







# An Ornamental Plant Pest Management Guide and Pesticide Rotation Planning Aid

Control Options for Nursery, Greenhouse, Interiorscape, and Commercial Landscape Use Sites

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## **Special Notes Regarding Use of This Publication:**

- Pest resistance to insecticides and acaricides is a growing concern. Efforts to limit pesticide resistance should be an active part of IPM decision-making. Populations of pest species infesting ornamental plants—like *Tetranychus* and *Panonychus* spider mites, western flower thrips, glasshouse and silverleaf whiteflies, and green peach aphids—are among the top 12 species to have developed resistance to multiple pesticide active ingredients (a.i.) spanning several chemical classes. Cross-resistance by populations of pest arthropods is increasingly common to multiple a.i. products *within* an IRAC group. Serial applications to control a generational cycle of a pest should NOT be made using a.i. products *within* an IRAC Group. Cross-resistance occurs much less commonly *between* IRAC groups. See footnote <sup>25</sup> for information about recommendations for rotation *between* IRAC groups, particularly when managing select pest populations.
- More detailed information about modes of action and pesticide resistance will be forthcoming in a publication titled "Understanding Insecticide and Miticide Modes of Action Used to Manage Arthropod Pests of Ornamental Plants."
- Product labels change frequently and will include more details and specifics about potential phytotoxity that may result in certain plant species when products are applied or used at certain rates. **All** product labels should be reviewed prior to treatment application. Footnote <sup>12</sup> as provided within the chart can assist in indicating products with labels that may provide additional details regarding plant safety.
- Many product labels, particularly among generic products (e.g., carbaryl, bifenthrin, imidacloprid and others) differ in many regards, including which pests may be controlled, details about plant safety/phytotoxicity, re-entry intervals, etc. It is the applicator's responsibility to consult **each** product label prior to application and understand its restrictions and limitations.

#### **University of Tennessee Disclaimer Notice**

This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. The label always takes precedence over the recommendations found in this publication. Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

#### **Clemson University Precautionary Statement**

In order to protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. It is a violation of State and Federal Laws to use pesticides in a manner inconsistent with its label.

#### **Clemson University Disclaimer Statement**

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticide registrations are continuously being reviewed. Should registration of a recommended pesticide be canceled, Clemson University would no longer recommend it. This information is supplied with the understanding that no discrimination is intended and no endorsement by the Clemson University Cooperative Extension Service is implied. Brand names of pesticides are given as a convenience and are neither an endorsement nor guarantee of the product nor a suggestion that similar products are not effective. Use pesticides only according to the directions on the label. Follow all directions, precautions and restrictions that are listed.

## An Ornamental Plant Pest Management Guide<sup>1</sup> and Pesticide Rotation Planning Aid

Control Options for Nursery, Greenhouse, Interiorscape and Commercial Landscape Use Sites<sup>2</sup>
Juang-Horng 'JC' Chong, William E. Klingeman, and Frank Hale

