

The Two Mildews

The latest research on control measures for downy and powdery mildew.

By A. R. Chase

Powdery mildew is one of the most common types of diseases on ornamentals. Some common hosts include rose, gerbera daisy, salvia, pansy, hydrangea, begonia, African violet, crape myrtle, delphinium, zinnia, azalea, sunflower, ranunculus, grape ivy, phlox, beebalm, oaks...and that is just the tip of the iceberg. Don't forget that powdery mildew fungi attack more than leaves. We often see rose and gerbera daisy flowers covered with powdery mildew sporulation. Greenhouse growers are sometimes able to prevent powdery mildew using environmental modification, while many other growers must rely on fungicides. Every once in a while, I hear of a grower who actually eliminates powdery mildew problems by choosing cultivars that are resistant to the disease — the ultimate in biological control approaches.

There are almost as many fungicides that can prevent or eradicate powdery mildew as there are plants attacked by these fungi. This is a situation where something besides efficacy can determine which products are used. You can use environmentally friendly products, fertilizer, biological extracts and biological controls, systemic or protectant products, and even wetting agents with good results. You can even settle on products to use based solely on cost!

How about downy mildew diseases? These diseases sound deceptively similar but are in fact quite different in nature and seriousness. While powdery mildew can be eradicated, downy mildew outbreaks are often exercises



Typical symptoms of powdery mildew on gerbera daisy leaves.



Powdery mildew attacking a miniature rose flower. (Photos courtesy of A.R. Chase)

Figure 1. Partial list of downy mildew pathogens and their reported ornamental hosts.

Pathogen	Hosts
<i>Basidiophora entospora</i>	Aster, callistephus, erigeron, solidago
<i>Bremia lactucae</i>	Centaurea, cineraria, gnaphalium, helichrysum, osteospermum
<i>Bremiella megasperma</i>	<i>Viola x wittrockiana</i>
<i>Peronospora antirrhini</i>	Antirrhinum
<i>Peronospora arborescens</i>	Argemone, meconopsis, papaver
<i>Peronospora arthuri</i>	Clarkia, gaura, godetia, oenothera
<i>Peronospora chlorae</i>	Eustoma
<i>Peronospora conglomerate</i>	Geranium (not pelargonium)
<i>Peronospora cynoglossi</i>	Cynoglossum
<i>Peronospora dianthicola</i>	Dianthus
<i>Peronospora dicentrae</i>	Dicentra
<i>Peronospora ficariae</i>	Delphinium, larkspur, ranunculus
<i>Peronospora gangliformisi</i>	Cineraria
<i>Peronospora grisea</i>	Collinsia, hebe, veronica
<i>Peronospora hiemalis</i>	Ranunculus
<i>Peronospora jacksonii</i>	Mimulus
<i>Peronospora lamii</i>	Lamium, salvia (other mints)
<i>Peronospora linariae</i>	Linaria
<i>Peronospora oerteliana</i>	Primula
<i>Peronospora parasitica</i>	Arabis, broccoli, cauliflower, erysimum, hesperis, iberis, kale, lobularia, matthiola, nasturium
<i>Peronospora potentillae</i>	Potentilla
<i>Peronospora sparsa</i>	Feijoa, rosa, rubus
<i>Peronospora tabacina</i>	Solanum, capsicum, nicotiana
<i>Peronospora trifoliorum</i>	Lathyrus, lupinus
<i>Peronospora violae</i>	Viola
<i>Plasmopara geranii</i>	Geranium (not pelargonium)
<i>Plasmopara halstedii</i>	Centaurea, cineraria, coreopsis, dimorphotheca, erigeron, helianthus, osteospermum, verbena, rudbeckia, solidago
<i>Plasmopara obducens</i>	Impatiens
<i>Plasmopara pygmaea</i>	Aconitum, anemone
<i>Plasmopara viburni</i>	Viburnum
<i>Plasmopara viticola</i>	Cissus, parthenocissus, vitis

in how much product can be applied before the crop is lost. The fungi attack a wide variety of bedding plants, perennials and cut flower crops and have sometimes been quite a problem on bare-root garden roses. Downy mildew diseases were once a serious concern for ornamental growers primarily on the West Coast. Along the Pacific Coast conditions are often cool and wet, and relative humidity is high. In the past 10 years, the downy mildew phenomenon has spread throughout the country, equalizing the dangers growers face to some degree.

