83 | 2.83 | 2.67 | 2.08 | 1.58 | 2.00 | 3.17 |

**<u>Weston 2007</u>**

In this experiment, Weston tested seven products for their efficacy on viburnum leaf beetle infesting established arrowwood viburnum (*Viburnum dentatum*) in field plots at the Bluegrass Lane Turf and Ornamentals Research Farm in Ithaca, NY. The shrubs, which had been growing under field conditions for 7 years, were approximately 6' tall and were naturally infested by viburnum leaf beetle in previous years. Products were applied as foliar sprays on May 22, 2007 when viburnum leaf beetle was in its first larval instar (egg hatch had begun on May 9). Five plants (replicates) were used for each treatment, and larval feeding damage was assessed 1 and 2 weeks after treatment. Data were analyzed with randomized complete block ANOVA, and treatments were compared with LSD.

The range of feeding damage was dramatic, ranging from 55% on the untreated control to near zero for the most effective treatments (Table 28). *Metarhizium anisopliae*, a fungus effective against many immature insects, had no effect on larvae (defoliation was virtually identical to that of the untreated control). The remaining products provided good to excellent control. Most effective were Celero and Safari, which were slightly more efficacious than Acelypryn, BAS 320i, Merit and Tolfenpyrad through 14 DAT.

*[NOTE: Earlier field trials by Weston have shown that soil drenches with Merit 75 WP have resulted in nearly complete protection from viburnum leaf beetle for several years. In the current trial, Merit was applied as a foliar spray, like all of the other test products.]*

**Table 28. Efficacy of several insecticides for Viburnum Leaf Beetle (*Pyrrhalta viburni*) management on Arrowwood viburnum (*Viburnum dentatum*), Weston, 2007.**

| Treatment | Rate per 100 gal | Defoliation | |
|---|---|---|---|
| | | 1 WAT | 2 WAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz | 3.3 ab | 4.3 b |
| BAS 320i (metaflumizone) | 16 oz | 2.5 b | 2.2 bc |
| Celero (clothianidin) | 4 oz | 0.7 b | 0.7 d |
| Merit (imidacloprid) | 10 tsp | 3.6 ab | 3.6 b |
| *Metarhizium anisopliae* (Strain F52) | 29 oz | 22.2 ab | 50.2 a |
| Safari 20SG (dinotefuran) | 8 oz | 2.7 b | 1.7 cd |
| Tolfenpyrad EC | 21 oz | 4.4 ab | 3.9 b |
| Untreated | | 24.4 a | 55.4 a |

### *Comparative Efficacy on Red headed Flea Beetle (Systena frontalis)*

Redheaded flea beetle (also called cranberry flea beetle), *Systena frontalis,* has become a serious pest of nursery stock and has been considered the most damaging flea beetle in container nurseries in recent years. It has a wide range of ornamental hosts including Itea, hydrangea, forsythia, roses, holly, azalea, hibiscus, asters, chrysanthemum and zinnia, where the adults typically chew leaves causing small holes and skeletonized leaves. They also feed on growing tips causing deeply notched leaves.

**Braman 2012 and 2013**

In 2012 and 2013, Braman compared several products applied foliar for ability to protect nurserygrown *Itea* and *Hydrangea* from chewing damage by red headed flea beetle, *Systena frontalis*. In 2012, all treatments were applied on May 11; a second application was made for MBI-203 on May 18.Plants treated at the nursery were evaluated on-site for foliar damage at 1, 2, 4, and 11 weeks-post application. In both years, detached leaves from treated plants were bagged and returned to the laboratory and evaluated for beetle survival and % leaf damage (chewing injury)at various times after treatment application in a petri dish exposure trial. Data were subjected to ANOVA using the GLM procedure in SAS and mean separation was accomplished using the LSD procedure.

In the detached-leaf study in 2012, Aloft and Flagship consistently reduced beetle survival and reduced damage in both Itea and hydrangea (Table 29, Table 30). In the nursery, Marathon provided the most consistent damage reduction from 1 to 11 weeks post application on both Itea and hydrangea. At 1 week post application, Hachi-Hachi also reduced damage on Itea; on Hydrangea, Marathon, Hachi-Hachi, Aloft and Safari provided the greatest protection. At 11 weeks post application, all products showed a reduction in damage on Itea, with the least damage observed on plants treated with Marathon, Aloft, Safari, Hachi-Hachi and MBI-203; on hydrangea, only Marathon treated plants displayed less damage than the Untreated.

In the 2013 detached leaf study, Only Aloft provided a significant reduction in beetle survival relative to the UTC at 1 and 10 days after treatment (Table 31). Beetle survival at 21, 24 and 30 DAT did not vary significantly with treatment. Leaf injury, however, was affected on all sample dates, suggesting antifeedant behavior in response to residual application even when mortality was not inflicted by treatment. Damage was reduced at 1 DAT by Aloft, Safari, GF2860, MBI 203, Onyx and Discus. Damage was reduced at 10 DAT by Aloft, Safari- foliar and drench, GF2860, MBI 203, Onyx and Discus. At 21 DAT, feeding was significantly reduced by the Safari drench, GF 2860, A20520, Aloft and Discus. Subsequent exposure by that same set of beetles resulted in continued suppression of damage on leaves from plants treated with Safari (drench), Aloft and Discus.

**Frank 2013**

In 2013, Frank compared efficacy of several products applied foliar to protect nursery grownVirginia sweetspire from chewing damage by cranberry flea beetle, *Systena frontalis*. All products were sprayed once on July 10, 2013 except Discus which was sprayed on July 10 and 24, and MBI-203, sprayed on July 10, 17, 24 and 31. All applications were made at least 4 hours prior to rain; however, it rained nearly every day during the experiment. Flea beetle abundance was not a good assessment of flea beetle damage because flea beetles were jumping from plants as observers approached plots. Thus, no significant differences were detected in number of flea beetles per plant (Table 32); however, assessment of shot-hole leaf damage showed that all products significantly reduced feeding injury.

**Kunkel 2014**

In this experiment, Kunkel compared several products (GF-2860, Hachi-Hachi, Mainspring, MBI-203, Safari and Scimitar) for ability to protect Virginia sweetspire (*Itea virginica*) sage (*Salvia nemorosa*), and stonecrop (*Sedum telephium*) from chewing damage by red headed flea beetle, *Systena frontalis* (Table ). All products were applied as foliar sprays, except Safari applied as drench in one treatment. Treatments were applied on Jun 16, and all treatments, except Hachi-Hachi and Safari, reapplied on Jul 7. A minimum of six (caged) or eight replicates (natural) were requested for this trial; however, nurseries did not have enough plants of one species or cultivar available to use in the experiments. The trial had three replicates of *Salvia* and two replicates of *Itea* and *Sedum* placed side-by-side in the greenhouse. Previous work with redheaded flea beetles found all three species to be suitable hosts. Adult feeding damage was assessed at various times after treatment.

The three different species of plants resulted in a complicated analysis because there was a three-way interaction between products, plants, and amount of damage (Table 33). Scimitar and Safari provided the most consistent control across the duration of the experiment. Adult *S. frontalis* prefer to feed on *Itea* and *Salvia* when compared to *Sedum,* and they fed on either *Itea* or *Salvia* similarly most of the observation periods. Additional research is needed to develop management tactics for both larva and adult *S. frontalis*.

In summary, Scimitar, Safari and most frequently the higher rate of GF2860 significantly reduced redheaded flea beetle feeding damage on these ornamental plants tested; Mainspring and MBI-203 also provided some damage reduction. *Sedum* frequently had significantly less damage than either *Itea* or *Salvia*. The experiment found greater than acceptable foliage damage occur from 14 to 21 DAT after initial treatment. Although populations were low preceding 14 DAT, this beetle exhibited the capability of increasing populations rapidly. This increase in population could be from within the nursery crops or potentially peripheral areas since it has a wide host range that includes many weed species. This aspect of the pest’s biology warrants further investigation.

No phytotoxicity and no significant differences in plant height and width between treatments were observed.

**Table 29. Detached Leaf Study for Redheaded Flea Beetle (*Systena frontalis*) adults feeding on Virginia Sweetspire (*Itea virginica*) 'Henry's Garnet' and Hydrangea (*Hydrangea sp.*) 'White Diamonds', Braman, 2012.**

| **Treatment** | **Rate (per 100 gal)** | **No. of Living Beetles** [x] | | **% Damage Itea** | | **% Damage Hydrangea** | |
|---|---|---|---|---|---|---|---|
| | | **Day 1*** | **Day 5*** | **Day 1*** | **Day 5*** | **Day 1*** | **Day 5*** |
| Aloft (clothianidin/bifenthrin) | 14.9 fl oz | 0.2 c | 0 b | 0.4 c | 0 c | 0 c | 0 c |
| Flagship 25WG (thiamethoxam) | 8 fl oz | 0.4 bc | 0 b | 1.0 bc | 0 c | 0 c | 1.0 c |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 1.0 a | 1.0 a | 7.0 abc | 14.0 abc | 9.0 a | 15.0 ab |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 0.8 ab | 0.8 a | 5.4 abc | 4.0 bc | 1.0 bc | 13.0 abc |
| Marathon G (imidacloprid) | 7 g/pot | 0.8 ab | 0.6 a | 2.8 bc | 2.0 bc | 1.6 abc | 7.4 abc |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb | 1.0 a | 1.0 a | 11.0 a | 15.0 ab | 5.0 abc | 20.0 a |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 0.8 ab | 0.8 a | 3.0 bc | 16.0 ab | 8.0 ab | 12.0 abc |
| Onyx (bifenthrin) | 12.8 fl oz | 1.0 a | 1.0 a | 3.0 bc | 12.0 abc | 7.0 abc | 12.0 abc |
| Safari 20SG (dinotefuran) | 8 oz | 0.8 ab | 0.6 a | 5.4 abc | 3.0 bc | 1.0 bc | 15.0 abc |
| TriStar 30SG (acetamiprid) | 8 g | 0.8 ab | 0.6 a | 3.6 bc | 5.6 bc | 3.0abc | 3.4 bc |
| Untreated | | 1.0 a | 1.0 a | 8.0 ab | 23.0 a | 6.0 abc | 18.0 a |

**Table 30. Damage Rating [z] for Redheaded Flea Beetle (*Systena frontalis*) adults feeding on Virginia Sweetspire (*Itea virginica*) 'Henry's Garnet' and Hydrangea (*Hydrangea sp.*) 'White Diamonds', Braman, 2012.**

| Treatment | Rate (per 100 gal) | Itea | | | | Hydrangea | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 WAT | 2 WAT | 4 WAT | 11 WAT | 1 WAT | 2 WAT | 4 WAT | 11 WAT |
| Aloft (clothianidin/bifenthrin) | 14.9 fl oz | 5.6 a[x] | 0 a | 0.4 bc | 0.4 de | 2.0 cd | 1.2 a | 0 b | 0.8 bc |
| Flagship 25WG (thiamethoxam) | 8 oz | 3.6 bc | 0.6 a | 0.8 bc | 1.2 c | 3.4 bc | 0.8 a | 0.6 b | 0.6 bc |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 1.0 d | 0.2 a | 0.8 bc | 1.0 cd | 0.4 d | 0.6 a | 0.2 b | 1.6 a |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 3.8 bc | 0.2 a | 0.2 c | 1.4 bc | 1.2 d | 1.0 a | 0.2 b | 0.8 bc |
| Marathon G (imidacloprid) | 7 g/pot | 0 d | 0.4 a | 0.7 bc | 0.4 de | 1.6 d | 0 a | 0.4 b | 0.2 c |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb per | 4.4 ab | 0.6 a | 1.0 b | 2.0 b | 4.4 b | 1.6 a | 0.6 b | 0.8 bc |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 3.0 bc | 3.0 a | 2.0 a | 0.2 e | 4.0 bc | 1.0 a | 3.0 a | 1.0 ab |
| Onyx (bifenthrin) | 12.8 fl oz | 3.4 bc | 0.2 a | 1.0 b | 1.4 bc | 3.6 bc | 1.0 a | 0.2 b | 1.2 ab |
| Safari 20SG (dinotefuran) | 8 oz | 2.6 c | 0.2 a | 0.4 bc | 1.0 cd | 0.2 d | 1.0 a | 0.2 b | 0.8 bc |
| TriStar 30SG (acetamiprid) | 8 g | 3.2 bc | 0 a | 0.4 bc | 1.2 c | 3.6 bc | 2.8 a | 0 b | 0.6 bc |
| Untreated | | 2.6 c | 1.0 a | 0.6 bc | 3.0 a | 8.4 a | 1.0 a | 1.0 b | 1.2 ab |

* Days post-exposure

[x] Means followed by the same letter are not significantly different, P = 0.05

[z] Rating: 1 = 10 % defoliation, 10 = 100 % defoliation.

**Table 31. Efficacy of several insecticides for Redheaded Flea Beetle (*Systena frontalis*) adults feeding on Virginia Sweetspire (*Itea virginica*), Braman, 2013.**

| Treatment | Rate (per 100 gal) | No. of Beetles at Days Post Treatment [x] | | | | | % Leaf Damage at Days Post Treatment | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 10 | 21 | 24 | 30 | 1 | 10 | 21 | 24 | 30 |
| Aloft (clothianidin/bifenthrin) | 15 fl oz | 0.2 c | 0.2 b | 1.0 a | 0.7 a | 0.7 a | 0.2 c | 0.2 c | 0 c | 2.0 cd | 9.0 bc |
| Discus (imidacloprid + cyfluthrin) | 50 oz | 0.5 bc | 1.0 a | 0.7 a | 0.7 a | 0.7 a | 1.6 c | 1.6 c | 0.3 c | 0.7 d | 1.0 c |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 8.6 abc | 8.6 abc | 8.3 ab | 18.7 abc | 43.3 a |
| Mainspring/A20520A (cyantraniliprole) | 16 oz | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 12.0 ab | 12.0 ab | 3.3 bc | 16.9 a-d | 21.7 abc |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 3.2 c | 3.2 c | 11.7 a | 26.7 a | 45.0 a |
| Onyx (bifenthrin) | 1.28 fl oz | 0.7 ab | 0.8 b | 1.0 a | 1.0 a | 1.0 a | 8.0 bc | 8.0 bc | 8.3 ab | 18.3 a-d | 33.3 ab |
| Safari 20SG foliar (dinotefuran) | 8 oz | 0.7 ab | 0.8 a | 1.0 a | 1.0 a | 1.0 a | 0.2 c | 0.2 c | 9.0 ab | 11.7 a-d | 30.0 abc |
| Safari 20SG drench(dinotefuran) | 24 oz | 0.6 ab | 0.6 ab | 1.0 a | 1.0 a | 0.7 a | 1.2 c | 1.2 c | 0 c | 4.3 bcd | 9.3 bc |
| XXpire/GF-2860 40WP (spinoteram+sulfoxaflor) + 6 oz Capsil | 3.5 oz | 0.8 ab | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 6.0 bc | 6.0 bc | 3.3 bc | 20.0 ab | 43.3 a |
| Untreated | | 0.8 ab | 1.0 a | 1.0 a | 1.0 a | 1.0 a | 8.0 a | 15.0 a | 15.0a | 25.0 a | 26.7 abc |

[x] Means followed by the same letter are not significantly different, P= 0.05

**Table 32. Efficacy of several insecticides for Cranberry Flea Beetle (*Systena frontalis*) adults feeding on Virginia Sweetspire (*Itea virginica*), Frank, 2013.**

| **Treatment** | **Rate (per 100 gal)** | **No. of Beetles/Plant at Days Post Initial Treatment** [x] | | | | | **% Leaf Area Consumed at Days Post Initial Treatment** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **-1** | **7** | **14** | **33** | **57** | **-1** | **7** | **14** | **33** | **57** |
| Bifenthrin | 40 fl oz | 0.5 ab | 0 b | 0 a | 0 a | 0 b | 13.5 a | 17.50 a | 7.08 b | 1.92 cd | 1.83 b |
| Cyantraniliprole | 8 fl oz | 0.3 ab | 0 b | 0 a | 0 a | 0 b | 4.75 a | 5.33 abc | 2.58b | 2.00 cd | 9.17 ab |
| Cyantraniliprole | 16 fl oz | 0 b | 0 b | 0 a | 0 a | 0 b | 3.83 a | 12 abc | 5.50 b | 8.58 a-d | 2.67 b |
| Discus (imidacloprid + cyfluthrin) | 50 fl oz | 0.3 ab | 0 b | 0.2 a | 0 a | 0 b | 15.17 a | 15.83 ab | 7.83 b | 1.67 cd | 1.75 b |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 0 b | 0 b | 0.2 a | 0 a | 0 b | 7.83 a | 8.50 abc | 3.67 b | 3.67 cd | 4.58 b |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 0 b | 0 b | 0 a | 0 a | 0.2 a | 3.92 a | 10.25 abc | 3.92 b | 5.92bcd | 7.75 ab |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb | 0.3 ab | 0 b | 0 a | 0 a | 0 b | 5.92 a | 2.17 c | 3.83 b | 15.25 ab | 15.92 a |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 0.2 ab | 0 b | 0 a | 0 a | 0 b | 4.42 a | 3.00 bc | 3.00 b | 0.42 d | 2.58 b |
| Safari 20SG foliar (dinotefuran) | 8 fl oz | 0 b | 0 b | 0 a | 0 a | 0 b | 10.92 a | 6.83 abc | 3.50 b | 4.50 cd | 3.58 b |
| Safari 20SG foliar (dinotefuran) | 24 fl oz | 0.2 ab | 0 b | 0 a | 0 a | 0 b | 4 .33 a | 3.67 bc | 6.25 b | 4.33 cd | 1.67 b |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) | 3.5 fl oz | 0.3 ab | 0 b | 0 a | 0 a | 0 b | 10.33 a | 14.33 abc | 0.50 b | 1.83 cd | 1.17 b |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) | 7 fl oz | 0.8 a | 0 b | 0 a | 0 a | 0 b | 4.83 a | 11.17 abc | 0.33 b | 11.17 abc | 9.33 ab |
| Untreated | | 0.8 a | 0.7 a | 0 a | 0 a | 0 b | 7.00 a | 9.42 ab | 18.75 a | 16.83 a | 9.66 ab |

[x] Means followed by the same letter are not significantly different, P= 0.05, Duncan's New MRT.

**Table 33. Efficacy of several insecticides for Redheaded Flea Beetle (Systena frontalis) adults feeding on Virginia Sweetspire (Itea virginica) 'Little Henry', Sage (Salvia nemorosa) 'Blue Hill', and Stonecrop (Sedum telephium) 'Autumn Joy', Kunkel, 2014.**

| Treatment | Rate (per 100 gal) | Pretrt | 7 DAT | 14 DAT | 21 DAT | 28 DAT | 35 DAT | 42 DAT | 49 DAT |
|---|---|---|---|---|---|---|---|---|---|
| | | *Percent Damaged Foliage on Virginia Sweetspire* | | | | | | | |
| % Damaged Foliage on Viginia Sweetspire [x] | | | | | | | | | |
| Treatment | Rate (per 100 gal) | Pretrt | 7 DAT | 14 DAT | 21 DAT | 28 DAT | 35 DAT | 42 DAT | 49 DAT |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 1.3 b | 2.5 ab | 11.9 a-e | 25.0 a-d | 21.3 a-i | 36.3 a-h | 26.3 a-g | 38.8 a-g |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 4.4 a | 4.4 ab | 10.0 b-f | 21.3 a-f | 15.0 c-k | 25.0 c-k | 21.3 a-h | 38.8 a-g |
| Mainspring (cyantraniliprole) | 8 fl oz | 1.3 b | 1.3 ab | 10.6 a-f | 23.8 a-d | 36.3 a-d | 36.3 a-g | 30.0 a-g | 47.5 a-d |
| Mainspring (cyantraniliprole) | 16 fl oz | 0.0 b | 2.5 ab | 6.9 b-g | 15.0 c-g | 15.0 c-k | 27.5 a-k | 20.0 b-h | 28.8 a-i |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 16 oz | 0.0 b | 1.9 ab | 3.1 fg | 15.0 b-g | 13.8d-k | 26.3 b-k | 17.5 b-h | 25.0 b-j |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 32 oz | 0.0 b | 0.0 b | 5.6 b-g | 15.0 b-g | 12.5 f-k | 31.3 a-i | 20.0 b-h | 21.3 b-j |
| Safari 20SG foliar (dinotefuran) | 8 oz | 0.0 b | 1.3 ab | 16.3 ab | 18.8 a-f | 30.0 a-f | 48.8 a | 37.5 ab | 36.3 a-g |
| Safari 20SG drench (dinotefuran) | 24 oz | 0.0 b | 0.6 ab | 8.1 b-g | 18.8 a-f | 33.8 a-d | 46.3abc | 32.5 a-e | 48.8 ab |
| Scimitar (lambda-cyhalothrin) | 5 fl oz | 0.6 b | 2.5 ab | 3.8 efg | 11.3 c-g | 13.8 e-k | 20.0 f-l | 16.3 c-h | 23.8 b-j |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 2.75 oz | 0.0 b | 5.0 ab | 8.1 b-g | 22.5 a-f | 18.8 b-j | 47.5 ab | 32.5 a-e | 48.8 abc |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 3.5 oz | 0.6 b | 1.3 ab | 10.0 b-f | 15.0 b-g | 20.0 b-j | 30.0 a-i | 23.8 a-h | 26.3 a-j |
| Untreated | | 1.3 b | 5.6 ab | 10.6 a-f | 23.8 a-e | 21.3 b-j | 45.0 a-d | 36.3 abc | 43.8 a-e |
| % Damaged Foliage on Sage [x] | | | | | | | | | |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 0.8 a | 5.8 ab | 14.2 abc | 26.7 abc | 21.7 b-j | 38.3 a-f | 25.8 a-g | 23.3 c-j |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 2.1 a | 1.3 ab | 9.2 b-g | 21.7 a-f | 25.8 a-g | 32.5 a-h | 28.3 a-f | 30.0 a-h |
| Mainspring (cyantraniliprole) | 8 fl oz | 1.7 a | 4.2 ab | 7.1 b-g | 24.2a-d | 23.3 a-g | 36.7 a-g | 31.3 a-f | 56.7 a |
| Mainspring (cyantraniliprole) | 16 fl oz | 0.8 a | 2.1 ab | 7.9 b-g | 22.5 a-f | 20.8 b-i | 31.7 a-h | 20.0 b-h | 38.3 a-f |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 16 oz | 0.0 a | 2.5 ab | 12.9 a-d | 33.3 ab | 25.8 a-g | 36.7 a-g | 20.0 b-h | 4.2 a-g |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 32 oz | 0.4 a | 2.1 ab | 7.1 b-g | 12.9 c-g | 17.5 d-j | 25.4 e-k | 15.8 e-h | 26.7 c-j |
| Safari 20SG foliar (dinotefuran) | 8 oz | 0.4 a | 2.9 ab | 10.8 b-e | 20.8 a-f | 20.8 b-i | 39.2 a-e | 21.7 b-h | 22.5 d-j |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Safari 20SG drench (dinotefuran) | 24 oz | 1.3 a | 2.1 ab | 4.6 efg | 9.6 e-h | 11.7 j-k | 25.0 e-k | 13.3 fgh | 16.7 hij |
| Scimitar (lambda-cyhalothrin) | 5 fl oz | 0.0 a | 2.1 ab | 4.2 efg | 8.8 e-h | 9.6 ijk | 20.8 g-l | 11.7 gh | 18.8 g-j |
| Untreated | | 0.0 a | 7.1 a | 11.3 a-f | 19.2 a-f | 22.5 b-h | 36.7 a-g | 20.4 b-h | 23.3b-j |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 2.75 oz | 1.7 a | 8.8 a | 21.7 a | 33.3 a | 30.0 a-e | 44.2 a-d | 28.3 a-f | 21.7 d-j |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 3.5 oz | 0.8 a | 2.1 ab | 7.5 b-g | 16.7 b-f | 20.8 b-h | 26.7 b-j | 25.8 a-g | 19.2 f-j |
| % Damaged Foliage on Stonecrop [x] | | | | | | | | | |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 1.9 a | 2.5 ab | 12.5 a-d | 15.6 b-g | 18.8 b-j | 25.0 d-k | 25.0 a-h | 30.0 a-j |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 2.5 a | 3.8 ab | 9.4 b-g | 36.3 a | 47.5 a | 36.3 a-g | 45.0 a | 21.3 c-j |
| Mainspring (cyantraniliprole) | 8 fl oz | 0.0 a | 0.6 ab | 9.4 b-g | 18.8 a-f | 20.0 b-i | 22.5 e-l | 22.5 a-h | 28.8 a-i |
| Mainspring (cyantraniliprole) | 16 fl oz | 1.9 a | 2.5 ab | 8.1 b-g | 14.4 b-g | 21.9 b-j | 20.6 f-l | 15.0 d-h | 27.5 a-j |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 16 oz | 2.5 a | 1.9 ab | 10.6 a-f | 18.8 a-f | 16.3 b-j | 14.4 i-m | 15.6 d-h | 18.8 f-j |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 32 oz | 0.0 a | 5.6 ab | 15.0 abc | 23.8 a-d | 35.0 abc | 18.8 g-m | 18.8 b-h | 25.0 a-j |
| Safari 20SG foliar (dinotefuran) | 8 oz | 0.0 a | 1.3 ab | 8.8 b-g | 9.4 e-h | 17.5 c-k | 16.9 h-m | 13.8 e-h | 20.0 f-j |
| Safari 20SG drench (dinotefuran) | 24 oz | 0.6 a | 1.9 ab | 4.4 d-g | 6.3 gh | 5.0 k | 8.1 lm | 6.3 h | 10.0 ij |
| Scimitar (lambda-cyhalothrin) | 5 fl oz | 0.0 a | 1.3 ab | 2.5 g | 3.8 h | 8.1 jk | 5.0 m | 6.9 h | 9.4 j |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 2.75 oz | 0.6 a | 5.0 ab | 9.4 b-g | 13.8 c-g | 7.5 jk | 11.3 j-m | 12.5 e-h | 13.1 hij |
| XXpire/GF-2860 (spinetoram + sulfoxaflor) + Capsil | 3.5 oz | 0.6 a | 3.1 ab | 7.5 b-g | 8.8 e-h | 9.4 h-k | 10.6 klm | 10.0 gh | 18.8 e-j |
| Untreated | | 0.0 a | 1.3 ab | 13.1 a-d | 36.3 a | 38.8 ab | 46.3 abc | 35.0 a-d | 37.5 a-g |

[x] Means followed by the same letter are not significantly different, P = 0.05, Tukey's HSD.

### *Comparative Efficacy onEuropean elm flea weevil (Orchestes alni)*

The European elm flea weevil (*Orchestes alni*)is a native to Europe. It feeds many elm species but can be especially damaging to Siberian and hybrid elms. Adults overwinter and feed during the early spring mainly on the underside of leaves, producing shothole injuries to the leaf interior. Soon after bud break the adults lay eggs and larvae hatch. The larvae are leafminers and feed in a serpentine pattern moving toward the leaf margin. They drop to the ground to pupate and adults emerge and feed for the remainder of the growing season. Damage is primary aesthetic.

In 2013, Jones compared efficacy of several products applied foliar or drench for European elm flea weevil feeding on elm (Table 34 - Table 36). All treatments resulted in better control of European elm flea weevil activity (percent of leaf area affected, percent of the tree canopy affected, and leafminer activity) than the untreated control. Additionally, all treatments provided EEFW control that consumers would find acceptable. Of the treatments, Xytect resulted in the least EEFW activity. There were no significant difference in EEFW activity between the two Hachi-Hachi rates and the two MBI-203 rates.

