

Project Name: Borer & Beetle Efficacy

Dates Active: 2006 – 2013; 2016-2022

Project Description:

Coleopteran borers and foliar feeding beetles present difficult to manage for distinct reasons. Borers are deposited as eggs on or just under bark. Once they hatch, they feed on trunks and branches with little visible sign of their presence until they pupate and emerge from the trees or shrubs as adults which then mate and start the cycle again. Many borer species have a single life cycle per year, but others may have multiple cycles and adult flights. The management challenge is how to best target the life cycle to minimize infestation when the most active and damaging life stage is hidden from view. Foliar feeding beetles present another challenge in that often the adults may be the most destructive feeding stage and may move away from the treated areas until the residues are too low to be effective.

Research Project Abstract:

Abstract from the 2023 Coleopteran Efficacy Summary

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 2022, 91 products representing 58 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, red headed flea beetle, Sri Lankan weevil, and viburnum leaf beetles to recommend actions to register or amend labels for these pests.

Target Species (Phytotoxicity, or common and Latin name of arthropod, pathogen, weed):

Ambrosia Beetle (*Xylosandrus germanus*)
 Ambrosia Beetle, Granulate/Asian (*Xylosandrus crassiusculus*)
 Ambrosia Beetle, Redbay (*Xyleborus glabratus*)
 Banded Ash Clearwing Borer (*Podosesia aureocincta*)
 Black Vine Weevil - adults (*Otiorhynchus sulcatus* - adults)
 Borer, Mediterranean Oak (*Xyleborus monographus*)
 Bronze Birch Borer (*Agrilus anxius*)
 Emerald Ash Borer (*Agrilus planipennis*)
 European Elm Flea Weevil (*Orchestes alni*)
 Flatheaded Apple Tree Borer (*Chrysobothris femorata*)
 Flea Beetle, Garden, Epitrix sp. (*Epitrix* sp.)
 Japanese Beetle - adults (*Popillia japonica* - adults)
 Lilac Borer (*Podosesia syringa*)
 Pacific Flatheaded Borer (*Chrysobothris mali*)
 Peachtree Borer (*Synanthedon exitiosa*)
 Red Headed Flea Beetle (*Systema frontalis*)
 Rednecked Cane Borer (*Agrilus ruficollis*)
 Sri Lankan Weevil (*Myllocerus undatus*)
 Viburnum Leaf Beetle (*Pyrrhalta viburni*)

Target Crops (list tested crops if ongoing or completed project)

Maple, Red (*Acer rubrum*)
 Mimosa Silk Tree (*Albizia julibrissin*)
 Birch, Paper (*Betula papyrifera*)
 European White Birch (*Betula pendula*)
 Birch (*Betula sp.*)
 American Redbud, Eastern Redbud (*Cercis canadensis*)
 Dogwood, Flowering (*Cornus florida*)
 Dogwood, Kousa (*Cornus kousa*)
 Joe Pye Weed (*Eupatorium maculatum*)
 Forsythia (*Forsythia sp.*)
 Ash, Green (*Fraxinus pennsylvanica*)
 Shoeblackplant; Chinese hibiscus (*Hibiscus rosa-sinensis*) 'Double Peach'
 Rose-Of-Sharon (*Hibiscus syriacus*)
 Panicle Hydrangea (*Hydrangea paniculata*)
 Hydrangea (*Hydrangea sp.*)
 Witch's Moneybags (*Hylotelephium telephium*) 'Autumn Joy'
 Virginia Sweetspire (*Itea virginica*)
 Walnut, Black (Non-Bearing) (*Juglans nigra*)
 Crape Myrtle (*Lagerstroemia indica*)
 Sweet Bay (*Magnolia virginiana*)
 Evening Primrose; Sundrops (*Oenothera sp.*) O. sp 'Sundrops'
 Redbay (*Persea borbonia*)
 Cherry, Sargent (*Prunus sargentii*)
 Prunus, Non-bearing (*Prunus sp.*) P. cistina
 Oak (*Quercus sp.*)
 Rhododendron (*Rhododendron sp.*)
 Rose (*Rosa sp.*)
 Blackberry (*Rubus sp.*)
 Willow (*Salix sp.*) S. hakuro nishiki
 Woodland Sage (*Salvia nemorosa*) 'Blue Hill'
 Lilac (*Syringa sp.*)
 Hybrid Yew (*Taxus X media*)
 Linden, Shamrock (*Tilia cordata*)
 Elm (*Ulmus sp.*)
 Arrowwood (*Viburnum sp.*)
 Grape (Non-Bearing) (*Vitis sp.*) 'Seyval Blanc'

