

Project Name: Borer & Beetle Efficacy

New		Ongoing	X	Completed		Duration if ongoing or completed:	2006–2013, 2016–2021
------------	--	----------------	---	------------------	--	--	----------------------

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 (if available):

Abstract from 2020 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 2019, 78 products representing 53 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.

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

Ambrosia Beetle (granulate) (<i>Xylosandrus crassiusculus</i>)	Flea beetles, garden (<i>Epitrix</i> sp.)
Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Japanese Beetle - adults (<i>Popillia japonica</i>)
Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)
Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i>)	Red Headed Flea Beetle (<i>Systema frontalis</i>)
Bronze Birch Borer (<i>Agilus anxius</i>)	Redbay Ambrosia Beetle (<i>Xyleborus glabratus</i>)
European Elm Flea Weevil (<i>Orchestes alni</i>)	Sri Lankan Weevil (<i>Mylocherus undatus</i>)
Flatheaded Apple Tree Borer (<i>Chrysobothris femorata</i>)	Viburnum leaf beetle (<i>Pyrrhalta viburni</i>)

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

American Redbud, Eastern Redbud (<i>Cercis canadensis</i>)	Crape Myrtle (<i>Lagerstroemia indica</i>)	Forsythia (<i>Forsythia</i> sp.)
Arrowwood (<i>Viburnum</i> sp.)	Dogwood, Kousa (<i>Cornus kousa</i>)	Grape (Non-Bearing) (<i>Vitis</i> sp.)
Arrowwood (<i>Viburnum dentatum</i>)	Elm (<i>Ulmus</i> sp.)	Hybrid Yew (<i>Taxus X media</i>)
Ash (<i>Fraxinus pennsylvanica</i>)	European White Birch (<i>Betula pendula</i>)	Hydrangea (<i>Hydrangea</i> sp.) 'White Diamonds'
Blackberry (<i>Rubus idaeus</i>)	Evening Primrose; Sundrops (<i>Oenothera speciosa</i> var. <i>berlandieri</i>)	Joe Pye Weed (<i>Eupatorium maculatum</i>)
Cherry, Sargent (<i>Prunus sargentii</i>)		

Linden, Shamrock (<i>Tilia cordata</i>) 'Bailley'	Redbay (<i>Persea borbonia</i>)	Sweet Bay (<i>Magnolia virginiana</i>)
Maple, Red (<i>Acer rubrum</i>)	Rhododendron (<i>Rhododendron</i> sp.)	Virginia Sweetspire (<i>Itea virginica</i>)
Mimosa Silk Tree (<i>Albizia julibrissin</i>)	Rose (<i>Rosa</i> sp.)	Willow (<i>Salix</i> sp.)
Panicle Hydrangea (<i>Hydrangea paniculata</i>)	Rose-Of-Sharon (<i>Hibiscus syriacus</i>)	Witch's Moneybags (<i>Hylotelephium telephium</i>) ¹
Plum (<i>Prunus cistina</i>)	Shoeblackplant; Chinese hibiscus (<i>Hibiscus rosa-sinensis</i>)	Woodland Sage (<i>Salvia nemorosa</i>)

Target Product(s)(list tested products or numbered compounds if ongoing or completed project)				
Acelepryn (aka DPX-E2Y45) 1.67	BotaniGard ES (BioWorks)	Hachi-Hachi SC	Onyx	Tempo 20WP
Allectus SC	BotaniGard MAXX	Kontos (BYI 8330 240SC)	Perm-Up 3.2EC	Thiodan EC
Aloft SC	Celero 16WSG	Lorsban 4E	Precise Acephate	TickEx EC
Ammo EC	DEET	Lynx EC 5.0	Preferal (SePro)	TriStar 30SG
Ancora	Discus	Mainspring GNL	Proclaim	TriStar 70WSP
Arena 50WDG	DPX-HGW86	200SC	Pyridium	TriStar 8.5SL
Asana XL	Dursban	Marathon 1%	Safari 20SG	UP-Star Gold
Astro	Flagship 0.22G	granular	Safari 2G	V-10433
AzaGuard	Flagship 25WG	Marathon II	Sarisa 50SL	Venerate CG
Azatin XL	Grandevo (MBI 203 DF)	MBI-203 WDG	Scimitar CS	VST-006350 (Liquid)
BAS 320i	Hachi-Hachi EC	Met52	Talstar Flowable	Xpectro OD
beetleGONE! tlc		NEI 25925	Insecticide/Miticide	Xpire 40WG
Bifenthrin 8% ME			Talstar NF	Xytect 2F