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IRAC Code <sup>3</sup>	Mode of Action	Chemical subgroup	Active Ingredient	Selected Trade Names <sup>4,5</sup>	Use Site <sup>2</sup>	REI (hours) <sup>6</sup>	Adelgids	Aphids	Psyllids	Armored scales	Soft scales	Mealybugs	Whiteflies	2	Leannoppers &/ or planthoppers <sup>7</sup>	Plant bugs	Lace bugs		Leaf beetles and other Leaf-feeding beetles	Japanese beetles (adult)	White grubs (incl. Japanese & Oriental beetle larvae)	Weevils	Caterpillars	Sawflies	Gall-forming pests <sup>8</sup>	Leafminer (fly & midge)	Leafminer (moth)	Leafminer (wasp)	Clearwing borers	Flatheaded borers	Ambrosia beetles	Bark and pine beetles	Longhorned (roundheaded) borers	Fungus gnat and/or Shore flies³	Midges & flies	Fire ant <sup>10</sup>	Broad mite	Eriophyid mites	Spider mites
1A	Acetylcholinesterase	Carbamates	carbaryl <sup>11</sup>	Sevin SL	L, N, G	12		х	x	х	х	х	x	х	<b>x</b> <sup>lh</sup>	х	х	х	х	х	t/s*2	х	х	х	x <sup>p, w, m,f</sup>	х	х	х				х	х					х	
	inhibitors		methiocarb	Mesurol 75W	N, G	24		х				_		x																-						$\vdash$	х	х	х
1B <sup>25</sup>		Organophosphates				24		x			х	х		_	x <sup>lh</sup>					х		1	х					x							х	х	Ĥ		^
18		Organophosphates	acephate <sup>11,12</sup>	Orthene T&O <sup>12</sup>	L, N, G					х			_			х	х		х			х		х			х									<u> </u>	$\vdash$	_	
				Lepitect <sup>13</sup>	L, N, G	24		х		х		_	х :	х	x <sup>lh</sup>	х	х		х	х		х	х	х	x <sup>p, w, m,f</sup>	х	х	х		_					х	$\vdash$	$\vdash$	$\dashv$	X
			chlorpyrifos	Precise GN <sup>12</sup> Dursban 50W <sup>12</sup>	G, N N	12 24	-	x	x	х		x	x :	v	x <sup>lh</sup>	х	x	х	x	v	t/s* <sup>2</sup>	x	х	х	x <sup>f</sup>	х	х	х	х	х	х	х	х			x		+	x
			cinorpyrnos	DuraGuard ME <sup>12</sup>	N, G	24	<u> </u>	x	^	x		x	^ ;		x <sup>lh</sup>	x	^	x	x	x	1/5	x	x	^		x	^	^	^	^	^	^	^	x <sup>fg,sf</sup>		Ĥ	-		x
			dicrotophos	Inject-A-Cide B <sup>14</sup>	L	N/A		x	х	х	x				x <sup>lh</sup>	x			x	Ť		<u> </u>	x	х	x <sup>p, w</sup>	<u> </u>		х	х	х			х			$\vdash$			x
				Dimethoate 4E <sup>12</sup> ,		10-14																																	
			dimethoate	4EC <sup>12</sup>	N	days		х	х	х	х	х	x 1	х	x <sup>lh</sup>		х		х				X	х	х <sup>р</sup>	х	х	х							Х		x		x
			malathion 12,13	Malathion 5EC <sup>12,13</sup>	L	12		х		х	х	х	х :		x <sup>lh</sup>	х	х			х			х			х	х	х											x
				Malathion 8F <sup>12</sup>	N	12		х		х		х	x :	х	x <sup>lh</sup>	х				х			х													Ш		4	x
			methidathion	Supracide 2E <sup>12,23</sup>	N	3 days				х	х		_									1				<u> </u>				_						$\vdash$	$\vdash$	<b>-</b>	
			oxydemeton methyl	Harpoon <sup>14,23</sup>	L	0	x	х		x	х								x				x						х	x		x	x				i li		x
				MSR Spray	N	10	х	х						х								х	х			х	х	х											х
				Concentrate <sup>15,23</sup>		days								-								1								_						$\boldsymbol{\sqcup}$	$\vdash$	_	
	GABA-gated chloride		trichlorfon	Dylox 420 SL	L	N/A															t/s*2		X												х	$\vdash$	+	<del>-</del>	4
2B	channel antagonists	Phenylpyrazoles	fipronil	CeaseFire <sup>16</sup>	L	24																														x	1		
				TopChoice <sup>10</sup>	L, N	24																														х	$\Box$	$\Box$	
3A <sup>25</sup>	Sodium channel modulators	Pyrethroids	bifenthrin <sup>11</sup>	Attain TR	G	12		х		x	x	x	<b>x</b>	x		x							x											$\mathbf{x}^{\mathrm{fg}}$			i li		x