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)	
Acelepryn (Chlorantraniliprole)	BW238 WP (BW238 WP)
Acelepryn (Dupont) (Chlorantraniliprole)	Cease (Bacillus subtilis strain QST 713)
Acephate 97UP (Acephate)	Celero 16WSG (Clothianadin)
Acephate Pro 75 WSP (Acephate)	Conserve SC (Spinosad)
Admire PRO (imidacloprid)	DEET (DEET)
Allectus SC (Bifenthrin + Imidacloprid)	Dimethoate 4EC (Drexel) (Dimethoate)
Aloft SC (Clothianadin + bifenthrin)	Discus (Imidacloprid + cyfluthrin)
Altacor (chlorantraniliprole)	Double Nickel LC (Bacillus amyloliquefaciens Strain D747)
Amaryllis (Amaryllis)	DPX-HGW86 (Cyantraniliprole)
Ammo EC (Cypermethrin)	Dursban (Chlorpyrifos)
Ancora (Isaria fumosorosea Apopka Strain 97 (ATCC 20874))	Entrust (Spinosad)
Arbormectin (emamectin benzoate)	Exirel (cyantraniliprole)
Arena 50WDG (Clothianadin)	Fanfare 2EC (bifenthrin)
Asana XL (Esfenvalerate)	Flagship 0.22G (Thiamethoxam)
Assail 30SC (acetamiprid)	Flagship 25WG (Thiamethoxam)
Astro (Permethrin)	Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655)
Avaunt (indoxacarb)	Hachi-Hachi EC (Tolfenpyrad)
Avelo Fungicide (Mefentrifluconazole)	Hachi-Hachi SC (Tolfenpyrad)
AzaGuard (Azadirachtin)	Heritage (Azoxystrobin)
Azatin O (Azadirachtin)	Insignia 20WDG Intrinsic Brand Fungicide (Pyraclostrobin)
Azatin XL (Azadirachtin)	Intrepid Edge (methosyfenozide + spinentoram)
Banner MAXX (Propiconazole)	ISM-555 (ISM-555, A21377X)
BAS 320i (Metaflumizone)	JMS Stylet Oil (Aliphatic petroleum distillate)
BCS-507 (BCS-507)	KOC22018-8 (Botanical Oil Blend)
beetleGONE! tlc (Bacillus thuringiensis subsp. galleriae Strain SDS-502)	Kontos 240SC (Spirotetramat)
Belay (clothianadin)	Lorsban 4E (Chlorpyrifos)
Benefit 60 WP (imidacloprid)	Lynx EC 5.0 (Pyrethrins)
Bifenthrin 8% ME (Bifenthrin)	Mach 2 Liquid (Halofenazide)
BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA)	Mainspring GNL 200SC (Cyantraniliprole)
BotaniGard MAXX (Pyrethrins + Beauveria bassiana Strain GHA)	Marathon 1% granular (Imidacloprid)
Bountify (MBI 306) (Burkholderia rinojensis strain A396)	Marathon II (Imidacloprid)
BW133 (BW133)	MBI 203 SC2 (MBI 203)
BW238 ES (BW238 ES)	MBI-203 WDG (Chromobacterium subtsugae)