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	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			Venerate	
No longer available for development	DPX-HGW86 Dursban 50W		Acelepryn * 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				

Area	Characteristic	Pro	Con
Availability & effectiveness of alternative management tools	Successful project for registrations	x	
	Wide range of borers	x	
	Flat-headed borer & long-horn beetles	x	
	Good testing sites easy to find for bark and Ambrosia beetles	x	
	Need for thousand canker options (walnut twig borer)	x	
	New actives available (biological & chemical) for foliar feeding beetles	x	
	Several IRAC classes are available		x
	Very few new tools for screening		x
	Wide range of borers and sites sometimes difficult to find or arrange, not enough infested trees to test		x
	Ambrosia beetle – only pyrethroids		x
	Lep borers primarily landscape issues		x
	For some foliar feeding beetles, grubs are root feeders		x
Damage potential of target	Can be production limiting factor	x	
	Ambrosia beetle is number 1 pest in parts of the US	x	
Performance and crop safety of proposed products (from other systems)			
Compatibility with IPM, resistance management programs			
Economics	Wide range of economic impact based on system	x	
Geographic distribution			
Manufacturer interest in labeling products			
Other			
2017 comments: growers need more options including soil incorporation for larval stage of foliar feeding beetles. For ambrosia beetles, need antifeedants and systemic fungicides to kill ambrosia fungi. Timing of apps is critical. For flat headed vorers, timing of the applications are also important. Currently heavily dependent on pyrethroids. Lepidopteran borers			

IR-4 Efficacy Trials to Date

Average rating on a scale of 1 – 5 with 1 = 0 to about 50% efficacy (not effective) and 5 = 95 to 100 efficacy (very effective); minimum to maximum rating; number of trials (See table on next page). For product/insect combinations that are blank, IR-4 has not screened this combination.

‘Labeled’ indicates that this insect species or genera is listed on the label. A rating of 2 or lower is considered unacceptable efficacy (**red text**). A rating of 3 or higher is considered commercially acceptable (black text). Non-labeled, completed product/insect combinations (3 or more trials) with an average rating of 3 or higher are highlighted with **green text**. For insect/product combinations that are blank, IR-4 has not screened this combination.

Table 1 of 2. Borers

MOA	Product (Active Ingredients)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)	Sri Lankan Weevil (<i>Myloccerus undatus</i>)
IRAC 1B	Dursban (Chlorpyrifos)		1.0 (1 - 1) n2			
	Lorsban 4E (Chlorpyrifos)		2.5 (2 - 3) n2			
IRAC 2A	Thiodan EC (Endosulfan)		1.0 (1 - 1) n1			
IRAC 3A	Ammo EC (Cypermethrin)		1.5 (1 - 2) n2			
	Asana XL (Esfenvalerate)		2.0 (1 - 3) n3			
	Bifenthrin 8% ME (Bifenthrin)		4.0 (3 - 5) n2			
	Lynx EC 5.0 (Pyrethrins)					1.0 (1 - 1) n1
	Onyx (Bifenthrin)	3.0 (3 - 3) n1 Labeled	3.4 (1 - 5) n9 Labeled	2.0 (2 - 2) n1 Labeled	5.0 (5 - 5) n1 Labeled	
	Perm-Up 3.2EC (Permethrin)		5.0 (5 - 5) n1			
	Scimitar CS (Lambda-cyhalothrin)	1.0 (1 - 1) n1 Labeled			5.0 (5 - 5) n1 Labeled	
	Talstar NF (Bifenthrin)		3.0 (1 - 5) n3 Labeled			
IRAC 3A + ?	Tank Mix: Onyx + Deet (Bifenthrin + DEET)		4.0 (4 - 4) n1			
	Tank Mix: Talstar L&T + DEET (Bifenthrin + DEET)		3.0 (3 - 3) n1			
	Tank Mix: Tempo 2 + DEET (Cyfluthrin + DEET)		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 18B	Tank Mix: Onyx + Azatin XL (Bifenthrin + Neem Oil Extract)		3.0 (3 - 3) n1			
IRAC 3A + IRAC UNF	BotaniGard MAXX (Pyrethrins + Beauveria bassiana Strain GH)		1.0 (1 - 1) n1			
IRAC 3A + IRAC UNF	Xpectro OD (Pyrethrins + Beauveria bassiana Strain GH)					1.0 (1 - 1) n1
IRAC 4 + IRAC 3A	Discus (Imidacloprid + cyfluthrin)		2.5 (2 - 3) n2 Labeled		5.0 (5 - 5) n1 Labeled	
IRAC 4A	Celero 16WSG (Clothianidin)		1.5 (1 - 2) n2 Labeled			