Downy mildew diseases are caused by fungi such as *Peronospora*, *Bremia*, *Bremiella*, *Plasmopara* and *Basidiophora* (See Figure 1, left). The sporulation appears as white to purplish-gray "down" on leaf undersides. On pansy and snapdragon the color is purple, while on stock and rose sporulation is white and looks a little like the plants were sprinkled with sugar. The appearance of downy mildew infection is not always accompanied by sporulation. Under adverse weather conditions the leaves may turn red or even dark purple to black. The list of plants affected by many different downy mildew fungi is long and increases every year.

The optimal temperature for downy mildew on many crops is approximately 45-70° F. Humidity usually has to reach 85 percent or higher to favor sporulation and disease development. The infection-to-sporulation cycle can be as short as four days but is usually longer — around 7-10 days. Since there are so many different downy mildew fungi-causing diseases on ornamentals, these generalizations should not be taken too literally. Most of the parameters for specific downy mildew diseases have not been determined.

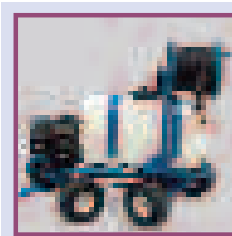
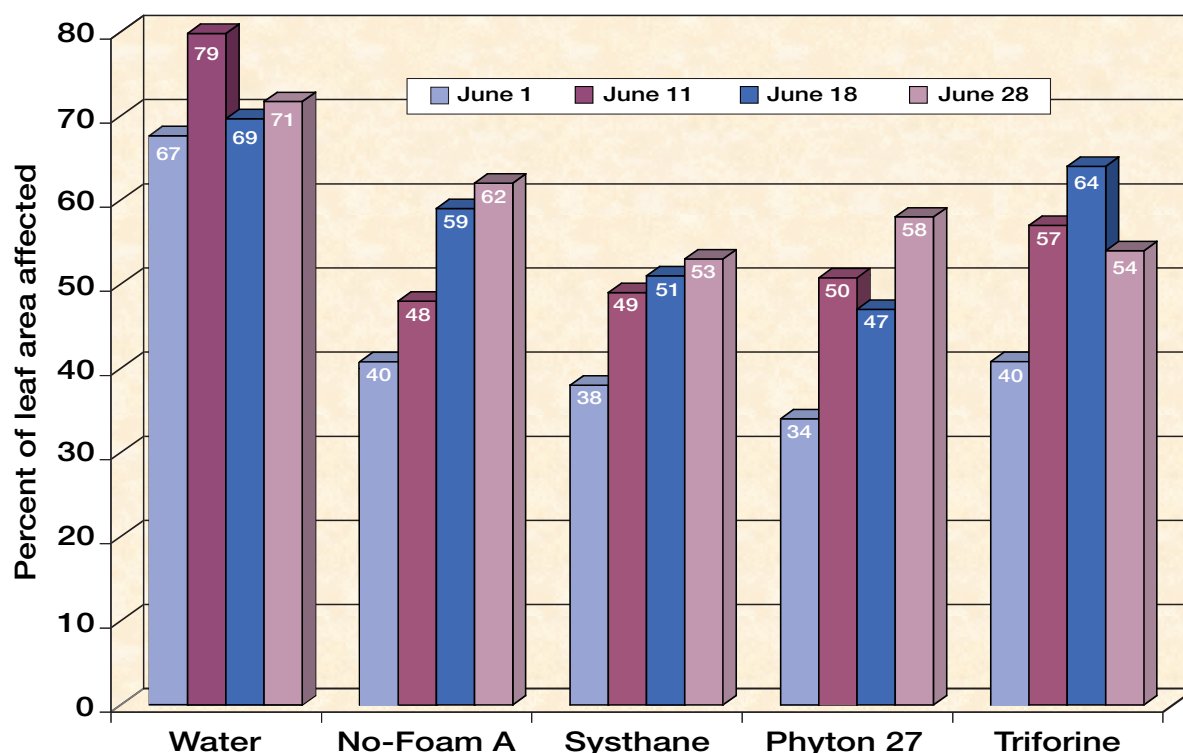
Control of downy mildew relies heavily on preventative fungicide

Figure 2. Control of gerbera daisy powdery mildew with non-traditional products.

