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Resistance Management Guide

For Healthy, Quality Ornamental Plants

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Innovation that solves your toughest challenges

BASF is dedicated to investing in research that produces quality solutions. For over 150 years, we have developed innovations that help to solve your most pressing challenges, backed by research and supported by an experienced sales and technical team. We create chemistry that leads to healthy, quality plants, greater efficiency and more sustainable solutions for greenhouse and nursery growers.

A comprehensive guide to resistance management

This easy-to-use reference guide from BASF can help you determine the best resistance management programs for your nursery or greenhouse operation. As always, BASF listens to your challenges and works with you to deliver useful solutions that help maximize your productivity.

How to Use This Guide

This Resistance Management Guide was developed as a companion piece to the BASF Plant Production Guide. It contains the same fungicide, insecticide and herbicide resistance management information tables found in the Plant Production Guide in a more portable quick-reference format.

Because other manufacturers' products are included in this Resistance Management Guide, where there is any conflict between a product's label and the product information in this guide, the current label language takes precedence.

Scan the QR code below, or visit betterplants.basf.us for more detailed technical information on every BASF product listed here.



Fungicide Resistance Management Guide

FRAC Group	Chemical Group(s)	Primary Target Disease(s)	Active Ingredient(s)	Fungicide Trade Name(s)	REI	Use Site(s)
1	Thiophanate	<i>Rhizoctonia</i> , <i>Thielaviopsis</i> , Fungal leaf spots	Thiophanate-methyl	AllBan®, Cleary's 3336®, Fungo®, OHP 6672®, T-Storm®, Systec®	12	G,N,L
2	Dicarboxamide	<i>Botrytis</i> , Powdery mildew, Fungal leaf spots, <i>Fusarium</i>	Iprodione	26GT®, Chipco® 26019 WP, Sextant®	12	G,N,L
3	Imidazole	Scab, Powdery mildew, Fungal leaf spots, Rusts	Triflumizole	Terraguard®	12	G,N
	Triazole	Oak wilt, Dutch elm disease, Scab	Tebuconazole	Tebuject™	N/A	L
		Powdery mildew, Scab, Rusts, Blights, Fungal leaf spots	Propiconazole	Alamo®, Banner MAXX® II, Spectator™	24	N,L
			Triadimefon	Bayleton®, Fungisol®, Systrex® + Nutrient®, Strike® 50 WDG	12	G,N,L
			Myclobutanil	Eagle® 20 EW, Systhane™	24	G,N,L
		Anthracnose, Powdery mildew, Leaf spots, Stem and Crown rots	Triticonazole	Trinity® fungicide, Trinity® TR total release fungicide	12	G,N,L G
		Powdery mildews, Scab, Rusts, Blights, Fungal leaf spots	Metconazole	Tourney®	12	N,L
		Powdery mildews, Scab, Rusts, Blights, Fungal leaf spots	Tebuconazole	Torque™	12	N,L
4	Acylalanine	<i>Pythium</i> , <i>Phytophthora</i>	Mefenoxam	Mefenoxam® 2, Subdue MAXX®	0	G,N,L
5	Piperadine	Powdery mildew	Piperalin	Pipron®	12	G
7	Phenyl-benzamide	<i>Rhizoctonia</i> , Southern blight, Rusts	Flutolanil	ProStar® WG, Contrast®	12	G,N,L

G = Greenhouse, N= Nursery, L=Landscape

1 Some products within the same chemical group may not control all pests listed, or there may be some products within the group that offer superior performance. Consult your local manufacturer's representative or your university/extension specialist if needed.

