

Joining Forces

Syngenta and Ball Horticultural Company have partnered to educate the North American horticultural industry about impatiens downy mildew, a disease that our European counterparts have been facing for several years.

Think of them like horticulture's "Justice League" or "Avengers," but without the fancy superhero outfits.

Ball and Syngenta, two of the industry's largest breeder/producers, have teamed up to pool their knowledge and expertise to help growers understand and fight a new foe: impatiens downy mildew (*Plasmopara obducens*), a disease caused by a fungus-like organism that is attacking one of our most vital spring bedding plants, *Impatiens walleriana*.

Now, it's important to note that this disease—which can cause leaf yellowing, stunting, premature defoliation and flower drop—**only affects *Impatiens walleriana*** and interspecific hybrids with *I. walleriana* in their bloodline. Since the first report of the disease in the United States in the 1940s, it has mostly been off the radar, with only a few occasional, scattered reports. But now, it has appeared in the landscape in a significant way.

For the last few years, some European countries (especially the United Kingdom) and South Africa have been battling impatiens downy mildew in the landscape. The outcome has been devastating to the point where it has greatly impacted impatiens sales from supply to retail. (See sidebar on page 52.) Fortunately, the United States and Canada haven't been affected. However, just this past summer, instances of impatiens downy mildew were reported in the landscape on the East Coast (including the Niagara region of Canada), the Midwest and California. It's these reports that have plant pathologists at Syngenta and Ball on high alert, hoping to prevent a widespread epidemic, and both working toward helping growers and landscapers prevent and manage the disease.

"Ball and Syngenta are global companies, and we're quite aware of the impact of this disease in other parts of the world," said Dr. Mike Klopmeier, general manager of Darwin Perennials and former corporate plant pathologist for Ball, during a meeting with *GrowerTalks* that included Dr. Brian Corr, head of technical services for Syngenta's North America Flowers Pro division, and Dr. Colleen Warfield, corporate pathologist for Ball.

"We've been observing what's happened in Europe," Mike continued, "including extreme, radical problems in the landscape that are now affecting the supply chain from young plants through retail. So as developers of the varieties, we are concerned for the future success of our North American customers. That's why we're working together to increase awareness—to try to avoid the same situation in North America in the next five years that Europe is now experiencing."

Brian Corr says that what has people concerned is the uncertainty of where the disease starts and how it spreads.

"Last year [2010], it was a non-issue. In 2011, it was measureable in North America. And we don't know what the trend will be."

Luckily for the industry, both Ball and Syngenta have already been conducting research on the disease individually and have recommendations on control and prevention. (See sidebar on page 54 and Pest

Management on page 78.)

"We want to learn from how things were handled in Europe. They may not have jumped on this fast enough; maybe by jumping on it quickly, we can minimize the problems," explained Brian. "North America has very different climates that may affect disease development, and that creates uncertainty in the minds of growers and landscapers. We can't predict accurately how this will work out. It's the responsible thing for Ball and Syngenta to take all reasonable actions in order to minimize the problem here in North America."

Dr. Colleen Warfield has been researching this disease and conducting fungicide efficacy trials since August 2010, but not because of the problems surfacing now in North America. One of her original goals was to ensure that the disease management program in place at Ball's production facilities in Central America remains up-to-date and is as effective as possible. She's now collaborating with other pathologists around the country to structurally and genetically characterize the downy mildew cases found in different regions of the country in 2011 to gain a better understanding of the pathogen and to determine if these downy mildew populations are indeed even the same species.

"After I started seeing this disease in the Chicago area in early September, I contacted several of my plant pathology colleagues to inquire if they were seeing impatiens downy mildew in their region of the country," said Colleen. "I learned of one report of impatiens downy mildew in a greenhouse earlier in the spring from a diagnostician in Michigan, and multiple landscape reports, mainly in the Cape Cod area. Another pathologist was quite surprised to discover it on the impatiens in his own backyard. One of our managers at Ball discovered downy mildew-infected impatiens in flower beds at a hotel in southern California while on a business trip. Many landscapers and consumers are unaware of this disease and the symptoms it can cause, so unfortunately, there's no concrete data that tells us when or where the disease may have started or how far it spread in 2011."

