

Chemical Class Chart

June 2016
Volume XVIII

Greenhouse and Nursery Production

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

ohp.com

Technical Service
800-356-4647



REFERENCE GUIDE for GREENHOUSE and NURSERY PRODUCTION INSECTICIDES / MITICIDES

RESISTANCE MANAGEMENT

Pest populations that are over-exposed to a single pesticide may develop resistance to that pesticide. Resistance is due to the innate ability of some individuals in the pest population to survive even after being treated with a pesticide. When using pesticides repeatedly for crop protection, it is important to manage pesticide resistance by rotating chemicals with different modes of action (MOA) on the target pest or combining chemicals with different modes of action in the tank/spray mix.

When labels permit, make two (2) applications of a product or tank mix in sequence, then rotate to products with different modes of action to improve coverage on target life stages of the pest. Try to avoid applying pesticides with the same mode of action to more than one generation of the pest per cycle.

Good resistance management starts with accurate identification of the pest problem and good record-keeping of all pesticide applications.

Time pesticide applications to coincide with the susceptible life stage of the pest based on their life cycle.

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 insect and mite eggs and nymphs.

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

(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 |
| | | Malathion | Gowan Malathion 8F | 12 | N | Gowan Company |
| | | Phosmet | Imidan® 70W | 24 | N | Gowan Company |
| 2B | Phenylpyrazoles | Fipronil | TopChoice™ | 24 | N | Bayer Environmental Science |
| 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 | Nufarm |
| | | 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. |
| | Botanicals | Pyrethrins | Pyrethrum® TR | 12 | GH | BASF |

* Depends on Greenhouse ventilation

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

*** Greenhouse roses only

Insecticides / Miticides

continued

(by Mode of Action Group and Class)

| MOA Group* | Class | Common Name | Trade Name | REI | Use Site(s)** | Company |
|------------|--|--|------------------------|-------|---------------|---------------------------|
| 4A | Neonicotinoids | Acetamiprid | TriStar® | 12 | GH/N | Nufarm |
| | | Dinotefuran | Safari® | 12 | GH/N | Nufarm |
| | | Imidacloprid | Marathon® | 0-12 | GH/N | OHP, Inc. |
| | | | Discus® Tablets | 12 | GH/N | OHP, Inc. |
| | Thiamethoxam | Flagship® | 12 | GH/N | Syngenta | |
| 5 | Spinosyns | Spinosad | Conserve® | 4 | GH/N | Dow |
| | | | Entrust® | 4 | GH/N | Dow |
| 6 | Glycosides | Abamectin | Avid® | 12 | GH/N | Syngenta |
| | Avermectin | Emamectin benzoate | Enfold™ | 12 | N | Syngenta |
| | | Milbemectin | Ultiflora® | 12 | N | Gowan Company |
| 7A | Juvenile hormone mimics | s-Kinoprene | Enstar® AQ | 12 | GH | Wellmark International |
| 7B | Juvenile hormone mimics | Fenoxycarb | Award® | 12 | N | Syngenta |
| 7C | Pyridine - Insect Growth Regulators | Pyriproxyfen | Distance® | 12 | GH/N | Nufarm |
| | | | Fulcrum® | 12 | GH/N | OHP, Inc. |
| 9A | Pyridine azomethines | Pymetrozine | Endeavor® | 12 | GH/N | Syngenta |
| 9B | Pyridine azomethines | Pyrifluquinazon | Rycar® | 12 | GH | SePRO Corp. |
| 10A | Tetrazines | Clofentezine | Ovation® | 12 | GH/N | ICL Specialty Fertilizers |
| | Thiazolidinones | Hexythiazox | Hexygon® DF | 12 | GH/N | Gowan Company |
| 10B | 2, 4 - Diphenyloxzoline Derivatives | Etoxazole | TetraSan® | 12 | GH/N | Nufarm |
| | | | Beethoven™ TR | 4-24* | GH | BASF |
| 11 | Biopesticides | <i>Bacillus thuringiensis</i> Kurstaki | DiPel® Pro DF | 4 | GH/N | Nufarm |
| | | | Deliver® | 4 | GH/N | Certis USA, LLC |
| | | | Javelin® WG | 4 | GH/N | Certis USA, LLC |
| | | <i>Bacillus thuringiensis</i> Israelensis | Gnatrol® | 4 | GH/N | Nufarm |
| 12B | Organotin miticides | Fenbutatin-oxide | ProMITE™ | 48 | GH/N | SePRO Corp. |
| 13 | Pyrroles | Chlorfenapyr | Pylon® | 12 | GH | BASF |
| 15 | Benzoylureas - Insect Growth Regulators | Diflubenzuron | Adept® | 12 | GH | OHP, Inc. |
| | | | Dimilin® SC | 12 | GH/N** | OHP, Inc. |
| | | Novaluron | Pedestal™ | 12 | GH/N | OHP, Inc. |
| 16 | Buprofezin | Buprofezin | Talus® | 12 | GH/N | SePRO Corp. |
| 17 | Cyromazine - Insect Growth Regulators | Cyromazine | Citation® | 12 | GH/N | Syngenta |