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)	
Merit 2F (Imidacloprid)	Talstar NF (Bifenthrin)
Met52 (Metarhizium anisopliae strain F52)	Tempo 20WP (Cyfluthrin)
NEI 25925 (Acetamiprid)	TetraCURB Concentrate (Rosemary Oil)
Onyx (Bifenthrin)	TetraCURB Organic (Rosemary Oil)
Perm-Up 3.2EC (Permethrin)	Thiodan EC (Endosulfan)
Pradia (Cyclaniliprole + Flonicamid)	TickEx EC (Metarhizium anisopliae)
Precise Acephate (Acephate)	Torque 3.6SC (Tebuconazole)
Pre-fe-ral (Biobest) (Paecilomyces fumosoroseus)	Tourney 50WDG (Metconazole)
Preferal (SePro) (Isaria fumosoroseus)	Transtect (dinotefuran)
Proclaim (Emamectin benzoate)	TREE-age (emamectin benzoate)
Pyridium (Beta-cyfluthrin)	TriStar 30SG (Acetamiprid)
RTSA 503 (Unknown)	TriStar 70WSP (Acetamiprid)
RTSA 721 (RTSA 721)	TriStar 8.5SL (Acetamiprid)
RTSA-7650 (RTSA-7650)	UP-Star Gold (Bifenthrin)
Safari 20SG (Dinotefuran)	V-10433 (V-10433)
Safari 2G (Dinotefuran)	Velifer (Beauveria bassiana Strain PPRI 5339)
Sarisa 50SL (Cyclaniliprole)	Venerate CG (Burkholderia rinojensis strain A396)
Scimitar CS (Lambda-cyhalothrin)	Verdepryn (cyclaniliprole)
Sevin (zeta-cypermethrin - consumer label) (zeta-cypermethrin)	VST 06330 EP (GS-omega/kappa-Hxtx-Hv1a)
Sevin SL (Carbaryl)	VST-006350 (Liquid) (GS-omega/kappa-Hxtx-Hv1a)
Snipper (bifenthrin)	Xpectro OD (Pyrethrins + Beauveria bassiana Strain GHA)
SP2478 (SP2478)	Xxpire 40WG (Spinetoram + sulfoxaflor)
SP3014 (SP3014)	Xytect 2F (Imidacloprid)
Stargus (Bacillus nakamurai strain F727)	Xytect 75WP (Imidacloprid)
Talstar Flowable Insecticide/Miticide (Bifenthrin)	

Product Registration and Research Status			
	Fully Screened (also includes standards)	Partially Screened through IR-4 ¹	Need Data for Additional Species ?
Labeled for Borers & Beetles Generally & Commercialized	Flagship 25WG Safari 20SG * Scimitar CS Talstar NF	Tempo 20WP TriStar 30SG TriStar 70WSP Acelepryn * Grandevo (MBI 203 DF) Hachi-Hachi * Met 52 EC (TickEx EC)* Sarisa (IKI-3106)	Allectus SC ² Aloft SC ² BeetleGONE Botanigard ES Botanigard MAXX Discus Marathon 1G Safari 2G Xpectro OD
Labeled Generally But NOT Commercialized			
Labeled for Specific Pests & Commercialized			
Labeled for Specific Pests but NOT Commercialized			
Not yet registered or labeled		Amaryllis ISM-555 Bountify (MBI-306) SP3014 V-10433 Venerate	
No longer available for development	Dursban 50W	BAS 320i Celero 16WSG ² Kontos *	
* IR-4 Data contributed to registration decision – either adding pest to label or not pursuing further research 1 At least one species screened fully 2 Product not available for production ornamentals			

IR-4 Efficacy Trials to Date

Average rating on a scale of 1 – 5 where 1 = <60% Control (not effective), 2 = 60-79% control, 3 = 80-89% control, 4 = 90-94% control and 5 = 95-100% control; minimum to maximum rating; number of trials (See table on next page). For product/pest combinations that are blank, IR-4 has not screened this combination. A rating of 3 or higher is considered commercially acceptable. 'Labeled' indicates that this pest species or genera is listed on the label.