**Table 34. Efficacy of several insecticides for European Elm Flea Weevil (*Orchestes alni*) feeding on Elm (*Ulmus sp.*) 'Patriot' - % leaf area affected, Jones, 2013.**

| % Leaf Area Affected by Weevil Feeding [x] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Treatment [z]** | **Rate (per 100 gal)** | **5/23** | **5/31** | **6/10** | **6/17** | **7/1** | **7/16** | **7/30** | **8/28** |
| Aloft (clothianidin/bifenthrin) | 15 fl oz | 3 a | 6 b | 9 bc | 9 b | 14 b | 11 cd | 8 bc | 6 b |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 3 a | 7 b | 9 bc | 9 b | 14 b | 17 b | 10 b | 6 b |
| Hachi-Hachi (tolfenpyrad) | 32 fl oz | 3 a | 7 b | 9 bc | 9 b | 14 b | 15 bc | 9 b | 5 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb | 3 a | 6 b | 10 b | 9 b | 15 b | 16 b | 8 bc | 5 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 3 a | 6 b | 9 bc | 9 b | 13 b | 14 bc | 9 b | 6 b |
| Safari 20SG (dinotefuran) | 12 g / DBH inch | 3 a | 6 b | 9 bc | 8 b | 13 b | 9 d | 5 bc | 4 bc |
| Xytect 2F (imidacloprid) | 0.2 fl oz / DBH inch | 3 a | 4 b | 7 c | 5 b | 11 b | 8 d | 4 c | 2 c |
| Untreated | | 4 a | 14 a | 19 a | 24 a | 33 a | 23 a | 19 a | 13 a |

[x] Means followed by the same letter are not significantly different, P = 0.05, Duncan's New MRT.

[y]Ratings were made using a 0-1 scale where 0 = no leafminer activity and 1 = leafminer activity present.

[z] Aloft and Hachi-Hachi applied foliar on May 18, MBI 203 applied foliar on May 18, 23, 31 and June 10; Xytect and Safari applied as soil drench on April 5 and May 6, respectively.

**Table 35. Efficacy of several insecticides for European Elm Flea Weevil (*Orchestes alni*) feeding on Elm (*Ulmus sp.*) 'Patriot' - % tree canopy affected, Jones, 2013.**

| % Tree Canopy Area Affected by Weevil Feeding [x] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatment [z] | Rate (per 100 gal) | 5/23 | 5/31 | 6/10 | 6/17 | 7/1 | 7/16 | 7/30 | 8/28 |
| Aloft (clothianidin/bifenthrin) | 15 fl oz | 3 a | 11 b | 19 b | 14 b | 19 b | 25 cd | 29 bc | 18 b |
| Hachi-Hachi SC (tolfenpyrad) | 21 fl oz | 3 a | 12 b | 18 b | 14 b | 19 b | 38 b | 40 b | 19 b |
| Hachi-Hachi SC (tolfenpyrad) | 32 fl oz | 3 a | 12 b | 18 bc | 13 b | 19 b | 33 bc | 38 b | 16 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb | 3 a | 11 b | 9 b | 14 b | 20 b | 38 b | 33 b | 19 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 3 a | 11 b | 18 bc | 14 b | 18 b | 31 bc | 39 b | 17 b |
| Safari 20SG (dinotefuran) | 12 g / inch DBH | 3 a | 11 b | 17 bc | 13 b | 18 b | 17 d | 21 cd | 13 b |
| Xytect 2F (imidacloprid) | 0.2 fl oz / inch DBH | 3 a | 8 b | 14 c | 10 b | 18 b | 15 d | 12 d | 6 c |
| Untreated | | 4 a | 24 a | 29 a | 29 a | 38 a | 61 a | 76 a | 68 a |

[x] Means followed by the same letter are not significantly different, P = 0.05, Duncan's New MRT.

[y]Ratings were made using a 0-1 scale where 0 = no leafminer activity and 1 = leafminer activity present.

[z] Aloft and Hachi-Hachi applied foliar on May 18, MBI 203 applied foliar on May 18, 23, 31 and June 10; Xytect and Safari applied as soil drench on April 5 and May 6, respectively.

**Table 36. Efficacy of several insecticides for European Elm Flea Weevil (*Orchestes alni*) feeding on Elm (*Ulmus sp.*) 'Patriot' - presence of leafmine activity, Jones, 2013.**

| | | Presence of Weevil Leafminer Activity [x y] | | |
|---|---|---|---|---|
| **Treatment** [z] | **Rate (per 100 gal)** | **5/31** | **6/10** | **6/17** |
| Aloft (clothianidin/bifenthrin) | 15 fl oz | 0.1 b | 0.1 b | 0.1 b |
| Hachi-Hachi SC (tolfenpyrad) | 21 fl oz | 0.1 b | 0.1 b | 0.1 b |
| Hachi-Hachi SC (tolfenpyrad) | 32 fl oz | 0.1 b | 0.0 b | 0.0 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 1 lb | 0.0 b | 0.0 b | 0.0 b |
| MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T) | 2 lb | 0.1 b | 0.0 b | 0.1 b |
| Safari 20SG (dinotefuran) | 12 g / inch DBH | 0.1 b | 0.1 b | 0.1 b |
| Xytect 2F (imidacloprid) | 0.2 fl oz / inch DBH | 0.0 b | 0.0 b | 0.0 b |
| Untreated | | 1.0 a | 0.9 a | 0.9 a |

[x] Means followed by the same letter are not significantly different, P = 0.05, Duncan's New MRT.

[y] Ratings were made using a 0-1 scale where 0 = no leafminer activity and 1 = leafminer activity present.

[z] Aloft and Hachi-Hachi applied foliar on May 18, MBI 203 applied foliar on May 18, 23, 31 and June 10; Xytect and Safari applied as soil drench on April 5 and May 6, respectively.

## *Comparative Efficacy on Sri Lankan Weevil (Myllocerus undatus)*

The Sri Lankan weevil (*Myllocerus undatus*) is a native to southern India, Sri Lanka and Pakistan. The species has been reported in Florida on numerous ornamental plants and fruit crops. Adults feed on leaves potentially reducing the quality and quantity of ornamentals and fruit production. Damage can range from notching on the leaf margins in an irregular pattern to much more extensive feeding along the leaf veins. Small plants and young trees usually need protection. Oviposition occurs in soil close to roots. A single female lays on an average of 360 eggs over a period of 24 days. Larvae feed on roots, however, extent of root damage is unknown. Pupation occurs in soil inside the earthen cells and take about one week. Life cycle is usually completed in 6-8 weeks.This is considered a pest of quarantine significance.

In 2016, Dale compared efficacy of several products applied foliar on Sri Lankan weevil feeding on hibiscus (Table 37 - Table 39). Three days after treatment, the industry standard TriStar, as well as BeetleGONE and MBI-203 had significantly fewer beetles per plant than the control. At 7 DAT, Tristar and BeetleGONE had four times fewer beetles per plant than the untreated control. Although not statistically different, MBI-203 and TriStar maintained the lowest beetle abundance per plant through 28 DAT. Although not statistically different, by the conclusion of the study, average percent plant chewing damage was less than the control for all treatments except BotaniGard and Hachi-Hachi 3.28. Among treated plants, those treated with Xpectro and BotaniGard had the highest percentage of leaves with greater than 1% damage. Those treated with Acelepryn and MBI-203 had the fewest leaves with at least 1% damage (P=0.0008). At 14 DAT MBI-203 and Acelepryn still had significantly fewer leaves with at least 1% damage.

In general, Acelepryn and MBI- 203 provided the greatest efficacy through the duration of the study. TriStar, the industry standard, was also among the most efficacious products tested. Plants treated with these products had the lowest beetle abundance through 14 DAT, the fewest leaves with greater than 1% herbivory through 14 DAT, and the lowest leaf-level percent chewing damage through 14 DAT. No treatments showed phytotoxic effects or had any association with plant growth.

**Table 37. Efficacy of several insecticides for Sri Lankan Weevil (*Myllocerus undatus*) feeding on Hibiscus (*Hibiscus rosa-sinensis*) 'Double Peach' - % leaf area affected, Dale, 2016.**

| % Leaf Area Affected by Weevil Feeding [x] | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Treatment** | **Rate (per 100 gal)** | **Applic Dates** | **0 DAT** | **3 DAT** | **7 DAT** | **14 DAT** | **28 DAT** |
| Acelepryn (chlorantraniliprole) | 16 fl oz | 5/31 | 0 | 2.7 ± 0.71ab | 1.8 ± 0.75ab | 1.3 ± 0.49 | 1.2 ± 0.65 |
| AzaGuard (azadirachtin) | 16 fl oz | 5/31, 6/8, 6/14 | 0 | 1.3 ± 0.42abc | 2.0 ± 0.77ab | 2.0 ± 0.89 | 0.8 ± 0.48 |
| BeetleGONE (*Bacillus thuringiensis galleriae* str) + NuFilm 17 | 16 lb | 5/31, 6/8, 6/14 | 0 | 0.8 ± 0.31bc | 1.3 ± 0.76b | 1.5 ± 0.62 | 2.0 ± 0.68 |
| BotaniGard (*Beauveria bassiana* GHA) | 32 fl oz | 5/31 | 0 | 2.3 ± 0.33ab | 2.5 ± 0.43ab | 1.5 ± 0.56 | 1.2 ± 0.79 |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 5/31 | 0 | 3.0 ± 1.20ab | 2.5 ± 1.0ab | 3.2 ± 1.1 | 1.8 ± 0.70 |
| Hachi-Hachi (tolfenpyrad) | 27 fl oz | 5/31 | 0 | 2.3 ± 0.56abc | 2.5 ± 0.89ab | 2.2 ± 0.83 | 1.5 ± 0.50 |
| IKI-3106 (cyclaniliprole) | 22 fl oz | 5/31 | 0 | 3.2 ± 1.10a | 1.7 ± 0.67ab | 1.5 ± 1.0 | 1.5 ± 0.72 |
| IKI-3106 (cyclaniliprole) | 27 fl oz | 5/31 | 0 | 1.5 ± 0.5abc | 2.8 ± 0.60ab | 2.8 ± 0.65 | 1.0 ± 0.52 |
| Lynx (pyrethrins) | 16 fl oz | 5/31, 6/8 | 0 | 1.7 ± 0.33abc | 4.0 ± 0.37a | 1.7 ± 0.42 | 1.5 ± 0.96 |
| MBI-203 (*Chromobacterium subsugae*) + NuFilm 17 | 3 lb | 5/31, 6/8, 6/14 | 0 | 1 ± 0.36bc | 2.5 ± 0.85ab | 1.8 ± 0.60 | 0.5 ± 0.34 |
| Preferal (*Isaria fumosoroseus*) | 1 lb | 5/31 | 0 | 2.5 ± 0.67ab | 2.3 ± 0.76ab | 2.2 ± 0.75 | 1.3 ± 0.42 |
| TriStar (acetamiprid) | 8 oz | 5/31 | 0 | 0.7 ± 0.21c | 0.7 ± 0.21b | 1.3 ± 0.49 | 0.7 ± 0.33 |
| Venerate (*Burkholderia rinojensis A396*) + NuFilm 17 | 1 gallon | 5/31, 6/8, 6/14 | 0 | 1.2 ± 0.54abc | 3.0 ± 0.86ab | 1.8 ± 0.70 | 0.6 ± 0.49 |
| Xpectro (Pyrethrins + *Beauveria bassiana* GHA) | 32 oz | 5/31, 6/8 | 0 | 2.0 ± 0.89abc | 2.8 ± 1.05ab | 2.0 ± 0.52 | 2.2 ± 0.79 |
| Untreated | | | 0 | 3.0 ± 0.77a | 4.0 ± 0.97a | 3.3 ± 1.2 | 1.8 ± 0.48 |
| | | $F_{14,70}$ | - | 2.08 | 2.08 | 0.65 | 1.50 |
| | | *P* | - | **0.0233** | **0.0440** | 0.7629 | 0.1676 |

[x] Means followed by the same letter are not significantly different based on Duncan-Waller's test. Data were log (x+1) transformed and analyzed with one-way ANOVA.

**Table 38. Efficacy of several insecticides for Sri Lankan Weevil (*Myllocerus undatus*) feeding on Hibiscus (*Hibiscus rosa-sinensis*) 'Double Peach' - % herbivory per 20 leaves, Dale, 2016.**

| Mean percent herbivory per 20 leaves [x] | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Treatment** | **Rate (per 100 gal)** | **Applic Dates** | **0 DAT** | **3 DAT** | **7 DAT** | **14 DAT** | **28 DAT** |
| Acelepryn (chlorantraniliprole) | 16 fl oz | 5/31 | 0.0 ± 0.04 | 0.5 ± 0.35 | 0.3 ± 0.28 | 0.7 ± 0.22 | 1.1 ± 0.28 |
| AzaGuard (azadirachtin) | 16 fl oz | 5/31, 6/8, 6/14 | 0.0 ± 0.02 | 0.37 ± 0.12 | 2.0 ± 0.68 | 2.1 ± 0.75 | 1.8 ± 0.34 |
| BeetleGONE (*Bacillus thuringiensis galleriae* str) + NuFilm 17 | 16 lb | 5/31, 6/8, 6/14 | 0.0 ± 0.02 | 1.1 ± 0.46 | 0.2 ± 0.08 | 1.1 ± 0.48 | 1.3 ± 0.24 |
| BotaniGard (*Beauveria bassiana* GHA) | 32 fl oz | 5/31 | 0.7 ± 0.69 | 1.8 ± 1.06 | 1.6 ± 0.79 | 1.3 ± 0.33 | 1.5 ± 0.45 |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 5/31 | 0.2 ± 0.2 | 0.8 ± 0.46 | 1.2 ± 0.65 | 1.6 ± 0.52 | 1.9 ± 0.44 |
| Hachi-Hachi (tolfenpyrad) | 27 fl oz | 5/31 | 0.1 ± 0.04 | 0.3 ± 0.17 | 1.3 ± 0.62 | 1.9 ± 0.91 | 1.5 ± 0.29 |
| IKI-3106 (cyclaniliprole) | 22 fl oz | 5/31 | 0.2 ± 0.10 | 0.6 ± 0.26 | 0.7 ± 0.25 | 0.9 ± 0.33 | 2.1 ± 0.44 |
| IKI-3106 (cyclaniliprole) | 27 fl oz | 5/31 | 0.1 ± 0.12 | 1.3 ± 0.73 | 1.1 ± 0.39 | 2.6 ± 0.83 | 2.4 ± 0.76 |
| Lynx (pyrethrins) | 16 fl oz | 5/31, 6/8 | 0.7 ± 0.59 | 0.5 ± 0.22 | 1.0 ± 0.48 | 1.3 ± 0.38 | 3.1 ± 0.92 |
| MBI-203 (*Chromobacterium subsugae*) + NuFilm 17 | 3 lb | 5/31, 6/8, 6/14 | 0 ± 0.01 | 0.7 ± 0.36 | 0.1 ± 0.07 | 0.8 ± 0.23 | 1.7 ± 0.41 |
| Preferal (*Isaria fumosoroseus*) | 1 lb | 5/31 | 0.0 ± 0.01 | 0.68 ± 0.26 | 0.6 ± 0.19 | 2.5 ± 0.92 | 2.0 ± 0.61 |
| TriStar (acetamiprid) | 8 oz | 5/31 | 0.3 ± 0.23 | 0.5 ± 0.34 | 0.8 ± 0.74 | 1.8 ± 0.64 | 2.1 ± 0.46 |
| Venerate (*Burkholderia rinojensis A396*) + NuFilm 17 | 1 gallon | 5/31, 6/8, 6/14 | 0.1 ± 0.04 | 1.3 ± 0.39 | 0.6 ± 0.28 | 1.9 ± 0.96 | 1.6 ± 0.25 |
| Xpectro (Pyrethrins + *Beauveria bassiana* GHA) | 32 oz | 5/31, 6/8 | 0.0 ± 0.02 | 0.54 ± 0.34 | 1.1 ± 0.44 | 1.3 ± 0.46 | 2.6 ± 0.27 |
| Untreated | | | 0.6 ± 0.62 | 1.7 ± 0.86 | 1.8 ± 0.63 | 1.95 ± 0.95 | 1.9 ± 0.44 |
| | | $F_{14,70}$ | 13.05 | 12.92 | 27.36 | 9.68 | 12.46 |
| | | *P* | 0.5230 | 0.5329 | **0.0173** | 0.7852 | 0.5693 |

[x] Due to non-normal distributions, data were analyzed using the non-parametric Wilcoxon test.

**Table 39. Efficacy of several insecticides for Sri Lankan Weevil (*Myllocerus undatus*) feeding on Hibiscus (*Hibiscus rosa-sinensis*) 'Double Peach' – proportionof leaves with damage, Dale, 2016.**

| Proportion of leaves sampled with chewing damage (>1%) [x] | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Treatment** | **Rate (per 100 gal)** | **Applic Dates** | **0 DAT** | **3 DAT** | **7 DAT** | **14 DAT** | **28 DAT** |
| Acelepryn (chlorantraniliprole) | 16 fl oz | 5/31 | 0.03 ± 0.03 | 0.12 ± 0.07 | 0.03 ± 0.03c | 0.10 ± 0.04d | 0.17 ± 0.06 |
| AzaGuard (azadirachtin) | 16 fl oz | 5/31, 6/8, 6/14 | 0.0 ± 0.0 | 0.13 ± 0.04 | 0.17 ± 0.03bc | 0.14 ± 0.04cd | 0.26 ± 0.04 |
| BeetleGONE (*Bacillus thuringiensis galleriae* str) + NuFilm 17 | 16 lb | 5/31, 6/8, 6/14 | 0.02 ± 0.03 | 0.18 ± 0.07 | 0.08 ± 0.04bc | 0.14 ± 0.04cd | 0.29 ± 0.05 |
| BotaniGard (*Beauveria bassiana* GHA) | 32 fl oz | 5/31 | 0.07 ± 0.06 | 0.23 ± 0.11 | 0.20 ± 0.04b | 0.28 ± 0.03ab | 0.30 ± 0.05 |
| Hachi-Hachi (tolfenpyrad) | 21 fl oz | 5/31 | 0.02 ± 0.01 | 0.08 ± 0.04 | 0.12 ± 0.03bc | 0.22 ± 0.04a-d | 0.33 ± 0.05 |
| Hachi-Hachi (tolfenpyrad) | 27 fl oz | 5/31 | 0.03 ± 0.02 | 0.10 ± 0.05 | 0.12 ± 0.05bc | 0.26 ± 0.05abc | 0.26 ± 0.03 |
| IKI-3106 (cyclaniliprole) | 22 fl oz | 5/31 | 0.05 ± 0.01 | 0.18 ± 0.08 | 0.10 ± 0.04bc | 0.18 ± 0.04bcd | 0.37 ± 0.05 |
| IKI-3106 (cyclaniliprole) | 27 fl oz | 5/31 | 0.03 ± 0.02 | 0.22 ± 0.11 | 0.15 ± 0.06bc | 0.33 ± 0.06a | 0.32 ± 0.06 |
| Lynx (pyrethrins) | 16 fl oz | 5/31, 6/8 | 0.1 ± 0.08 | 0.10 ± 0.04 | 0.18 ± 0.05bc | 0.25 ± 0.04abc | 0.37 ± 0.06 |
| MBI-203 (*Chromobacterium subsugae*) + NuFilm 17 | 3 lb | 5/31, 6/8, 6/14 | 0.0 ± 0.0 | 0.17 ± 0.08 | 0.07 ± 0.03bc | 0.12 ± 0.02d | 0.19 ± 0.04 |
| Preferal (*Isaria fumosoroseus*) | 1 lb | 5/31 | 0.0 ± 0.0 | 0.12 ± 0.04 | 0.18 ± 0.05bc | 0.28 ± 0.03ab | 0.28 ± 0.06 |
| TriStar (acetamiprid) | 8 oz | 5/31 | 0.03 ± 0.02 | 0.13 ± 0.08 | 0.08 ± 0.05bc | 0.14 ± 0.05cd | 0.23 ± 0.04 |
| Venerate (*Burkholderia rinojensis A396*) + NuFilm 17 | 1 gallon | 5/31, 6/8, 6/14 | 0.02 ± 0.03 | 0.25 ± 0.08 | 0.10 ± 0.04bc | 0.15 ± 0.03cd | 0.27 ± 0.02 |
| Xpectro (Pyrethrins + *Beauveria bassiana* GHA) | 32 oz | 5/31, 6/8 | 0.02 ± 0.01 | 0.10 ± 0.08 | 0.20 ± 0.06b | 0.18 ± 0.03bcd | 0.32 ± 0.03 |
| Untreated | | | 0.05 ± .01 | 0.20 ± .08 | 0.38 ± 0.08a | 0.28 ± 0.06abc | 0.33 ± 0.05 |
| | | $F_{14,70}$ | 0.65 | 0.89 | 3.13 | 3.60 | 1.71 |
| | | *P* | 0.8970 | 0.5740 | **0.0008** | **0.0002** | *0.0732* |

[x] Means followed by the same letter are not significantly different based on Duncan-Waller's test. Data were log (x+1) transformed and analyzed with one-way ANOVA.

## Results: Soil Dwelling Immatures

### *Comparative Efficacy on Black Vine Weevil (Otiorhynchus sulcatus)*

Black vine weevil (*Otiorhynchus sulcatus*) is a serious pest of ornamental nursery crops (field and container-grown), vineyards, strawberries and hops. Even though, it is suspected the black vine weevil (BVW)originated in northern Europe, it was first identified in North America in 1835 and became a notable pest in Missouri by 1871. It is found predominantly in the northern portions of the United States, but its range extends into Virginia and out to the Pacific Northwest.

Throughout Asia, Europe, and North America, black vine weeviladults feed on the foliage and larvae feed on the roots dmaging a tremendous variety of species, including azalea strawberry, begonia, blackberry, blueberry, and cranberry, cyclamen, euonymus, forsythia, fuchsia, hemlock, impatiens, primrose, rhododendron, sedum and yew (http://www.mortonarb.org/res/CLINIC_pests_BlackVineWeevil.pdf; http://www.entomology.umn.edu/cues/blackvw/blackvh.html).

IR-4 sponsored nine experiments studies on BVW larvae and a single experiment on adult BVW [See Comparative Efficacy on Black Vine Weevil Adults (Otiorhynchus sulcatus)].

In general, preventative applications provided better control than curative rescue treatments (Table 40). The preventative applications were incorporated into the soil prior to transplanting or were drenched prior to infestation. In at least one experiment, Acelepryn, BAS 320i, Celero, Safari, and Talstar provided excellent (greater than 95%) control of black vine weevil. Curative drenches can reduce populations also, but in this series of experiments only BAS 320i provided excellent control when used in this manner.

## Table 40. Summary of Black Vine Weevil (*Otiorhynchus sulcatus*) Efficacy.

| Treatment | Timing | Gilrein | Reding | Reding | Reding | Cowles | Cowles | Reding | Alm | Nielsen |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Astilbe** | **Rhodo.** | **Sedum** | **Sedum** | **Strawberry** | **Strawberry** | **Yew** | **Yew** | **Yew** |
| | | **2005*** | **2004** | **2004** | **2006** | **2007** | **2008** | **2004** | **2006** | **2006** |
| | | **47 DAT** | **16 DAT** | **138 DAT** | **149 DAT** | **70 DAT** | **11 WAT** | **138 DAT** | **121 DAT** | **119 DAT** |
| | | **45 larvae** | **40 larvae** | **4 adults** | **5 adults** | **45 eggs** | **0.83 larvae** | **4 adults** | **4,263 eggs** | **eggs** |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Pre-infestation drench | | | | ++ | | | | - | |
| | Pre-plant incorporation | | | | | ++ | - | | | |
| | Curative drench | | | | | +/- | - | | | + |
| Arena 50WDG (clothianidin) | Curative drench | | | | | - | | | | |
| | Pre-plant incorporation | | | | | | ++ | | | |
| BAS 320i EC (metaflumizone) | Pre-plant incorporation | | | | | ++ | ++ | | | |
| | Curative drench | | | | | ++ | ++ | | | |
| BotaniGard ES (Beauveria bassiana) | Curative drench | | | | | | - | | | |
| | Pre-plant incorporation | | | | | | - | | | |
| BotaniGard WP (Beauveria bassiana) | Curative drench | | | | | | - | | | |
| | Pre-plant incorporation | | | | | | - | | | |
| Celero 16WSG (clothianidin) | Pre-infestation drench | | | | ++ | | | | - | |
| | Curative drench | | | | | | | | | + |
| Discus (imidacloprid + cyfluthrin) | Curative drench | | | | | - | | | | |
| Flagship 25WDG (thiamethoxam) | Curative drench | | | | | - | | | | + |
| Mach 2 SC | Curative drench | | | | | | | | | - |
| Marathon 1G (imidacloprid) | Soil incorporation | | | | | | | | | - |
| Marathon II 2F | Curative drench | - | | | | | | | | |
| *Metarhizium anisopliae* | Soil incorporation | | | | | - | - | | | - |
| | Curative drench | +/- | | | | | - | | | |
| Precise G & N (acephate) | Soil incorporation | | | | | | | | | - |
| Safari 2G (dinotefuran) | Pre-plant incorporation | | | | | | - | | | |
| Safari 20SG (dinotefuran) | Pre-infestation drench | | | ++ | ++ | | | | - | |
| | Curative drench | - | - | | | - | | | | + |
| | Foliar spray | | | | | | | - | | |
| | Pre-plant incorporation | | | | | | ++ | | | |
| Talstar 0.2G (bifenthrin) | Pre-plant incorporation | | | | | ++ | | | | - |
| Tolfenpyrad | Pre-plant incorporation | | | | | | - | | | |

* Not an IR-4-sponsored experiment.
[z] Data not conclusive.
[1] Rating Scale: ++ = clearly statistically better than untreated and greater than 95% control; + = statistically better than untreated and between 85 and 95% control; +/- statistically better than untreated with control between 70 and 85%; - = statistically equivalent to untreated and/or efficacy less than 70%.
[2] Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

**Alm 2006**

In 2006, Alm examined the efficacy of three products to control black vine weevil larvae on yew. This experiment also tested these products on oriental beetle; seeComparative Efficacy on Oriental Beetle (Anomala orientalis) for information on this pest. Drenches of Acelepryn, Celero, and Safari were applied on July 11. Alm collected black vine weevil eggs placed theminto the pots on twelve dates:July 13, July 20, July 24, Aug. 1,Aug. 7, Aug. 9, Aug. 17, Aug. 23, Aug. 29, Sept. 6, Sept. 15, and Sept. 26.A total of 4,263 eggs were added to each pot. Pots were destructively sampled on Nov 9 and the number of live larvae were counted.

None of the treatments provided significant control of black vine weevil larvae (Table 41). This could have been due to the constant, but realistic, repeat infestations after application. Another factor could be the length of residual control for these three products and that no repeat drench applications were made.

**Table 41. Efficacy of several insecticides for Black Vine Weevil on Yew (*Taxus media)* 'Nigra', Alm, 2006.**

| **Treatment** | **Rate** | **Mean Number Larvae per pot121 DAT (Nov 9, 2006)[z]** |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 6.47 fl oz | 91.8 $\pm$ 13.8 a |
| Celero 16WSG (clothianidin) | 1.2 oz | 164.6 $\pm$ 28.0 a |
| Safari 20SG (dinotefuran) | 24 oz | 132.4 $\pm$ 23.8 a |
| Untreated | | 145.6 $\pm$ 27.5 a |

[z]Means in the same column followed by the same letter are not significantly different, (*P* = 0.05, LSD test).

**Cowles 2007**

This experiment used potted strawberries as a model system to determine which insecticides would provide protection against BVW larvae.Special attention was paid to determine whether there was a dose-response for Acelepryn and BAS 320, to compare neonicotinoids, and to compare preventive preplant incorporation into potting media with curative drenches targeting 3rd instars.Strawberry daughter plants were taken from research plots at the Valley Laboratory on 16 Nov 2006.Cultivars used were 'Allstar', 'Annapolis', 'Darselect', 'Idea' (two replicates), and 'Jewel'.Black vine weevil eggs were obtained from a colony at the Valley Laboratory.About 200 adults were enclosed in a 20 L plastic bucket with yew foliage, and eggs were collected by shaking foliage on a weekly basis.Pots were repeatedly infested in January and early February until there were 45 eggs added per pot.Eggs were placed 1 – 2 cm deep in the soil, close to the crown of the plant. Larvae were counted on April 16 and 17 by sifting through the potting media shaken from the strawberry root system.

All preplant potting mix incorporation treatments, including the positive control standard Talstar 0.2G, were completely effective (Table 42).All tested concentrations of BAS 320i caused complete mortality.Although the Acelepryn pretreatment was completely effective, only the higher dosage of this product applied as an early curative drench suppressed the BVW population.Neonicotinoid products performed poorly against BVW larvae as early curative drench treatments.Results with *Metarhizium anisopliae* were disappointing.Cool temperatures and poor quality inoculum may have contributed to its ineffectiveness in this experiment.

