

Chemical Class Chart



Volume X

Greenhouse and Nursery Production

- Insecticides/Miticides
- Fungicides
- Herbicides
- Plant Growth Regulators

REFERENCE GUIDE for ORNAMENTAL PRODUCTION INSECTICIDES / MITICIDES

RESISTANCE MANAGEMENT

When applying insecticides/miticides, always focus on resistance management. Do not rely on one product or tank mix or the same mode of action.

When labels permit, make 2 or 3 applications of a product or tank mix in sequence, then rotate to products with different modes of action. Try to avoid applying the same mode of action to more than one generation of the pest.

NOTE: THIS IS ONE OF THE MAIN REASONS WHY IT IS VITALLY IMPORTANT TO PROPERLY DETECT THE PROBLEM PEST AND KEEP GOOD SPRAY RECORDS.

Using insecticides/miticides correctly also includes proper timing, understanding the pest life cycle, and the stage that each product controls. The appropriate and labeled (legal) method of application is also a very important factor to consider.

Low volume (L.V.) applications (smoke generator, thermal fog, cold fog, aerosol, and electrostatic) are commonly used in greenhouses. Low volume sprays generally are more effective against adults than immature stages. Use high volume sprays, directed under the leaves for best results against eggs, nymphs and pupae.

Always read the label and check with your state or county extension specialists for further information regarding resistance management.

****Use Site(s) KEY:** GH = Greenhouse; N = Nursery

Insecticides / Miticides

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
1A	Carbamates	Carbaryl	Sevin®	12	N	Bayer Environmental Science
		Methiocarb	Mesuro®	24	GH/N	Gowan Company
1B	Organophosphates	Acephate	Orthene® TT&O	24	GH/N	Valent USA Corp.
			Orthene® TR	24	N	Whitmire Micro-Gen
		Chlorpyrifos	DuraGuard™	24	GH/N	Whitmire Micro-Gen
			Dursban® 50 WP	24	N	Dow AgroSciences LLC
		Dichlorvos	Fulex DDVP Fumigator	*	GH	Fuller System, Inc
		Dimethoate	Dimethoate 267	48	N	Micro Flo Company LLC
			Cygon 2E	48	N	Value Garden Supply
		Malathion	Gowan Malathion 8F	12	N	Gowan Company
		Methidathion	Supracide®	48 (to 14 days)	N	Gowan Company
		Oxydemeton-methyl	MSR® Spray Concentrate	48-72	N	Gowan Company
Phosmet	Imidan® 70W	24	N	Gowan Company		

* Depends on greenhouse ventilation

Insecticides / Miticides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company	
2	Cyclodiene organochlorines	Endosulfan	Fulex Thiodan Insecticidal Smoke	*	GH	Fuller System, Inc	
			Thionex®	24	N	Makhteshim Agan, Inc.	
3	Pyrethroids	Bifenthrin <small>** Greenhouse and/or nursery uses depend on the formulation. Check labels for uses.</small>	Talstar®	12	GH/N**	FMC Corp.	
			OnyxPro™	12	N	FMC Corp.	
			Attain® TR	12	GH	Whitmire Micro-Gen	
			Attain® Greenhouse	12	GH	Whitmire Micro-Gen	
			Cyfluthrin	Decathlon®	12	GH/N	OHP, Inc.
			Fenpropathrin	Tame®	24	GH/N	Valent USA Corp.
			Fluvalinate	Mavrik®	12	GH	Wellmark International
			Lambda-Cyhalothrin	Scimitar® GC	24	GH/N	Syngenta
			Permethrin	Astro®	12	GH	FMC Corp.
				Perm-Up	12	GH/N	United Phosphorus
				Permethrin 3.2 EC	12	GH/N***	Helena Chemical Co.
				Ambush®	12	GH/N***	Amvac Chemical Corp.
				<small>*** Greenhouse roses only</small>			
4A	Neonicotinoids	Acetamiprid	TriStar®	12	GH/N	Cleary Chemical Corp.	
			Dinotefuran	Safari™	12	GH/N	Valent USA Corp.
			Imidacloprid	Marathon®	12	GH/N	OHP, Inc.
4 B	Botanicals	Nicotine	Flagship™	12	GH/N	Syngenta	
			Fulex Permethrin Fumigator	*	GH	Fuller System, Inc.	
5	Spinosyns	Spinosad	Pyrethrum® TR	12	GH	Whitmire Micro-Gen	
			Pyreth-It™	12	GH/N	Whitmire Micro-Gen	
6	Glycosides	Abamectin	Conserve®	4	GH/N	Dow AgroSciences LLC	
			Milbemectin	Entrust®	4	GH/N	Dow AgroSciences LLC
6	Glycosides	Abamectin	Avid®	12	GH/N	Syngenta	
			Milbemectin	Ultiflora™	12	N	Gowan Company