Brian said Syngenta has also been conducting research on impatiens downy mildew since the disease started decimating the crop in Europe. "[The research] has been focused on control—like Colleen, we all have the same concerns. You want to make sure that the production facilities do all they can to control the disease. So the supply chain is extremely important for all of us. But we've also been focused on control for the grower and for the landscape, because if we don't do that, the rest of it doesn't matter."

Quarantine questions

As all seasoned growers know, this isn't the industry's first run-in with a plant disease that spread to near devastating outcomes. Shivers run down the spine of many who experienced challenges with *Ralstonia* on geraniums or chrysanthemum white rust. But impatiens downy mildew is **not** like those diseases for many reasons—the primary one being that it's not considered a quarantine pest by the USDA.

"First, this is not an actionable quarantine pest," Mike stated emphatically. "Chrysanthemum white rust and *Ralstonia* are quarantine pests, which means that all measures are to be taken to eradicate them, since they are currently not present in the U.S. Impatiens downy mildew is not a regulated pest but rather a 'quality pest'—meaning it could impact the quality of the finished plants at the grower, landscaper or consumer level."

Also, the research done by Ball and Syngenta suggests that the pathogen is not transmitted by seed; however, seed-raised impatiens are also susceptible to the disease in the plug and young plant stage. But says Mike, "We don't believe this is the primary source of infection."

This doesn't mean that rooting stations and growers who buy in cuttings should switch to seed impatiens. Both Ball and Syngenta have processes in place at their respective production locations to ensure that all of the cuttings shipped out to customers are as clean as possible.

The disease triangle

During the discussion, Brian talked about what every student learns in horticulture school. "It's classic plant pathology 101." Making a triangle shape with his fingers, Brian refers to the first two points and says, "You have to have the susceptible plant, and the pathogen has to be present—but those two alone don't result in disease. You have to have an environment that's favorable for the disease to develop."

That environment is cool temperatures and moist conditions—both of which are common occurrences in the UK and Western Europe. Most of the cases in the U.S. were reported after a period of low temperatures and lots of precipitation, like what happened with the East Coast late in the summer of 2011 after Hurricane Irene.

"This year, it came in late when we saw it in the landscape, which is why some people didn't notice it," said Mike. "In some cases in Europe, the disease hit them early and hard, causing massive destruction in the landscape. European weather conditions through the summer consist of cool, cloudy, windy and wet weather. That, coupled with a lot of impatiens used in landscape settings and easy movement of wind-blown spores over miles, doesn't take long to have a big-time problem."

Logic would suggest that since this disease only affects one species of impatiens of commercial importance, it would be easier to pinpoint and eradicate. But it's not that simple.

"The trouble is, it's one of the most important bedding plants out there that is used ubiquitously," Mike says. "We are trying to increase awareness in getting people to look for symptoms and, if you have to down the line, do crop rotations at the landscape level within those particular beds if symptoms were seen the previous season. Try to lessen the impact of the disease by not putting *Impatiens walleriana* in those beds and rotate with another crop, which you should be doing anyway."

Avoiding Henny Penny

Although nothing beats the color range offered by *Impatiens walleriana*, there are other options—especially since the disease is host specific. New Guinea impatiens, begonias and coleus are obvious choices to replace impatiens because of their shade tolerance. Growers in the UK are also trying out phlox and cosmos. Growers in North America should be aware of their market and have a Plan B ready if their spring impatiens sales start to decline.

Both Syngenta and Ball were steadfast in their message that growers should continue to offer this core crop for this coming spring. Their efforts to educate all levels of the supply chain have made them hopeful that the likelihood of a widespread outbreak is minimal. They agreed that it was important to sit down at the same table and figure out a way to inform the industry about impatiens downy mildew without it becoming another "Chicken Little" story.