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FRAC Group	Chemical Group(s)	Primary Target Disease(s)	Active Ingredient(s)	Fungicide Trade Name(s)	REI	Use Site(s)
11	Strobilurin	Fungal leaf spots, Rusts, Powdery mildew, <i>Phytophthora</i> , <i>Rhizoctonia</i>	Azoxystrobin	Heritage®	4	G,N,L
		<i>Rhizoctonia</i> , Fungal leaf spots & blights, Scab, Rusts, Anthracnose, Downy mildew, Powdery mildew, <i>Fusarium</i> , <i>Phytophthora</i> , Southern blight	Fluoxastrobin	Fame®	12	G,N,L
		<i>Fusarium</i> , <i>Phytophthora</i> , <i>Pythium</i> , <i>Rhizoctonia</i>	Pyraclostrobin	Empress™ Intrinsic® brand fungicide	12	G,N
		Fungal leaf spots, Rusts, Powdery mildew, <i>Rhizoctonia</i>	Trifloxystrobin	Compass®	12	G,N,L
	Imidazolinone	<i>Pythium</i> , <i>Phytophthora</i> , Downy mildew	Fenamidone	FenStop™	12	G
12	Phenylpyrrole	Fungal leaf spots, <i>Botrytis</i> , <i>Cylindrocladium</i> , <i>Fusarium</i> , <i>Rhizoctonia</i>	Fludioxonil	Medallion®, Emblem™	12	G,N,L
14	Aromatic Hydrocarbon	<i>Rhizoctonia</i>	PCNB	Pennstar® Pro, Revere®, Terraclor®	12	G,N, L
	1, 2, 4-thiadiazole	<i>Pythium</i> , <i>Phytophthora</i>	Etridiazole	Truban®, Terrazole®	12	G,N,L
17	Hydroxyanilide	<i>Botrytis</i>	Fenhexamid	Decree®	4	G,N
19	Peptidyl Pyrimidine Nucleoside	<i>Botrytis</i> , <i>Rhizoctonia</i> , <i>Alternaria</i> , Downy mildew, Powdery mildew, Anthracnose, Scab	Polyoxin-D	Affirm®	4	G,N,L
21	Cyano-imidazole	<i>Phytophthora</i> , <i>Pythium</i> , Downy mildew	Cyazofamid	Segway® Fungicide SC Segway® O	12	G,N,L
28	Carbamate	<i>Phytophthora</i> , <i>Pythium</i>	Propamocarb	Banol®	24	G,N,L
33	Ethyl-phosphonate	<i>Phytophthora</i> , <i>Pythium</i> , Downy mildew	Fosetyl-al	Aliette®	12	G,N,L
		<i>Phytophthora</i> , <i>Pythium</i> , Downy mildew	Phosphorous acid	Agri FOS®, Alude®, ArborFox®, Bio-phos®, Magellan®, Resyst®	4	G,N,L
40	Cinnamic Acid Amides	<i>Phytophthora</i> , Downy mildew	Dimethomorph	Stature® SC fungicide	12	G,L
	Mandelic Acid Amides	<i>Phytophthora</i> , Downy mildew	Mandipropamid	Micora®	4	G,N,L
41	Tetracycline Antibiotic	Bacterial diseases, Lethal yellows, Elm phloem necrosis	Oxytetracycline	Mycoject®, Tree Tech OTC®	NOL	L
43	Pyridinylmethyl Benzamide	<i>Phytophthora</i> , <i>Pythium</i> , Downy mildew	Fluopicolide	Adorn®	12	G,N,L
U15	Piperidinyl-thiazole-isoxazoline	<i>Phytophthoras</i> , Downy mildew	Oxathiapiprolin	Segovis®	4	G,N,L

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Fungicide Resistance Management Guide – (continued)

FRAC Group	Chemical Group(s)	Primary Target Disease(s)	Active Ingredient(s)	Fungicide Trade Name(s)	REI	Use Site(s)
M1	Copper, Complex	Fungal leaf spots, Bacterial diseases, Powdery mildew, Scab, Downy mildew	Copper sulfate	Camelot®	12	G,N,L
			Copper sulfate pentahydrate	Phyton® 27	24	G,N,L
	Copper, Fixed	Fungal leaf spots, Bacterial diseases, Powdery mildew, Scab, Downy mildew	Copper hydroxide	Kocide 2000®	24	G
M4	Phthalimide	Fungal leaf spots, <i>Botrytis</i> , Downy mildew, <i>Thielaviopsis</i>	Captan	AllPro™ Captan 50W	96	G,N,L
M5	Chloronitrile	Fungal leaf spots, <i>Botrytis</i> , Powdery mildew, Rusts, Scab, <i>Fusarium</i>	Chlorothalonil	Agrisel®, Chlorostar®, AllPro®, Concorde®, Echo®, Manicure®, Thaloni®, Daconil® Ultrex®, Legend®	12-48	G,N,L
M3	Dithio-carbamate	Fungal leaf spots, <i>Botrytis</i> , Rusts, Downy mildew, Scab	Mancozeb	Dithane®, Fore®, Formec®, Mancozeb®, Junction®, Pentathlon®, Protect®	24	G,N,L
		Fungal leaf spots, <i>Botrytis</i> , Rusts, Downy mildew	Ferbam	Ferbam Granuflo®	24	G, N
		Fungal leaf spots, <i>Botrytis</i> , Rusts	Ziram	Ziram Granuflo®	48	G, N
M3+3		Fungal leaf spots, <i>Botrytis</i> , Rusts, Downy mildew, Powdery mildew	Mancozeb + Myclobutanil	Manhandle®	24	G,N,L
M5+3	Chloronitrile + Pyrimidine	Fungal leaf spots, <i>Botrytis</i> , Powdery mildew, Rusts, Scab	Chlorothalonil + Fenarimol	TwoSome™	NOEL*	L
	Chloronitrile + Triazole	Leaf spots and blights, Powdery mildew, Rusts, Scab, Flower blights	Chlorothalonil + Propiconazole	Concert® II	12	L
1+2	Thiophanate + Dicarboxamide	Fungal leaf spots, <i>Botrytis</i> , <i>Rhizoctonia</i>	Thiophanate-methyl + iprodione	26/36®	24	G,N,L
1+14	Thiophanate + 1, 2, 4-thiadiazole	<i>Rhizoctonia</i> , <i>Thielaviopsis</i> , <i>Pythium</i> , <i>Fusarium</i>	Thiophanate-methyl + etridiazole	Banrot®	12	G,N,L
1+M3	Thiophanate + Dithiocarbamate	Fungal leaf spots, Powdery mildew, Downy mildew, <i>Botrytis</i>	Thiophanate-methyl + mancozeb	ConSyst®, Spectro90®, Zyban®	12	G,N,L
3+11	Triazole + Strobilurin	Rust, <i>Rhizoctonia</i> , <i>Botrytis</i> , Powdery mildew	Triadimefon + Trifloxystrobin	Strike Plus®, Trigo™	12	G,N,L

