

GROWER**TALKS**

MAGAZINE • SINCE 1937

Insecticide, Miticide, & Fungicide Guide

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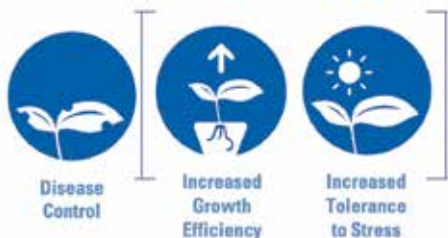
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2022

PIONEERS OF PLANT HEALTH

By Dr. Emma Lookabaugh, BASF Technical Service Representative

The Power of Intrinsic



FOR OVER A DECADE, BASF

has been an industry pioneer with our Intrinsic® brand fungicides: Pageant® Intrinsic brand fungicide, Empress® Intrinsic brand fungicide and Orkestra® Intrinsic brand fungicide. These products, powered by the active ingredient pyraclostrobin, offer superior plant protection through a combination of broad-spectrum disease control and plant health benefits in the form of increased growth efficiency and increased tolerance to stress.

Not All Strobilurins Are Created Equal

Plant health effects associated with pyraclostrobin were first observed on agronomic grain crops. Growers reported seeing increased yields and increased drought tolerance in plants that had been treated with certain fungicides. Extensive laboratory studies in Germany and the United States proved that these plant health benefits, in the form of increased growth efficiency during environmental stresses, were tied to pyraclostrobin.

In ornamentals, plant health benefits can be seen in the form of disease control, superior rooting, increased plant quality and increased tolerance to cold, heat and drought stress.

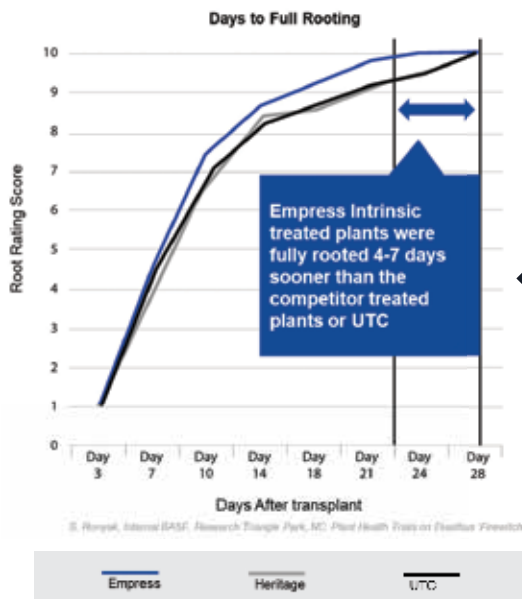
So, when you are considering a strobilurin fungicide for your program, choose one powered by Intrinsic brand fungicide. With over a decade of research behind us, the power of plant health is proven with science.



Block treated with Pageant Intrinsic

Block treated with Mural

After mowing, Dipladenias treated with Pageant Intrinsic brand fungicide (left) exhibited strong growth uniformity and overall plant vigor. An outbreak of aerial Phytophthora occurred in the neighboring block of plants treated with Mural fungicide (right) and a section of diseased plants were discarded.



Empress Intrinsic brand fungicide treated plants have superior root systems compared to Heritage and the untreated control (UTC) @ 18 days after transplant. Superior rooting allows for quicker finishing opportunities because once the plants are fully rooted they can efficiently put resources into growth and flower production.

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Always read and follow label directions.

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GreenProfit Supplement Enclosed



It's hard to believe that we're already back for the 2022 Insecticide, Miticide & Fungicide Guide, here for the seventh year in a row. The time has flown by, and we as an industry have survived and thrived in an unprecedented amount of change and challenge. We continue to sponsor this important guide for you, our growers, because it is a tangible representation of what BASF strives to be—a useful resource to help navigate pest, disease and weed pressures in an integrated, safe and sustainable way.

While challenges with labor and inputs persist and the cost of operating continues to rise, we continue to be a partner advocating for issues that impact the industry. Understanding the importance of safety, stewardship and inclusion for your non-English-speaking team members and helping to lead the integration of conventional and biological solutions are of high priority.

Earlier this year, BASF became the first chemical manufacturer to publish specimen labels in both English and Spanish. While no law requires manufacturers to provide Spanish versions of a specimen label, we identified this as a critical need for our greenhouse and nursery customers to ensure safety and ease of use for their team members. For many in the agricultural industry, Spanish is the first learned language. This, combined with the added challenge of highly technical language and information presented on specimen labels, presented an opportunity to lead the industry in inclusive stewardship.

We're also proud to bring a new innovation and a new formulation to the greenhouse and nursery market this year—**Avelyo™ fungicide** and **Finale® XL T&O herbicide**. Finale XL T&O herbicide is a new non-selective, contact herbicide with enhanced active ingredient loading that delivers fast and precise control of tough weeds at lower use rates than prior formulations.

Avelyo fungicide is a next-generation DMI with broad-spectrum disease control and exceptional plant safety. Avelyo fungicide adds a new mode of action (MOA) to our fungicide portfolio and can be tank mixed or used in rotation with any of our **Intrinsic®** brand products—Pageant® Intrinsic, Empress® Intrinsic and Orkestra® Intrinsic brand fungicides—for improved resistance management of key foliar and root diseases.

The tools included in this guide highlight our team's continued commitment to being a leading partner for the greenhouse and nursery industry, sharing educational resources and expert insights for grower confidence and crop protection needs. We hope that you find this information valuable and we wish you all success and continued growth in the 2022 season.



Liz Dunbar
Product Manager
Greenhouse & Nursery



Caren A. Schmidt, Ph.D.
Regional Sales Manager
Greenhouse & Nursery

On the cover: Cercospora leaf spot on hydrangea.

Disclaimer: These recommendations may not be appropriate for conditions in all states and may not comply with laws and regulations in every state. These recommendations were current as of July 2021. Individuals who use agricultural chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Be sure to obtain current information about usage regulations and examine a current product label before purchasing or applying any chemical. For assistance, contact your county Cooperative Extension Agent or pest control advisor. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by Ball Publishing.