MOA	Product (Active Ingredients)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)	Sri Lankan Weevil (<i>Myllocerus undatus</i>)
IRAC 4A	Flagship 25WG (Thiamethoxam)	3.0 (3 - 3) n1	<i>1.0 (1 - 1) n1</i>		<i>1.0 (1 - 1) n1</i>	
	Safari 20SG (Dinotefuran)	<i>2.0 (1 - 3) n2 Labeled</i>	<i>1.0 (1 - 1) n1 Labeled</i>		5.0 (5 - 5) n1 Labeled	
	Safari 2G (Dinotefuran)					
	TriStar 30SG (Acetamiprid)			<i>1.0 (1 - 1) n1 Labeled</i>	5.0 (5 - 5) n1 Labeled	
IRAC 4A / ?	Rotation: Marathon II / BCS-507 (Imidacloprid / BCS-507)		<i>1.0 (1 - 1) n1</i>			
IRAC 4A + IRAC 3	Aloft SC (Clothianadin + bifenthrin)			5.0 (5 - 5) n1 Labeled		
IRAC 4A + IRAC 3A + ?	Tank Mix: Discus + DEET (Imidacloprid + cyfluthrin + DEET)		4.0 (3 - 5) n2			
FRAC 7 / ?	Rotation: ESP 715 / BCS-507 (Fluopyram / BCS-507)		<i>1.0 (1 - 1) n1</i>			
IRAC 11A	beetleGONE! tlc (Bacillus thuringiensis subsp. galleriae Strain SDS-502)					<i>2.0 (2 - 2) n1</i>
IRAC 21A	Hachi-Hachi EC (Tolfenpyrad)	3.0 (3 - 3) n1	<i>1.0 (1 - 1) n1</i>	5.0 (5 - 5) n1	<i>1.0 (1 - 1) n1</i>	
	Hachi-Hachi SC (Tolfenpyrad)					<i>2.0 (2 - 2) n1</i>
IRAC 22B	BAS 320i (Metaflumizone)		<i>1.0 (1 - 1) n1</i>			
IRAC 23	Kontos (BYI 8330 240SC) (Spirotetramat)		<i>1.0 (1 - 1) n1</i>			
IRAC 28	Acelepryn (Dupont) (Chlorantraniliprole)	<i>1.0 (1 - 1) n1 Labeled</i>	<i>1.0 (1 - 1) n2 Labeled</i>	5.0 (5 - 5) n1 Labeled	5.0 (5 - 5) n1 Labeled	
	DPX-HGW86 (Cyantraniliprole)		<i>1.0 (1 - 1) n1 Labeled</i>		5.0 (5 - 5) n1 Labeled	
	Sarisa 50SL (Cyclaniliprole)					<i>2.0 (2 - 2) n1 Labeled</i>
IRAC 28 / IRAC 3A	Rotation: Mainspring / Scimitar (cyantraniliprole / lambda cyhalothrin)		<i>2.0 (2 - 2) n1</i>			
IRAC 28 + IRAC 3A	Tank Mix: Mainspring GNL + Scimitar GC (cyantraniliprole + lambda cyhalothrin)		3.0 (3 - 3) n1			
FRAC NC & IRAC UNB	Venerate CG (Burkholderia rinojensis strain A396)					<i>2.0 (2 - 2) n1</i>

