

GROWERTALKS

MAGAZINE • SINCE 1937

Insecticide, Miticide, & Fungicide Guide



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We create chemistry

2023

PASSION GROWS PROGRESS

We share a common passion with growers: to cultivate stronger plants, lasting beauty and real results. For more than a decade, that passion has been the driving force behind the Intrinsic® brand fungicide portfolio — the first fungicide solutions recognized by the EPA for their plant health benefits. It's why we always push the scientific envelope and our industry forward. So let's put down our roots, watch them grow and together, we'll be Pioneers of Plant Health.

BASF
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Intrinsic®
Brand Fungicides

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GROWERTALKS

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GreenProfit Supplement Enclosed



Here we are again, back for our eighth iteration of the Insecticide, Miticide, & Fungicide Guide. This industry continues to demonstrate resilience, perseverance and grit as we ride the waves of supply chain and socio-economic challenges. We take great pride in this sponsorship and challenge ourselves to gather and elevate the tools and resources year after year.

There continues to be no shortage of challenges affecting our industry, from rising gas prices and inflation to consumer demand. The key difference is that these challenges are now universally understood throughout our value chain and seemingly across all industries. We also recognize the fundamental shift in the perception of plants that has occurred among consumers.

Pre-pandemic, plants were considered a discretionary spend that ebbed and flowed with the health of the housing market. In a post-pandemic world, plants for many consumers have become a tangible representation of mental health and wellness. That shift in perspective has put added consumer influence on the value chain with more scrutiny on how a plant is treated before it hits the store.

Navigating these complexities requires strong supplier partnerships. We recognize that we're only one part of a growing operation, but we're dedicated to providing the technical resources and expertise needed to navigate many unique challenges.

We continue to innovate unique products like **Avelyo**® fungicide, which is a next-generation DMI with no injury to plants. Avelyo fungicide, in rotation with **Pageant**® and **Orkestra**® **Intrinsic**® brand fungicides, offers improved resistance management for tough-to-control diseases like powdery mildew, leaf spots and soilborne diseases.

As part of our dedication to sustainable solutions, we're shifting to targeted and soft chemistries with favorable safety profiles to beneficial insects. **Ventigra**® insecticide is our latest example of this approach targeting piercing and sucking insect pests. **Nemasys**® beneficial nematodes and **Velifer**® fungal contact insecticide/miticide are two biological solutions that can be used in rotation with conventional chemistries to manage resistance issues.

Additionally, we previously announced the translation of our pesticide labels to Spanish for the safety and stewardship of our products. We've now expanded these efforts to include this very guide, providing Spanish translated versions going forward in partnership with *GrowerTalks*.



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

Liz Dunbar
Product Manager
Greenhouse & Nursery

On the cover: A gerbera showing yellow streaking on the petals from thrips feeding and there's a fungus gnat on one of the petals, as well. Photo by Dr. Emma Lookabaugh.

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 2022. 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.



Case Study: Young's Plant Farm

PREVENTION, PRESERVATION AND PLANT HEALTH

For six decades, Young's Plant Farm has built a reputation for producing healthy, beautiful plants for its customers; learn how BASF chemistries help them navigate continuous growth and innovation.

In 1961, Gene Young founded Young's Plant Farm in Auburn, Alabama, with the vision of innovating and adopting new technologies to ensure that future generations could always enjoy beautifully grown plants. Over the last six decades, the space has expanded to three farms in two states to accommodate customers' different desires for ornamental plants, including annuals, perennials, potted plants and holiday crops.

As the Director of Horticulture, Tom Costamagna oversees all aspects of growing, including culture, technology and consulting. In his role, he must also help ensure his team is equipped with the best chemistries possible to address any pest or disease issues that may arise throughout the season. They may ship 150-200 truckloads of plants in any given week, so there is little room for error. "Having blemishes or some disease is not really an option," said Tom. "We have to produce these plants to the best of our capability."

Between damaging insects, fungal pathogens and the extreme Alabama temperatures, Tom and his team must be ready for anything that can negatively impact the health and beauty of their plants, from the time they're planted until the moment they arrive at their final destination. With the help of BASF products and support, Tom and his team have been able to keep up with the intense demands of the ornamental industry and the consumers that buy their plant products.



"BASF and their chemistries have been crucial in my success, academically and commercially."