**Table 42. Efficacy of several insecticides for Black Vine Weevilon Strawberry (*Fragraria sp.)*, Cowles, 2007.**

| Treatment | Application Method | Application Date | Rate | Active Ingredient (mg/pot)[z] | Number of Larvae 10 weeks after last infestation [y, x] | Percent Control |
|---|---|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Curative drench | Mar 15 | 0.8 fl oz/100 gal | 0.873 | 4.8 a | 0 |
| | | | 6.5 fl oz/100 gal | 7.07 | 0.8 cd | 75 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Pre-plant incorporation | Nov 10 | 5 ppm | 3.02 | 0.0 d | 100 |
| | | | 10 ppm | 6.03 | 0.0 d | 100 |
| | | | 20 ppm | 12.1 | 0.0 d | 100 |
| Arena 50WDG (clothianidin) | Curative drench | Mar 15 | 1.28 oz/100 gal | 4.79 | 5.4 a | 0 |
| BAS 320i SC (metaflumizone) | Curative drench | Mar 15 | 50 ppm | 30.2 | 0.0 d | 100 |
| | | | 100 ppm | 60.4 | 0.0 d | 100 |
| BAS 320i EC (metaflumizone) | Pre-plant incorporation | Nov 10 | 25 ppm | 15.1 | 0.0 d | 100 |
| | | | 50 ppm | 30.2 | 0.0 d | 100 |
| | | | 100 ppm | 60.4 | 0.0 d | 100 |
| | | | 200 ppm | 121 | 0.0 d | 100 |
| Discus (imidacloprid + cyfluthrin) | Curative drench | Mar 15 | 13 fl oz/100 gal | 1.0 + 0.239 | 4.2 ab | 0 |
| Flagship 25WDG (thiamethoxam) | Curative drench | Mar 15 | 8 oz/100 gal | 0.5 | 3.8 ab | 0 |
| *Metarhizium anosipliae* | Soil incorporation | Jan 9 | $4.5 \times 10^8$ spores/L | 28.3 | 4.8 a | 0 |
| Safari 20SG (dinotefuran) | Curative drench | Mar 15 | 24 oz/100 gal | 27.0 | 1.0 bcd | 69 |
| Talstar 0.2G (bifenthrin) | Pre-plant incorporation | Nov 10 | 10 ppm | 6.03 | 0.0 d | 100 |
| Untreated | | | | | 3.2 abc | 0 |

[z]Expressed in µl per pot. This amounts to 1.00 mg of imidacloprid and 0.239 mg cyfluthrin per pot.
[y] Pots were infested repeatedly fromJan 9to Feb 6 until there were 45 eggs added per pot.
[x] Means followed by the same letter do not significantly differ (Fisher's protected LSD test, $P < 0.05$).

**Cowles 2008**

Cowles conducted a second experimentwith potted strawberries to continue investigating dose-response of Acelepryn and BAS 320i, to compare neonicotinoids (Safari vs. Arena), and to compare preventive preplant incorporation into potting media with curative drenches.

Black vine weevil eggs were repeatedly infested to potted strawberries on June 5, 12 and 19, for a total of 123 eggs per pot. Eggs were placed 1 – 2 cm deep in the soil, close to the crown of the plant. Larvae were counted on September 4, 5 and 8 by sifting through the potting media shaken from the strawberry root system.Root systems were rated on a zero to four scale, where 0 indicated total destruction, always involving crown feeding and imminent plant death; 1 was poor roots, in which the living roots were found within a 50 ml volume of medium; 2 was fair, with most of the soil falling away from the roots; 3 was good, with most of the soil being held together by the root system; 4 was excellent, with roots encircling the bottom of the pot and great difficulty in removing soil from the extensive root system.

Recovery of BVW larvae was unusually low, with the untreated Check having one of the lowest numbers and the most extensive root system (Table 43). Two factors other than insecticide treatment probably contributed to poor recovery of larvae: ant predation (maximized by running the trial during the summer) and over-exploitation of food resources by BVW larvae in some treatments.Therefore, the results from this experiment have to be interpreted from the combination of the number of larvae and the root ratings. Based on these data, BAS 320i, applied as preventive preplant incorporation into potting media or curative drenches, should be considered an outstanding material to target control of BVW. Acelepryn looked ineffective at the lower rates used this year compared to those in the 2007 study. Arena was effective applied as a preplant incorporation; in 2007, it was ineffective when applied as a curative drench. Safari 20SG was effective in this year's trial with preplant incorporation while Safari 2G was ineffective. The poorer control from the Safari 2G granules suggests that the product distribution within the mix was inadequate.

BotaniGard ES and WP formulations require further testing before concluding that they have poor potential for control of BVW. It is possible that the dosage applied was inadequate.*Metarhizium*- and Tolfenpyrad-treated pots had uniformly healthy plants and few larvae, however the low counts in the untreated check preclude being able to determine whether these treatments provided significant benefits.

**Table 43. Efficacy of several insecticides for Black Vine Weevilon Strawberry (*Fragraria sp.)*, Cowles, 2008.**

| Treatment | Application Method | Application Date | Rate | Active Ingredient (mg/pot) | Number of Larvae 11 weeks after last infestation [z, y] (% control) | Root Rating[z,x] 11 WAT |
|---|---|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Curative drench | Jul 15 | 0.8 fl oz/100 gal | 0.44 | 4.5 bc (0) | 2.8 ab |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | Pre-plant incorporation | Apr 24 | 1 ppm | 0.22 | 3.8 bcd (0) | 2.7 bc |
| | | | 2 ppm | 0.43 | 10.8 a (0) | 1.0 d |
| | | | 4 ppm | 0.86 | 0.67 e (20) | 4.0 a |
| Arena 50WDG (clothianidin) | Pre-plant incorporation | Apr 24 | 49 mg/pot | 24.7 | 0 e (100) | 4.0 a |
| BAS 320i SC (metaflumizone) | Curative drench | Jul 15, 29, Aug 13, 28 | 16 fl oz/100 gal | 240 | 0 e (100) | 4.0 a |
| BAS 320i EC (metaflumizone) | Pre-plant incorporation | Apr 24 | 1 ppm | 0.22 | 0.50 e (40) | 4.0 a |
| | | | 2 ppm | 0.43 | 0.33 e (60) | 4.0 a |
| | | | 4 ppm | 0.86 | 0 e (100) | 4.0 a |
| BotaniGard ES (*Beauveria bassiana*) | Curative drench | Jul 15, 29, Aug 13, 28 | 39 µL/pot | | 4.2 bc (0) | 1.3 d |
| BotaniGard WP (*Beauveria bassiana*) | Curative drench | Jul 15, 29, Aug 13, 28 | 18.7 mg/pot | | 1.2 de (0) | 0.5 d |
| BotaniGard ES (*Beauveria bassiana*) | Pre-plant incorporation | Apr 24 | 39 µL/pot | | 2.0 cde (0) | 1.3 d |
| BotaniGard WP (*Beauveria bassiana*) | Pre-plant incorporation | Apr 24 | 18.7 mg/pot | | 5.8 b (0) | 1.5 d |
| *Metarhizium anisopliae* | Curative drench | Jul 15 | 2.9 g/pot | | 0.67 e (20) | 4.0 a |
| *Metarhizium anisopliae* | Pre-plant incorporation | Apr 24 | 2.9 g/pot | | 0.33 e (60) | 4.0 a |
| Safari 2G (dinotefuran) | Pre-plant incorporation | Apr 24 | 1.23 g/pot | 24.7 | 1.7 cde (0) | 2.7 bc |
| Safari 20SG (dinotefuran) | Pre-plant incorporation | Apr 24 | 24 oz/100 gal | 24.7 | 0 e (100) | 4.0 a |
| Tolfenpyrad | Pre-plant incorporation | Apr 24 | 10 ppm | 2.2 | 0.83 e (0) | 3.8 ab |
| Untreated | | | | | 0.83 e (0) | 4.0 a |

[z] Pots were infested repeatedly from Jun 5, 12 and 19 until there were 123 eggs added per pot.
[y] Means followed by the same letter do not significantly differ (Fisher's protected LSD test, P < 0.05).
[x] Root rating 0-4, where 0 = all roots destroyed, 4 = extensive root system.

**Gilrein 2005**

In 2005, Gilrein tested whether Marathon II, *Metarhizium anisopliae* and Safari as curative applications would control black vine weevil on *Astilbe simplicifolia* 'Pink Sprite'. Laboratory reared black vine weevil larvae were placed into pots on Sept 10, Oct 5, and Oct 26. Treatments were drenched on Nov 5 using 120 ml solution per pot. ANOVA and multiple comparisons among treatment means were performed using a statistical multiple comparison procedure (SuperAnova v. 1.1, Abacus Concepts).

Only *Metarhizium anisopliae* provided both statistically and biologically significant levels of control 47 days after treatment (Table 44). Applications to early instars may have improved control so early curative or preventative applications could have reduced populations to a greater extent.

**Table 44. Efficacy of several insecticides for curative control of Black Vine Weevil on Astilbe (*Astilbe simplicifolia*) 'Pink Sprite', Gilrein, 2005*.**

| Treatment | Rate | Live Grubs per pot 47 DAT (% control)[z] |
|---|---|---|
| Marathon II 2F | 20 g/650 pots | 9.6 bc (18.6%) |
| *Metarhizium anisopliae (Strain F52)* | 14.04 cfu/pot | 2.0 a (83.1%) |
| | 28.08 cfu/pot | 2.6 a (78.0%) |
| | 56.16 cfu/pot | 3.5 a (70.3%) |
| Safari 20SG (dinotefuran) | 12 oz / 100 gal | 9.0 b (23.7%) |
| | 24 oz / 100 gal | 8.7 b (26.3%) |
| Untreated | -- | 11.8 c (0.0%) |

* Not an IR-4 experiment.

[z]Means within columns followed by the same letter are not significantly different at p=0.05 (Fisher's LSD).

**Nielsen 2006**

Nielsen tested nine products for their control of black vine weevil larvae on yew. Treatments consisted of preventative soil mixtures or curative top dressings and drenches approximately 3 weeks before or 2 weeks after infestations, respectively. Incubated, brown vine weevil eggs were obtained from weevils collected from a taxus nursery and maintained in a rearing room on taxus foliage. Plants were maintained outdoors under standard nursery management conditions throughout the growing season. Phytotoxicity was assessed 7 & 14 days after treatment, periodically after that and at the time of efficacy evaluation, when roots were evaluated for phytotoxicity.

Larval establishment in untreated check containers was marginal but sufficient to compare treatment effects. Marathon and Talstar, the industry standards, Metarhizium, Mach 2 and Precise failed in this trial (Table 45). Acelepryn, Celero, and Safari drenches prevented establishment of black vine weevil larvae: No larvae were found in any containers that received these treatments. The Flagship drench was nearly as effective.

No phytotoxicity was observed.

**Table 45. Efficacy of several insecticides for Black Vine Weevilon Yew (*Taxus media densiformis*), Nielsen, 2006.**

| Treatment | Rate | Application Method | Number of larvae per pot 12/6/06 17 WAT[z] |
|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 16 oz/100 gal | 8 oz drench per pot | 0.0 a |
| Celero 16WSG (clothianidin) | 20 oz/100 gal | 8 oz drench per pot | 0.0 a |
| Flagship 25WG (thiamethoxam) | 8 oz/100 gal | 8 oz drench per pot | 0.2 a |
| Mach 2 SC | 2 lb ai/Acre | 8 oz drench per pot | 8.2 b |
| Marathon 1G (imidacloprid) | 0.1 g ai/gal | Premixed into soil media | 3.0 ab |
| *Metarhizium* | 6.25 grams/pot | Premixed into soil media | 9.4 b |
| Precise G & N (acephate) | 6 g product/can | Premixed into soil media | 6.8 ab |
| Safari 20 SG (dinotefuran) | 24 oz/100 gal | 8 oz drench per pot | 0.0 a |
| Talstar 0.2 G(bifenthrin) | 25 ppm | Premixed into soil media | 4.8 b |
| Untreated | | | 4.2 ab |

[z] Means within columns followed by the same letter are not significantly different at p=0.05 (Fisher-Hayter LSD).

**<u>Reding 2004</u>**

In 2004, Reding conducted a series of experiments testing Safari as a tool to manage black vine weevil.

For the first experiment, Rhododendron plants were purchased as 6” plants and transplanted into 2 gallon pots on April 23. The containers were then infested with black vine weevil larvae (40 larvae per pot). Because the larvae were mature and many had begun to pupate by the time the drench was applied, the treatments were considered curative, rescue applications. The containers were put outdoors in a container nursery and irrigated when needed with a drip irrigation system. On April 28, pots were drenched with 240 ml of solution per each 2 gallon pot.On May 14 (16 DAT), the containers were dumped and the soil sifted for black vine weevils. There was no biologically significant impact on black vine weevil larvae with drenches on late instars (Table 46).

For the second experiment, sedum plants were purchased as 4” bare root plants and transplanted into 2 gallon pots on April 15. The drench treatment was applied on June 2 and four hours later each container was infested with 4 adult black vine weevils and caged to prevent the insects from leaving. The containers were put outdoors in a container nursery and irrigated as needed with a drip irrigation system. Plants were evaluated for feeding damage on three dates (Table 47). To determine efficacy, the containers were dumped on October 18 and the roots and soil carefully examined for black vine weevil larvae. Many of the larvae found were within the roots. The plants were destroyed in the process of examination. All Safari drench applications significantly reduced feeding damage and the number of larvae found in Sedum roots.

For the third experiment, yew plants were purchased as 6” bare root plants and transplanted into 2 gallon pots on May 7. The foliar spray was applied on June 2 and four hours later each container was infested with 4 adult black vine weevils and caged to prevent the insects from leaving. The containers were put outdoors in a container nursery and irrigated as needed with a drip irrigation system. Plants were evaluated for feeding damage on three dates. To determine efficacy, the containers were dumped on October 18 and the roots and soil carefully examined for black vine weevil larvae. Many of the larvae found were within the roots. The plants were destroyed in the process of examination. There were no significant differences in the number of larvae or in feeding damage (Table 48).

There was no phytotoxicity on any of the treated plants.

**Table 46. Efficacy of Safari 20SG for Black Vine Weevil on Rhododendron (*Rhododendron sp.*) 'Nova Zembla', Reding, 2004.**

| Treatment | Rate per 100 gal[z] | Insect Counts 5/14/0416 DAT[y] |
|---|---|---|
| *Late Instar Larvae* | | |
| Safari 20SG (dinotefuran) | 12 oz | 3.8 |
| Safari 20SG (dinotefuran) | 24 oz | 3.8 |
| Safari 20SG (dinotefuran) | 48 oz | 2.8 |
| Untreated | | 3.8 |
| *Pupae* | | |
| Safari 20SG (dinotefuran) | 12 oz | 14.3 |
| Safari 20SG (dinotefuran) | 24 oz | 10.6 |
| Safari 20SG (dinotefuran) | 48 oz | 7.0 |
| Untreated | | 14.3 |
| *Adults* | | |
| Safari 20SG (dinotefuran) | 12 oz | 1.5 |
| Safari 20SG (dinotefuran) | 24 oz | 2.0 |
| Safari 20SG (dinotefuran) | 48 oz | 5.2 |
| Untreated | | 3.8 |
| *Total* | | |
| Safari 20SG (dinotefuran) | 12 oz | 19.7 |
| Safari 20SG (dinotefuran) | 24 oz | 15.5 |
| Safari 20SG (dinotefuran) | 48 oz | 15.5 |
| Untreated | | 22.0 |

[z]Treatments were applied as 240 ml of solution to each 10" (2 gallon) pot on April 23, 2004.
[y]There were no statistical differences according to ANOVA and Fisher-Hayter LSD.

**Table 47. Efficacy of Safari 20SG drenches for Black Vine Weevilon Sedum (*Sedum sp.*) 'Vera Jameson', Reding, 2004.**

| Treatment | Rate per 100 gal[z] | Feeding damage[y] | | | Number of live larvae 10/18/04 138 DAT |
|---|---|---|---|---|---|
| | | 6/22/04 20 DAT | 7/27/04 57 DAT | 8/20/04 79 DAT | |
| Safari 20SG (dinotefuran) | 12 oz | 1.5 a | 1.0 a | 1.3 a | 0.0 a |
| Safari 20SG (dinotefuran) | 24 oz | 0.6 a | 0.5 a | 0.3 a | 0.0 a |
| Safari 20SG (dinotefuran) | 48 oz | 0.6 a | 0.3 a | 0.1 a | 0.5 a |
| Untreated | | 8.8 b | 10.0 b | 6.8 b | 8.3 b |

[z]Treatments were applied as 240 ml of solution to each 10" (2 gallon) pot on June 2, 2004.
[y] Means within columns followed by the same letter are not significantly different at p=0.05 (Fisher-Hayter LSD).

**Table 48. Efficacy of Safari 20SG drenches for Black Vine Weevilon Yew (*Taxus sp.*) 'Brownii', Reding, 2004.**

| Treatment | Rate per 100 gal[z] | Feeding damage | | | Number of live larvae 10/18/04 138 DAT |
|---|---|---|---|---|---|
| | | 6/22/04 20 DAT[y] | 7/27/04 57 DAT | 8/20/04 79 DAT | |
| Safari 20SG (dinotefuran) | 12 oz | 2.3 | 3.0 | 2.0 | 4.0 |
| Safari 20SG (dinotefuran) | 24 oz | 0.5 | 0.4 | 0.3 | 0.5 |
| Safari 20SG (dinotefuran) | 48 oz | 1.0 | 1.3 | 1.0 | 3.8 |
| Untreated | | 2.5 | 2.8 | 1.5 | 5.5 |

[z]Treatments were applied as 240 ml of solution to each 10" (2 gallon) pot on June 2, 2004.
[y]There were no statistical differences according to ANOVA and Fisher-Hayter LSD.

**Reding 2006**

*Sedum spurium* 'Vera Jameson' plants, grown in one gallon containers, were used to test the efficacy of soil drench treatments of various products against black vine weevil (BVW). All treatment rates were applied in 200 ml of solution as a surface drench poured over the potting media, on June 5.On June 6, four adult BVW were placed on each caged plant. One additional BVW adult was added to each cage two weeks later.

To determine any differences in insecticidal activity on adults and larvae, efficacy was measured by rating feeding damage on foliage by adults on 8 August (percent of total damaged leaves and number of remaining blossoms per plant) and number of larvae found in the roots, on 2 November. There was a significant difference in percentage of leaves fed on and number of flower blossoms on untreated and Acelepryn treated plants compared to Celero and Safari treated plants (Table 49). There was also a significant difference in numbers of larvae recovered from untreated plants compared to all three insecticide treatments

**Table 49. Efficacy of several insecticides for Black Vine Weevilon Sedum (*Sedum spurium)* 'Vera Jameson', Reding, 2006.**

| Treatment | Rate per 100 gal[z] | Percentage of leaves with feeding damage[y] | Mean # of Sedum Blooms | Mean number of larvae per plant 149 DAT |
|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 47.9 oz | 93.2 a | 2.5 a | 1.0 b |
| Celero 16WSG (clothianidin) | 4 oz | 21.5b | 11.8b | 0.0b |
| Safari 20SG (dinotefuran) | 24 oz | 22.0b | 9.8b | 0.0b |
| Untreated | | 93.2a | 1.8a | 12.2a |

[z]Each treatment was drenched onto soil using 200 ml per plant.
[y]Means within columns followed by the same letter are not significantly different ANOVA (*P* = 0.05), means separated by LSD ($\alpha = 0.05$).

## *Comparative Efficacy on Japanese Beetle Grubs (Popillia japonica)*

The Japanese beetle (*Popillia japonica*) is a widespread and destructive exotic pest of turf, landscape, and ornamental plants in the United States. Outside of its native Japan, it is also found in China, Russia, Portugal, and Canada. Since the first detection in the US in a nursery near Riverton, New Jersey in 1916, it has spread to many states east of the Mississippi River, as well as parts of Wisconsin, Minnesota, Iowa, Missouri, Nebraska, Kansas, Arkansas and Oklahoma. Despite regulatory efforts, by 2002 it has become established in at least 30 states. Occasional introductions are made into western states such as California and Oregon when the adult beetles or larvae are shipped in commerce.

The Japanese beetle has a total host range of more than 400 plant species, including turf, ornamentals, fruits, and vegetables. Currently the Japanese beetle is the most widespread pest of turf and costs the turf and ornamental industry approximately $450 million each year in management alone (http://ohioline.osu.edu/hyg-fact/2000/2504.html, http://edis.ifas.ufl.edu/IN630).

IR-4 sponsoreda couple experiments on JB larvae and several experiments on the larvae [See Comparative Efficacy on Japanese Beetle Adults (Popillia japonica)].

## Braman 2006

In 2006, Braman tested seven products as soil applications for efficacy on Japanese beetle grubs infesting Caldwell Pink Roses. Pots were treated on June 13 with drenches or surface application of granular products. On August 2 (50 DAT), five replications of the 8 treatments were infested with 5 second instar grubs recovered from turf plot cages used to enable adult beetles to lay eggs and larvae to grow. Pots were destructively sampled on August 16 (64 DAT) and evaluated for surviving larvae. Data were subjected to ANOVA using the GLM procedure of SAS.

Recovery in control pots was 92% of the original larvae used to infest the pots. Although mortality ranged from 8 to 60%, differences among treatments were not significant (Table 50). Several factors could have contributed to the lack of mortality observed including evaluating populations at 2 weeks instead of 4 weeks post infestation and infesting 5 weeks after application date

## Braman 2007

In the experiment conducted in 2007, Braman examined 5 products for efficacy on Japanese beetle grubs infesting rose. Caldwell Pink roses, grown in 3 gallon pots, were treated (drenched) July 17. Design was a randomized complete block with 5 replications. Ten, first instar grubs were inserted into pots by inserting a pencil into the pots and dropping in the larvae on July 19. Pots were destructively sampled on October 5 (80 DAT) and the number of grubs were recorded. Data were analyzed using the GLM procedure of SAS and mean separation was by LSD.

Very few grubs survived in the pots. Differences were only significant at the 10% level and all treatments were equivalent to the UTC (Table 51).

**Table 50. Efficacy of several insecticides for *Popillia japonica* on rose (*Rosa sp.)* 'Caldwell Pink', Braman, 2006.**

| Treatment | Rate per 100 gal | Number of Grubs per Pot 2 weeks after infestation (64 DAT) $^{z}$ |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 oz, Apply 1 pint per 2.25 sq ft | 3.8 a |
| Celero 16WSG (clothianidin) | 0.5 oz, Apply 1 pint per 2.25 sq ft | 3.4 a |
| Flagship 25WG (thiamethoxam) | 5 oz | 3.6 a |
| Precise (acephate) | 3 tsp/pot | 2.8 a |
| Safari 20 SG (dinotefuran) | 24 oz | 3.6 a |
| Scimitar (lambda-cyhalothrin) | 60 oz | 2.0 a |
| Tristar 70 WSP (acetamipid) | 8 oz | 2.8 a |
| Untreated | | 4.6 a |

$^{z}$ Means followed by the same letter are not significantly different, P> 0.05

**Table 51. Efficacy of several insecticides for *Popillia japonica* on rose (*Rosa sp.)* 'Caldwell Pink', Braman, 2007.**

| Treatment | Rate per 100 gal | Drench Volume per pot | Number of Grubs per Pot 80 DAT [z] |
|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 oz | 100 ml | 0.80 a |
| BAS 320i (metaflumizone) | 16 oz | 400 ml | 1.60 a |
| Celero 16/WSG (clothianidin) | 16 oz | 500 ml | 0.80 a |
| Met 52 (*Metarhizium anisopliae*) | 58 oz | 400 ml | 1.00 a |
| Talstar (bifenthrin) | 80 oz | 400 ml | 0.80 a |
| Untreated | | | 1.00 a |

[z] Means followed by the same letter are not significantly different, P> 0.05

### *Comparative Efficacy on May/June Beetle Grubs (Phyllophaga spp.)*

True white grubs are the larvae of May beetles (also called June Beetles) found in the genus *Phyllophaga*, of which there are over 100 different species. *Phyllophaga* spp. and related insects are distributed throughout the United States and Canada. Larvae can be very damaging to the roots of ornamental plants grown in nurseries.

In 2008, Buss evaluated three products as soil applications on live oak trees that were severely infested with white grubs (primarily *Phyllophaga* spp.). The 40-inch diameter root ball of each tree served as a "plot". Roots had been cut several months before the test, and the balls had been placed in burlap-wrapped wire baskets with frequent irrigation. The treatments were applied on 19 May 2008. Liquid treatments were applied to the surface area beginning at the outside edge of the ball to the trunk, then, applying similarly on four sides of the tree (90º perpendicular to the one previously administered). Trees that received the CoreTect treatment had 12 tablets each, inserted 4 inches deep, spaced 5 inches apart within the root ball. About 0.17 inch of post-treatment irrigation was immediately applied. Destructive sampling evaluation was conducted (29 August; 2-4 September 2008). The entire basket of each tree was lifted out of the ground, the burlap was removed from the root ball, and the entire root ball was sifted by hand for all grubs.

The two higher rates of Acelepryn reduced the number of May/June beetle and other grubs compared to the untreated Control, and were comparable to the standard Merit 75WP in efficacy (Table 52). Although CoreTect tablet provided the best efficacy, it is not a good formulation for nursery work, given the labor-intensive method of placing the tablets into the soil and the large number of trees that would need to be treated.

**Table 52.Efficacy of several insecticides for May/June Beetle Grubs (*Phyllophaga spp*)on Live Oak (*Quercus virginiana)* 'Highrise', Buss, 2008*.**

| Treatment | Rate per acre[z] | Mean #. of *Phyllophaga* grubs per tree[y] 15 WAT | Mean # of all grub species[x] per tree 15 WAT |
|---|---|---|---|
| Acelepryn 1.67SC (chlorantraniliprole) | 8 fl oz | 181.0 b | 203.2 bc |
| Acelepryn 1.67SC (chlorantraniliprole) | 12 fl oz | 87.8 ab | 113.4 ab |
| Acelepryn 1.67SC (chlorantraniliprole) | 16 fl oz | 132.0 ab | 159.4 ab |
| CoreTect (imidacloprid) | 3 tablets per inch trunk diam. | 55.8 a | 76.2 a |
| Merit 75WP (imidacloprid) | 6.4 oz | 119.0 ab | 139.8 ab |
| Untreated | | 293.8 c | 315.4 c |

* Not an IR-4 experiment.

[z] Each treatment was applied onto soil on 19 May, 2008.

[y] Means within columns followed by the same letter are not significantly different (Tukey's HSD).

[x]Species identified were May/June beetles (*Phyllophaga* spp.), flower beetle (*Euphoria sepulcralis*) and ox beetle (*Strategus antaeus*).

### *Comparative Efficacy on Oriental Beetle (Anomala orientalis)*

The oriental beetle is one of the important soil pests of nursery ornamental plants and turf grasses. Four researchers examined the efficacy of 14 products and unregistered materials for managing oriental beetle grubs (Table 53). The products tested included Acelepryn, BAS 320i, Celero 16 WSG, Discus, Dylox, Flagship, Marathon, Safari 20SG, Talstar and Tick-EX. In general, treatments were more effective when applied to less mature grubs. In tests targeted to newly-hatched and 2nd instar larvae, Aceepryn, BAS 320i, Flagship and Safari generally provided good control but were ineffective in two trials targeted to 3rd instar larvae. In a Freiberger 2005 trial on natural infestation of oriental beetle, products provided more reduction of grubs when applied in summer compared to fall application. These results suggest that growers and landscapers should target applications at or immediately after peak oriental beetle mating flights.