* 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 | |
|------------|---------------------------------------|---|---|-----------------------|---------------|------------------|---------------------|
| 18 | Diacylhydrazines | Tebufenozide | Confirm® | 4 | N | Gowan Company | |
| | | Methoxyfenozide | Intrepid® | 4 | GH/N | Dow | |
| 20A | Trifluoromethyl Aminohydrazone | Hydramethylnon | Amdro® Pro | 12 | N | BASF | |
| 20B | Napthoquinone Derivatives | Acequinocyl | Shuttle® O | 12 | GH/N | OHP, Inc. | |
| 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 | |
| 22B | Semicarbazone | Metaflumizone | Siesta™ | 12 | GH/N | BASF | |
| 23 | Tetronic acids | Spiromesifen | Judo® | 12 | GH/N | OHP, Inc. | |
| | Tetramic acids | Spirotetramat | Kontos® | 0-24 | GH/N | OHP, Inc. | |
| 25A | Beta-ketonitrile | Cyflumetofen | Sultan™ | 12 | GH/N | BASF | |
| 28 | Anthranillic diamide | Cyantraniliprole | Mainspring® | 4 | GH/N | Syngenta | |
| 29 | Pyridine carboxamides | Flonicamid | Aria® | 12 | GH/N | FMC Corp. | |
| UN | Carbazates | Bifenazate | Floramite® | 12 | GH | OHP, Inc. | |
| | Biopesticide Insect Growth Regulators | Azadirachtin | Azatin® O | 4 | GH/N | OHP, Inc. | |
| | Pyridalyl | Pyridalyl | Overture® | 12 | GH | Nufarm | |
| M | Biopesticides | <i>Beauveria bassiana</i> | BotaniGard® | 4 | GH/N | BioWorks, Inc. | |
| | | | Captiva® | 4 | GH/N | Gowan Company | |
| | | | Mycotrol® O | 4 | GH/N | BioWorks, Inc. | |
| | | <i>Isaria fumosorosea</i> Apopka Strain 97(ATCC20874) | Preferal™ | 4 | GH/N | SePro Corp. | |
| | | <i>Steinernema feltiae</i> | Nemasys® | 0 | GH | BASF | |
| | | <i>Steinernema carpocaspae</i> | Millenium® | 0 | GH | BASF | |
| | | Oils | Clarified hydrophobic extract of neem oil | Triact® 70 | 4 | GH/N | OHP, Inc. |
| | | | Mineral oil | Ultra-Pure™ Oil | 4 | GH/N | BASF |
| | | | Petroleum | Suffoil-X™ | 4 | GH/N | BioWorks, Inc. |
| | | Soaps | Potassium salts of fatty acids | AllPro® | 12 | GH/N | Value Garden Supply |
| | | | | Insecticidal Soap 40% | | | |
| | | 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 | Chlorpyrifos + Cyfluthrin | DuraPlex® TR | 24 | GH | BASF |