MOA	Product (Active Ingredients)	Ambrosia Beetle (<i>Xylosandrus germanus</i>)	Ambrosia Beetle, Granulate/Asian (<i>Xylosandrus crassiusculus</i>)	Banded Ash Clearwing Borer (<i>Podosesia aureocincta</i>)	Peachtree Borer (<i>Synanthedon exitiosa</i>)	Sri Lankan Weevil (<i>Myllocerus undatus</i>)
FRAC NC & IRAC UNF	Met52 (Metarhizium anisopliae strain F52)		1.0 (1 - 1) n1 Labeled			
	Preferal (SePro) (Isaria fumosoroseus)					2.0 (2 - 2) n1
IRAC UN	AzaGuard (Azadirachtin)					1.0 (1 - 1) n1
	Azatin XL (Azadirachtin)		1.0 (1 - 1) n1 Labeled			
IRAC UNF	BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA)					2.0 (2 - 2) n1
unknown	BCS-507 (BCS-507)		1.0 (1 - 1) n1			
?	DEET (DEET)		4.0 (3 - 5) n2			
unknown	MBI-203 WDG (Chromobacterium subtsugae)					3.0 (3 - 3) n1
unknown	V-10433 (V-10433)		1.0 (1 - 1) n1			

Table 2 of 2 Foliar Feeding Coleopterans

MOA	Product (Active Ingredients)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i> - adults)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i> - adults)	Red Headed Flea Beetle (<i>Systena frontalis</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
IRAC 1A	Sevin SL (Carbaryl)			5.0 (5 - 5) n2		
IRAC 1B	Acephate 97UP (Acephate)				1.0 (1 - 1) n1	
	Acephate Pro 75 WSP (Acephate)				1.0 (1 - 1) n1	
	Precise Acephate (Acephate)			2.0 (2 - 2) n1 Labeled		
IRAC 3A	Onyx (Bifenthrin)			4.7 (3 - 5) n7 Labeled	1.0 (1 - 1) n2 Labeled	
	Pyridium (Beta-cyfluthrin)			4.0 (4 - 4) n1	5.0 (5 - 5) n1	
	Scimitar CS (Lambda-cyhalothrin)			4.0 (3 - 5) n2 Labeled	3.0 (1 - 5) n5 Labeled	
	Talstar Flowable Insecticide/Miticide (Bifenthrin)			5.0 (5 - 5) n2 Labeled		
	Talstar NF (Bifenthrin)	5.0 (5 - 5) n1 Labeled				
	UP-Star Gold (Bifenthrin)				3.0 (3 - 3) n1	
IRAC 3A + IRAC UNF	BotaniGard MAXX (Pyrethrins + Beauveria bassiana Strain GHA)			1.0 (1 - 1) n2	1.0 (1 - 1) n2	

