

GROWER TALKS

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Insecticide, Miticide, & Fungicide Guide



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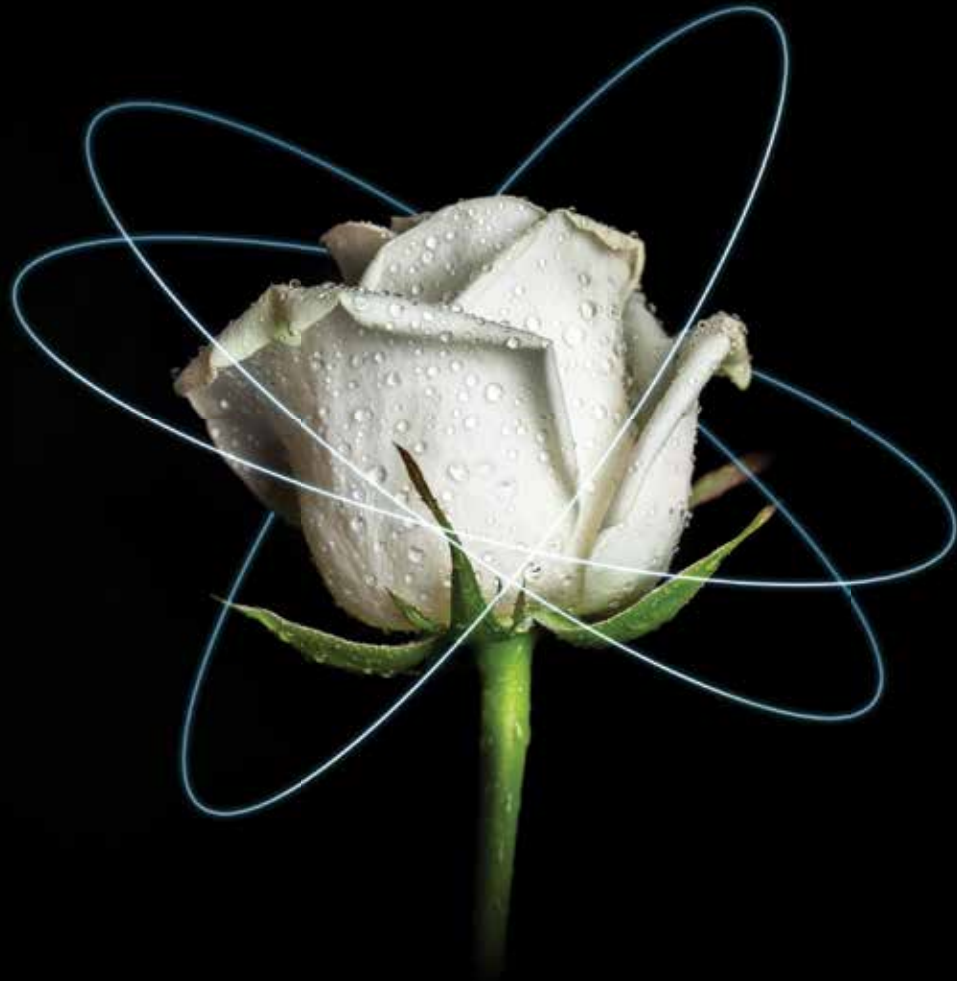
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Recalibration seems to be the theme throughout the industry as we all get to the other side of so many unprecedented historical events over the last few years. As we sit and reflect on the year and our industry's performance, the adaptability, strength and resilience that shines through and overcomes the challenges continue to be awe-inspiring. This is our ninth year sponsoring the Insecticide, Miticide & Fungicide Guide with *GrowerTalks* and we're excited for this iteration.

In this edition, you'll see our handy and reliable tables and resources updated with new products and recommendations, as well as fresh content to help navigate the unique challenges growing operations face. This year, we added a grower's perspective on the importance of Integrated Pest Management and its impact to local ecology with an article featuring North Creek Nurseries, Inc. It highlights their approach to predictive pest management with the use of historical data tailored to their production cycles.

While the universal challenges persist on in our industry—labor, inflation, input costs, etc.—the collective push of the “reset button” is an important step forward. We rode the pandemic rollercoaster to new heights; it's a new foundation from which we can grow with more stability in the long term.

Consumer demand continues to validate the fundamental shift in perspective we saw during the pandemic that correlates plants and gardening to overall mental health and wellness. With that shift, we see new ways of influence with social media outlets and continued growth in online plant purchases from big box growers, as well as direct from some large growing operations. These new centers of influence bring consumers ever closer to production operations and their influence up the value chain will only grow.

The increase in online purchases adds a new layer of stressors that plants experience now being boxed up and handled (roughly) by shipping carriers. Our **Pageant[®]** and **Orkestra[®] Intrinsic[®] brand fungicides** provide broad-spectrum disease control, increased growth efficiency and enhanced tolerance to stress. Add **Avelyo[®] fungicide** as a dynamic rotation partner to complement the Intrinsic plant health benefits in Pageant and Orkestra for broad-spectrum disease control and exceptional plant quality.

Consumer influence also drives a renewed focus around sustainability and pollinator safety. Products like **Ventigra[®] insecticide** and **Sultan[®] miticide** are targeted, safe chemistries with activity on piercing-sucking insects and spider mites, and can both be applied within IPM programs, which also use predatory mites and other beneficial insects. For added resistance management, incorporating foundational applications



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

Liz Dunbar
Product Manager
Greenhouse & Nursery

of **Velifer[®] fungal contact insecticide/miticide** keeps pest pressures low and extends the period between knock-down conventional applications.

As you reset and recalibrate heading into 2024, remember that BASF is here as a collaborative partner for your conventional and biological crop protection solutions. Our team is passionately dedicated to supporting growers to produce high-quality, sellable crops. We take pride in our sponsorship of the IMF Guide and hope it continues to add value to your operations. On behalf of our entire team, we wish you success in the 2024 season.

On the cover: Sclerotinia blight on petunia.

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 2023. 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.

NORTH CREEK NURSERIES: BRIDGING THE GAP BETWEEN HORTICULTURE AND ECOLOGY

North Creek Nurseries' data-driven, environmentally-conscious approach to the native plug business helps set them apart. And it's showing the industry another way forward.

Founded by Dale Hendricks and Steve Castorani in 1988, North Creek Nurseries is a wholesale propagation nursery specializing in perennials, ornamental grasses, ferns and vines — with an emphasis on Eastern US natives.

But there's more to it than that. North Creek is a perennial plug supplier with a real desire to bring more natives into the horticulture world and a strong commitment to protecting people, wildlife and the environment. This vision is perfectly summed up by their tagline: Where Horticulture Meets Ecology™.