* Depends on Greenhouse ventilation

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

(by Mode of Action Group and Class)

| MOA Group* | Class | Common Name | Trade Name | REI | Use Site(s)** | Company |
|------------|----------------------------|---------------------------|--------------------|-----|---------------|------------------|
| 3+4A | Pyrethroid + Neonicotinoid | Cyfluthrin + Imidacloprid | Discus® N/G | 12 | GH/N | OHP, Inc. |
| 6+UN | Glycoside+Carbazate | Abamectin+Bifenazate | Sirocco® | 12 | GH/N | OHP, Inc. |

*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
22. Sodium channel blocker: Nerve action
23. Inhibitors of acetyl CoA carboxylase
25. Mitochondrial complex II electron transport inhibitors
28. Ryanodine receptor modulators: Nerve and muscle action
29. Chordotonal organ Modulators – undefined target site: Nerve action
- UN 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.irac-online.org.

REFERENCE GUIDE for GREENHOUSE and NURSERY PRODUCTION FUNGICIDES

RESISTANCE MANAGEMENT

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 | Nufarm |
| | | | AllBan® | 12 | GH/N | ICL Specialty Fertilizers |
| MBC-fungicides (Methyl Benzimidazole Carbamates) 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. |
| Dicarboximides Resistance risk Medium to High | | | | | | |
| 3 | Imidazoles | Triflumizole | Terraguard® | 12 | GH/N | OHP, Inc. |
| | | Pyrimidines | Fenarimol | Rubigan® | 12 | N |
| | Triazoles (includes conazole) | Propiconazole | Banner® MAXX® II | 12 | N | Syngenta |
| | | Myclobutanil | Eagle® 20 EW | 24 | GH/N | Dow |
| | | Triticonazole | Trinity® | 12 | GH/N | BASF |
| | | | Trinity® TR | 4-12 | GH | BASF |
| DMI-fungicides (DeMethylation Inhibitors) Resistance risk Medium | | | | | | |
| 4 | Acylamines | Metalaxyl-M (=Mefenoxam) | Subdue® MAXX® | 0-48 | GH/N | Syngenta |
| PA-fungicides (PhenyAmides) 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 |
| SDHI (Succinate dehydrogenase inhibitors) Resistance risk Medium to High | | | | | | |