MOA	Product (Active Ingredients)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i> - adults)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i> - adults)	Red Headed Flea Beetle (<i>Systema frontalis</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
IRAC 3A + IRAC UNF	Xpectro OD (Pyrethrins + Beauveria bassiana Strain GHA)			2.0 (1 - 3) n2		
IRAC 4	Benefit 60 WP (imidacloprid)				1.0 (1 - 1) n1	
IRAC 4 + IRAC 3A	Discus (Imidacloprid + cyfluthrin)				4.0 (4 - 4) n1 Labeled	
IRAC 4A	Celero 16WSG (Clothianidin)	1.0 (1 - 1) n1 Labeled		2.4 (1 - 5) n8 Labeled		3.3 (3 - 4) n3 Labeled
	Flagship 0.22G (Thiamethoxam)				1.0 (1 - 1) n1	
	Flagship 25WG (Thiamethoxam)			2.5 (2 - 3) n2	3.5 (3 - 4) n2	
	Marathon 1% granular (Imidacloprid)				3.0 (3 - 3) n2 Labeled	
	Marathon II (Imidacloprid)			5.0 (5 - 5) n1	3.0 (3 - 3) n1	
	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) n11 Labeled	3.0 (2 - 4) n3 Labeled
	Safari 2G (Dinotefuran)			4.0 (3 - 5) n2		1.0 (1 - 1) n1
	TriStar 30SG (Acetamiprid)			5.0 (5 - 5) n1 Labeled	2.0 (1 - 3) n3 Labeled	4.0 (4 - 4) n1 Labeled
	TriStar 70WSP (Acetamiprid)			3.3 (1 - 5) n4 Labeled		
	TriStar 8.5SL (Acetamiprid)			5.0 (5 - 5) n1	5.0 (5 - 5) n1	
	Xytect 2F (Imidacloprid)		3.0 (3 - 3) n1	1.0 (1 - 1) n1		
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 5 + IRAC 4C	Xxpire 40WG (Spinetoram + sulfoxaflor)				2.6 (1 - 5) n7 Labeled	
IRAC 11A	beetleGONE! tlc (Bacillus thuringiensis subsp. galleriae Strain SDS-502)				1.3 (1 - 2) n6	
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
	Hachi-Hachi SC (Tolfenpyrad)				1.9 (1 - 5) n11	
IRAC 22B	BAS 320i (Metaflumizone)	5.0 (5 - 5) n1		2.8 (1 - 5) n5		3.0 (3 - 3) n2
IRAC 28	Acelepryn (Chlorantraniliprole)			5.0 (5 - 5) n2	1.0 (1 - 1) n2	
	Acelepryn (Dupont) (Chlorantraniliprole)	1.0 (1 - 1) n1 Labeled		3.6 (1 - 5) n9 Labeled		3.3 (3 - 4) n3 Labeled
	Mainspring GNL 200SC (Cyantraniliprole)				2.4 (1 - 5) n5	
	Sarisa 50SL (Cyclaniliprole)			4.6 (4 - 5) n5 Labeled	3.0 (1 - 5) n8 Labeled	

MOA	Product (Active Ingredients)	Black Vine Weevil - adults (<i>Otiorhynchus sulcatus</i> - adults)	European Elm Flea Weevil (<i>Orchestes alni</i>)	Japanese Beetle - adults (<i>Popillia japonica</i> - adults)	Red Headed Flea Beetle (<i>Systema frontalis</i>)	Viburnum Leaf Beetle (<i>Pyrrhalta viburni</i>)
IRAC 28 +	Tank Mix: Sarissa + Azatin O (Cyclaniliprole + azadirachtin)				3.0 (3 - 3) n1	
IRAC 28 + IRAC 29	Pradia (Cyclaniliprole + Flonicamid)				2.0 (2 - 2) n1	
IRAC 32	VST-006350 (Liquid) (GS-omega/kappa-Hctx-Hv1a)			1.0 (1 - 1) n1	1.0 (1 - 1) n4	
FRAC NC	BW133 (BW133)			1.0 (1 - 1) n2		
	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 NC & IRAC UNF	Ancora (Isaria fumosorosea Apopka Strain 97 (ATCC 20874))				1.0 (1 - 1) n1	
	Met52 (Metarhizium anisopliae strain F52)	1.0 (1 - 1) n1 Labeled				1.0 (1 - 1) n2 Labeled
	Pre-fe-ral (Biobest) (Paecilomyces fumosoroseus)				1.0 (1 - 1) n1	
	Preferal (SePro) (Isaria fumosoroseus)				1.4 (1 - 3) n5	
IRAC UN	AzaGuard (Azadirachtin)			1.0 (1 - 1) n1		
	Azatin O (Azadirachtin)				1.0 (1 - 1) n1	
IRAC UNE	TetraCURB Concentrate (Rosemary Oil)			1.0 (1 - 1) n1	2.0 (2 - 2) n1	
	TetraCURB Organic (Rosemary Oil)			1.0 (1 - 1) n1		
IRAC UNF	BotaniGard ES (BioWorks) (Beauveria bassiana Strain GHA)			1.3 (1 - 2) n3		
	TickEx EC (Metarhizium anisopliae)			1.0 (1 - 1) n5		
unknown	BCS-507 (BCS-507)			5.0 (5 - 5) n1	5.0 (5 - 5) n1	
unknown	BW238 ES (BW238 ES)			1.0 (1 - 1) n2		
unknown	BW238 WP (BW238 WP)			1.0 (1 - 1) n2		
unknown	ISM-555 (ISM-555, A21377X)			4.7 (4 - 5) n3	4.0 (4 - 4) n1	
unknown	KOC22018-8 (Botanical Oil Blend)			1.0 (1 - 1) n1	4.0 (4 - 4) n1	
unknown	MBI 203 SC2 (MBI 203)			1.7 (1 - 3) n3	1.0 (1 - 1) n1	
unknown	MBI 306 (MBI 306)			1.0 (1 - 1) n3	1.0 (1 - 1) n1	
unknown	RTSA 721 (RTSA 721)			2.1 (1 - 5) n9		
unknown	SP3014 (SP3014)			1.0 (1 - 1) n3	1.0 (1 - 1) n1	
unknown	V-10433 (V-10433)			1.6 (1 - 3) n5	1.5 (1 - 2) n2	