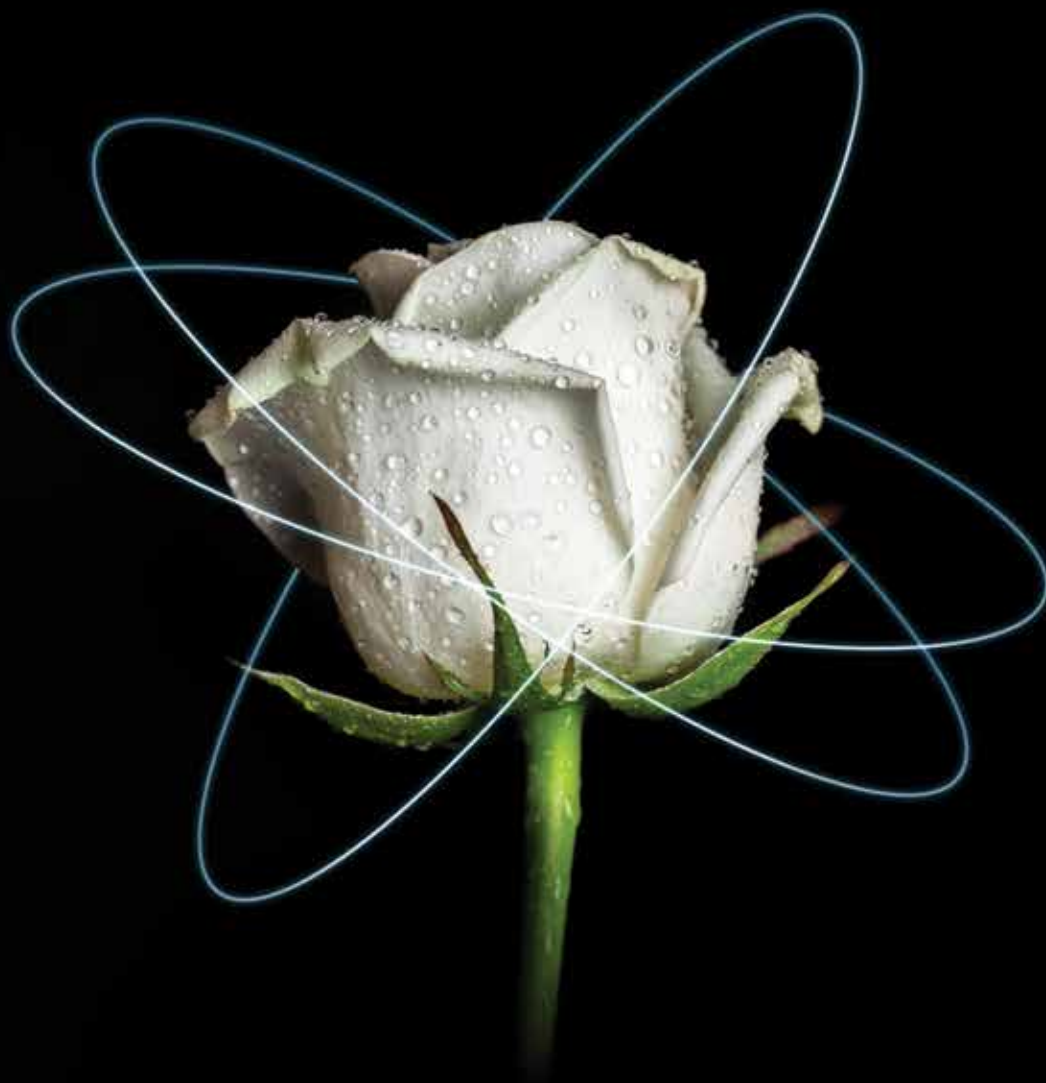



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Avelyo™
Fungicide

MAKE YOUR ROTATION REVOLVE AROUND PLANT SAFETY

Discover a brand new DMI fungicide that delivers long-lasting disease control with exceptional plant safety. Introducing Avelyo™ fungicide — designed to keep plants healthy from every angle, it's a dynamic addition to your rotation that is safe to apply at any stage in production.



 DYNAMIC ROTATION PARTNER

Always read and follow label directions.
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Say goodbye to DMIs of the past...

BASF

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INTRODUCING THE NEXT-GENERATION

The Revysol® active ingredient, mefentrifluconazole, is the industry's first ever isopropanole-azole. Powered by this next-generation DMI technology, **Avelyo fungicide** delivers broad-spectrum disease control with unsurpassed plant safety.



Avelyo fungicide @ 3 fl oz / 100 gal
2 applications, 28-day interval
More visible, white healthy roots



TM 4.5 fungicide @ 15 fl oz / 100 gal
4 applications, 14-day interval
sparse roots

Control of black root rot
2021, Kerns, NC State University



BROAD-SPECTRUM DISEASE CONTROL

Avelyo fungicide offers strong preventive protection against leaf spots, anthracnose, powdery mildew, black spot of rose, scab and stem blights.

Avelyo fungicide also provides excellent control of root and crown diseases caused by *Thielaviopsis* and *Cylindrocladium*.

SAY HELLO TO A NEW STANDARD

In replicated university trials, **Avelyo fungicide** provided excellent control of black root rot – with **control as good or better** than the industry standard thiophanate-methyl.

For root and crown diseases:
Drench Avelyo fungicide @ 2-3 fl oz / 100 gal

**PROVEN
PLANT
SAFETY.**

Unlike other DMI products currently on the market, **Avelyo fungicide** has proven plant safety at any stage in the production cycle:

- No observed plant growth regulating effects
- No injury to small plants or propagative material
- No damage to blooms
- No visible residue
- Demonstrated safety on sensitive crops like Hydrangea, Impatiens, and succulents
- Demonstrated safety in replicated trials on poinsettia bracts in color ('Prestige Red' and 'Christmas Spirit')



No Visible Residue, No Injury

'Prestige Red' in full color
and with flowers present
2020, Uber, Crop Inspection Service

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Rooting Out Black Root Rot

By Margery Daughtrey—Cornell University, Long Island Horticultural Research & Extension Center