— Tom Costamagna, Director of Horticulture, Young's Plant Farm

Tom credits innovative chemistries from BASF as one of the key contributors to both his own success and that of Young's day-to-day operations. These chemistries include Avelyo® fungicide, a new broad-spectrum DMI technology that is safe to use at every stage of plant production, as well as Orkestra® Intrinsic® brand fungicide and Pageant® Intrinsic brand fungicide. Intrinsic brand fungicides from BASF offer superior plant protection through a combination of broad-spectrum disease control and plant health benefits in the form of increased growth efficiency and better stress tolerance. "BASF and their chemistries have been crucial in my success, academically and commercially," said Tom. "The tools they provide fill gaps [by] controlling a number of insects and diseases that are not manageable [with] other products."



Learn more at betterplants.basf.us

Always read and follow label directions.

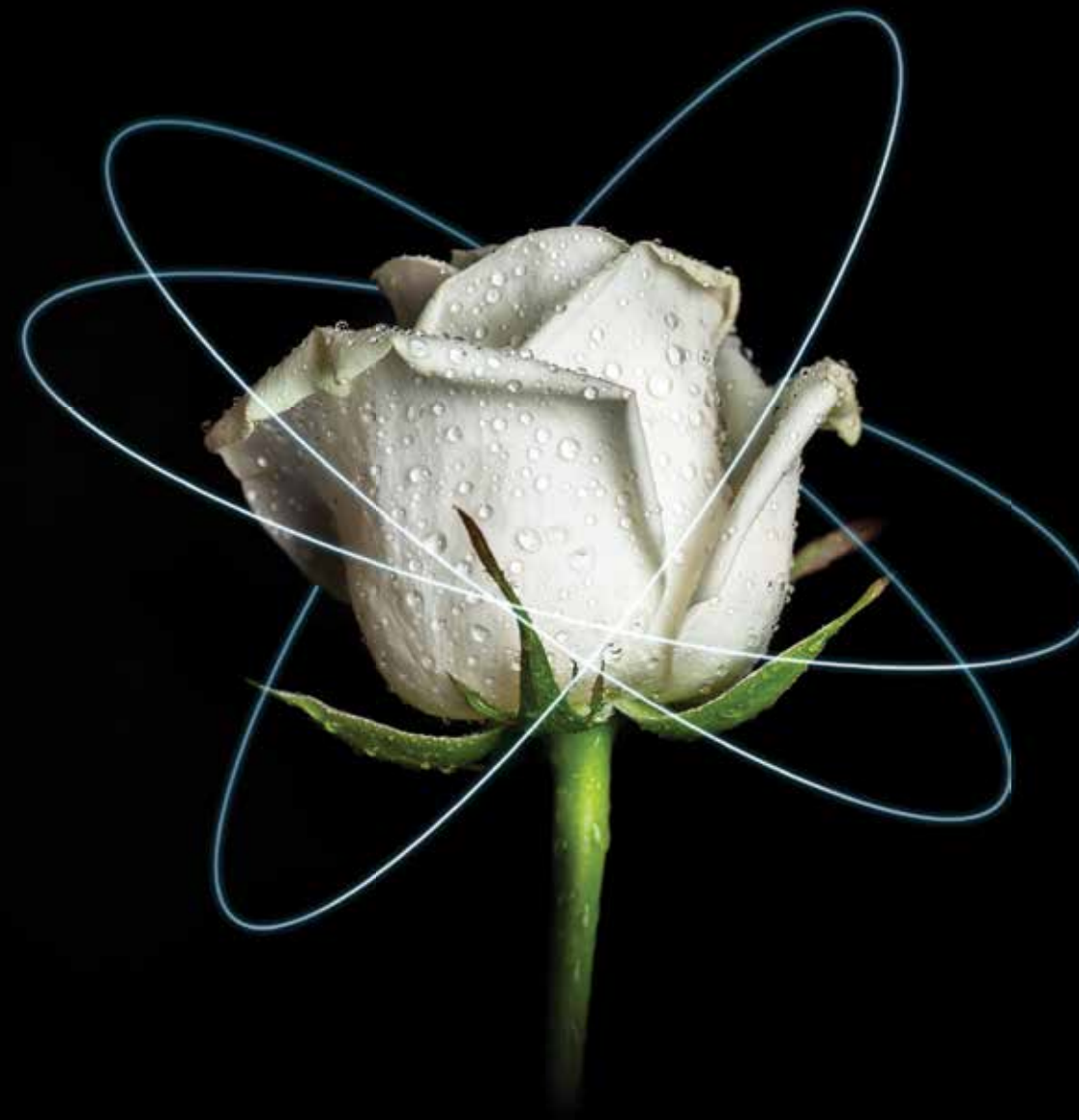
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BASF
We create chemistry