Fungicide	Rate per 100 gal.	Type of product	Comparison to Standard*
Actinovate and Latron B 1956	6 oz. and 2 oz.	Biological/wetting agent	Better
Actinovate and ThermX-70	6 oz. and 4 oz.	Biological/wetting agent	Equal
Alude	64 oz.	Phos-acid	Equal
Capsil	2 oz.	Wetting agent	Better
Decree	24 oz.	Fenhexamid	Equal
Latron B 1956	2 oz.	Wetting agent	Equal/better
Milstop	1.25-5 lb.	Potassium bicarbonate	Better
Mimik	16-64 oz.	Fertilizer	Better
Silwet	2 oz.	Wetting agent	Better
Vital	64 oz.	Phos-acid	Equal

*Standard products were either Compass O (0.5 or 1 oz.) or Systhane (2 oz.) in each trial.

Figure 3. Trial 1 — Percentage of leaf area with active powdery mildew sporulation on miniature roses. Plants were sprayed on a 10-day interval (except the last spray as after five days only) for a total of five applications.



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applications. Weekly applications are usually necessary, and some growers report using as many as three applications per week. We have found that applications of three times per week can be counterproductive. This is probably due to the extra water applied in these fungicide sprays, as the benefits of the chemical appear to be outweighed by the excess water. Thus, twice a week appears to be the maximum effective frequency in many situations. Rotating between chemical classes is critical to prevent development of downy mildew fungi that are resistant to the fungicides. This can also be accomplished through use of tank-mixes.

POWDERY MILDEW TRIALS

In the past two years, we have conducted a series of trials on gerbera daisy and miniature roses with powdery mildew. Gerbera daisy plants were sprayed before (four preventive trials) or after infection (one eradication trial). Each trial had at least one standard fungicide comparison: either Compass O (Olympic Horticultural Products) at ½ or 1 oz. per 100 gal. or Systhane (Dow AgroSciences) at 2 oz. per 100 gal. Spray intervals were either seven or 10 days, and sprays were applied three or four times (prevention) or twice (eradication). Trials were run between June 2003 and April 2004.

We found that many of the products were equal or better at preventing (and sometimes eradicating) powdery mildew on gerbera daisy when compared to the two standards (Compass O and Systhane). One of the interesting trends was the high degree of control achieved with all wetting agents we tried [Latron B 1956 (Dow AgroSciences), Capsil (Aquatrols) and Silwet (Helena Development Lab)]. We also saw the biological control agent Actinovate (Natural Industries, Inc.), which contains *Streptomyces*, performs well. MilStop (BioWorks) is best known for efficacy on powdery mildew, and we did find it performed better than the industry standard. At one time last year, I remember hearing from a grower that the Phos-acids worked on powdery mildew, which I found hard to believe but clearly compelling. We did a trial with Alude (Cleary Chemical Corp.) and Vital (Griffin LLC) and found that they performed equal to or better than the standard fungicide in one trial on gerbera daisy. We also included some Phos-acids in an eradication trial on miniature rose.

The miniature rose trials were performed with 'Raspberry Sunblaze' moderately infected with *Sphaerotheca pannosa*. The first trial evaluated another wetting agent [No-Foam A (Argent Labs) at 8 oz. per 100 gal.], Systhane (3 oz.), Phyton 27 (Phyton Corporation) (25 oz.) and Rose Pride (triforine-50 oz.). The second trial

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Top: Purple sporulation of *Peronospora violae* (downy mildew) on undersides of a pansy leaf. **Bottom:** White sporulation of *Peronospora parasitica* (downy mildew) on undersides of a stock leaf.

compared pHortress (Western Farm Service, Agrium) at 64 oz. per 100 gal., Experimental 1 (JH Biotech Inc.) at 64 oz. and Aliette (Bayer Environmental Science) at 16 oz. to Pipron (SePro) at 8 oz. Plants were sprayed to drip on a 7- to 10-day interval, three times in June. Both trials were started after powdery mildew infections were advanced.

Results from the first trial indicated that all products worked to approximately the same degree, including standards like Systhane and triforine as well as Phyton 27 and the wetting agent No Foam A. Over the course of the trial, the degree of control decreased with all of these products to about the same level. Although control was significantly better than water alone, it was overall poor. The second trial on this extremely susceptible cultivar showed about the same response — early good eradication with all products tested (especially Experimental 1 and Pipron) and loss of control later in the trial.

