

GROWER TALKS

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Insecticide, Miticide, & Fungicide Guide

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GROWERTALKS

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GreenProfit Supplement Enclosed



Once again, BASF is proud to partner with *GrowerTalks*, delivering the 2021 Insecticide, Miticide & Fungicide Guide. We frequently hear from growers that such reference guides are an important resource and we aim to provide tangible pest management guidance.

By the time you read this, the initial uncertainty that the global pandemic inflicted upon the world and closer to home, our industry, will have passed. I personally cannot tell you where Spring of 2020 went. I can tell you, however, that greenhouse and nursery growers responded in remarkable ways. Recognizing

that some segments of the industry suffered significantly, many segments thrived in the face of unprecedented consumer demand of ornamental and edible plants. To meet these demands, growers had to pivot in many ways, drastically shifting labor practices, holding plants longer early on and/or shifting crop mixes.

No matter what 2021 brings, greenhouse and nursery growers are up for the challenge. BASF couldn't be prouder to offer industry support by providing sustainable pest management solutions in this comprehensive edition of the Insecticide, Miticide & Fungicide Guide.

To meet this challenge, BASF recently introduced new innovations including **Ventigra**[®] insecticide, a new subgroup class of chemistry for fast, effective control of piercing/sucking insects; and **Velifer**[®] fungal contact insecticide/miticide, targeting piercing-sucking insects and mite pests. They join the broader insecticide and miticide portfolio of **Sultan**[®] miticide, **Nemasys**[®] beneficial nematodes and **Millenium**[®] beneficial nematodes for integration into IPM programs, while sustaining beneficial insects and pollinators.

To further round out the spectrum, BASF offers the portfolio of **Intrinsic**[®] brand fungicides—**Pageant**[®] **Intrinsic** brand fungicide, **Orkestra**[®] **Intrinsic** brand fungicide and **Empress**[®] **Intrinsic** brand fungicide—for optimal ornamental plant disease control and plant health benefits. As pioneers of the plant health benefits associated with the **Intrinsic** brand fungicides, BASF provides professional growers with a strong disease management foundation for production of top-quality ornamental plant products. Readers will find within this guide excellent resources on weed management that include both pre-emergent and post-emergent brand information about **FreeHand**[®] **1.75G** herbicide and **FreeHand CA 1.75G** herbicide, **Pendulum 2G** herbicide, **Tower** herbicide, and the newest addition to the BASF portfolio, **Finale**[®] herbicide.

Please enjoy and utilize this reference for your pest management needs.

Best wishes for a safe, healthy and productive 2021.

Caren A. Schmidt, Ph.D.

Ornamentals Regional Sales Manager

BASF Professional & Specialty Solutions

On the cover: Western flower thrips (*Frankliniella occidentalis*) being infected by **Velifer**[®] fungal contact insecticide/miticide.

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 2020. 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.

Managing Black Root Rot

By Janna Beckerman, Purdue University

Black root rot (BRR), caused by the fungus *Thielaviopsis basicola*, is a plant pathogen with serious boundary issues and can infect over 120-plus genera of plants in 33 different families. In addition to many hosts in the green industry (nursery, greenhouse and landscape—see inset), BRR is a significant pathogen of fruit, vegetable and even agronomic crops. BRR is a common—and commonly mis- and underdiagnosed—pathogen despite causing black root rot (Figure 1) and having huge spores, as far as soilborne plant pathogens are concerned.

Above-ground symptoms of BRR infection in bedding plants are vague, with symptoms often resembling nitrogen deficiency. Plants are yellow (chlorosis), growth is stunted and dieback may occur (Figure 2). In woody ornamentals, BRR can cause similar symptoms (Figure 3) and has contributed to the failure of scion-rootstock grafts of tree peony, camellia and honeysuckle. Examination of BRR-infected roots reveal blackened, rotted roots that are intact, possibly with black longitudinal cracks (Figure 4). Blackened lesions often appear at the tips of feeder roots and contrast sharply to healthy, white adjacent portions. Rinsing roots of potting media and viewing with a high-powered hand lens or dissecting scope may reveal the characteristic dark brown to black, thick-walled,



Figure 1. The black root discoloration is caused by the dark thick-walled, multi-celled chlamydo spores of *Thielaviopsis*, growing in the roots.

barrel-shaped chlamydo spores in the infected tissues (Figure 5). Professional diagnostic services will utilize a microscope to conclusively identify this pathogen. Roots aren't mushy or water-soaked unless other root rot pathogens are involved, like *Rhizoctonia* or *Pythium spp.*

A quick look at the spores provides an obvious feature of this pathogen's biology: This is one thick-walled, spore! As such, its ability to persist and survive is an issue in its management. To make matters worse, the thick-walled black overwintering spore (termed a chlamydo spore) is only one part of its lifecycle.

Thielaviopsis also produces conidia, smaller

spores that are easily dispersed in soil, water and splashing media (Figure 6). It's probably through these smaller, lighter spores that the disease spreads, whereupon it eventually develops these black, thick-walled spores that allow it to persist as a thoroughly unwelcome guest. Fungus gnats and shore flies also vector this fungus.

Management

It goes without saying that the use of pathogen-free plants is a key step in managing this disease. Unfortunately, many plug growers are able to effectively manage plug production in such a way that symptoms go undetected until the plug trays are subjected to some sort of stress (cool, hot, high pH, etc.) that can exacerbate BRR.

Summer pansy production (for fall plantings) creates tremendous plant stress, resulting in outbreaks of BRR, particularly in parts of the country where water pH rises to 8 or even 8.5 in the summer.

For spring production, wet media, coupled with temperatures between 55 to 61F, drives the disease, particularly when soil pH is alkaline (above pH 7). Regardless of season, pathogen growth can be reduced if soil media is lowered to pH 5.5 or below or even prevented

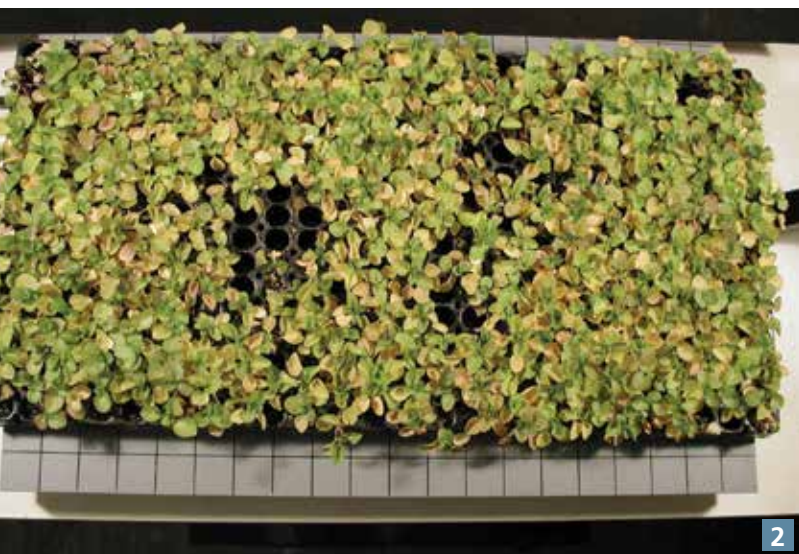


Figure 2. Chlorotic and discolored plants are a signal of root problems; in this case, the cause was *Thielaviopsis*.



Photo by Tom Creswell.



Photo by Tom Creswell.



Photo by Tom Creswell.

Figure 3. Infected holly succumb to BRR in the landscape. ■ Figure 4. Black longitudinal cracks filled with chlamydospores. ■ Figure 5. Chlamydospores so big you can see them with a high-powered hand lens or dissecting scope. ■ Figure 6. Thielaviopsis also produces huge numbers of conidia to aid in spread, in addition to their big, bad chlamydospore counterpart.



at pH 4.8. Unfortunately, many plants don't grow well under such acid conditions, although pansies appear to grow quite well at a pH of 5.5.