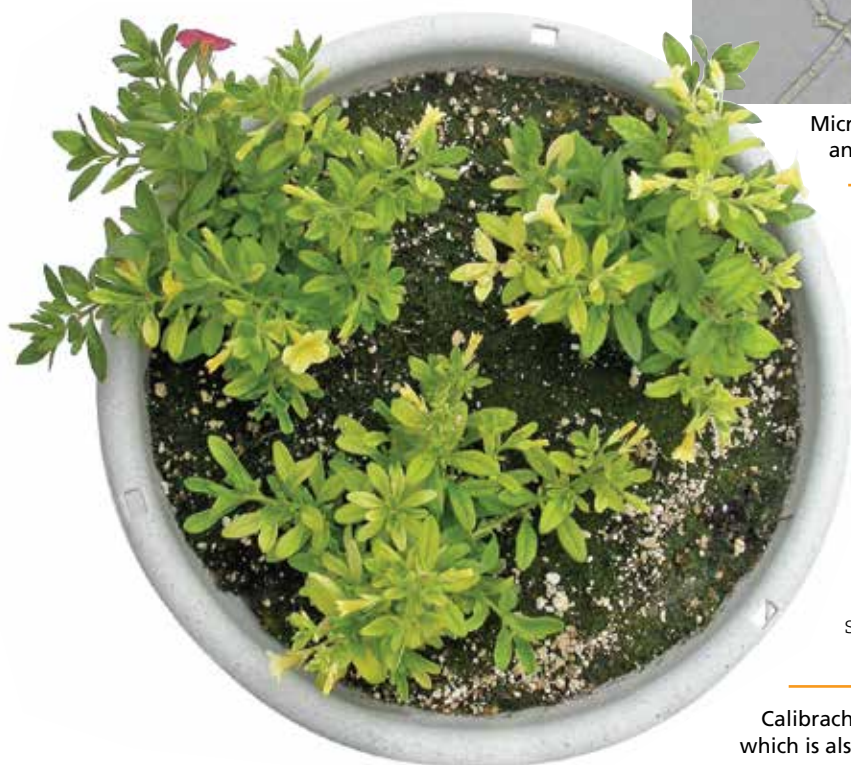
The insidious disease called black root rot is caused by a fungus, *Berkeleyomyces basicola* (*Thielaviopsis basicola* was its old, discarded name). It moves invisibly from greenhouse to greenhouse on the roots of plugs to be noticed only weeks later when plants aren't growing normally. This is the key way you'll know you have it if you observe that plants are growing in a very non-uniform fashion, so that some of them are very stunted. The real battle between the plant and the fungus, however, is going on underground. It's only by managing the root environment that you can prevent attacks of black root rot.

Sanitation is very relevant. You probably know already whether you're growing crops prone to black root rot. Of the bedding plants, pansies and violas are the most prone to infection by *B. basicola*. This may be in part because these *Viola* spp. are such a major crop and because growers are likely to re-use flats and pots from the previous year.

The biggest danger is when those pots from the previous year harbor an undiagnosed problem with black root rot. The fungus forms extremely effective resting spores (chlamydospores), and these glom onto plastic surfaces and carry



Microscopic view of *B. basicola* showing rectangular endospores and larger brown resting spores.



infection from one year to the next. Only with purposeful washing and disinfestation can you make flats and pots safe to use again after a black root rot outbreak.

Hosts. It's not just the pansies and violas that are vulnerable; close behind them in susceptibility to black root rot are vincas (from *Catharanthus roseus* to *Vinca major* to *Vinca minor*). Petunias are another important host. Large losses occur in calibrachoa crops annually. Black root rot doesn't affect every crop, but the pathogen has its favorites. It wreaks havoc in cotton and tobacco fields. Poinsettias, snapdragons, sweet peas, cyclamen and brugmansia

Calibrachos showing early indications of black root rot (foliar chlorosis, which is also associated with the high pH that's conducive to the disease).

are among its hosts, as well as many herbaceous perennial crops, such as gaillardias, lupines, phlox and penstemons. Even trees can be attacked by *B. basicola* (hollies in particular, but citrus, birch, elms and other assorted woody plants as well).

Symptoms to scout for. So how do you know your plants are suffering from black root rot? The first hint is an irregular stand, with some plants



Poinsettia roots with black root rot.



Gaillardia roots under attack by both *Rhizoctonia solani* and *Berkeleyomyces basicola*.

full size and others pint-sized even in quart containers. Also, plants will be chlorotic—yellowish or purplish or a combination of the two. When you check the roots, they'll be less than impressive. If infected from the time of transplanting, root systems will be small and blackened (or at least dark brown). Sometimes you'll see the survival spores in masses on the base of the stems. If you're unsure of your diagnosis, a laboratory can help you by locating the distinctive spores with the aid of a microscope.

Countermeasures. First, stop recycling containers without first sanitizing them, especially for black root rot-prone crops like pansy. Both a peroxide-based disinfectant spray and a 10-minute dip in 0.525% sodium hypochlorite (diluted household bleach) performed well in a North Carolina State University research trial investigating ways to counteract black root rot inoculum on plug trays.

Second, inspect plug root systems before transplanting, to make sure roots appear healthy. Third, lower your pH. A high pH (pH 6.2 and above) helps *B. basicola* to attack roots. Don't overwater, as flooded soils also aid the pathogen. Control fungus gnats—they're attracted to diseased plants and they spread the fungus.

Sensitive crops should be protected with fungicides that aid in the battle against *B. basicola*. Include thiophanate-methyl (FRAC Group 1) in your rotation, as it has especially impressive performance against this pathogen in many research trials over the years. Rotational partners for thiophanate-methyl include triflumizole (FRAC Group 3), polyoxin D zinc salt (FRAC Group 19) and fludioxonil (FRAC Group 12).

A new fungicide with mefentrifluconazole as its active ingredient (FRAC Group 3) performed as well as thiophanate-methyl in a recent Long Island trial. Some of these ingredients are available in combination products. Putting all these countermeasures together into a disease management program will sharply reduce the likelihood of any black root rot losses! **G**

Building Better Fungicide Rotations

Disease control begins and ends with proper fungicide selection. Below are suggested fungicide rotations for key diseases.



Anthracnose

Rotation 1: Orkestra® Intrinsic® brand fungicide (Group 7 + 11)

Rotation 2: Avelyo™ fungicide (Group 3)

Rotation 3: Chlorothalonil (Group M5) or Palladium (Group 9 + 12)



Botrytis Blight

Rotation 1: Orkestra Intrinsic brand fungicide (Group 7 + 11)

Rotation 2: Decree® (Group 17) + Chipco® 26019 (Group 2)

Rotation 3: Affirm™ (Group 19) or Palladium® (Group 9 + 12)



Downy Mildew

Rotation 1: Stature® fungicide (Group 40) or

Orvego® fungicide (Group 40 + 45)

Rotation 2: Orkestra Intrinsic brand fungicide (Group 7 + 11)

Rotation 3: Segovis® (Group 49)



Leaf Spots (Alternaria, Cercospora, Diplocarpon - black spot, Entomosporium, Myrothecium, Septoria)

Rotation 1: Pageant Intrinsic brand fungicide (Group 7 + 11) or

Orkestra Intrinsic brand fungicide (Group 7 + 11)

Rotation 2: Avelyo fungicide (Group 3)

Rotation 3: Chlorothalonil (Group M5) or Protect™ DF (Group M3)



Powdery Mildew and Rust

Rotation 1: Pageant® Intrinsic brand fungicide (Group 7 + 11) or

Orkestra Intrinsic brand fungicide (Group 7 + 11)

Rotation 2: Avelyo fungicide (Group 3)

Rotation 3: Protect DF (Group M3)

**FROM ROOT
TO BLOOM**



“PREVENT > CURE”

Be **proactive** instead of reactive when it comes to plant protection. Make **preventive** fungicide applications **before disease** occurs. Don't wait until you see symptoms to act – by then it may be too late!