Environmental Horticulture Program Research Project Sheet

<https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-extension-resources/>

Table 1 of 3. Borers

MOA	Product (Actives)	Flatheaded Apple Tree Borer (<i>Chrysobothris femorata</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)	Rednecked Cane Borer (<i>Agrilus ruficollis</i>)	Pacific Flatheaded Borer (<i>Chrysobothris mali</i>)
IRAC 21A	Hachi-Hachi EC (Tolfenpyrad)		1.0 (1 - 1) n1		
IRAC 22	Avaunt (indoxacarb)			1.0 (1 - 1) n1	
IRAC 28	Acelepryn (Dupont) (Chlorantraniliprole)		5.0 (5 - 5) n1 Labeled		
IRAC 28	DPX-HGW86 (Cyantraniliprole)		5.0 (5 - 5) n1 Labeled		
IRAC 28	Mainspring GNL 200SC (Cyantraniliprole)	3.7 (1 - 5) n3			
IRAC 3	Fanfare 2EC (bifenthrin)			1.0 (1 - 1) n1	
IRAC 3A	Onyx (Bifenthrin)		5.0 (5 - 5) n1 Labeled		
IRAC 3A	Scimitar CS (Lambda-cyhalothrin)		5.0 (5 - 5) n1 Labeled		
IRAC 4	Assail 30SC (acetamiprid)				2.0 (2 - 2) n1
IRAC 4a	Admire PRO (imidacloprid)			3.0 (3 - 3) n1	1.0 (1 - 1) n1
IRAC 4A	Flagship 25WG (Thiamethoxam)	1.0 (1 - 1) n2	1.0 (1 - 1) n1		
IRAC 4A	Merit 2F (Imidacloprid)	5.0 (5 - 5) n2			
IRAC 4A	Safari 20SG (Dinotefuran)		5.0 (5 - 5) n1 Labeled		
IRAC 4A	Transtect (dinotefuran)	5.0 (5 - 5) n1			
IRAC 4A	TriStar 30SG (Acetamiprid)		5.0 (5 - 5) n1 Labeled		

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MOA	Product (Actives)	Flatheaded Apple Tree Borer (<i>Chrysobothris femorata</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)	Rednecked Cane Borer (<i>Agrilus ruficollis</i>)	Pacific Flatheaded Borer (<i>Chrysobothris mali</i>)
IRAC 4A + IRAC 3A	Discus (Imidacloprid + cyfluthrin)	2.0 (2 - 2) n2 Labeled	5.0 (5 - 5) n1 Labeled		
IRAC 5	Entrust (Spinosad)	1.0 (1 - 1) n1			
IRAC UNF	BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA)			1.0 (1 - 1) n1	
IRAC 28	Altacor (chlorantraniliprole)				1.0 (1 - 1) n1
IRAC 4A	Belay (clothianadin)				1.0 (1 - 1) n1
IRAC 28	Exirel (cyantraniliprole)				1.0 (1 - 1) n1
IRAC 18 + IRAC 5	Intrepid Edge (methosyfenozide + spinentoram)				2.0 (2 - 2) n1
unknown	ISM-555 (ISM-555, A21377X)	5.0 (5 - 5) n1			
unknown	JMS Stylet Oil (Aliphatic petroleum distillate)			2.0 (2 - 2) n1	
unknown	RTSA 721 (RTSA 721)	1.0 (1 - 1) n1			
unknown	RTSA-7650 (RTSA-7650)	5.0 (5 - 5) n1			
IRAC 3A	Snipper (bifenthrin)				1.0 (1 - 1) n1
unknown	V-10433 (V-10433)	1.0 (1 - 1) n1			
IRAC 28	Verdepryn (cyclaniliprole)				3.0 (3 - 3) n1