Regardless of the fungicide chosen, even the best fungicides fail to provide good control once symptoms are seen, which is why it's so important to be proactive and treat if there's a history of Thielaviopsis. Unfortunately, fungicide use for control of BRR has been inconsistent, at best, with one exception: Thiophanate-methyl (Cleary's 3336, Fungo WSB, OHP 6672). Terraguard (triflumazole) and Medallion (fludioxanil) are also labeled for use, but both have given inconsistent results under different conditions. Orkestra Intrinsic works to suppress Thielaviopsis and would also serve as a good rotation partner, particularly if other root rots (Rhizoctonia, Phytophthora) are involved.

To further prevent fungicide resistance issues from developing, tank or rotate an active ingredient like thiophanate-methyl with either Terraguard, Medallion, Orkestra or BanRot (etrizazole + thiophanate methyl) to prevent both black root and fungicide resistance in the black root rot fungus from becoming established. Remember: All

drench fungicides for the control of root rots should be applied to damp (not dry) media with enough solution to wet the plant root zone unless the label specifies otherwise.

Preventative treatments should begin if there's a history of BRR in the greenhouse or nursery, water with high salts and high (alkaline) pH, or to protect highly susceptible crops, like pansy, calibrachoa and some species of holly (see inset). Proper dose and rate ensures the greatest likelihood for success and minimizes the risk of developing fungicide resistance.

When reusing trays, the thick-walled chlamydospores create a serious contamination issue for future crops. Trays must be cleaned and scrubbed with a 10% solution of bleach (1 part bleach to 9 parts water) WITH detergent—the detergent is necessary to get the bleach through the thick wall to kill the spore. Trays must soak for 30 minutes. Commercial products, such as Zero-Tol (2.5 ounces per gallon sprayed onto trays), Greenshield (1 tablespoon per gallon for 10 minutes as a dip) or KleenGrow (2 tablespoons per gallon), are all effective in eliminating Thielaviopsis spores. ⑤

Some of the most common hosts of black root rot include:

Greenhouse: Begonia; Calibrachoa; Cyclamen; Florist's geranium (*Pelargonium spp.*); Gerbera daisy (*Gerbera spp.*); Pansy-viola (*Viola spp.*); Petunia; Annual phlox (*Phlox spp.*); Poinsettia (*Euphorbia pulcherrima*); Snapdragon (*Antirrhinum spp.*); Sweet pea (*Lathyrus spp.*); Annual vinca (*Catharanthus spp.*); and Verbena spp.

Perennials: Blanketflower (*Gaillardia spp.*); Daisy (*Leucanthemum spp.*); Foxglove (*Digitalis spp.*); Hardy geranium (*Geranium spp.*); Milkweed-butterfly weed (*Asclepius spp.*); and creeping and garden phlox (*Phlox subulata*, *Phlox paniculata*)

Woody ornamentals: Boxwood (*Buxus spp.*); Japanese holly (*Ilex crenata*); Lavender (*Lavender spp.*); Tree peony (*Paeonia spp.*); Rosemary (*Rosmarinus spp.*); and yew (*Taxus spp.*)

Resistance: The use of resistant cultivars is always a good management strategy and BRR is no different. Work by Wills and Lamb (1978) found that Chinese holly (*Ilex cornuta*) and English holly (*I. aquifolium*) are highly resistant to BRR. Yaupon (*I. vomitoria*), Inkberry (*I. glabra*), blue (*Meserve holly*) (*I. x meserveae*) and American holly (*I. opaca*) are moderately resistant to BRR, while Japanese hollies (*I. crenata*) are very susceptible.

Wills, W.H. and R.C. Lamb. 1978. "Pathogenicity of *Thielaviopsis basicola* from Japanese holly to some other host plants." *Plant Disease Reporter* 62 (12) 859-863.

Talking Pests

By Paul Pilon, Perennial Solutions Consulting

As a horticultural consultant and past grower myself, I'm always interested in learning how other successful growers manage their pests and diseases. I recently had a great discussion with Teresa Waldhour, the Grower/Production Manager at Piedmont Carolina Nursery in Colfax, North Carolina, and would like to share several highlights from our conversation.

Paul Pilon: Teresa, thanks for taking the time to meet with me today. Before we dive into specifics about your approach to managing pests and diseases, would you please give me an overview of the types of production facilities being used and what crops are being grown?

Teresa Waldhour: We have around 40 acres where we produce container-grown trees, shrubs, perennials, trellised plants and unique, hard-to-find plants inside small Quonset-style greenhouses and on outside beds.

PP: Most greenhouses and nurseries frequently deal with what I refer to as "traditional" pests, such as aphids, fungus gnats, twospotted spider mites, thrips and whiteflies. Correct me if I'm wrong, but I'm assuming you also experience these pests in North Carolina. What other pests do you have to manage?

TW: Yes, we have all of those "traditional" pests, but we also have a few other nursery pests such as ambrosia beetles, flea beetles, tulip weevils and scale that we have to deal with.

PP: How troublesome are these "nursery" pests?

TW: Ambrosia beetles are borers that can severely damage trees if these little critters get into them. Flea beetles are not picky at all; they'll consume any plant they can find on the nursery. I'd have to say scale is the one insect that gives me the most trouble.

PP: I imagine you also face a few challenging diseases on the crops you grow, is that correct?

TW: Unfortunately, there are a few challenging pathogens I have to contend with. I'd say shothole is probably the most common one. We also battle with several of the leaf spot diseases, including Cercospora, Anthracnose and Entomosporium from time to time.

PP: What is shothole and what crops get this disease?

TW: Shothole starts as a bacteria (*Pseudomonas syringae* and *Xanthomonas arboricola*) from water spots on leaves of most laurels. The bacteria opens the plant up for multiple types of fungal diseases. The common name shothole came about because it leaves numerous holes and tattered areas in the leaves that looks like someone has taken a gun and shot holes in the plant.

PP: Now that you've given me an overview of your facilities and the challenges you face, let's shift gears and talk about how you identify these issues before they become problematic. Many growers routinely scout their crops looking for pests and diseases—how do you identify problems in the crops?

TW: Walking the nursery and looking at the plants is an everyday occurrence. I'm constantly scouting and my hand

lens is never far away. I also rely on other sets of eyes to inform me of any issues that have gone under the radar. For example, our sales team often finds plants that don't look quite like the others. Identifying issues is my responsibility, but it's also a team effort.

PP: We've all heard the phrase, "sanitation is the first line of defense"—what measures do you take to start clean or to remain clean during production?

TW: I agree, sanitation is definitely key in this business. There are several things we do to start clean and stay clean. If there's been an outbreak of anything serious, we sanitize the houses before setting down new crops. We only use new pots for potting. When pruning, we sanitize our shears between different blocks of plants.

For the most part, we rely on the irrigation system to sanitize the open areas that are empty of plants in the interim. We've treated our water in the past with chlorine gas, but are currently transitioning to a new sanitation process of using Sanidate.

PP: Why the change from chlorine gas to Sanidate?

TW: We are changing from chlorine gas to Sanidate because we had an incident last summer with a chlorine tank that was leaking. Chlorine gas can be dangerous and is extremely corrosive. After that, we started looking into different and safer ways to sanitize our irrigation water.

PP: With nearly 40 acres of production space, I imagine there are a few weeds. How do you manage them?

TW: We do some pre-emergent herbicide applications, but for the most part our crew hand-weeds daily. When we keep up with them in this manner, weeds really aren't too problematic.

PP: Depending on the issues you face, I imagine you implement both preventative and curative management strategies.

TW: Plant health changes daily—old problems subside and new ones come in. In some instances, issues are recurring and in other cases they rarely show up. So I'd say it's a mix between preventative programs for recurring problems that I know I'll see and curative programs to manage issues that arise and are detected with my scouting.

PP: What pests or diseases do you routinely use preventative programs on?

TW: I have a few preventative tactics that I've come up with for shothole using a spray rotation of bactericides and fungicides every seven to 10 days. I've learned it's best to err on the preventative side with scale insects. Scouting and monitoring life stages is a huge part of controlling them.

I utilize seasonal programs for certain things. For example, if I don't spray for cedar apple rust preventively right at leaf break in the spring, then I'll have to deal with it for the entire year.



