

## Chemical Class Chart

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### Greenhouse and Nursery Production

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

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# REFERENCE GUIDE for GREENHOUSE and NURSERY 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	Mesuroi®	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
		Dimethoate	Dimethoate 267	48	N	Arysta LifeScience
			Dimethoate 4EC	48	N	Helena Chemical Co.
		Naled	Dibrom®	24	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		
2B	Phenylpyrazoles	Fipronil	TopChoice™	24	N	Bayer Environmental Science

\* 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	
3	Pyrethroids	Bifenthrin	Talstar®	12	GH/N**	FMC Corp.	
			OnyxPro®	12	N	FMC Corp.	
			Attain® TR	12	GH	BASF	
		Cyfluthrin	<b>Decathlon®</b>	12	GH/N	<b>OHP, Inc.</b>	
		Fenpropathrin	Tame®	24	GH/N	Valent USA Corp.	
		Fluvalinate	Mavrik® Aquaflo	12	GH/N	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.	
			*** Greenhouse roses only				
	Botanicals	Pyrethrins	Pyrethrum® TR	12	GH	BASF	
4A	Neonicotinoids	Acetamiprid	TriStar®	12	GH/N	Cleary Chemical Corp.	
			Dinotefuran	Safari®	12	GH/N	Valent USA Corp.
			Imidacloprid	<b>Marathon®</b>	12	GH/N	<b>OHP, Inc.</b>
				<b>Discus® Tablets</b>	12	GH/N	<b>OHP, Inc.</b>
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® AQ	12	GH	Wellmark International	
7B		Fenoxycarb	Preclude® TR	12	GH	BASF	
			Award®	12	N	Syngenta	
7C	Pyridine insect growth regulators	Pyriproxyfen	Distance®	12	GH/N	Valent USA Corp.	
9A	Pyridine azomethines	Pymetrozine	Endeavor®	12	GH/N	Syngenta	
9B	Pyridine carboxamides	Fonicamid	Aria®	12	GH/N	FMC 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
10A	Tetrazines	Clofentezine	Ovation®	12	GH/N	Everris NA, Inc
	Thiazolidinones	Hexythiazox	Hexygon® DF	12	GH/N	Gowan Company
10B	2, 4 - Diphenyloxzoline Derivatives	Etoxazole	TetraSan®	12	GH/N	Valent USA Corp.
			Beethoven™ TR	4-24*	GH	BASF
11	Biopesticides	<i>Bacillus thuringiensis</i> Kurstaki	DiPel® Pro DF	4	GH/N	Valent USA Corp.
			Deliver®	4	GH/N	Certis USA, LLC
			Javelin® WG	4	CH/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	BASF
15	Benzoyl Urea Insect Growth Regulators	Diflubenzuron	<b>Adept®</b>	12	GH	<b>OHP, Inc.</b>
			<b>Dimilin® SC</b>	12	GH/N**	<b>OHP, Inc.</b>
			<b>Pedestal™</b>	12	GH/N	<b>OHP, Inc.</b>
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	Gowan Company
		Methoxyfenozide	Intrepid®	4	GH/N	Dow AgroSciences LLC
20A	Trifluoromethyl Aminohydrazone	Hydramethylnon	Amdro® Pro	12	N	BASF
20B	Napthoquinone Derivatives	Acequinocyl	<b>Shuttle® O</b>	12	GH/N	<b>OHP, Inc.</b>
21A	METI Acaricides and Insecticides	Pyridaben	Sanmite®	12	GH/N	Gowan Company
		Fenpyroximate	Akari®	12	GH	SePRO Corp.
		Tolfenpyrad	Hachi-Hachi®	12	GH	SePRO Corp.
		Fenazaquin	Magus™	12	GH/N	Gowan Company
23	Tetronic acids	Spiromesifen	<b>Judo®</b>	12	GH/N	<b>OHP, Inc.</b>
	Tetramic acids	Spirotetramat	<b>Kontos®</b>	24	GH/N	<b>OHP, Inc.</b>
UN	Carbazates	Bifenazate	<b>Floramite®</b>	12	GH/N	<b>OHP, Inc.</b>
	Biopesticide Insect Growth Regulators	Azadirachtin	<b>Azatin® XL</b>	4	GH/N	<b>OHP, Inc.</b>
	Pyridalyl	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>	BotaniGard®	4	GH/N	BioWorks, Inc.	
			Mycotrol® O	4	GH/N	BioWorks, Inc.	
		<i>Isaria fumosorosea</i> Apopka Strain 97(ATCC20874)	Preferal™	4	GH/N	SePro Corp.	
	Oils	Clarified hydrophobic extract of neem oil		<b>Triact® 70</b>	4	GH/N	<b>OHP, Inc.</b>
			Paraffinic oil	Ultra-Pure™ Oil	4	GH/N	BASF
			Petroleum	Suffoil-X™	4	GH/N	BioWorks, Inc.
	Soaps	Potassium salts of fatty acids		AllPro® Insecticidal Soap 40%	12	GH/N	Value Garden Supply
			M-Pede®	12	GH/N	Gowan Company	