EMMA LOOKABAUGH, Ph.D.
Technical Specialist, Southeast



360° of plant protection



Black Root Rot (*Berkeleyomyces* = *Thielaviopsis*)

Rotation 1: Avelyo fungicide (Group 3)

Rotation 2: Orkestra Intrinsic brand fungicide (Group 7 + 11)

Rotation 3: 3336® or OHP 6672™ (Group 1)



Root and Crown Rots (*Fusarium*, *Rhizoctonia*, *Cylindrocladium*)

Rotation 1: Empress® Intrinsic brand fungicide (Group 11) + Avelyo fungicide (Group 3)

Rotation 2: Medallion® (Group 12)

Rotation 3: Pageant Intrinsic brand fungicide (Group 7 + 11) or Orkestra Intrinsic brand fungicide (Group 7 + 11)



Phytophthora Diseases

Rotation 1: Orvego fungicide (Group 40 + 45)

Rotation 2: Adorn® (Group 43) + Aliette® WDG (Group P07)

Rotation 3: Segovis (Group 49)



Pythium Root Rot

Rotation 1: Empress Intrinsic brand fungicide (Group 11) + Segway® O (Group 21)

Rotation 2: Terrazole® (Group 14)

Rotation 3: Empress Intrinsic brand fungicide (Group 11) + Subdue MAXX® (Group 4)



Bacterial Diseases

see labels for specific pathogens

Rotation 1: Phytan® 27 (M1) or Junction® (Group M1 + M3) or Camelot® O (M1) or Grotto™ (M1)

Rotation 2: Cease® (Group BM 02) or Triathlon® BA (Group BM 02)

Don't forget to add multi-site contact fungicides to your rotation for improved disease control and resistance management

Always read and follow label directions.

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Sanitation for Greenhouse Crops

By A. R. Chase, Chase Agricultural Consulting, LLC

Many diseases can be avoided when a thorough and consistent sanitation program is in place. Stopping disease before it becomes established is critical and always more cost effective. Some of the steps included in this article include “cleaning” with physical and chemical means. It can include cleaning the greenhouse, pots and flats, or cleaning seeds or other plant propagules. The best method of sanitation isn’t a single approach, but relies on a combination, including physical and chemical means.

Cleaning the greenhouse/nursery

Physical cleaning. Get rid of weeds (including moss and liverworts), volunteer plants, pet plants and potting media debris. They harbor bacteria and fungi that can cause disease. Surfaces can be hard to clean since organic matter by its very nature disables many “oxidants” like bleach and chlorine dioxide. Cleaning up dead flowers (even fallen petals) can be an important way to reduce Botrytis spread. Try a blower to remove fallen petals of small flowers. Hand-picking larger flowers or infected leaves reduces Botrytis spread into the crop.



Cleaning up dead flowers (even fallen petals) can be an important way to reduce Botrytis spread.

Non-porous surfaces. Cleaning porous surfaces like wood and dirt (floors) makes your job much harder than using non-porous surfaces like metal, concrete or plastic. Gravel is a sort of combination of porous and non-porous surfaces since rock may be easy to clean, but gravel has a lot of crop and potting medium debris in it that isn’t easy to clean. Capillary mats are also very hard to clean due to their ability to store water and everything from algae to fungi and bacteria—not to mention insect pests. Depending on the type of surface, treating with disinfectants like Green-Shield II, KleenGrow and ZeroTol 2.0 between crops is critical.

Chemical cleaning agents for surfaces

The most common “disinfectants” used in our industry are based on chlorine—from bleach to chlorine dioxide to hydrogen peroxides and quaternary ammoniums. They have different abilities to “clean” benches, walkways, pots and tools. Even the type of surface (wood, plastic or concrete) can influence which product may work best.

Our trials have shown better control of plant pathogens on wood, plastic and concrete when KleenGrow is utilized with Strip-It applied first. KleenGrow has residual control ability not present in many other products. It’s also safer on plants than some of the other disinfectants.



Alcohol and quaternary ammoniums are routinely used for foot baths, hand-washing stations and cutting tools since they're effective and human-friendly. Make sure everyone knows how to use them and doesn't bypass these sanitation steps.

Cuttings cannot tolerate much more toxic products than humans, making use of chlorine-based products unlikely. However chlorine and peroxides, which are hard on cuttings, have been used to treat seeds since seeds are somewhat resistant to oxidants. Test safety on seeds or cuttings before broad scale use.

Cleaning water

No matter what your reason is for reusing water, from environmental to legal to financial, you must consider water treatment. Many research studies on *Phytophthora* and *Pythium* show that if you have these fungi-causing crop losses and you recirculate your water, you'll likely be infecting new plants with these diseases.

Methods for water treatment range from slow sand filtration

to ultra-violet light, ozonation, copper ionization and chemical disinfectants (like chlorine). Research shows that the amount of chlorine needed to kill *Phytophthora* zoospores (that is 2 ppm of free chlorine) is more effective and still safe for the crops being treated. There's a large difference between cleaning the water before re-use and treating the water on a constant basis (such as in propagation). The rates of product used won't be the same or at least not have the same safety to the crop.

Conclusions

Sanitation isn't accomplished in a single step; it's a commitment to an ongoing series of steps that requires a change of mindset for employees. Periodic training is critical, especially when you adopt a new method.

One final thought—remember that if it looks clean it's more likely to be clean. 🧼



Left: Depending on the type of surface, treating with disinfectants like Green-Shield II, KleenGrow and ZeroTol 2.0 between crops is critical.

Below: Sanitation is a commitment to an ongoing series of steps that requires a change of mindset for employees.



Chemical Class Chart for Greenhouse Nursery Fungicides

FRAC Group	Chemical Group	Active Ingredient Common Name	Trade Name
1	MBC - fungicides (MethylBenzimidazole Carbamates)	thiophanate-methyl	Banrot*, 3336, OHP 6672, Spectro 90*, 26/36*
2	dicarboximides	iprodione	OHP Chipco 26019
3	DMI-fungicides (DeMethylation Inhibitors)	mefentrifluconazole	Avelyo
		metconazole	Tourney
		myclobutanil	Eagle 20EW
		propiconazole	Banner MAXX, Concert II*, Strider
		tebuconazole	Torque
		triadimefon	Bayleton
		triflumizole	Terraguard
		triticonazole	Trinity, Trinity TR
4	PA – fungicides (PhenylAmides)	mefenoxam	Subdue GR, Subdue MAXX, Hurricane*
5	amines (“morpholines”)	piperalin	Pipron
7	SDHI (Succinate dehydrogenase inhibitors)	benzovindiflupyr	Mural*
		boscalid	Pageant Intrinsic*
		fluopyram	Broadform*
		flutolanil	ProStar
		fluxapyroxad	Orkestra Intrinsic *
		isofetamid	Astun
9	AP - fungicides (AnilinoPyrimidines)	cyprodinil	Palladium*
11	QoI-fungicides (Quinone outside Inhibitors)	azoxystrobin	Heritage, Mural*
		fluoxastrobin	Fame SC
		pyraclostrobin	Empress Intrinsic, Orkestra Intrinsic*, Pageant Intrinsic*
		trifloxystrobin	Compass
		fenamidone	FenStop
12	PP-fungicides (PhenylPyrroles)	fludioxonil	Medallion, Hurricane*, Palladium*, Spirato GHN
14	AH-fungicides (AromaticHydrocarbons) (chlorophenyls, nitroanilines)	pentachloronitrobenzene (PCNB)	Terraclor
	heteroaromatics	etridiazole	Banrot*, Terrazole, Terrazole CA, Truban
17	KRI fungicides (KetoReductase Inhibitors)	fenhexamid	Decree
19	polyoxins	polyoxin - D	Affirm WDG
21	Qil - fungicides (Quinone inside Inhibitors)	cyazofamid	Segway O
28	Carbamate	propamocarb	Banol