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Table 2 of 3. Borers

MOA	Product (Actives)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Emerald Ash Borer (<i>Agilus planipennis</i>)
	DEET (DEET)		4.0 (3 - 5) n2		
FRAC 7 / unknown	Rotation: ESP 715 / BCS-507 (Fluopyram / BCS-507)		1.0 (1 - 1) n1		
FRAC NC & IRAC UNF	Met52 (Metarhizium anisopliae strain F52)		1.0 (1 - 1) n1 Labeled		
IRAC 1B	Dursban (Chlorpyrifos)		1.0 (1 - 1) n2		
IRAC 1B	Lorsban 4E (Chlorpyrifos)		2.5 (2 - 3) n2		
IRAC 21A	Hachi-Hachi EC (Tolfenpyrad)	3.0 (3 - 3) n1	1.0 (1 - 1) n1	5.0 (5 - 5) n1	
IRAC 22B	BAS 320i (Metaflumizone)		1.0 (1 - 1) n1		
IRAC 23	Kontos 240SC (Spirotetramat)		1.0 (1 - 1) n1		
IRAC 28	Acelepryn (Dupont) (Chlorantraniliprole)	1.0 (1 - 1) n1 Labeled	1.0 (1 - 1) n2 Labeled	5.0 (5 - 5) n1 Labeled	
IRAC 28	DPX-HGW86 (Cyantraniliprole)		1.0 (1 - 1) n1 Labeled		
IRAC 28 / IRAC 3A	Rotation: Mainspring / Scimitar (cyantraniliprole / lambda cyhalothrin)		2.0 (2 - 2) n1		
IRAC 28 + IRAC 3A	Tank Mix: Mainspring GNL + Scimitar GC (cyantraniliprole + lambda cyhalothrin)		3.0 (3 - 3) n1		
IRAC 2A	Thiodan EC (Endosulfan)		1.0 (1 - 1) n1		
IRAC 3A	Ammo EC (Cypermethrin)		1.5 (1 - 2) n2		
IRAC 3A	Asana XL (Esfenvalerate)		2.0 (1 - 3) n3		
IRAC 3A	Bifenthrin 8% ME (Bifenthrin)		4.0 (3 - 5) n2		
IRAC 3A	Onyx (Bifenthrin)	3.0 (3 - 3) n1 Labeled	3.4 (1 - 5) n9 Labeled	2.0 (2 - 2) n1 Labeled	

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MOA	Product (Actives)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Emerald Ash Borer (<i>Agrilus planipennis</i>)
IRAC 3A	Perm-Up 3.2EC (Permethrin)		5.0 (5 - 5) n1		
IRAC 3A	Scimitar CS (Lambda-cyhalothrin)	1.0 (1 - 1) n1 Labeled			
IRAC 3A	Talstar NF (Bifenthrin)		3.0 (1 - 5) n3 Labeled		
IRAC 3A + ?	Tank Mix: Onyx + Deet (Bifenthrin + DEET)		4.0 (4 - 4) n1		
IRAC 3A + ?	Tank Mix: Talstar L&T + DEET (Bifenthrin + DEET)		3.0 (3 - 3) n1		
IRAC 3A + ?	Tank Mix: Tempo 2 + DEET (Cyfluthrin + DEET)		3.0 (3 - 3) n1		
IRAC 3A + IRAC 18B	Tank Mix: Onyx + Azatin XL (Bifenthrin + Neem Oil Extract)		3.0 (3 - 3) n1		
IRAC 3A + IRAC 1B	Tank Mix: Onyx + Dursban (Bifenthrin + chlorpyrifos)		5.0 (5 - 5) n1		
IRAC 3A + IRAC 4A	Tank Mix: Onyx + Celero 16WSG (Bifenthrin + clothianadin)		5.0 (5 - 5) n1		
IRAC 3A + IRAC UNF	BotaniGard MAXX (Pyrethrins + Beauveria bassiana Strain GHA)		1.0 (1 - 1) n1 Labeled		
IRAC 4A	Celero 16WSG (Clothianadin)		1.5 (1 - 2) n2 Labeled		