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4+12	Acylalanine + Phenylpyrrole	<i>Phytophthora</i> , <i>Pythium</i> , <i>Fusarium</i> , Crown and Stem rots	Mefenoxam + Fludioxonil	Hurricane®	48	G
7+11	Pyridine-Carboxamide + Strobilurin	Fungal leaf spots, Downy mildew, Powdery mildew, Anthracnose, <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Phytophthora</i> , <i>Pythium</i> , Scab and Rusts, <i>Botrytis</i> , Blights	Boscalid + Pyraclostrobin	Pageant® Intrinsic® brand fungicide	12	G,N,L
	Pyrazole-4-Carboxamides + Strobilurin	Fungal leaf spots, Downy mildew, Powdery mildew, Anthracnose, <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Phytophthora</i> , <i>Pythium</i> , Scab and Rusts, <i>Botrytis</i> , Blights	Benzovindiflupyr + Azoxystrobin	Mural®	12	G,N,L
		Fungal leaf spots, Downy mildew, Powdery mildew, Anthracnose, <i>Fusarium</i> , <i>Rhizoctonia</i> , <i>Phytophthora</i> , <i>Pythium</i> , Scab and Rusts, <i>Botrytis</i> , Blights, <i>Thelaviopsis spp.</i>	Fluxapyroxad + Pyraclostrobin	Orkestra™ Intrinsic® brand fungicide	12	G,N,L
FRAC Group	IRAC Group	Combination Fungicide / Insecticides Designated Within Fungicide Resistance Action Committee and Insecticide Resistance Action Committee Groups				
1	6	Benzimidazole + Glycocide	Vascular Pathogens: Wilts, Cankers, Dutch elm disease, <i>Fusarium</i>	Debacarb + Abamectin	Abasol®	NOL L
1	4A	Benzimidazole + Neonicotinoid	Vascular Pathogens: Wilts, Cankers, Dutch elm disease, <i>Fusarium</i>	Debacarb + Imidacloprid	Imisol®	NOL L

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Fungicide Resistance Management Guide – (continued)

FRAC Group	Chemical Group(s)	Primary Target Disease(s)	Active Ingredient(s)	Fungicide Trade Name(s)	REI	Use Site(s)
NC	Hydrogen Peroxide	Bacteria and Soilborne Fungi	Hydrogen Peroxide	ZeroTol® 2.0, TerraClean®	0	G,N,L
	Biopesticide	Fungal and Bacterial leaf spots, Powdery mildew, <i>Botrytis</i> Gray Mold, Stem blights and rots	Extract of <i>Reynoutria sachalinensis</i>	Regalia®	4	G,N,L
		<i>Phytophthora</i> , <i>Pythium</i> , <i>Fusarium</i> , <i>Cylindrocladium</i> , <i>Thielaviopsis</i>	<i>Trichoderma harzianum</i> T-22 + <i>T. virens</i> G-41	Rootshield® Plus (BW240)	4	G,N,L
		<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Cylindrocladium</i> , <i>Fusarium</i>	<i>Trichoderma harzianum</i> T22	PlantShield® HE, RootShield®	0	G,N,L
		<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i>	<i>Gliocadium virens</i> GL21	SoilGard® G	0	G,N,L
		<i>Botrytis</i> , Powdery and Downy mildews, <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Fusarium</i>	<i>Bacillus amyloliquefaciens</i>	Subtilex® NG fungicide Triathion® BA fungicide	4	G,N
		<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i>	<i>Bacillus subtilis</i> GB03	Cease®	4	G,N
		<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i>	<i>Bacillus subtilis</i> QST713	Rhapsody® AS	4	G,N,L
		<i>Pythium</i> , <i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Verticillium</i>	<i>Streptomyces lydicus</i> WYEC108	Actinovate®	4	G,N,L
	Bicarbonate	Powdery mildew, Rusts, <i>Downy mildew</i>	Potassium Bicarbonate	Armcarb® 100, Bi-Carb®, Firststop®, Kaligreen®, MilStop®	1-4	G,N,L
	Botanical Extract	Powdery mildew	Jojoba oil	Permatrol®	4	G,N, L
		Powdery mildew, Fungal leaf spots, Rusts, Scab	Clarified hydrophobic neem oil	Triact 70®	4	G,N,L
		Powdery mildew, Fungal leaf spots	Macheaya extract	Qwel®	12	G
		Powdery mildew	<i>Raynourtia sachalinensis</i>	Milsana®	24	G
	Hydrogen Dioxide	Fungal leaf spots, Powdery mildew, <i>Botrytis</i>		ZeroTol®	0	G,N,L
	Oil	Powdery mildew	Unsulfonated residue of petroleum oil	SuffOil-X®	4	G,N
		Powdery mildew and Rusts		Ultra-Pure Oil®	0	G,N,L
	Quaternary Ammonium	Bacteria/Algae	Quaternary amines	Green-Shield II®	0	G
			Quaternary ammonium chloride	KleenGrow®	48	G
	Soap	Powdery mildew	Potassium salts of fatty acids	M-Pede®	12	G,N, L