Chemical Class Chart for Greenhouse Nursery Fungicides

FRAC Group	Chemical Group	Active Ingredient Common Name	Trade Name
40	CAA-fungicides (Carboxylic Acid Amides)	dimethomorph	Stature SC, Orvego*
		mandipropamid	Micora
43	benzamides	fluopicolide	Adorn
45	QoSI fungicides (Quinone outside Inhibitor, stigmatellin binding type)	ametoctradin	Orvego*
49	OSBPI oxysterol binding protein homologue inhibition	oxathiapiprolin	Segovis
50	aryl-phenyl-ketones	pyriofenone	Seido
P 05	plant extract	extract from <i>Reynoutria sachalinensis</i>	Regalia
P 07	Phosphonates	fosetyl-Al	Aliette, Areca
		phosphorous acid, potassium phosphite	Alude, Fosphite, Phostrol
M1	inorganic (electrophiles)	copper salts	Camelot O, CuPro 5000, Cuproxat FL, Junction*, Kalmor, Phytan 27, Phytan 35, Grotto
M3	dithiocarbamates and relatives (electrophiles)	mancozeb	Dithane, Fore, Junction*, Protect DF
M5	chloronitriles (phthalonitriles) (unspecified mechanism)	chlorothalonil	Daconil Ultrex, Daconil Weatherstik, Spectro 90*
BM 01	plant extract	extract from <i>Swinglea glutinosa</i>	Ecoswing
BM 02	microbial	<i>Bacillus amyloliquifaciens</i> (strain D747)	Triathlon BA
		<i>Bacillus amyloliquifaciens</i> (strain QST 713)	Cease
		<i>Bacillus amyloliquefaciens</i> (strain F727)	Stargus
		<i>Pseudomonas chlororaphis</i> (strain AFS009)	Zio
		<i>Streptomyces griseoviridis</i>	Mycostop
		<i>Streptomyces lydicus</i> (strain WYEC 108)	Actinovate SP
		<i>Trichoderma harzianum</i> (strain T-22)	Rootshield
		<i>Trichoderma harzianum</i> (strain T-22), <i>Trichoderma virens</i> (strain G-41)	Rootshield Plus*
		<i>Trichoderma asperellum</i> (strain ICC 012), <i>Trichoderma gamsii</i> (strain ICC 080)	Obtego*
		<i>Gliocladium virens</i> (strain GL021)	SoilGard
Not Classified	inorganic protectants	botanical extract	Neem Oil, Triact 70
		hydrogen dioxide	Zerotol
		oil	Ultra-Pur oil, SuffOil-X
		potassium bicarbonate	NMilStop
		quaternary ammoniums	KleenGrow

* Indicates a product that contains more than one active ingredient in a pre-pack mixture.

Consult label for specific use site where the product will be used on ornamentals since not all products are registered for both production greenhouses and outdoor nurseries or for use in landscapes.

2022 Pest Control Materials for Managing Insect and Mite Pests of Greenhouse-grown Horticultural Crops

Raymond A. Cloyd
Department of Entomology
Kansas State University

Greenhouse pest management/plant protection involves using a multitude of strategies in order to minimize the prospect of dealing with insect and mite pest populations. The use of pest control materials (insecticides and miticides) is one component of a pest management/plant protection program, which also includes pest identification and monitoring along with cultural, physical, and biological control. Proper stewardship of pest control materials involves resistance management by rotating products with different modes of action. The Insecticide Resistance Action Committee (IRAC) has developed a grouping, based on mode of action, to facilitate the implementation of appropriate rotation programs. Pest control materials have been assigned a designated number (sometimes number and letter combinations) associated with their mode of action. For more information, consult the IRAC website (www.irac.online.org). **The information presented in this chart is not a substitute for the label. Always read and understand all information presented on the label before using any pest control material.** Also, be sure to check county and state regulations to determine if there are any local restrictions associated with the use of specific pest control materials listed in this chart.