Teresa Waldhour,
Grower/Production
Manager at
Piedmont Carolina
Nursery in Colfax,
North Carolina.

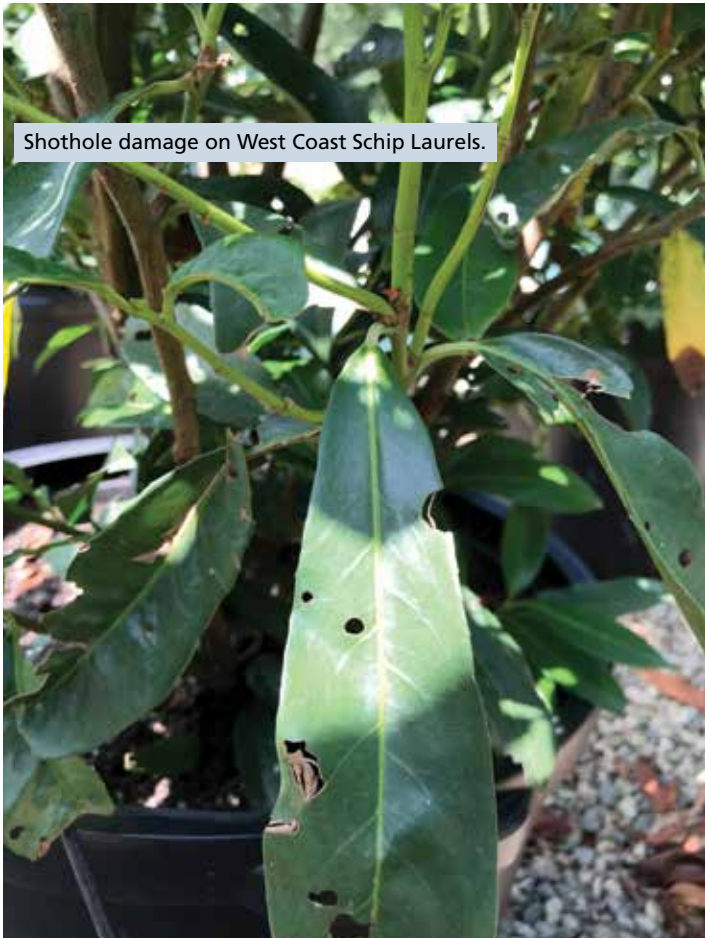


Flea beetle damage on itea.



Flea beetle damage on a buddleia.

Photos courtesy of Teresa Waldhour.



Shothole damage on West Coast Schip Laurels.



Teresa walks the nursery and looks at the plants every day, constantly scouting with her handy hand lens.

PP: I frequently use the phrase, “coverage equals kill” when discussing pest management with growers. Would you please share how you ensure proper coverage is achieved when spraying your crops?


TW: I’m with you on that one. I use a Jacto Cannon sprayer with a hose and spray gun attached. I can adjust speeds and rates to get good coverage. Our greenhouses are arranged so that I can easily maintain coverage from just about any angle. I find using the right

tools with the right crop layout is key to obtaining good coverage and getting good kill.

PP: Do you have any secret weapons to help you manage pests and diseases?

TW: I wish there were secret weapons. The thing that has helped me the most is being prepared and using notes and pictures from previous growing seasons. I have these in a notebook along with what the best preventative and curative management strategies are for the problems I’ve faced in the past and the ones I’ll likely come across in the future. That is my secret weapon.

PP: Do you have any pest management advice you’d like to offer to other growers?

TW: The best advice I can give another grower is take notes and pictures. They should keep track of what they did, why they did it and what the results were. Don’t be afraid ask questions! I have several people in the industry that I can call and send pictures to when I’m facing an issue I’m not familiar with. 

Dealing With Spider Mites

By Suzanne Wainwright-Evans, Buglady Consulting

Part of being a grower is dealing with pests and one pest that all growers have dealt with is the twospotted spider mite (*Tetranychus urticae*). It seems that over the last several years growers have been able to keep it in check, but this year it seems it's back. I've received numerous calls and emails from growers having issues this past spring across many different crops. Why? I'm not really sure, but maybe everyone was more focused on other pests like western flower thrips and aphids, and wasn't being as proactive to prevent the mites. Growers often only realize they have a problem with them when the webbing starts.

A little about spider mites: they're actually a family of mites called Tetranychidae. There are many species in this group that have caused a lot of economic problems for growers. The most problematic and widespread species is the twospotted spider mite (*T. urticae*). It's found worldwide and is a pest of many ornamental, fruit and vegetable crops.

Other species in the family include southern red mite (*Oligonychus ilicis*), Pacific spider mite (*Tetranychus pacificus*), Lewis mite (*Eotetranychus lewisi*), citrus red mite (*Panonychus citri*) and the European red mite (*Panonychus ulmi*).

The reason I point out these different species is because when a grower says they have "spider mites," sometimes that's not good enough to put a management plan together. Knowing the specific kind of spider mite helps us look at its particular biology, host plants list and other details to help create a management plan. When it comes to selecting a miticide or a biological control agent, it's critical to know the specific species because not all miticides work on all mite species, and biological control agents are often pretty targeted.

How do you get your mites identified? You can easily use a small paint brush and collect them off the plants, put them in alcohol and send to your extension office to get a positive ID. Often, mites have to be slide-mounted to be able to see the details well enough for positive identification.

Even without identification, we know one thing—spider mites damage plant material. They feed by inserting their mouthparts into plant cells. They suck up the contents of the cell and then move onto the next cell, leaving behind damaged plant tissue that almost looks white. Once this damage is done, those cells will not regain their color, leaving unsightly looking leaves.

After feeding, spider mites will mate and lay eggs, but mating isn't always necessary for egg production. Unmated females can still lay eggs, but her offspring will all be males.

Life cycle time can vary depending on temperature. In warmer weather, a twospotted spider mite can complete its life cycle in as little as five days. The adult females can live two to four weeks and can lay several hundred eggs in

that time. Their eggs are perfectly round and often laid in their webbing.

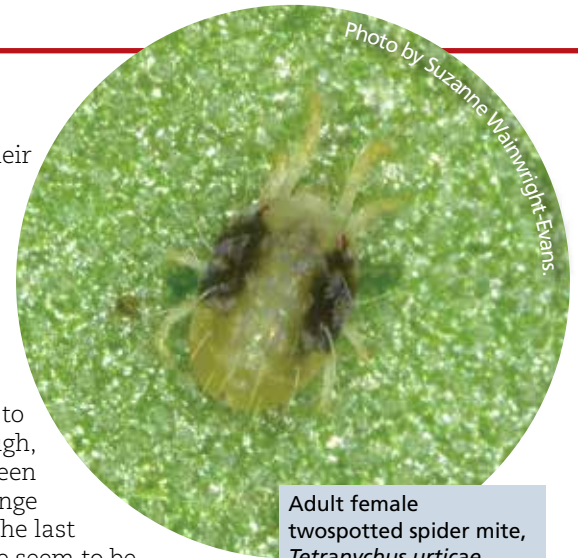
Identifying twospotted spider mites seems to be easy enough, but there's been a new challenge with this in the last few years. We seem to be seeing more of what's called the "red form" of the twospotted spider mite. These are the same twospotted mites, but in their adult form their body is a dark red. People often mistake them for southern red mites or carmine spider mite (*Tetranychus cinnabarinus*). Interestingly, the carmine spider mite is really just a twospotted spider mite. Genetic testing work has been done and it was found that the carmine and the twospotted are the same mite.

When it comes to managing twospotted spider mite, I find growers often wait until it's too late—by too late I mean when it's to the point where one can see damage on leaves or find webbing. By then it's very hard to get them under control and the leaves are so damaged the plants often have to be thrown out. If you're going to remove the infected plants, bag them right where they are or put them in a bin with a lid for transport out of the facility. If you just leave the plants, the population will continue to grow. When this happens, twospotted spider mites will climb to the top of the plants and catch a ride on wind currents to new plants.