	modulators			Menace GC	L, N, G	12		х		х	х	х	x :	x	x <sup>lh</sup>	х	х	х	х	х	x <sup>17</sup>	х	х								х	х		x <sup>fg</sup>		х	х	х	x
				Onyx	L	N/A		х	х	х	х	х	х :	_	x <sup>lh</sup>	х	х	х	х	х		х	х	х		х	х	х	х	х	х	х		x <sup>fg</sup>		х	х		x
				OnyxPro <sup>10</sup>	L, N, I	12	х	х	х	х	х	х	х :	х	x <sup>lh</sup>	х	х	х	х	х		х	х	х		х	х	х	х	х	х	х		x <sup>fg</sup>		х	х		x
				Talstar S Select <sup>10</sup>	N, G	12		х		х	х	х	х :	х	x <sup>lh</sup>		x	х	х	х		х	х											x <sup>fg</sup>		х	х	х	x
				Talstar Nursery G <sup>10</sup>	N	12						х										х												x <sup>fg</sup>		х			
			cyfluthrin	Decathlon <sup>18</sup>	L, N, G, I	12		х		х		х	х :		x <sup>lh</sup>	х	х	х	х	х		х	х	х										x <sup>fg</sup>	х	ш	ш.	_	
			ß-cyfluthrin	Tempo Ultra WP <sup>18</sup>	L, I	N/A		х		х		_	_		x <sup>lh</sup>	x	х	x	х	х		х	х	х						х				x <sup>fg</sup>	х	ш	4	_	
			la mala da	Tempo SC Ultra <sup>18</sup>	L, I	N/A		х		х	х	х	х :	х	x <sup>lh</sup>	х	х	х	х	Х		х	х	х						х				x <sup>fg</sup>	х	$\boldsymbol{\longmapsto}$	$\vdash$	<b>—</b>	
			lambda- cyhalothrin	Scimitar CS; Scimitar GC	L; L, N, G	24; 24		х		x	х	х	x :	х	x <sup>lh</sup>	x	х	x	x	х	x <sup>19</sup>	x	x	х		х	x	x							х	x	х		x
			cypermethrin	Demon WP	L, I	N/A		х											х				х												х	х			
			deltamethrin	DeltaGard G <sup>18</sup>	L, I	N/A						х		_	x <sup>lh</sup>			x		х		х	х													х		4	
			fenpropathrin	Tame 2.4 EC <sup>12</sup>	N, G, I	24		х		х		_	x :		x <sup>lh</sup>	х	х			Х		х	х				х									$\boldsymbol{\longmapsto}$	$\vdash$	_	x
			tau-fluvalinate	Mavrik Aquaflow	L, N, G, I	12	х	х	х			_	x :		x <sup>lh</sup>	х		х	х			х	х			-				_				fa		х	$\vdash$	$\dashv$	x
			permethrin	Astro	L, G, I	12 N/A		x				_	_	_	x <sup>lh</sup>	x	x			x		x	x	X		x	x	x	x	X		x		x <sup>fg</sup>		x	$\vdash$	+	_
				Permethrin Pro Perm-Up 3.2 EC	L, I L, N, G, I	12		x				_	x 2	_	x x <sup>lh</sup>	x	x			x		x	x	x		x	x	x	x	x	_	x		x fg		x		+	
			pyrethrins	Tersus	N, G	12		x	×	х		_	x :	_	Ih, ph	x	x	х	х	x		x	x	^		x	x	x	x	x	х	^	х	x fg, sf	х	Ĥ	х	х	x
			F,. 535	Pyganic	N, G	12		x		x		_	x :		x <sup>lh</sup>			x	x			Ė	x	х										x fg		х	Ħ		x
			pyrethrum	Pyrethrum TR	N, G	12		х		х	_	_	х :	_	x <sup>lh</sup>			х	х				х	х										x <sup>fg</sup>		х			x
3A + 4A		Pyrethroids +	bifenthrin +	Aloft LC G, LC SC	L	N/A	х			- 1		х	х :		x <sup>lh</sup>	х	х	х		х	х	х	х			х	х	х								х	ıΠ		
		Neonicotinoids	clothianidin bifenthrin +	Allectus SC	L, I	N/A	х	х	х	x			-		x <sup>lh</sup>	х	х	х	х	x	х	x	х	х		х	х	х	$\dashv$	x	+	+	х	x <sup>fg</sup>		х	х	+	x
			imidacloprid cyfluthrin +	Discus N/G	N, G, I	12	x	x	x	x	-		-		x <sup>lh</sup>	x	x		x	x	x	x	x	x		x	x	x	$\dashv$	x	$\dashv$	+	x	x x <sup>fg</sup>	х	x	$\dashv$	+	$\dot{\dashv}$
			imidacloprid lambda-	Discus N/G	14, 0, 1	12	*	_	^	^	^	^	^ '			^	^		^	_		<u> </u>	^	*		*	^	^	$\dashv$	^	$\dashv$	+	^	х-	*	$\stackrel{ullet}{\vdash}$	$\dashv$	+	-
			cyhalothrin + thiamethoxam	Tandem	L	N/A	x	х	х	x	х	х	х :	×	x <sup>lh</sup>	х	х	х	x	x	t/s*²	х	х	х	х	x	x	x							х		х		
3A + 27A		Pyrethroids + Piperonyl butoxide (PBO)	pyrethrins + piperonyl butoxide <sup>11</sup>	Pyreth-It	N, G	12		х	x				x 2	x	x <sup>lh</sup>	x		x	x				x												x	х			