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
APHIDS	Abamectin	Avid	12 hours	6: GABA ¹ chloride channel activator
	Acephate	1300 Orthene TR/Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Afidopyropen	Ventigra	12 hours	9D: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	<i>Beauveria bassiana</i> Strain PPRI 5339	Velifer	12 hours	
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Bifenthrin	Attain TR/Talstar	12 hours	3A: Prolong opening of sodium channels
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyantraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cycaniliprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniliprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Flupyradifurone	Altus	4 hours	4D: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
APHIDS <i>continued</i>	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Methiocarb	Mesulol	24 hours	1A: Acetylcholine esterase inhibitor
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pymetrozine	Endeavor	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Pyrethrins	Pyreth-lt/ Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyrifluquinazon	Rycar	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Spinetoram + Sulfoxaflor	XXpire	12 hours	5 + 4C: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator + nicotinic acetylcholine receptor modulator
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
BROAD MITE	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Fenpyroximate	Akari	12 hours	21A: Mitochondria electron transport inhibitor
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyridaben	Sanmite	12 hours	21A: Mitochondria electron transport inhibitor
	Spiromesifen	Savate	12 hours	23: Lipid biosynthesis inhibitor
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
CATERPILLARS	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	Dipel	4 hours	11: Midgut membrane disruptor
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Cyantraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
CATERPILLARS <i>continued</i>	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyrethrins	Pyreth-lt/ Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyridalyl	Overture	12 hours	Unknown mode of action
	Methoxyfenozide	Intrepid	4 hours	18: Ecdysone agonist: mimics action of molting hormone
	Novaluron	Pedestal	12 hours	15: Chitin synthesis inhibitor
	Spinetoram + Sulfoxaflor	XXpire	12 hours	5 + 4C: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator + nicotinic acetylcholine receptor modulator
	Spinosad	Conserve	4 hours	5: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
CYCLAMEN MITE	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Fenpyroximate	Akari	12 hours	21A: Mitochondria electron transport inhibitor
	Spiromesifen	Savate	12 hours	23: Lipid biosynthesis inhibitor
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
FUNGUS GNAT LARVAE	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Bacillus thuringiensis</i> subsp. <i>israelensis</i>	Gnatrol	4 hours	11: Midgut membrane disruptor
	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Cyromazine	Citation	12 hours	17: Chitin synthesis inhibitor
	Diflubenzuron	Adept	12 hours	15: Chitin synthesis inhibitor
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Pyriproxyfen	Distance/Fulcrum	12 hours	7C: Juvenile hormone mimic
	<i>Steinernema feltiae</i>	Nemasys , NemaShield, Scanmask, and Entonem		
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
FUNGUS GNAT ADULTS	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
LEAFHOPPERS	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Flupyradifurone	Altus	12 hours	4D: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyrethrins	Pyreth-I ^t / Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
LEAFMINERS	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Acephate	1300 Orthene TR /Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
LEAFMINERS <i>continued</i>	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Cyantranilprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclanilprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclanilprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin + Imidacloprid	Discus	4 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Cyromazine	Citation	12 hours	17: Chitin synthesis inhibitor
	Diflubenzuron	Adept	12 hours	15: Chitin synthesis inhibitor
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Novaluron	Pedestal	12 hours	15: Chitin synthesis inhibitor
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Spinosad	Conserve	4 hours	5: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
MEALYBUGS	Acephate	1300 Orthene TR /Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Afidopyropen	Ventigra	12 hours	9D: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	<i>Beauveria bassiana</i> Strain PPRI 5339	Velifer	12 hours	
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyclanilprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
MEALYBUGS <i>continued</i>	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Flupyradifurone	Altus	4 hours	4D: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	Nicotinic acetylcholine receptor modulator (4A)
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyrifluquinazon	Rycar	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Spineotram + Sulfoxaflor	XXpire	12 hours	5 + 4C: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator + nicotinic acetylcholine receptor modulator
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
PLANT BUGS	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Cyclaniloprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Flupyradifurone	Altus	4 hours	4D: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
SCALES (HARD AND SOFT) ^a	Acephate	1300 Orthene TR /Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	Bifenthrin	Attain TR /Talstar	12 hours	4A: Prolong opening of sodium channels
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
SCALES (HARD AND SOFT) ^a <i>continued</i>	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyantranilprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclanilprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclanilprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Mineral oil	Ultra-Pure Oil/SuffOil-X	4 hours	Suffocation or membrane disruptor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyriproxyfen	Distance/Fulcrum	12 hours	7C: Juvenile hormone mimic
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
SHORE FLY LARVAE	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Cyromazine	Citation	12 hours	17: Chitin synthesis inhibitor
	Diflubenzuron	Adept	12 hours	15: Chitin synthesis inhibitor
	Pyriproxyfen	Distance/Fulcrum	12 hours	7C: Juvenile hormone mimic
	Spinosad	Conserve	4 hours	5: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator
	<i>Steinernema carpocapsae</i>	Millenium	0 hours	
SLUG AND SNAIL	Iron phosphate	Sluggo	0 hours	Inhibits calcium metabolism
	Metaldehyde	Deadline	Refer to Label	Central nervous system toxin
	Methiocarb	Mesuroi	24 hours	1A: Acetylcholine esterase inhibitor
SPIDER MITE (TWO-SPOTTED)	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Acequinocyl	Shuttle	12 hours	20B: Mitochondria electron transport inhibitor
	<i>Beauveria bassiana</i> Strain PPRI 5339	Velifer	12 hours	
	Bifenazate	Floramite	4 hours	20D: Mitochondria electron transport inhibitor
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
SPIDER MITE (TWOSPOTTED) <i>continued</i>	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Clofentezine	Novato	12 hours	10A: Growth and embryogenesis inhibitor
	Cyflumetofen	Sultan	12 hours	25: Mitochondria electron transport inhibitor
	Etoxazole	TetraSan/Beethoven	12/24 hours	10B: Chitin synthesis inhibitor
	Fenazaquin	Magus	12 hours	21A: Mitochondria electron transport inhibitor
	Fenpyroximate	Akari	12 hours	21A: Mitochondria electron transport inhibitor
	Hexythiazox	Hexygon	12 hours	10A: Growth and embryogenesis inhibitor
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Metarhizium brunneum</i> Strain F52	Met52	4 hours	
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyridaben	Sanmite	12 hours	21A: Mitochondria electron transport inhibitor
	Spiromesifen	Savate	12 hours	23: Lipid biosynthesis inhibitor
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
THRIPS	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Acephate	1300 Orthene TR /Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	<i>Beauveria bassiana</i> Strain PPRI 5339	Velifer	12 hours	
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Chlorfenapyr	Pylon	12 hours	13: Oxidative phosphorylation uncoupler
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Cyantraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
THRIPS <i>continued</i>	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	<i>Metarhizium brunneum</i> Strain F52	Met52	4 hours	
	Methiocarb	Mesulol	24 hours	1A: Acetylcholine esterase inhibitor
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Novaluron	Pedestal	12 hours	15: Chitin synthesis inhibitor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pyrethrins	Pyreth-It/ Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyridalyl	Overture	12 hours	Unknown mode of action
	Spinetoram + Sulfoxaflor	XXpire	12 hours	5 + 4C: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator + nicotinic acetylcholine receptor modulator
	Spinosad	Conserve	4 hours	5: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	<i>Steinernema feltiae</i>	Nemasys		
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
WHITEFLIES	Abamectin	Avid	12 hours	6: GABA chloride channel activator
	Acephate	1300 Orthene TR /Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Afidopyropen	Ventigra	12 hours	9D: Selective feeding blocker/chordotonal organ TRPV modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	<i>Beauveria bassiana</i> Strain PPRI 5339	Velifer	12 hours	
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyantraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole + Flonicamid	Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator



Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
WHITEFLIES <i>continued</i>	Diflubenzuron	Adept	12 hours	15: Chitin synthesis inhibitor
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenazaquin	Magus	12 hours	21A: Mitochondria electron transport inhibitor
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Flupyradifurone	Altus	4 hours	4D: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Isaria fumosorosea</i> Strain FE 9901	NOFLY WP	12 hours	
	<i>Metarhizium brunneum</i> Strain F52	Met52	4 hours	
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Novaluron	Pedestal	12 hours	15: Chitin synthesis inhibitor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pymetrozine	Endeavor	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Pyrethrins	Pyreth-I/Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyridaben	Sanmite	12 hours	21A: Mitochondria electron transport inhibitor
	Pyrifluquinazon	Rycar	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Pyriproxyfen	Distance/Fulcrum	12 hours	7C: Juvenile hormone mimic
	Spinetoram + Sulfoxaflor	XXpire	12 hours	5 + 4C: Nicotinic acetylcholine receptor disruptor/agonist and GABA chloride channel activator + nicotinic acetylcholine receptor modulator
	Spiromesifen	Savate	12 hours	23: Lipid biosynthesis inhibitor
	Spirotetramat	Kontos	24 hours	23: Lipid biosynthesis inhibitor
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor

^a Refer to label for specific scale species.