A way to prevent getting to the "webbed" point is to make a list of all the twospotted spider mite-prone crops and make sure when you scout you bang the plants over a blackboard. Often when people scout, they just flip leaves up for a look, but this is a hard way to find something the size of a pin head. If you bang the plants, spider mites, aphids and thrips will fall out and be easy to see. This way growers can find a population before it gets going strong and then choose how to treat—whether it be a miticide or predatory mites.

Another option is to select those very prone crops like mums, verbena and crotons, and preemptively treat them with predatory mites. Using biocontrol as a preventative measure for twospotted spider mite can be very economical. It's been done for decades, so there's a good track record with these programs. If there's a flare-up of mites, there are some great products on the market that can be used in conjunction with the predators. Softer products like horticultural oils have a good track record, but they can still kill your beneficials.

There are some other products, like Sultan miticide containing cyflumetofen, which can be sprayed right over the top of your predatory mites with no impact, while killing



Adult female twospotted spider mite, *Tetranychus urticae*.

- Adults spider mites are ~ 0.4 mm long with eight legs.
- Twospotted spider mites often have two dark spots on the sides.
- Eggs are perfectly round.
- Many university websites have identification tools.

twospotted spider mites. More and more research is being done on how pesticides can be used in conjunction with a biological control program. You can get this information from pesticide manufacturers, producers of biological control agents and university research.

When selecting a spray product for mite control, make sure you understand what life stage it targets. Many miticides only control the immature and adult stages, not the eggs. If you want to control the eggs you need a product that's an ovicide. If you spray a product and it doesn't kill eggs, you may have to come back in a few days and spray again to kill the newly hatched mites. This is why reading the label and understanding a product before you apply will help you manage a pest more efficiently.

When it comes to selecting a biocontrol agent for spider mite management, make sure the predator will feed on your specific species of pest mite. Predatory mites can be pretty targeted on the specific species of mites they feed on. A good example is *Phytoseiulus persimilis*—this mite is used solely to control twospotted spider mite, not other spider mite species.

Knowing your crop is important, too. *P. persimilis* works great in strawberries, roses, tropical foliage and other crops, but doesn't work well on tomatoes. This is due to the leaf surface—hairs sometimes can pose a challenge for mites. Other predatory mites like *Neoseiulus californicus* are less targeted. They do feed on twospotted spider mites, but they also feed on western flower thrips (*Frankliniella occidentalis*) and broad mites (*Polyphagotarsonemus latus*). There are many other factors involved with setting up a program, so make sure you work closely with your biological control specialist.

Twospotted spider mites are a pest that's always been around and will unfortunately continue to be with us as far as we can tell. Make sure you've identified them correctly, have a solid scouting program, select a treatment program that works in your growing operation and be vigilant to keep their population from getting out of control. 🕒

Photo by Suzanne Wainwright-Evans.



If you've reached a point where the mites are webbing on your plant, biocontrol agents aren't going to be able to catch up fast enough. A knockdown spray will be needed.

Photo by Suzanne Wainwright-Evans.



When twospotted spider mite populations grow, they'll often head to tips of leaves to disperse.

Pioneers of Plant Health

By Dr. Emma Lookabaugh

For over a decade, BASF has been an industry pioneer with our Intrinsic brand of fungicides: Pageant Intrinsic brand fungicide, Empress Intrinsic brand fungicide, and Orkestra Intrinsic brand fungicide. These products, powered by the active ingredient pyraclostrobin, offer superior plant protection through a combination of broad-spectrum disease control and plant health benefits.

What are plant health benefits and why are they important to you?

At BASF, this is a question we get asked a lot by distributors, channel partners and end users of our Intrinsic brand fungicide product line. 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'd been treated with certain fungicides. Extensive laboratory studies in Germany and the United States proved that these plant health benefits, in the form of increased growth efficiency during environmental stresses, were tied to pyraclostrobin.

So aside from being an excellent, broad-spectrum fungicide, pyraclostrobin also affects plant metabolism in a positive way. Pyraclostrobin jumpstarts a string of subtle, metabolic changes that help the plant get through stressful periods like droughts or extreme cold weather. In plant pathogenic fungi, pyraclostrobin blocks energy production that fuels fungal growth and effectively stops infection. Pyraclostrobin also affects mitochondrial respiration and nitrogen assimilation in plants. Less carbon dioxide is lost through night respiration, so more carbon is available for plant growth. These physiological changes translate into increased crop resilience.

Stress management at key production stages

In ornamentals, plant health benefits can be seen in the form of disease control, increased growth efficiency and increased tolerance to external stresses. In order to maximize the plant health benefits, pyraclostrobin should be applied prior to the stress event. In ornamental production systems, plants

are subject to the most stress at three key production stages: 1) propagation; 2) transplanting; and 3) final finishing and shipping.

Pageant Intrinsic brand fungicide during propagation = Enhanced rooting

Unmatched rooting benefits set Pageant Intrinsic brand fungicide apart from other strobilurins available in the marketplace. Research has shown that two applications of Pageant Intrinsic brand fungicide applied to unrooted cuttings accelerates callus formation, improves root density and protects against common cutting diseases caused by Botrytis, Rhizoctonia and Pythium. The best application timing is at sticking followed by a sequential application seven to 14 days later. Not all plant species respond the same, so there's some flexibility in application timings and rates.

For best results, apply Pageant Intrinsic brand fungicide at 4 to 6 fl. oz./100 gal. for herbaceous ornamentals and 6 to 8 fl. oz./100 gal. for woody species.

Empress Intrinsic brand fungicide at transplant = Faster finishing time

Empress Intrinsic brand fungicide is an excellent option whenever you're transplanting or staging up plants into larger pots. BASF conducted a series of trials that demonstrated Empress Intrinsic brand fungicide applied at transplant reduced the time it takes to root a plant into its finished container. Empress

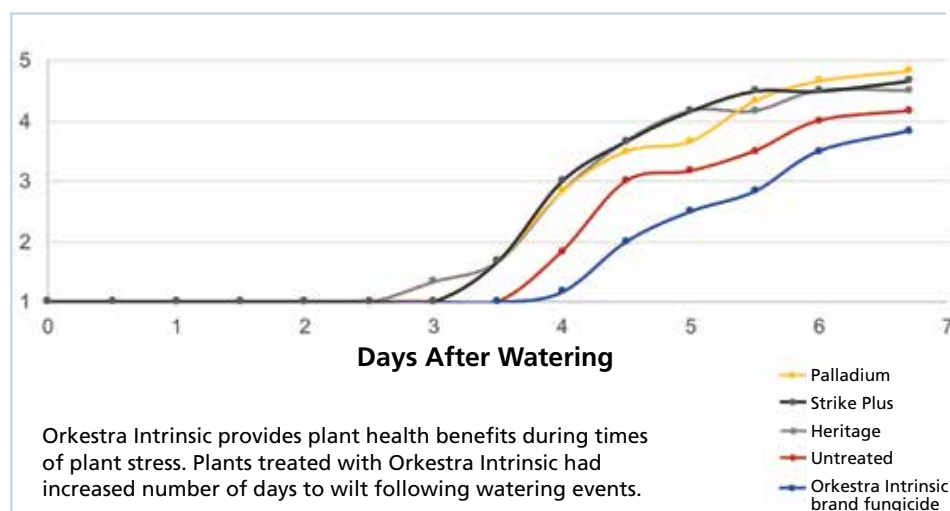
Intrinsic brand fungicide-treated plants were fully rooted four to seven days sooner than plants treated with competitive products or untreated check plants. Earlier rooting and faster establishment correlate with stronger plants.

For best results, apply Empress Intrinsic brand fungicide to rooted plugs or transplants at 3 to 6 fl. oz./100 gal.

Orkestra Intrinsic brand fungicide for outdoor production = Superior rainfastness and drought tolerance

Orkestra Intrinsic brand fungicide combines the active ingredient pyraclostrobin with fluxapyroxad to provide fast-acting disease control, and excellent rainfastness and longevity. Orkestra Intrinsic brand fungicide shows the greatest utility in outdoor production nurseries and landscapes where regular rain events, overhead irrigation and temperature extremes can trigger disease outbreaks and leave plants feeling stressed.