**Table 53.Summary of Oriental Beetle Grub (*Anomala orientalis*) Efficacy.**

| **Treatments** | **Alm 2008** | **Alm 2006** | **Freiberger 2005** | | **Freiberger 2009** | **Gilrein 2005** | **Gilrein 2007** | **Reding 2009** | |
|---|---|---|---|---|---|---|---|---|---|
| | **Rhododendron** | **Yew** | **Arborvitae** | **Holly** | **Arborvitae** | **Lawn Grass** | **Lawn Grass** | **Lilac** | **White Oak** |
| | **17 WAT** | **20 WAT** | | | | **53 DAT** | **30 DAT** | **14 WAT** | **22 WAT** |
| | **20 larvae, 2nd instar** | **20 larvae, 2nd instar** | **Natural infestation** | **Natural infestation** | **Natural infestation** | **10 larvae, 3rd instar** | **10 larvae, 3rd instar** | **20 eggs** | **20 eggs** |
| | **Container** | **Container** | **In Ground** | **In Ground** | **In Ground** | **Container** | **Container** | **Container** | **Container** |
| | **Preventative** | **Preventative** | **Preventative** | **Preventative** | **Preventative** | **Curative** | **Curative** | **Early Curative** | **Early Curative** |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | + | ++ | - | +/- | + | - | - | ++ | ++ |
| BAS 320i (metaflumizone) | ++ | | | | - | | - | | |
| Cal-Agri 50 1 % (potassium phosphate) | | | | | | - | | | |
| Celero 16WSG (clothianidin) | | +/- | - | - | | + | | | |
| Discus (imidaclorid + cyfluthrin) | | | - | +/- | | | | | |
| Dylox 80S (trichlorfon) | | | | | | | + | | |
| Flagship (thiamethoxam) | | | - | +/- | + | | - | ++ | ++ |
| Hexacide (rosemary oil) | | | | | | | - | | |
| Marathon II 2F (imidacloprid) | | | | | + | + | | | |
| Safari 20SG (dinotefuran) | ++ | ++ | | | - | | - | ++ | ++ |
| Talstar G (bifenthrin) | ++ | | | | | | | | |
| Met52 (*Metarhizium anisopliae*) | - | | | | | - | | | |
| Sevin XLR 4F (carbaryl) | | | | | | - | | | |
| Tick-EX (*Metarhizium anisopliae*) | | | | | | | - | | |

[1] Rating Scale: ++ = clearly statistically better than untreated and greater than 95% control; + = statistically better than untreated and between 85 and 95% control; +/- statistically better than untreated with control between 70 and 85%; - = statistically equivalent to untreated and/or efficacy less than 70%.
[2] Where more than one rate or application type for a product was included in the experiment and each performed statistically different, the better rating is provided in this table.

**Alm 2006**

As part of a combined study examining Acelepryn, Celero, and Safari for black vine weevil and oriental beetle control, Alm collected 500 second instar oriental beetle larvae from turf and placed 20 larvae on the surface of each pot containing yew ‘Nigra’ on Aug 31.Drenches of Acelepryn, Celero, and Safari were applied as preventative treatments on July 11. See Comparative Efficacy on Black Vine Weevil (Otiorhynchus sulcatus) for the results on black vine weevil.

Pots were destructively harvested 20 weeks after application. All three products did provide significant control of oriental beetle larvae (Table 54).

No phytotoxicity was observed.

**Table 54. Efficacy of several insecticides for Oriental Beetle grubs on Yew (*Taxus media)* ‘Nigra’, Alm, 2006.**

| Treatment | Rate per 100 gal [z] | Mean Number Larvae per pot 20 WAT (Nov 9, 2006) [z] |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 6.47 fl oz | 0.0 ± 0.0 a |
| Celero 16WSG (clothianidin) | 1.2 oz | 1.2 ± 0.6 a |
| Safari 20SG (dinotefuran) | 24 oz | 0.0 ± 0.0 a |
| Untreated | | 7.6 ± 1.1 b |

[z] Means in the same column followed by the same letter are not significantly different, (*P* = 0.05, LSD test).

**Alm 2008**

In 2008 Alm evaluatedseveral insecticides applied as preventative treatments for oriental beetle control.Acelepryn, BAS 320i, and Safari were applied as drenches while Met52G and Talstar were incorporated with the potting mix on July 25 prior to planting. Alm collected 720 second instar oriental beetle larvae from turf and placed 20 larvae on the surface of each potcontaining rhododendron ‘Scintillation’ on Aug 25.

BAS 320i, Safari 20 SG and Talstar Nursery Granular treatments provided 100% control of oriental beetle larvae (Table 55);Acelepryn also provided excellent control of larvae and was not significantly different from these treatments. Met 52 G was not significantly different from the untreated pots.

**Table 55. Efficacy of several insecticides for Oriental Beetle grubs on Rhododendron (*Rhododendron sp.)* ‘Scintillation’, Alm, 2008.**

| Treatment | Rate per 100 gal | Mean Number Larvae per pot 17 WAT (Nov 5, 2008) [z] |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz | 1.7 ± 0.3b |
| BAS 320i (metaflumizone) | 16 fl oz | 0.0 ± 0.0 b |
| Met52G (*Metarhizium anisopliae* strain F52) | 20 g/4 gal media | 10.2 ± 0.9a |
| Safari 20SG (dinotefuran) | 24 oz | 0.0 ± 0.0 a |
| Talstar Nursery Granular (bifenthrin) | 33.7 g/4 gal media | 0.0 ± 0.0 b |
| Untreated | | 11.7 ± 1.4a |

[z] Means in the same column followed by the same letter are not significantly different, (*P* = 0.05, LSD test).

**Freiberger 2005**

Arborvitae ‘Emerald’ and Holly ‘Blue Girl’ were planted into field soil at Rutgers UniversityTree Fruit Research & Extension Center in Cream Ridge, NJ. The field where the arborvitae andholly were planted had formerly been planted with strawberries heavily infested with orientalbeetle. In 2005, four products were drenched once either during summer (Aug 3) or fall (Nov 1)with 1 pint of diluted product per plant – Acelepryn (chlorantraniliprole), Celero (clothianadin), Discus (bifenthrin +imidacloprid), and Flagship (thiamethoxam). Starting April 24, 2006, arborvitae and holly plants were destructively harvested and the number of oriental beetle larvae in and around each root ball was counted.

Timing of the applications was critical. When thedrenches occurred in the summer all products significantly reduced larvae on both crops (Table 56).However, when the drench applications occurred in the fall, only Acelepryn exhibited a statistically significant reduction in population on arborvitae; and for holly, Acelepryn, Celero, and Discus reduced oriental beetle grubs.

No phytotoxicity was observed.

**Table 56. Efficacy of several insecticides for Oriental Beetle on Arborvitae (*Thuja sp)* 'Emerald Giant'and holly (*Ilex sp*) 'Blue Girl' – Number of Grubs, Freiberger, 2005.**

| Treatment [z] | Rate per 100 gal | Mean number of larvae per plant [y] | | | |
|---|---|---|---|---|---|
| | | Arborvitae | | Holly | |
| | | Summer Drench | Fall Drench | Summer Drench | Fall Drench |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz | 2.2 a | 4.5 a | 0.8 a | 1.2 a |
| Celero 16WSG (clothianidin) | 0.5 oz | 2.6 ab | 4.6 ab | 1.7 a | 1.7 a |
| Discus (imidacloprid + cyfluthrin) | 10.0 oz | 3.7 ab | 5.0 ab | 0.7 a | 0.8 a |
| Flagship (thiamethoxam) | 0.4 oz | 4.2 b | 4.9 ab | 0.9 a | 2.2 ab |
| Untreated | | 6.3 c | 6.3 b | 3.0 b | 4.0 b |

[z]Each plant was drenched with 1 pint of solution.

[y]Means within columns followed by the same letter are not significantly different according to Fisher-Hayton (P<0.05).

**Table 57. Efficacy of several insecticides for Oriental Beetle on Arborvitae (*Thuja sp)* 'Emerald Giant'and holly (*Ilex sp*) 'Blue Girl' – Plant Height, Freiberger, 2005.**

| Treatment [z] | Rate per 100 gal | Plant Height [y] | | | |
|---|---|---|---|---|---|
| | | Arborvitae | | Holly | |
| | | Summer Drench | Fall Drench | Summer Drench | Fall Drench |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz | 41.3 a | 43.7 a | 16.3 b | 15.5 b |
| Celero 16WSG (clothianidin) | 0.5 oz | 43.8 a | 44.0 a | 17.4 b | 18.0 c |
| Discus (imidacloprid + cyfluthrin) | 10.0 oz | 41.9 a | 42.4 a | 13.9 a | 13.2 a |
| Flagship (thiamethoxam) | 0.4 oz | 43.4 a | 42.6 a | 14.4 a | 15.4 ab |
| Untreated | | 42.4 a | 43.5 a | 15.8 ab | 16.2 bc |

[z] Each plant was drenched with 1 pint of solution.

[y] Means within columns followed by the same letter are not significantly different according to Fisher-Hayton (P<0.05).

**<u>Freiberger 2009</u>**

A field known to be infested with oriental beetle at Rutgers University Tree Fruit Research & Extension Center in Cream Ridge, NJ was planted with arborvitae (*Thuja sp.*) in the spring of 2007. The established saplings were treated with drenches or granular broadcast applications during the peak adult flight in August 2009. The products tested included BAS 320i (metaflumizone), Acelepryn (chlorantraniliprole), Flagship 0.22G (thiamethoxam), Flagship 25WG (thiamethoxam), Marathon II (imidacloprid), Safari 2G (dinotefuran), and Safari 20SG (dinotefuran). Starting April 5, 2010, arborvitae were destructively harvested and the number of oriental beetle larvae in and around each root ball was counted.

The outcome of this experiment was intriguing. While some products did decrease the average number of grubs on arborvitae, the average height did not appear to be shorter for those treatments with higher grub infestations nor did the average width correlate with the average number of grubs. In other words, the variability in arborvitae height and width observed at this site was not related the number of grubs attacking the roots in this experiment. The products with the least number of Oriental Beetle larvae included Acelepryn, Flagship 0.22G, Flagship 25WG, and Marathon II.

No phytotoxicity was observed.

**Table 58. Efficacy of Seven Products to Reduce Oriental Beetle Populations on Arborvitae, Freiberger, 2009.**

| Treatment | Rate | Average Number of Grubs per Tree | Average Tree Height | Average Tree Width |
|---|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz | 1.1 a | 56.2 a | 31.7 b |
| BAS 320i (metaflumizone) | 16 oz per 100 gal | 6.6 bc | 52.9 a | 31.2 ab |
| Flagship 0.22G (thiamethoxam) | 11.25 g product per 9 sq ft | 2.2 a | 53.1 a | 30.2 ab |
| Flagship 25WG (thiamethoxam) | 0.1 g product per 9 sq ft in ½ gal water | 1.1 a | 53.3 a | 30.2 ab |
| Marathon II (imidacloprid) | 0.6 fl oz per 1,000 sq ft in 10 gal water | 1.2 a | 53.4 a | 31.5 ab |
| Safari 2G (dinotefuran) | 120 grams per inch dbh for trees | 6.2 b | 55.7 a | 32.5 b |
| Safari 20SG (dinotefuran) | 12 grams per inch dbh for trees | 6.9 bc | 53.5 a | 31.8 b |
| Untreated | | 8.7 c | 52.3 a | 28.3 a |

[z] Mean number of grubs counted in approximately 3.5 cu ft of soil per tree.
[y]Means within column followed by the same letter are not significantly different (P>0.05, Fishers LSD).

**<u>Gilrein 2005</u>**

In 2005, Gilrein examined drenches of five products to manage oriental beetle larvae in lawn-type grass grown in pots. After grass was well established in 1 gal pots, third instar larvae were collected and 10 place in each pot on Oct 21 and Oct 24. Treatments were applied on Nov 4 and pots were destructively harvested on Dec 27. ANOVA and multiple comparisons among treatment means were performed using a statistical multiple comparison procedure (SuperAnova v. 1.1, Abacus Concepts).

Only Celero and Marathon provided good control of third instar grubs (Table 59). Acelepryn, Cal-Agri, *Metarhizium anisopliae* and Sevin did not provide acceptable control in this test. First or second instar larvae may be more susceptible to these products.

**Table 59. Efficacy of several insecticides for Oriental Beetle (*Anomala orientalis)* on lawn type grass, Gilrein, 2005*.**

| Treatment | Rate | Live Grubs per pot (% control) 53 DAT z |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 11.5 fl oz/A | 8.2 cd (4.7%) |
| | 23 fl oz/A | 7.6 bcd (11.6%) |
| | 46 fl oz/A | 7.1 bc (17.4%) |
| Cal-Agri 50 1% (potassium phosphate) | 128 fl oz/100 gal | 8.6 d (0.0%) |
| Celero 16WSG (clothianidin) | 4 oz/1320 pots | 0.6 a (93.0%) |
| Marathon II 2F (imidacloprid) | 20 g/650 pots | 1.1 a (87.2%) |
| | 20 g/244 pots | 0.6 a (93.0%) |
| *Metarhizium anisopliae (Strain F52)* | 14.04 cfu/pot | 7.1 bc (17.4%) |
| | 28.08 cfu/pot | 6.3 b (26.7%) |
| Sevin XLR 4F (carbaryl) | 6 fl oz/1000 sq ft | 7.7 bcd (10.4%) |
| Untreated | | 8.6 d (0.0%) |

* Not an IR-4 experiment.

zMeans within columns followed by the same letter are not significantly different at p=0.05 (Fisher's LSD).

**Gilrein 2007**

In 2007, Gilrein compared several insecticide drenches to control oriental beetle larvae in lawn-type grass grown in pots. After grass was well established in 1 gal pots, third instar larvae were collected and 10 place in each pot on Nov 5. Treatments were applied on Nov 7 and pots were destructively harvested on Dec 7. ANOVA and multiple comparisons among treatment means were performed using a statistical multiple comparison procedure (SuperAnova v. 1.1, Abacus Concepts).

Only Dylox provided good control of third instar grubs (Table 60).Acelepryn, BAS 320i, Flagship, Hexacide, Safari and Tick-EX did not provide acceptable control in this test.

**Table 60. Efficacy of several insecticides for Oriental Beetle (*Anomala orientalis)* on lawn type grass, Gilrein, 2007.**

| Treatment | Rate | Live Grubs per pot (% control) 30 DAT z |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz/100 gal | 4.4 bc (37) |
| | 3.2 fl oz/100 gal | 5.2 bcd (26) |
| BAS 320i 240SC | 16 fl oz/100 gal | 8.3 ef (0) |
| Dylox 80S (trichlorfon) | 3.75 oz/100 gal | 0.5a (93) |
| Flagship 25WG (thiamethoxam) | 8 oz/100 gal | 3.8 b (46) |
| | 17 oz/100 gal | 4.2 bc (40) |
| Flagship 0.22G (thiamethoxam) | 6 g/pot | 3.7 b (47) |
| Hexacide (rosemary oil) | 1.5 qt/100 gal | 4.8 bc (31) |
| Safari 20SG (dinotefuran) | 24 oz/100 gal | 6.2 cde (11) |
| Tick-EX EC 11% (*Metarhizium anisopliae Strain F52*) | 21 fl oz/100 gal | 8.4 f (0) |
| | 29 fl oz/100 gal | 7.8 ef (0) |
| Untreated | | 7.0 def (0) |

z Means within columns followed by the same letter are not significantly different at p=0.05 (Fisher's LSD).

**Reding 2006**

Lilac (*Syringa vulgaris*) plants were used to determine efficacy of soil drenches of various products against oriental beetle larvae (*Anomala orientalis*). Bare root lilacs were planted in one gallon pots on April 17, 2006 for the study. All treatment rates were applied in 200 ml of solution as a surface drench poured over the potting media, on June 5.Each lilac plant was then placed in a separate cage. On June 12 three pairs (male/female) ofOBs were placed on each caged plant.

To determine efficacy, plant roots and potting media were searched for oriental beetle larvae on September19, 2006. No larvae were found in any of the treatments, including the untreated controls, therefore no efficacy data was acquired (Table 61).Foliar feeding damage by adult OBs could not be accessed on lilac because feeding by adults is minimal. Adult OBs were observed within the cages, on the lilac plants and potting media surface for several weeks after infestation, subsequently the lack of larvae in all pots was unexpected.

**Table 61. Efficacy of several insecticides for Oriental Beetle on Lilac (*Syringa vulgaris)*, Reding, 2006.**

| Treatment | Rate per 100 gal [z] | Mean number of larvae per plant[y] |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 47.9 oz | 0.0 a |
| Celero 16WSG (clothianidin) | 4 oz | 0.0 a |
| Safari 20SG (dinotefuran) | 24 oz | 0.0 a |
| Untreated | | 0.0 a |

[z]Each treatment was drenched onto soil using 200 ml per plant.

[y]Means within columns followed by the same letter are not significantly different ANOVA (*P* = 0.05), means separated by LSD ($\alpha$ = 0.05).

**Reding 2009**

In 2009 Reding evaluated the efficacy of soil drench applications of Acelepryn, Flagship and Safari against oriental beetle larvae. Bare root lilacs (*Syringa x chinensis*) and white oaks (*Quercus alba*) were planted in two gallon pots on April23, 2009 for the study.Each plant was infested with 20 eggs on July16. Insecticides were applied in 300 ml of solution as a surface drench poured over the potting media, on July 21.To determine efficacy, oaks were evaluated on October 29and lilacs on November19, 2009. Plant roots and potting media were searched for oriental beetle larvae.

All insecticides prevented infestation by oriental beetle on both species of plants (Table 62).

**Table 62. Efficacy of several insecticides for Oriental Beetle on Lilac (*Syringa x chinensis)* and White Oak (*Quercus alba*), Reding, 2009.**

| Treatment | Rate per 100 gal [z] | Mean number of larvae per plant [y] | |
|---|---|---|---|
| | | Lilac 14 WAT | Oak 17 WAT |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 32 fl oz | 0.0 b | 0.0 b |
| Flagship 25WG (thiamethoxam) | 8 oz | 0.0 b | 0.0 b |
| Safari 20SG (dinotefuran) | 24 oz | 0.0 b | 0.0 b |
| Untreated | | 2.6 a | 3.0 a |

[z] Each treatment was drenched onto soil using 300 ml per plant.

[y] Means within columns followed by the same letter are not significantly different ANOVA (*P* = 0.05), means separated by LSD ($\alpha$ = 0.05).

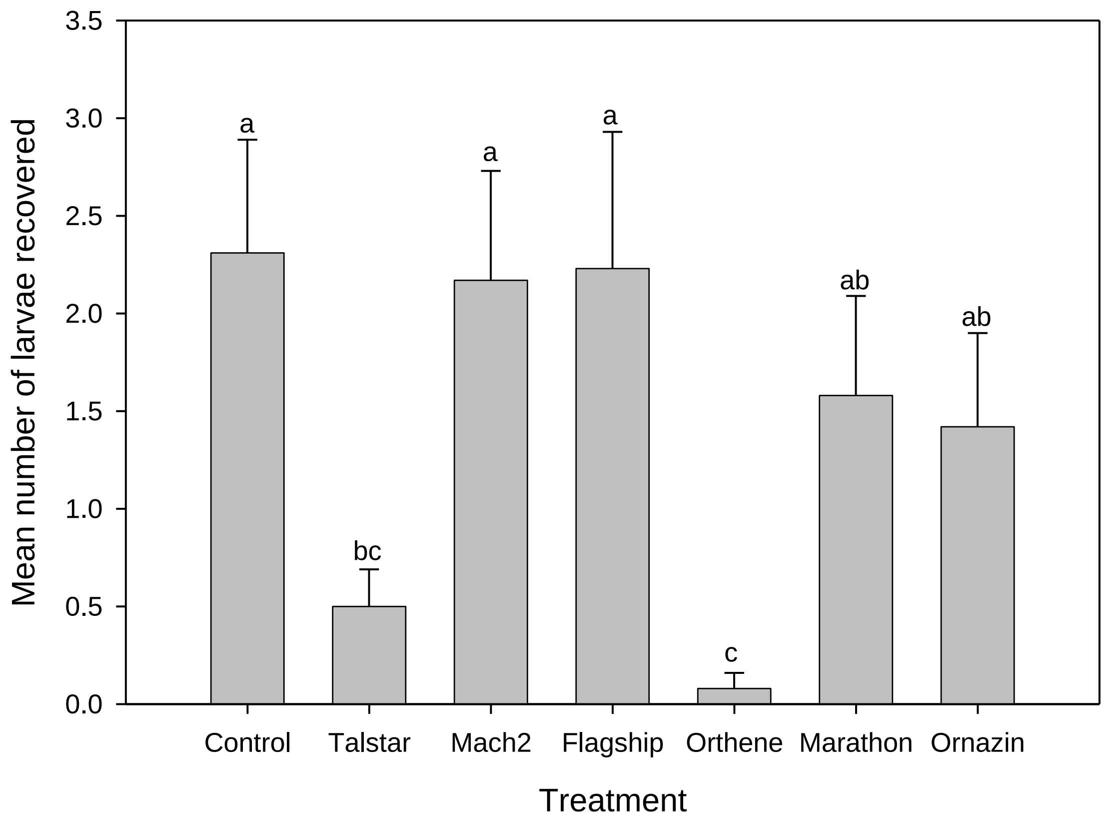
### ***Comparative Efficacy on Strawberry Rootworm (Paria fragariae)***

The strawberry rootworm, *Paria fragaria*e Wilcox, is a beetle that is a pest of strawberries, blueberries, and even greenhouse roses. It is becoming amajor insect pest in container azalea production.

Two experiments were conducted for efficacy on strawberry rootworm infesting azalea. In 2005, Hesselein examined six products: Flagship, Mach2, Marathon, Ornazin, Orthene, and Talstar. At 21 days after inoculation plants were treated with one of eight treatments: water-treated control, Flagship (thiamethoxam) at 0.18 oz/1000 sq ft, Mach 2 (halofenozide) at 2.9 fl oz/1000 sq ft, Marathon 60 WP (imidacloprid) at 20 gm/ 3000 sq ft, Ornazin (azadirachtin) at 10 oz/ 100 gal, Orthene 97 (acephate) at 12 oz/ 100 gal, and Talstar N (bifenthrin) at 25 fl oz/ 100 gal. Each treatment was replicated five times. Drench volume was calculated based on 20% of the container volume.Of these treatments, the best control was achieved with Orthene and Talstar (Graph 63).

In 2007 the strawberry rootworm populations were not sufficiently high to provide a good test of the six treatments planned for that year (Table 64).

**Graph 63. Efficacy of several insecticides for Strawberry Rootworm larvae (*Paria fragariae*) on Azalea (*Rhododendron sp.*), Hesselein, 2005.**




Treatment columns topped by the same letter are not different, α=0.05.

**Table 64. Efficacy of several insecticides for Strawberry Rootworm (Paria fragariae) on Azalea (*Rhododendron sp.*), Hesselein, 2007.**

| Treatment | Rate per 100 gal | Adults collected on sticky cards | |
|---|---|---|---|
| | | 9/25 & 26 | 11/8 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 0.8 fl oz | 0.29 a | 0 |
| BAS320i (metaflumizone) | 12 fl oz | 0.57 a | 0 |
| Celero (clothianidin) | 12 oz | 0.29 a | 0 |
| DuraGuard | 50 fl oz | 0.29 a | 0 |
| Met52 (*Metarhizium anisopliae Strain F52*) | 58 fl oz | 0.29 a | 0 |
| Safari (dinotefuran) | 24 oz | 0.29 a | 0 |
| Untreated Control | | 0.43 a[z] | 0 |

[z]Means separation tests performed using Tukey's Studentized Range (HSD) Test, $\alpha$=0.05.
Treatments applied on August 23 using 375 ml per pot for all but Met52 which used 750 ml per pot.

## Results: Trunk and Stem Borers

Bark beetles species in general are often difficult to control due to their behavior or physiology. These are often the insects that can impact and kill large trees in the landscape as well as providing a challenge for growers. Many of bark beetles and stem borers are introduced species and have become problematic because native trees and bushes have not co-evolved and are thus more vulnerable. Because the larvae stages feed deep within plant tissues, timing of control measures is critical to achieving a successful reduction in insect populations. The need for effective insecticides for the nursery industry to manage this group of pests is imperative.

### *Comparative Efficacy on Asian Ambrosia Beetle (Xylosandrus crassiusculus)*

The Asian ambrosia beetle or granulate ambrosia beetle, *Xylosandrus crassiusculus,* was introduced into the U.S. from Asia or Africa. In the United States, it is found in Hawaii, Delaware, Maryland, Ohio, and it is widely established in the Southeast. Unlike most ambrosia beetles, this one is known to attack apparently healthy plants. It is reported to attack over 200 species of plants in 41 families, although it prefers hardwoods. Mated females construct galleries, inoculate the wood with the ambrosia fungus, and lay their eggs in excavated galleries of susceptible trees and shrubs. They have become a very important nursery and landscape pest from TX to NJ. In nurseries, seedling and small diameter trees and shrubs are attacked causing girdling, stunting, and death. Asian ambrosia beetle can also attack and kill larger trees, particularly if they are stressed. Between 5 and 10 attacks on trees less than 10 -15 cm in diameter usually kill this sized tree. The trend in the nursery industry is to grow larger trees in larger pots for instant landscapes. As a result there are higher numbers of stressed trees available.

**Ludwig 2004**

In 2004, Ludwig conducted an experiment at the Tram-Tex Nursery in Tyler, TX examining the efficacy of Onyx and Talstar Flowable preventative trunk spray applications against ambrosia beetles on container produced redbuds and Bradford pears.Onyx and Talstar were applied to the tree trunks until run-off.Repeat applications were made once for Onyx and twice for Talstar. Tree trucks were visually inspected once a month for signs of beetle attack.Trees that were attacked in one sample period were not check in following sample periods.

In the first block of redbud trees, both Onyx and Talstar reduced the overall number of ambrosia beetle attacks throughout the experiment from 72% in the untreated control to as low as 41% (Table 65). However, various levels of control were achieved at each reading date.This was probably a result of a beetle flight and the pesticide residues declining over time.Both Onyx and Talstar were applied after the assessment in June.The count on July 16 revealed only beetle attacks in the control plants.The results from this block suggest a shorter spray period should be evaluated.

In the second block of redbud trees, the results were mixed (Table 66). The untreated trees had an attack rate of 40%, but Onyx at 6.4 oz had more attacks. The other two rates of Onyx did reduce attackswith 12.8 oz having no evidence of ambrosia beetle damage. Talstar reduced the attacks down to 5% of the treated trees.

In the Bradford pear block, the untreated trees only had one tree attacked so no conclusions on efficacy can be drawn (Table 67).

**Table 65. Efficacy of Onyx and Talstar for *Xylosandrus crassiusculus* on Redbud (*Cercis canadensis*), Ludwig, 2004a.**

| Treatment [z] | Rate (per 100 gal) | Number New Attacks | | | Total Trees | Percent with Attacks |
|---|---|---|---|---|---|---|
| | | 5/10/04 | 6/10/04 | 7/16/04 | | |
| Onyx (bifenthrin) | 6.4 oz | 1 | 11 | 0 | 24 | 50% |
| Onyx(bifenthrin) | 12.8 | 0 | 7 | 0 | 17 | 41% |
| Onyx(bifenthrin) | 16 oz | 2 | 8 | 0 | 23 | 43% |
| Talstar(bifenthrin) | 40 oz | 3 | 9 | 0 | 22 | 55% |
| Untreated | | 4 | 13 | 4 | 29 | 72% |

[z]The Onyx treatments were applied on 9 April and 15 June.The Talstar treatment was applied on 9 April, 10 May, and 15 June.

**Table 66. Efficacy of Onyx and Talstar for *Xylosandrus crassiusculus* on Redbud (*Cercis canadensis*), Ludwig, 2004b.**

| Treatment [z] | Rate (per 100 gal) | Number New Attacks | | Total Trees | Percent with Attacks |
|---|---|---|---|---|---|
| | | 5/10/04 | 6/10/04 | | |
| Onyx (bifenthrin) | 6.4 oz | 1 | 6 | 12 | 58% |
| Onyx(bifenthrin) | 12.8 | 0 | 0 | 20 | 0% |
| Onyx(bifenthrin) | 16 oz | 2 | 1 | 11 | 27% |
| Talstar(bifenthrin) | 40 oz | 0 | 1 | 22 | 5% |
| Untreated | | 2 | 4 | 15 | 40% |

[z] The Onyx treatments were applied on 9 April and 15 June. The Talstar treatment was applied on 9 April, 10 May, and 15 June.