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Fungicide Resistance Action Committee (FRAC) Mode of Action Classification List:

- 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 Complex II in the mitochondria: succinate-dehydrogenase enzyme inhibitor
- 11 Complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site- Quinone outside- (cyt b gene) affecting respiration
- 12 MAP protein kinase in osmotic signal transduction
- 14 Lipid peroxidation
- 17 3-keto reductase during C4 demethylation in sterol biosynthesis
- 19 Chitin synthase
- 21 Complex III: cytochrome bc1(ubiquinone reductase) at Qi- Quinone inside- site in the mitochondria affecting respiration
- 28 Affects cell membrane permeability (proposed)
- 33 Mode of action unknown
- 40 Affects cell wall biosynthesis - cellulose synthase specifically
- 41 Protein synthesis attachment of aminoacyl-tRNA to ribosomal acceptor (A) site
- 43 Affects spectrin-like proteins, believed to play a role in maintaining the membrane stability
- 45 Complex III: cytochrome bc1 (ubiquinone reductase) at Qo site, stigmatellin binding sub-site affecting respiration
- U15 Oxysterol binding protein (OSBP) inhibition (proposed)
- M Multi-site contact activity
- NC Not classified

Insecticide Resistance Action Committee (IRAC) Mode of Action Classification List:

- 4a Neonicotinoids
- 6 Chloride channel activators

The above lists are from the U.S. Environmental Protection Agency, in cooperation with the Fungicide Resistance Action Committee (FRAC) and the the Insecticide Resistance Action Committee (IRAC) respectively.

FRAC and IRAC are technical working groups 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.

More information on the Insecticide Resistance Action Committee and the Mode of Action Classification is available from www.irac.info.

Insecticide Resistance Management Guide

IRAC Group	Chemical Sub Group(s)	Primary Target Insect(s)	Active Ingredient(s)	Insecticide Trade Name(s)	REI	Use Site(s)
1A	Carbamates	Caterpillars, Soft scale insects, Thrips*	Carbaryl Methiocarb	Sevin® Mesurol®	12 24	N,L G,N
1B	Organophosphates	Aphids, Caterpillars, Mealybugs*, Ants, Whiteflies (general and B-type), Fungus gnats, Shore flies, Glassy-winged sharpshooter	Acephate	1300 Orthene® TR total release insecticide, Orthene® TT&O WSP insecticide, Pinpoint® PT 1300, Tame®/Orthene TR total release insecticide	24	G,N,L
			Chlorpyrifos	DuraGuard® ME microencapsulated insecticide, DuraPlex® TR total release insecticide, Dursban	24	G,N
			Diazinon	Diazinon®	12	N
			Naled	Diabrom®	24	G
			Dimethoate	Dimethoate® 267, Cygon® 2E, Dimate® 4EC	48	N
			Malathion	Malathion® 8F	12	N,L
			Methidathion	Supracide®	48	N
			Oxydemeton-methyl	MSR® Spray Concentrate	48-72	N
			Phosmet	Imidan® 70 W	24	N,L
			Trichlorfon	Dylox® 80	N/A	L
2A	Cyclodiene Organochlorides	Aphids, Mites, Borers, True bugs and Whiteflies	Endosulfan	Fulex Thiodan® insecticidal smoke, Thionex® EC	24	G
2	Phenylpyrazoles (Fiproles)	Imported fire ants, Nuisance ants, Fleas, Ticks, Mole crickets	Fipronil	Ceasefire®, Topchoice®	24	L
3	Pyrethroids	Aphids, Caterpillars, Glassy-winged sharpshooter, Mealybugs*, Thrips*, Scales*	Bifenthrin	OnyxPro®, Talstar®, Attain TR® total release insecticide	12	G,N,L
			Cyfluthrin	Decathlon®, Tempo®	12	G,N,L
			Fenpropathrin	Tame®	24	G,N,L
			Fluvalinate	Mavrik® AF	12	G,N,L
			Lambda-cyhalothrin	Scimitar® GC	24	G,N,L
			Permethrin	Astro®, Perm-Up®, Permethrin® 3.2 EC	12	L
			Deltamethrin	DeltaGard®	12	N,L
	Pyrethrins	Aphids, Caterpillars, Glassy-winged sharpshooter, Mealybugs*, Thrips*, Scales*	Pyrethrins	Pyrethrum® TR total release insecticide	12	G,N

