

Chemical Class Chart



Volume XII

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	Amvac Chemical Corp.
			Orthene® TR	24	GH	BASF
		Chlorpyrifos	DuraGuard® ME	24	GH/N	BASF
			Dursban® 50 WP	24	N	Dow AgroSciences LLC
		Dichlorvos	Fulex DDVP Fumigator	*	GH	Fuller System, Inc
		Dimethoate	Dimethoate 267	48	N	Arysta LifeScience
			AllPro® Cygon 2E	48	N	Value Garden Supply
		Naled	Dibrom®	*	GH	Amvac Chemical Corp.
		Malathion	Gowan Malathion 8F	12	N	Gowan Company
		Methidathion	Supracide®	3 days	N	Gowan Company
		Oxydemeton-methyl	MSR® Spray Concentrate	10 days	N	Gowan Company
	Phosmet	Imidan® 70W	24	N	Gowan Company	
2	Cyclodiene organochlorines	Endosulfan	Thionex®	24	N	Makhteshim Agan, Inc.

* 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	
3	Pyrethroids	Bifenthrin	Talstar®	12	GH/N**	FMC Corp.	
			OnyxPro™	12	N	FMC Corp.	
			Attain® TR	12	GH	BASF	
		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.	
			Permethrin 3.2 EC	12	GH/N***	Helena Chemical Co.	
			Ambush®	12	GH/N***	Amvac Chemical Corp.	
Fulex Permethrin Fumigator	*		GH	Fuller System, Inc.			
Botanicals	Pyrethrins	Pyrethrum® TR	12	GH	BASF		
		Pyreth-It®	12	GH/N	BASF		
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.
			Thiamethoxam	Flagship™	12	GH/N	Syngenta
5	Spinosyns	Spinosad	Conserve®	4	GH/N	Dow AgroSciences LLC	
			Entrust®	4	GH/N	Dow AgroSciences LLC	
6	Glycosides	Abamectin	Avid®	12	GH/N	Syngenta	
		Milbemectin	Ultiflora™	12	N	Gowan Company	
7A	Juvenile hormone mimics	s-Kinoprene	Enstar® II	12	GH	Wellmark International	
7B		Fenoxycarb	Preclude® TR	4	GH	BASF	
7C	Pyridine insect growth regulators	Pyriproxyfen	Distance®	12	GH/N	Valent USA Corp.	
9 A	Pyridine azomethines	Pymetrozine	Endeavor®	12	GH/N	Syngenta	
9B	Pyridine carboxamides	Fonicamid	Aria™	12	GH	FMC Corp.	

*** Greenhouse roses only

* Depends on greenhouse ventilation

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

Insecticides / Miticides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
10A	Tetrazines	Clofentezine	Ovation [®]	12	GH/N	Scotts Company
	Thiazolidinones	Hexythiazox	Hexygon [®] DF	12	GH/N	Gowan Company
10 B	2, 4 - Diphenyloxzoline Derivatives	Etoxazole	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	Organotin	Fenbutatin-oxide	ProMite [™]	48	GH/N	SePRO Corp.
13	Pyrroles	Chlorfenapyr	Pylon [®]	12	GH	BASF
15	Benzoyl Urea Insect Growth Regulators	Diflubenzuron	Adept[®]	12	GH	OHP, Inc.
			Dimilin[®] 25W, SC	12	GH/N**	OHP, Inc.
			Pedestal[™]	12	GH/N	OHP, Inc.
16		Novaluron				
16		Buprofezin	Talus [®]	12	GH/N	SePRO Corp.
17	Triazine Insect Growth Regulators	Cyromazine	Citation [®]	12	GH/N	Syngenta
18	Diacylhydrazine	Tebufenozide	Confirm [®]	4	N	Dow AgroSciences LLC
20A	Trifluoromethyl Aminohydrazone	Hydramethylnon	Amdro [®] Pro	12	N	BASF
20B	Napthoquinone Derivatives	Acequinocyl	Shuttle[™] O	12	GH/N	OHP, Inc.
21A	Pyridazinones	Pyridaben	Sanmite [®]	12	GH/N	Gowan Company
	Phenoxy pyrazoles	Fenpyroximate	Akari [®]	12	GH	SePRO Corp.
23	Tetronic acids	Spiromesifen	Judo[™]	12	GH/N	OHP, Inc.
	Tetramic acids	spirotetramat	Kontos[™]	24	GH/N	OHP, Inc.
Unknown	Carbazates	Bifenazate	Floramite[®]	12	GH/N	OHP, Inc.
	Biopesticide Insect Growth Regulators	Azadirachtin	Azatin[®] XL	4	GH/N	OHP, Inc.
		Pyridalyl	Overture [®]	12	GH	Valent USA Corp.