"Right now, we think it's very early on and we're increasing awareness so the disease can be managed," explained Mike. "[The growers] need to be looking and scouting for the disease at the greenhouse level, and if they're hearing reports back of problems in the landscape, they need to get it properly diagnosed to make sure that's what it is and then work closely with their landscapers to look at alternate crops to rotate."

Colleen agreed. "The confirmed cases in the landscape are very regional, so the reality is the number of landscapers or consumers that might actually be impacted is relatively small when looking at the country as a whole. But for landscape beds where impatiens downy mildew was confirmed in 2011, we recommend not planting *Impatiens walleriana* into those beds this season."

Both companies want to get the word out quickly so that growers were armed with enough information to be on the look out during the next vital growing months.

"We don't know if we're in the middle of a perfect storm right now and as soon as the storm goes away the problem goes away, or if this is going to become something more significant," said Brian. "That's why we're here. Let's put a stop to anything now; let's minimize the spread of the disease so we can minimize potential problems in the future. Even if it just goes away on its own, we've done what we need to do to be responsible stakeholders in this industry."

IDM Across the Pond

By Jennifer Zurko

What started as a small problem turned into a disaster in some parts of Europe and South Africa. The first reports of the recent outbreak of impatiens downy mildew came from the United Kingdom, the Netherlands and Germany. Luckily, the effects from the disease were minor in Dutch and German landscapes, but the UK wasn't as fortunate.

Colin Turvey, who works for Ball's UK subsidiary Ball Colegrave, said that up until 2011 the impact on expected impatiens sales had been low, but the decline for the coming year "has been devastating in such a short period."

This past summer, Colin says the disease devastated *Impatiens walleriana* at the grower level and later in the landscape. "It appeared that the spores were now resistant to all chemical applications," he said.

The combination of susceptible plants, previously infected beds and atypical weather conditions caused the problem to snowball over a number of years.

"In 2004, there was only one reported case of the disease, and in 2005 and 2006, no cases were reported—probably because of less favorable environmental conditions for the disease," Colin explained. "Relatively low levels were found in 2007, but in 2008, the disease was widespread in both outdoor planted material and also crops [in] nurseries. There were instances in 2009 and 2010, but not widespread possibly because of better monitoring in commercial crops and fungicide control measures applied during production."

For the upcoming growing season, Ball Colegrave is not offering any vegetative cuttings of *I. walleriana* to the market—most of the large supermarket customers haven't even order impatiens because of the press the disease has been getting in the British media. Colin went on to say, "The impact of this has not yet been felt by Ball Colegrave ... but we anticipate that impatiens product sales for seed and seed-raised plugs will be down significantly."

Which is why here in North America, Ball and Syngenta have made strides to gather and share research, in order to educate all of the market segments, avoiding a similar problem experienced by their European subsidiaries.

EDITOR'S NOTE: As you read the articles regarding impatiens downy mildew, you'll notice similarities in control and prevention recommendations. This is because there is no controversy about the initial suggestions on symptoms and control measures. However, we're also including specific information from Syngenta's technical services team, a highly respected university plant pathologist (both below), and Ball's research and development department (page 78) that provides additional support for maintaining a successful impatiens crop this spring. —JZ

Don't Let Downy Mildew Win Over Your Impatiens

By Margery Daughtrey

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Downy mildew on impatiens is a disease the flower industry could certainly do without. Given the right conditions, it destroys garden performance. The pathogen, *Plasmopara obducens*, was noted in a few greenhouses in the U.S. this year and made a real impression in landscapes in some localities—including my own neighborhood. Landscape plantings were transformed from beautiful, lush flowering plants to green stems over the course of a few weeks near the end of the growing season. With time, even the green stems collapsed. Impatiens downy mildew is suddenly a disease to be reckoned with—but we know very little about it.