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MOA	Product (Actives)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Emerald Ash Borer (<i>Agrilus planipennis</i>)
IRAC 4A	Flagship 25WG (Thiamethoxam)	3.0 (3 - 3) n1	1.0 (1 - 1) n1		
IRAC 4A	Safari 20SG (Dinotefuran)	2.0 (1 - 3) n2 Labeled	1.0 (1 - 1) n1 Labeled		
IRAC 4A	TriStar 30SG (Acetamiprid)			1.0 (1 - 1) n1 Labeled	
IRAC 4A	Xytect 75WP (Imidacloprid)				1.0 (1 - 1) n1
IRAC 4A / ?	Rotation: Marathon II / BCS-507 (Imidacloprid / BCS-507)		1.0 (1 - 1) n1		
IRAC 4A + IRAC 3	Aloft SC (Clothianadin + bifenthrin)			5.0 (5 - 5) n1 Labeled	
IRAC 4A + IRAC 3A	Discus (Imidacloprid + cyfluthrin)		2.5 (2 - 3) n2 Labeled		
IRAC 4A + IRAC 3A + ?	Tank Mix: Discus + DEET (Imidacloprid + cyfluthrin + DEET)		4.0 (3 - 5) n2		
IRAC UN	Azatin XL (Azadirachtin)		1.0 (1 - 1) n1 Labeled		
IRAC 6	Arbormectin (emamectin benzoate)				4.0 (4 - 4) n1
unknown	BCS-507 (BCS-507)		1.0 (1 - 1) n1		
IRAC 6	TREE-age (emamectin benzoate)				5.0 (5 - 5) n1
unknown	V-10433 (V-10433)		1.0 (1 - 1) n1		

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Table 3 of 3 Foliar Feeding Coleopterans

MOA	Product (Actives)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i>)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i>)	Red Headed Flea Beetle (<i>Systema frontalis</i>)	Sri Lankan Weevil (<i>Myloccerus undatus</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
FRAC BM02	Grandevo (MBI 203 DF) (Chromobacterium subtsugae NRRL B-30655)		1.0 (1 - 1) n1	1.0 (1 - 1) n1	1.7 (1 - 3) n6		
FRAC BM02	MBI-203 WDG (Chromobacterium subtsugae)					3.0 (3 - 3) n1	
FRAC BM02 & IRAC UNB	Venerate CG (Burkholderia rinojensis strain A396)					2.0 (2 - 2) n1	
FRAC NC	BW133 (BW133)			1.0 (1 - 1) n2	3.0 (3 - 3) n1		
FRAC NC & IRAC UNB	Bountify (MBI 306) (Burkholderia rinojensis strain A396)			1.4 (1 - 2) n5	1.0 (1 - 1) n4		
FRAC NC & IRAC UNF	Ancora (Isaria fumosorosea Apopka Strain 97 (ATCC 20874))				2.0 (1 - 3) n2		
FRAC NC & IRAC UNF	Met52 (Metarhizium anisopliae strain F52)	1.0 (1 - 1) n1 Labeled					1.0 (1 - 1) n2 Labeled
FRAC NC & IRAC UNF	Pre-fe-ral (Biobest) (Paecilomyces fumosoroseus)				1.0 (1 - 1) n1		
FRAC NC & IRAC UNF	Preferal (SePro) (Isaria fumosoroseus)				1.4 (1 - 3) n5	2.0 (2 - 2) n1	