* 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 |
|---|--|---|------------------------------|----------|---------------|---|
| 11 | Oximino-acetates | Trifloxystrobin | Compass® O | 12 | GH/N | OHP, Inc. |
| | Methoxy-acrylates | Azoxystrobin | Heritage® | 4 | GH/N | Syngenta |
| | Methoxy-carbamates | Pyraclostrobin | Empress™ Intrinsic | 12 | GH/N | BASF |
| | Imidazolinones | Fenamidone | FenStop® | 12 | GH | OHP, Inc. |
| QoI-fungicides (Quinone outside inhibitors) Resistance risk High | | | | | | |
| 12 | Phenylpyrroles | Fludioxonil | Medallion® | 12 | GH/N | Syngenta |
| PP-fungicides (PhenylPyrroles) Resistance risk Low to Medium | | | | | | |
| 14 | Aromatic Hydrocarbons | PCNB | Terraclor® | 12 | GH/N | OHP, Inc. |
| | Thiadiazole | Etridiazole | Terrazole® Truban® | 12 12 | GH/N GH/N | OHP, Inc. ICL Specialty Fertilizers |
| AH fungicides (Aromatic Hydrocarbons) Resistance risk Low to Medium | | | | | | |
| 17 | Hydroxyanilides | Fenhexamid | Decree® | 12 | GH/N | SePRO Corp. |
| (SBI: Class III) Resistance risk Low to Medium | | | | | | |
| 19 | Polyoxins | Polyoxin-D | Affirm™ | 4 | GH/N | Nufarm |
| Polyoxins Resistance risk Low to Medium | | | | | | |
| 21 | Cyano-imidazole | Cyazofamid | Segway® O | 12 | GH/N | OHP, Inc. |
| Qil-fungicide (Quinone inside inhibitor) Resistance risk Medium to High | | | | | | |
| 28 | Carbamates | 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. |
| | Phosphite | Phosphorous acid | Alude™ | 4 | GH/N | Nufarm |
| Phosphonates Resistance risk Low | | | | | | |
| 40 | Cinnamic Acid Amides | Dimethomorph | Stature® SC | 12 | GH/N | BASF |
| | Mandelic Acid Amides | Mandipropamid | Micora™ | 4 | GH/N | Syngenta |
| CAA-fungicides (Carboxylic Acid Amides) Resistance risk Low to Medium | | | | | | |
| 43 | Pyridinylmethyl-benzamides | Fluopicolide | Adorn® | 12 | GH/N | Nufarm |
| Benzamides Resistance risk Unknown | | | | | | |
| 44 | <i>Bacillus</i> sp. and the fungicidal lipopeptides produced | <i>Bacillus amyloliquefaciens</i> strain D747 | Triathlon® BA | 4 | GH/N | OHP, Inc. |
| Microbial (<i>Bacillus</i> sp.) Resistance risk Unknown | | | | | | |

* 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 | |
|---|-----------------------------------|--|---|-------------------|---------------|--|------------------|
| M1 | Inorganic | Copper sulfate | Camelot® | 12 | GH/N | SePRO Corp. | |
| | | | Phyton® 27 | 24 | GH/N | Phyton Corp. | |
| | | Copper hydroxide | CuPro™ 2005 T/N/O | 24 | GH/N | SePRO Corp. | |
| | | | Copper sulfate | Cuproxat® | 24 | GH/N | Nufarm |
| | | | Cuprous Oxide | Nordox 75WG | 12 | GH/N | Nordox AS |
| Inorganic Resistance risk Low to Medium | | | | | | | |
| M3 | Dithiocarbamates and relatives | Mancozeb | Dithane® | 24 | GH/N | Dow | |
| | | | Fore® | 24 | GH/N | Dow | |
| | | | Junction™ | 24 | GH/N | SePRO Corp. | |
| | | | Pentathlon™ | 24 | GH/N | SePRO Corp. | |
| | | Manganese + zinc | Protect™ DF | 24 | GH/N | Nufarm | |
| Dithiocarbamates and relatives Resistance risk Low to Medium | | | | | | | |
| M5 | Chloronitriles (phthalonitriles) | Chlorothalonil | Daconil® Ultrex® | 12 | GH/N | Syngenta | |
| | | | AllPro® Exotherm Termil | * | GH | Value Garden Supply * Depends on greenhouse ventilation | |
| Chloronitriles (phthalonitriles) Resistance risk Low to Medium | | | | | | | |
| U15 | Piperidinyl-thiazole-isoxazolines | Oxathiapiprolin | Segovis® | 4 | GH/N | Syngenta | |
| Piperidinyl-thiazole-isoxazolines 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. | |
| | | | RootShield® Plus | 0 | GH/N | BioWorks, Inc. | |
| | | <i>Trichoderma harzianum</i> T22 + <i>Trichoderma virens</i> G41 | SoilGard® | 4 | GH/N | OHP, Inc. | |
| | | <i>Gliocladium virens</i> GL21 | | 4 | GH/N | Growth Products | |
| | | <i>Bacillus subtilis</i> GB03 | | 4 | GH/N | BASF | |
| | | <i>Bacillus subtilis</i> MBI600 | Subtilex® NG | 4 | GH | BioWorks, Inc. | |
| | | <i>Bacillus subtilis</i> QST713 | Cease® | 4 | GH/N | Novozymes | |
| | | <i>Streptomyces lydicus</i> WYEC108 | Actinovate® SP | 4 | GH/N | BioAg, Inc. | |
| | | Bicarbonate | Potassium bicarbonate | Carb-O-Nator™ | 4 | GH/N | Certis USA, LLC |
| | MilStop® | | | 1 | GH/N | BioWorks, Inc. | |
| | ZeroTol® | | | 0 | GH/N | Biosafe Systems | |
| | Hydrogen Dioxide/Peroxide | Oils | Clarified hydrophobic extract of neem oil (also classified by EPA as a biopesticide) | Xeroton X3™ | 0 to 2 | GH/N | Phyton Corp. |
| | | | | Triact® 70 | 4 | GH/N | OHP, Inc. |
| | Quaternary Ammonium | Potassium salts of fatty acids | Petroleum oil | Suffoil-X™ | 4 | GH/N | BioWorks, Inc. |
| Quaternary Amines | | | | Greenshield® | 0 | GH | BASF |
| Didecyl dimethyl ammonium chloride | | | | KleenGrow™ | 0 | GH | BASF |
| Soaps | Potassium salts of fatty acids | M-Pede® | 12 | GH/N | Gowan Company | | |