IRAC Code <sup>3</sup>	Mode of Action	Chemical subgroup	Active Ingredient	Selected Trade Names <sup>4,5</sup>	Use Site²	REI (hours) <sup>6</sup>	Adelgids	Aphids	Psyllids	Armored scales	Soft scales	Mealybugs	Whitelies	Leafhoppers &/or	planthoppers'	Plant bugs	Lace bugs	Flea beetles Leaf beetles and other Leaf-feeding beetles	Japanese beetles (adult)	White grubs (incl. Japanese & Oriental beetle larvae)	Weevils	Caterpillars	Sawflies	Gall-forming pests <sup>8</sup>	Leafminer (fly & midge)	Leafminer (moth)	Leafminer (wasp)	Clearwing borers	Flatheaded borers	Ambrosia beetles Bark and pine beetles	Longhorned (roundheaded)	Borers	rungus gnatanu/ or Shore flies <sup>9</sup>	Midges & flies	Fire ant	Broad mite	Eriophyid mites Spider mites	
4A <sup>25</sup>	Nicotinic acetylcholine	Neonicotinoids	acetamiprid	TriStar 8.5 SL <sup>12.13,18</sup>	L, N, G	12	x	х	х	x	x	x z	k )	x x	h	x		x	х		х	x	х		х	х			x				$\mathbf{x}^{\mathrm{fg}}$	x				
	receptor agonists		clothianidin	Arena 0.25 G <sup>13</sup>	L, I	12		х				х з	ĸ							t/s* <sup>2</sup>															士	1		
				Arena 50 WDG <sup>13</sup>	L, I	12		х			_	х 2	ĸ							х													,		工	1	工	1
			dinotefuran	Safari 2G <sup>13</sup>	L, N, G, I	12	х		х	_	_		K X			_	х	х		х	Х				Х			_	х		х	_	x <sup>fg</sup>	$-\!\!\!\!+$	+	+	+	4
				Safari 20 SG <sup>13</sup>	L, N, G, I L	12 N/A	X	x	x	x	_		x x	_		_	x x	x	х	x	x	x	х	xw	x	х	х	_	x	+	x		x <sup>fg</sup>	+	+	+	+	-
				Zylam Liquid <sup>13</sup> Transtect 70 WSP <sup>13</sup>	L	N/A	x	x	x	x	_	x >				_	x	x	х	x	x	x	x	x x <sup>w</sup>	x	x	X	_	x		x		χ°		+	+	+	-
			imidacloprid <sup>11</sup>	Xytect 75WSP; 2F <sup>13</sup>	L, N, G, I	12	x	x	x	10	_		x x	_			x	x	x	×	x		x	x	_	^		_	x		x			x <sup>1</sup>	19	+	+	-
			acciopita	Marathon II <sup>13</sup>	N, G, I	12	х	x			_	x >	_	_			x	х	х	x	х		х		х	х	х		x	_	х	-	x <sup>fg</sup>	<del></del>	+	+	$\dashv$	1
				Marathon 60WP <sup>13</sup>	N, G, I	12	х	х	х	x <sup>19</sup>	х	х >	( )	c χ <sup>ll</sup>	h		x	х	х	х	х		х		х	х	х				х	_	$\mathbf{x}^{\mathrm{fg}}$					1
				Merit <sup>13</sup>	L, I	N/A	х	х	х	x <sup>19</sup>	х	х )	( x	23 x <sup>lh,</sup>	ph	х	x	х	х	x	х		х		х	х	х		х		х							٦
				CoreTect <sup>13</sup>	L, I	N/A	X	х	х	x <sup>19</sup>	х	х )	( )	¢χ <sup>lh,</sup>	ph		x	х	х	х	х		X		X	х	х		x		х							]
				Discus Tablets <sup>13</sup>	N, G, I	12	x	х	х	x <sup>19</sup>	_	x >	( )	_			x	х	х	х	х		x		x	х	х		x		х				_	$\bot$		_
			thiamethoxam	Flagship 25WG <sup>13</sup>	N, G, I	12	х	х	x	_	_	x )	_	_		_	х	х		х	х		х	x <sup>p, w, f</sup>	х	х	х			_		_	x <sup>fg</sup>	х	1	_	+	_
				Meridian 0.33G <sup>13</sup>	L, I	N/A	х	х			_	x >	_			_	-+	х х	х	х	X	х	X	n w f	х	_	х			_		_			+	-	+	_
		Sulfoxaflor +	sulfoxaflor +	Meridian 25WG <sup>13</sup>	L, I	N/A	Х	х	х			x >			"	X :	x	х х	х	х	х	х	X	x <sup>p, w, f</sup>	х	х	х							х	<b>+</b>	+	+	_
4C + 5 <sup>25</sup>		Spinosyns	spinetoram	XXpire <sup>20</sup>	L, N, G	12		X		x		x 2	K 2	(		х	х	х				х	х	x <sup>f</sup>									x <sup>sf</sup>				х	
5	Nicotinic acetylcholine receptor allosteric activators	Spinosyns	spinosad	Conserve SC	L, N, G	4							,	¢ .				х				х	х	<b>x</b> <sup>f</sup>	х				x				x <sup>sf</sup>	х	ι		x	