* Depends on greenhouse ventilation

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

Insecticides / Miticides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company			
M	Biopesticides	<i>Beauveria bassiana</i>	Naturalis® L	4	GH/N(V)	OHP, Inc.			
			BotaniGard®	4	GH/N	BioWorks, Inc.			
			Mycotrol O®	4	GH/N	BioWorks, Inc.			
			PFR-97™	4	GH/N	Certis USA LLC			
	Oils	Clarified hydrophobic extract of neem oil	<i>Paecilomyces fumorosoroseus</i>	Triact® 70	4	GH/N	OHP, Inc.		
				Ultra-Pure™ Oil	4	GH/N	BASF		
				PureSpray Green®	4	GH/N	BASF		
				Suffoil-X™	4	GH/N	BioWorks, Inc.		
				Soaps	Potassium salts of fatty acids	Insecticidal Soap 40%	12	GH/N	Value Garden Supply
						M-Pede®	12	GH/N	Dow AgroSciences LLC

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® N/G	12	GH/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: (METI acaricides/insecticides)
 23. Inhibitors of acetyl CoA carboxylase
- U Products with unknown or uncertain modes 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.irc-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	OHP 6672™	12	GH/N	OHP, Inc.		
			3336™	12	GH/N	Cleary Chemical Corp.		
			AllBan®	12	GH/N	Scotts Company		
Resistance risk High (See explanation of resistance risk following the mode of action listing)								
2	Dicarboximides	Iprodione	OHP Chipco® 26019 N/G	12	GH/N	OHP, Inc.		
Resistance risk Medium to High								
3	Imidazole	Triflumizole	Terraguard®	12	GH/N	OHP, Inc.		
			Imazalil	Fungaflor®	24	GH	BASF	
	Pyrimidine	Fenarimol	Rubigan®	12	N	Gowan Company		
			Triazole (includes conazole)	Propiconazole	Banner® MAXX®	12	N	Syngenta
			Demethylation Inhibitors (DMI fungicides)	Triadimefon	Strike® 50 WDG	12	GH/N	OHP, Inc.
Myclobutanil	Eagle® 20 EW	24		GH/N	Dow AgroSciences LLC			
Resistance risk Medium								
4	Acylamine	Metalaxyl-M (=Mefanoxam)	Subdue® MAXX®	0 to 48	GH/N	Syngenta		
Phenylamides (PA fungicides)								
Resistance risk Medium to High								
5	Piperadines	Piperalin	Pipron®	12	GH	SePRO Corp.		
Amines ("Morpholines")								
Resistance risk Low to Medium								
7	Phenyl-Benzamides	Flutolanil	ProStar®	12	GH/N	Bayer Environmental Science		
Carboxamides								
Resistance risk Medium								