* Depends on greenhouse ventilation

Insecticides / Miticides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
7	Carbamate Insect Growth Regulators	Fenoxycarb	Preclude [®] TR	12	GH	Whitmire Micro-Gen
	Pyridine Insect Growth Regulators	Pyriproxyfen	Distance [®]	12	GH/N	Valent USA Corp.
	Biopesticide Insect Growth Regulators	s-Kinoprene	Enstar [®] II	4	GH	Wellmark International
9	Pyridine azomethines	Pymetrozine	Endeavor [™]	12	GH/N	Syngenta
	Pyridine carboxamides	Flonicamid	Aria [™]	12	GH	FMC Corp.
10 A	Tetrazines	Clofentezine	Ovation [™]	12	GH/N	Scotts Company
	Thiazolidinones	Hexythiazox	Hexygon [®] DF	12	GH/N	Gowan Company
10 B	2, 4 - Diphenyloxzoline Derivatives	Etozazole	TetraSan [™]	12	GH/N	Valent USA Corp.
11	Biopesticides	<i>Bacillus thuringiensis</i> Kurstaki	DiPel [®]	12	GH/N	Valent USA Corp.
			Deliver [®]	12	GH/N	Certis USA, LLC.
		<i>Bacillus thuringiensis</i> Israelensis	Gnatrol [®]	4	GH/N	Valent USA Corp.
12	Organotins	Fenbutatin-oxide	ProMite [™]	48	GH/N	SePRO Corp.
13	Pyrroles	Chlorfenapyr	Pylon[®]	12	GH	OHP, Inc.
15	Benzoyl Urea Insect Growth Regulators	Diflubenzuron	Adept[®]	12	GH	OHP, Inc.
			Dimilin[®] 25W, SC	12	GH/N**	OHP, Inc.
		Novaluron	Pedestal[™]	12	GH/N	OHP, Inc.
16		Buprofezin	Talus [®]	12	GH/N	SePRO Corp.
17	Triazine Insect Growth Regulators	Cyromazine	Citation [®]	12	GH/N	Syngenta
18	Biopesticide Insect Growth Regulators	Azadirachtin	Azatin[®] XL	4	GH/N	OHP, Inc.
			Ornazin [®]	12	GH/N	SePRO Corp.
20	Napthoquinone derivatives	Acequinocyl	Shuttle [™]	12	GH/N	Arysta Life Sciences
21	Pyridazinones	Pyridaben	Sanmite [®]	12	GH/N	Gowan Company
	Phenoxyprazole	Fenpyroximate	Akari [™]	12	GH	SePRO Corp.
23	Tetronic acids	Spiromesifen	Judo[™]	12	GH/N	OHP, Inc.
25	Carbazates	Bifenazate	Floramite[®]	4	GH/N	OHP, Inc.
M	Biopesticides	<i>Beauveria bassiana</i>	Naturalis[®] O	4	GH/N	OHP, Inc.
			BotaniGard [®]	4	GH/N	BioWorks, Inc.

* Depends on greenhouse ventilation

** Greenhouse and/or nursery uses depend on the formulation. Check labels for uses.

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Insecticides / Miticides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
M	Oils	Clarified hydrophobic extract of neem oil	Triact® 70	4	GH/N	OHP, Inc.
		Paraffinic oil	Ultra-Fine Spray Oil	4	GH/N	Whitmire Micro-Gen
		Petroleum Oil	PureSpray Green	4	GH/N	Whitmire Micro-Gen
	Soaps	Potassium salts of fatty acids	Insecticidal Soap 40%	12	GH/N	Value Garden Supply
		Boric Acid	Sodium Tetraborohydrate Decahydrate	TriCon™	12	GH/N

MOA Combination Products

MOA Codes	Classes	Common Names	Trade Name	REI	Use Site(s)**	Company
1+3	Organophosphate + Pyrethroid	Acephate + Fenpropathrin	Tame/Orthene™ TR	24	GH	Whitmire Micro-Gen
1+3	Organophosphate + Pyrethroid	Chlorpyrifos + Cyfluthrin	DuraPlex® TR	24	GH	Whitmire Micro-Gen
3+4A	Pyrethroid + Neonicotinoid	Cyfluthrin + Imidacloprid	Discus®	12	N	OHP, Inc.