				Entrust	L, N, G	4							)	(	_			х				х	х	x <sup>f</sup>	х			_	x			_	x <sup>sf</sup>	х	1	_	х	Ц
6 <sup>25</sup>	Chloride channel activators	Avermectins, Milbemycins	abamectin <sup>12</sup>	Lucid, Avid <sup>12</sup>	L, N, G	12		x				)	( )	(											x										)	x x	х	
				Aracinate TM <sup>14</sup>	L, N, G, I	N/A	х	х		х	х		)				х	х			х	х			х	х	х	х	х						,	х )	х х	
				Award II <sup>16</sup>	L, N	12															-											_		х		4	4	
			emamectin benzoate	Arbormectin	L	N/A		x		x						х			х			x	x	xw		x	х		х	х	х						х	
				Tree-äge	L	N/A				х						х						х	х			х	х	х	х	х	х							
			milbemectin	Ultiflora	N	12									_																	-		<b>—</b>	-	-	х	_
6 + un			abamectin + bifenazate	Sirocco <sup>18</sup>	L, N, G, I	12		х				)	( )	(											х										,	х 2	х	
7A	Juvenile hormone mimics	Juvenile hormone analogues	s-kinoprene s-methoprene	Enstar AQ  Extinguish <sup>6</sup>	G, I L, N	4		х		х	х	x >	( )	c x <sup>II</sup>	h										х	х	x						x <sup>fg</sup>	×	×	4		
7B		Fenoxycarb	fenoxycarb	Preclude TR	Ğ	12		х		х	х	х )	( )	(							х	х			х										,	х :	х х	
7C		Pyriproxyfen	pyriproxifen	Distance IGR <sup>12</sup>	L, N, G, I	12		х		х	х	x >	(		I											х			$\Box$				x <sup>fg,sf</sup>		4			
				Distance <sup>6</sup>	L, N	12			_						4		4											4	4			_	fa cf	×	1	4	4	
	Miscellaneous non-		sodium	Fulcrum	L, N, G, I	12		х	-	х	х	х )	(													х						-	x <sup>fg,sf</sup>	_	#	#	#	4
8D	specific (multi-site) inhibitors	Borates	tetraborohydrate decahydrate	Prev-AM Ultra	N, G	12		х		x	х	x >	(																					_	,	x )	x x	
9B <sup>25</sup>	Selective homopteran feeding blockers	Pymetrozine	pymetrozine	Endeavor <sup>12,18</sup>	L, N, G, I	12		х				)	•																									
9C		Flonicamid	flonicamid	Aria <sup>12,20</sup>	L, N, G	12		х		х	х	х )	( )	x <sup>II</sup>	h	х																						
10A <sup>25</sup>	Mite growth inhibitors	Clofentezine	clofentazine	Ovation SC <sup>12</sup>	N, G	12		J	耳		Ţ		$\bot$		$\bot$	$\bot$	Ţ				$\bot$				lacksquare		Į	Ţ	$-\mathbb{I}$			$\Box$		$\bot$	#	Д.	х	
10B <sup>25</sup>		Hexythiazox Etoxazole	hexythiazox etoxazole	Hexygon DF <sup>12,18</sup> Beethoven TR	L, N, G, I G	12 24			$\dashv$		+	+		-	+		+	-	-		1	<u> </u>			<u> </u>			+	-	+	1	+		+	+	+	x	_
TOB		ELUADZUIE	ELUXAZUIE	TetraSan 5 WDG	L, N, G, I				$\dashv$	-+	+	+	+	-	$\dashv$		+	-	1	+	1	<del>                                     </del>			<del>                                     </del>			$\dashv$	-	+	1	+		+	+	+	×	
11	Microbial disruptors of insectmidgut membranes	Bacillus thuringiensis (Bt) & insecticidal proteins	Bt subsp. aizawai	XenTari	L, N, G, I	4																x																
			Bt subsp.	GrubGONE! G	N, G, L, I	4														х																		
			galleriae Bt subsp. israelensis	Gnatrol WDG	N, G, I	4																											x <sup>fg</sup>					
			Bt subsp. kurstaki <sup>11</sup>	Dipel Pro DF	L, N, G, I	4																х																
12B	Inhibitors of mitochondrial ATP synthase	Organotin miticides		Meraz, ProMite 50WP <sup>12</sup>	L, N, G	48																															х	