The stories from the U.K. indicate that it will “come and go” from year to year. The “Busy Lizzies” there began to show the problem in 2003; only one case was seen in 2004 and none in 2005 or 2006. Low levels of disease were noted in 2007, but in 2008 it was widespread. Environmental conditions alone could be responsible for this variation, as disease expression is regulated by to-be-determined details of temperature and moisture. The amount of inoculum in the trade would also have a major effect on what is seen in the landscape. Although the disease was seen in Long Island greenhouses for the first time in 2004, no cases of the disease were found in the local landscape until 2011.

Thus, growers and propagation companies need to be alert to this new problem: impatiens should be watched for symptoms and suspect plants should never be planted outdoors. The symptoms are easily missed: downcurling, stunting or yellowing leaves are the clues. Plants may look as if they have a spider mite infestation. To verify a suspicion, put leaves into a plastic bag with a wet paper towel for 24 to 48 hours. This typically stimulates the growth of whitish sporangia on the leaf undersurface.

The oospores we have seen in the impatiens stems are likely to allow overwintering of the pathogen. This means that if a bed was full of diseased impatiens in 2011, healthy impatiens planted in that bed in 2012 may well come down with the disease. One town in upstate New York has seen landscape outbreaks of impatiens downy mildew in 2009, 2010 and 2011, which suggests that each year's fresh impatiens plantings might be picking up the disease from oospores surviving in the soil.

Fungicide treatments of already-infected greenhouse plants might not be able to prevent development of symptoms in the landscape later, but they can minimize spread within the crop. Colleen Warfield's studies (see her article in this issue on page 78) have shown effectiveness for several active ingredients, and the study I conducted last fall indicated that mandipropamid (Micora), mefenoxam (SubdueMAXX), azoxystrobin (Heritage, applied with Capsil as a spreader-sticker) and dimethomorph (Stature SC) all prevented symptoms when inoculated with a population of *P. obducens* sporangia collected from naturally-infected plants in New York that wilted 80% of the inoculated controls. Research is needed on this disease: it's very hard to extrapolate all the necessary information from downy mildew on grapes, for example, because the plants and the production systems are so very different.

Managing downy mildew in *Impatiens walleriana*

By Syngenta Technical Services

Although the pathogen that causes impatiens downy mildew has been present in North America for more than 100 years, until recently impatiens downy

mildew was considered a European disease. However, in 2011, reports from parts of the United States suggested downy mildew could become a threat for North American impatiens. Global players in the impatiens market, such as Syngenta, have research experience with this disease in the European market, as well as experience in North America, and are educating the industry regarding this disease.

Growers should focus on prevention of impatiens downy mildew because control of an active infection is difficult. Following are some preventive tips from Syngenta:

■ **Start with propagation material free of the disease.** Since the disease has not been shown to be seed transmitted, seedling plugs of *I. walleriana* that have been isolated from any source of the disease should be disease free. Vegetatively propagated *I. walleriana* from reputable suppliers should also be disease free. However, since the disease may be initially symptomless, it is prudent to isolate vegetatively propagated *I. walleriana* from seed-propagated impatiens.

■ **Maintain good culture.** Ideal culture conditions minimize the risk of disease development. Keep humidity moderate and avoid foliage moisture for extended periods.

Provide good air movement and irrigate early in the day so foliage will be dry by night.

■ **Scout impatiens crops frequently.** Pay close attention to early leaf symptoms—yellow or pale green foliage with subtle mottling. Remove suspect plants from the greenhouse and send foliage samples to a diagnostics lab for disease identification immediately.

■ **Greenhouse sanitation.** Any impatiens plants left after the crop has been shipped should be promptly removed from the greenhouse and discarded. No volunteer plants should be allowed to grow in or around the production area. Facilities and equipment should be cleaned between production runs.

Should impatiens downy mildew be confirmed in the greenhouse, all plants with symptoms and any fallen leaves must be immediately placed in sealed bags and removed from the greenhouse. Plants within 3 ft. of infected plants should also be discarded. Use an approved greenhouse disinfectant to sterilize greenhouse surfaces contacted by infected plants and begin a preventive fungicide program on all remaining *I. walleriana*.