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* Some, but not all, species of selected pests within the group are controlled. Read the product specimen label for additional information. Consult your local university/extension specialist if needed.

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4A	Neonicotinoids	Aphids, Whiteflies (general, B- and Q-type), Grubs*, Scales*, Mealybugs & Scale, Caterpillars, Midges, Thrips	Acetamiprid	TriStar®	12	G,N,L
			Dinotefuran	Safari®	12	G,N,L
			Imidacloprid	Marathon®, Merit®, Discus® Tablets	0-12	G,N,L
			Imidacloprid + Cyfluthrin	Discus® NG	12	N
			Imidacloprid + Bifenthrin	Allectus® G	12	L
			Imidacloprid + Debacarb	Imisol®	NOL	L
			Imidacloprid + 12-9-4 fertilizer carrier	Corectect®	NOL	L
			Imidacloprid slow release	SusCon®	NOL	L
			Bifenthrin + Clothianidin	Allectus®, Aloft®	12	L
			Dinotefuran	Safari®	12	G,N,L
			Thiamethoxam	Flagship 25 WG®	12	G,N
4B	Nicotine	Whiteflies, Spider mites, Aphids, Mealybugs	Nicotine	Fulex® Nicotine® Fumigator,* Nicotine Smoke Generator		G
5	Spinosyns	Caterpillars, Mites*, Thrips	Spinosad	Conserve®	4	G,N,L
		Caterpillars, Leafminers, Red Imported Fire Ants	Spinosad	Entrust® SC	4	G,N
6	Avermectins, Milbemycins	Mites, Thrips	Abamectin	Avid®	12	G,N,L
			Abamectin + Debacarb	Abasol®	NOL	L
		Mites	Milemectin	Ultiflora Miticide®	12	N
	Glycoside	Caterpillars, Leafminers, Mites, Psylla	Emamectin Benzoate	Enfold®	12	N
7A		Whiteflies, Fungus gnats, Scales, Mealybugs, Aphids	s-Kinopronone	Enstar® AQ	4	G
	Juvenile Hormone Analogues	Imported fire ants	Methoprene	Extinguish®	4	N,L
7B	Fenoxycarb	Ants	Fenoxycarb	Award®	12	G
7C	Pyriproxyfen	Fungus gnats, Shore flies	Pyriproxyfen	Distance®, Fulcrum®	12	G,N
9B	Pyridine Azomethine Derivatives	Aphids, Mealybugs*, Whiteflies*	Pymetrozine	Endeavor®	12	G,N,L
29	Flonicamid	Aphids, Glassy-winged sharpshooter, Mealybugs, Thrips	Flonicamid	Aria®	12	G,N,L
10A	Clofentezine, Hexythiazox	Mites	Clofentezine	Ovation®, Applause™,	12	G,N
			Hexythiazox	Hexygon DF®	12	G,N,L

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Insecticide Resistance Management Guide – (continued)