IRAC Code <sup>3</sup>	Mode of Action	Chemical subgroup	Active Ingredient	Selected Trade Names <sup>4,5</sup>	Use Site <sup>2</sup>	REI (hours) <sup>6</sup>	Adelgids	Aphids	Psyllids	Armored scales	Soft scales	Mealybugs	Willemes	Leafhoppers &/or	€	Plant bugs	Lace bugs		Leaf beetles and other Leaf-feeding beetles	Japanese beetles (adult)	White grubs (incl. Japanese & Oriental beetle larvae)	Weevils	Caterpillars	Sawflies	Gall-forming pests <sup>8</sup>	Leafminer (fly & midge)	Leafminer (moth)	Leafminer (wasp)	Clearwing borers	Flatheaded borers	Ambrosia beetles	Bark and pine beetles	Longhorned (roundheaded) borers	Fungus gnat and/or Shore flies <sup>9</sup>	Midges & flies	Fire ant <sup>10</sup>	Broad mite	Eriophyid mites Soider mites	opinei iiiico
13	Uncouplers of oxidative phosphorylation via disruption of the proton gradient	Chlorfenapyr	chlorfenapyr	Pylon <sup>12</sup>	G	12							х	¢									x											x <sup>fg</sup>			х	x x	Ī
15 <sup>25</sup>	Inhibitors of chitin biosynthesis, type 0	Benzoylureas	diflubenzuron	Adept <sup>12</sup>	G	12						×	(										х				х							x <sup>fg,sf</sup>					
				Dimilin 25W	L, N	12																х	х	х			х										$\vdash$	4	]
			novaluron	Dimilin 4L Pedestal <sup>12</sup>	L, N N, G	12 12					-	<b>x</b>	, ,	_		-	-					х	x	х		x <sup>19</sup>	x x <sup>19</sup>			-	-					${oldsymbol{dash}}$	$\dashv$	+	┥
	Inhibitors of chitin	_												_	h ah								^			X	X											$\rightarrow$	
16	biosynthesis, type 1 Moulting disruptor,	Buprofezin	buprofezin	Talus 70DF	L, N, G	12				х	х	х >	ĸ	х"	h, ph																			x <sup>fg,sf</sup>			-	+	4
17	Dipteran Ecdysone receptor	Cyromazine	cyromazine	Citation Intrepid 2F	L, N, G, I	12																	х			х								X or			$\dashv$	+	
10	agonists	Diacylhydrazines	methoxyfenozide tebufenozide	Confirm 2F <sup>21</sup>	L, N, G, I N	4					-		-	+	-	-							×								-					$\vdash$	$\rightarrow$	+	
20A	Mitochondrial complex III electron transport	Hydramethylnon	hydramethylnon	Amdro Pro <sup>16</sup>	L, N	12																														x			
20B <sup>25</sup>	inhibitors	Acequinocyl	acequinocyl	Shuttle 15 SC	L, I	12																															士	х	
				Shuttle-O <sup>12</sup>	N, G	12																														ш		х	_
21A	Mitochondrial complex I electron transport inhibitors	METI acaricides and insecticides	fenazaquin	Magus <sup>12</sup>	L, N, G, I	12						×																										х	ı
			fenpyroximate	Akari 5SC	N, G, I	12						х																									х	х х	1
			pyridaben	Sanmite	N, G	12			x			х	•	x <sup>lh</sup> nymį	phs																						x	х	I
			tolfenpyrad	Hachi-Hachi <sup>12</sup>	G	12		х		х	х	x >	<b>x</b> >	( )	( <sup>lh</sup>								х																
22A	Voltage-dependent sodium channel blockers	Indoxacarb	indoxacarb	Advion <sup>16</sup>	L	N/A																														x			
				Provaunt	L	N/A								)	( <sup>lh</sup>								х	x															
22B		Metaflumizone	metaflumizone	Siesta <sup>16</sup>	L, N	12																														х	$\Box$		
23	Inhibitors of acetyl CoA carboxylase	Tetronic and Tetramic acid derivatives	spiromesifen	Forbid 4F	L	N/A						×																									х	x x	ı
				Judo <sup>12</sup>	N, G	12						х	(																								х	х х	_
			spirotetramat	Kontos <sup>12</sup>	N, G, I	24	х	х	х	х	х	х >	K >	( )	(lh																						х	х х	4
25	Mitochondrial complex II electron transport inhibitors	Beta-ketonitrile derivatives	cyflumetofen	Sultan	L, N, G, I	12																																x	I
28	Ryanodine receptor modulators	Diamides	chlorantraniliprole	Acelepryn	L, I	N/A	x <sup>22</sup>	х			x <sup>22</sup>						х			x <sup>22</sup>	х		х	x <sup>22</sup>				х	х										
			cyantraniliprole	Acelepryn G Mainspring	L, I G, I	N/A 4		х			v	,	+	_		_	х		х	x	х		x					-			$\dashv$						$\rightarrow$	+	
	tt-t-	A													lh		^					l .			f						$\dashv$			fø.sf			$\neg \uparrow$		٩
Unknown	Unknown	Azadirachtin	azadirachtin <sup>11</sup>	Azatin O  Azatin XL	L, N, G, I N, G, I	4	X	x	x	х	_	x x	с х		c <sup>lh</sup>	х	$\dashv$	x	x	x	x	x	x	x	х <sup>f</sup>	x	x	х	х	х	-	х	х	x <sup>fg,sf</sup>	x	Н	$\dashv$	+	$\dashv$
				Azatrol EC Insecticide			H			_						Ţ					x	x	x			x		1	1	$\dashv$	$\dashv$			x <sup>fg,sf</sup>		П	$\vdash$	+.	Ħ
							$\vdash$	X	x			x x	_	_			x	X	X	x	*	x		x		x	x	_	Ţ	_		x	×	x -	X	ш	$\dashv$	х	4
				Molt-X Ornazin 3% EC	L, N, G, I L, N, G, I	12		x	x			х х х х	_			-	x	x	x	x		x	x	x		x	x	х	x	+	_	x	x	x <sup>fg,sf</sup>	x	$\vdash$	$\dashv$	+	٦
				TreeAzin <sup>14</sup>	L, N, G	until	х										T		х				х	х		х	х	х		x	T						, T		٦
unk. <sup>25</sup>		Bifenazate	bifenazate	Floramite SC	L, N, G, I	dry 12	$\vdash$				+	+	_				$\dashv$						$\vdash$					_		$\dashv$	+					$\vdash\vdash$	$\dashv$	х	$\exists$
1				Floramite SC/LS	L	N/A																															二	х	_
		Cryolite	cryolite (sodium aluminofluoride)	Kryocide <sup>5</sup>	L	N/A											,	(	х			x	x																
		Dicofol	dicofol	Kelthane <sup>23</sup>	L, N, G	48				工					_[	$\Box$	-							$\Box$				$\blacksquare$	_[	-	Ţ					ш	х	х х	_
		Pyridalyl Pyrifluquinazon	pyridalyl pyrifluquinazon	Overture 35 WP Rycar	G G	12 12		x		-	+	х >	x >	_	<b>c</b> lh		$\dashv$						х	-				-		$\dashv$	$\dashv$					$\vdash$	$\dashv$	+	$\dashv$
	l .	. 7quiiiazoli	P7uquiliazoli	,				^				'	`   '	٠ ,	`						1	1													1				