A downy mildew management program should include a fungicide rotation with different modes of action applied as foliar sprays and periodic drenches to the growing medium (see Table 1 on page 56). Implementing a preventive program as described in Tables 2 and 3 help prevent downy mildew and control most common fungal diseases

Table 1. Products suitable for use in a greenhouse control program for impatiens downy mildew.

MOA (FRAC#)	Product	Active Ingredient	Activity	Application	Re-entry Interval (REI)	Company
4	Subdue MAXX	Mefenoxam	Systemic	Spray Drench	48-hr REI exemptions for certain drench applications.	Syngenta
11	Disarm O	Fluoxastrobin	Systemic	Spray Drench	12 hr	OHP
11	Fenstop	Fenamidone	Systemic	Spray	12 hr	OHP
11+7	Pageant	Pyraclostrobin + Boscalid	Translaminar (11) + Systemic (7)	Spray	12 hr	BASF
21	Segway	Cyazofamid	Systemic	Spray Drench	12 hr	FMC
33	Aliette	Fosetyl-AL	Systemic	Spray Drench	12 hr	OHP/Bayer
33	Alude	Potassium salts of Phosphorous Acid	Systemic	Spray Drench	4 hr	Cleary Chemical Corp.
33	Vital	Potassium phosphite	Systemic	Spray	4 hr	Phoenix
40	Stature SC	Dimethomorph	Translaminar	Spray	12 hr	BASF
40	Micora	Mandipropamid	Translaminar	Spray	4 hr	Syngenta
43	Adorn	Fluopicolide	Systemic	Spray Drench	12 hr	Valent
M	Protect DF	Mancozeb	Contact	Spray	24 hr	Cleary Chemical Corp.

NOTES: ■ Always test products on a small area before using on an entire crop.

■ For brevity, some products with the same mode of action—which may have activity against impatiens downy mildew—have been omitted.

■ Micora has been shown to be effective against impatiens downy mildew and was recently registered by the U.S. Environmental Protection Agency, but is not currently registered in all states.

Young plant production

If only seed-propagated *I. walleriana* are grown and there is no contact with other impatiens, there's no need for preventive fungicide applications that target downy mildew. However, vegetatively propagated impatiens may be infected with impatiens downy mildew with subtle to no symptoms, so making fungicide applications is sensible insurance. Since propagation time is short, one or two applications should be sufficient as described in Table 2.

Table 2. An example of a program for prevention of impatiens downy mildew, as well as other diseases of *Impatiens walleriana* seedling plugs or liners during propagation.

Propagation Week	Application	Fungicide FRAC code
1		
2	Drench	21 or 4
3		
4	Spray	M or 11

Finished plant production

During finished production, plants may be in the greenhouse for as long as 12 weeks from transplanting to shipping, which results in longer time for the disease to potentially spread throughout the crop. At this time, no options providing curative control or eradication of the disease have been found; therefore, preventative control programs, such as those in Table 3, provide options for multiple applications of protective fungicides. This schedule helps prevent downy mildew and other impatiens diseases.

Syngenta recommends a drench application to finished plants shortly before shipping. While no product will provide season-long control of impatiens downy mildew, drench applications prior to shipping have been shown to provide early-season protection against the disease and increase the duration of acceptable performance in the landscape.

Important: Always read and follow label instructions before buying or using Syngenta products. The instructions contain important conditions of sale, including limitations of warranty and remedy. Micora is not currently registered in all states. Please check with your state or local extension service prior to buying or using this product.

Table 3. An example of a program for prevention of impatiens downy mildew, as well as other diseases of impatiens during production of finished plants.

Container size	Week post-transplant	Application	Fungicide FRAC code
4-inch pot or smaller	1	Recommended Drench	4 + 43
	2	Optional Spray	M
	3	Recommended Spray	11
	4	Recommended Drench	21
	5	Optional Spray	11
	6	Recommended Spray	40
	7	Recommended Drench	33
6-inch pot	8	Optional Spray	11
	9	Recommended Spray	40
Larger containers	10	Optional Spray	40
	11	Recommended Drench	33

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Pest Management

BY DR. COLLEEN Y. WARFIELD



A white, downy-like growth composed of spores may be visible on the underside of impatiens leaves infected with downy mildew.