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10B	Etoxazole	Mites*	Etoxazole	TetraSan® Beethoven TR® miticide/insecticide	4-24	G,N,L G
11A	Bacillus thuringiensis and the insecticidal proteins they produce	Fungus gnat larvae, Caterpillars	<i>Bacillus thuringiensis</i> sub <i>Israelensis</i>	Gnatrol®, Deliver®, Javelin® WG	4	G,N,L
12B	Organotin Miticides	Mites*	Fenbutatin-oxide	ProMITE® 50 WP	48	G,N,L
13	Pyrroles	Mites*, Thrips, Fungus gnats, Foliar nematodes, Caterpillars	Chlorfenapyr	Pylon® Insecticide, Pylon® TR Insecticide	12 4- 12	G G,N
15	Benzoylureas	Fungus gnats	Diflubenzuron	Adept®	12	G
		Fungus gnats	Diflubenzuron	Dimilin® SC	12	G,N
		Aphids, Mites, Thrips	Novaluron	Pedestal®	12	G,N
16	Buprofezin	Mealybugs*, Whiteflies*	Buprofezin	Talus®	12	G,N,L
17	Cyromazine	Fungus gnats, Leafminers	Cyromazine	Citation®	12	G,N,L
18		Caterpillars	Tebufenozide	Confirm®	4	N
			Methoxyfenozide	Intrepid®	4	G,N
20A	Hydramethylnon	Imported fire ants	Hydramethylnon	Amdro Pro® fire ant bait insecticide	12	N,L
20B	Acequinocyl	Mites	Acequinocyl	Shuttle® O	12	G,N,L
21A	Pyridazinones	Mites, Whiteflies* (general and Q-type)	Pyridaben	Sanmite®	12	G,N
			Fenazaquin	Magus®	12	G,N
	METI Acaricides and Insecticides	Spider mites	Fenpyroximate	Akari®	12	G
22A	Oxadizines	Caterpillars, European crane fly, Ants including fire ants	Indoxacarb	Advion®	N/A	L
22B	Semicarbazones	Fire ants	Metaflumizone	Siesta® fire ant bait insecticide	12	N,L
23	Tetronic and Tetramic Acid Derivatives	Spider Mites*, Whiteflies*	Spiromesifen	Judo®, Forbid®, Savate™	12	G,N
		Aphids, Leafhoppers, Mealybugs, Psyllids, Whiteflies, Mites	Spirotetramat	Kontos®	24	G,N

G = Greenhouse, N= Nursery, L=Landscape

* Some, but not all, species of selected pests within the group are controlled. Read the product specimen label for additional information. Consult your local university/extension specialist if needed.

1 Some products within the same chemical group may not control all pests listed, or there may be some products within the group that offer superior performance.

2 Specific use sites may vary by formulation and manufacturer; therefore, always read and consult product label directions.

IRAC Group	Chemical Sub Group(s)	Primary Target Insect(s)	Active Ingredient(s)	Insecticide Trade Name(s)	REI	Use Site(s)
25	Beta-ketonitrile Derivatives	Spider mites	Cyflumetofen	Sultan® miticide	12	G,N,L
28	Diamides	Aphids, Whiteflies, Thrips	Cyanotraniliprole	Mainspring® Mainspring® GNL	4	G,N,L
NC	Oils	Mites, Mealybugs, Aphids, Thrips	Clarified hydrophobic extract of neem oil	Triact 70®	4	G,N,L
			Petroleum oil	Ultra-Pure Oil® , PureSpray®, Green Organic Horticultural Spray Oil	4	G,N,L
	Soaps	Mites*, Mealybugs*, Whiteflies*	Potassium salts of fatty acids	M-Pede®	12	G,N,L
	Inorganics	Slugs, Snails	Iron phosphate	Sluggo®	0	L
	Aldehydes	Slugs, Snails	Metaldehyde	Durham®, Trail's End®, Slug-It®	12	L
	Biological Agents	Nematodes*	<i>Myrothecium verrucaria</i>	DiTera®	4	N,L
		Fungus gnat	<i>Steinernema feltiae</i>	Nemasys® beneficial nematodes	0	G,I,N
		Grubs	<i>Heterorhabditis bacteriophora</i>	Nemasys G® beneficial nematodes	0	G,N
		Black vine weevil	<i>Steinernema kraussei</i>	Nemasys L® beneficial nematodes	0	G,N
		Weevils*, Borers*, Shore flies	<i>Steinernema carpocapsae</i>	Millenium® beneficial nematodes	0	G,N,L
		Weevils*	<i>Steinernema carpocapsae</i>	Nematac® C beneficial nematodes	0	G,N,L
		Aphids, Q-type Whitefly, Thrips	<i>Beauveria bassiana</i>	Naturalis® L, BotaniGard®	4	G,N,L
UN	Pyridalyl	Thrips, Caterpillars	Pyridalyl	Overture®	12	G
	Dicofol	Mites*	Dicofol	Dicofol 4-E	12-48	G,N,L
	Pyridine Azomethines	Whiteflies, Aphids, Mealybugs	Pyrafluquinazon	Rycar®	12	G
	Carbazates	Spider mites	Bifenazate	Floramite®	4	G,N,L
	Biopesticide Insect Growth Regulator	Aphids, Thrips, Whiteflies	Azadirachtin	Azatin O®	4	G,N
	Diacylhydrazines	Aphids, Thrips*, Whiteflies*	Azadirachtin	Azatin XL®, Ornazin®	4-12	G,N,L
				Captiva®	4	G,N
6+UN		Mites, Leaf Miners	Bifenazate + Abamectin	Sirocco™	12	G,N,L