## 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	BASF
1+3	Organophosphate + Pyrethroid	Chlorpyrifos + Cyfluthrin	DuraPlex® TR	24	GH	BASF
3+4A	Pyrethroid + Neonicotinoid	Cyfluthrin + Imidacloprid	<b>Discus® N/G</b>	12	GH/N	<b>OHP, Inc.</b>
6+UN	Glycoside+Carbazate	Abamectin+Bifenazate	<b>Sirocco®</b>	12	GH/N	<b>OHP, Inc.</b>

## \*Insecticides / Miticides Modes of Action

1. Acetylcholinesterase 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. Nicotinic acetylcholine receptor (nAChR) agonists. 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. Mite growth inhibitors.
10. Mite growth inhibitors.
11. Microbial disruptors of insect midgut membranes.
12. Inhibitors of mitochondrial ATP synthase.
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 receptor agonists.
20. Mitochondrial complex III electron transport inhibitors.
21. Mitochondrial complex I electron transport inhibitors.
23. Inhibitors of acetyl CoA carboxylase
- UNProducts 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.irac-online.org](http://www.irac-online.org).**

# REFERENCE GUIDE for GREENHOUSE and NURSERY 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	<b>OHP 6672®</b>	12	GH/N	<b>OHP, Inc.</b>
			3336™	12	GH/N	Cleary Chemical Corp.
			AllBan®	12	GH/N	Everris NA, Inc.
Resistance risk <b>High</b> (See explanation of resistance risk following the mode of action listing)						
2	Dicarboximides	Iprodione	<b>OHP Chipco® 26019 N/G</b>	12	GH/N	<b>OHP, Inc.</b>
			Iprodione Pro™	12	GH/N	BASF
Resistance risk <b>Medium to High</b>						
3	Imidazole	Triflumizole	<b>Terraguard®</b>	12	GH/N	<b>OHP, Inc.</b>
			Imazalil	Fungaflor®	24	GH
	Pyrimidine	Fenarimol	Rubigan®	12	N	Gowan Company
			Triazole (includes conazole)	Propiconazole	Banner® MAXX® II	12
	Strider™	24			N	Cleary Chemical Corp.
	Metconazole	Tourney®			12	N
	Demethylation Inhibitors (DMI fungicides)	Triadimefon	<b>Strike® 50 WDG</b>	12	GH/N	<b>OHP, Inc.</b>
Myclobutanil			Eagle® 20 EW	24	GH/N	Dow AgroSciences LLC
		Triticonazole	Trinity® TR	4-12	GH	BASF
Resistance risk <b>Medium</b>						
4	Acylamine	Metalaxyl-M (=Mefenoxam)	Subdue® MAXX®	0 to 48	GH/N	Syngenta
Phenylamides (PA fungicides) Resistance risk <b>Medium to High</b>						
5	Piperadines	Piperalin	Pipron®	12	GH	SePRO Corp.
Amines ("Morpholines") Resistance risk <b>Low to Medium</b>						