**Table 67. Efficacy of Onyx and Talstar for *Xylosandrus crassiusculus* on Bradford Pear (*Pyrus sp*), Ludwig, 2004.**

| Treatment [z] | Rate (per 100 gal) | Number New Attacks | | | Total Trees | Percent with Attacks |
|---|---|---|---|---|---|---|
| | | 5/10/04 | 6/10/04 | 7/16/04 | | |
| Onyx (bifenthrin) | 6.4 oz | 0 | 0 | 0 | 26 | 0% |
| Onyx(bifenthrin) | 12.8 | 5 | 3 | 1 | 24 | 37% |
| Onyx(bifenthrin) | 16 oz | 0 | 0 | 0 | 27 | 0% |
| Talstar(bifenthrin) | 40 oz | 1 | 3 | 1 | 20 | 25% |
| Untreated | | 1 | 0 | 0 | 20 | 5% |

[z] The Onyx treatments were applied on 9 April and 15 June. The Talstar treatment was applied on 9 April, 10 May, and 15 June.

**<u>Mizell 2005</u>**

During 2005, Mizell conducted a series of five experiments testing various products for their efficacy in controlling Asian ambrosia beetle. For each experiment, bolts from mimosa (*Albizia julibrissin*) were cut to approximately 46 cm long x 2-7 cm in diameter. Bolts were treated immediately with insecticide by dipping the bolts for 5 sec into the insecticide solution. After the bolts dried a few minutes, they were placed in the field and subjected to a proprietary induction technique and exposed to attack by AAB. Each test consisted of six replicate bolts per insecticide treatment along with six control bolts. Blocks were separated by 20-50 m in a location with known populations and/or active infestations of AAB. AAB attacks observed on each bolt were counted and recorded daily for 7-12 days. The tests were terminated when the number of AAB attacks on the control bolts exceeded an average of 20 per bolt or the time after treatment reached 21 days. Seven to 12 days of field exposure was usually required to attain the number of attacks on the test bolts.The mean number of successful attacks per bolt per treatment was used to evaluate the efficacy of the insecticides.Analysis of variance using the Proc Mixed procedure from SAS 8.1 (Littell et al. 1996) was conducted to analyze the results.

In living nursery trees of less than 10 cm in diameter, the formation of 5-10 successful galleries usually kills the attacked trees and statistics often do not tell the true story. However, because cut bolts were used, these experiments present a distinctly more challenging situation than a typically growing environment. Any product demonstrating significantly lower attacks than the untreated bolts may provide higher levels of control in a landscape or nursery setting.

In this series of experiments, Onyx routinely reduced AAB attacks. Discus performed well in the two experiments where it was tested. Ammo, Asana, Celero chlorpyrifos and Talstar were variable in performance. In single experiments, Acelepryn and Thiodan were not statistically different than the untreated controls.

**Table 68. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 1, Mizell, 2005.**

| Treatment | Rate ai per 100 gal | Mean Attacks per Bolt$^{z}$ |
|---|---|---|
| Ammo EC (cyfluthrin) | 66.3 g | 6.3 a |
| Dursban Turf (chlorpyrifos) | 92.8 g | 8.0 |
| Onyx (bifenthrin) | 212.3 g | 6.5 a |
| Talstar F (bifenthrin) | 41.0 g | 8.7 |
| Thiodan EC (endosulfan) | 83.0 | 10.7 |
| Untreated | | 12.5 |

$^{z}$Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 69. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 2, Mizell, 2005.**

| Treatment | Rate ai per 100 gal | Mean Attacks per Bolt $^{z}$ |
|---|---|---|
| Asana XL (esfenvalerate) | 8.0 g | 27.2 |
| Bifenthrin 8% ME (bifenthrin) | 42.5 g | 10.2 |
| Bifenthrin 8% ME (bifenthrin) | 85.0 g | 13.5 |
| Onyx (bifenthrin) | 212.3 g | 0.2 a |
| Untreated | | 48.2 |

$^{z}$Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 70. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 3, Mizell, 2005.**

| Treatment | Rate ai per 100 gal | Mean Attacks per Bolt [z] |
|---|---|---|
| Asana XL (esfenvalerate) | 76.5 g | 5.2 a |
| Asana XL (esfenvalerate) | 153.5 g | 3.8 a |
| Bifenthrin 8% ME (bifenthrin) | 170.0 g | 0.7 a |
| Lorsban 4E (chlorpyrifos) | 767.5 g | 2.7 a |
| Onyx (bifenthrin) | 212.3 | 0.0 a |
| Talstar F (bifenthrin) | 135.3 | 0.5 a |
| Untreated | | 15.0 |

[z]Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 71. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 4, Mizell, 2005.**

| Treatment | Rate ai per 100 gal | Mean Attacks per Bolt [z] |
|---|---|---|
| Ammo 2.5EC (cyfluthrin) | 144.9 g | 10.5 |
| Asana XL (esfenvalerate) | 95.9 g | 11.3 |
| Celero 16WSG (clothianidin) | 170.0 g | 8.2 a |
| Discus (cyfluthrin + imidacloprid) | 19.8 + 83.3 g | 6.3 a |
| Lorsban 4E (chlorpyrifos) | 474.0 g | 6.7 a |
| Onyx (bifenthrin) | 212.3 g | 4.2 a |
| Talstar F (bifenthrin) | 214.0 g | 5.0 a |
| Untreated | | 13.8 |

[z]Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 72. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 5, Mizell, 2005.**

| Treatment | Rate ai per 100 gal | Monticello Mean Attacks per Bolt | Quincy Mean Attacks per Bolt [z] |
|---|---|---|---|
| Acelepryn/DPX-E2Y45 (chlorantraniliprole) | 47.0 g | 5.3 | 6.2 |
| Acelepryn/DPX-E2Y45 (chlorantraniliprole) | 189.4 g | 6.3 | 6.3 |
| Acelepryn/DPX-E2Y45 (chlorantraniliprole) | 754.4 g | 3.5 | 6.3 |
| Celero 16WSG (clothianidin) | 38.8 g | 2.3 | 2.8 |
| Celero 16WSG (clothianidin) | 77.6 g | 2.2 | 4.7 |
| Discus (cyfluthrin + imidacloprid) | 19.8 + 83.3 g | 2.0 | 1.8 a |
| Discus (cyfluthrin + imidacloprid) | 39.6 + 169.6 g | 1.5 | 3.8 |
| Onyx (bifenthrin) | 212.3 g | 2.3 | 2.5 |
| Untreated | | 3.0 | 6.3 |

[z]Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Mizell 2006**

In 2006, Mizell further explored insecticides along with the common repellent, DEET to prevent Asian ambrosia beetle infestations on mimosa bolts. Methods of treatment and infestation were as in 2005.

In experiment 1, DEET, Discus, Discus + DEET, Onyx, Onyx + Celero, Onyx + DEET, and Onyx + Dursban significantly reduced Asian ambrosia beetle attacks (Table 51). Although the number of attacks was lower for Azatin, Celero, Dusban and Onyx + Azatin than the untreated controls, they were not statistically different 12 DAT.

In experiment 2, while there was a trend for the combination treatments with DEET to have reduced attacks, there were no statistical differences for either location.

**Table 73. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 1, Mizell, 2006.**

| Treatment | Rate per 100 gal | Mean Attacks per Bolt[z] |
|---|---|---|
| Azatin XL | 256 fl oz | 21.3 |
| Celero 16WSG (clothianidin) | 8 oz | 14.7 |
| DEET | 40% | 0.0 a |
| DEET | 90% | 0.0 a |
| Discus (cyfluthrin + imidacloprid) | 100 fl oz | 8.3 a |
| Discus + DEET | 100 fl oz +40% | 0.0 a |
| Dursban 2E (chlorpyrifos) | 32 fl oz | 10.3 |
| Onyx (bifenthrin) | 32 fl oz | 2.7 a |
| Onyz + Azatin XL | 32 fl oz + 2% | 10.3 |
| Onyx + Celero 16WSG | 32 fl oz + 8 oz | 0.0 a |
| Onyx + DEET | 32 fl oz + 40% | 3.5 a |
| Onyx + Dursban 2E | 32 fl oz + 32 oz | 0.0 a |
| Untreated | | 37.2 |

[z]Number of attacks assessed 12 DAT.Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 74. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 2, Mizell, 2006.**

| Treatment | Rate per 100 gal | Location 1 Mean Attacks per Bolt [z] | Location 2 Mean Attacks per Bolt |
|---|---|---|---|
| DEET | 40% | 5.5 | 13.5 |
| Discus(cyfluthrin + imidacloprid) | 100 fl oz | 20.0 | 15.5 |
| Discus + DEET | 100 fl oz + 40% | 2.3 | 8.3 |
| Onyx (bifenthrin) | 32 fl oz | 19.7 | 11.2 |
| Onyx + DEET | 32 fl oz + 40% | 3.5 | 9.0 |
| Proclaim (emamectin benzoate) | 256 fl oz | 9.8 | 12.3 |
| Talstar L&T (bifenthrin) | 32 fl oz | 20.8 | 27.5 |
| Talstar L&T + DEET | 32 fl oz + 40% | 3.3 | 16.2 |
| Tempo 2 (cyfluthrin) | 32 fl oz | 7.3 | 11.0 |
| Tempo 2 + DEET | 32 fl oz + 40% | 1.2 | 11.7 |
| Untreated | | 17.5 | 15.7 |

[z] Number of attacks assessed 12 DAT. Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Mizell 2007**

In 2007, Mizell conducted three experiments examining Acelepryn, BAS 320i, *Metarhizium*, and Onyx. Only in experiment 1 were there any statistical differences between treated and untreated bolts (Tables 53 – 55). In this experiment, Onyx alone and in combination with two different surfactants provided acceptable reduction in Asian ambrosia beetle attacks. In experiment 2, *Metarhizium* at several concentrations and in combination with oil did not reduce attacks. In experiment 3, Acelepryn, BAS 320i, and Onyx did not reduce attacks in comparison to the untreated controls.

**Table 75. Efficacy of Onyx with and without surfactants forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 1, Mizell, 2007.**

| Treatment | Rate (per 100 gal) | Mean Attacks per Bolt (14 DAT) |
|---|---|---|
| Onyx (bifenthrin) | 32 fl oz | 3.3 ± 1.7 a |
| Onyx + PentaBark | 32 fl oz +1% | 3.0 ± 1.1 a |
| Onyx + Previa | 32 fl oz + 1% | 2.0 ± 0.3 a |
| Untreated | | 13.8 ± 1.5 b |

[z] Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 76. Efficacy of *Metarhizium* forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 2, Mizell, 2007.**

| Treatment | Rate (per 100 gal) | Mean Attacks per Bolt (14 DAT) |
|---|---|---|
| *Metarhizium* | $1.3 \times 10^9$ | 19.8 ± 4.4 a |
| *Metarhizium* | $3.9 \times 10^8$ | 18.0 ± 3.6 a |
| *Metarhizium* | $3.9 \times 10^9$ | 14.5 ± 3.9 a |
| *Metarhizium* (oil) | $3.9 \times 10^9$ | 16.9 ± 4.4 a |
| Untreated | | 18.3 ± 2.4 a |

[z] Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Table 77. Efficacy of several insecticides forAsian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Mimosa (*Albizia julibrissin*) bolts – Experiment 3, Mizell, 2007.**

| Treatment | Rate (per 100 gal) | Mean Attacks per Bolt (14 DAT) |
|---|---|---|
| Acelepryn (chlorantraniliprole) + PentaBark | 32 fl oz +1% | 11.0 ± 3.3 a |
| Acelepryn/DPX-E2Y45 (chlorantraniliprole) | 32 fl oz/100 gal | 18.2 ± 1.5 a |
| BAS320i (metaflumizone) | 16 fl oz/100 gal | 11.3 ± 1.4 a |
| Onyx (bifenthrin) | 32 fl oz/100 gal | 11.8 ± 4.0 a |
| Untreated | | 16.5 ± 3.6 a |

[z] Means followed by the same letter are significantly different from the control as determined by a least squares mean test at P<0.05.

**Schultz 2009**

In 2009, Schultz tested six products as either trunk sprays or soil drenches to determine whether any could prevent AAB infestation on magnolia. Applications were made on April 7, 2009 for Flagship 25WP and

Safari 20SG as drenches. The remaining products were applied as trunk sprays on April 13, 2009: Each magnolia with the exception of the planned untreated without ethanol was injected with an ethanol solution on April 14 to more uniformly attrack adult beetle attacks. Acelepryn, DPX-HGW86, Onyx, and Tolfenpyrad. Every 2 days over a 4 day period in late April, the number of holes created by adult beetles were counted.

On the first day of assessment, there were very few attacks; on the second assessment two days later

**Table 78. Efficacy Efficacy of several insecticides for Asian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Magnolia, Schultz, 2009.**

| Treatment | Rate | Average Number of Attack Holes (cumulative with previous date) | | |
|---|---|---|---|---|
| | | 4/24/2009 | 4/26/2009 | 4/28/2009 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 32 fl oz trunk spray | 1.0 a | 4.5 a | 5.6 a |
| DPX-HGW86 / Mainspring (cyantraniliprole) | 32 fl oz trunk spray | 0.0 a | 1.4 bc | 2.8 abc |
| Flagship 25WG (thiamethoxam) | 8 oz drench | 1.75 a | 3.4 ab | 1.5 bc |
| Onyx (bifenthrin) | 32 fl oz trunk spray | 0.0 a | 1.0 bc | 1.5 bc |
| Safari 20SG (dinotefuran) | 24 oz drench | 0.75 a | 2.0 abc | 2.1 bc |
| Tolfenpyrad | 21 fl oz trunk spray | 0.75 a | 2.6 abc | 4.3 ab |
| Water | | 0.0 a | 1.1 bc | 3.5 ab |
| Control (no ETOH) | | 0.0 a | 0.1 c | 0.0c |

**<u>Chong 2010</u>**

In 2009, Chong compared efficacy of Kontos and OnyxPro applied applied as trunk spraysto prevent AAB infestation on Eastern redbud. Both treatments were applied on March 26, 2010 (immediately after the first detection of adult flight with ethanol traps) and a second application of OnyxPro was applied on April 9, 2010 (during the peak flight of adult AAB). Frass tubes or entry holes on each tree were counted before the treatment and weekly for 5 weeks after the treatment. On May 21, 2010, about 50 days after the peak flight, glass vials were glued over the entry holes on the trunk with silicon sealant to capture emerging AAB's. The glass vials were collected on June 4, 2010. The percentage of holes that yielded AAB's or the percentage of emergence was used as an indication of potential systemic effects of Kontos against the AAB.

Kontos was not effective in preventing attacks by AAB during the adult flight period; on the other hand, the standard OnyxPro was effective (Table 79). Treated trees were attacked at the same intensity as the untreated trees. The systemic activity of Kontos did not reduce the number of entry holes that yielded offspring of the original attackers. Overall, offspring emerged from 91.6, 96.2 and 98.2% of the entry holesfrom trees treated with OnyxPro, Kontos and Untreated, respectively.

**Table 79. Efficacy Efficacy of insecticides for Asian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Eastern Redbud (*Cercis canadensis*) 'Forest Pansy', Chong, 2010.**

| Percentage of Trees Attacked [x] | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Treatment** | **Rate (per 100 gal)** | **Pre-Trt** | **1 WAT** | **2 WAT** | **3 WAT** | **4 WAT** | **5 WAT** |
| Kontos (spirotetramat) | 3.4 fl oz | 0 a | 3.3 ± 2.1 ab | 10.0 ± 2.6 ab | 10.0 ± 2.6 ab | 11.7 ± 3.1 a | 11.7 ± 3.1 a |
| OnyxPro (bifenthrin) | 6.4 fl oz | 0 a | 0 b | 3.5 ± 2.2 b | 3.5 ± 2.2 b | 3.5 ± 2.2 b | 3.5 ± 2.2 b |
| Untreated | | 0 a | 11.7 ± 4.0 a | 13.3 ± 4.0 a | 13.3 ± 4.0 a | 13.3 ± 4.0 a | 13.3 ± 4.0 a |
| Average Number of Holes Per AttackedTree [x] | | | | | | | |
| **Treatment** | **Rate (per 100 gal)** | **Pre-Trt** | **1 WAT** | **2 WAT** | **3 WAT** | **4 WAT** | **5 WAT** |
| Kontos (spirotetramat) | 3.4 fl oz | - | 3.5 ± 0.5 a | 5.8 ± 1.6 a | 5.8 ± 1.6 a | 5.8 ± 1.6 a | 5.8 ± 1.6 a |
| OnyxPro (bifenthrin) | 6.4 fl oz | - | - | 6.0 a | 6.0 a | 6.0 a | 6.0 a |
| Untreated | | - | 5.3 ± 0.8 a | 4.1 ± 0.4 a | 4.1 ± 0.4 a | 4.1 ± 0.4 a | 4.1 ± 0.4 a |

[x] Means followed by the same letter do not significantly differ (Tukey's LSD test, P = 0.10).

**<u>Ludwig 2010</u>**

In 2010, Ludwig compared efficacy of several applied as drenches or sprays to prevent AAB infestation on Eastern redbud (Table 80).All treatments were applied once on April 22, 2010. To induce beetle attack, trees were injected with 75 ml of 25% ethanol 24 hours after the insecticides were applied. The total number of entrance holes in each tree was recorded 4 weeks after treatment. Unfortunately, majority of trees (including Untreated) were not attacked so no conclusions can be made.

**Table 80. Efficacy of several insecticides for Asian Ambrosia Beetle (*Xylosandrus crassiusculus*) on Redbud (*Cercis canadensis*), Ludwig 2010.**

| **Treatment** | **Rate per 100 gal** | **Application Method** | **Mean No. of Holes Per Tree** |
|---|---|---|---|
| DPX-E2Y45 / Acelepryn (chlorantraniliprole) | 32 fl oz | Drench | 0.7 |
| DPX-HGW86 / Mainspring (cyantraniliprole) | 32 fl oz | Drench | 0.1 |
| Flagship (thiamethoxam) | 8 oz | Drench | 0.1 |
| OnyxPro (bifenthrin) | 32 fl oz | Foliar | 0.0 |
| Safari 2G (dinotefuran) | 2.2 grams per gal potting media | Drench | 0.1 |
| Safari 20SG (dinotefuran) | 24 oz | Drench | 0.3 |
| Safari 20SG (dinotefuran) + Capsil | 8 oz/gal + 2.5%v/v | Basal Spray | 0.0 |
| Tolfenpyrad | 21 fl oz | Foliar | 0.0 |
| Tristar (acetamiprid) + Capsil | 8 oz + 2.5%v/v | Spray | 0.1 |
| Uninjected Control | | | 0.0 |
| Injected Control | | | 0.1 |

### *Comparative Efficacy on Ambrosia Beetle (Xylosandrus germanus)*

The ambrosia beetle or black stem borer, *Xylosandrus germanus,* originated from Asia and now has dispersed to many regions of the US including the Northeast, South, Southeast and the Pacific Northwest. Like the Asian ambrosia beetle, the ambrosia beetle is known to attack both weakened and healthy plants. It is reported to attack over 200 species of plants and is increasingly being recognized as a key pest of ornamental nursery stock. Beyond direct damage to trees and shrubs, there is concern that *X. germanus*is responsible for carrying *Fusarium* fungus into trees as they tunnel into the wood (http://oregonstate.edu/dept/nurspest/Xylosandrusgermanus.htm)

**Reding 2009**

In 2009, Reding evaluatedfive insecticides applied as trunk sprays or soil drenches for control of the ambrosia beetle (*Xylosandrus germanus*) on magnolia, a known favorite host of *X. germanus*. The plants were purchased in 3 gallon pots from a nursery in Lake County, Ohio on March 17. Soil drenches were applied April28 one week before ethanol injection and trunk sprays were appliedMay 4 one day before injection. Two sets of control plants were used, one injected with ethanol but untreated with insecticide and the other un-injected and untreated. On May 5 all magnolia trees, except the un-injected control plants, were injected with ethanol to attract ambrosia beetles and then placed along the wooded border of a field. Trees were watered as needed until the study was terminated on May 27, 2009. Beetle attacks (entrance holes in stems) were counted 2, 7, 14, and 23 days after treatment and exposure to beetles. All stems with attack holes were cut from the trees, labeled and brought back to the laboratory to determine survivability and ambrosia beetle species causing damage.

Attacks occurred on all treatments except for the un-injected controls (Table 81). Efficacy results showed a difference in treatments for the first few days but no statistical difference between treatments 5 days after exposure to ambrosia beetles.Flagship applied as drench and Tolfenpyrad trunk spray provided control that was almost comparable to the standard Onyx. Acelepryn, Safari and Scimitar were ineffective.

**Table 81. Efficacy of several insecticides for Ambrosia Beetle (*Xylosandrus germanus*) on Magnolia (*Magnolia virginiana*), Reding, 2009.**

| Treatment | Rate per 100 gal | Application Method | Mean Attacks[z] | |
|---|---|---|---|---|
| | | | May 6 – 11 | May 12 - 27 |
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 32 fl oz | Trunk Spray | 2.7 a | 13.9 |
| Flagship 25WG (thiamethoxam) | 8 oz | Drench | 0.9 bc | 17.9 |
| Onyx (bifenthrin) | 32 fl oz | Trunk Spray | 0.4 c | 13.9 |
| Safari 20SG (dinotefuran) | 24 oz | Drench | 1.7 abc | 10.0 |
| Safari 20SG (dinotefuran) | 24 oz | Trunk Spray | 3.2 a | 12.5 |
| Scimitar GC(lambda-cyhalothrin) | 5 fl oz | Trunk Spray | 2.4 ab | 17.3 |
| Tolfenpyrad 15EC | 21 fl oz | Trunk Spray | 0.8 bc | 11.0 |
| Untreated Control | | - | 2.6 a | 13.9 |
| Un-injected Control | | - | 0.0 c | 0.0 |

[z]Means within columns followed by the same letter are not significantly different ANOVA ($P$ = 0.05), means separated by LSD ($\alpha$ = 0.05).

### *Comparative Efficacy on Bronze Birch Borer (Agrilus anxius)*

The bronze birch borer is a native insect which occurs throughout the range of birch in North America. It is a serious pest of ornamental birch plantings. The bronze birch borer attacks paper (canoe), European white (especially cutleaf variety), gray, yellow, and other birches, as well as poplar, cottonwood and willow. The larva bores in the trunk and larger limbs, often girdling them. Trees weakened by drought or injured are most susceptible to attack. Tree injury is caused by larval tunneling in the inner bark or cambium (http://www.uri.edu/ce/factsheets/sheets/brbiborer.html).

In 2006, Nielsen located infested trees in early May followed byapplying treatments on May 24when red horsechestnuts were in bloom.Trees were cut May 15, 2007, and all old emergence holes circled with a wax pencil.Tree trunks were placed upright in the shade at Wooster.New emergence holes (EH) were counted and trunk surface area measured, August 29, 2007, to evaluate treatment effects.

In the first experiment, Arena, DPX-E2Y45, and Safari reduced the number of exit holes, but not statistically (Table 82).

In the second experiment, both NEI 25925 and Flagship significantly reduced infestations (Table 83).

**Table 82. Efficacy of several insecticides for Bronze Birch Borer (*Agrilus anxius*) on Weeping European white birch (*Betula pendula*) – Experiment 1, Nielsen, 2006.**

| Treatment[z] | Rate per inch DBH | Number of Exit Holes[y] |
|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 14.8 ml | 1.3 |
| Arena 50WGD (clothianidin) | 1.9 g | 2.5 |
| Safari 20SG (dinotefuran) | 12 g | 0 |
| Untreated | | 7.3 |

[z]All treatments applied in 1 gal water as drench to root flare and soil.

[y] Means within columns followed by the same letter are not significantly different according to Fisher-Hayton (P<0.05).

**Table 83. Efficacy of several insecticides for Bronze Birch Borer (*Agrilus anxius*) on Weeping European white birch (*Betula pendula*) – Experiment 2, Nielsen, 2006.**

| Treatment [z] | Rate | Number of Exit Holes |
|---|---|---|
| NEI 25925 9.25% (acetamiprid) + Capsil | 4 ml/ inch DBH + 1% | 3.1 a |
| Flagship 25 WG (thiamethoxam) | 16 oz./acre (1200 trees/acre - nursery) | 2.1 a |
| Untreated | | 28.9 b |

[z]All treatments applied in 1 liter of water/tree spraying 18” of lower tree trunk.

[y] Means within columns followed by the same letter are not significantly different according to Fisher-Hayton (P<0.05).

### *Comparative Efficacy on Flatheaded Apple Tree Borer (Chrysobothris femorata)*

Flatheaded apple tree borer is a native pest of apple, beech, cherry, chestnut, cotoneaster, dogwood, elm, flowering crabapple, hawthorn, hickory, linden, maple, mountain ash, oak, peach, pear, pecan, plum, poplar, quince, shadbush, sycamore, willow, and other hardwood species. This borer preferentially attacks diseased or dying trees, inhabiting all parts of the tree from the base of the trunk to the limbs. Its hosts are primarily newly transplanted nursery stock and to trees that have been weakened from causes such as inappropriate pruning, drought, or inadequate soil or nutrient conditions. Trees suffering from sun scald are regarded as being particularly subject to attack. Like many borers, the flatheaded appletree borer will often girdle a small tree, with a single larva sometimes capable of killing the tree (http://www.nysipm.cornell.edu/factsheets/treefruit/pests/ab/ab.asp).

In 2005, Potter tested Discus and Flagship as treatments for two cultivars of red maple. The infestation rate in control trees was > 60% in 2005 (Table 84).Trees that are stressed are more attractive to FHATBso the hot dry 2005 summer likely contributed to borer attacks in this trial.Although Discus significantly reduced the overall proportion of infested trees, the level of control obtained would not be acceptable in nursery production, nor was it comparable to the > 95% control previously obtained with lindane or chlorpyrifos bark sprays.

Insecticide Trial 2.(Data not shown).Only three of the 300 total trees at the two study sites showed symptoms of FHATB attack, so no conclusions can be drawn regarding efficacy of the treatments.Two of those borers were in untreated trees; the other was in a tree that received DPX-E2Y45.The 2006 growing season was relatively cool and had record rainfall so absence of tree stress, as occurs in more typical Kentucky summers, may have contributed to the low incidence of borers.

**Table 84. Efficacy of Discus and Flagship Drenches for Flatheaded Apple Tree Borer (*Chrysobothris femorata*) on Red Maples (*Acer rubrum*), Potter, 2005*.**

| Treatment | Number Infested Trees | | | Percent with No Attacks | | |
|---|---|---|---|---|---|---|
| | October Glory | Red Sunset | Total | October Glory | Red Sunset | Total |
| Discus (imidacloprid + cyfluthrin) | 9 | 2 | 11** | 44% | 88% | 66% |
| Flagship (thiamethoxam) | 10 | 6 | 16 | 38% | 63% | 50% |
| Untreated | 14 | 6 | 20 | 13% | 63% | 38% |

* Not an IR-4 experiment.

Treatments were applied at high label rate with 1 L per tree. Assumed 0.18 g/1000 sq ft for flagship and 1.5 fl oz per inch DBH for Discus

** Proportion of trees infested is significantly lower for Discus than untreated ($\chi^2 = 5.07$, 1 df, $P = 0.02$) but does not differ between Flagship and untreated ($\chi^2= 1.02$, 1 df,$P = 0.31$).

### *Comparative Efficacy on Banded Ash Clearwing Borer (Podosesia aureocincta)*

The banded ash clearwing borer is a serious pest of ornamental ash plantings. Day flying females lay eggs in wounds and bark crevices. Hatching larvae chew into the bark and feed both laterally and vertically in the phloem tissue. Later most larvae excavate upward in the sapwood where they concentrate most of their feeding. Completed galleries are about 7 - 32 cm long and 5 - 7 mm in diameter. The sapwood galleries physically weaken the structure of the tree.

In 2008, Nielsen evaluated five products for controlling banded ash clearwing borer (Table 85). The green ash trees chosen for this project were heavily infested when treatments were applied on 8 August 2008. Presence or absence of new frass was recorded on July 13 as evidence of borer infestation; by this time the borer population had crashed. Frass indexing showed little frass production, even from untreated Check trees. No frass production was noted from any of the trees treated with Acelepryn, Aloft, or Tolfenpyrad. Onyx reduced frass production. Tristar + Capsil, applied to bark from the soil to a height of 8’, was ineffective.

No phytotoxicity was observed.