* Depends on Greenhouse ventilation

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

MOA Combination Products

| MOA Code* & Group | Classes | Common Name | Trade Name | REI | Use Site(s)** | Company |
|----------------------|--|-------------------------------------|----------------------------|-----|---------------|---------------------------|
| 1+2 | Thiophanate + Dicarboxamide | Thiophanate-methyl + Iprodione | 26/36™ | 12 | GH/N | Nufarm |
| 1+14 | Thiophanate + Thiadiazole | Thiophanate-methyl + Etridiazole | Banrot® | 12 | GH/N | ICL Specialty Fertilizers |
| 1+M3 | Thiophanate + Dithiocarbamate | Thiophanate-methyl + Mancozeb | Zyban® | 24 | GH/N | ICL Specialty Fertilizers |
| 1+M5 | Thiophanate + Chloronitrile | Thiophanate-methyl + Chlorothalonil | Spectro® 90 | 12 | GH/N | Nufarm |
| 3+11 | Demethylation Inhibitors (DMI fungicides) + Strobilurins | Triadimefon + Trifloxystrobin | Strike® Plus 50 WDG | 12 | GH/N | OHP, Inc. |
| 3+M5 | Demethylation inhibitor + Chloronitrile | Propiconazole + Chlorothalonil | Concert® II | 12 | N | Syngenta |
| 7+11 | Pyridine Carboxamide + Strobilurin | Boscalid + Pyraclostrobin | Pageant® Intrinsic™ | 12 | GH/N | BASF |
| | Pyridine Carboxamide + Strobilurin | BenZovindiflupyr + Azoxystrobin | Mural™ | 12 | GH/N | Syngenta |
| 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 |

* Depends on Greenhouse ventilation

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

*Fungicides Modes of Action

- | | |
|--|---|
| 1. Inhibition of tubulin formation in mitosis | 21. Quinone inside inhibitors (Qil) |
| 2. Affect cell division, DNA and RNA synthesis and metabolism | 28. Affect cell membrane permeability, fatty acids (proposed) |
| 3. DMI (DeMethylation Inhibitors) Demethylase in sterol biosynthesis | 33. Unknown mode of action. Phosphonates. The mode of action cannot be placed within any other grouping |
| 4. Phenylamides-Affect RNA synthesis | 40. Cell wall biosynthesis: cellulose synthase |
| 5. Inhibition of isomerase in sterol biosynthesis | 43. Delocalization of spectrin-like proteins |
| 7. Affect mitochondrial transport chain | 44. Microbial disrupters of pathogen cell membranes (Biologicals) |
| 9. Methionine biosynthesis (proposed) | 45. Respiration Complex III: cytochrome bc1 (ubiquinone reductase) at Qo 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 Unknown |
| 14. Lipid peroxidation (proposed) | |
| 17. 3-keto reductase during C4 demethylation | |
| 19. Chitin synthase inhibition in cell wall development | |

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.