General Manager Tim McGinty told us, "North Creek pioneered the Landscape Plug™ line to satisfy the landscape market where largescale direct installation applications such as meadows, restoration projects and habitat enhancement are the scale. To start, this product mix was exclusive to native species — as to not compete with our grower/horticulture customers. Today, our product mix leverages both markets thanks to the ever-growing popularity of native plants and increased demand for native species and standout selections. Consumer awareness continues to drive demand for gardens that incorporate beauty and ecological appeal."

Tim, a woody plant propagator by trade, was attracted to North Creek because of their strong conservation ethic (and their tagline). "There are a lot of complexities with growing native plants. They aren't as straightforward as one would think."

Native Plants are a Growing Market

North Creek has been about natives from the very beginning, but they really saw the market shift in 2006-2008, as natives were getting their foothold in the industry. According to Marketing Manager Carrie Wiles, "In 2005 Steve and Dale joined forces with Prides Corner Farms to lay the foundation of what would become American Beauties Native Plants® — the nation's premier retail-ready branded collection of native plants. Through the brand inception phase, North Creek used the new line to generate interest on the perennials side in the marketplace.

Today, the brand has national visibility and native palettes representative of growers and regions participating in the program. Independent garden centers have thrived thanks to the informative branding and local marketing efforts made by regional and territory sales managers and brand ambassadors. North Creek's customer base is wholesale growers, retail nursery and garden centers plus mail order vendors and landscape professionals which support the American Beauties Native Plants® brand. From their Landenberg and Oxford, PA locations, they're as dedicated to seeing their customers grow and flourish as they are germinating their native varieties.

The Community Needs Nurturing, Too

When you get a bunch of green thumbs together, what happens? They start looking for a place to grow things. The folks at North Creek made room not just for growing, but for giving back.

For several years now, additional acres at North Creek's Landenberg facility are used to grow vegetables. Employees are able to share in the experience and learn about food production in addition to propagating perennials. Everyone gets involved and has a lot of fun. The harvest, as much as 25,000 pounds a year, is shared among North Creek's employees and local food banks.



Kassie Garris



Ryan Butcher

More Data, Fewer Pests

North Creek Nurseries' dedication to environmental responsibility and stewardship drives their "soft chemistry" approach to Integrated Pest Management (IPM). When making pest control decisions, they begin with a biological product before turning to biorational controls, insect growth regulators or low toxicity synthetics.

According to Tim McGinty, "Plant and pollinator interdependence is the keystone to our IPM approach and where we put strong emphasis with growing practices. I am proud to say that we have been a neonicotinoid-free nursery since 2006. We want to provide the healthiest *Asclepias* for Monarch larvae so they can complete their metamorphosis."

They've harnessed historical data to predict trends in insect reproductive cycles and environmental conditions and create detailed treatment plans — specific to their two growing locations.

"By mining the data, we can accurately and effectively pair soft chemistry with beneficial insects to make applications that are favorable for the environment," according to Tim McGinty. "In the past, we would scout, apply pesticides, and then apply beneficials the following week. Today, we can utilize data collection of pest pressures, graph predicated presence of greenhouse pests, and make preventative applications instead of corrective measures."

He goes on to say, "Data and results of our beneficial insect program also tie directly into our marketing effort — both internally and externally — we convey growing methods and procedures to North Creek staff, direct customers, and industry professionals. This way, awareness about our pollinator focus is transparent and consistent."

North Creek Nurseries has seen impressive results from this program, but challenges still arise. "Ever-changing factors,

especially weather, can cause diseases and pests to pop up at odd times. Consistent scouting is the best way to overcome such anomalies. An IPM program is never 'set it and forget it,' our team is trained to stay vigilant and work together to adjust and take action as needed."

Share What You Grow, Share What You Know

Along with their natives, deep plugs (Landscape Plugs™) and vegetables, North Creek Nurseries is happy to share their IPM learnings and best practices — so others can benefit from this experience. Ryan Butcher and Kassie Garris, Oxford & Landenberg Growing Coordinators, respectively, have two great suggestions:

First, "Start your IPM sooner rather than later. Start with your problem crops and build up as you are comfortable and learn more. I would also start with education, knowing what you have is important. There are so many useful resources out now where answers can be obtained. This is not an overnight solution. It takes time to build a good program so gather resources and information to help build the best program and make changes as needed."

And second, "Make the computer work for you. There are platforms to aid growers in tracking pest issues and scheduling applications, whether chemical or beneficial insects, for the best outcome. Yearly mapping of pests along with production planning can combine crop plans with expected pressures."

You'll also find a wealth of plant information, resources and ideas on their website (www.northcreeknurseries.com).

At their core, North Creek Nurseries strives to be a leader in the development and practice of sustainable horticultural systems, producing world-class plant material. Through quality products, their dedication to the land and eagerness to share what they learn with others, they continue to be the bridge between horticulture and ecology.

BUILDING BETTER FUNGICIDE PROGRAMS

Balanced plant protection solutions



We create chemistry

BOTRYTIS BLIGHT

Orkestra® Intrinsic® brand fungicide (Group 7 + 11)
Decree + Chipco 26019 (Groups 17 + 2)
Palladium (Groups 12 + 9)
Affirm or Daconil (Group 19 or M5)

LEAF SPOTS

(*Alternaria*, *Cercospora*, *Colletotrichum*, *Diplocarpon* [black spot], *Entomosporium*, *Myrothecium*, *Septoria*)

Orkestra Intrinsic brand fungicide (Group 7 + 11) or **Pageant® Intrinsic** brand fungicide (Group 7 + 11)
Avelyo® fungicide (Group 3)
Protect DF or Daconil (Group M3 or M5)
Palladium (Groups 12 + 9)