IRAC Code <sup>3</sup>	Mode of Action	Chemical subgroup	Active Ingredient	Selected Trade Names <sup>4,5</sup>	Use Site <sup>2</sup>	REI (hours) <sup>6</sup>	Adelgids	Apnids	Psyllids Armored scales	Soft scales	Mealybugs	Whiteflies	Thrips	Leafhoppers &/or olanthoppers <sup>7</sup>	Plant bugs	Lace bugs	Flea beetles	Leaf beetles and other Leaf-feeding beetles	lapanese beetles (adult)	White grubs (incl. Japanese & Oriental beetle larvae)	Weevils	Caterpillars	Sawflies	Gall-forming pests <sup>8</sup>	Leafminer (fly & midge)	Leafminer (moth)	Leafminer (wasp)	Clearwing borers	Flatheaded borers	Ambrosia beetles Bark and pine beetles	Longhorned (roundheaded) borers	Fungus gnat and/or Shore flies	Midges & flies	Fire ant <sup>10</sup>	Broad mite	Eriophyid mites Spider mites
Not classified	Various		Beauveria bassiana 11	BotaniGard ES	L, N, G, I	4			x		x	х	х	x <sup>lh,ph</sup>	х		х	x		х	х															х
				BotaniGard 22 WP	L, N, G, I	4		х :	х		х	х	х	x <sup>lh,ph</sup>	х	х				х	х															
				Naturalis-L <sup>26</sup>	L, N, G	4		<b>x</b> :	x		х	х	х	х	х		х	х		t/s* <sup>2</sup>	х	x										x <sup>sf</sup>			х	х х
			Chromobacterium subtsugae	Grandevo PTO <sup>13</sup>	L, N, G	4	2	x			х	х	x		х	x				x		x													х	х
			Heterorhabditis bacteriophera	B-Green, TerraNem	L	N/A														х																
				LarvaNem	L	N/A														х	х															
				Exhibitline H	N	N/A														х	x <sup>17</sup>															
				Nemasys G	L, N, G, I	N/A														х																
				Terranem-NAm	L, N, G, I	N/A														х			_													
				NemaShield HB	L, N, G, I	N/A			_											х	х	х	_							_						-
			Isaria formosorosea (=Paecilomyces fumosoroseus)	NoFly	G	12			x		х	х	х	x <sup>lh</sup>	х			х																		
			Metarhizium	Preferal	L, N, G	4		x :	x		х	х	х		х					х	х	х	_		х	х				_			-		х	х х
			anisopliae	Met52, Tick-EX	L, N, G	4							х								х															
			Steinernema sp.	TigraNem	L, N, G, I	N/A			_							х						_	_										-			$-\!\!\!-\!\!\!\!-$
			Steinernema carpocapsae	Millenium	L, N, G, I	N/A																x						х				x <sup>sf</sup>				
				Nematac C	L, N, G, I	N/A																x <sup>24</sup>														
				Exhibitline SC	L, N, G, I	N/A																х	4				_									
				Carpocapsae-System	L, N, G, I	N/A									1					2	_	х	-			-	-			_			-			+
			Steinernema	Capsanem NemaSys,	L, N, G, I	N/A									1					t/s* <sup>2</sup>		х	-			-	-			_			-			_
			feltiae	Steinernema-System	L, N, ,G, I	N/A							x																			x <sup>fg</sup>				
				NemaShield	L, N, G, I	N/A							х																			x <sup>fg</sup>				
			Steinernema	EntoNem	L, N, G, I	N/A							х								х					_						x <sup>fg</sup>				4
			kraussei	Nemasys L	L, N, G, I	N/A															х															
			horticultural oil <sup>11,12</sup>	Kraussei-System  Ultra-Pure Oil, TriTek	N L, N, G, I	N/A 4	х	x :	x x	x	х	x	х		х	х		х			х	х	х	x <sup>m</sup>	x	х	x					x <sup>fg</sup>				хх
			insecticidal				-		-					lh									-	^			•					x x <sup>sf</sup>				
			soap <sup>11,12</sup> kaolin clay	M-Pede <sup>12</sup> Surround WP	L, N, G, I	12 N/A	x		X X	х	х	x x <sup>19</sup>	x x <sup>19</sup>	x <sup>lh</sup>	x x 19	х		x x <sup>19</sup>	x x <sup>19</sup>		x <sup>19</sup>		X 19		х	_		x <sup>19</sup>			x <sup>19</sup>	x	x <sup>19</sup>	х		х
			· ·		L, N, G, I L, N	N/A 4		x	_	х		-	X	x <sup>lh</sup>	X			х	х		X	× ×	+			-	-			-	X		X			хх
			neem oil <sup>11</sup>	Trilogy  Triact 70 <sup>12</sup>		-			x		1	x		x <sup>lh</sup>							H		+			-	-	-		-						x x
				Triact 70**	L, N, G, I	4		x	х	х	х	х		Χ																						X X