# Fungicides

continued

## (by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
7	Phenyl-Benzamides	Flutolanil	ProStar®	12	GH/N	Bayer Environmental Science
Carboxamides Resistance risk <b>Medium to High</b>						
11	Strobilurins	Trifloxystrobin	<b>Compass® O</b>	12	GH/N	<b>OHP, Inc.</b>
		Fluoxastrobin	<b>Disarm® O</b>	12	GH/N	<b>OHP, Inc.</b>
		Azoxystrobin	Heritage®	4	GH/N	Syngenta
		Kresoxim-methyl	Cygnus®	12	GH/N	BASF
		Pyraclostrobin	Insignia®	12	GH/N	BASF
	Imidazolinones	Fenamidone	<b>FenStop®</b>	12	GH	<b>OHP, Inc.</b>
Quinone outside Inhibitors (QoI fungicides) Resistance risk <b>High</b>						
12	Phenylpyrrole (PP fungicides)	Fludioxonil	Medallion®	12	GH/N	Syngenta
			Mozart™ TR	6-12*	GH	BASF
Resistance risk <b>Low to Medium</b>						
14	Aromatic Hydrocarbons	PCNB	<b>Terraclor®</b>	12	GH/N	<b>OHP, Inc.</b>
	Thiadiazole	Etridiazole	<b>Terrazole®</b>	12	GH/N	<b>OHP, Inc.</b>
			Truban®	12	GH/N	Everris NA, Inc.
Aromatic Hydrocarbons (AH fungicides) Resistance risk <b>Low to Medium</b>						
17	Hydroxylanilide	Fenhexamid	Decree®	12	GH/N	SePRO Corp.
Hydroxylanilides Resistance risk <b>Low to Medium</b>						
19	Polyoxins	Polyoxin-D	Affirm™	4	GH/N	Cleary Chemical Corp.
Resistance risk <b>Low to Medium</b>						
21	Cyano-imidazole	Cyazofamid	Segway®	12	GH/N	FMC Corp.
Resistance risk <b>Medium to High</b>						
28	Carbamate	Propamocarb	Banol®	24	GH/N	Bayer Environmental Science
Carbamates Resistance risk <b>Low to Medium</b>						
33	Ethyl Phosphonates	Fosetyl-Al	<b>Aliette®</b>	12	GH/N	<b>OHP, Inc.</b>
		[Also classified by EPA with plant host defense inducers]				
	Phosphite	Phosphorous acid	Alude™	4	GH/N	Cleary Chemical Corp.
Phosphonates Resistance risk <b>Low</b>						

\* Depends on greenhouse ventilation

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

# Fungicides

continued

## (by Mode of Action Group and Class)

MOA Code* & Group	Class	Common Name	Trade Name	REI	Use Site(s)**	Company		
40	Cinnamic Acid Amides	Dimethomorph	Stature® SC	12	GH/N	BASF		
		Mandipropamid	Micora™	4	GH/N	Syngenta		
Carboxylic Acid Amides (CAA fungicides) Resistance risk <b>Low to Medium</b>								
43	Pyridinemethyl-benzamides	Fluopicolide	Adorn®	12	GH/N	Valent USA Corp.		
Resistance risk <b>Unknown</b>								
M1	Copper, Complex	Copper sulfate	Camelot®	12	GH/N	SePRO Corp.		
			Phyton® 27	24	GH/N	Phyton Corp.		
	Copper, Fixed	Copper hydroxide	CuPro™ 2005 T/N/O	24	GH/N	SePRO Corp.		
Resistance risk <b>Low to Medium</b>								
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™ DF	24	GH/N	Cleary Chemical Corp.	
Resistance risk <b>Low to Medium</b>								
M4	Phthalimides	Captan	Captan 80WDG	0 to 48	GH/N	Arysta LifeScience		
			Captan 50W	96	GH/N	Arysta LifeScience		
Resistance risk <b>Low to Medium</b>								
M5	Chloronitriles	Chlorothalonil	Daconil® Ultrex®	12	GH/N	Syngenta		
			AllPro® Exotherm Termil	*	GH	Value Garden Supply		
Resistance risk <b>Low to Medium</b> * Depends on greenhouse ventilation								
NC	Biopesticide	<i>Trichoderma harzianum</i> T22	PlantShield® HC	0	GH/N	BioWorks, Inc.		
			RootShield®	0	GH/N	BioWorks, Inc.		
			RootShield® Plus	0	GH/N	BioWorks, Inc.		
		<i>Trichoderma harzianum</i> T22 + <i>Trichoderma virens</i> G41	<b>SoilGard® 12G</b>	4	GH/N	<b>OHP, Inc.</b>		
				<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® SP	4	GH/N	Natural Industries, Inc		
		Bicarbonate	Potassium bicarbonate	Armcarb® 100	4	GH/N	Helena Chemical Co.	
				MilStop®	1	GH/N	BioWorks, Inc.	
				ZeroTol®	0	GH/N	Biosafe Systems	
		Hydrogen Dioxide/Peroxide		Xeroton X3™	0 to 2	GH/N	Phyton Corp.	
				<b>Triact® 70</b>	4	GH/N	<b>OHP, Inc.</b>	
				Petroleum oil	Suffoil-X™	4	GH/N	BioWorks, Inc.
		(also classified by EPA as a biopesticide)						
		Quaternary Ammonium	Quaternary Amines	Quaternary Amines	Greenshield®	0	GH	BASF