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



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Building Better Fungicide Programs

Balanced Plant Protection Solutions

Well-rounded programs rooted with Intrinsic plant health benefits: let's cultivate stronger plants, lasting beauty and real results

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)



“ Sometimes the early stages of disease are overlooked or misidentified. Here we try to avoid expensive reactive sprays and calibrate our preventive approaches for better results. Get ahead of disease with a **strong foundation.** ”

EMMA LOOKABAUGH, PhD
BASF Senior Technical Specialist

Spray ←
For foliar diseases

Adjuvants ←
For efficacy boosts & residue management

Proper Diagnosis ←

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



pick your favorite **foundation -**
add specialists

when you need extra control

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 ROTTS (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 PO7 + 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 PO7 + 4)
Segovis (Group 49)

BACTERIAL DISEASES

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

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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, Hurricane*
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, 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

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.

THE INTRINSIC® DIFFERENCE – Backed by Science, Proven in Production

We share a common passion with growers: to cultivate stronger plants, lasting beauty and real results. For more than a decade, that passion has been the driving force behind the Intrinsic® brand fungicide portfolio – **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.

Increased Growth Efficiency	Increased Tolerance to Plant Stress	Powerful Disease Control
<ul style="list-style-type: none"> • Reduces carbon loss • Increases activity of nitrate reductase (key enzyme for nitrogen assimilation in plant cells) <p>More energy and nitrogen available for plant growth</p>	<ul style="list-style-type: none"> • Increases nitric oxide • Triggers defense mechanisms • Reduces ethylene production • Increases antioxidative capacity <p>Improved tolerance to drought, moisture and mechanical stress plus ability to recover from temperature extremes</p>	<ul style="list-style-type: none"> • Inhibits mitochondrial respiration in fungal cells <p>Broad-spectrum control of root, crown and foliar diseases</p>

The Science Behind Plant Health

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 the active ingredient, pyraclostrobin, improved disease control and plant health through inhibition of mitochondrial respiration – in both fungal pathogens AND plants.

So what does mitochondrial respiration have to do with anything? Well in pathogenic fungi, it's simple. If you remember anything from high school biology, you might recall that the mitochondria is the powerhouse of the cell. Mitochondrial respiration is basically a set of metabolic

reactions that convert the energy stored in carbon sources (think sugars) into the fuel required for fungal growth. Long story short, pyraclostrobin (the active ingredient in Intrinsic fungicides) inhibits mitochondrial respiration and as a result, the fungus can't supply the energy it needs to keep growing— so it dies.

In plants, it's a little more complicated. Pyraclostrobin still inhibits mitochondrial respiration, but because a plant's primary source of energy comes from sunlight, decreasing respiration can actually have a positive effect on plant growth. Pyraclostrobin jumpstarts a cascade of positive metabolic changes in the plant.

Intrinsic

(adjective) belonging naturally; essential

This combination of disease control, stress reduction and increased growth efficiency is intrinsically tied to pyraclostrobin. Not all fungicides are created equal and Intrinsic brand fungicides provide a difference you can see. The Intrinsic difference is backed by science – these were the first fungicide solutions recognized by the EPA for their plant health benefits. But even more importantly, the Intrinsic difference has been proven in production, by you, the growers. In greenhouse and nursery crops, Intrinsic plant health benefits can be seen in the form of superior disease control, improved callus formation, increased root density, improved plant quality and

increased tolerance to cold, heat and drought stress. To see the greatest plant health benefits, apply Intrinsic brand fungicides regularly throughout production – before stress happens. **So let's put down our roots, watch them grow, and together, we'll be Pioneers of Plant Health.**

i Extensive laboratory studies in Germany and the United States proved that the active ingredient pyraclostrobin improved disease control and plant health through inhibition of mitochondrial respiration – in both fungal pathogens AND plants.