**Table 85. Efficacy of several insecticides forBanded Ash Clearwing Borer (*Podosesia aureocincta*)on Green Ash (*Fraxinus pennsylvanica*); Nielsen, 2008.**

| Treatment [z] | Rate | Application Method | Frass Index[y] |
|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 10 fl oz/100 gal | Trunk spray to just above first scaffold limbs | 0 |
| Aloft (clothianidin+bifenthrin) | 32 fl oz/100 gal | Sprayed trunk and soil at base of tree | 0 |
| NEI-25925 (acetamiprid) | 6 ml/inch DBH + Capsil | Applied 1 quart of mix/tree up to height of 8' | 0.6 |
| Onyx 2EC (bifenthrin) | 12.8 fl oz/100 gal | Trunk spray to just above first scaffold limbs | 0.2 |
| Tolfenpyrad | 24 fl oz/100 gal | Trunk spray to just above first scaffold limbs | 0 |
| Untreated | | | 0.6 |

[z] Treatments were applied 8 August 2008 and evaluated 13 July, 2009 . Five plants per treatment were used.

[y] Frass index 0-3 where 0 = no frass, 3 = heavy frass

### *Comparative Efficacy on Peachtree Borer (Synanthedon exitiosa)*

The peachtree borer is a native insect that is a serious pest of all stone fruits in the genus *Prunus* (peach, cherry, plum, prune, nectarine, apricot) and ornamental shrubs. Larvae feed on the cambium of trunks and large roots forming galleries that are found from about the soil surface to a depth of nearly 30 cm. Extensive larval feeding can girdle and kill trees. Young trees are highly susceptible to severe damage by even a single larva.

In 2009, Nielsen tested six products for their residual efficacy in controlling peachtree borer. An experimental block of purple-leaf sand cherry used in this trial supported a moderately high level infestation of peachtree borer larvae. Treatments were applied on June 25 when Catalpa was in full bloom. Presence or absence of new orange frass and gummosis near base of plants were recorded on September 13 as evidence of borer infestation. Drench application of Discus, DPX-E2Y45, DPX-HGW86 and Safari, and spray application of Onyx, Scimitar and Tristar provided excellent control (Table 86). The top-dress treatment with Flagship 25WG was somewhat effective, but inadequate for nursery production. Tolfenpyrad spray was ineffective.

No phytotoxicity was observed.

**Table 86. Efficacy of several insecticides forPeachtree Borer (*Synanthedon exitiosa*) on Sand Cherry (*Prunus cistina*), Nielsen, 2009.**

| Treatment [z] | Rate | Application Method | Percent Plants Infested 11 WAT |
|---|---|---|---|
| Acelepryn / DPX-E2Y45 (chlorantraniliprole) | 100 fl oz per 100 gal | Drench | 0 |
| Discus (imidacloprid+cyfluthrin) | 44 ml/inch DBH | Drench | 0 |
| DPX-HGW86 (cyantraniliprole) | 0.25 fl oz/quart | Drench | 0 |
| Flagship 25WG (thiamethoxam) | 0.09 g/linear foot | Top-dress | 15 |
| Onyx 2EC (bifenthrin) | 102 fl oz/100 gal. | Trunk spray to run-off | 0 |
| Safari 20SG (dinotefuran) | 6 g/ft shrub height | Drench | 0 |
| Scimitar (lambda-cyhalothrin) | 5 fl oz/100 gal + Capsil | Trunk spray to run-off | 0 |
| Tolfenpyrad | 21 fl oz/100 gal | Trunk spray to run-off | 25 |
| Tristar 30SG (acetamiprid) | 4 oz/inch DBH + Capsil | Trunk spray to run-off | 0 |
| Untreated | | - | 65 |

[z] Treatments were applied June 25 2009 and evaluated September, 13 2009 . Twenty plants per treatment were used.

## Results: Efficacy Summary by Product

**<u>A20520A / DPX-HGW86 / Mainspring (cyantraniliprole)</u>**
This new product showed good efficacy on peachtree borer in one test. It exhibited variable efficacy on redheaded flea beetles in three trials.

**<u>Acelepryn / DPX-E2Y45 (chlorantraniliprole)</u>**
This product did not impact black vine weevil adults or Asian ambrosia beetle, but it did control adult Japanese beetles in six out of nine trials. DPX-E2Y45 also provided excellent control of viburnum leaf beetle.Promising efficacy was observed among researchers for oriental beetle grubs and black vine weevil larvae. Also this product showed good efficacy on May/June beetle grubs, banded ash clearwing borer and peachtree borer. It provided good efficacy on Sri Lankan weevil in a single trial.

**<u>Aloft SC (clothianidin+bifenthrin)</u>**
In single trials, Aloft provided excellent control of Japanese beetle adults and banded ash clearwing borer. It provided good control of redheaded flea beetles in one hydrangea and two Itea trials, and commercially acceptable control of European elm leaf weevils in a single trial.

**<u>Ammo EC (cypermethrin)</u>**
This cypermethrin-based product provided reasonable reduction in Asian ambrosia beetle infestations of mimosa bolts.

**<u>Arena 50WDG/Celero 16WSG (clothianidin)</u>**
No significant reduction in black vine weevil adults or Asian ambrosia beetle infestation was observed with these two products. For Japanese beetle adults, efficacy levels were variable possibly due to differences in techniques and assessments among researchers. Excellent control of viburnum leaf beetle was achieved. Celero also provided good to excellent control of oriental beetle grubs. There were mixed levels of efficacy on black vine weevil larvae.

**<u>Asana XL (esfenvalerate)</u>**
In two out of four trials, Asana reduced Asian ambrosia beetle infestations. This warrants further exploration.

**<u>AzaGuard (azadirachtin)</u>**
This product provided poor efficacy on Sri Lankan weevil in a single trial.

**<u>BAS 320i (metaflumizone)</u>**
Metaflumizone exhibited excellent efficacy for black vine weevil adults, Japanese beetle adults, and viburnum leaf beetle. There was virtually no impact on Asian ambrosia beetle infesting mimosa bolts. Excellent efficacy was achieved with black vine weevil larvae. Promising efficacy on oriental beetle larvae was observed in one test.

**<u>Bifenthrin 8%ME, Onyx, Talstar (bifenthrin)</u>**
These bifenthrin products provided excellent management of Asian ambrosia beetle. Onyx also gave excellent efficacy for Japanese beetle adults. Talstar NL exhibited excellent control of black vine weevil adults. In single trials, Talstar exhibited good control or oriental beetle larvae, and Onyx 2EC provided good to excellent control of ambrosia beetle, banded ash clearwing borer and peachtree borer. Bifenthrin provided good control of redheaded flea beetles in a single trial but Onyx gave poor control in two other trials.

**<u>BeetleGONE (*Bacillus thuringiensis galleriae* str</u>**

This product provided good efficacy on Sri Lankan weevil in a single trial.

**<u>BotaniGard ES (*Beauveria bassiana*)</u>**
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment. An experiment on Japanese beetle adults provided inconclusive data.

**<u>CoreTec/Marathon/Merit/Xytect (imidacloprid)</u>**
Imidacloprid showed good efficacy for larvae of oriental beetle and May/June beetles, but no efficacy for larvae of black vine weevil and strawberry rootworm in single trials. This active ingredient provided excellent control of redheaded flea beetles and commercially acceptable control of European elm leaf weevils.

**<u>DEET</u>**
This repellent exhibited inconsistent control of Asian ambrosia beetle infestations. There, however, was some indication of improved efficacy for conventional materials when tank mixed with DEET.

**<u>Discus (imidacloprid + cyfluthrin)</u>**
In two out of four trials, Discus provided a good reduction in Asian ambrosia beetle infestations. It also reduced oriental beetle grubs and peachtree borer, and provided good to excellent control of redheaded flea beetles.

**<u>DuraGard/Dursban/Lorsban 4E (chlorpyrifos)</u>**
Very little impact was observed for Asian ambrosia beetle with the Dursban formulation, but the Lorsban 4E formulation provided good efficacy.

**<u>Dylox 80S (trichlorfon)</u>**
Dylox was the only product that provided good control of 3$^{rd}$ instar oriental beetle larvae in one trial.

**<u>Flagship (thiamethoxam)</u>**
Flagship provided some control of Japanese beetle adults, variable control of black vine weevil, but good control of oriental beetle larvae and redheaded flea beetles. In single trials, it showed poor efficacy on ambrosia beetle and peachtree borer.

**<u>GF 2860/XXpire (spinoteram+sulfoxaflor)</u>**
This new product exhibited variable control of redheaded flea beetles.

**<u>Hachi-Hachi/Tolfenpyrad EC</u>**
In single experiments, this compound provided no control of black vine weevil adults, poor control of ambrosia beetle and peachtree borer, commercially acceptable control of European elm leaf weevils, and excellent control of banded ash clearwing borer. It exhibited poor control of redheaded flea beetles, variable control of Japanese beetle adults, and excellent control of viburnum leaf beetle.

**<u>IKI-3106 (cyclaniliprole)</u>**
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment. An experiment on Japanese beetle adults provided inconclusive data.

**<u>Lynx (pyrethrins)</u>**
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment.

**MBI-203 DF (*Chromobacterium subtsugae* strain PRAA4-1T)**
This biological organism provided variable control of redheaded flea beetles, and commercially acceptable control of European elm leaf weevils. It provided good efficacy on Sri Lankan weevil in a single trial.

***Metarhizium anisopliae***
This biological organism was tested as two formulations (Met 52, Tick Ex EC). No efficacy was observed for viburnum leaf beetles, Asian ambrosia beetle, Japanese beetle adults or oriental beetle larvae. While good control of black vine weevil larvae in the greenhouse, little was seen with trials in field containers.

**Preferal (*Isaria fumosoroseus*)**
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment.

**Safari 2G/20SG (dinotefuran)**
Variable levels of efficacy were observed among researchers working with Japanese beetle and redheaded flea beetle adults. Safari did provide very effective control of viburnum leaf beetle. It gave excellent control of oriental beetle, but had variable impact on black vine weevil larvae.In single trials, Safari showed no efficacy on ambrosia beetle, but commercially acceptable control of European elm leaf weevils, and good control of peachtree borer.

**TriStar 30SG/NEI 25925 (acetamiprid)**
Variable levels of efficacy were observed among researchers working with Japanese beetle adults. In single trials, Tristar exhibited no efficacy for banded ash clearwing borer, poor efficacy on redheaded flea beetles, but good control of Sri Lankan weevil, and excellent control of peachtree borer.

**Venerate (*Burkholderia rinojensis)***
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment.

**Xpectro (Pyrethrins + *Beauveria bassiana*)**
This compound exhibited poor efficacy on Sri Lankan weevil in a single experiment. An experiment on Japanese beetle adults provided inconclusive data.

### *Phytotoxicity*

No phytotoxicity was observed during these experiments.

**Table 87. Summary of Efficacy By Product – Borers and Foliar Feeding Beetles**

Note: Table entries are sorted by crop Latin name. Only those trials received by 2/1/2017 are included in the table below.

| PR# | Product (Active Ingredients) | Target | Crop | ProductionSite | Researcher | State | Year | ApplicationType | Results |
|---|---|---|---|---|---|---|---|---|---|
| 26100 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Bronze Birch Borer (Agrilus anxius) | European White Birch (Betula pendula) 'Youngi' | Field Container | Nielsen | OH | 2006 | Drench | Very low infestation. |
| 25909 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Flatheaded Apple Tree Borer (Chrysobothris femorata) | Maple, Red (Acer rubrum) 'October Glory' | Field In-Ground | Potter | KY | 2006 | Trunk spray | Very little insect pressure so no conclusions can be drawn. |
| 25512 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Drench | Inconclusive; population too low. |
| 27619 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) | Field Container | Nielsen | OH | 2007 | Foliar | No efficacy at 10 oz per 100 gal. |
| 27838 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Banded Ash Clearwing Borer (Podosesia aureocincta) | Ash (Fraxinus sp.) F. pennsylvanica | Field In-Ground | Nielsen | OH | 2008 | Trunk spray | Low infestation. Excellent efficacy at 1qt per 100 gal. |
| 26757 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) | Field In-Ground | Reding | OH | 2007 | Foliar | No significant reduction of feeding damage at 10 oz per 100 gal; no phytotoxicity and growth effect. |
| 26757 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) 'Notwoodone' | Field In-Ground | Reding | OH | 2006 | Drench | No significant reduction of feeding damage; no phytotoxicity and growth effect. |
| 26757 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) 'Notwoodone' | Field In-Ground | Reding | OH | 2006 | Foliar | No difference among treatment or untreated plants in this study; no phytotoxicity and no impacts on growth. |
| 25521 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2006 | Foliar | Excellent control up to 31 DAT. |
| 25521 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2007 | Foliar | Excellent control of Japanese beetle adults at 0.026, 0.052 and 0.104 lb ai per 100 gal; equal to bifenthrin. |

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|---|---|---|---|---|---|---|---|---|---|
| 26948 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 10 fl oz per 100 gal. |
| 26948 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Excellent efficacy. |
| 26948 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Foliar | Significantly reduced number of adults and feeding damage at 10 fl oz per 100 gal; inferior to Flagship. |
| 27788 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Caneberry (Non-Bearing) (Rubus sp.) R. idaeus | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 26488 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Good efficacy. |
| 26488 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. hakuro nishiki | Field Container | Braman | GA | 2007 | Foliar | Excellent efficacy at 10 oz per 100 gal. |
| 25516 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Linden, Shamrock (Tilia cordata) 'Bailyei' | Field Container | Alm | RI | 2006 | Foliar | Excellent control up to 31 DAT using 10 fl oz per 100 gal. |
| 27783 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Grape (Non-Bearing) (Vitis sp.) 'Seyval Blanc' | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 25734 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | Some reduction in defoliation severity and extent using 10 fl oz per 100 gal, equivalent level to permiethrin. |
| 29862 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | Effective control at 10 oz per 100 gal; equal to imidacloprid. |
| 25734 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) V. dentatum | Field Container | Costa | VT | 2006 | Foliar | Effective control; equal to standard permethrin. |
| 29292 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Drench | Excellent control at 0.25 fl. Oz./quart water; 1-qt per inch caliper. |
| 28851 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 10 oz per 100 gal; data not reliable due to high Control mortality and unfavorable environment. |

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|---|---|---|---|---|---|---|---|---|---|
| 29134 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Drench | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 29872 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 1: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 29872 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 2: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 25481 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Monticello - Results inconclusive due to low numbers of attacks per bolt. |
| 25481 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Quincy - Results inconclusive due to low numbers of attacks per bolt. |
| 25481 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2007 | Tree bolt immersion | No control at 32 oz per 100 gal. |
| 30497 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | | Untreated trees not attacked; no conclusions can be made. |
| 26826 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Trunk spray | No infestation; no phytotoxicity. |
| 29493 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Trunk spray | No control at 32 fl oz per 100 gal. |
| 31423 | Acelepryn (aka DPX-E2Y45) 1.67 (Chlorantraniliprole) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Trunk spray | Did not reduce X. germanus beetle attacks at 32 fl oz per 100 gal. |

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|---|---|---|---|---|---|---|---|---|---|
| 27925 | Allectus SC (Bifenthrin + Imidacloprid) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 1: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 27925 | Allectus SC (Bifenthrin + Imidacloprid) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 2: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 31711 | Aloft SC (Clothianadin + bifenthrin) | European Elm Flea Weevil (Orchestes alni) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Mediocre but commercially acceptable feeding damage reduction with 15 fl oz per 100 gal applied once. |
| 27841 | Aloft SC (Clothianadin + bifenthrin) | Banded Ash Clearwing Borer (Podosesia aureocincta) | Ash (Fraxinus sp.) F. pennsylvanica | Field In-Ground | Nielsen | OH | 2008 | Sprench | Low infestation. Excellent efficacy at 10 fl oz per 100 gal. |
| 28156 | Aloft SC (Clothianadin + bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 8 fl oz oz per 100 gal. |
| 31716 | Aloft SC (Clothianadin + bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Did not reduce feeding damage with 15 fl oz per 100 gal applied once. |
| 31588 | Aloft SC (Clothianadin + bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) 'White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a high leaf damage with 14.9 fl oz per 100 gal applied once; better than Tristar applied once. |
| 31580 | Aloft SC (Clothianadin + bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Excellent reduction of low to moderate leaf damage with 15 fl oz per 100 gal; better than Onyx. |
| 31580 | Aloft SC (Clothianadin + bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Henry's Garnet' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a low leaf damage with 14.9 fl oz per 100 gal applied once; better than Tristar applied once. |
| 27963 | Ammo EC (Cypermethrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 1: About 50% reduction in attacks per bolt treated with 66.3 g ai per 100 gal. |
| 27963 | Ammo EC (Cypermethrin) | Ambrosia Beetle (granulate) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Virtually no impact on attacks per bolt |

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|---|---|---|---|---|---|---|---|---|---|
| | | (Xylosandrus crassiusculus) | | | | | | | treated with 144.9 g ai per 100 gal. |
| 26098 | Arena 50WDG (Clothianadin) | Bronze Birch Borer (Agrilus anxius) | European White Birch (Betula pendula) 'Youngi' | Field Container | Nielsen | OH | 2006 | Drench | Very low infestation. |
| 27965 | Asana XL (Esfenvalerate) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 2: Approximately 50% reduction in attacks per bolt treated with 8 g ai per 100 gal. |
| 27965 | Asana XL (Esfenvalerate) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 3: Approximately 60 to 80% reduction in attacks per bolt treated with 76.5 and 153.5 g ai per 100 gal. |
| 27965 | Asana XL (Esfenvalerate) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Virtually no impact on attacks per bolt treated with 95.9 g ai per 100 gal. |
| 29522 | Astro (Permethrin) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Foliar | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 32656 | AzaGuard (Azadirachtin) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 16 fl oz per 100 gal applied 3 times weekly; comparable to the standard Tristar. |
| 26181 | Azatin XL (Azadirachtin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt Immersion | Experiment 1: Poor efficacy with a 2% rate. |
| 27617 | BAS 320i (Metaflumizone) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Rhododendron (Rhododendron sp.) | Field Container | Nielsen | OH | 2007 | Foliar | Excellent efficacy at 16 oz per 100 gal. |
| 26825 | BAS 320i (Metaflumizone) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) | Field In-Ground | Reding | OH | 2007 | Foliar | No significant reduction of feeding damage at 4.5 oz per 100 gal; no phytotoxicity and growth effect. |
| 26945 | BAS 320i (Metaflumizone) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 16 oz per 100 gal. |
| 26945 | BAS 320i (Metaflumizone) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Excellent efficacy. |

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|---|---|---|---|---|---|---|---|---|---|
| 26945 | BAS 320i (Metaflumizone) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Foliar | Significantly reduced number of adults and feeding damage at 16 fl oz per 100 gal; inferior to Flagship. |
| 26945 | BAS 320i (Metaflumizone) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Sunsprite' | Field Container | Alm | RI | 2008 | Foliar | Poor control at 16 fl oz per 100 gal; inferior to standard. |
| 26402 | BAS 320i (Metaflumizone) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | Some reduction in defoliation severity and extent using 16 oz per 100 gal, equivalent level to permiethrin. |
| 29865 | BAS 320i (Metaflumizone) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | Effective control at 16 oz per 100 gal; equal to imidacloprid. |
| 28850 | BAS 320i (Metaflumizone) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 16 oz per 100 gal; data not reliable due to high mortality in the untreated and unfavorable environment. |
| 26849 | BAS 320i (Metaflumizone) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2007 | Tree bolt immersion | No significant control at 16 oz per 100 gal. |
| 32657 | beetleGONE! tlc (Bacillus thuringiensis subsp. galleriae Strain SDS-502) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 16 lb per 100 gal + NuFilm applied 3 times weekly; comparable to the standard Tristar. |
| 27966 | Bifenthrin 8% ME (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 2: Approximately 75% reduction in attacks per bolt treated with 42.5 and 85 g ai per 100 gal. |
| 27966 | Bifenthrin 8% ME (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 3: Almost complete reduction in attacks per bolt treated with 170 g ai per 100 gal. |
| 32658 | BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 32 fl oz per 100 gal applied once; inferior to the standard Tristar. |
| 32887 | BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA) | Japanese Beetle - adults (Popillia japonica - adults) | Crape Myrtle (Lagerstroemia indica) 'Pink Velour' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; no significant differences between treatments. |

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| 32641 | BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Louis Philippe' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; significantly reduced % leaf damage with 32 fl oz per 100 gal applied once; inferior to Tristar. |
| 25908 | Celero 16WSG (Clothianidin) | Flatheaded Apple Tree Borer (Chrysobothris femorata) | Maple, Red (Acer rubrum) 'October Glory' | Field In-Ground | Potter | KY | 2006 | Drench | Very little insect pressure so no conclusions can be drawn. |
| 25511 | Celero 16WSG (Clothianidin) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandiere | Field Container | Schultz | VA | 2006 | Drench | Population declined but numbers too low for statistical analysis |
| 27618 | Celero 16WSG (Clothianidin) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) | Field Container | Nielsen | OH | 2007 | Foliar | Poor efficacy at 4 oz per 100 gal. |
| 26756 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) | Field In-Ground | Reding | OH | 2007 | Foliar | No significant reduction of feeding damage at 4 oz per 100 gal; no phytotoxicity and growth effect. |
| 26756 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) ‘Notwoodone’ | Field In-Ground | Reding | OH | 2006 | Drench | No significant reduction of feeding damage; no phytotoxicity and growth effect. |
| 26756 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) ‘Notwoodone’ | Field In-Ground | Reding | OH | 2006 | Foliar | No difference among treatment or untreated plants in this study; no phytotoxicity and no impacts on growth. |
| 25520 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2006 | Foliar | Excellent control up to 10 DAT. |
| 26946 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Excellent efficacy. |
| 27787 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Caneberry (Non-Bearing) (Rubus sp.) R. idaeus | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 26487 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Poor efficacy. |

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| 26487 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. hakuro nishiki | Field Container | Braman | GA | 2007 | Foliar | Fair efficacy at 4 oz per 100 gal. |
| 25515 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Linden, Shamrock (Tilia cordata) 'Bailyei' | Field Container | Alm | RI | 2006 | Foliar | Good control up to 19 DAT using 6 oz per 100 gal. |
| 27782 | Celero 16WSG (Clothianidin) | Japanese Beetle - adults (Popillia japonica - adults) | Grape (Non-Bearing) (Vitis sp.) 'Seyval Blanc' | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 25733 | Celero 16WSG (Clothianidin) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | Some reduction in defoliation severity and extent using 4 oz per 100 gal, equivalent level to permiethrin. |
| 29866 | Celero 16WSG (Clothianidin) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | Effective control at 4 oz per 100 gal; better than imidacloprid. |
| 25733 | Celero 16WSG (Clothianidin) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) V. dentatum | Field Container | Costa | VT | 2006 | Foliar | Effective control; equal to standard permethrin. |
| 25479 | Celero 16WSG (Clothianidin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Some impact on attacks per bolt treated with 144.9 g ai per 100 gal. |
| 25479 | Celero 16WSG (Clothianidin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Monticello - Results inconclusive due to low numbers of attacks per bolt. |
| 25479 | Celero 16WSG (Clothianidin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Quincy - Results inconclusive due to low numbers of attacks per bolt. |
| 25479 | Celero 16WSG (Clothianidin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Mediocre efficacy (about 50% reduction in attacks per bolt) with 8 oz per 100 gal. |
| 26828 | Celero 16WSG (Clothianidin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Trunk spray | No infestation; no phytotoxicity. |
| 32655 | Cyclaniliprole (IKI-3106) 50SL (Cyclaniliprole) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 22 and 27 fl oz per 100 gal applied once; comparable to the standard Tristar. |

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| 32888 | Cyclaniliprole (IKI-3106) 50SL (Cyclaniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Crape Myrtle (Lagerstroemia indica) 'Pink Velour' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; no significant differences between treatments. |
| 32642 | Cyclaniliprole (IKI-3106) 50SL (Cyclaniliprole) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Louis Philippe' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; significantly reduced % leaf damage with 22 and 27 fl oz per 100 gal applied twice biweekly; comparable to Tristar. |
| 26180 | DEET (DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree Bolt Immersion | Experiment 1: Excellent control at 40% and 90%. |
| 26180 | DEET (DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - some reduction in attacks on bolts with 40%, but not statistically significant. |
| 26180 | DEET (DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistically significant differences among treatments. |
| 25477 | Discus (Imidacloprid + cyfluthrin) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Drench | Inconclusive; population too low. |
| 29298 | Discus (Imidacloprid + cyfluthrin) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Drench | Excellent control at 44 ml per inch dbh. |
| 31893 | Discus (Imidacloprid + cyfluthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Excellent reduction of low to moderate leaf damage with 50 oz per 100 gal; better than Onyx. |
| 31893 | Discus (Imidacloprid + cyfluthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation; some plant damage reduction with 50 fl oz per 100 gal. |
| 29523 | Discus (Imidacloprid + cyfluthrin) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Drench | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |

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| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Approximately 50% reduction in attacks per bolt treated with 144.9 g ai per 100 gal. |
| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Monticello - Results inconclusive due to low numbers of attacks per bolt. |
| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Quincy - Results inconclusive due to low numbers of attacks per bolt. |
| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Approximate 70% reduction in attacks per bolt treated with 100 oz per 100 gal. |
| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - no statistical differences among treatments. |
| 24764 | Discus (Imidacloprid + cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical differences among treatments. |
| 29293 | DPX-HGW86 (Cyantraniliprole) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Drench | Excellent control at 0.25 fl. oz./quart water; 1-qt per inch caliper. |
| 29135 | DPX-HGW86 (Cyantraniliprole) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Drench | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 30498 | DPX-HGW86 (Cyantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | | Untreated trees not attacked; no conclusions can be made. |
| 29861 | DPX-HGW86 (Cyantraniliprole) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Trunk spray | No significant control at 32 fl oz per 100 gal. |
| 25480 | Dursban (Chlorpyrifos) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 1: Some reduction in attacks per bolt treated with 92 g ai per 100 gal. |

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| 25480 | Dursban (Chlorpyrifos) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Poor efficacy. |
| 31589 | Flagship 0.22G (Thiamethoxam) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Flagship 25WG used. Significantly reduced a high leaf damage with 8 oz per 100 gal applied once; comparable to Tristar applied once. |
| 26099 | Flagship 25WG (Thiamethoxam) | Bronze Birch Borer (Agrilus anxius) | European White Birch (Betula pendula) 'Crimson Frost' | Field Container | Nielsen | OH | 2006 | Trunk/ground spray | Data inconclusive. |
| 25791 | Flagship 25WG (Thiamethoxam) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Drench | Inconclusive; population too low. |
| 31672 | Flagship 25WG (Thiamethoxam) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Surface of potting media | Significantly reduced number of adults and feeding damage at 2.2 g per gal media. |
| 26491 | Flagship 25WG (Thiamethoxam) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Fair efficacy. |
| 29294 | Flagship 25WG (Thiamethoxam) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Top Dress | Inadequate control at 0.09 g per linear ft. |
| 28852 | Flagship 25WG (Thiamethoxam) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 8 oz per 100 gal; data not reliable due to high Control mortality and unfavorable environment. |
| 31581 | Flagship 25WG (Thiamethoxam) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2012 | | |
| 31581 | Flagship 25WG (Thiamethoxam) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) ‘Henry’s Garnet’ | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a low leaf damage with 8 oz per 100 gal applied once; better than Tristar applied once. |
| 29136 | Flagship 25WG (Thiamethoxam) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Directed | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 29873 | Flagship 25WG (Thiamethoxam) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 2: Too few attacks for biological significance. Several additional experiments were conducted to refine |

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| | | | | | | | | | methodologies for future research. |
| 30499 | Flagship 25WG (Thiamethoxam) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Drench | Untreated trees not attacked; no conclusions can be made. |
| 29495 | Flagship 25WG (Thiamethoxam) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Drench | No significant control at 8 oz per 100 gal. |
| 31424 | Flagship 25WG (Thiamethoxam) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Drench | Signifcantly reduced X. germanus beetle attacks for less than 5 days at 8 oz per 100 gal; comparable to Onyx. Beyond 5 days, all treatments were attacked, possibly due to high rate of ethanol injection. |
| 31708 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | European Elm Flea Weevil (Orchestes alni) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Poor but commercially acceptable feeding damage reduction with 1 and 2 lb per 100 gal applied once. |
| 31713 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Japanese Beetle - adults (Popillia japonica - adults) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Did not reduce feeding damage with 1 and 2 lb per 100 gal applied 4 times. |
| 31585 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a high leaf damage with 1 and 2 lb per 100 gal applied twice; comparable to Tristar applied once. |
| 31577 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Poor reduction of low to moderate leaf damage with 2 lb per 100 gal. |
| 31577 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation. |