*Insecticides / Miticides Modes of Action

1. Acetyl cholinesterase inhibitors. Inhibition of the enzyme acetylcholinesterase, interrupting the transmission of nerve impulses
2. GABA-gated chloride channel antagonists: Interferes with GABA receptors of insect neurons, leading to repetitive nervous discharges
3. Sodium channel modulators: Acts as an axonic poison by interfering with the sodium channels of both the peripheral and central nervous system stimulating repetitive nervous discharges, leading to paralysis.
4. Acetylcholine receptor agonists/antagonists: Binds to nicotinic acetylcholine receptor disrupting nerve transmission.
5. Nicotine acetylcholine receptor agonists (not group 4)
6. Chloride Channel Activators: Interferes with the GABA nerve receptor of insects.
7. Juvenile hormone mimics (Insect growth regulator): Mimic juvenile hormones, which prevent molting from the larval to the adult stage.
9. Compounds of unknown or non-specific mode of action (selective feeding blockers)
10. Compounds of unknown or non-specific target site of action (mite growth inhibitors)
11. Microbial disruptors of insect midgut membranes
12. Inhibition of oxidative phosphorylation at the site of dinitrophenol uncoupling (Disrupt ATP formation)
13. Uncoupler of oxidative phosphorylation (disrupt H proton gradient formation).
15. Inhibit chitin biosynthesis – type 0, Lepidopteran
16. Inhibit chitin biosynthesis – type 1, Homopteran
17. Molting disruptor, Dipteran
18. Ecdysone agonists/molting disruptors
20. Coupling site II electron transport inhibitors (Complex III)
21. Site I electron transport inhibitor
23. Inhibitors of lipid biosynthesis
25. Neuronal inhibitors (unknown mode of action)
- M. Miscellaneous

This list is from the U.S Environmental Protection Agency, in cooperation with the Insecticide Resistance Action Committee (IRAC). IRAC is a technical working group within the Global Crop Protection Federation (GCPF). More information on the Insecticide Resistance Action Committee and the Mode of Action Classification is available from: www.irac-online.org.

REFERENCE GUIDE for ORNAMENTAL PRODUCTION FUNGICIDES

As with other pesticides, fungicides must be used in a program to avoid or delay resistance. Do not rely on products with the same mode of action. Rotation of products with different modes of action, and using product combinations with different modes of action are parts of a resistance management strategy. Be especially careful when using products considered to be high risk for resistance development. This category includes many of our newer products. See the explanation of resistance risk at the end of the fungicide section.

Most fungicides work more effectively to prevent disease from becoming established, rather than eradicating disease that is already present. Constant monitoring – and modification where possible – of environmental conditions and scouting crops for signs of disease symptoms are vital parts of effective fungicide use and resistance management.

Always read the label and check with local authorities for further information regarding resistance management.

****Use Site(s) Key:** GH = Greenhouse; N = Nursery.

Fungicides

(by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company	
1	Thiophanates	Thiophanate-methyl	3336™	12	GH/N	Cleary Chemical Corp.	
			Methyl Benzimidazole	OHP 6672™	12	GH/N	OHP, Inc.
			Carbamates (MBC fungicides)	AllBan®	12	GH/N	Scotts Company
			Resistance risk High (See explanation of resistance risk following the mode of action listing)				
2	Dicarboximides	Iprodione	OHP 26 GT®-O	12	GH/N	OHP, Inc.	
			OHP Chipco® 26019 N/G	12	GH/N	OHP, Inc.	
			Sextant®	12	GH/N	OHP, Inc.	
3	Imidazole	Triflumizole	Terraguard®	12	GH/N	OHP, Inc.	
			Imazalil	Fungaflor®	24	GH	Whitmire Micro-Gen
	Pyrimidine	Fenarimol	Rubigan®	12	N	Gowan Company	
			Triazole (includes conazole)	Propiconazole	Banner® MAXX®	24	N
	Demethylation Inhibitors (DMI fungicides)	Resistance risk Medium	Triadimefon	Strike® 50 WDG	12	GH/N	OHP, Inc.
			Myclobutanil	Eagle® 20 EW	24	GH/N	Dow AgroSciences LLC
4	Acylamine	Mefenoxam	Subdue® MAXX®	0	GH/N	Syngenta	
Phenylamides (PA fungicides)							
Resistance risk High							