Orkestra Intrinsic brand fungicide has excellent activity on fungal leafspot diseases like Anthracnose, powdery mildews and rusts and is the first BASF fungicide that delivers control of black root rot caused by Thielaviopsis. In addition to superior disease control, Orkestra Intrinsic brand fungicide also offers plant health benefits in summer months when heat and water stress are common. Treated plants take longer to show signs of water stress and can recover from wilting once watering is





Untreated Check

Pageant Intrinsic

Pageant Intrinsic treatments prior to shipping can increase shelf-life. Two-weeks after shipping, untreated plants had a significant amount of brown, senescing flowers and were no longer marketable. Plants treated with Pageant Intrinsic had no brown flowers and were still highly marketable 14 days after arriving at the store.



Pageant Intrinsic

Heritage

Untreated Check

Pageant Intrinsic increases crop resilience following exposure to drought stress. Plants were allowed to desiccate to near permanent wilting and then watering resumed. Pageant Intrinsic-treated plants showed fewer symptoms of drought stress than untreated and competitor-treated plants.



UTC

Empress Intrinsic

Heritage

Empress Intrinsic applied at transplanting increased rooting speed and top growth. Empress Intrinsic-treated plants were fully rooted four to seven days sooner than competitor-treated plants or untreated controls. Faster rooting = faster finishing times.

resumed. Orkestra Intrinsic brand fungicide gives peace of mind that plants are protected rain or shine.

For best results, apply Orkestra Intrinsic brand fungicide at 8 to 10 fl. oz./100 gal.

Pageant Intrinsic brand fungicide prior to shipping = Increased shelf life and tolerance to heat and cold


After season-long inputs to protect plants from pests and diseases at the production facility, Pageant Intrinsic brand fungicide can provide the insurance needed to make sure plants survive shipping and stay looking their best on market shelves. Shipping is stressful and plants can be exposed to extreme temperatures along the way to their destination. Pageant Intrinsic brand fungicide can help plants bounce back after exposure to cold temperatures and withstand short-term heat and drought stresses.

Ethylene is a plant hormone produced in response to stress and high levels of ethylene can cause a plant to drop leaves, mature earlier than normal and abort flowers. BASF studies have shown that Intrinsic brand fungicides help to regulate enzymes involved in ethylene production. This can be visualized as less yellowing of leaves and bud drop in plants that were treated with Intrinsic brand fungicides than in plants that weren't treated. This translates to longer shelf-life because plants keep blooms longer and maintain marketability.

For best results, apply Pageant Intrinsic brand fungicide at 12 to 16 fl. oz./100 gal prior to shipping.

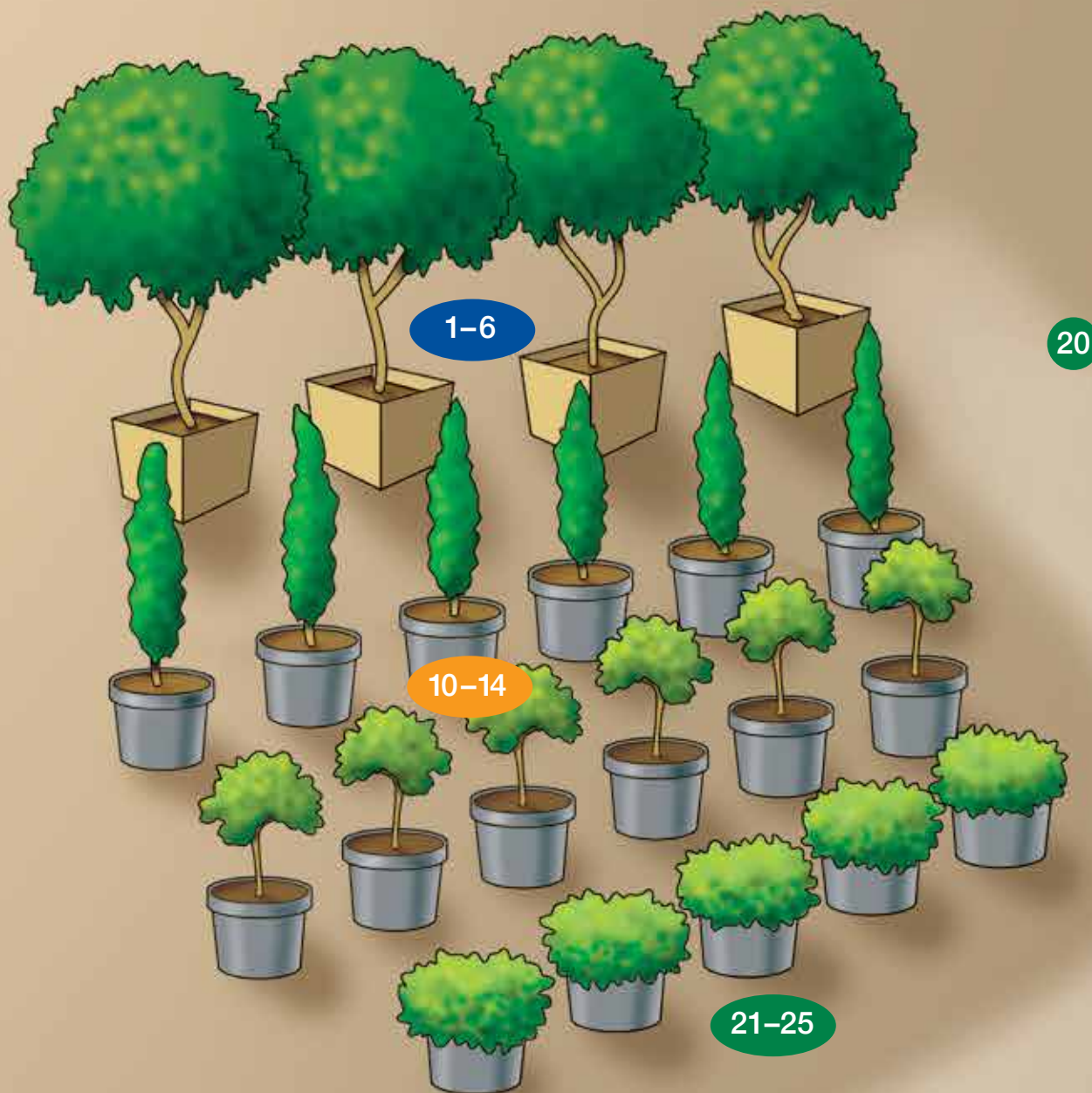
Not all strobilurins are created equal

There are many strobilurins on the market that offer excellent disease control. What sets Intrinsic brand fungicides above the rest is that they were the first fungicides to have received EPA approval to have plant health claims on the product labels. This means BASF has extensive data and research proving positive plant health benefits from Intrinsic brand fungicides.

So, when you reach for a strobilurin fungicide, reach for the best with Pageant Intrinsic brand fungicide at propagation and shipping, Empress Intrinsic brand fungicide at transplanting, and Orkestra Intrinsic brand fungicide for outdoor production and landscapes. For best results, make Intrinsic brand fungicides the backbone of your fungicide rotational programs. 

BASF Grower Solutions for Greenhouse and Nursery

BASF provides a diverse portfolio of products to help manage diseases, insects and weeds in the nursery and greenhouse. This illustration is a handy tool to quickly remind you which BASF products can be used outdoors and/or indoors. Please consult the label before making an application so you can get the most out of each product.



betterplants.basf.us

Always read and follow label directions.

Attain, Beethoven, Empress, Finale, FreeHand, Intrinsic, Millenium, Nemasys, Orkestra, Orvego, Pageant, Pendulum, Pylon, Pyrethrum, Stature, Sultan, Tower, Trinity, Velifer and Ventigra are registered trademarks of BASF.

Products may not be registered in all states. Please check with your state or local Extension Service.