The Power to Withstand Stress



Learn more about the plant health benefits of **Intrinsic®** brand fungicides



THE INTRINSIC® DIFFERENCE – Start with a Strong Foundation

Benefits Proven in Propagation

Pageant Intrinsic brand fungicide @ 12 oz

Mural® fungicide @ 7 oz

Powerful Disease Control

Empress® Intrinsic
brand fungicide @ 3 fl oz
+ Segway® O fungicide
@ 1.5 fl oz Tank Mixed

Segway O fungicide
@ 3.0 fl oz

Prestige Red Poinsettia plants inoculated with
Pythium aphanidermatum

Geranium rooting
16 days after treatment
23 days after treatment



6-7 Weeks of Coverage to Transplant

At sticking	+14 days	+14 days under mist	Prior to transplant
Pageant Intrinsic brand fungicide	Pageant Intrinsic brand fungicide	Chipco® 26019 fungicide or Daconil® fungicide or Avelyo® fungicide	Empress® Intrinsic brand fungicide
12 oz	12 oz	SLR (Standard Label Rate)	3 fl oz drench

“Pageant Intrinsic in propagation
is a total game-changer. For difficult-to-root
cultivars or stressed-out cuttings, spray
Pageant @12 oz right after sticking. Early
protection under mist delivers Intrinsic
benefits for fewer skips and more roots
in the prop house.”

– Leah Van der Heide
BASF Sales Specialist



Intrinsic®
Brand Fungicides

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BENEFICIAL NEMATODES BIOLOGICAL PEST CONTROL

By Suzanne Wainwright, Buglady Consulting

Beneficial nematodes are microscopic worms that attack and kill many targeted pest insects. Within the infected insect, the beneficial nematodes reproduce and then disperse control.

Types of beneficial nematodes and target pests

Heterorhabditis bacteriophora

- European chafer grub (*Rhizotrogus majalis*)
- Japanese beetle grub (*Popillia japonica*)
- Oriental beetle grub (*Exomala orientalis*)

Steinernema carpocapsae

- Armyworm (*Noctuidae*)
- Black vine weevil (*Otiorhynchus sulcatus*)
- Cutworms (*Noctuidae*)
- Shore flies (*Ephydriidae*)

Steinernema kraussei

- Black vine weevil (*Otiorhynchus sulcatus*)

Steinernema feltiae

- Fungus gnat (*Bradysia* spp.)
- Western flower thrips (*Frankliniella occidentalis*)
- Onion thrips (*Thrips tabaci*)

How to confirm you are applying live nematodes

Take either a petri dish or the plastic tray the nematodes came in and set it out in the area where nematodes are going to be applied. Spray over top of the dish and collect the water being applied with the nematodes. You can then either use a 10X hand lens or place the collection tray under a dissecting scope. Look for nematodes swimming in an “S” pattern. If you do not see any, there is a problem. If nematodes are straight and not moving there is a problem.

Benefits to using beneficial nematodes

- No REI
- Do not have to worry about developing resistance
- Compatible with many pesticides on the market (there are a few that can cause issues so make sure you check the BASF combability guide)
- No odor
- Target life stages that pesticides sometimes cannot kill
- Easy biological control agent to get started with

Common mistakes

- Storing nematodes too warm (store at 41°F/5°C)
- Not checking nematode quality before mixing and applying
- Leaving nematodes in spray tank with no agitation and aeration; they will be drowned and sink over time
- Leaving screens in water lines
- Applying over 300 PSI
- Applying in full sun

“You can apply
nematodes through the
chemigation system for
ease of application and
better coverage.”



– Scott Dunham
BASF Sr. Sales
Specialist

BASF
Chemical
Compatibility
Guide



“Nematodes are an amazing biological control
option, but if they are not applied correctly,
growers will not see their pests controlled.”

SUZANNE WAINWRIGHT



How to be successful with beneficial nematodes

By Suzanne Wainwright, Buglady Consulting

Commercial beneficial nematodes have been around for decades now and are part of many standard pest management programs. Even with billions of these tiny worms being applied in so many crops, many growers do not understand how they work and what they really are.

The basics of nematodes

In the simplest of terms, nematodes are microscopic, non-segmented worms. They are the most numerous multicellular animals on Earth. Just as with any group of organisms there are some nematodes that are beneficial, some that are problematic, and some irrelevant to agricultural production.