(by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company	
5	Piperadine	Piperalin	Pipron [®]	12	GH/N	SePRO Corp.	
Amines ("Morpholines") Resistance risk Low to Medium							
7	Benzamides	Flutolanil	ProStar [®]	12	GH/N	Bayer Environmental Science	
Carboxamides Resistance risk Medium							
11	Strobilurins	Azoxystrobin [®]	Heritage [®]	4	GH/N	Syngenta	
		Kresoxim-methyl [®]	Cygnus [®]	12	GH/N	BASF	
		Trifloxystrobin	Compass[®] O	12	GH/N	OHP, Inc.	
		Pyraclostrobin	Insignia [®]	12	GH/N	BASF	
Quinone outside Inhibitors (QoI fungicides) Resistance risk High							
	Imidazolinones	Fenamidone	FenStop[™]	12	GH	OHP, Inc.	
12	Phenylpyrrole	Fludioxonil	Medallion [®]	12	GH/N	Syngenta	
Phenylpyrroles (PP fungicides) Resistance risk Low to Medium							
14	Aromatic Hydrocarbon	PCNB	Terraclor[®]	12	GH/N	OHP, Inc.	
		Thiadiazole	Etridiazole	Truban [®]	12	GH/N	Scotts Company
			Terrazole[®]	12	GH/N	OHP, Inc.	
Aromatic Hydrocarbons (AH fungicides) Resistance risk Low to Medium							
17	Hydroxylanilide	Fenhexamid	Decree [®]	4	GH/N	SePRO Corp.	
Hydroxylanilides Resistance risk Low to Medium							
19	Polyoxins	Polyoxin	Endorse [®]	4	GH/N	Cleary Chemical Corp.	
Resistance risk Low to Medium							
28	Carbamate	Propamocarb	Banol [®]	24	GH/N	Bayer Environmental Science	
Carbamates Resistance risk Low to Medium							
33	Ethyl Phosphonates	Fosetyl-Al	Aliette[®]	12	GH/N	OHP, Inc.	
		[Also classified by EPA with plant host defense inducers]					
	Phosphite	Phosphorous acid	Alude [™]	4	GH/N	Cleary Chemical Corp.	
Phosphonates Resistance risk Low							
40	Cinnamic Acid Amides	Dimethomorph	Stature [®] DM	12	GH/N	BASF	
Carboxylic Acid Amides (CAA fungicides) Resistance risk Low to Medium							

Fungicides

continued

(by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company	
M1	Copper, Complex	Copper sulfate	Camelot [®]	12	GH/N	SePRO Corp.	
			Phyton 27 [®]	24	GH/N	Phyton Corp.	
	Copper, Fixed	Copper hydroxide	CuPro [™] 2005	24	GH/N	SePRO Corp.	
Resistance risk Low							
M3	Dithiocarbamates and relatives	Mancozeb	Dithane [®]	24	GH/N	Dow AgroSciences LLC	
			Fore [®]	24	GH/N	Dow AgroSciences LLC	
			Junction [™]	24	GH/N	SePRO Corp.	
			Pentathlon [™]	24	GH/N	SePRO Corp.	
		Manganese + zinc	Protect [®] T/O	24	GH/N	Cleary Chemical Corp.	
M4	Phthalimides	Captan	Captan 50W	96	GH/N	Micro Flo Company LLC	
M5	Chloronitriles	Chlorothalonil	Daconil [®] Ultrex [®]	12	GH/N	Syngenta	
			AllPro [®] Exotherm Termil	*	GH	Value Garden Supply	
Resistance risk Low							
NC	Biopesticide	<i>Trichoderma harzianum</i> T22	PlantShield [®] HC (RootShield [®])	0	GH/N	BioWorks, Inc.	
		<i>Trichoderma virens</i> GL21	SoilGard[®] G	4	GH/N	OHP, Inc.	
		<i>Bacillus subtilis</i> GB03	Companion [®]	4	GH/N	Growth Products	
		<i>Bacillus subtilis</i> QST713	Cease [™]	4	GH/N	BioWorks, Inc.	
		<i>Streptomyces lydicus</i> WYEC108	Actinovate [®]	4	GH/N	Natural Industries, Inc	
		Bicarbonate	Potassium bicarbonate	Armcarb [®] 100	4	GH/N	Helena Chemical Co.
				MilStop [®]	1	GH/N	BioWorks, Inc.
		Hydrogen Dioxide		ZeroTol [™]	0	GH/N	Biosafe Systems
		Oil	Clarified hydrophobic extract of neem oil (also classified by EPA as a biopesticide)	Triact[®] 70	4	GH/N	OHP, Inc.
		Botanical Extract	<i>Macheaya</i> extract	Qwel [®]	12	GH	Camas Technologies
				<i>Raynouria sachalinesis</i>	Milsana [®]	24	GH
		Boric Acid	Sodium tetraborohydrate decahydrate	TriCon [™]	12	GH/N	BioWorks, Inc.
		1+2	Thiophanate + Dicarboxamide	Thiophanate + iprodione	26/36 [™]	12	GH/N