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Fungicides

- 1 Pageant® Intrinsic® brand fungicide
- 2 Empress® Intrinsic® brand fungicide
- 3 Orkestra® Intrinsic® brand fungicide
- 4 Orvego® fungicide
- 5 Stature SC® fungicide
- 6 Trinity® fungicide
- 7 Pageant® TR Intrinsic® total release fungicide
- 8 Trinity® TR fungicide

Biological Insect Controls, Insecticides & Miticides

- 9 Velifer® fungal contact insecticide/miticide
- 10 Nemasys® beneficial nematodes
- 11 Millenium® beneficial nematodes
- 12 Ventigra® insecticide
- 13 Sultan® miticide
- 14 Ultra-Pure Oil horticultural insecticide, miticide and fungicide
- 15 Pylon® miticide/insecticide
- 16 Pylon® TR total release miticide/insecticide
- 17 Pyrethrum® TR total release insecticide
- 18 Beethoven® TR miticide/insecticide
- 19 Attain® TR total release insecticide

Herbicides

- 20 Finale® herbicide
- 21 FreeHand® 1.75G herbicide
- 22 Pendulum® AquaCap herbicide
- 23 Pendulum® 3.3 EC herbicide
- 24 Pendulum® 2G herbicide
- 25 Tower® herbicide



2021 Pest Control Materials 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.irac.online.org). **The information presented in this chart is not a substitute for the label. Always read and understand all information presented on the label before using any pest control material.** Also, be sure to check county and state regulations to determine if there are any local restrictions associated with the use of specific pest control materials listed in this chart.

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

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

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

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
FUNGUS GNAT ADULTS	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
LEAFHOPPERS	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	<i>Beauveria bassiana</i> Strain GHA	BotaniGard	4 hours	
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor
	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	Clarified hydrophobic extract of neem oil	Triact	4 hours	Suffocation or membrane disruptor
	Cyfluthrin	Decathlon	12 hours	3A: Prolong opening of sodium channels
	Cyfluthrin + Imidacloprid	Discus	12 hours	3A + 4A: Prolong opening of sodium channels + nicotinic acetylcholine receptor modulator
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Fonicamid	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 fumosoroseus</i> Strain FE 9901	NoFly	4 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
	Bifenazate + Abamectin	Sirocco	12 hours	20D + 6: Mitochondria electron transport inhibitor + GABA chloride channel activator
	Bifenthrin	Attain TR /Talstar	12 hours	3A: Prolong opening of sodium channels

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
LEAFMINERS <i>continued</i>	Chlorpyrifos	DuraGuard ME	24 hours	1B: Acetylcholine esterase inhibitor
	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	Ventiga	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
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic

Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
MEALYBUGS <i>continued</i>	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	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 fumosoroseus</i> Strain FE 9901	NoFly	4 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
	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
	Thiamethoxam	Flagship	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Tolfenpyrad	Hachi-Hachi	12 hours	21A: Mitochondria electron transport inhibitor
PLANT BUGS	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Cyclaniloprole + Fonicamid	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 fumosoroseus</i> Strain FE 9901	NoFly	4 hours	
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Tau-fluvalinate	Mavrik	12 hours	3A: Prolong opening of sodium channels
SCALES (HARD AND SOFT) ^a	Acephate	1300 Orthene TR/Precise	24/12 hours	1B: Acetylcholine esterase inhibitor
	Acetamiprid	TriStar	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Azadirachtin	Azatin/Ornazin/Molt-X/Azatrol ²	4/12/4/4 hours	Ecdysone antagonist: inhibits action of molting hormone
	Bifenthrin	Attain TR/Talstar	12 hours	4A: Prolong opening of sodium channels
	Buprofezin	Talus	12 hours	16: Chitin synthesis inhibitor

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

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



Insect or Mite Pest	Pest Control Material Common Name	Pest Control Material Trade Name(s)	Restricted Entry Interval (REI)	Mode of Action (IRAC Mode Of Action Group)
WHITEFLIES <i>continued</i>	Diflubenzuron	Adept	12 hours	15: Chitin synthesis inhibitor
	Dinotefuran	Safari	12 hours	4A: Nicotinic acetylcholine receptor modulator
	Fenazaquin	Magus	12 hours	21A: Mitochondria electron transport inhibitor
	Fenoxycarb	Preclude	12 hours	7B: Juvenile hormone mimic
	Fenpropathrin	Tame	24 hours	3A: Prolong opening of sodium channels
	Flonicamid	Aria	12 hours	29: Selective feeding blocker/chordotonal organ modulator
	Flupyradifurone	Altus	4 hours	4D: Nicotinic acetylcholine receptor modulator
	Imidacloprid	Marathon/Benefit/Mantra	12 hours	4A: Nicotinic acetylcholine receptor modulator
	<i>Isaria fumosorosea</i> Apopka Strain 97	Ancora	4 hours	
	<i>Isaria fumosoroseus</i> Strain FE 9901	NoFly	4 hours	
	<i>Metarhizium brunneum</i> Strain F52	Met52	4 hours	
	Kinoprene	Enstar	4 hours	7A: Juvenile hormone mimic
	Mineral oil	Ultra-Pure Oil /SuffOil-X	4 hours	Suffocation or membrane disruptor
	Novaluron	Pedestal	12 hours	15: Chitin synthesis inhibitor
	Potassium salts of fatty acids	M-Pede	12 hours	Desiccation or membrane disruptor
	Pymetrozine	Endeavor	12 hours	9B: Selective feeding blocker/chordotonal organ TRPV channel modulator
	Pyrethrins	Pyreth-I/ Pyrethrum	12 hours	3A: Prolong opening of sodium channels
	Pyrethrins + Oil	Pycana	12 hours	3 + suffocation (oil on board): Sodium channel modulators
	Pyridaben	Sanmite	12 hours	21A: Mitochondria electron transport inhibitor
	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.

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Suggested Rotations by Key Diseases

Note at least three different chemical groups are included for overall program to target the disease.

Disease Targets	Rotation 1	Rotation 2	Rotation 3
Anthracnose	Pageant Intrinsic or Orkestra Intrinsic Group 7 + 11	Daconil Group M5 or Mancozeb Group M3	Palladium Group 9 + 12
Powdery Mildews and Rusts	Pageant Intrinsic or Orkestra Intrinsic Group 7 + 11	Camelot Group M1 or Mancozeb Group M3	Terraguard Group 3
Botrytis	Pageant Intrinsic or Orkestra Intrinsic Group 7 + 11	Palladium Group 9 + 12 or Decree Group 17	Astun Group 7 + Daconil Group M5
Leaf spots Myrothecium, Diplocarpon (Black Spot) Alternaria, Cercospora, Entomosporium	Pageant Intrinsic or Orkestra Intrinsic Group 7 + 11	Daconil Group M5 or Spectro 90 Group 1 + M5	Palladium Group 9 + 12
Fusarium, Rhizoctonia, Cyliandrocladium	Empress Intrinsic (drench) Group 11 + Medallion Group 12	Terraguard Group 3 or Cleary's 3336 Group 1	Pageant Intrinsic or Orkestra Intrinsic Group 7 + 11
Thielaviopsis	Cleary's 3336 Group 1 or Banrot Group 1 + 14 + Medallion 12	Orkestra Intrinsic Group 7 + 11	Cleary's 3336 Group 1 + Terraguard Group 3
Downy Mildews	Segovis Group U15	Stature Group 40	Aliette Group 33 + Adorn Group 43
Pythiums	Empress Intrinsic (drench) Group 11 + Segway 0 Group 21	Terrazole / Truban Group 14	Empress Intrinsic (drench) Group 11 + Segway 0 Group 21
Phytophthoras	Orvego Group 40 + 45	Aliette Group 33 + Adorn Group 43	Empress Intrinsic (drench) Group 11 + Segway 0 Group 21
Bacterial diseases see labels for specific pathogens	Copper Kocide 2000 or copper based Phyton 27 or Camelot 0 Group M1	Cease or Rhapsody Biopesticide	Junction copper + mancozeb Group M1 + M3

Products Registered for Use with Ornamental Vegetable Transplants and Greenhouse Vegetable Production

BASF is working to keep pace with the dynamic needs of the professional horticulture industry, particularly as growers expand their product offerings to meet changing consumer trends.

We're pleased to provide this convenient reference chart that highlights the portfolio of BASF grower solutions. The listed products help provide protection from disease and insect pests in specialty ornamental vegetable transplants to consumers and in indoor vegetable production.