The beneficial nematodes (also called entomopathogenic, which means insect-killing) often refer to the species in the genera *Steinernema* and *Heterorhabditis*. There are commercially produced products containing these species, and they are considered beneficial because of their ability to kill insects. There are other beneficial nematodes (not commercially available) that feed on bacteria and fungi and can aid in nutrient cycling.

Problematic nematodes can include root-knot nematodes (*Meloidogyne* spp.) and lesion nematodes (*Pratylenchus* spp.), as well as many other species. These plant-parasitic nematodes can be devastating to agriculture, and researchers are continually working on control and suppression options.

Entomopathogenic nematodes

There are many naturally occurring species of insect-killing nematodes in the environment, but only a few are commercially produced. By far the species *Steinernema feltiae* is the most produced (by volume) because of the pests it targets. *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* are also commercially produced.

But how do these small worms actually kill insects? When beneficial nematodes are purchased, they are in the infective juvenile stage, which is the free-living stage of their life. This means they can live outside of an insect's body and are ready to infect a host. The nematodes will use chemical cues to find their prey, then enter the insect through a natural opening such as the anus or mouth.

Each nematode carries a specific insect killing bacteria such as *Xenorhabdus* spp. This bacteria is a critical component needed by nematode to complete its life cycle. Once the nematode is inside the host, it will release its associated bacteria, killing the insect. The nematodes will feed and reproduce inside of the cadaver. If the host is large enough, the next generation of nematodes will emerge. However, in smaller hosts like Western flower thrips (*Frankliniella occidentalis*), there is not enough room for reproduction.

Entomopathogenic nematodes use several foraging strategies to hunt prey. They are the “ambushers” (which include the *Steinernema* spp.): they patiently sit and wait for an insect host to move by, and then force their way into the

host's body. They are very effective against pests that are in the top layers of the soil, such as cutworms, fungus gnats and others.

On the other hand, there are the “cruisers” that will move around actively searching for hosts. They are usually found deeper in the soil profile attacking many types of grubs. These are normally in the genus *Heterorhabditis*. Then there is *S. feltiae* which actually employ an intermediate foraging strategy where they both cruise and ambush.

Applying nematodes correctly

Nematodes are an amazing biological control option, but if they are not applied correctly, growers will not see their pests controlled. First you need to see if there is a commercially available nematode species for the target pest. If so, place an order for the appropriate amounts. How many you need will depend on the recommended rates. Rates can vary depending on whether the application is preventative or curative.

When placing an order try to have them delivered as close as possible to your planned application date. Nematodes can be stored in a refrigerator at 41°F (5 °C), but ideally growers should not store them long term because most refrigerators are not accurate enough to maintain a constant 41°F (5 °C). Packages will have an expiration date on them.

When it is time to apply the nematodes, remove them from the refrigerator. Check the temperature of the water that

is going to be used for application. You do not want this water too warm. Ideally the nematodes and water should be roughly the same temperature. The nematodes may need to sit out for a period to warm up closer to the water temperature. Normally cool tap water is a good temperature to target.

Cooler water is better because it holds more dissolved oxygen. Your water also will need to have some form of agitation and aeration to both keep the nematodes from sinking as well as to provide them with oxygen during the application. This will ensure you get your nematodes applied evenly and alive.

Growers will also need to remove the screens from the water lines. Screens are fatal to nematodes. Ideally its best to apply nematodes on an overcast day because UV can kill nematodes. If it is going to be a sunny day, it will be best to apply the nematodes in the early morning and irrigate directly after application to wash the nematodes down into the media. Use the entire spray tank, do not leave nematodes in the tank for the next day.

Once your nematodes are in the soil, how long before you see control of the target pest will depend on the species. Nematodes often go after the larval or pupal stage of an insect that lives in the soil, not the adult. This means that growers will have to wait for the adults to die off or apply a pesticide targeting the adult.

Key Pests



Thrips

Most everyone will agree that using *S. feltiae* for the control of Western flower thrips (*Frankliniella occidentalis*) was a game changer. For years growers

struggled spraying pesticides on the foliage only killing the early instars and adults of this pest, but not killing the pupae in the soil. Because growers were spraying so often and not rotating MOAs enough, thrips developed resistance to some key pesticides. By adding nematodes into the program, growers were finally able to kill the pupae in the soil, targeting this life stage. Nematodes could also be used repeatedly without concerns of developing resistance. Unfortunately, nematodes do not work on all thrips species. Some like poinsettia thrips (*Echinothrips americanus*) or chilli thrips (*Scirtothrips dorsalis*) are not controlled. This is why identification is so important. Positively ID before you treat.