* Depends on greenhouse ventilation

MOA Combination Products

MOA Codes	Classes	Common Names	Trade Name	REI	Use Site(s)**	Company
1+14	Thiophanate + Thiadiazole	Thiophanate-methyl + Etridiazole	Banrot®	12	GH/N	Scotts Company
1+M3	Thiophanate + Dithiocarbamate	Thiophanate-methyl + Mancozeb	Zyban®	24	GH/N	Scotts Company
1+M5	Thiophanate + Chloronitrile	Thiophanate-methyl + Chlorothalonil	Spectro® 90	12	GH/N	Cleary Chemical Corp.
4+12	Acylalanine + Phenylpyrrole	Mefenoxam + Fludioxonil	Hurricane™	48	GH	Syngenta
7+11	Pyridine Carboxamide + Strobilurin	Boscalid + Pyraclostrobin	Pageant™	12	GH/N	BASF

*Fungicides Modes of Action

1. Inhibition of tubulin formation in mitosis
2. Affect cell division, DNA and RNA synthesis and metabolism
3. DMI (Demethylation Inhibitor): Inhibition of sterol synthesis
4. Phenylamides-Affect RNA synthesis
5. Inhibition of an isomerase in sterol biosynthesis- Piperadines, Morpholines
7. Affect mitochondrial transport chain
11. Quinone outside inhibitors (QOI)
12. MAP protein kinase in osmotic signal transduction
14. Lipid peroxidation (proposed)
17. 3-keto reductase during C4 demethylation in sterol biosynthesis
19. Chitin synthase inhibition in cell wall development
28. Affect cell membrane permeability (proposed)
33. Mode of action unknown. The mode of action cannot be placed within any other grouping
40. Phospholipid biosynthesis and cell wall deposition (proposed)
- M. Multi-site activity. Chemicals that act at several sites, which may differ among the group members
- NC. Not classified

This list is from the U.S. Environmental Protection Agency, in cooperation with the Fungicide Resistance Action Committee (FRAC). FRAC is a technical working group within the Global Crop Protection Federation (GCPF)

Explanation of Resistance Risk

Resistance risk categories were developed by FRAC. They are a way to estimate the potential for resistance development. The resistance risk is generally based on whether the fungicide mode of action (MOA) is single or multi-site. Single site MOA products have a higher resistance risk than multi site MOA products. The pathogen types targeted by the fungicides also are factors.

Fungicides should always be used by rotating MOA types. Users need to be especially careful not to rotate or alternate among fungicides in any one high resistance risk category. Follow resistance management instructions on product labels.

REFERENCE GUIDE for CHEMICAL PLANT GROWTH REGULATORS

***Use Site(s) KEY: GH = Greenhouse; N = Nursery; T = Turf

Chemical Plant Growth Regulators

(by Mode of Action Group and Class)