G = Greenhouse, N= Nursery, L=Landscape

Insecticide Resistance Action Committee (IRAC) Mode of Action Classification List:

- 1 Acetylcholine esterase inhibitor
- 2 GABA-gated chloride channel antagonists
- 3 Sodium channel modulators
- 4 Nicotinic Acetylcholine receptor agonists/antagonists
- 5 Nicotinic Acetylcholine receptor agonists (allosteric) (not group 4)
- 6 Chloride channel activators
- 7 Juvenile hormone mimics
- 9 Compounds of unknown or non-specific mode of action (selective feeding blockers)
- 10 Compounds of unknown or non-specific mode of action (mite growth inhibitors)
- 11 Microbial disruptors of insect midgut membranes (includes transgenic crops expressing B.t. toxins)
- 12 Inhibitors of oxidative phosphorylation, disruptors of ATP formation (inhibitors of ATP synthase)
- 13 Uncouplers of oxidative phosphorylation via disruption of proton gradient
- 15 Inhibitors of chitin biosynthesis, type 0, Lepidopteran
- 16 Inhibitors of chitin biosynthesis, type 1, Homopteran
- 17 Moulting disruptor, Dipteran
- 18 Ecdysone agonists / moulting disruptors
- 20 Mitochondrial complex III electron transport inhibitors (Coupling site II)
- 21 Mitochondrial complex I electron transport inhibitors
- 22 Voltage-dependent sodium channel blocker
- 23 Inhibitors of lipid synthesis
- 25 Neuronal inhibitors (unknown mode of action)
- 28 Ryanodine receptor modulator
- NC Not classified by IRAC

The above 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.info.

Herbicide Resistance Management Guide – Preemergent Herbicides

WSSA Group	Chemical Group(s)	Primary Target Weed(s)	Active Ingredient(s)	Herbicide Trade Name(s)	REI	Use Site(s)
3	Dinitroaniline	Selected annual and broadleaf weeds	Pendimethalin	Pendulum® 2G herbicide, Pendulum Aquacap herbicide, Pendulum 3.3 EC herbicide, Pre-M®, ProPendi®, Corral® 2.68G	24	N,L
			Prodiamine	Barricade®, Regalkade®, Stonewall®	12	N,L
			Oryzalin	Surflan®, Weed Impede®	12	N,L
			Trifluralin	Treflan®	12	N,L
			Benefin + Oryzalin	XL 2G®	24	N,L
	Pyridine		Dithlopyr	Dimension®, Lifeguard®	12	N,L
14	N-Phenylphthalimide	Selected annual grasses and broadleaf weeds	Flumioxazin	BroadStar® SureGuard®	12 12	N N,L
	Diphenylether + Oxadiazole	Selected annual grasses and broadleaf weeds	Oxyfluorfen + Oxadiazon	Regal 00®	24	N,L
	Oxadiazole	Selected annual grasses and broadleaf weeds	Oxadiazon	Ronstar®	12	N,L
15	Amide	Selected annual and broadleaf weeds	Napropamide	Devrinol®, Strawberry & Fruit Tree Weeder®	12	N,L
	Chloroacetamide	Yellow nutsedge and selected annual and broadleaf weeds	S-metolachlor	Pennant Magnum®	24	N,L
		Selected annual grasses, broadleaf weeds and annual sedges	Dimethenamid-P	Tower® herbicide	12	N,L
20	Nitrile	Selected annual and perennial weeds	Dichlobenil	Casoron®, Barrier®	12	N,L
21	Benzamide	Selected broadleaf weeds	Isoxaben	Gallery®	12	N,L
29	Alkylazine	Grasses, Annual sedge, Annual broadleaf weeds	Indaziflam	Marengo®, Marengo® G	12	G,N,L
3 + 14	Dinitroaniline + Oxadiazole	Selected annual grasses and broadleaf weeds	Pendimethalin + Oxadiazon	Jewel®	12	N,L
3 + 15	Dinitroaniline + Chloroacetamide	Selected annual grasses, broadleaf weeds and annual sedges	Pendimethalin + Dimethenamid-P	FreeHand® 1.75G herbicide	12	N,L
21 + 3	Benzamide + Dinitroaniline	Selected annual and broadleaf weeds	Isoxaben + Trifluralin	Snapshot TG®, Gallery® Woodace Preen Plus®	12	N,L
			Isoxaben + Prodiamine	Gemini®	12	N,L
14 + 3	Diphenylether + Dinitroaniline Oxadiazole + Dinitroaniline	Selected annual and broadleaf weeds	Oxyfluorfen + pendimethalin	OH2®	24	N
			Oxyfluorfen + oryzalin	Rout®	24	N,L
			Oxyfluorfen + oryzalin	RegalStar®	12	N
			Oxyfluorfen + prodiamine	Biathalon®	24	N,L
21 + 14 + 3	Benzamide + Oxadiazole + Dinitroaniline	Selected annual and broadleaf weeds	Isoxaben + Oxyfluorfen + Trifluralin	Showcase®	24	N