[illegible]

IRAC Class	Foliar or Trunk Applied Insecticides (active ingredients)	Registered Use Site(s)	Knock Down	Residual Control (days)	REI	Borer Efficacy					Foliar Feeding Beetle Efficacy					
						Ambrosia Beetles	Banded Ash Clearwing Borer	Bronze Birch Borer	Flat-headed Appletree Borer	Peachtree Borer	Black Vine Weevil Adults	Japanese Beetle Adults	Redheaded Flea Beetle Adults	Viburnum Leaf Beetle Larvae	European Elm Flea Weevil	European Elm Flea Weevil
23	Kontos, BYI-8330 (spirotetramat)	G, I, N	S	7-14	24 h	-	-	-	-	-	-	-	-	-	-	-
28	Mainspring, A20520A, DPX-HGW86 (cyantraniliprole)	G, I	F	-	4 h	P	-	-	-	E**	-	F	P	-	-	-
28 + 29	Pradia (cyclaniliprole + flonicamid)	G, N, S	-	7	12 h	-	-	-	-	-	-	-	F	-	-	-
28	Sarisa, IKI-3106 (cyclaniliprole)	G, N, S	-	7	4 h	-	-	-	-	-	-	G-E	F-E	-	-	P
UN	Azatin, AzaGuard, Molt-X, etc. (azadirachtin)	G, I, N, S	S	7	4 h	P	-	-	-	-	-	P-F	-	-	-	P
UNB	Venerate, MBI-206 (<i>Burkholderia</i> sp. strain A396)	G, N	S	-	4 h	-	-	-	-	-	-	-	-	-	-	P
UNE	Ecotec, Ecotrol (rosemary and peppermint oils)	G, N	-	5-7	0 h	-	-	-	-	-	-	-	-	-	-	-
UNE	M-Pede, Safer Soap, etc. (potassium salts of fatty acids)	G, I, N	F	Cont act	12 h	-	-	-	-	-	-	-	-	-	-	-
UNE	TetraCURB Org (rosemary oil)	TBD	-	-	-	-	-	-	-	-	-	P	-	-	-	-
UNF	BotaniGard, Mycotrol, Naturalis L (<i>Beauveria bassiana</i>)	G, I, N, S	M	2-5	4 h	-	-	-	-	-	-	P	-	-	-	P
	NoFly WP (<i>Paecilomyces fumosoroseus</i> strain FE 9901)	G	M	3-7	4 h	-	-	-	-	-	-	-	-	-	-	-
UNF + 3A	BotaniGard MAXX, Xpectro OD, (<i>Beauveria bassiana</i> + pyrethrins)	G, I, N, S	F	-	12 h	P-F ^a	-	-	-	-	-	P-E	-	-	-	P
UNM	Ultra pure oil, SuffOil-X, etc. (paraffinic oil)	G, N	F	Cont act	4 h	-	-	-	-	-	-	-	-	-	-	-
UNM	Surround WP (kaolin)	G	?	Cont act	4 h	-	-	-	-	-	-	-	-	-	-	-
-	Cinnacure (cinnamaldehyde)	G, N	F	-	4 h	-	-	-	-	-	-	-	-	-	-	-
-	Grandevo, MBI-203 DF (<i>Chromobacterium subsugae</i> strain PRAA4-1 ¹)	G, N	S	-	4 h	-	-	-	-	-	-	P	P	-	P	E
Experimental Products																
1B + 4A	UPI 301 (imidacloprid + acephate)	TBD	F	-	-	-	-	-	-	-	-	-	-	-	-	-
3A	Lynx EC 5.0 (pyrethrins)	TBD	F	Cont act	12 h	-	-	-	-	-	-	-	-	-	-	P
3A + 4A	Allectus (bifenthrin + imidacloprid) ^a	TBD	F	-	12 h	-	-	-	-	-	-	-	-	-	-	-
	Aloft (bifenthrin + clothianidin)	TBD	F	-	12 h	-	E	-	-	-	-	P-E	F-G	-	P	-
21A	Hachi-Hachi EC (tolfenpyrad)	G	F	7-14	12 h	P-F	E	-	-	P	P	P-E	P-E	F-G	P	P