## MOA Combination Products

MOA Code* & Group	Classes	Common Name	Trade Name	REI	Use Site(s)**	Company
NC <small>continued</small>	Soaps	Potassium salts of fatty acids	M-Pede®	12	GH/N	Gowan 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	Everris NA, Inc.
1+M3	Thiophanate + Dithiocarbamate	Thiophanate-methyl + Mancozeb	Zyban®	24	GH/N	Everris NA, Inc.
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
3+M5	Demethylation inhibitor + Chloronitrile	Propiconazole + Chlorothalonil	Concert® II	12	N	Syngenta
4+12	Acylalanine + Phenylpyrrole	Mefenoxam + Fludioxonil	Hurricane™	48	GH	Syngenta
7+11	Pyridine Carboxamide + Strobilurin	Boscalid + Pyraclostrobin	Pageant® Intrinsic™	12	GH/N	BASF
45+40	Triazolo-pyrimidylamines + Cinnamic Acid Amides	Ametoctradin + Dimethomorph	Orvego™	12	GH/N	BASF
9+12	Anilo-pyrimidine+ Phenylpyrrole	Cyprodinil + Fludioxinil	Palladium™	12	GH/N	Syngenta

## \*Fungicides Modes of Action

- |  |  |
|--|--|
| 1. Inhibition of tubulin formation in mitosis                                  | 19. Chitin synthase inhibition in cell wall development  |
| 2. Affect cell division, DNA and RNA synthesis and metabolism                  | 21. Quinone inside inhibitors (QII)  |
| 3. DMI (Demethylation Inhibitor): Inhibition of sterol synthesis               | 28. Affect cell membrane permeability (proposed)   |
| 4. Phenylamides-Affect RNA synthesis   | 33. Mode of action unknown. The mode of action cannot be placed within any other grouping            |
| 5. Inhibition of an isomerase in sterol biosynthesis- Piperadines, Morpholines | 40. Phospholipid biosynthesis and cell wall deposition (proposed)                                    |
| 7. Affect mitochondrial transport chain  | 43. Delocalization of spectrin-like proteins   |
| 9. Methionine biosynthesis (proposed)  | 45. Complex III: cytochrome bc1 (ubiquinone reductase) at Q x (unknown) site                         |
| 11. Quinone outside inhibitors (QOI)   | M Multi-site activity. Chemicals that act at several sites, which may differ among the group members |
| 12. MAP protein kinase in osmotic signal transduction                          | NC Not classified.   |
| 14. Lipid peroxidation (proposed)  |  |
| 17. 3-keto reductase during C4 demethylation in sterol biosynthesis            |  |

**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). More information on the fungicide Resistance Action Committee and the Mode of Action Classification is available from: [www.frac.info](http://www.frac.info).**

## 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 GREENHOUSE and NURSERY PRODUCTION PLANT GROWTH REGULATORS

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

## 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	Medium	Chlormequat chloride	<b>Cycocel®</b>	12	GH/N	<b>OHP, Inc.</b>
	Hydrazide	Low	Daminozide	<b>B-Nine®</b>	24	GH/N	<b>OHP, Inc.</b>
	Triazole	High	Pacllobutrazol	<b>Paczol®</b>	12	GH/N	<b>OHP, Inc.</b>
Uniconazole-p			Sumagic®	12	GH	Valent USA Corp.	
2	Cyclohexaketone	Medium	Dikegulac sodium	<b>Augeo®</b>	4	GH/N	<b>OHP, Inc.</b>
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.
	Synthetic Cytokinin	High	N-(phenylmethly)- IH-purine-6-amine	Configure®	12	GH	Fine Agrochemicals, LTD.
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	<b>Hormodin®</b>	0	GH/N	<b>OHP, Inc.</b>
			IBA + NAA	Dip'N Grow	0 to 24	GH/N	Dip'N Grow, Inc.