DOWNY MILDEW

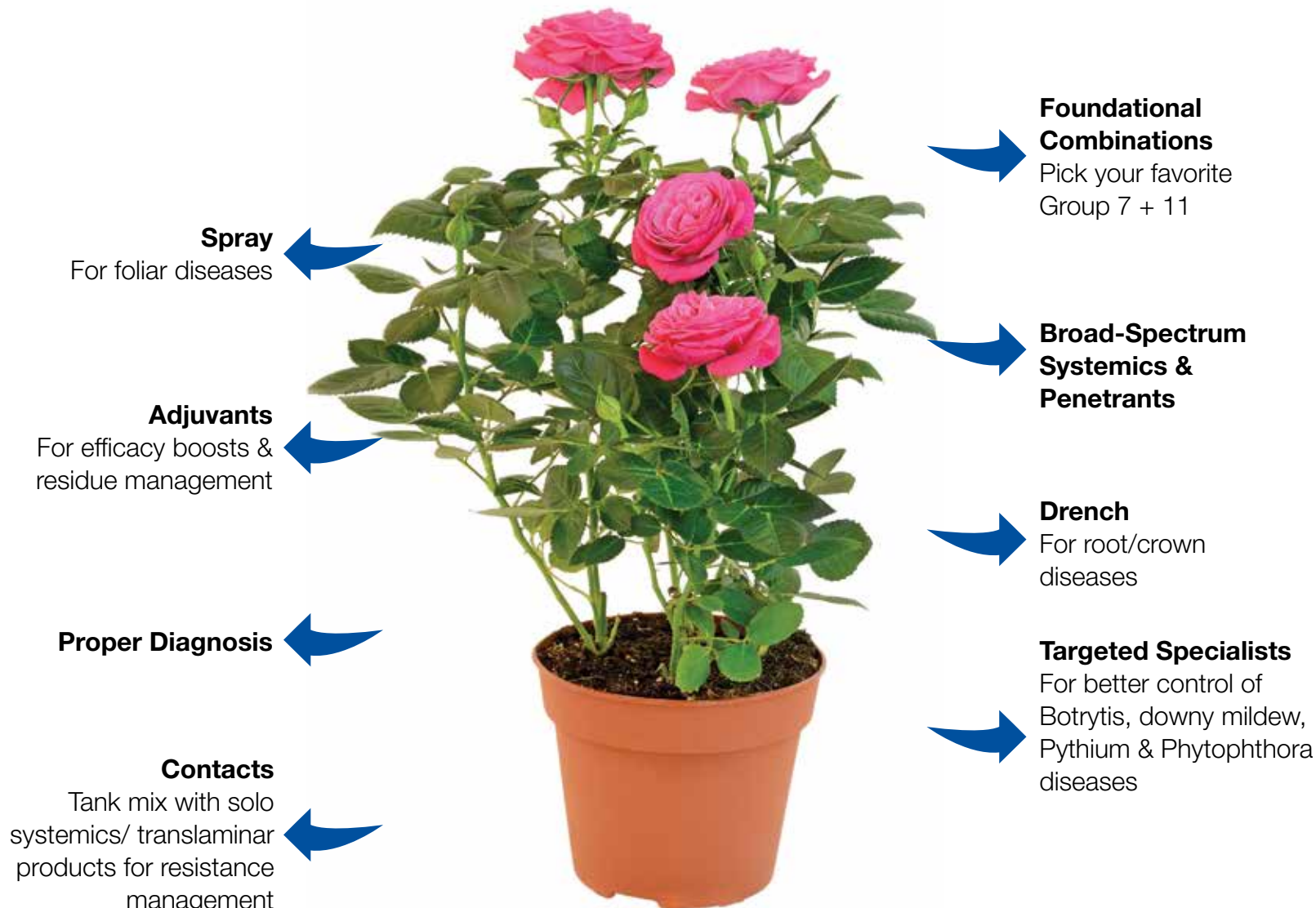
Adorn + Subdue Maxx (Groups 43 + 4)
Stature® fungicide (Group 40) or **Orvego®** fungicide (Group 40 + 45)
Orkestra Intrinsic brand fungicide (Group 7 + 11) + Protect DF (Group M3)
Segovis® (Group 49)

POWDERY MILDEW AND RUST

Orkestra Intrinsic brand fungicide (Group 7 + 11) or **Pageant Intrinsic** brand fungicide (Group 7 + 11)
Avelyo fungicide (Group 3)
Protect DF or Daconil (Group M3 or M5)
Palladium (Groups 12 + 9)

Always read and follow label directions.

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Spray
For foliar diseases

Adjuvants
For efficacy boosts & residue management

Proper Diagnosis

Contacts
Tank mix with solo systemics/ translaminar products for resistance management

Foundational Combinations
Pick your favorite Group 7 + 11

Broad-Spectrum Systemics & Penetrants

Drench
For root/crown diseases

Targeted Specialists
For better control of Botrytis, downy mildew, Pythium & Phytophthora diseases

ROOT AND CROWN ROTS (NON-OOMYCETE)

(*Fusarium*, *Rhizoctonia*, *Cylindrocladium*, *Thielaviopsis* = *Berkeleyomyces*)

Empress® Intrinsic brand fungicide + **Avelyo** fungicide (Group 11 + 3)
Medallion® or OHP 6672 or 3336 (Group 12 or 1)
Orkestra Intrinsic brand fungicide (Group 7 + 11) or **Pageant Intrinsic** brand fungicide (Group 7 + 11)

PYTHIUM ROOT ROT

Empress Intrinsic brand fungicide + Segway® O (Group 11 + 21)
Terrazole® (Group 14)
Aliette [or Areca] + Subdue Maxx® (Group P 07 + 4)

PHYTOPHTHORA DISEASES

Orvego fungicide (Group 40 + 45) or **Stature** fungicide (Group 40)
Empress Intrinsic brand fungicide + Segway® O (Group 11 + 21)
Aliette [or Areca] + Subdue Maxx (Group P 07 + 4)
Segovis (Group 49)

BACTERIAL DISEASES

Phyton® 27, Camelot® O or Grotto™ (M1)
Triathlon® BA (Group BM 02)
Junction (Group M1 + M3)

Pick your favorite foundation and add specialists to help your plants achieve peak performance

EMMA LOOKABAUUGH, PHD
BASF Senior Technical Specialist



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)	Difenoconazole	Postiva*
		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
5	amines (“morpholines”)	piperalin	Pipron
7	SDHI (Succinate dehydrogenase inhibitors)	benzovindiflupyr	Mural*
		boscalid	Pageant Intrinsic*
		flupropram	Broadform*
		flutolanil	ProStar
		fluxapyroxad	Orkestra Intrinsic *
		isofetamid	Astun
		Pydiflumetofen	Postiva*
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, 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

Chemical Class Chart for Greenhouse Nursery Fungicides

FRAC Group	Chemical Group	Active Ingredient Common Name	Trade Name
28	Carbamates	propamocarb	Banol
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	oxathiapirolin	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, Phyton 27, Phyton 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 amyloliquifaciens</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
<i>Ulocladium oudemansii</i> (strain U3)	BotryStop		
Not Classified	inorganic protectants	botanical extract	Neem Oil, Triact 70
		hydrogen dioxide	Zerotol
		oil	Ultra-Pure Oil, SuffOil-X
		potassium bicarbonate	MilStop
		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.