Shore Flies (Family: Ephydriidae)

Adult shore flies are similar in size to fungus gnats but are strong fliers that are stoutly built with

short legs and antennae. They look like small houseflies with five distinctive light-colored spots on each wing. Why it is important to ID your species is because different nematodes are used for different fly species. For shore fly management, the nematode *S. carpocapsae* is used (different than the one for fungus gnats).



Fungus Gnats (Family: Sciaridae)

One of the more annoying pests are the fungus gnats. They are known to vector plant

pathogens, feed on roots of plants, and be an aesthetic problem if not controlled. There are some conventional pesticides that can be used to manage the larval stage, but they must be rotated because of resistance issues. Using *S. feltiae* make fungus gnat control easy with no need to worry about resistance: so easy and they just work. Do remember they just kill the larvae so you will still have adults for 7-10 days after treatment.



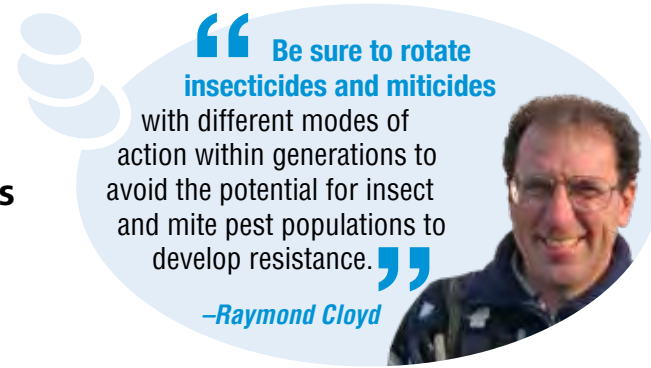
Black Vine Weevil (*Otiorhynchus sulcatus*)

This small black beetle is another pest that can cause very serious damage to roots and foliage. The

larvae go unseen, living underground and feeding on roots. This is where the beneficial nematodes *S. kraussei* or *S. carpocapsae* can really work well, going after the immatures in the soil. The adults feed on the foliage of plants, and conventional pesticides are used to manage them. Check the BASF nematode compatibility guide to select a product safe to use with the nematodes.

2023 Insecticides and Miticides for Managing Insect and Mite Pests of Greenhouse-Grown Horticultural Crops

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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.ircac.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

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
	Cyantranilprole	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
	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
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
	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
	Cyclaniliprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniliprole + 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
	Cyclaniliprole	Sarisa	4 hours	28: Selective activation of ryanodine receptors
	Cyclaniliprole + 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	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: rclloyd@ksu.edu

Updated: July, 2021

Come Grow with Us: Programs That Meet You Where You Are Now

Biologicals + Chemistry = Better Together

Let's look at some ways to make tools, timings and approaches work better all year long