Fungicides

continued

(by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company	
11	Strobilurins	Trifloxystrobin	Compass[®] O	12	GH/N	OHP, Inc.	
		Fluoxastrobin	Disarm[™] O	12	GH/N	OHP, Inc.	
		Azoxystrobin [®]	Heritage [®]	4	GH/N	Syngenta	
		Kresoxim-methyl [®]	Cygnus [®]	12	GH/N	BASF	
		Pyraclostrobin	Insignia [®]	12	GH/N	BASF	
	Imidazolinones	Fenamidone	FenStop[™]	12	GH	OHP, Inc.	
Quinone outside Inhibitors (QoI fungicides)							
Resistance risk High							
12	Phenylpyrrole (PP fungicides)	Fludioxonil	Medallion [®]	12	GH/N	Syngenta	
Resistance risk Low to Medium							
14	Aromatic Hydrocarbon	PCNB	Terraclor[®]	12	GH/N	OHP, Inc.	
		Thiadiazole	Etridiazole	Terrazole[®]	12	GH/N	OHP, Inc.
			Truban [®]	12	GH/N	Scotts Company	
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 (Biopesticides)		Veranda[™] O	4	GH/N	OHP, Inc.	
			Affirm [™]	4	GH/N	Cleary Chemical Corp.	
Resistance risk Low to Medium							
21	Cyano-imidazole	Cyazofamid	Segway [™]	12	GH/N	FMC Corp.	
Resistance risk Medium to High							
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 SC	12	GH/N	BASF	
Carboxylic Acid Amides (CAA fungicides)							
Resistance risk Low to Medium							
43	Pyridinemethyl-benzamides	Fluopicolide	Adorn [™]	12	GH/N	Valent USA Corp.	
Resistance risk Unknown							

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 X3 [®]	24	GH/N	Phyton Corp.	
	Copper, Fixed	Copper hydroxide	CuPro [™] 2005	24	GH/N	SePRO Corp.	
Resistance risk Low to Medium							
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.
Resistance risk Low to Medium							
M4	Phthalimides	Captan	Captan 80WDG	0 to 48	GH/N	Arysta LifeScience	
			Captan 50W	96	GH/N	Arysta LifeScience	
Resistance risk Low to Medium							
M5	Chloronitriles	Chlorothalonil	Daconil [®] Ultrex [®]	12	GH/N	Syngenta	
			AllPro [®] Exotherm Termil	*	GH	Value Garden Supply	
Resistance risk Low to Medium							
NC	Biopesticide	<i>Trichoderma harzianum</i> T22	PlantShield [®] HC	0	GH/N	BioWorks, Inc.	
			RootShield [®]	0	GH/N	BioWorks, Inc.	
			SoilGard[®] 12G	4	GH/N	OHP, Inc., Certis USA, LLC.	
		<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
		Oils	Clarified hydrophobic extract of neem oil (also classified by EPA as a biopesticide)	Triact[®] 70	4	GH/N	OHP, Inc.
				Petroleum oil	Suffoil-X [™]	4	GH/N
		Soaps	Potassium salts of fatty acids	M-Pede [®]	12	GH/N	Dow AgroSciences LLC
		Botanical Extract	<i>Raynouria sachalinesis</i>	Regalia [®]	24	GH	Marrone Organic BioInnovations

* Depends on greenhouse ventilation

MOA Combination Products

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
1+2	Thiophanate + Dicarboxamide	Thiophanate + iprodione	26/36™	12	GH/N	Cleary Chemical Corp.
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.
3+M3	Demethylation inhibitor+ Dithiocarbamate	Myclobutanil + Mancozeb	Clevis™	24	GH/N	ProKoz
4+12	Acylalanine + Phenylpyrrole	Mefanoxam + 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
 21. Quinone inside inhibitors (QII)
 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)
 43. Delocalization of spectrin-like proteins
- 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

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	Paczol ™	12
Uniconazole-p	Sumagic®	12			GH	Valent USA Corp.	
2	Cyclohexaketone	Medium	Dikegulac sodium	Augeo ™	12	GH/N	OHP, Inc.
3	Fatty acid	Medium	methyl esters of fatty acids	Off-Shoot O	0	GH/N	Cochran Corp.
4	Gibberellin (GA)	High	Gibberellic acid (A3)	ProGibb® T&O	12	GH/N	Valent USA Corp.
	Synthetic Cytokinin/ Gibberellin	High	Cytokinin/ Gibberellic acid	Fascination®	4	GH	Valent USA Corp.
5	Acid	Medium	Ethephon	Florel Brand Pistill	48 to 72	GH/N	Monterey Chemical
				Florel brand Ethephon	48 to 72	GH/N	Southern Agricultural Insecticides, Inc.
6	Rooting Hormones Synthetic Auxin		IBA	Hormodin ®	0	GH/N	OHP, Inc.
			IBA + NAA	Dip N Grow	0 to 24	GH/N	Dip 'N Grow, Inc.
7	S-abscisic acid		S-ABA	ConTego™			Valent USA Corp.