	Ornamental Vegetable Transplants	Greenhouse Vegetable Production
Pageant Intrinsic Brand Fungicide	●	●
Nemasys Beneficial Nematodes	●	●
Millenium Beneficial Nematodes	●	●
Velifer Fungal Contact Insecticide	●	●
Ventigra Insecticide	●	pending ¹
Pylon Miticide/Insecticide		●
Ultra Pure Oil Horticultural Insecticide, Miticide and Fungicide ²	●	●

¹ Registration for Ventigra insecticide use with greenhouse vegetable production is expected in 2020. Please check with your state or local Extension Service.

² OMRI Listed for organic use.

Always read and follow label directions.

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Chemical Class Chart for Ornamental Fungicides

FRAC group	Chemical Class	Active Ingredient common name	Trade Name
1	Methyl Benzimidazole Carbamates (Thiophanates)	thiophanate-methyl	AllBan Flo, Banrot*, 3336, ConSyst*, OHP 6672, Spectro 90*, SysTec 1998, T-Storm, TM 4.5, TM/C*, 26/36*, Zyban*
2	Dicarboximides	iprodione	Chipco 26019, Lesco 18 Plus, OHP 26GT-0, 26/36*
3	Demethylation Inhibitors (imidazole, pyrimidine, triazole)	metconazole	Tourney
		myclobutanil	Clevis*, Eagle, MANhandle*
		propiconazole	Banner MAXX, Concert II*, Strider
		tebuconazole	Torque
		triadimefon	Bayleton, Trigo*
		triflumizole	Terraguard
		triticonazole	Trinity, Trinity TR
4	Phenylamides	mefenoxam	Subdue GR, Subdue MAXX, Hurricane*
5	Amines "Morpholines" (Piperadines)	piperalin	Pipron
7	Succinate dehydrogenase inhibitors - SDHI (Pyridine carboxamides, phenyl-benzamides, pyrazole-4-carboxamides)	benzovindiflupyr	Mural*
		boscalid	Pageant Intrinsic*
		fluropyram	Broadform
		flutolanil	Contrast, ProStar
		fluxapyroxad	Orkestra Intrinsic *
		isofetamid	Astun
9	Anilinopyrimidines	cyprodinil	Palladium*
11	QoI-fungicides (strobilurins)	azoxystrobin	Heritage, Mural*
		fluoxastrobin	Fame
		pyraclostrobin	Pageant Intrinsic*, Empress Intrinsic, Orkestra Intrinsic*
		trifloxystrobin	Compass, Broadform*
	Imidazolinone	fenamidone	Fenstop
12	Phenylpyrroles	fludioxonil	Medallion, Hurricane*, Palladium*, Spirato GHN
14	Aromatic Hydrocarbons (chlorophenyl)	dicloran	Botran
		pentachloronitrobenzene (PCNB)	Terraclor
	Thiadiazole	etridiazole	Banrot*, Terrazole, Terrazole CA, Truban
17	Hydroxyanalide	fenhexamide	Decree
19	Polyoxins	polyoxin - D	Affirm WDG
21	Quinone inside inhibitors (Cyano-imidazole)	cyazofamid	Segway O
28	Carbamate	propamocarb	Banol
33	Phosphonates	fosetyl-Al	Aliette, Areca
		phosphorous acid, potassium phosphite	Alude, Biophos, Fosphite, Reliant, Vital, Phostrol
40	Carboxylic Acid Amines (cinnamic acid amides, mandelic acid amides)	dimethomorph	Stature SC, Orvego*
		mandipropamid	Micora
43	Benzamides (Pyridinemethyl-benzamides)	fluopicolide	Adorn

Chemical Class Chart for Ornamental Fungicides

FRAC group	Chemical Class	Active Ingredient common name	Trade Name
44	Microbials	Bacillus amyloliquifaciens (D747)	Triathlon BA
		Bacillus amyloliquifaciens (MBI600)	Subtilex NG
		Bacillus amyloliquifaciens (QST 713)	Cease, Companion
45	Quinone x Inhibitor	ametoctradin	Orvego*
49	piperidinyl-thiazole-isoxazolines	oxathiapiprolin	Segovis
M1 (multi-site)	Inorganics	copper salts	Camelot O, Champion, Copper-Count N, CuPro 5000, Cuproxat, Junction*, Kalmor, Nordox, Nu-Cop, Phytan 27, Phytan 35
M3 (multi-site)	Dithiocarbamate	mancozeb	Clevis*, Dithane, Fore, Junction*, Pentathlon, Protect, Zyban*
M5 (multi-site)	Chloronitriles	chlorothalonil	Clevis*, ConSyst*, Concert II*, Daconil Ultrex, Daconil
			Weatherstik, Echo, Exotherm Termil, Manicure 6FL, Spectro 90*, TM/C*
P5	plant extract	complex mixture, ethanol extract	Regalia, Milsana
Not Classified	Microbial/Biopesticides	Gliocladium catenulatum (J1446)	PreStop
		Pseudomonas chlororaphis (strain AFS009)	Zio
		Streptomyces griseoviridis	Mycostop
		Streptomyces lydicus (strain WYEC 108)	Actinovate SP
		Trichoderma harzianum Rifai strain	Rootshield
		Trichoderma asperellum (ICC 012) Trichoderma gamsii (ICC 080)	Obtego*
		Trichoderma harzianum T22, Trichoderma virens G41	RootShield Plus*
Not Classified	Inorganic Protectants	botanical extract	Neem Oil, Triact 70
		hydrogen dioxide	Zerotol
		hydrogen peroxide	X3, Xeroton
		oil	Ultra-Pure Oil, SuffOil-X
		potassium bicarbonate	Armcarb 100, Kaligreen, 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.

Building Better Rotations: Timing Pre-emergence Herbicide Applications When They Benefit You Most

By Dr. Chris Marble, UF/IFAS Mid-Florida Research & Education Center

Of all the pests, weeds are the most unbiased. No matter what kind of production environment is created, there will be a weed species that can thrive in that situation. Weeds are, of course, unsightly, but they can also dramatically increase production times by reducing crop growth by as much as 70% or more. Luckily, there are some great pre-emergence herbicides that you have at your disposal. Proper selection and application of these herbicides can help tilt the balance of power back in your favor.

So how should herbicides be selected? In reality, your crop mix and the common weeds in your area and nursery will determine what herbicides will work for your situation. I like to think of herbicides as tools, in that they can all be useful for different or specific jobs. Most jobs are going to require different tools and weed management is no exception. A solid herbicide rotation will utilize different herbicides with different modes of action at different times of the year.

Building a rotation for your nursery can be broken down

into four steps: 1) Determining which herbicides are safe for your crops; 2) selecting herbicides for key weeds each season; 3) optimizing your herbicide applications for when they'll be most useful; and 4) rotating through different modes of action.

Determining what herbicides are safe for your crops

There are two key considerations to consider when selecting the best herbicides for your operation: 1) crop safety; and 2) spectrum of control the herbicide offers or efficacy. The first thing most growers consider is crop safety. This makes sense because if the herbicide injures many of the plants you grow, then that herbicide might not be the best option. However, it's important to keep in mind that not all ornamental plants have been tested for every herbicide—there are just too many to test them all (but we're working on it!).

This is where efficacy comes in to play. If an herbicide is highly efficacious on a particular weed, but some ornamental species you grow aren't listed on the label, small-scale plant safety trials may be necessary. In fact, testing plant safety before wide-scale application is recommended in many cases.

Let's take spotted spurge as an example: Spotted spurge is one of, if not the most, problematic warm-season weeds in container production. FreeHand is an excellent choice for spurge control, and while it's labeled for use on hundreds of ornamental species, you may have some species that aren't on the label. As FreeHand is a good option for spurge and is safe on most woody ornamentals, some small-scale testing might be warranted to determine if it could be used on other ornamental hosts not listed on the label.