¹ GABA=Gamma-aminobutyric acid.

² Additional azadirachtin products include the following: AzaGuard, Aza-Direct, and AzaSol.

For more information contact Dr. Raymond A. Cloyd, Professor and Extension Specialist in Horticultural Entomology/Plant Protection at Kansas State University, Department of Entomology, 123 Waters Hall, Manhattan, KS 66506-4004
Phone: (785) 532-4750; Email: rcloyd@ksu.edu

Updated: July, 2021

Come Grow With Us: IPM for Better Plants

New Ideas for Integrated Pest Management

IPM steers our decision-making about pest management as a dynamic system we constantly adjust to meet our changing needs. We can tackle any pest system from weeds to diseases to insects with the 5 basic approaches: **chemical, biological, cultural, mechanical, and genetic**. Let's look at ways to leverage some of the approaches in **insect and mite pest management** for ornamental and greenhouse vegetable production.

Predators:

insects and mites that eat others – *Orius*, *Dalotia*, and *P. persimilis*



Biological Control Agents (BCAs)

Parasitoids:

insects that parasitize other insects – *Aphidius*, *Diglyphus*, and *Encarsia*



Colonizers:

fungi and nematodes that grow on and in pests – *Beauveria* and *Steinernema*



BIOLOGICAL

Beneficial nematodes and *Beauveria bassiana* products serve as gateway biologicals: simple applications that provide reliable results.

Start biologicals when your pest pressure is low and maintain regular applications.

LEAH VAN DER HEIDE
Sales Specialist, West

To learn about integrating biologicals into a conventional-focused program, visit the BASF Better Plants website to read Funky Pests Biological Basics.



CULTURAL

Two unsung heroes of successful IPM programs are sanitation and record-keeping – everyone knows their value, putting them into consistent practice is a game-changer for keeping pest pressure down.

KIMBERLY NOFFKE
Sales Specialist, Northeast

For more information on the utility of functional groups, visit the BASF Better Plants website to read Effective Pest Management Approaches - use your smart phone's camera on this QR code to see the article in your browser.



IPM



Mechanical practices are not only physical methods but can also include techniques like horticultural oil applications.

MECHANICAL

To make plant-safe hort oil applications, choose a highly refined product and follow the 85-85 rule: make applications at temperatures below 85 degrees F and below 85% relative humidity.

MINDY MONEY

Sales Specialist, Southeast



CHEMICAL

To create an insecticide program from scratch that automatically includes different modes of action (MOAs), try choosing products from each of the **Functional Groups** below. Each group provides key activity for insect or mite management that can do a lot of heavy lifting in an IPM program.

PEGGY CLANTON

Sales Specialist, Florida

INSECTICIDE FUNCTIONAL GROUPS

Oils and Soaps
Insect Growth Regulators (IGRs)
Biopesticides
Targeted Chemistries
Broad Spectrum Chemistries

Insect Growth Regulators (IGRs)
Disrupt the lifecycle

Biopesticides
Enhance efficacy, preserve beneficials

Targeted and Broad-Spectrum Chemistries
Kill and/or suppress insects and mites

Oils and Soaps
Smother and desiccate



Hard-Learned Lessons on Managing Scale Insects & Mealybugs

By Juang Horng “JC” Chong, Clemson University

We’ve waged a vicious war against the scale insects for as long as we’ve cultivated plants for their beauty and services to ecosystems and human wellbeing. We’ve learned a thing or two on how to fight against scale insects over the millennia.

Let’s review the lessons we’ve learned and renew our resolve to implement some of these hard-learned lessons in our pest management programs.

Lesson #1: Know your scales.

Although all scale insect and mealybug species feed on plants, only dozens of them can be considered the “usual suspects.” Familiarizing yourself with these common

species can help you prepare for their management. When you come across scale insects you aren’t familiar with, it’s best to send samples to a private or extension diagnosis lab because scale insect identification is best done by trained diagnosticians.

At the bare minimum, you should learn to identify armored scales, soft scales and mealybugs, which are the three most commonly encountered families. The differences in biology among these groups of scale insects make tremendous differences in their management approach, so identification is the first step towards better understanding their biology.

Mealybugs have a dusting of wax deposits and retain



Figure 1. The body of an armored scale separates from its shell when flipped over with a pin (1A), while the body and shell of a soft scale do not separate (1B).

legs their entire life. Some scale insects have a thicker layer of wax and also have legs. True soft scales and armored scales lose their legs in the first nymphal molt. To distinguish a soft scale from an armored scale, you only need to flip over a live scale insect with a pin. If it has legs, it's neither a soft scale nor an armored scale. If it has no legs, and the shell remains attached to the insect body, then it's a soft scale. If the body and the shell separate, it's an armored scale (Figure 1).

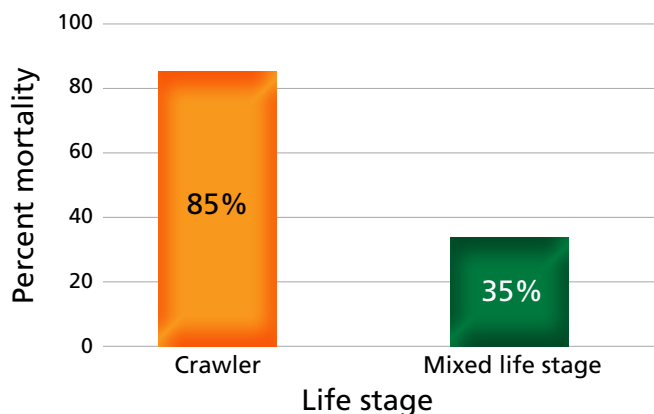
Lesson #2: They have to come from somewhere.

That "somewhere" is often plant you brought in, therefore, take cuttings only from clean stock plants or buy only from reputable propagators. If you don't know where the plants came from, quarantine and carefully inspect them before bringing them into the growing areas. Reject infested plants. If rejection isn't an option, you should consider throwing away all infested plants and treat the remaining seemingly clean plants (scale insects are very hard to detect). If you plan to take the risk by keeping the infested plants, they should be treated with the most effective insecticides before being planted or moved into the production area.