G = Greenhouse, N= Nursery, L=Landscape

Herbicide Resistance Management Guide – Postemergent Herbicides

WSSA Group	Chemical Group(s)	Primary Target Weed(s)	Active Ingredient(s)	Herbicide Trade Name(s)	REI	Use Site(s)
1	Aryloxyphenoxy Propionate	Annual and perennial grasses	Fluazifop-P	Fusilade®, Ornamec®	12	N,L
			Fenoxaprop-P	Acclaim® Extra	12	N,L
	Cyclohexanedione		Sethoxydim	Segment® herbicide	12	N,L
			Clethodim	Envoy®	12	G,N,L
2	Imidazolinone	Sedges and selected broadleaf weeds	Imazaquin	Image®	12	L
	Sulfonylurea	Annual and perennial sedges	Halosulfuron-methyl	Sedge Hammer®	12	L
4	Pyridine carboxylic acid	Broadleaf weeds, including Canada thistle, Legumes, Aster and Nightshade family	Clopyralid	Lontrel®	12	N,L
	Benzoic Acid	Broadleaf weeds	Dicamba	Various	24	L
	Phenoxy-alkanoic acid	Broadleaf weeds	Mecoprop	Chem-Weed®	NOL	L
5	Triazine	Annual grassy and broadleaf weeds	Simazine	Princep®	12	N,L
6	Benzothiadiazinone	Yellow nutsedge, annual sedges and selected broadleaf weeds	Bentazon	Basagran® T&O herbicide, Nutgrass Nihilator®	48	N,L
9	Glycine	Annual and perennial weeds	Glyphosate	Gly-Flo®, GlyphoMate®, Gly Star® Pro, Prosecutor®, Roundup® Pro, Touchdown® Pro, Trail Blazer®	4	G,N,L
10	Phosphinic Acid	Annual and perennial weeds	Glufosinate-ammonium	Finale®	12	N,L
14	Aryl-triazinone	Selected annual and perennial broadleaf weeds	Carfentrazone-ethyl	Quicksilver®	NOL	L
			Sulfentrazone	Dismiss®	12	N,L
	Dicarboxamide		Flumioxazin	SureGuard®	12	G,N,L
NC	Organoarsenical	Annual and perennial weeds	Cacodylic acid	EcoExempt®, Montar®, Weed Ender®	12	L
20	Nitrile	Selected annual and perennial weeds	Dichlobenil	Casoron®, Barrier®	12	N,L
22	Bipyridylium	Annual and perennial weeds	Diquat	Reward®, AquaTrim®	24	G,N,L
26	Pyrazolium	Annual and perennial weeds	Pelargonic acid	Scythe®	24	G,N,L
9 + 22	Glycine + Bipyridylium	Annual and perennial weeds	Glyphosate + Diquat	QuickPro®	NOL	L

G = Greenhouse, N= Nursery, L=Landscape

WSSA Group	Chemical Group(s)	Primary Target Weed(s)	Active Ingredient(s)	Herbicide Trade Name(s)	REI	Use Site(s)
NC	Soaps, Fatty Acids	Selected annual and perennial weeds	Ammoniated soaps of fatty acids	Quik-Fire®	24	G,N,L
	Organoarsenical	Annual and perennial weeds	Cacodylic acid	EcoExempt®, Montar®, Weed Ender®	12	L
					12	L

G = Greenhouse, N= Nursery, L=Landscape

1 Some products within the same chemical group may not control all weeds listed, or there may be some products within the group that offer superior performance. Consult your local university/extension specialist if needed.

2 Specific use sites may vary by formulation and manufacturer; therefore, always read and consult product label directions.

WSSA Classification List:

- 1 Inhibition of acetyl CoA carboxylase (ACCase)
- 2 Inhibition of acetolactate synthase ALS (acetohydroxyacid synthase AHAS)
- 3 Microtubule assembly inhibition
- 4 Synthetic auxin
- 5 Inhibition of photosynthesis at photosystem II site A
- 6 Inhibition of photosynthesis at photosystem II site B
- 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 mitosis (inhibition of very long chain fatty acids [VLCFAs])
- 20 Inhibition of cell wall synthesis site A
- 21 Inhibition of cell wall synthesis site B
- 22 Photosystem I electron
- 26 Unknown
- NC Not classified

The above list was developed by the Weed Science Society of America (WSSA). WSSA is a non-profit professional society made up of scientists from academia and private industry that promote research, education and outreach. More information on the Weed Science Society of America is available from www.wssa.net.

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