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MOA	Product (Actives)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i>)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i>)	Red Headed Flea Beetle (<i>Systema frontalis</i>)	Sri Lankan Weevil (<i>Myloccerus undatus</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
IRAC 11A	beetleGONE! tlc (Bacillus thuringiensis subsp. galleriae Strain SDS-502)				1.3 (1 - 2) n6	2.0 (2 - 2) n1	
IRAC 1A	Sevin SL (Carbaryl)			5.0 (5 - 5) n2			
IRAC 1B	Acephate 97UP (Acephate)				1.0 (1 - 1) n1		
IRAC 1B	Acephate Pro 75 WSP (Acephate)				1.0 (1 - 1) n1		
IRAC 1B	Precise Acephate (Acephate)			2.0 (2 - 2) n1 Labeled			
IRAC 21A	Hachi-Hachi EC (Tolfenpyrad)	1.0 (1 - 1) n1	1.0 (1 - 1) n1	1.5 (1 - 3) n4	1.7 (1 - 3) n3		3.0 (3 - 3) n2
IRAC 21A	Hachi-Hachi SC (Tolfenpyrad)				2.2 (1 - 5) n12 Labeled	2.0 (2 - 2) n1 Labeled	
IRAC 22B	BAS 320i (Metaflumizone)	5.0 (5 - 5) n1		2.8 (1 - 5) n5			3.0 (3 - 3) n2
IRAC 28	Acelepryn (Chlorantraniliprole)			4.7 (4 - 5) n3	1.0 (1 - 1) n4		
IRAC 28	Acelepryn (Dupont) (Chlorantraniliprole)	1.0 (1 - 1) n1 Labeled		3.6 (1 - 5) n9 Labeled			4.0 (3 - 5) n7 Labeled
IRAC 28	Mainspring GNL 200SC (Cyantraniliprole)				2.4 (1 - 5) n7		
IRAC 28	Sarisa 50SL (Cyclaniliprole)			4.6 (4 - 5) n5 Labeled	3.1 (1 - 5) n9 Labeled	2.0 (2 - 2) n1 Labeled	
IRAC 28 +	Tank Mix: Sarissa + Azatin O (Cyclaniliprole + azadirachtin)				3.0 (3 - 3) n1		

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MOA	Product (Actives)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i>)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i>)	Red Headed Flea Beetle (<i>Systema frontalis</i>)	Sri Lankan Weevil (<i>Mylocherus undatus</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
IRAC 28 + IRAC 29	Pradia (Cyclaniliprole + Flonicamid)				2.0 (2 - 2) n1		
IRAC 32	VST-006350 (Liquid) (GS-omega/kappa-Hxtx-Hv1a)			1.0 (1 - 1) n1	1.0 (1 - 1) n4		
IRAC 3A	Lynx EC 5.0 (Pyrethrins)					1.0 (1 - 1) n1	
IRAC 3A	Onyx (Bifenthrin)			4.7 (3 - 5) n7 Labeled	1.0 (1 - 1) n2 Labeled		
IRAC 3A	Pyridium (Beta-cyfluthrin)			4.0 (4 - 4) n1	5.0 (5 - 5) n1		
IRAC 3A	Scimitar CS (Lambda-cyhalothrin)			4.0 (3 - 5) n2 Labeled	3.0 (1 - 5) n5 Labeled		
IRAC 3A	Talstar Flowable Insecticide/Miticide (Bifenthrin)			5.0 (5 - 5) n2 Labeled			
IRAC 3A	Talstar NF (Bifenthrin)	5.0 (5 - 5) n1 Labeled					
IRAC 3A	UP-Star Gold (Bifenthrin)				3.0 (3 - 3) n1		
IRAC 3A + IRAC UNF	BotaniGard MAXX (Pyrethrins + Beauveria bassiana Strain GH4)			1.0 (1 - 1) n2 Labeled	1.0 (1 - 1) n2 Labeled		
IRAC 3A + IRAC UNF	Xpectro OD (Pyrethrins + Beauveria bassiana Strain GH4)			2.0 (1 - 3) n2		1.0 (1 - 1) n1	