Consider key weeds each season

Depending on the herbicide and the rate, you'll be allowed two or sometimes three applications per year. The key to good herbicide performance (besides sprayer calibration) is utilizing those two or three applications when they'll be most beneficial to you, which is determined by your most problematic weeds each season. Before you schedule your herbicide applications, first determine what the most important or problematic weed is each season. After figuring out what your worst weed is, determine what your second or third most problematic species are. These species aren't as common or troublesome as number one, but are still an issue.

Next, find the herbicide that's effective on your worst weed. This information can be found on herbicide labels, manufacturer websites, university webpages and in regional guides such as the 2017 Southeast Pest Management Guide for Nursery Crops. The first priority is to select an herbicide that's highly efficacious on your worst weed and also has some efficacy on your problematic secondary weed species. Even if these species aren't a big problem now, any uncontrolled weed can take over. It's important to select an herbicide option that's effective on all or at least most of your weeds each season.



Seed head of woodsorrel (*Oxalis stricta*). Woodsorrel is generally well controlled by most pre-emergence herbicides, but can still become problematic if proper sanitation practices aren't followed.



Doveweed (*Murdania nudiflora*) growing in a nursery container. FreeHand or Tower would be good options if doveweed becomes an issue in the nursery.



Several spurge species (*Euphorbia* spp.) in a nursery container. Heavy weed pressure can reduce growth of container grown plants by as much as 70%.



A bittercress infestation in large container-grown trees. A good rotation program will help keep weed pressure to a minimum when combined with other recommended strategies.

Many efficacy charts rank herbicide efficacy using a system such as either “Good,” “Fair” or “Poor” for different weeds. For your number one weed, you want a good or the best option you can use depending on your crop mix. If your number two or three weeds aren’t that problematic, something that’s ranked as Fair might work, as long as it’s good on the worst weed.

Optimizing herbicide applications when they’re most useful

After looking at different efficacy charts, you’ll quickly realize that there are more herbicide options for some weed species compared to others. For example, in the cool-season, oxalis might be a big issue, but you would have many herbicides to choose from that offer a high level of control of oxalis and other cool-season species like annual bluegrass or bittercress.

Alternatively, there are limited chemistries available to control warm-season weed species like doveweed. Options for doveweed control include FreeHand, Tower, Marengo or Broadstar. All four of these herbicides also control oxalis, but since you only get two applications per year, you may want to reserve these products for doveweed season. In this specific scenario, a product like FreeHand will give you the most bang for your buck during the summer months when doveweed, spurge and other warm-season weeds like phyllanthus are most problematic.

Herbicides can be used in different seasons and no single rotation program is going to work for every nursery. There are many possibilities depending upon your specific situation. The key point to remember is to apply herbicides during the season when they’ll benefit you the most based on your weed pressure.

Building a rotation schedule

After determining what herbicides are safe for your crops and which herbicides will work on the common weed species

at your nursery each season, you’ll have narrowed down your list of potential chemical options. The next step is to look at the herbicide mode of action (or modes of action in combination products) to determine how to best rotate those herbicides each season. While there are many pre-emergence herbicides and combinations available, there are only a few modes of action available, including Weed Science Society of America Groups 3, 14, 15, 21 and 29.

The best results are usually achieved when no herbicides or combinations are applied in back-to-back or sequential applications. For example, if you applied a Group 3 + 14 combination at potting, you wouldn’t want to follow that up with another 3 + 14 combination. If there’s a weed species that a 3 + 14 combination does control, a back-to-back application would allow more time for that weed to take over and spread before another herbicide is applied.

Rotating can also increase crop safety. Some plants can tolerate one application of some herbicides, but not sequential applications. There might not be observable injury immediately, but injury could occur over time in some cases. Keep in mind that some herbicides shouldn’t be applied at potting, therefore potting schedules may limit your herbicide options at different times throughout the year.

The number of different herbicides you may need in your rotation product depends on many factors, but good programs can be built with four or five different herbicide products. This is largely dependent on the number of applications you need to apply each year or growing season. In most cases, an application every eight to 10 weeks during the growing season is recommended to control weeds before they become problematic.

By following these steps, you can develop a list of herbicides that will work for your crops, control your weed spectrum and know how you’ll rotate them with different modes of action with your new herbicide program. Now just implement, scout regularly and adjust if needed. **GT**

So You Need a Post-emergence Herbicide Treatment

By Dr. Katelyn Venner, Technical Market Manager, BASF

Proper application of pre-emergence herbicides provide the majority of weed control in ornamental production operations. But what happens if that herbicide application breaks, is mis-applied or simply isn't applied to an area? As a grower, those undesirable plants cannot continue growing where they weren't intended—that is, after all, an informal definition of a weed!

Post-emergence herbicides are those that control weeds that have already germinated and begun to grow. In many situations, utilization of a post-emergence herbicide is quite simple: spray over the top and wait for the weeds to succumb to the effects of the application. In ornamentals, however, making applications of herbicides to control emerged weeds isn't quite as straight forward. Safety to our desired plants is of utmost importance and these herbicides cannot distinguish between a healthy boxwood and the hairy bittercress, crabgrass or spotted spurge that might be growing alongside.

Much like choosing which pre-emergence herbicide is the best fit for your purposes, post-emergence herbicides require some thought. Sure, hand weeding would remove nearly all chance for plant injury, but herbicides are much more cost and time effective. Certain herbicides can be broadcast in ornamentals, but more often, herbicides are applied in more precise, directed applications to minimize the potential for injury. This can be done with directional spray equipment, shielding or even a simple spot spray application.

If you're growing containerized perennials that are infested with crabgrass or another grassy weed, one option would be a graminicide like sethoxydim (Segment II herbicide), clethodim (Envoy Plus herbicide), fenoxaprop-ethyl (Acclaim Extra herbicide) or fluazifop-p (Ornamec herbicide). Before making the application, make sure to read each label to ensure safety on your desired crop or test a small area before making a large-scale application. Although these products selectively control grasses, they can sometimes cause injury to sensitive non-grass ornamentals.

Commonly mistaken for grasses, sedges can also be problematic in ornamental production. Their reproductive structures (nutlets) transfer readily in potting media and soil to the landscape, creating unsightly, hard-to-control patches. There are two herbicides labeled for the control of sedges in ornamentals, including halosulfuron (SedgeHammer herbicide) and bentazon (Basagran T&O herbicide). Applications of these types of products should be directed to the weeds themselves; desirable foliage should be avoided.

Broadleaf weeds are tough to control in ornamentals, as most of our ornamentals are broadleaf plants. Bentazon (Basagran T&O herbicide) is one herbicide that can be used to control broadleaf weeds in ornamental production areas. Most other options are broad spectrum and less selective, requiring very careful, directed application.

The last group of herbicides to mention is the broad-spectrum (non-selective) herbicides. These products don't distinguish between broadleaves, grasses, sedges or your desirable



plant materials. Extra care must be taken when applying these products around desirable plants, but these are also well suited to applications in areas that aren't being utilized for growing plant material.

For example, the contact herbicide glufosinate (Finale herbicide) can be applied to control weeds in ditches, out-of-production nursery pads, bareground and other areas where desirable plants aren't being grown, but weeds are undesirable.

In addition to glufosinate, products like diquat (Reward herbicide) and pelargonic acid (Scythe) can aid in the burn-down of weeds in areas between plants or areas that are out of production. Since glufosinate, diquat and pelargonic acid don't translocate within the plant, any off-target contact with desirable plants is localized and could be pruned out if the crop allows it.

Glyphosate is a systemic herbicide that can be utilized in many of the same ways as the contact herbicides. It can be applied as a directed or spot application to the areas between plant rows, or as a maintenance material around the growing operation. The only major difference is that glyphosate can cause injury that moves throughout the plant if accidental contact is made to desirable foliage.

When you make post-emergent herbicide applications, mix in a pre-emergent herbicide of your choice at the high rate to lend some residual control and elongate the interval before you'll need to spray again.

It's important to choose the right post-emergence herbicide for the weeds you're trying to control, but it's even more important to utilize these products as a compliment or support to your pre-emergence program. Applying pre-emergence products will control the bulk of the weeds that germinate in your growing area. Rely on post-emergence products to catch what might be missed or appear later on, courtesy of birds on your existing weed seed bank. **ST**

Always read and follow label directions.

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