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| 31577 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Henry's Garnet' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a low leaf damage with 1 and 2 lb per 100 gal applied twice; comparable to Tristar applied once. |
| 31577 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Reduced feeding damage, though not significantly, with 1 and 2 lb per 100 gal applied twice; inferior to the standard Scimitar. |
| 32552 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 1 and 2 lb per 100 gal applied twice; inferior to the standard Scimitar. |
| 32558 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 1 and 2 lb per 100 gal applied twice; inferior to the standard Scimitar. |
| 31707 | Hachi-Hachi EC (Tolfenpyrad) | European Elm Flea Weevil (Orchestes alni) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Poor but commercially acceptable feeding damage reduction with 21 and 32 fl oz per 100 gal applied once. |
| 27621 | Hachi-Hachi EC (Tolfenpyrad) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) | Field Container | Nielsen | OH | 2007 | Foliar | No efficacy at 21 fl oz per 100 gal. |
| 27840 | Hachi-Hachi EC (Tolfenpyrad) | Banded Ash Clearwing Borer (Podosesia aureocincta) | Ash (Fraxinus sp.) F. pennsylvanica | Field In-Ground | Nielsen | OH | 2008 | Trunk spray | Low infestation. Excellent efficacy at 24 fl oz per 100 gal. |
| 26951 | Hachi-Hachi EC (Tolfenpyrad) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Virtually no control at 21 fl oz per 100 gal. |
| 26951 | Hachi-Hachi EC (Tolfenpyrad) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Good efficacy; some foliar feeding damage. |
| 26951 | Hachi-Hachi EC (Tolfenpyrad) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Foliar | Poor efficacy at 21 fl oz per 100 gal + NIS. |
| 31712 | Hachi-Hachi EC (Tolfenpyrad) | Japanese Beetle - adults (Popillia japonica - adults) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Foliar | Did not reduce feeding damage with 21 and 32 fl oz per 100 gal applied once. |

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| 26404 | Hachi-Hachi EC (Tolfenpyrad) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | Some reduction in defoliation severity and extent using 21 fl (?) oz per 100 gal, equivalent level to permethrin. |
| 29869 | Hachi-Hachi EC (Tolfenpyrad) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | Effective control at 21 oz per 100 gal; equal to imidacloprid. |
| 29296 | Hachi-Hachi EC (Tolfenpyrad) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Foliar | Poor control at 21 fl oz per 100 gal. |
| 28853 | Hachi-Hachi EC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 21 oz per 100 gal; data not reliable due to high Control mortality and unfavorable environment. |
| 31584 | Hachi-Hachi EC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) 'White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a high leaf damage with 21 and 32 fl oz per 100 gal applied once; better than Tristar applied once. |
| 31576 | Hachi-Hachi EC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Poor reduction of low to moderate leaf damage with 32 fl oz per 100 gal. |
| 31576 | Hachi-Hachi EC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation. |
| 31576 | Hachi-Hachi EC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Henry's Garnet' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a low leaf damage with 21 and 32 fl oz per 100 gal applied once; inferior to Tristar applied once. |
| 29139 | Hachi-Hachi EC (Tolfenpyrad) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Foliar | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 30500 | Hachi-Hachi EC (Tolfenpyrad) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Foliar | Untreated trees not attacked; no conclusions can be made. |
| 29496 | Hachi-Hachi EC (Tolfenpyrad) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Trunk spray | No control at 21 fl oz per 100 gal. |
| 31425 | Hachi-Hachi EC (Tolfenpyrad) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Trunk spray | Signifcantly reduced X. germanus beetle attacks for < 5 days at 21 fl oz per 100 gal; comparable to Onyx. |

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| 32654 | Hachi-Hachi SC (Tolfenpyrad) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 21 and 27 fl oz per 100 gal applied once; comparable to the standard Tristar. |
| 32548 | Hachi-Hachi SC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 21 and 32 fl oz per 100 gal + Capsil applied once; inferior to the standard Scimitar applied twice. |
| 32554 | Hachi-Hachi SC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 21 and 32 fl oz per 100 gal + Capsil applied once; inferior to the standard Scimitar applied twice. |
| 32560 | Hachi-Hachi SC (Tolfenpyrad) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 21 and 32 fl oz per 100 gal + Capsil applied once; inferior to the standard Scimitar applied twice. |
| 29904 | Kontos (BYI 8330 240SC) (Spirotetramat) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) 'Forest Pansy' | Field Container | Chong | SC | 2010 | Trunk spray | No significant control at 3.4 fl oz per 100 gal. |
| 27967 | Lorsban 4E (Chlorpryifos) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 3: Approximately 80% reduction in attacks per bolt treated with 767.5 g ai per 100 gal. |
| 27967 | Lorsban 4E (Chlorpryifos) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Approximately 50% reduction in attacks per bolt treated with 144.9 g ai per 100 gal. |
| 32659 | Lynx EC 5.0 (Pyrethrins) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 16 oz per 100 gal applied twice weekly; comparable to the standard Tristar. |
| 31892 | Mainspring (A20520A) 200SC (Cyantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Poor reduction of low to moderate leaf damage with 16 oz per 100 gal. |

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| 31892 | Mainspring (A20520A) 200SC (Cyantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation; some plant damage reduction with 8 and 16 fl oz per 100 gal. |
| 31892 | Mainspring (A20520A) 200SC (Cyantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Reduced feeding damage, though not significantly, with 16 fl oz per 100 gal applied twice; inferior to the standard Scimitar. |
| 32549 | Mainspring (A20520A) 200SC (Cyantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 8 and 16 fl oz per 100 gal applied twice; inferior to the standard Scimitar. |
| 32555 | Mainspring (A20520A) 200SC (Cyantraniliprole) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 8 and 16 fl oz per 100 gal applied twice; inferior to the standard Scimitar. |
| 31591 | Marathon 1% granular (Imidacloprid) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Broadcast | Significantly reduced a high leaf damage with 7 g per pot; better than Tristar applied once. |
| 31583 | Marathon 1% granular (Imidacloprid) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) ‘Henry’s Garnet’ | Field Container | Braman | GA | 2012 | Broadcast | Significantly reduced a low leaf damage with 7 g per pot; better than Tristar applied once. |
| 32660 | MBI-203 WDG (Chromobacterium subtsugae) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 3 lb per 100 gal + NuFilm applied 3 times weekly; better than the standard Tristar. |
| 27620 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) | Field Container | Nielsen | OH | 2007 | Foliar | No efficacy at 29 fl oz per 100 gal. |
| 26403 | Met52 (Metarhizium anisopliae strain F52) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | No efficacy at 29 oz per 100 gal. |
| 29867 | Met52 (Metarhizium anisopliae strain F52) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | No efficacy at 29 oz per 100 gal |
| 26850 | Met52 (Metarhizium | Ambrosia Beetle (granulate) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2007 | Tree bolt immersion | No significant control at rates up to 3.9 X 10,000,000,000. |

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| | anisopliae strain F52) | (Xylosandrus crassiusculus) | | | | | | | |
| 26101 | NEI 25925 (Acetamiprid) | Bronze Birch Borer (Agrilus anxius) | European White Birch (Betula pendula) 'Crimson Frost' | Field Container | Nielsen | OH | 2006 | Trunk spray | Data inconclusive. |
| 25912 | NEI 25925 (Acetamiprid) | Flatheaded Apple Tree Borer (Chrysobothris femorata) | Maple, Red (Acer rubrum) 'October Glory' | Field In-Ground | Potter | KY | 2006 | Trunk spray | Very little insect pressure so no conclusions can be drawn. |
| 25910 | Onyx (Bifenthrin) | Flatheaded Apple Tree Borer (Chrysobothris femorata) | Maple, Red (Acer rubrum) 'October Glory' | Field In-Ground | Potter | KY | 2006 | Trunk spray | Very little insect pressure so no conclusions can be drawn. |
| 25831 | Onyx (Bifenthrin) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Foliar | Inconclusive; population too low. |
| 29303 | Onyx (Bifenthrin) | Banded Ash Clearwing Borer (Podosesia aureocincta) | Ash (Fraxinus sp.) F. pennsylvanica | Field In-Ground | Nielsen | OH | 2008 | Trunk spray | Low infestation. Fair efficacy at 12.8 fl oz per 100 gal. |
| 25524 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2006 | Foliar | Excellent control up to 31 DAT. |
| 25524 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2007 | Foliar | Excellent control of Japanese beetle adults at 0.2 lb ai per 100 gal. |
| 26949 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 12.8 fl oz per 100 gal. |
| 26949 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Excellent efficacy. |
| 26949 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Sunsprite' | Field Container | Alm | RI | 2008 | Foliar | Standard treatment; effective control at 6.4 fl oz per 100 gal. |
| 27791 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Caneberry (Non-Bearing) (Rubus sp.) R. idaeus | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 25519 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Linden, Shamrock (Tilia cordata) 'Bailyei' | Field Container | Alm | RI | 2006 | Foliar | Good control up to 31 DAT using 12.8 fl oz per 100 gal. |

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| 27786 | Onyx (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Grape (Non-Bearing) (Vitis sp.) 'Seyval Blanc' | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 29300 | Onyx (Bifenthrin) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Foliar | Excellent control at 3.2 pt per 100 gal |
| 31587 | Onyx (Bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a high leaf damage with 12.8 fl oz per 100 gal applied once; comparable to Tristar applied once. |
| 31579 | Onyx (Bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Poor reduction of low to moderate leaf damage with 12.8 fl oz per 100 gal. |
| 31579 | Onyx (Bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation; some plant damage reduction with 40 fl oz per 100 gal. |
| 29524 | Onyx (Bifenthrin) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Foliar | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 1: About 50% reduction in attacks per bolt treated with 212.3 g ai per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 2: Approximately 99% reduction in attacks per bolt treated with 212.3 g ai per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 3: 100% reduction in attacks per bolt treated with 212.3 g ai per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Approximately 70% reduction in attacks per bolt treated with 144.9 g ai per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Monticello - Results inconclusive due to low numbers of attacks per bolt. |

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| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 5: Quincy - Results inconclusive due to low numbers of attacks per bolt. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Effective control using 32 fl oz per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - no significant differences among treatments. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no significant differences among treatments. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2007 | Tree bolt immersion | Test 1: significant control at 16 oz per 100 gal. |
| 25220 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2007 | Tree bolt immersion | Test 2: no significant control at 32 oz per 100 gal. |
| 26137 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field In-Ground | Ludwig | TX | 2004 | Trunk spray | Inconclusive results due to application timing. |
| 30504 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | | Untreated trees not attacked; no conclusions can be made. |
| 26137 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) 'Forest Pansy' | Field In-Ground | Chong | SC | 2010 | Trunk spray | Effective control at 6.4 fl oz per 100 gal. |
| 27721 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Trunk spray | No infestation; no phytotoxicity. |
| 29497 | Onyx (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Trunk spray | No significant control at 32 fl oz per 100 gal. |

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| 31426 | Onyx (Bifenthrin) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Trunk spray | Significantly reduced X. germanus beetle attacks for < 5 days at 32 fl oz per 100 gal. |
| 26429 | Perm-Up 3.2EC (Permethrin) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Foliar | Inconclusive; population too low. |
| 26492 | Precise Acephate (Acephate) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Broadcast | Fair efficacy. |
| 32661 | Preferal (SePro) (Isaria fumosoroseus) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 1 lb per 100 gal applied once; inferior to the standard Tristar. |
| 28002 | Proclaim (Emamectin benzoate) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - no statistical difference among treatments. |
| 28002 | Proclaim (Emamectin benzoate) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical difference among treatments. |
| 26102 | Safari 20SG (Dinotefuran) | Bronze Birch Borer (Agrilus anxius) | European White Birch (Betula pendula) 'Youngi' | Field Container | Nielsen | OH | 2006 | Drench | Very low infestation. |
| 25911 | Safari 20SG (Dinotefuran) | Flatheaded Apple Tree Borer (Chrysobothris femorata) | Maple, Red (Acer rubrum) 'October Glory' | Field In-Ground | Potter | KY | 2006 | Drench | Very little insect pressure so no conclusions can be drawn. |
| 25513 | Safari 20SG (Dinotefuran) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Drench | Population declined but numbers too low for statistical analysis. |
| 31709 | Safari 20SG (Dinotefuran) | European Elm Flea Weevil (Orchestes alni) | Elm (Ulmus sp.) | Field In-Ground | Jones | OH | 2012 | | Mediocre but commercially acceptable feeding damage reduction with 12 g per DBH inch applied once at dormancy. |
| 27623 | Safari 20SG (Dinotefuran) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) | Field Container | Nielsen | OH | 2007 | Foliar | No efficacy at 8 oz per 100 gal. |
| 26758 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus | Field In-Ground | Reding | OH | 2006 | Drench | No significant reduction of feeding damage; no |

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| | | | syriacus) ‘Notwoodone’ | | | | | | phytotoxicity and growth effect. |
| 26758 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) ‘Notwoodone’ | Field In-Ground | Reding | OH | 2006 | Foliar | No difference among treatment or untreated plants in this study; no phytotoxicity and no impacts on growth. |
| 25522 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2006 | Foliar | Virtually no control. |
| 26947 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 8 oz per 100 gal. |
| 26947 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Drench | Excellent efficacy. |
| 26947 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Drench | Significantly reduced number of adults and feeding damage at 24 oz per 100 gal; inferior to Flagship. |
| 27789 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Caneberry (Non-Bearing) (Rubus sp.) R. idaeus | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 26489 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Poor efficacy. |
| 26489 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. hakuro nishiki | Field Container | Braman | GA | 2007 | Foliar | Fair efficacy at 8 oz per 100 gal. |
| 25517 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Linden, Shamrock (Tilia cordata) 'Bailyei' | Field Container | Alm | RI | 2006 | Foliar | Good control up to 19 DAT using 6 fl oz per 100 gal. |
| 31714 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Drench | Did not reduce feeding damage with 12 g per DBH inch applied once at dormancy. |
| 27784 | Safari 20SG (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Grape (Non-Bearing) (Vitis sp.) 'Seyval Blanc' | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 25735 | Safari 20SG (Dinotefuran) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Foliar | Some reduction in defoliation severity and extent using 4 oz per 100 gal, equivalent level to permiethrin. |
| 29868 | Safari 20SG (Dinotefuran) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field In-Ground | Weston | NY | 2007 | Foliar | Effective control at 8 oz per 100 gal; better than imidacloprid. |

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| 25735 | Safari 20SG (Dinotefuran) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) V. dentatum | Field Container | Costa | VT | 2006 | Foliar | Effective control; equal to standard permethrin. |
| 29295 | Safari 20SG (Dinotefuran) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Drench | Excellent control at 60 g per ft height. |
| 28855 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 8 oz per 100 gal; data not reliable due to high Control mortality and unfavorable environment. |
| 31586 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Drench | Significantly reduced a high leaf damage with 8 oz per 100 gal applied once; better than Tristar applied once. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Drench | Excellent reduction of low to moderate leaf damage with 24 oz per 100 gal; better than Onyx. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Excellent reduction of low to moderate leaf damage with 8 oz per 100 gal; better than Onyx. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation; some plant damage reduction with 8 and 24 oz per 100 gal. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) ‘Henry’s Garnet’ | Field Container | Braman | GA | 2012 | Drench | Significantly reduced a low leaf damage with 8 oz per 100 gal applied once; comparable to Tristar applied once. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Drench | Did not significantly reduce feeding damage with 24 oz per 100 gal applied once; inferior to the standard Scimitar applied twice. |
| 31578 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 8 oz per 100 gal applied once; inferior to the standard Scimitar applied twice. |

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| 32553 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Drench | Reduced feeding damage, though not significantly, with 24 oz per 100 gal applied once; inferior to the standard Scimitar applied twice. |
| 32553 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 8 oz per 100 gal applied once; inferior to the standard Scimitar applied twice. |
| 32559 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Drench | Significantly reduced feeding damage with 24 oz per 100 gal applied once; comparable to the standard Scimitar applied twice. |
| 32559 | Safari 20SG (Dinotefuran) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 8 oz per 100 gal applied once; inferior to the standard Scimitar applied twice. |
| 29137 | Safari 20SG (Dinotefuran) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Drench | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 29874 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 2: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 30501 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Basal spray | Untreated trees not attacked; no conclusions can be made. |
| 30501 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Drench | Untreated trees not attacked; no conclusions can be made. |
| 26827 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Drench | No infestation; no phytotoxicity. |
| 29492 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (granulate) | Sweet Bay (Magnolia virginiana) | Field Container | Schultz | VA | 2009 | Drench | No significant control at 24 oz per 100 gal. |

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| | | (Xylosandrus crassiusculus) | | | | | | | |
| 31427 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Drench | Reduced X. germanus beetle attacks for < 5 days, though not significantly different from untreated, at 24 oz per 100 gal. |
| 31427 | Safari 20SG (Dinotefuran) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Trunk spray | Did not reduce X. germanus beetle attacks at 24 oz per 100 gal. |
| 27923 | Safari 2G (V-10112 2G) (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Surface of potting media | Significantly reduced number of adults and feeding damage at 2.2 g per gal media; inferior to Flagship. |
| 27923 | Safari 2G (V-10112 2G) (Dinotefuran) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Sunsprite' | Field Container | Alm | RI | 2008 | Broadcast to media surface | Effective control at 60 g per plant; equal to standard. |
| 26613 | Safari 2G (V-10112 2G) (Dinotefuran) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) | Field Container | Costa | VT | 2007 | Top Dress | No efficacy at 2.2g per gal potting media. |
| 30502 | Safari 2G (V-10112 2G) (Dinotefuran) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Soil Incorporation | Untreated trees not attacked; no conclusions can be made. |
| 31673 | Scimitar CS (Lambda-cyhalothrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) R. x odorata 'Tiffany | Field Container | Davis | MI | 2009 | Surface of potting media | Significantly reduced number of adults and feeding damage at 2.2 g per gal media; inferior to Flagship. |
| 26493 | Scimitar CS (Lambda-cyhalothrin) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Excellent efficacy. |
| 29299 | Scimitar CS (Lambda-cyhalothrin) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Foliar | Excellent control at 5 fl oz per 100 gal + Capsil. |
| 32547 | Scimitar CS (Lambda-cyhalothrin) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 5 fl oz per 100 gal applied twice; best treatment. |
| 32551 | Scimitar CS (Lambda-cyhalothrin) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 5 fl oz per 100 gal applied twice; best treatment. |
| 32557 | Scimitar CS (Lambda-cyhalothrin) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 5 fl oz per 100 gal applied twice; best treatment. |

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| 29494 | Scimitar CS (Lambda-cyhalothrin) | Ambrosia Beetle (Xylosandrus germanus) | Sweet Bay (Magnolia virginiana) | Field Container | Reding | OH | 2009 | Trunk spray | Did not reduce X. germanus beetle attacks at 5 fl oz per 100 gal. |
| 28157 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | Excellent control at 21.7 fl oz per 100 gal. |
| 28854 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Red Headed Flea Beetle (Systena frontalis) | Joepye weed, Spotted (Eupatorium maculatum) | Field Container | Kunkel | DE | 2008 | Foliar | No significant control at 20 oz per 100 gal; data not reliable due to high Control mortality and unfavorable environment. |
| 26138 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field In-Ground | Ludwig | TX | 2004 | Trunk spray | Results inconclusive due to application timing. |
| 27622 | Talstar NF (Bifenthrin) | Black Vine Weevil - adults (Otiorhynchus sulcatus - adults) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Foliar | Excellent efficacy at 0.2 lb ai per 100 gal. |
| 25482 | Talstar NF (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 1: Some reduction in attacks per bolt treated with 41 g ai per 100 gal. |
| 25482 | Talstar NF (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 3: Almost complete reduction in attacks per bolt treated with 135.3 g ai per 100 gal. |
| 25482 | Talstar NF (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2005 | Tree bolt immersion | Experiment 4: Approximately 66% reduction in attacks per bolt treated with 144.9 g ai per 100 gal. |
| 25482 | Talstar NF (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - no statistical difference among treatments. |
| 25482 | Talstar NF (Bifenthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical difference among treatments. |
| 28000 | Tank Mix: Discus + DEET (Imidacloprid + cyfluthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Excellent control using 100 oz Discus per 100 gal and 40% DEET. |
| 28000 | Tank Mix: Discus + DEET (Imidacloprid | Ambrosia Beetle (granulate) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - Approximately 80% reduction |

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| | + cyfluthrin + DEET) | (Xylosandrus crassiusculus) | | | | | | | in bolt attacks but not statistically significant. |
| 28000 | Tank Mix: Discus + DEET (Imidacloprid + cyfluthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - No statistical difference among treatments. |
| 27997 | Tank Mix: Onyx + Azatin XL (Bifenthrin + Neem Oil Extract) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Approximately 66% reduction in bolt attacks, but not statistical significant. |
| 27998 | Tank Mix: Onyx + Celero 16WSG (Bifenthrin + clothianadin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Excellent control at 32 oz + 8 oz per 100 gal. |
| 27996 | Tank Mix: Onyx + Deet (Bifenthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Great control with 32 oz Onyx + 40% DEET. |
| 27996 | Tank Mix: Onyx + Deet (Bifenthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - some reduction in bolt attacks but not statistically significant. |
| 27996 | Tank Mix: Onyx + Deet (Bifenthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical difference among treatments. |
| 27999 | Tank Mix: Onyx + Dursban (Bifenthrin + chlorpyrifos) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 1: Excellent control using 32 oz + 32 oz per 100 gal. |
| 28003 | Tank Mix: Talstar L&T + DEET (Bifenthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - approximately 80% reduction in attacks per bolt, but no statistical significance. |
| 28003 | Tank Mix: Talstar L&T + DEET (Bifenthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical difference among treatments. |
| 28001 | Tank Mix: Tempo 2 + DEET (Cyfluthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - approximate 90% reduction in attacks per bolt, but not statistically different. |

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| 28001 | Tank Mix: Tempo 2 + DEET (Cyfluthrin + DEET) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 3: Quincy - no statistical differences among treaments. |
| 26182 | Tempo 20WP (Cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Monticello - no statistical difference among treatments. |
| 26182 | Tempo 20WP (Cyfluthrin) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | FL | 2006 | Tree bolt immersion | Experiment 2: Quincy - no statistical difference among treatments. |
| 27964 | Thiodan EC (Endosulfan) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Mimosa Silk Tree (Albizia julibrissin) | Field Container | Mizell | Fl | 2005 | Tree bolt immersion | Experiment 1: Very little impact on attacks per bolt treated with 83 g ai per 100 gal. |
| 27720 | TickEx EC (Metarhizium anisophliae) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) | Field In-Ground | Reding | OH | 2007 | Foliar | No significant reduction of feeding damage at 29 oz per 100 gal; no phytotoxicity and growth effect. |
| 26950 | TickEx EC (Metarhizium anisophliae) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Blushing' | Field Container | Braman | GA | 2008 | Foliar | No control at 29 fl oz per 100 gal. |
| 26950 | TickEx EC (Metarhizium anisophliae) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Julia Child Butter Gold' | Field Container | Schultz | VA | 2007 | Foliar | Poor efficacy - very slow acting and short residual. |
| 26950 | TickEx EC (Metarhizium anisophliae) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Sunsprite' | Field Container | Alm | RI | 2008 | Foliar | Poor control at 29 fl oz per 100 gal; inferior to standard. |
| 26547 | TickEx EC (Metarhizium anisophliae) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. hakuro nishiki | Field Container | Braman | GA | 2007 | Foliar | No efficacy at 29 oz per 100 gal. |
| 25514 | TriStar 30SG (Acetamiprid) | Flea beetles, garden (Epitrix sp.) | Evening Primrose, Sundrops (Oenothera sp.) O. speciosa var. berlandieri | Field Container | Schultz | VA | 2006 | Foliar | Inconclusive; population too low. |
| 27839 | TriStar 30SG (Acetamiprid) | Banded Ash Clearwing Borer (Podosesia aureocincta) | Ash (Fraxinus sp.) F. pennsylvanica | Field In-Ground | Nielsen | OH | 2008 | Trunk spray | Low infestation. No efficacy at 6 ml per inch dbh. |
| 25523 | TriStar 30SG (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Cherry, Sargent (Prunus sargentii) | Field Container | Alm | RI | 2006 | Foliar | 100 % control up to 31 DAT. |

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| 25736 | TriStar 30SG (Acetamiprid) | Viburnum leaf beetle (Pyrrhalta viburni) | Arrowwood (Viburnum sp.) V. dentatum | Field Container | Costa | VT | 2006 | Foliar | Effective control; equal to standard permethrin. |
| 29297 | TriStar 30SG (Acetamiprid) | Peachtree Borer (Synanthedon exitiosa) | Cherry (Non-Bearing) (Prunus sp.) P. cistina | Field In-Ground | Nielsen | OH | 2009 | Foliar | Excellent control at 4 fl oz per inch dbh + Capsil. |
| 31590 | TriStar 30SG (Acetamiprid) | Red Headed Flea Beetle (Systena frontalis) | Hydrangea (Hydrangea sp.) ‘White Diamonds' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a high leaf damage with 8 g per 100 gal applied once. |
| 31582 | TriStar 30SG (Acetamiprid) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Henry's Garnet' | Field Container | Braman | GA | 2012 | Foliar | Significantly reduced a low leaf damage with 8 g per 100 gal applied once. |
| 29140 | TriStar 30SG (Acetamiprid) | Redbay Ambrosia Beetle (Xyleborus glabratus) | Redbay (Persea borbonia) | Field In-Ground | Pena | FL | 2009 | Foliar | Trial not successful - no damage developed after infesting trees with beetles 3 different times. |
| 29875 | TriStar 30SG (Acetamiprid) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Maple, Red (Acer rubrum) | Field Container | Schultz | VA | 2008 | Trunk spray | Trial 2: Too few attacks for biological significance. Several additional experiments were conducted to refine methodologies for future research. |
| 30503 | TriStar 30SG (Acetamiprid) | Ambrosia Beetle (granulate) (Xylosandrus crassiusculus) | Red Bud, Eastern (Cercis canadensis) | Field Container | Ludwig | TX | 2010 | Foliar | Untreated trees not attacked; no conclusions can be made. |
| 26759 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) ‘Notwoodone’ | Field In-Ground | Reding | OH | 2006 | Drench | No significant reduction of feeding damage; no phytotoxicity and growth effect. |
| 26759 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Rose-Of-Sharon, Althaea (Hibiscus syriacus) ‘Notwoodone’ | Field In-Ground | Reding | OH | 2006 | Foliar | No difference among treatment or untreated plants in this study; no phytotoxicity and no impacts on growth. |
| 27790 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Caneberry (Non-Bearing) (Rubus sp.) R. idaeus | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 26490 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. gracilistyla 'Melanostachys' | Field Container | Braman | GA | 2006 | Foliar | Excellent efficacy. |
| 26490 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Willow (Salix sp.) S. hakuro nishiki | Field Container | Braman | GA | 2007 | Foliar | Provided about 50% efficacy 4 DAT however, there was a significant reduction in feeding although adult japanese beetle |

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| | | | | | | | | | were still alive using 96 g per 100 gal. |
| 25518 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Linden, Shamrock (Tilia cordata) 'Bailyei' | Field Container | Alm | RI | 2006 | Foliar | 100 % control up to 31 DAT using 3.38 oz per 100 gal. |
| 27785 | TriStar 70WSP (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Grape (Non-Bearing) (Vitis sp.) 'Seyval Blanc' | Field Container | Alm | RI | 2007 | Foliar | Infestations too low to determine efficacy. |
| 32890 | TriStar 8.5SL (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Crape Myrtle (Lagerstroemia indica) 'Pink Velour' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; no significant differences between treatments. |
| 32886 | TriStar 8.5SL (Acetamiprid) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Louis Philippe' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; significantly reduced % leaf damage with 25.3 fl oz per 100 gal applied twice biweekly. |
| 32662 | Venerate (MBI 206 F) (Burkholderia rinojensis strain A396) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 1 gal per 100 gal + NuFilm applied 3 times weekly; comparable to the standard Tristar. |
| 32663 | Xpectro OD (Pythrerins + Beauveria bassiana Strain GHA) | Sri Lankan Weevil (Myllocerus undatus) | (Hibiscus rosa-sinensis) 'Double Peach' | Field Container | Dale | FL | 2016 | Foliar | Significantly reduced leaf feeding damage with 32 oz per 100 gal applied twice weekly; inferior to the standard Tristar. |
| 32889 | Xpectro OD (Pythrerins + Beauveria bassiana Strain GHA) | Japanese Beetle - adults (Popillia japonica - adults) | Crape Myrtle (Lagerstroemia indica) 'Pink Velour' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; no significant differences between treatments. |
| 32643 | Xpectro OD (Pythrerins + Beauveria bassiana Strain GHA) | Japanese Beetle - adults (Popillia japonica - adults) | Rose (Rosa sp.) 'Louis Philippe' | TBD | Addesso | TN | 2016 | Foliar | Number of beetles and % leaf damage too low for reliable evaluations; significantly reduced % leaf damage with 32 fl oz per 100 gal applied twice weekly; inferior to Tristar. |
| 31891 | Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Braman | GA | 2013 | Foliar | Mediocre reduction of low to moderate leaf damage with 3.5 oz per 100 gal. |
| 31891 | Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) | Field Container | Frank | NC | 2013 | Foliar | Results inconclusive due to low infestation. |

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| 31891 | Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor) | Red Headed Flea Beetle (Systena frontalis) | Virginia Sweetspire (Itea virginica) 'Little Henry' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 2.75 and 3.5 oz per 100 gal + Capsil applied twice; inferior to the standard Scimitar. |
| 32550 | Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor) | Red Headed Flea Beetle (Systena frontalis) | Pasture Sage (Salvia nemorosa) 'Blue Hill' | Field Container | Kunkel | DE | 2013 | Foliar | Did not significantly reduce feeding damage with 2.75 and 3.5 oz per 100 gal + Capsil applied twice; inferior to the standard Scimitar. |
| 32556 | Xxpire (GF-2860) 40WG (Spinetoram + sulfoxaflor) | Red Headed Flea Beetle (Systena frontalis) | Live-forever stonecrop (Sedum telephium) 'Autumn Joy' | Field Container | Kunkel | DE | 2013 | Foliar | Significantly reduced feeding damage with 2.75 and 3.5 oz per 100 gal + Capsil applied twice; slightly inferior to the standard Scimitar. |
| 31710 | Xytect 2F (Imidacloprid) | European Elm Flea Weevil (Orchestes alni) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Drench | Good control with 0.2 fl oz per DBH inch applied once at dormancy. Best treatment. |
| 31715 | Xytect 2F (Imidacloprid) | Japanese Beetle - adults (Popillia japonica - adults) | Elm (Ulmus sp.) 'Patriot' | Field In-Ground | Jones | WI | 2012 | Drench | Significantly reduced feeding damage with 0.2 fl oz per DBH inch applied once at dormancy. |

**Table 88. Summary of Efficacy By Product – White Grubs and Weevils**

Note: Table entries are sorted by crop Latin name. Only those trials received by 5/12/2010 are included in the table below.