ConTego, a plant growth regulator, likely in early 2010. ConTego's active ingredient is S-abscisic acid (S-ABA), the biologically active form of ABA, which Valent produces through microbial fermentation.

** PGR activity varies greatly depending on product class i.e the triazole class is very active. The low, medium and high ratings are guides to product activity. The Higher the level the more care must be taken when using.

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
2. DNA synthesis inhibitor
3. Chemical pincher
4. Growth promoter
5. Ethylene generator
6. Rooting Hormones
7. ABA abscisic acid

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-p-ethyl	Acclaim [®] Extra	24	PO; A, P	Bayer Environmental Science	
		fluazifop-P-butyl	Fusilade [®] II	12	PO; A, P	Syngenta	
	Cyclohexanedione 'DIMs'	clethodim	Envoy Plus [™]	24	PO; A, P	Valent USA Corp.	
		sethoxydim	Segment [™]	12	PO; A, P	BASF	
2	Imidazolinone	imazaquin	Image [®]	12	PR/PO; A, P, 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
				Regalkade [®]	12	PR; A, BW	Regal Chemical Co.
			oryzalin	Surflan [®]	12	PR; A, BW	United Phosphorus
			trifluralin	Treflan [®]	12	PR; A, BW	Dow AgroSciences LLC
	Benzoic acid	DCPA	Dacthal [®]	12	PR; A, BW	Amvac Chemical Corp.	

Greenhouse & Nursery Herbicides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
4	Pyridine carboxylic acid	clopyralid	Lontrel®	12	PO; WO	Dow AgroSciences LLC
5	Triazine	simazine	Princep®	12	PR; A, BW	Syngenta
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	PO; A, P, BW (GH)	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; PO, A, BW	Dow AgroSciences LLC
			GoalTender®	24	PR; PO, 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®	12-24	PR; A, BW	United Phosphorous
	Chloroacetamide	s-metolachlor	Pennant® Magnum	24	PR; A, BW	Syngenta
		dimethenamid-P	Tower™	12	PR; A BW, S	BASF
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 to 24	PO; MA, P, BW	Syngenta
		diquat	Reward®	24	PO; MA, P (GH)	Syngenta
27	Other	dazomet	Basamid®	24	SF; MA, P	Certis USA, LLC.
		metam	Vapam®	48	SF; MA, P	Amvac Chemical Corp.
		pelargonic acid	Scythe®	12	PO; MA, P (GH)	Mycogen / Dow AgroSciences LLC

Greenhouse & Nursery Herbicides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
3 + 3	Dintiroaniline + Dintiroaniline	benefin + oryzalin	XL 2G	24	PR; A, BW	Helena Chemical Co.
14 + 3	Diphenylether + Dinitroaniline	oxyfluorfen + pendimethalin	OH2®	24	PR; A, BW	Scotts Company
14 + 3	Oxadiazole + Dinitroaniline	oxadiazon + proflumicetone	RegalStar® II	12	PR; A, BW	Regal Chemical Co.
14 + 3	Diphenylether + Dinitroaniline	oxyfluorfen + oryzalin	Rout®	24	PR; A, BW	Scotts Company
14 + 3	Oxadiazole + Dintiroaniline	oxadiazon + pendimethalin	Jewel™	12	PR; A, BW	Scotts Company
15 + 3	Chloroacetamide + Dinitroaniline	dimethenamid-P + pendimethalin	Freehand™	24	PR; A, BW, S	BASF
14 + 14	Diphenylether + Oxadiazole	oxyfluorfen + oxadiazon	Regal O-O®	24	PR; A, BW	Regal Chemical Co.
15 + 14	Acetamide + Oxadiazole	napropamide + oxadiazon	Pre Pair®	12	PR; A, BW	Loveland Products
21 + 3	Benzamide + Dinitroaniline	isoxaben + trifluralin	Snapshot® TG	12	PR; A, BW	Dow AgroSciences LLC
21 + 14 + 3	Benzamide + Diphenylether + Dintiroaniline	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.