Downy Mildew of Impatiens

Impatiens downy mildew is a destructive foliar disease of *Impatiens walleriana*. While there have been sporadic reports of this disease in production greenhouses in the United States since 2004, widespread regional outbreaks of impatiens downy mildew were observed for the first time in North American landscapes in 2011. Impatiens downy mildew was confirmed in landscape beds and container plantings on the central and southern coast of California, northeast Illinois, northern Indiana, the Twin Cities area of Minnesota, Cape Cod, Massachusetts, and Long Island and upstate New York. Unconfirmed cases of impatiens downy mildew were also reported in landscape beds in southern Wisconsin and the Niagara Falls region of Ontario, Canada. The incidence and distribution of this disease in North America may be even greater than realized due to unfamiliarity with the signs and symptoms of the disease, especially as seen in landscape settings.

Hosts

All varieties and intraspecific hybrids of *Impatiens walleriana* are susceptible to impatiens downy mildew, including both vegetative- and seed-produced *I. walleriana*. There are no marketable differences in susceptibility among varieties; however, research conducted by The Food and Environmental Research Agency (FERA) in the United Kingdom has shown no evidence of seed-borne transmission. A few species of wild impatiens are also hosts of this disease, but there are no other known hosts. New Guinea impatiens (*Impatiens hawkerii*) are highly tolerant to this downy mildew and have been successfully grown in greenhouses and landscape beds even under high disease pressure for downy mildew.

Symptoms

Impatiens downy mildew symptoms begin as a light-green yellowing or stippling of infected leaves. Very subtle gray lines or markings are sometimes observed on the top of the

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leaf. Infected leaves may curl downward at the edges, but generally this is a more advanced symptom of infection. Young plants and immature plant tissues are especially susceptible to infection. As such, leaf symptoms are often first observed on the younger or terminal growth. Seedling cotyledons are also highly susceptible to infection. Plants infected at an early stage of development may be stunted in both height and leaf size, yet may show no visible signs of sporulation if environmental conditions are not favorable for disease expression.

A white, downy-like growth composed of spores may be visible on the underside of infected leaves under cool temperatures (about 60 to 73F/15 to 22C) and moist or humid conditions. When scouting, it is very important to turn leaves over to observe the undersides for this white growth. The time from infection to the appearance of symptoms varies from about five to 14 days depending on the age of plant tissue, temperature and humidity. The latent period between infection and visible plant symptoms is of concern because infected plants could potentially be shipped or moved without even knowing there is a disease problem. This highlights the importance of preventive control at both the production and young plant producer level to ensure cuttings and seed-produced plugs are kept free of this disease.

If the disease continues to progress, eventually the leaves and flowers will drop, resulting in bare stems with only a few tiny, yellow leaves remaining. This symptom is more likely to be observed in a landscape setting where symptoms and early signs of infection are more likely to go unnoticed, in comparison to a greenhouse setting where plants are frequently scouted and suspect plants would be quickly rogued.

Pathogen Biology

Impatiens downy mildew is caused by *Plasmopara obducens*. This host-specific, fungus-like organism is known as an oomycete or water mold. Oomycetes, which include Pythium and Phytophthora, are some of the most destructive plant pathogens due, in part, to their swimming spores that thrive in wet conditions and can spread with alarming speed. These swimming spores (zoospores) are produced inside sac-like fungal structures called sporangia. The sporangia form on microscopic, treelike structures that are produced from a fungal mat inside the leaf tissue and emerge through the stomata on the underside of infected leaves. It is these spore-bearing structures that are responsible for the visible white, downy-like growth on the leaf underside. In response to changes in light, temperature and/or humidity, the sporangia are dislodged and can easily become airborne or splashed by rain or water to other leaves and distant plants. Zoospores released from the sporangia can swim in moisture on the leaf surface, encyst, then germinate and penetrate the leaf tissue through the stoma by means of a germ tube.