last updated May 2015

#### **Explanations and Supplemental Notes**

- 1. Pests listed on pesticide labels are subject to change. Pests listed on pesticide labels are subject to change. Within states and counties, products may have additional permitted uses by 2(ee) and Special Local Need allowances.

  Consult your County Extension Agent or State Agency to determine if other uses are allowable. The label should always be consulted to confirm that chart-listed pests still appear on the label. Check the product labels for specific site restriction information, notes on application, sensitive plant species and specific target pest species.
- 2. Use site information is provided for reference only: L = landscape; N = nursery; G = greenhouse; I = interiorscape. t/s\* Products listed for use in L, N, G or I sites may include active ingredients in differently labeled products that are designated for use in turfgrass or sod production use sites. Mention of those products is beyond the scope of this resource guide, and products listed herein may not be legal or appropriate for site uses in turfgrass or sod production.
- 3. IRAC Code designations and Related Modes of Action are explained at the Insecticide Resistance Action Committee Database 2014 (IRAC 2013; http://www.irac-online.org/teams/mode-of-action/).
- 4. Trade names of products are provided as examples only. No endorsement of mentioned product nor criticism of unmentioned products is intended.
- 5. Products may not be registered or renewed for use in all southeastern U.S. states. Consult your state's Department of Agriculture to confirm legal use of products in your state.
- 6. Re-Entry Interval (REI) designations apply to agricultural (nursery) uses. Within the Re-Entry Interval (REI) designation, 'N/A' is used to indicate products with Landscape and/or Interiorscape site uses and that present Non-Agricultural Use Requirements. Additionally, some product labels may list site uses that are beyond the scope of this publication (e.g., sod farms, pastures, rights-of-way, etc.). These site uses may involve Agricultural Use Requirements that list an REI not presented here. Consult the product labels for specific details required for compliance within those application conditions.
- 7. lh = leafhopper; ph = planthopper
- 8. Several arthropods may cause plant galls to form on plant parts, including: w = wasps; f/m = flies or midges; p = psyllids, a = aphids and/or adelgids; m = mites. Pest type must be known for insecticides to be used effectively.
- 9. fg = fungus gnats; sf = shore flies
- 10. Management of imported fire ants in quarantine areas should follow approved quarantine treatment guidelines developed by USDA-APHIS; http://www.aphis.usda.gov/plant\_health/plant\_pest\_info/fireants/downloads/IFA\_nursery.pdf
- 11. Multiple formulations and trade names of the same active ingredients are available. Labels among these products often differ in legally allowable uses (regarding sites, pest, REI, etc.); representative example(s) presented.
- 12. See product label for information about potential crop phytotoxicity, known plant sensitivity, and how to test for phytotoxicity.
- 13. Check label for additional restrictions (e.g., on the number of times the product can be applied in a growing season or year, or additional application restrictions within permitted use sites; and crop types or flowering status that may not be legally treated.)
- 14. Product formulated for tree or shrub injection; specialized equipment may be required.
- 15. Use of handheld application equipment is prohibited. For use only on seedling trees and non-bearing fruit trees in commercial nurseries.
- 16. Products formulated as fire ant baits.
- 17. Label includes white grub and weevil larval control in nursery containers.
- 18. Intended for commercial/professional use only. Not intended for homeowner use.
- 19. Label-indicated efficacy against target pest group is primarily by population suppression.
- 20. Product labels may restrict landscape uses only to commercial landscapes. Residential landscapes are not a permitted application site.
- 21. Only for use on Christmas trees.
- 22. On the Acelepryn Section 2ee label.
- 23. Product uses cancelled or in process of Federal cancellation. Use of existing stocks of any end-use product may be allowable beyond the cancellation date. Consult your extension agent or state agency for information about allowable use and conditions for proper disposal.
- 24. Nematac C provides entomopathogenic management of larval cranberry girdler caterpillars (Chrysoteuchia sp.).
- 25. Applications of products from these footnoted IRAC groups are optimized when not preceded by/or followed by products in subsequently noted IRAC Group(s), particularly when managing the indicated pest. Suggested rotation combinations to avoid include serial treatments with a.i. products from: IRAC 1B, 3A, 6 (western flower thrips); IRAC 4A, 4B, 4C (green peach aphid); IRAC 4A and 9B (glasshouse and silverleaf whiteflies); IRAC 10A, 10B, 15 (Panonychus [red and citrus] spider mites); IRAC 20B and unclassified\* bifenazate (twospotted spider mite). \*Although unclassified within IRAC, bifenazate appears to have mode of action similarities to other IRAC 20 mitochondrial complex III electron transport inhibitors.