DISEASES CAUSED BY XANTHOMONAS

By A. R. Chase, Chase Agricultural Consulting

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The number of new bacterial diseases found by diagnosticians each year continues to grow. Unfortunately, little research is done to fully describe and characterize these diseases, which leaves them somewhat unknown. The difficulty of identifying bacteria that cause disease remains the most serious problem. Although there have been great strides in identifying viruses on ornamentals, little specific work has been done on bacterial pathogens of ornamental plants.

A further complication is that many types of bacteria that cause leaf spots have close relatives that are not normally plant pathogens, and it is very hard to tell one from the other. The most common causes of bacterial leaf spots are species of *Xanthomonas* and *Pseudomonas*.

Xanthomonas pathovars cause diseases of a wide variety of plants, including many ornamentals. In many cases, a specific pathovar that causes disease on one member of a plant family causes disease on many other members of the same family. The most common diseases caused by *Xanthomonas* pathovars are foliar, and many are typified by lesions, which are corky, dryish, and have irregularly shaped margins or straight edges because the bacterium grows up to a leaf vein but cannot cross it.

At one time, many researchers believed all *Xanthomonas* strains to be plant pathogens, but so much work has been done in the past 20 years it has been proven time and again that some of them do not cause diseases in plants. The original method for differentiating pathovars of this species was host range testing to find out what they attacked. Many so-called “pathovars” are heterogeneous in nature, further complicating the naming process since they can attack many unrelated plants. Possibly some of these “pathovars” are essentially the same organism, and as such, are capable of infecting several families of plants. Fatty acid analysis, carbon source utilization (Biolog) and use of monoclonal antibodies have more recently shown potential for identifying different strains of *Xanthomonas*. The current method is fast and simple and has us testing for *Xanthomonas* and many other bacterial and viral diseases using ImmunoStrip tests. We have stopped actually proving a bacterium causes a disease at all and jump to the conclusion that a positive result on an ImmunoStrip is enough to call it a new disease.

A Case Study - Senetti

In 2022, we saw an outbreak of *Xanthomonas* on geranium that got everyone’s attention and eventually identified the source to a genetics company. In the aftermath of this reaction, we started hearing about a new *Xanthomonas*

disease on Senetti. This was “identified” by use of a generic strip test for *Xanthomonas*. This means it will test positive for different pathovars, and I believe even those *Xanthomonas* may not be pathogenic at all.

The symptoms on Senetti were not typical for any *Xanthomonas* disease and mainly were marginal burning that did not make me think of a bacterial disease at all. It looked more like drought or salt damage at first glance. While I was a professor at the University of Florida, I worked extensively on about 20 different *Xanthomonas* diseases of tropical foliage plants and other ornamentals. I know what this bacterial pathogen typically does. I got tired of this leap to a conclusion and did what had to be done: prove the *Xanthomonas* was the cause of the “disease.”

The only way to prove it was a real disease caused by a *Xanthomonad* was performing Koch’s postulates. Here

photos provided by Margery Daughtrey



Xanthomonas leaf spot on Zinnia ‘Magellan Orange’, BASF sponsored trial, M. Daughtrey & L. Hyatt, Cornell University, 2019.

is a definition for a human disease, and it is the same for humans, animals or plants:

1. The microorganism must be found in diseased, but not healthy individuals.
2. The microorganism must be cultured from the diseased individual.
3. Inoculation of a healthy individual with the cultured microorganism must cause disease.
4. The microorganism must be re-isolated from the inoculated, diseased individual and matched to the original microorganism.

I did this for *Xanthomonas* with this approach and results:

1. Start with looking for consistent symptoms.
 - I did not see any consistent symptoms based on images and samples received from growers.
2. Isolate the “pathogen” always.
 - The bacterium was nearly impossible to isolate.
 - A typical bacterial disease will end up having nearly 100% of the colonies the same. In this case, I found two or three colonies per plate that looked like they might be *Xanthomonas*.
3. Inoculate a healthy plant and see the same symptoms.
 - I did not see symptoms develop on the inoculated plants, with a single exception, and then it actually did look like the nondescript marginal burning.
4. Re-isolate the pathogen.
 - I did find a few colonies of what again might be *Xanthomonas* when re-isolated from the test plants.

Table 1.
Proven *Xanthomonas* diseases.
Plants in the same box are attacked by the same strain (pathovar).

Aglaonema, Anthurium, Dieffenbachia, Philodendron, Syngonium	Geranium	Zinnia
Aralia, English Ivy, Polyscias, Schefflera	Hibiscus	Broccoli, Cabbage, Erysimum, Iberis, Matthiola
Begonia (including Rex)	Pilea, Pellonia	Lettuce
Croton	Poinsettia	Pepper
Ficus	Ranunculus	Pumpkin
Fittonia	Rosemary, Lavender	Tomato

Table 2.
Effective bactericides on *Xanthomonas* leaf spots based on trials.
Check labels for legal uses on your crops in your state.

Bactericides	Active ingredient(s)	FRAC group
Agri-Strep, Agri-Mycin	Streptomycin sulfate	25
Camelot O, Kalmor, Kocide, Phyton 27, Phyton 35	Copper	M1
Cease, Triathlon BA	<i>Bacillus</i> spp.	44
Daconil forms	Chlorothalonil	M5
Dithane, Protect T&O	Mancozeb	M3
Junction	Mancozeb, copper	M1, M3
Postiva	Difenoconazole, pydiflumetofen	3, 7

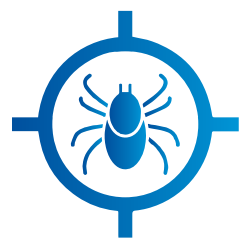
5. I tested some of the symptoms on the inoculated plants with a generic *Xanthomonas* strip test, and only 20% of the attempts yielded a positive result. This also happened using a single sample and checking multiple strip tests.

As far as I am concerned, I failed to prove that a *Xanthomonad* was causing a disease on Senetti. Since you cannot prove a negative, I can’t say the disease is real, but also I cannot say it is not.

Now what? I am not saying the strip tests don’t work. I would simply like the users of this technology to understand that they have not proven there is a new disease simply because they have a positive test. Unfortunately, some diagnostic labs also report the cause of a problem using only a lab test. I know they cannot take the resources and time to prove Koch’s Postulates, and it is not needed if they identify a proven disease caused on a particular plant such as those listed in the table. It is not their job.

Did you know?

- You can mix some *Bacillus*-based bactericides safely with a copper product without reducing the efficacy of the bio-pesticide - many of them are tolerant of copper.
- Aliette can make some bacterial leaf spots worse while controlling others.
- Aliette should not be used in a bactericide rotation due to the low pH, which makes too much copper available and causes copper burn on many plants.
- Excess fertilizer can make bacterial leaf spots worse.