IRAC Class	Foliar or Trunk Applied Insecticides (active ingredients)	Registered Use Site(s)	Knock Down	Residual Control (days)	REI	Borer Efficacy					Foliar Feeding Beetle Efficacy					
						Ambrosia Beetles	Banded Ash Clearwing Borer	Bronze Birch Borer	Flat-headed Appletree Borer	Peachtree Borer	Black Vine Weevil Adults	Japanese Beetle Adults	Redheaded Flea Beetle Adults	Viburnum Leaf Beetle Larvae	European Elm Flea Weevil	European Elm Flea Weevil
22B	BAS 320i (metaflumizone)	TBD	-	-	-	P	-	-	-	-	E	P-E	-	G-E	-	-
28	Acelepryn/DPX-E2Y45 (chlorantraniliprole)	TBD	F	-	4 h	P	E	-	-	E**	P	P-E	P	F-E	-	E
UNE	KOC22018-8 (botanical oil blend)	TBD	-	-	-	-	-	-	-	-	-	P-G	-	-	-	-
UNF	Met 52, Tick Ex (<i>Metarhizium anisopliae</i> F52)	G, N	M	5-7	4 h	P	-	-	-	-	P	P-E	-	P	-	-
	Preferal (<i>Isaria fumosoroseus</i>)	G, N	S	-	4 h	-	-	-	-	-	-	-	P	-	-	P
-	A20520A	TBD	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	BCS 507 (BCS 507)	TBD	-	-	-	P	-	-	-	-	-	G-E	-	-	-	-
-	ISM-555 (ISM-555, A21377X)	TBD	-	-	-	-	-	-	-	-	-	-	G	-	-	-
-	MBI 203 SC2 (MBI 203)	TBD	-	-	-	-	-	-	-	-	-	-	P	-	-	-
-	MBI 306(MBI 306)	TBD	-	-	-	-	-	-	-	-	-	-	P	-	-	-
-	SP 3014 (SP 3014)	TBD	-	-	-	-	-	-	-	-	-	-	P	-	-	-
-	V-10433 (V-10433)	TBD	-	-	-	P	-	-	-	-	-	P	-	-	-	-
-	VST 06330	TBD	-	-	-	-	-	-	-	-	-	P	P	-	-	-

Registered Use Sites: G = Greenhouse; L = Lath House; I = Indoors; N = Nursery; S = Shade House; TBD = To Be Determined

Knockdown: Fast (< 1 day), Medium (1-7 days), Slow (>7 days).

Efficacy: P = Poor (< 70% control); F = Fair (70% to 85% control); G = Good (85% to 95% control), E = Excellent (>95% control) on immatures and/or adults 1 to 3 weeks after first app.

Residual Control taken from product technical and label information recommendations on earliest application intervals; Efficacy taken from 2020 IR-4 efficacy summary and 1 2021 IR-4 report; no reports found in AMT. Only one insect biological control agent for borers and leaf feeding beetles, *Harmonia axyridis*, listed in Koppert and Biobest websites.

^a Efficacy rating based on three BotaniGard MAXX trials provided by Bioworks.

* Soil treatment

** Drench treatment

*** Top-dress treatment

^aNo longer available for testing

Updated 9/20/21