MOA Group*	Class	Activity Level**	Common Name	Trade Name	REI	Use Site(s)***	Company
1	Pyrimidine	Medium	Ancymidol	A-Rest®	12	GH/N	SePRO Corp.
			Flurprimidol	Topflor®	12	GH/N	SePRO Corp.
	Ammonium	Low	Chlormequat chloride	Cycocel®	12	GH/N	OHP, Inc.
			Daminozide	B-Nine®	24	GH/N	OHP, Inc.
			Triazole	High	Paclobutrazol	Bonzi®	12
Uniconazole-p	Sumagic®	12			GH	Valent USA Corp.	
2	Cyclohexaketone	Medium	Dikegulac sodium	Atrimmec®	12	GH/N	PBI Gordon
3	Fatty acid	Medium	methyl esters of fatty acids	Off-Shoot O		GH/N	Cochran Corp.
4	Gibberellin (GA)	High	Gibberellic acid (A3)	ProGibb® T&O	12	GH/N/T	Valent USA Corp.
	Synthetic Cytokinin/ Gibberellin	High	Cytokinin/ Gibberellic acid	Fascination™	4	GH	Valent USA Corp.
5	Acid	Medium	Ethephon	Florel Brand Pistill	48-72	GH/N	Monterey Chemical Southern Ag
6	Rooting Hormones Synthetic Auxin		IBA	Hormodin®	0	GH/N	OHP, Inc.
			IBA + NAA	Dip N Grow	0-24	GH/N	Dip 'N Grow, Inc.

** Activity level is related to difficulty of use. The higher the level the more difficult the product is to use.

Thanks to Dr. Joyce Latimer, Virginia Tech, for help in preparing the PGR chart.

*Chemical Plant Growth Regulators Modes of Action

- | | | |
|--|---------------------|-----------------------|
| 1. Gibberellic Acid synthesis inhibitors | 3. Chemical pincher | 5. Ethylene generator |
| 2. DNA synthesis inhibitor | 4. Growth promoter | 6. Rooting Hormones |

REFERENCE GUIDE for GREENHOUSE & NURSERY HERBICIDES

Reference Guide for Ornamental Production Herbicides

Rotation of herbicide classes is not necessary in field grown nursery crops to prevent weed resistance problems. Weed resistance to herbicides has not been a concern in the production of field grown nursery crops.

Please read and follow all label directions and precautions.

**Use Site(s) Key:

PO = post emergence; PR = pre emergence; SF = soil fumigant; (GH) = registered for use in greenhouses;
 A = Annual Grasses; BW = Broadleaf Weeds; WO = Certain Woody Ornamentals; P = Perennials; MA = Most annuals;
 S = Sedges

Greenhouse & Nursery Herbicides

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
1	Aryloxyphenoxy propionate 'FOPs'	fenoxaprop	Acclaim [®] Extra	12	PO	Bayer Environmental Science
		fluazifop-P-butyl	Fusilade [®] II	12	PO; A, P	Syngenta
	Cyclohexanedione 'DIMs'	clethodim	Envoy Plus [®]	12	PO; A, P (GH)	Valent USA Corp.
			Arrow	12	PO; A, P (GH)	Makhteshim Agan, Inc.
		sethoxydim	Sethoxydim-E-Pro	12	PO; A, P	Etigra
2	Imidazolinone	imazaquin	Image [®]	12	PR/PO; A BW, S	BASF
3	Pyridine	dithiopyr	Dimension [®]	12	PR; A, BW	Dow AgroSciences LLC
	Benzamide	pronamide	Kerb [®]	12	PR/PO; A, BW	Dow AgroSciences LLC
	Dinitroaniline	pendimethalin	Pendulum [®]	24	PR; A, BW	BASF
			Corral	24	PR; A, BW	Scotts Company
		prodiamine	Barricade [®]	12	PR; A, BW	Syngenta
		oryzalin	Surflan [®]	12	PR; A, BW	United Phosphorus
		trifluralin	Treflan [®]	12	PR; A, BW	Dow AgroSciences LLC
3 + 3	Dintiroaniline + Dintiroaniline	benefin + oryzalin	XL 2G	12	PR; A, BW	Helena Chemical Co.
4	Pyridine carboxylic acid	clopyralid	Lontrel [™]	12	PO; WO	Dow AgroSciences LLC
5	Triazine	simazine	Princep [®]	12	PR; A, BW	Syngenta