BUILD A SUCCESSFUL MITE MANAGEMENT PROGRAM

By JC Chong, Clemson University (now SePRO Corporation)

photos provided by JC Chong

What are your top five pests? I bet mites are one of them. While infestation by mites may be unavoidable, their management can be successful if a program is built on good understanding of the mites and the management tools available.

Got mites?

Detection of mite infestation is difficult because they are extremely small and love to hide under leaves or in concealed places. Damage caused by mites, such as stippling, discoloration, and distortion, can be mistaken for damage by other issues, such as feeding by thrips, nutrient deficiency, disease infection, phytotoxicity, and unsuitable environmental conditions. Therefore, the first step in management is to confirm that you indeed have a mite infestation. You can do that by looking for signs of infestation, such as the mites and their eggs or shed skin using hand lens, magnifiers (handheld or attached to your mobile devices), or microscopes.

Next, you'll have to figure out which species the mites are. The most common species is the twospotted spider mite (*Tetranychus urticae*). But this is not the only mite species possible in greenhouses and nurseries. Spruce spider mite (*Oligonychus ununguis*), southern red mite (*Oligonychus illicis*), broad mite (*Polyphagotarsonemus latus*), and various species of rust, russet or eriophyid mites raise their ugly heads from time to time. Bulb mites are important in bulb crops, but also are becoming more problematic in tissue culture. As you will see in this article, proper identification of these species, either by you, your local Extension personnel, or by a diagnostic service, is crucial to having a successful management program.

Pre-planting treatment

Stock plants should be as pest-free as possible, and incoming propagated materials should be quarantined and treated before transplanting them or moving them into the production area. Starting with clean seedlings, cuttings or liners will minimize pest problems (whether they are spider mites, thrips, whiteflies or others) in the remaining crop cycle.

An effective method of pre-planting treatment is to dip cuttings, liners or seedlings in 0.1% horticultural oil (such as SuffOil-X), a combination of insecticidal soap (M-Pede) and *Beauveria bassiana* strain GHA (BotaniGard WP), or hexythiazox (Hexygon IQ). These treatments resulted in six to eight weeks of low mite infestation in my experiments. These are valuable times when biological control can provide continuous suppression of mite population and reduce the need for miticide application. Dipping of poinsettia cuttings in **Velifer** fungal contact insecticide/miticide (*Beauveria bassiana* strain PPRI 5339) solution also reduced whitefly abundance; I expect dips with Velifer to be effective against spider mites. In another experiment, results suggest that the efficacy of Velifer was not affected by sprench with **Pageant Intrinsic** fungicide (pyraclostrobin + boscalid) applied four days after cutting dip. The result suggests that Pageant Intrinsic fungicide can be used for disease prevention during the rooting phase without reducing the efficacy of cutting dips with Velifer.



Left unchecked spider mites can kill even vigorous plants. This webbing is hydrophobic and difficult for sprays to penetrate. Take these to the trash and treat the rest.



The characteristic feeding damage, or stippling, of spider mites up close: bleached spots appear on the tissue look white or light yellow here. On some crops they can appear bronze, brown or orange.

Cultural control methods

Maintaining plant health is the best way to allow plants to tolerate and recover from spider mite infestation. Reducing or eliminating weeds from the growing area, which serve as refuges and alternative hosts of mites, particularly spider mites, can go a long way in reducing mite infestation.

Heavily infested, distorted or webbed plants should be thrown away immediately. Infestation may already be too heavy to manage successfully or rescue when webbing occurs. After taking the trash out, treat the remaining plants to reduce mite populations and prevent more damage.

Use biological control as the first line of defense

A biological control program should be initiated as soon as mites are detected and before damage occurs. Many biological control agents are available for managing mites. Almost all commercially available biological control agents are recommended for managing spider mites, but some species can also be used for managing broad mites or russet mites. Check with your local suppliers to determine which species and which method of release is most suitable for your mite management needs.

In some cases, one to two applications of biological-compatible miticides may be needed to reduce the mite population so that the biological control agents have a chance of suppressing the surviving mite population. It is important to think about how miticides or insecticide applications against other pests may impact the effectiveness of biological control programs against spider

mites on the same crop. Insecticides and miticides are created to kill insects and mites, so it should not be a surprise that they will have negative impacts on the survival and behavior of predatory and parasitic insects and mites. Different pesticides have different effects on biological control agent species. You should consult with your biological control agent suppliers on how to avoid the negative impact of pesticide application on biological control.

Choose your miticides wisely

Miticides should be used before a crop suffers unacceptable damage from mites. Miticides are more effective as an early curative tool, rather than a tool to rescue a heavily infested crop. A large number of pesticides are registered for use against mites. Most of these miticides are registered for spider mite management, but some are more broad-spectrum with efficacy against other mite groups. I recommend using only miticides for mite management. Avoid using broad-spectrum insecticides for mite management because these insecticides are toxic to many insects and mites, including the biological control agents you use for managing spider mites and other pests.

Like a broken record, I have to remind everyone to rotate miticides. Mites are notorious for their ability to develop resistance to insecticides and miticides in a very short period of time. To prevent pesticide resistance, you should only spray when needed, incorporate biological control and other non-chemical management tools, and always rotate among miticides of different modes of action or IRAC (Insecticide Resistance Action Committee) numbers.



To find more information on various families of mites that attack ornamental plants, read Clemson University's article at <https://tinyurl.com/5n84vzjb>.



Stippling on marigold leaves is a heavy hint, and the webbing with spider mites between the flower and bud in the upper right corner leaves no doubt.

Consider these factors when selecting the right miticides:

- Mite species:** Not all miticides are created to kill all mite species. Some (such as Akari and Pylon) kill broad mites, spider mites and eriophyid mites; some (such as Floramite and Sultan) only kill spider mites. Proper identification of the mite family or species will help you select the right miticide for the mite species.
- Mite life stages:** Not all miticides kill all life stages. Some (such as Akari and Sultan) kill eggs, nymphs and adults; some (such as Beethoven TR and Hexygon) only kill eggs and nymphs. Identify the predominant life stage of the mite population and start the program with the most effective miticide for that life stage(s).
- Contact vs. translaminar:** Contact miticides (such as Akari and Sultan) kill when mites are sprayed by the solution or are in contact with the residue. The active ingredients of translaminar miticides (such as Beethoven TR and Pylon) can move into leaf cells, so they can kill through contact and when mites feed on the treated leaves. Thorough coverage of the plant canopy will achieve better control regardless of whether you are using a contact or a translaminar miticide.
- Compatibility with biological controls:** As mentioned before, you want to choose a compatible miticide when biological control is deployed on the same crop. Direct and residual toxicities of miticides will determine when you can introduce or reintroduce biological control agents.