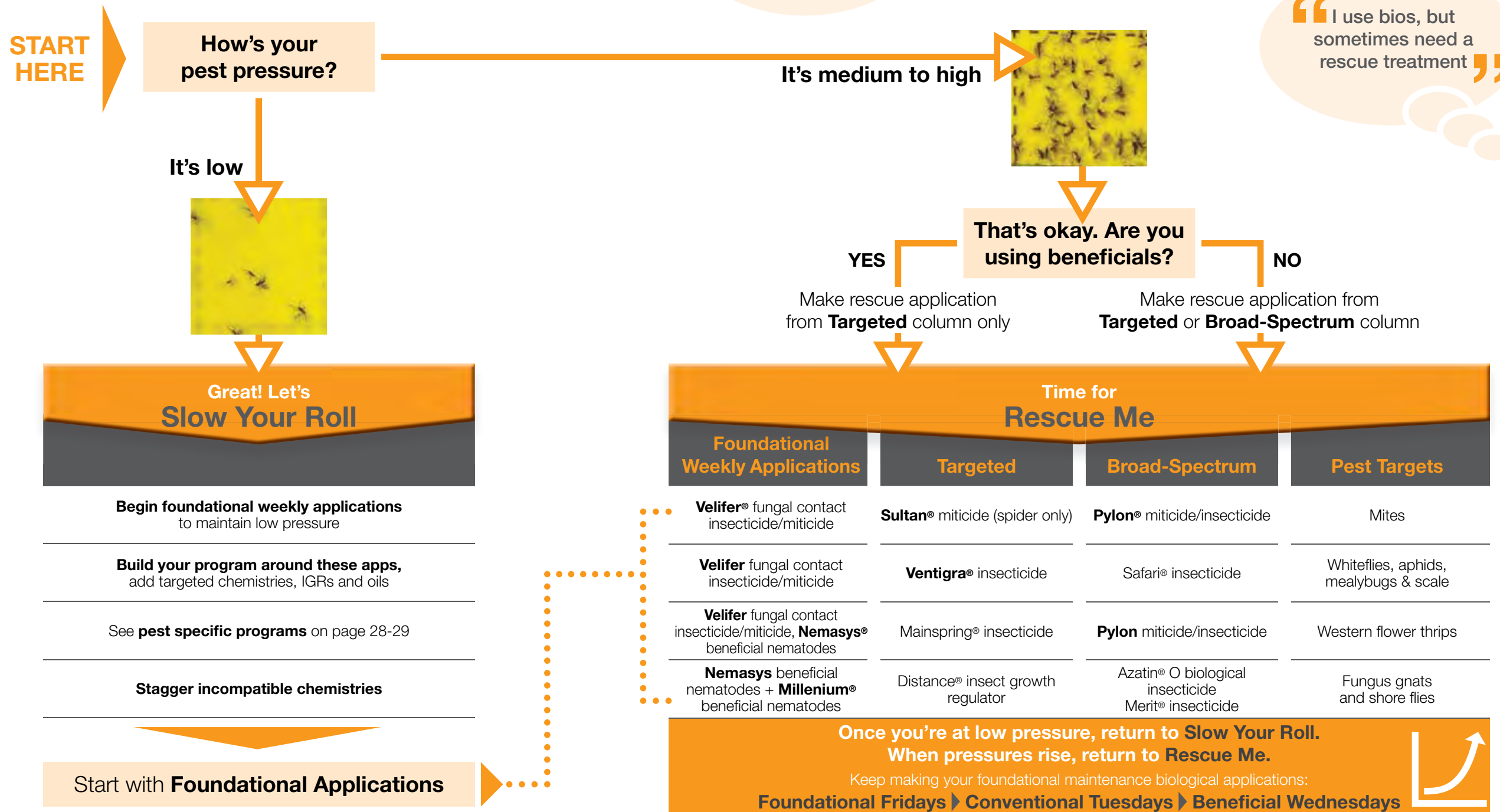
Watch your pest pressure as temps climb: conditions change fast in the greenhouse!

“I want to use bios, but I don't know where to start”

BASF
We create chemistry

“My program is conventional, and control could be better”

“I use bios, but sometimes need a rescue treatment”



Great! Let's Slow Your Roll

- Begin foundational weekly applications** to maintain low pressure
- Build your program around these apps**, add targeted chemistries, IGRs and oils
- See **pest specific programs** on page 28-29
- Stagger incompatible chemistries**

Start with **Foundational Applications**

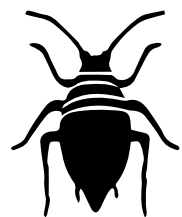
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Building Better Insecticide Programs

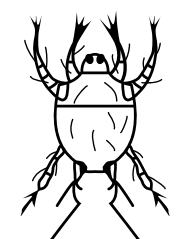
Basic Rotations + Functional Glow Ups

Well-rounded programs for common pests plus functional groups and other IPM tools and activities that take your results from acceptable control to outstanding plant quality



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)



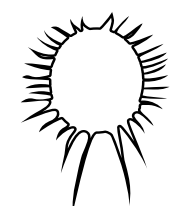
BROAD MITES

- 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)



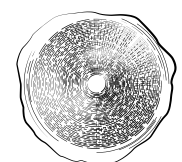
FUNGUS GNATS

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

Targeted Conventionals

Formulated Foundational Biologicals

Growth Regulators

Broad-Spectrum Conventionals

the IPM decision tree
basic rotations to build on

add functional groups

that work for your operation



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)
- IGR: Distance 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)



“ We added in broad mite rotations and more combination MOA products this year. The feedback has been that **the programs work**. Run them in this order or use each list as a menu of options. As per usual: **we make suggestions, you make the decisions.** ”

JEN BROWNING, PCA
BASF Senior Technical Specialist

Always read and follow label directions.