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IRAC 4A	Benefit 60 WP (imidacloprid)				1.0 (1 - 1) n1		
IRAC 4A	Celero 16WSG (Clothianadin)	1.0 (1 - 1) n1 Labeled		2.4 (1 - 5) n8 Labeled			3.3 (3 - 4) n3 Labeled
IRAC 4A	Flagship 0.22G (Thiamethoxam)				1.0 (1 - 1) n1		
IRAC 4A	Flagship 25WG (Thiamethoxam)			2.5 (2 - 3) n2	3.5 (3 - 4) n2		4.3 (4 - 5) n4
IRAC 4A	Marathon 1% granular (Imidacloprid)				3.0 (3 - 3) n2 Labeled		
IRAC 4A	Marathon II (Imidacloprid)			5.0 (5 - 5) n1	3.0 (3 - 3) n1		
IRAC 4A	Safari 20SG (Dinotefuran)	1.0 (1 - 1) n1 Labeled	2.0 (2 - 2) n1 Labeled	2.3 (1 - 5) n9 Labeled	2.6 (1 - 5) n13 Labeled		3.0 (2 - 4) n3 Labeled
IRAC 4A	Safari 2G (Dinotefuran)			4.0 (3 - 5) n2 Labeled			1.0 (1 - 1) n1 Labeled
IRAC 4A	TriStar 30SG (Acetamiprid)			5.0 (5 - 5) n1 Labeled	2.0 (1 - 3) n3 Labeled		4.0 (4 - 4) n1 Labeled
IRAC 4A	TriStar 70WSP (Acetamiprid)			3.3 (1 - 5) n4 Labeled			
IRAC 4A	TriStar 8.5SL (Acetamiprid)			5.0 (5 - 5) n1	4.8 (4 - 5) n4		
IRAC 4A	Xytect 2F (Imidacloprid)		3.0 (3 - 3) n1	1.0 (1 - 1) n1			

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IRAC 4A + IRAC 3	Aloft SC (Clothianadin + bifenthrin)		2.0 (2 - 2) n1 Labeled	3.0 (1 - 5) n2 Labeled	4.0 (4 - 4) n3 Labeled		
IRAC 4A + IRAC 3A	Discus (Imidacloprid + cyfluthrin)				4.0 (4 - 4) n1 Labeled		
IRAC 5	Conserve SC (Spinosad)						4.3 (3 - 5) n4 Labeled
IRAC 5 + IRAC 4C	Xxpire 40WG (Spinetoram + sulfoxaflor)				2.6 (1 - 5) n7 Labeled		
IRAC UN	AzaGuard (Azadirachtin)			1.0 (1 - 1) n1		1.0 (1 - 1) n1	
IRAC UN	Azatin O (Azadiractin)				1.0 (1 - 1) n1		
IRAC UNE	TetraCURB Concentrate (Rosemary Oil)			1.0 (1 - 1) n1	2.5 (2 - 3) n2		
IRAC UNE	TetraCURB Organic (Rosemary Oil)			1.0 (1 - 1) n1	1.0 (1 - 1) n1		
IRAC UNF	BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA)			1.3 (1 - 2) n3		2.0 (2 - 2) n1	
IRAC UNF	TickEx EC (Metarhizium anisopliae)			1.0 (1 - 1) n5			
IRAC UNF	Velifer (Beauveria bassiana Strain PPRI 5339)			2.0 (2 - 2) n1 Labeled	1.5 (1 - 2) n2 Labeled		

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unknown	BCS-507 (BCS-507)			5.0 (5 - 5) n1	5.0 (5 - 5) n2		
unknown	BW238 ES (BW238 ES)			1.0 (1 - 1) n2	3.0 (3 - 3) n1		
unknown	BW238 WP (BW238 WP)			1.0 (1 - 1) n2			
unknown	ISM-555 (ISM-555, A21377X)			4.0 (3 - 5) n5	4.0 (3 - 5) n4		
unknown	KOC22018-8 (Botanical Oil Blend)			1.0 (1 - 1) n1	2.5 (1 - 4) n2		
unknown	MBI 203 SC2 (MBI 203)			1.4 (1 - 3) n5	1.0 (1 - 1) n4		
unknown	RTSA 721 (RTSA 721)			2.2 (1 - 5) n12			
IRAC 3A	Sevin (zeta-cypermethrin - consumer label) (zeta-cypermethrin)			5.0 (5 - 5) n1			
unknown	SP3014 (SP3014)			1.2 (1 - 2) n5	1.5 (1 - 3) n4		
unknown	V-10433 (V-10433)			1.4 (1 - 3) n7	1.6 (1 - 3) n5		