Read this article, “Put Mites in the Rearview Mirror” in the April 2023 issue of *GrowerTalks* tinyurl.com/n2xvstfe, for more guidance on selecting the right miticides for your operation.

Table 1. Commercially available biological control agents recommended for the management of various phytophagous mites. Scan QR code or visit <https://tinyurl.com/bdfapsf4> for more information.



Type	Species	Target mite species	Target mite life stages
Predatory mite	<i>Amblyseius andersoni</i>	Broad mite	All, with preference for nymphs
		Cyclamen mite	
		Spider mites	
	<i>Galendromus occidentalis</i>	Tomato russet/rust mite	All
		Spider mites	
		Some eriophyid mites	
<i>Neoseiulus californicus</i>	<i>Mesoseiulus longipes</i>	Spider mites	All
	<i>Neoseiulus fallacis</i>	Twospotted spider mite	All
		Cyclamen mite	
		Broad mite	
Predatory thrips	<i>Scolothrips sexmaculatus</i>	Some eriophyid mites	All, but prefers eggs
		Broad mite	
Predatory midge	<i>Feltiella acarisuga</i>	Spider mites	All
Predatory beetle	<i>Stethorus punctillum</i>	Spider mites	All, but prefer eggs

Note: Consult your biological control agent suppliers for availability. Although *Amblyseius degenerans*, *Amblyseius swirskii* and *Neoseiulus cucumeris* are sometimes marketed for management of various mite species, they are generally not recommended for mite management.

Table 2. The IRAC (Insecticide Resistance Action Committee) group number, mobility property (T = translaminar; C = contact), and effective mite species and life stage of selected miticides. Scan the QR code or go to tinyurl.com/n2xvstfe to see “Put mites in the rearview mirror” in April 2023 issue of *GrowerTalks*.



IRAC Group Number	Active ingredient	Mobility property	Target mite family			Target mite life stage		
			Spider mites	Tarsonemid mites	Eriophyid mites	Egg	Nymph	Adult
5	spinetoram	T	■				■	■
	spinosad	T	■				■	■
6	abamectin	T and C	■	■	■		■	■
10A	clofentezine	C	■			■	■	
	hexythiazox	C	■			■	■	
10B	etoxazole	T and C	■			■	■	
12B	fenbutatin oxide	C	■				■	■
13	chlorfenapyr	T and C	■	■	■		■	■
20B	acequinocyl	C	■			■	■	■
20D	bifenazate	C	■			■	■	■
21A	fenazaquin	C	■	■	■	■	■	■
	fenpyroximate	C	■	■	■	■	■	■
	pyridaben	C	■	■	■	■	■	■
23	spiromesifen	T and C	■	■	■	■	■	■
	spirotetramat	T and C	■	■	■	■	■	■
25	cyflumetofen	C	■			■	■	■

2024 Insecticides and Miticides for Managing Insect and Mite Pests of Greenhouse-Grown Horticultural Crops

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Be sure to rotate insecticides and miticides with different modes of action within generations to avoid the potential for insect and mite pest populations to develop resistance. —Raymond Cloyd

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
	Cyantranilprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyranilprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclanilprole + Fonicamid	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
	Fonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
Flupyradifurone	Altus	4 hours	4D: 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)
APHIDS <i>continued</i>	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	
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Methiocarb	Mesuroil	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-It/ Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyriproxyfen	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
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
Cyantranilprole		Mainspring	4 hours	28: Selective activation of ryanodine receptors
Cyclanilprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors	

(Pest control materials in **bold typeface** are from BASF.)

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>	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
	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
	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
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

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 LARVAE <i>continued</i>	<i>Steinernema feltiae</i>	Nemasys , NemaShield, Scanmask, and Entonem		
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
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
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-It/ 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

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>	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
	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 + 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
	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)
MEALYBUGS <i>continued</i>	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
	Fonicamid	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
Cyclaniloprole + Flonicamid		Pradia	12 hours	28 + 29: Selective activation of ryanodine receptors + Selective feeding blocker/chordotonal organ modulator
Fonicamid		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
	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
	Cytraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole + Fonicamid	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
	Fonicamid	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	Mesuroil	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 (TWO SPOTTED) <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
	Cytraniliprole	Mainspring	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniloprole + Fonicamid	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	
Fonicamid	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	Mesuroil	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
	Cyfluthrin	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyfluthrin + Fonicamid	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
	Fonicamid	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-It/ 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
	Pyriproxyfen	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.

(Pest control materials in **bold typeface** are from BASF.)

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: rclloyd@ksu.edu

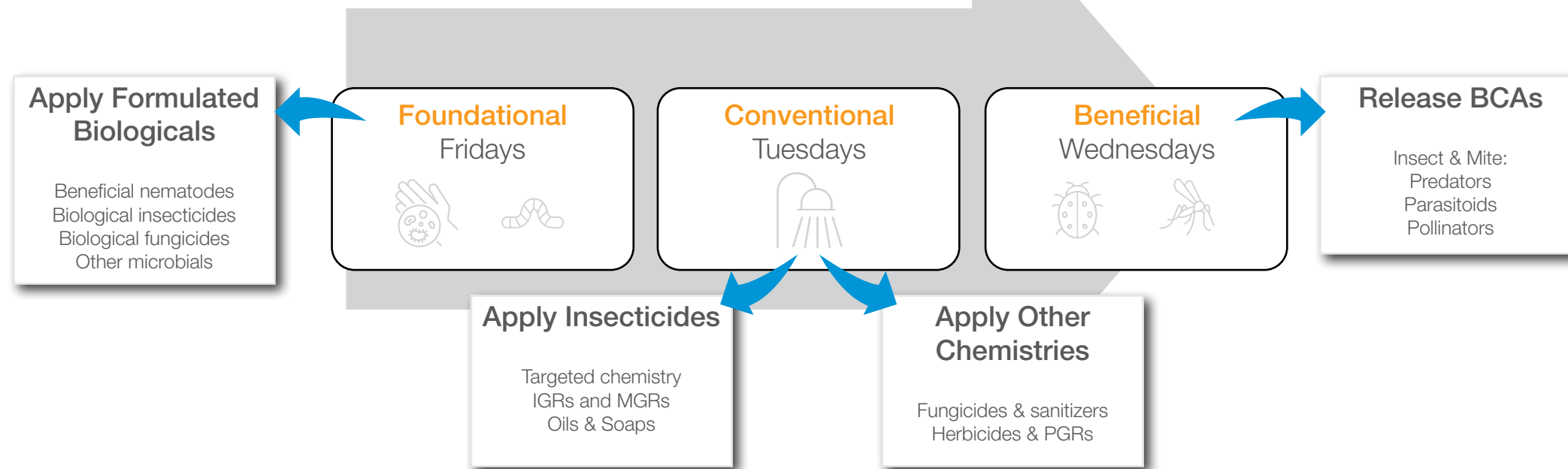
July, 2023

BASF APPROACHES TO IPM FOR INSECTS + MITES

Two Ways to Manage Pest Pressure: Maintenance and Response

Slow Your Roll

Dial down pest pressure • Elongate intervals between broad-spectrum applications • Delay resistance • Activate your IPM program