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Importance of Preemergent Herbicide Rotation in Nursery Weed Control Programs

By Chris Marble, PhD

A herbicide mode (or mechanism) of action is the overall way a herbicide works to control weeds. While there are currently more than 20 different preemergent herbicide products labeled for use in container nurseries, for most ornamental species these options are comprised of only five different modes of action (MOAs), including the Weed Science Society of America's MOA groups 3, 14, 15, 21, and 29, which are represented by different color codes on the Nursery Herbicide Selection chart. These herbicide MOAs may be applied alone [such as pendimethalin (Pendulum) or dimethenamid-P (Tower)] or are often combined into a single product (such as FreeHand) to either improve control or for convenience.

Rotating through different MOAs provides several advantages including:

- 1) preventing/delaying the development of herbicide resistant weeds;
- 2) increasing weed control; and
- 3) Improving crop safety.

Another consideration is that based on product labels, growers are usually limited to two to three applications per year depending on the rate that is applied. As growers



usually need to apply herbicides every 8 to 10 weeks throughout the growing season, somewhere between 4 to 6 or more herbicide applications are needed in a typical year. In addition to the three major benefits rotation provides, in most cases rotation is going to be required to stay within annual application limits while still achieving acceptable weed control.

Information on herbicide safety, efficacy, and developing a weed control program can be found on individual product labels and in guides such as the 2017 Southeast Pest Management Guide for Nursery Crops and Landscape Plantings (<https://content.ces.ncsu.edu/southeastern-us-pest-control-guide-for-nursery-crops-and-landscape-plantings>).



The Weed Science Society of America (<https://wssa.net/>)



The Herbicide Resistance Action Committee websites (<https://www.hracglobal.com/>)



CHRIS MARBLE, PhD
 Associate Professor

University of Florida
 Mid-Florida Research and Education Center

Common Nursery Herbicides and Mode of Action Groups

Active Ingredient	Example Trade Names	WSSA Herbicide Group*	Weeds Controlled*
Dithiopyr	Dimension EW	3	Grasses and some broadleaves
Oryzalin	Surflan AS	3	
Pendimethalin	Pendulum EC/AquaCap/G	3	
Prodiamine	Barricade L, RegalKade G	3	
Trifluralin	Treflan G	3	
Flumioxazin	Broadstar G, SureGuard SC	14	Broadleaves and some grasses
Oxadiazon	Ronstar G	14	
Oxyfluorfen	Goal XL	14	
Dimethenamid-P	Tower EC	15	Grasses, broadleaves, sedge suppression
s-Metolachlor	Pennant Magnum EC	15	Grasses, some broadleaves, sedge suppression
Napropamide	Devrinol DF	15	Grasses and some broadleaves
Isoxaben	Gallery SC	21	Broadleaves
Indaziflam	Marengo SC, G	29	Broadleaves and grasses
Benefin + Oryzalin	XL 2G	3+3	Grasses and some broadleaves
Dimethenamid-P + Pendimethalin	FreeHand 1.75G	15+3	Grasses and broadleaves
Trifluralin + Isoxaben	Snapshot G	3+21	
Prodiamine + Isoxaben	Gemini SC/G	3+21	
Dithiopyr + Isoxaben	Fortress G	21+3	
Flumioxazin + Prodiamine	Fuerte G	14+3	
Oxadiazon + Prodiamine	RegalStar G	14+3	
Oxyfluorfen + Oryzalin	Rout G	14+3	
Oxyfluorfen + Pendimethalin	OH2 G	14+3	
Oxyfluorfen + Prodiamine	Biathlon G	14+3	
Oxyfluorfen + Oxadiazon	Regal O-O G	14+14	

*Weed Science Society of America (WSSA) herbicide group numbers are based on herbicide mode of action (MOA) and represented by different color codes. MOA should be rotated to prevent/delay resistance development and improve weed control. Weeds control column lists general weed types controlled by each herbicide; user should consult individual product labels for a full list of weed species controlled.



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