Explanation of Resistance Risk

Resistance risk categories were developed by FRAC. There are ways 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 (PGRs)

(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. |
| | Quaternary Ammonium | Medium | Chlormequat chloride | Cycocel® | 12 | GH/N | OHP, Inc. |
| | | | Daminozide | B-Nine® | 24 | GH/N | OHP, Inc. |
| | | | Pacllobutrazol | Paczol® | 12 | GH/N | OHP, Inc. |
| Triazole | High | Bonzi® | | 12 | GH/N | Syngenta | |
| | | Uniconazole-p | Sumagic® | 12 | GH | Nufarm | |
| 2 | Cyclohexaketone | Medium | Dikegulac sodium | Augeo® | 4 | 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 | Nufarm |
| | Synthetic Cytokinin/ Gibberellin | High | Cytokinin/ Gibberellic acid | Fascination® | 4 | GH | Nufarm |
| | Synthetic Cytokinin | High | N-(phenylmethly)- IH-purine-6-amine | Configure® | 12 | GH | Fine Agrochemicals, LTD. |
| 5 | Organophosphorus | 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. |

** 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.

Thank you 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

RESISTANCE MANAGEMENT

Herbicide rotation is just as important as the rotation of other pest control products. Herbicide mode of action (MOA) groups are listed by the Herbicide Resistance Action Committee (HRAC). Rotating MOAs on a regular basis is key to controlling weeds and maintaining the effectiveness of herbicides.

Please read and follow all label directions and precautions.

**Use Site(s) Key:

PO = post emergence
A = Annual Grasses
S = Sedges

PR = pre emergence
BW = Broadleaf Weeds
WO = Certain Woody
Ornamentals

SF = Soil fumigant
P = Perennials

GH = registered for use in greenhouses
MA = Most annuals

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 | Nufarm |
| | | 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 |
| | Benzamide | Pronamide | Kerb® | 24 | PR/PO; A, BW | Dow |
| | Dinitroaniline | Pendimethalin | Pendulum® | 24 | PR; A, BW | BASF |
| | | | Corral® | 24 | PR; A, BW | ICL Specialty Fertilizers |
| | | Prodiamine | Barricade® | 12 | PR; A, BW | Syngenta |
| | 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 |
| 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 |
| | Oxadiazole | Oxadiazon | Ronstar® | 12 | PR; A, BW | Bayer Environmental Science |
| | N-phenylphthalimides | Flumioxazin | BroadStar® | 12 | PR; A, BW | Nufarm |
| | | | SureGuard® | 12 | PR; PO, A, BW | Nufarm |
| 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 |
| 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 | Marengo® | 12 | PR; A, GH, BW | OHP, Inc. |
| | | | Marengo® G | 12 | PR; A, BW | OHP, Inc. |
| 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 | ICL Speciality Fertilizers |
| 3+14 | Diphenylether + Dinitroaniline | Oxyfluorfen + Prodiamine | Biathlon® | 24 | PR; A, BW | OHP, Inc. |

(by Mode of Action Group and Class)

| MOA Group* | Class | 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 | ICL Speciality Fertilizers |
| 3+15 | Chloroacetamide + Dinitroaniline | Dimethenamid-P + Pendimethalin | Freehand® | 12 | PR; A, BW, S | BASF |
| 3+21 | Dinitroaniline + Benzamide | Prodiamine + Isoxaben | Gemini™ | 12 | PR; A, BW | ICL Speciality Fertilizers |
| 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 |
| M | Soaps | Ammonium Nonanoate | Axxe® | 24 | PO; GH | BioSafe Systems |

*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 VLCFAs (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.