Target Pest	Rescue Me		Foundational Friday Maintenance Product
	Broad-Spectrum	Targeted ¹	
Aphids	Safari [®] insecticide	Ventigra [®] insecticide	Velifer [®] fungal contact insecticide/miticide
Broad Mites	Pylon ^{®2} miticide-insecticide, Sanmite [®] miticide/insecticide	Savate [®] miticide/insecticide	Velifer fungal contact insecticide/miticide
Fungus Gnats	Discus [®] insecticide	Fulcrum [®] insect growth regulator or Distance [®] insect growth regulator	Nemasys [®] beneficial nematodes
Mealybugs + Scale	Ultra-Pure [®] Oil horticultural insecticide, miticide and fungicide, Safari insecticide	Ventigra insecticide	Velifer fungal contact insecticide/miticide
Shore Flies	Citation [®] insecticide	Fulcrum insect growth regulator or Distance insect growth regulator	Millenium [®] beneficial nematodes
Spider Mites	Pylon ² miticide-insecticide, Kontos [®] insecticide/miticide	Sultan [®] miticide, Hexygon [®] miticide	Velifer fungal contact insecticide/miticide
Western Flower Thrips	Pylon ² miticide-insecticide, Avid ² miticide/insecticide	Mainspring [®] insecticide	Velifer fungal contact insecticide/miticide, Nemasys beneficial nematodes
Whiteflies	Discus insecticide, XXpire [®] insecticide	Ventigra insecticide	Velifer fungal contact insecticide/miticide

Rescue Me

Knockdown pest spikes • Dial-in broad-spectrum or targeted rescue • Get on track for consistent management with fewer rescues

¹ Running a BCA program? Compare product labels to species in use. Confirm compatibility to your non-targets. Compatibility is a function of active ingredient + formulation + tank-mix partners + application method. BASF recommends Beneficials & Pollinator Safety Mindset to protect BCAs and non-target arthropods.

² Manage for resistance with established single A.I. chemistry: avoid sequential apps within a generation.

Always read and follow label directions.

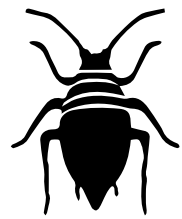
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BUILDING BETTER INSECTICIDE PROGRAMS

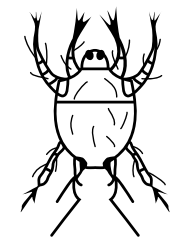
Basic Rotations + Functional Glow Ups

the IPM decision tree
basic rotations to build on
add functional groups that
work for your operation



APHIDS

- Ventigra® insecticide (Group 9D)
- Velifer® fungal contact insecticide/miticide (Group NC)
- Pradia® insecticide (Groups 28+29)
- Kontos® insecticide/miticide (Group 23)
- IGR: Azatin® O biological insecticide (Group UN)



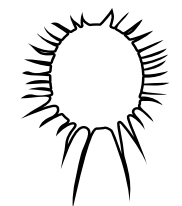
BROAD MITES

- Ultra-Pure Oil insecticide, miticide, fungicide (Group NC)
- Velifer® fungal contact insecticide/miticide (Group NC)
- Pylon® miticide or Pylon TR miticide (Group 13)
- Sanmite® miticide/insecticide (21A)
- Sirocco® miticide/insecticide (6+20D)



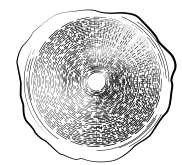
FUNGUS GNATS

- Nemasys® beneficial nematodes (Group NC)
- Citation® insecticide (Group 17)
- Discus® insecticide (Groups 3A+4A)
- IGR: Fulcrum® insect growth regulator (Group 7C)



MEALYBUGS

- Ultra-Pure Oil insecticide, miticide, fungicide (Group NC)
- Ventigra insecticide (Group 9D)
- Pradia insecticide (Groups 28+29)
- Safari® insecticide (Group 4A)
- IGR: Talus® insect growth regulator (Group 16)



SCALE

- Ultra-Pure Oil insecticide, miticide, fungicide (Group NC)
- Ventigra insecticide (Group 9D)
- Pradia insecticide (Groups 28+29)
- Safari insecticide (Group 4A)
- IGR: Fulcrum insect growth regulator (Group 7C)

Targeted
Conventionals

Formulated
Foundational
Biologicals

Growth
Regulators

Broad-Spectrum
Conventionals

Beneficials &
Predators

Oils & Soaps

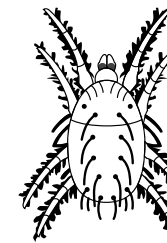
Cultural &
Mechanical
Controls

Scouting &
Record-Keeping



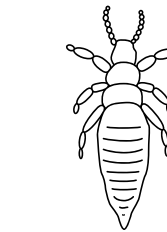
SHORE FLIES

- Millenium® beneficial nematodes (Group NC)
- Azatin O biological insecticide (Group UN)
- Citation insecticide (Group 17)
- Discus (IRAC 3A+4A)
- IGR: Fulcrum insect growth regulator (Group 7C)



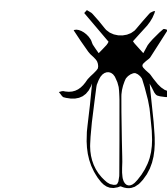
SPIDER MITES

- Sultan® miticide (Group 25)
- Velifer fungal contact insecticide/miticide (Group NC)
- Pylon miticide-insecticide or Pylon TR miticide-insecticide (Group 13)
- Kontos® insecticide/miticide (Group 23)
- IGR: TetraSan® miticide/ovicide or Beethoven® TR miticide/insecticide (Group 10B)



THRIPS

- Pylon miticide-insecticide (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 insect growth regulator (Group 16)

Always read and follow label directions.