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31409 | A16901B 45WG (Cyantraniliprole + thiamethoxam) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field In-Ground | Freiberger | NJ | 2012 | Broadcast & water-in | Excellent efficacy with 0.095 g product per 9 sq ft using 0.5 gal water. | N | 20130412a.pdf |
| 30397 | A16901B 45WG (Cyantraniliprole + thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | Significant reduction in grub population at 0.095g per 9 sq ft drench; no impact on plant height or width. | N | 20110331h.pdf |
| 25123 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Holly (Ilex sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Excellent reduction of grubs with Aug drench of 0.8 oz per 100 gal; great control with Nov application. | Y | 20080522a.pdf |
| 29498 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Oak, White (Quercus alba) | Field Container | Reding | OH | 2009 | Drench | 100 % control at 32 fl oz per 100 gal. | N | 20091130p.pdf |
| 26936 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Rhododendron (Rhododendron sp.) 'Scintillation' | Field Container | Alm | RI | 2008 | Drench | Excellent control at 0.08 fl oz per 100 gal; equal to standard. | Y | 20081113b.pdf |
| 26761 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2006 | Drench | No infestation developed; no phytotoxicity or impact on growth. | Y | 20070410b.pdf |
| 26761 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) S. chinensis | Field Container | Reding | OH | 2009 | Drench | 100 % control at 32 fl oz per 100 gal. | Y | 20091130p.pdf |
| 31669 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Yew (Taxus media) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | Excellent control of oriental beetle larvae. | N | 20061212w.pdf |
| 25124 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Good reduction of grubs with Aug drench of 0.8 oz per 100 gal; good control with Nov application. | Y | 20080522a.pdf |
| 25124 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2009 | Drench | An 87% reduction in grub counts using 0.8 fl oz per 100 gal drench. | Y | 20110324a.pdf |
| 25124 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | Significant reduction in grub population at 0.8 fl oz per 9 sq ft drench; no impact on plant height or width. | Y | 20110331h.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29117 | Acelepryn 1.67 (Chlorantraniliprole) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | 37 % to not significant control at 0.8 and 3.2 fl oz per 100 gal. | N | 20090429a.pdf |
| 26469 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | Great control with 6.5 fl oz per 100 gal, but poor control with 0.8 fl oz per 100 gal as curative drenches. | N | 20070418g.pdf |
| 26469 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Soil Incorporation | Excellent efficacy with 5, 10, and 20 ppm preplant soil incorporation. | N | 20070418g.pdf |
| 26469 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Drench | Poor control at 0.8 fl oz per 100 gal. | N | 20080910c.pdf |
| 26469 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Poor control at 1, 2 and 4 ppm. | N | 20080910c.pdf |
| 26754 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Stonecrop (Sedum spurium) 'Vera Jameson' | Field Container | Reding | OH | 2006 | Drench | 0.8 oz ai per 100 gal; excellent efficacy on larvae; no significant reduction of adult feeding damage; no phytotoxicity; plant not significantly taller than Untreated. | N | 20070412m.pdf |
| 26091 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Drench | Excellent efficacy with 16 oz per 100 gal drenched pre-infestation. | N | 20070228a.pdf |
| 26091 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Drench | Excellent efficacy at 0.8 fl oz per 100 gal. | N | 20071220b.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26091 | Acelepryn 1.67 (Chlorantraniliprole) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | No significant control of black vine weevil. | N | 20061212w.pdf |
| 27611 | Acelepryn 1.67 (Chlorantraniliprole) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 26495 | Acelepryn 1.67 (Chlorantraniliprole) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Drench | No statistical difference among treatments. | Y | 20070411a.pdf |
| 26495 | Acelepryn 1.67 (Chlorantraniliprole) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2007 | Drench | Only ~10 % grub survival; no statistical difference among treatments. | Y | 20080116f.pdf |
| 27916 | Arena 50WDG (Clothianadin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | No efficacy using 1.28 oz per 100 gal curative drench. | N | 20070418g.pdf |
| 27916 | Arena 50WDG (Clothianadin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Excellent control at 49 mg per pot. | N | 20080910c.pdf |
| 31410 | AzaGuard (Azadirachtin) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field In-Ground | Freiberger | NJ | 2012 | Drench | Poor efficacy with 16 fl oz per 100 gal using 0.5 gal diluent per 9 sq ft. | N | 20130412a.pdf |
| 26938 | BAS 320i (Metaflumizone) | Oriental Beetle (Anomala orientalis) | Rhododendron (Rhododendron sp.) 'Scintillation' | Field Container | Alm | RI | 2008 | Drench | 100 % control at 16 fl oz per 100 gal; equal to standard. | N | 20081113b.pdf |
| 30336 | BAS 320i (Metaflumizone) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2009 | Drench | A 24% reduction in grub counts using 16 oz per 100 gal. | N | 20110324a.pdf |
| 29113 | BAS 320i (Metaflumizone) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | No efficacy at 16 fl oz per 100 gal. | N | 20090429a.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26471 | BAS 320i (Metaflumizone) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | Excellent efficacy using 50 and 100 ppm as curative drenches. | N | 20070418g.pdf |
| 26471 | BAS 320i (Metaflumizone) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Soil Incorporation | Excellent efficacy with 25, 50, 100, and 200 ppm preplant soil incorporation. | N | 20070418g.pdf |
| 26471 | BAS 320i (Metaflumizone) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Drench | Excellent control at 16 fl oz per 100 gal. | N | 20080910c.pdf |
| 26471 | BAS 320i (Metaflumizone) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Excellent control at 4 ppm, less effective at 1 and 2 ppm. | N | 20080910c.pdf |
| 27614 | BAS 320i (Metaflumizone) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Rhododendron (Rhododendron sp.) R. roseum elegans | Field Container | Nielsen | OH | 2007 | Drench | Excellent efficacy at 16 oz per 100 gal. | N | 20071220b.pdf |
| 27610 | BAS 320i (Metaflumizone) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 27675 | BAS 320i (Metaflumizone) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2007 | Drench | Only ~10 % grub survival; no statistical difference among treatments. | N | 20080116f.pdf |
| 27917 | BotaniGard ES (BioWorks) (Beauveria bassiana) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Drench | Poor control at 18.7 mg per pot WP or 39 uL per pot ES formulations. | N | 20080910c.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27917 | BotaniGard ES (BioWorks) (Beauveria bassiana) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Poor control at 18.7 mg per pot WP or 39 uL per pot ES formulations. | N | 20080910c.pdf |
| 25119 | Celero 16WSG (Clothianidin) | Oriental Beetle (Anomala orientalis) | Holly (Ilex sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Good reduction of grubs with Aug drench of 0.5 oz per 100 gal; good control with Nov application. | Y | 20080522a.pdf |
| 26760 | Celero 16WSG (Clothianidin) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2006 | Drench | No infestation developed; no phytotoxicity or impact on growth. | Y | 20070410b.pdf |
| 31670 | Celero 16WSG (Clothianidin) | Oriental Beetle (Anomala orientalis) | Yew (Taxus media) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | Good control of oriental beetle larvae. | N | 20061212w.pdf |
| 25120 | Celero 16WSG (Clothianidin) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Good reduction of grubs with Aug drench of 0.5 oz per 100 gal; good control with Nov application. | Y | 20080522a.pdf |
| 26753 | Celero 16WSG (Clothianidin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Stonecrop (Sedum spurium) 'Vera Jameson' | Field Container | Reding | OH | 2006 | Drench | 0.64 oz ai per 100 gal; excellent efficacy on larvae; significantly reduced adult feeding damage; no phytotoxicity; plant significantly taller than Untreated. | Y | 20070412m.pdf |
| 26090 | Celero 16WSG (Clothianidin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Drench | Excellent efficacy with 20 oz per 100 gal drenched pre-infestation. | Y | 20070228a.pdf |
| 26090 | Celero 16WSG (Clothianidin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Drench | Excellent efficacy at 16 oz per 100 gal. | Y | 20071220b.pdf |
| 26090 | Celero 16WSG (Clothianidin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | No control of black vine weevil. | Y | 20061212w.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27609 | Celero 16WSG (Clothianidin) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 26494 | Celero 16WSG (Clothianidin) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Drench | No statistical difference among treatments. | Y | 20070411a.pdf |
| 26494 | Celero 16WSG (Clothianidin) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2007 | Drench | Only ~10 % grub survival; no statistical difference among treatments. | Y | 20080116f.pdf |
| 25125 | Discus (Imidacloprid + cyfluthrin) | Oriental Beetle (Anomala orientalis) | Holly (Ilex sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Excellent reduction of grubs with Aug drench of 0.8 oz per 100 gal; good control with Nov application. | Y | 20080522a.pdf |
| 25126 | Discus (Imidacloprid + cyfluthrin) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Some reduction of grubs with Aug drench of 0.8 oz per 100 gal; no statistical difference from untreated with Nov application. | Y | 20080522a.pdf |
| 25126 | Discus (Imidacloprid + cyfluthrin) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | Some reduction in grub population at 17 fl oz per 3000 sq ft drench; no impact on plant height or width. | Y | 20110331h.pdf |
| 26857 | Discus (Imidacloprid + cyfluthrin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | No control with 13 fl oz per 100 gal as curative drench. | Y | 20070418g.pdf |
| 27613 | DuraGuard (Chlorpyrifos) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 29110 | Dylox 80 SP (Dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | 93 % control at 3.75 oz per 100 gal. | Y | 20090429a.pdf |
| 31412 | Flagship 0.22G (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field In-Ground | Freiberger | NJ | 2012 | Broadcast & water-in | Poor efficacy with 11.25 g product per 9 sq ft. | Y | 20130412a.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30337 | Flagship 0.22G (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2009 | Broadcast | A 75% reduction in grub counts using 11.25 g product per 9 sq ft. | Y | 20110324a.pdf |
| 30337 | Flagship 0.22G (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Broadcast | Good reduction in grub population at 11.25 g per 9 sq ft drench; no impact on plant height or width. | Y | 20110331h.pdf |
| 29115 | Flagship 0.22G (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Broadcast | 47 % control at 6 g per pot. | Y | 20090429a.pdf |
| 25121 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Holly (Ilex sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Exellent reduction of grubs with Aug drench of 10 oz per 100 gal; excellent control with Nov application. | Y | 20080522a.pdf |
| 29500 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Oak, White (Quercus alba) | Field Container | Reding | OH | 2009 | Drench | 100 % control at 8 oz per 100 gal. | Y | 20091130p.pdf |
| 29499 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Freiberger | NJ | 2012 | Drench | Mediocre efficacy with 0.1 g product per 9 sq ft in 0.5 gal water. | Y | 20130412a.pdf |
| 29499 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) S. chinensis | Field Container | Reding | OH | 2009 | Drench | 100 % control at 8 oz per 100 gal. | Y | 20091130p.pdf |
| 25122 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2005 | Drench | Some reduction of grubs with Aug drench of 10 oz per 100 gal; no statistical difference from untreated with Nov application. | Y | 20080522a.pdf |
| 25122 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2009 | Drench | An 87% reduction in grub counts using 0.1 g product per 9 sq ft in ½ gal water. | Y | 20110324a.pdf |
| 25122 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | Significant reduction in grub population at 0.1 g per 9 sq ft drench; no impact on plant height or width. | Y | 20110331h.pdf |
| 29116 | Flagship 25WG (Thiamethoxam) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | 46 and 40 % control at 8 and 17 oz per 100 gal. | Y | 20090429a.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26858 | Flagship 25WG (Thiamethoxam) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | No control with 8 oz per 100 gal as curative drench. | Y | 20070418g.pdf |
| 26096 | Flagship 25WG (Thiamethoxam) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Drench | Great efficacy with 8 oz per 100 gal drench pre-infestation. | Y | 20070228a.pdf |
| 25032 | Flagship 25WG (Thiamethoxam) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Little efficacy using 0.18 oz per 1000 sq ft drenched post-infestation. | N | 20060626a.pdf |
| 26497 | Flagship 25WG (Thiamethoxam) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Drench | No statistical difference among treatments. | Y | 20070411a.pdf |
| 30399 | Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | No impact on grub population at 4 fl oz per tree; no impact on plant height or width. | N | 20110331h.pdf |
| 27920 | Hachi-Hachi EC (Tolfenpyrad) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Inconclusive data due to low untreated population; excellent root rating at 10 ppm. | N | 20080910c.pdf |
| 29114 | Hexacide (Rosemary Oil) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | 31 % control at 1.5 qt per 100 gal. | N | 20090429a.pdf |
| 26498 | Mach 2 Granular (Halofenazide) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Broadcast to media surface | No statistical difference among treatments. | N | 20070411a.pdf |
| 26097 | Mach 2 Liquid (Halofenazide) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Drench | Little efficacy with 2 lb ai per acre drenched pre-infestation. | N | 20070228a.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25034 | Mach 2 Liquid (Halofenazide) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Little efficacy using 2.9 fl oz per 1000 sq ft drenched post-infestation. | N | 20060626a.pdf |
| 26093 | Marathon 1% granular (Imidacloprid) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Soil Incorporation | Good efficacy with 0.1 g ai per gal soil as soil incorporation. | Y | 20070228a.pdf |
| 25035 | Marathon 60WP (Imidacloprid) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Little efficacy using 20 g per 3000 sq ft drenched post-infestation. | N | 20060626a.pdf |
| 30338 | Marathon II (Imidacloprid) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field Container | Freiberger | NJ | 2009 | Drench | An 86% reduction in grub counts using 0.6 fl oz per 1,000 sq ft in 10 gal water. | Y | 20110324a.pdf |
| 26824 | Met52 (Metarhizium anisopliae strain F52) | Oriental Beetle (Anomala orientalis) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Drench | No infestation; no phytotoxicity. | N | 20080128h.pdf |
| 26939 | Met52 (Metarhizium anisopliae strain F52) | Oriental Beetle (Anomala orientalis) | Rhododendron (Rhododendron sp.) 'Scintillation' | Field Container | Alm | RI | 2008 | Soil Incorporation | No significant control at 20 g per 4 gal media. | N | 20081113b.pdf |
| 27722 | Met52 (Metarhizium anisopliae strain F52) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2007 | Drench | No infestation; no phytotoxicity. | N | 20080128h.pdf |
| 26467 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Soil Incorporation | No efficacy using 450,000,000 spores per L. | Y | 20070418g.pdf |
| 26467 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Drench | Inconclusive data due to low Untreated population; excellent root rating at 2.9 g per pot. | Y | 20080910c.pdf |
| 26467 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Inconclusive data due to low Untreated population; excellent root rating at 2.9 g per pot. | Y | 20080910c.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26092 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Soil Incorporation | Little efficacy with 6.25 g per pot incorporated into soil pre-infestation. | Y | 20070228a.pdf |
| 26092 | Met52 (Metarhizium anisopliae strain F52) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Soil Incorporation | Poor efficacy at 6.25 g per pot. | Y | 20071220b.pdf |
| 27612 | Met52 (Metarhizium anisopliae strain F52) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 27674 | Met52 (Metarhizium anisopliae strain F52) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2007 | Drench | Only ~10 % grub survival; no statistical difference among treatments | N | 20080116f.pdf |
| 30398 | NI-CH001 (NI-CH001) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field In-Ground | Freiberger | NJ | 2010 | Drench | No impact on grub population at 1 oz per gal; no impact on plant height or width. | N | 20110331h.pdf |
| 26790 | Ornazin 3%EC (Azadirachtin) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Little efficacy using 10 oz per 100 gal drenched post-infestation. | N | 20060626a.pdf |
| 25279 | Orthene TTO 97 (Valent) (Acephate) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Excellent efficacy using 12 oz per 100 gal drenched post-infestation. | Y | 20060626a.pdf |
| 26094 | Precise Acephate (Acephate) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Soil Incorporation | Little efficacy wit 6 g ai per pot incorporated into soil pre-infestation. | Y | 20070228a.pdf |
| 26499 | Precise Acephate (Acephate) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Broadcast to media surface | No statistical difference among treatments. | Y | 20070411a.pdf |
| 26823 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Dogwood, Kousa (Cornus kousa) | Field Container | Reding | OH | 2007 | Drench | No infestation; no phytotoxicity. | Y | 20080128h.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29501 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Oak, White (Quercus alba) | Field Container | Reding | OH | 2009 | Drench | 100 % control at 24 oz per 100 gal. | N | 20091130p.pdf |
| 26937 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Rhododendron (Rhododendron sp.) 'Scintillation' | Field Container | Alm | RI | 2008 | Drench | 100 % control at 24 oz per 100 gal; equal to standard. | Y | 20081113b.pdf |
| 25796 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2005 | Drench | Excellent control at 6, 12 and 24 oz per 100 gal. | Y | 20060214a.pdf |
| 25796 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2006 | Drench | No infestation developed; no phytotoxicity or impact on growth. | Y | 20070410b.pdf |
| 25796 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field Container | Reding | OH | 2007 | Drench | No infestation; no phytotoxicity. | Y | 20080128h.pdf |
| 25796 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) S. chinensis | Field Container | Reding | OH | 2009 | Drench | 100 % control at 24 oz per 100 gal. | Y | 20091130p.pdf |
| 31671 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Yew (Taxus sp.) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | Excellent control of oriental beetle larvae. | N | 20061212w.pdf |
| 30339 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field Container | Freiberger | NJ | 2009 | Drench | A 21% reduction in grub counts using 12 grams per inch dbh for trees. | N | 20110324a.pdf |
| 29112 | Safari 20SG (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | No significant control at 24 oz per 100 gal. | N | 20090429a.pdf |
| 26470 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Drench | Good efficacy using 24 oz per 100 gal. | Y | 20070418g.pdf |
| 26470 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Excellent control at 24 oz per 100 gal. | Y | 20080910c.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25795 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Spruce, White; Cat (Picea glauca) | Field Container | Reding | OH | 2005 | Drench | No infestation developed. | Y | 20060214a.pdf |
| 25200 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Azalea, & Rhododendron (Rhododendron sp.) 'Nova Zembla' | Field Container | Reding | OH | 2004 | Drench | Very little efficacy at 0.75, 1.5 and 3.0 lb product per 100 gal when drenched onto mature and pupating larvae; no injury at any rate. | Y | 20080522b.pdf |
| 25201 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Stonecrop (Sedum sp.) 'Vera Jameson' | Field Container | Reding | OH | 2004 | Drench | Excellent efficacy at 0.75, 1.5, and 3.0 lb product per 100 gal when drenched shortly before adults layed eggs; no injury at any rate. | Y | 20080522c.pdf |
| 25201 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Stonecrop (Sedum sp.) 'Vera Jameson' | Field Container | Reding | OH | 2005 | Drench | No efficacy at 6, 12, and 24 oz product per 100 gal with drench application prior to adults laying eggs; no injury. | Y | 20060214a.pdf |
| 26755 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Stonecrop (Sedum spurium) 'Vera Jameson' | Field Container | Reding | OH | 2006 | Drench | 4.8 oz ai per 100 gal; excellent efficacy on larvae; significantly reduced adult feeding damage; no phytotoxicity; plant significantly taller than Untreated | Y | 20070412m.pdf |
| 25432 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus sp.) | Field Container | Nielsen | OH | 2006 | Drench | Excellent efficacy with 6.8 g ai per pot drenched pre-infestation. | Y | 20070228a.pdf |
| 25432 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus sp.) 'Brownii' | Field Container | Reding | OH | 2004 | Foliar | Good to excellent efficacy at 0.75, 1.5, and 3.0 lb product per 100 gal with foliar application shorlty before adults layed eggs; no injury at any rate. | Y | 20080522d.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25432 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus sp.) 'Brownii' | Field Container | Reding | OH | 2005 | Drench | No larvae in any treatment at final rating; no injury. | Y | 20060214a.pdf |
| 25432 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus sp.) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Drench | Excellent efficacy at 12 oz per 100 gal. | Y | 20071220b.pdf |
| 25432 | Safari 20SG (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus sp.) 'Nigra' | Field Container | Alm | RI | 2006 | Drench | No significant control of black vine weevil. | Y | 20061212w.pdf |
| 27608 | Safari 20SG (Dinotefuran) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2007 | Drench | Low infestation levels and no statistical significance among treatments. | N | 20071219p.pdf |
| 26496 | Safari 20SG (Dinotefuran) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Drench | No statistical difference among treatments. | Y | 20070411a.pdf |
| 30340 | Safari 2G (V-10112 2G) (Dinotefuran) | Oriental Beetle (Anomala orientalis) | Arborvitae (Thuja sp.) | Field Container | Freiberger | NJ | 2009 | Broadcast | A 29% reduction in grub counts using 120 grams per inch dbh for tree. | Y | 20110324a.pdf |
| 26609 | Safari 2G (V-10112 2G) (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) 'Idea' | Field Container | Cowles | CT | 2008 | Soil Incorporation | Poor control at 1.23 g per pot. | Y | 20080910c.pdf |
| 27616 | Safari 2G (V-10112 2G) (Dinotefuran) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Soil Incorporation | Excellent efficacy at 2.2 g per pot. | Y | 20071220b.pdf |
| 25033 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Strawberry Rootworm (Paria fragariae ssp. Fragariae) | Azalea (Rhododendron sp.) | Field Container | Hesselein | AL | 2005 | Drench | Highly efficacious using 25 fl oz per 100 gal drenched post-infestation. | N | 20060626a.pdf |

| PR# | Product (Active Ingredients) | Target | Crop | Production Site | Researcher | Trial State | Trial Year | Application Type | Results | EPA Reg | File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26500 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2006 | Drench | No statistical difference among treatments. | N | 20070411a.pdf |
| 26500 | Talstar Flowable Insecticide/Miticide (Bifenthrin) | Japanese Beetle - grubs (Popillia japonica - grubs) | Rose (Rosa sp.) 'Caldwell Pink' | Field Container | Braman | GA | 2007 | Drench | Only ~10 % grub survival; no statistical difference among treatments. | N | 20080116f.pdf |
| 27969 | Talstar NG (Bifenthrin) | Oriental Beetle (Anomala orientalis) | Rhododendron (Rhododendron sp.) 'Scintillation' | Field Container | Alm | RI | 2008 | Soil Incorporation | Standard treatment; 100 % control at 33.7 g per gal media. | Y | 20081113b.pdf |
| 26856 | Talstar NG (Bifenthrin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Strawberry (Non-Bearing) (Fragaria sp.) | Field Container | Cowles | CT | 2007 | Soil Incorporation | Excellent control with 10 ppm preplant soil incorporation. | Y | 20070418g.pdf |
| 26095 | Talstar NG (Bifenthrin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) | Field Container | Nielsen | OH | 2006 | Soil Incorporation | Poot efficacy with 25 ppm incorporated into soil pre-infestation. | Y | 20070228a.pdf |
| 26095 | Talstar NG (Bifenthrin) | Black Vine Weevil - grubs (Otiorhynchus sulcatus - grubs) | Yew (Taxus media) 'Densiformis' | Field Container | Nielsen | OH | 2007 | Soil Incorporation | Poor efficacy at 25 ppm ai. | Y | 20071220b.pdf |
| 31411 | Tank Mix: AzaGuard + TerraClean 5.0 (azadirachtin +) | Oriental Beetle (Anomala orientalis) | Lilac, Common (Syringa vulgaris) | Field In-Ground | Freiberger | NJ | 2012 | Drench | Poor efficacy with 16 fl oz + 1 gal per 100 gal using 0.5 gal diluent per 9 sq ft. | N | 20130412a.pdf |
| 29111 | TickEx EC (Metarhizium anisophliae) | Oriental Beetle (Anomala orientalis) | Turf (Turf) | Greenhouse | Gilrein | NY | 2007 | Drench | No efficacy at 21 and 29 fl oz per 100 gal. | N | 20090429a.pdf |

## Label Suggestions

Based upon data accumulated through the IR-4 research program in 2005-2016, we suggest that registrants consider the following updates to their current product labels:

- Arena/Celero
  - add drench applications at time of male oriental beetle flight to these labels
  - add viburnum leaf beetle to these labels
  - if additional favorable data are available, add soil incorporation, pre-infestation drench and post-infestation drench to the Celero 20SG label to control black vine weevil larvae
- BAS 320i
  - if additional favorable data are available, add Japanese beetle adults to the initial label
  - if additional favorable data are available, add viburnum leaf beetle to the initial label
  - if additional favorable data are available, add black vine weevil to the initial label
- DPX-E2Y45/Acelepryn
  - add drench applications at time of male oriental beetle flight to the initial label
  - include both Japanese beetle adults and larvae at appropriate rates in the initial label for ornamental horticulture crops
  - add viburnum leaf beetle on the label at 16 oz per 100 gal
  - if additional favorable data are available, add soil incorporation and pre-infestation drench to the label to control black vine weevil larvae
- Hachi-Hachi/Tolfenpyrad
  - if additional favorable data are available, add Japanese beetle adults to the initial label
  - if additional favorable data are available, add viburnum leaf beetle to the initial label
- Safari 20SG
  - add pre-infestation drench to the label to control black vine weevil larvae
  - add viburnum leaf beetle to the existing label at 8 oz per 100 gal
  - if additional favorable data are available, add drench applications at time of male oriental beetle flight to this label
- TriStar
  - if additional favorable data are available, add viburnum leaf beetle to the label

## Appendix 1: Contributing Researchers

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|---|---|
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