In addition to the zoospores produced in the aerial sporangia, another type of spore may form inside infected stems and leaves. These spores, called oospores, may survive in plant debris and be released into the soil as the stems decay. These resting spores can potentially survive in the soil for a period of years. Controlled experiments and observation of landscape beds have shown that impatiens planted into oospore-infested soil developed downy mildew. If *Plasmopara obducens* behaves similarly to other *Plasmopara* species, the following season the oospores in the soil may be triggered to produce the same treelike, spore-bearing structures that are observed on the leaf undersides. These sporangia are then splashed by rain or carried by wind to cause new plant infections. These airborne spores may potentially find their way into greenhouses, serving as one potential source of inoculum.



Impatiens downy mildew symptoms begin as a light-green yellowing or stippling of infected leaves.



From left to right: 1) a non-treated, non-inoculated control; 2) a non-treated, inoculated control; and 3) a plant treated with fungicide (Adorn).

Disease management

CULTURAL PRACTICES

Avoiding the introduction of diseased plant material is an important first step in managing downy mildew. The integrity of the supply source is an important component in minimizing the risk of introducing infected cuttings into a greenhouse facility. To help ensure a supply of healthy cuttings, downy mildew is managed very aggressively at the production level. While seed-raised impatiens are susceptible to downy mildew, there is no evidence of seed transmission. Therefore, vegetative cuttings and seed-grown plants should ideally be grown in separate houses to limit cross-contamination, especially given the potential for asymptomatic, latent infections. Because moisture favors the development of downy mildew, cultural controls should focus on reducing greenhouse humidity and limiting leaf moisture. Good air movement through plant spacing and horizontal air flow, adequate drainage and irrigating when leaves will dry most quickly will help to minimize leaf wetness and humidity. Avoiding high humidity and leaf wetness at night is especially important in limiting secondary infections.

CHEMICAL CONTROL

Apply fungicides preventively for maximum efficacy. I've conducted a series of fungicide efficacy trials applying products both preventively, as well as three or six days after inoculation. The highest levels of control were always obtained when fungicides were applied preventively. Adorn, Fenstop, Heritage, Orvego, Pageant, Protect, Stature, Segway and Vital all provided very good to excellent control of impatiens downy mildew when applied as foliar sprays prior to inoculation in repeated trials. Adorn was tank mixed with Protect following label guidelines for managing fungicide resistance. Aliette, applied as a drench one day prior to inoculation, did not adequately control the pathogen and almost 50% of the leaves had visible sporulation within 13 days after inoculation. Subdue MAXX, applied as either a foliar

spray or drench, was completely ineffective in controlling downy mildew using an isolate of *P. obducens* originally collected in Holland. However, excellent control was obtained when plants were drenched with Subdue MAXX prior to inoculation with downy mildew isolates collected in Illinois and California in 2011. This clearly demonstrates differences among downy mildew populations in their sensitivity to mefenoxam, and the importance of rotating between fungicides with different modes of action.

When fungicides were applied three days after inoculation, Adorn, Fenstop and Stature had the best efficacy of all products tested, providing good to very good control. With exception of Adorn, fungicides applied six days after inoculation, when sparse sporulation was just visible on a few leaves, reduced the severity of the disease but at levels that would not be acceptable in a production facility. Adorn provided very good control even when applied six days after inoculation, and was as equally effective as a foliar spray or drench.

It is critical to follow all label directions and guidelines for managing fungicide resistance, and make sure you are rotating among fungicides with different modes of action (refer to FRAC code). *Editor's note: See table on back page for FRAC codes and a list of active ingredients for the fungicides mentioned.*

SCOUTING

Frequent scouting of the crop, paying particular attention to early leaf symptoms (subtle stippling or yellowing), is critical for early detection. Symptomatic plants and any fallen leaves or petals should be promptly bagged and sealed before carrying out of the greenhouse. Avoid placing infected plants into the compost pile. **GT**

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