Greenhouse & Nursery Herbicides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
6	Benzothiadiazinone	bentazon	Basagran® T/O	12	PO; BW, S	BASF
9	Glycine	glyphosate	Roundup Pro®	4	PO; A, P, BW (GH)	Monsanto
			Touchdown® Pro	12		Syngenta
10	Phosphinic acid	glufosinate	Finale®	12	PO; MA, P (GH)	Bayer Environmental Science
12	Pyridazinone	norflurazon	Predict®	12	PR; A, BW	Syngenta
14	Diphenylether	oxyfluorfen	Goal®	24	PR; A, BW	Dow AgroSciences LLC
	Oxadiazole	oxadiazon	Ronstar®	12	PR; A, BW	Bayer Environmental Science
	N-phenylphthalimides	flumioxazin	BroadStar®	12	PR; A, BW	Valent USA Corp.
SureGuard®			12	PR, PO: A, BW	Valent USA Corp.	
15	Acetamide	napropamide	Devrinol®	12	PR; A, BW	United Phosphorous
	Chloroacetamide	s-metolachlor	Pennant® Magnum	24	PR; A, BW	Syngenta
20	Nitrile	dichlobenil	Casoron®	12	PR; A, P,	OHP, Inc.
21	Benzamide	isoxaben	Gallery®	12	PR; A, BW	Dow AgroSciences LLC
22	Bipyridylum	paraquat	Gramoxone® Inteon	12-24	PO; MA, P, BW	Syngenta
		diquat	Reward®	24	PO; MA, P (GH)	Syngenta
27	Other	dazomet	Basamid® Granular	24	SF; MA, P	Certis USA, LLC
		metam	Vapam®	48	SF; MA, P	Amvac Chemical Corp.
		pelargonic acid	Scythe®	24	PO; MA, P (GH)	Mycogen / Dow AgroSciences LLC
14 + 3	Diphenylether + Dinitroaniline	oxyfluorfen + pendimethalin	Ornamental Herbicide II (OH2)®	24	PR; A, BW	Scotts Company
14 + 3	Oxadiazole + Dinitroaniline	oxadiazon + proflamizone	RegalStar®	12	PR; A, BW	Regal Chemical Co.
14 + 3	Diphenylether + Dinitroaniline	oxyfluorfen + oryzalin	Rout®	24	PR; A, BW	Scotts Company
14 + 3	Oxadiazole+ Dinitroaniline	oxadiazon+ pendimethalin	Kansel +®	12	PR; A	Scotts Company

Greenhouse & Nursery Herbicides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
15 + 14	Acetamide + Oxadiazole	napropamide + oxadiazon	Pre Pair®	12	PR; A, BW	UAP Professional Products
15 + 4	Diphenylether + Oxadiazole	oxyfluorfen + oxadiazon	Regal O-O®	24	PR; A, BW	Regal Chemical Co.
21 + 3	Benzamide + Dinitroaniline	isoxaben + trifluralin	Snapshot® TG	12	PR; A, BW	Dow AgroSciences LLC
21 + 14 + 3	Benzamide + Oxadiazole + Dinitroaniline	isoxaben + oxyfluorfen + trifluralin	Showcase™	12	PR; A, BW	Dow AgroSciences LLC

****Use Site(s) KEY:**

PO = post emergence; PR = pre emergence; SF = soil fumigant; (GH) = registered for use in greenhouses; A = Annual Grasses; BW = Broadleaf Weeds; WO = Certain Woody Ornamentals; P = Perennials; MA = Most annuals; S = Sedges

*Greenhouse & Nursery Herbicides Modes of Action

1. Inhibition of acetyl CoA carboxylase (ACCase)
2. Inhibition of acetolactate synthase ALS (acetohydroxyacid synthase AHAS)
3. Microtubule assembly inhibition
4. Action like indole acetic acid (synthetic auxins)
5. Inhibition of photosynthesis at photosystem II (C1)**
6. Inhibition of photosynthesis at photosystem II (C3)**
7. Inhibition of photosynthesis at photosystem II (C2)**
9. Inhibition of EPSP synthase
10. Inhibition of glutamine synthetase
12. Bleaching: inhibition of carotenoid biosynthesis at the phytoene desaturase step (PDS)
14. Inhibition of protoporphyrinogen oxidase (PPO)
15. Inhibition of VLCFA's (Inhibition of cell division)
20. Inhibition of cell wall (cellulose) synthesis
21. Inhibition of cell wall (cellulose) synthesis
22. Photosystem -I- electron diversion
27. Unknown

**Subclasses with different binding behavior at the binding protein D1, or different classes

*Mode of action numbers based on WSSA classification

Thanks to Dr. Jeffrey Derr, Virginia Tech, for help in preparing the herbicide chart.