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We make suggestions,
you make the decisions

JEN BROWNING, PCA
BASF Senior Technical Specialist



RED-HEADED FLEA BEETLE MANAGEMENT IN CONTAINER NURSERIES

By Danny Lauderdale, Area Specialized Agent, NC State Extension

The red-headed flea beetle (RHFB), *Systema frontalis*, is a pest of broadleaved ornamental plants due to multiple generations in the super-heated and frequently irrigated container environment. It is found from the Rocky Mountains to the East Coast and Southern Canada to Florida and Texas. Growers have identified *Hydrangea paniculata*, *Itea virginica*, *Weigela florida*, *Rosa* spp., *Cornus* spp. (shrub and tree species), *Sedum* spp., and *Salvia* spp. as commonly damaged plants.

Any broadleaved plant with tender growth when adults are present is susceptible. Populations build on broadleaved deciduous plants and, as pressure increases, broadleaved evergreens like *Ilex* spp., *Osmanthus* spp., and *Rhododendron* spp. (azaleas) can be damaged. Adults eat holes in tender leaves or skeletonize older or thicker leaves making ornamental plants unsightly and difficult to market for retail sale.

Biology

RHFB adults are black with a reddish to light brown head and are up to one-quarter-inch long. Antennae are serrate and each segment ranges from light to dark brown. The last set of legs has enlarged femurs adapted for jumping.

Larvae are up to 0.4-inch long and creamy white, have a light brown head, and three pairs of legs. The gut may be visible through the translucent body. The last segment has a fleshy upward projection with hairs. They feed on roots and have been known to damage cranberry roots in production but don't seem to noticeably affect ornamental roots. Since most larvae of the insects are in container substrate in nurseries, they are a key stage to target to prevent pupation to the damaging adult stage.

Life Cycle

(GDD₅₀-Growing Degree Days based on 50°F)

- Overwinter as eggs laid in the fall in the substrate and soil of host plants.
- 1st generation larvae hatch begins at ~250-500 GDD₅₀ and are found up to ~800 GDD₅₀.
- 1st generation adult emergence begins at ~500-1,000 GDD₅₀.
- 2nd generation larvae hatch begins at ~1,500-1,800 GDD₅₀.
- 2nd generation adult emergence begins at ~1,800-2,200 GDD₅₀.
- All life stages are typically found once 2nd generation adults emerge and into fall.

photos provided by Danny Lauderdale



Larvae can be found in large numbers in one container.

Scouting Tips

First-generation larvae management is key to reducing heavy infestations.

- Check plants with previous year's foliar damage by inspecting root balls.
- Focus on bottom and sides of root balls.
- Inspect on warm days, 30 minutes to 1 hour after irrigation.
- If root balls are cold or dry to the touch larvae will move inside and can't be found.
- Larvae are light sensitive and will move in quickly in full sun.

- Scouts should use their body to shade sun to avoid missing quick, sun-shy larvae.
- Second-generation larvae can be targeted if first-generation is missed.

Adult scouting is important to detect the insects not controlled as larvae.

- Clusters of small holes on tender foliage are a key to look closer for adults.
- On sunny, hot days, look in the shade of the first few sets of leaves.
- Adults jump or fly away with disturbance or excess movement.
- Avoid brushing against plants that will result in insect escape.
- Walk on the down-sun side of plants to avoid shadows scaring adults.

Decision Making

Growers indicate foliar injury should be below 10% for retail sales. If growing for commercial landscape installation, greater injury may be tolerated. Growers should determine if susceptible species or cultivars are worth growing and may consider dropping heavily damaged, low-profitability plants. Work with sales and marketing staff to make sure efforts are made to sell smaller container-grown shrubs within one year. If plants remain for over a year, consider reducing future production. In larger production sizes (over 3 gallon), a long-term, multifaceted management plan is critical to producing quality plants with little injury for on-time sales.

Cultural Management

(production practices and tips to manage populations)

- Use enclosed or insect-screened houses to prevent propagation population buildup.
- Determine if liner sources have RHFB management programs.
- Scout plants for larvae and/or adults upon arrival based on lifecycle and GDD₅₀.
- Most pressure exists in container nursery production areas.
- Scout perimeter weeds and plants to find small numbers moving from border areas.
- Rotate susceptible plant production locations yearly to avoid population transfer.
- Rotating susceptible plants and non-host conifers.

Biological and Chemical Management

Historically, growers have focused on targeting adults. If growers see heavy, repeated years of injury, then targeting larvae prior to first generation egg hatch or after emergence is key to reducing plant injury by preventing pupation to adults.

Drench applications of systemic insecticides or insect growth regulators that target first-generation larvae just after egg hatch can be done prior to 250-400 GDD₅₀ (before egg hatch). Product options are azadirachtin (insect growth regulator), cyantraniliprole (diamide), dinotefuran (neonicotinoid), imidacloprid (neonicotinoid), or thiamethoxam (neonicotinoid). Chlorantraniliprole (diamide) is currently being trialed for this pest. Granular insecticides containing imidacloprid can be incorporated in the substrate or top-dressed after potting at medium to high rates to prevent injury to plants highly susceptible.

To target larvae after first-generation egg hatch in stock plants, previous year plants, or incoming liners, drench applications can be made between 250 GDD₅₀ and 800 GDD₅₀ when larvae are found in root balls. Options that require two applications are azadirachtin (insect growth regulator), *Beauveria bassiana*, *Isaria fumosorosea* Apopka Strain 97, and *Metarhizium anisophilae* (entomopathogenic fungi). Options that require one well-timed application are *Steinernema carpocapsae* (entomopathogenic nematode), or insecticides containing acephate (organophosphate), cyantraniliprole (diamide), or spinetoram + sulfoxaflor (spinosyn + sulfoximine). Second-generation larvae can be targeted also.

Foliar applications can be made as a last resort based on insect pressure when adults begin emerging around 500 to 1,000 GDD₅₀ or after. Light pressure requires monthly applications. Medium pressure requires applications every two weeks. High pressure without larvae management often requires weekly applications. There are many foliar-applied products that reduce adults. Good foliar-applied options include active ingredients acephate (organophosphate), bifenthrin (pyrethrin), carbaryl (carbamate), chlorantraniliprole (diamide), cyantraniliprole (diamide), cyclaniliprole (diamide), cyclaniliprole + flonicamid (diamide + flonicamid), cyfluthrin (pyrethroid), tau-fluvalinate (pyrethroid)(good in rotation to ensure mite suppression), lambda-cyhalothrin (pyrethroid), sulfoxaflor + spinetoram (sulfoximine + spinosyn), and tolfenpyrad (mitochondrial electron transport inhibitor). Boom or hand spraying may provide better coverage and reduction than air blast sprayers.

Always read and follow label instructions for rate or application limits. Rotate between classes of insecticides to prevent resistance. Consider your employees and the environment by following all label instructions, including personal protective equipment requirements, worker protection standards for re-entry, and precautions for environmental safety.



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