\*\*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.

### \*Plant Growth Regulators Modes of Action

- |  |                       |                           |
|--|-----------------------|---------------------------|
| 1. Gibberellic Acid synthesis inhibitors | 3. Chemical pincher   | 6. Rooting Hormones       |
| 2. DNA synthesis inhibitor               | 4. Growth promoter    | UN. Unkown mode of action |
| 7. ABA abscisic acid                     | 5. Ethylene generator |                           |

# REFERENCE GUIDE for GREENHOUSE and NURSERY PRODUCTION HERBICIDES

Rotation of herbicide classes is not necessary in field grown nursery crops to prevent weed resistance problems. Weed resistance to herbicides is generally not 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

## 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®	24	PR/PO; A, BW	Dow AgroSciences LLC
	Dinitroaniline	Pendimethalin	Pendulum®	24	PR; A, BW	BASF
			Corral®	24	PR; A, BW	Everris NA, Inc.
			Prodiamine	Barricade®	12	PR; A, BW
		Oryzalin	Surflan® WDG	12	PR; A, BW	United Phosphorus
Benzoic acid	DCPA	Dacthal®	12	PR; A, BW	Amvac Chemical Corp.	
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	48	PO; BW, S	BASF

# Herbicides

continued

(by Mode of Action Group and Class)

MOA Group*	Class	Common Name	Trade Name	REI	Use Site(s)**	Company
9	Glycine	Glyphosate	Roundup Pro®	4	PO; A, P, BW (GH)	Monsanto
			Refuge™	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	<b>Casoron®</b>	12	PR; A, P,	<b>OHP, Inc.</b>
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)	Gowan Company
29	Alkylazines	Indaziflam	<b>Marengo®</b>	12	PR; PO, A, N, BW	<b>OHP, Inc.</b>
3+3	Dinitroaniline + Dinitroaniline	Benefin + Oryzalin	XL 2G	24	PR; A, BW	Helena Chemical Co.
3+14	Diphenylether + Dinitroaniline	Oxyfluorfen + Pendimethalin	OH2®	24	PR; A, BW	Everris NA, Inc.
3+14	Diphenylether + Dinitroaniline	Oxyfluorfen + Prodiamine	<b>Biathlon®</b>	24	PR; A, BW	<b>OHP, Inc.</b>

## (by Mode of Action Group and Class)

MOA Group*	Classes	Common Name	Trade Name	REI	Use Site(s)**	Company
3+14	Oxadiazole + Dinitroaniline	Oxadiazon + Prodiamine	RegalStar® II	12	PR; A, BW	Regal Chemical Co.
3+14	Diphenylether + Dinitroaniline	Oxyfluorfen + Oryzalin	Rout®	24	PR; A, BW	Everris NA, Inc.
3+14	Oxadiazole + Dinitroaniline	Oxadiazon + Pendimethalin	Jewel™	12	PR; A, BW	Everris NA, Inc.
3+15	Chloroacetamide + Dinitroaniline	Dimethenamid-P + Pendimethalin	Freehand®	12	PR; A, BW, S	BASF
14+14	Diphenylether + Oxadiazole	Oxyfluorfen + Oxadiazon	Regal O-O®	24	PR; A, BW	Regal Chemical Co.
3+21	Benzamide + Dinitroaniline	Isoxaben + Trifluralin	Snapshot® TG	12	PR; A, BW	Dow AgroSciences LLC
3+14+21	Benzamide + Diphenylether + Dinitroaniline	Isoxaben + Oxyfluorfen + Trifluralin	Showcase®	24	PR; A, BW	Dow AgroSciences LLC
M	Soaps	Ammonium Nonanoate	Axxe®	24	PO; GH	BioSafe Systems

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## \*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
  29. Inhibit cellulose biosynthesis
- M. Miscellaneous

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

\*This mode of action listing is based on the Herbicide Resistance Action Committee (HRAC) and the Weed Science Society of America (WSSA). More information on the Herbicide Resistance Action Committee and the Mode of Action Classification is available from: [www.hracglobal.com](http://www.hracglobal.com).

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