It is of utmost importance to practice great (not just good) sanitation to get rid of any established scale insect population. Infested plants should be bagged and discarded instead of being kept for another season. Many scale insects, and particularly mealybugs, can feed on weeds, so the growing area should be kept clean of weeds.

And scout so that infestation can be detected and treated early. A small host spot of infestation is easier and cheaper to treat.

Figure 2. Two applications of 2% horticultural oil 14 days apart resulted in greater mortality in a citrus mealybug population consisted of only crawlers (hatchlings) than in a population of mixed life stages.



Lesson #3: Hit those babies!

Scouting also serves to detect the perfect life stage for treatment. For scale insects, the target life stage is the crawler or hatchling. Unlike older nymphs and adults, which are covered with wax, crawlers have no wax or only a very thin layer of wax. As a result, crawlers are much more susceptible to insecticide treatment.

What's the difference in efficacy when you apply against crawlers and a mix of life stages? Here's an example from my work with citrus mealybug: I sprayed a population of crawlers and a population of mixed life stages (including crawlers, older nymphs and adults) with 2% horticultural oil twice 14 days apart. The mortality rate of crawlers was close to 90%, but the mortality of mixed life stages didn't reach 40% at 28 days after the first treatment.

Lesson #4: Know where they feed and then choose your poison.

Based on my research and experience during the past 10 years, I now preach the importance of choosing your insecticide based on the feeding habit and the life history of the offending scale insect species.

For a scale insect species that feeds exclusively on leaves or spends part of its life on leaves, systemic insecticides applied via direct (foliar spray) and indirect methods (soil drench, soil injection, trunk spray, trunk injection and granules) can be very effective.

However, for scale insect species or life stage that feeds on twigs, branches and trunks, the most effective approach is to apply repeated sprays targeting the crawlers. Sprays of horticultural oil, insecticidal soap and insect growth regulators (buprofezin and pyriproxyfen) are highly effective.

Do not spray broad-spectrum insecticides (such as organophosphates, pyrethroids and neonicotinoids) against scale insects in nurseries and landscapes. Although these insecticides can be effective against crawlers, they're also deadly to lady beetles, lacewings and parasitic wasps that attack the scale insects. Killing these natural enemies will only make the infestation worse.

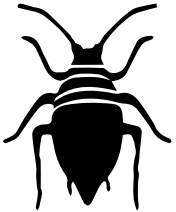
Lesson #5: Achieve excellent spray coverage.

Scale insects and mealybugs are very good at hiding in hard-to-reach places. It's important to achieve thorough spray coverage of the plant canopy, especially those secluded places where the pests are hiding.

Add a spreader-sticker type surfactant or adjuvant to the spray solution, and use high spray volume to improve spray coverage. There are also added benefits. Remember that the bodies of scale insects are covered with wax. Adjuvants improve adherence to a waxy surface, and high spray volume can help penetrate the wax layer and allow contact of the insecticide solution with the insect bodies. 6

Building Better Insecticide Rotations

Managing insects and mites during the growing season will be easier if you have a plan in place before heavy pressure can sneak up on you and your crop. Here are some targeted, broad-spectrum and biopesticide rotation options for the most common pests in production.



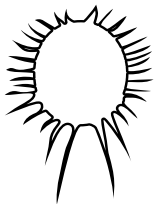
APHIDS

Ventigra® insecticide (Group 9D)
Velifer® fungal contact insecticide/miticide (Group NC)
Mainspring® insecticide (Group 28)
IGR: Azatin® O biological insecticide (Group UN)



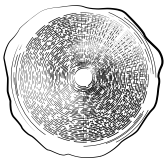
FUNGUS GNATS

Nemasys® beneficial nematodes (Group NC)
Citation® insecticide (Group 17)
IGR: Distance® (Group 7C)



MEALYBUGS

Ultra-Pure Oil insecticide, miticide, fungicide (Group NC)
Ventigra insecticide (Group 9D)
Safari® insecticide (Group 4A)
IGR: Talus® (Group 16)



SCALE

Ultra-Pure Oil insecticide, miticide, fungicide (Group NC)
Ventigra insecticide (Group 9D)
Safari insecticide (Group 4A)
IGR: Distance or Fulcrum® (Group 7C)



SHORE FLIES

Millenium® beneficial nematodes (Group NC)
Azatin O biological insecticide (Group UN)
IGR: Distance (Group 7C)

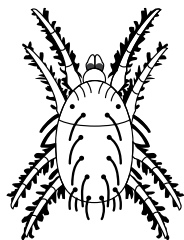


“ You can run these **programs** in the order listed or mix them up; use them as a **menu of options**, or deploy them according to where you are in the season. They’re **research-based** and grower tested and it’s up to you – **we make suggestions, you make decisions.** ”

JEN BROWNING PCA
Technical Specialist, West



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SPIDER MITES

Sultan® miticide (Group 25)

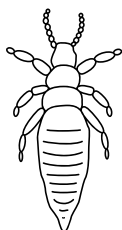
Velifer fungal contact insecticide/miticide (Group NC)

Pylon® miticide or **Pylon TR** miticide (Group 13)

Kontos® insecticide/miticide (Group 23)

IGR: TetraSan® miticide/ovicide or

Beethoven® TR miticide/insecticide (Group 10B)



THRIPS

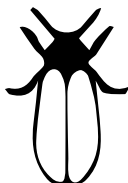
Pylon miticide (Group 13)

Velifer fungal contact insecticide/miticide (Group NC)

Aria® insecticide (Group 29)

Conserve® insecticide (Group 5)

IGR: Azatin O biological insecticide (Group UN)



WHITEFLIES

Ventigra insecticide (Group 9D)

Velifer fungal contact insecticide/miticide (Group NC)

Aria insecticide (Group 29)

Savate® miticide/insecticide (Group 23)

IGR: Talus (Group 16)

Every list of rotation options includes an insect growth regulator (IGR) for the pest – this functional group is a heavy lifter in the program. Plug it in when you have juveniles in the population and let IGRs work to disrupt the pest's life cycle and reduce populations!



Don't forget to monitor and scout regularly so you can adjust your application intervals - clear tape over a sticky card will protect your "catch" until you have time to count and identify later in the day or week.

Always read and follow label directions.

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with precision accuracy

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From bare ground and gravel pads to indoors under benches -- it's the perfect tool for precision weed control in container and field-grown ornamentals.

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Take an Integrated Approach to Greenhouse Pests

Velifer[®] fungal contact insecticide/miticide works with **Ventigra**[®] insecticide to keep pest pressure low between conventional applications – and both products are compatible with biologicals

To learn more about adding these two powerful tools to your program, visit betterplants.basf.us



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Velifer[®]

Fungal Contact Insecticide/Miticide

Ventigra[®]

Insecticide

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