These two trials do indicate the potential for using some non-traditional products for eradication of powdery mildew. All of the Phos-acid alternatives and Aliette provided significant eradication in the second trial. Further, it seems that all of the wetting agents we have trialed can control powdery mildew to some degree, including Capsil, Silwet, Latron B and now No Foam A.

DOWNY MILDEW TRIALS

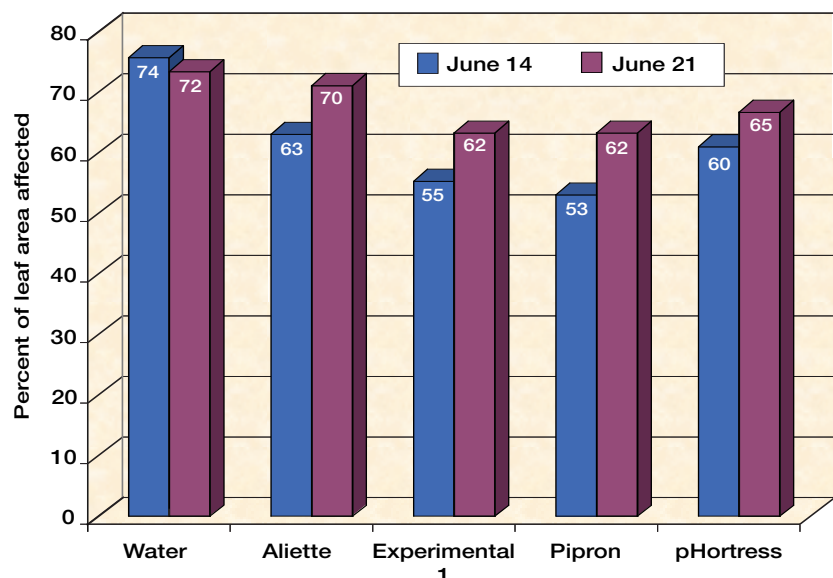
Our most recent trials on downy mildew control were performed on bedding plants including pansy, snapdragon, blue salvia and stock. All of the trials (except the salvia test) were conducted before any downy mildew was introduced into the greenhouse. Each trial had at least one standard fungicide comparison, usually Aliette at 16 oz. per 100 gal. The applications were made on a 7- or 10-day interval three times before the final rating was taken on the percentage of leaf surface area with downy mildew sporulation. Trials were run between December 2002 and December 2003.

Trials included several Phos-acids (Alude, pHortress and Vital) com-

pared to a Phos-acid fungicide standard (Aliette). Other standards included Phyton 27 (copper pentahydrate) and SePro's Stature DM (dimethomorph). We also compared four strobilurins in one trial [Insignia (BASF), Compass O, Cygnus (The Scotts Co.) and Heritage (Syngenta)]. Results for these trials are summarized in Figure 5, page 42.

The degree of control achieved with the strobilurins was not unexpected, with each delivering very good to excellent control of downy mildew. The standard comparison, Aliette, gave roughly the same level of control. Alude, pHortress and Vital each fall into the Phos-acid group with Aliette.

Figure 4. Trials 2 — Percentage of leaf area with active powdery mildew sporulation on miniature roses. Plants were sprayed on a seven-day interval twice.



Our trials for downy mildew control showed each of these fungicides or fertilizers (pHortress) capable of the same level of control as Aliette, although their use rates were three or four times that of Aliette.

In these four trials, we also tested Milstop and found very good to excellent prevention of downy mildew on stock. Another new downy mildew product we can look forward to is cyazofamid (ISK Biotech and FMC Corp.). This product is under development presently and has been very good to excellent for Pythium and Phytophthora diseases. The level of control in stock downy mildew was excellent for cyazofamid. We will be testing this further in the fall/winter when downy mildew weather is once again upon us. The final "new" product in our trials ▶



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was the biological control registered late last summer, AgraQuest's Rhapsody (*Bacillus subtilis*). Our single trial on preventing stock downy mildew showed at 1 or 1½ percent Rhapsody gave some control.

CONCLUSIONS

Our trials on both powdery mildew and downy mildew diseases have yielded some interesting twists over the past year. The Phos-acids clearly are efficacious for both downy mildew and powdery mildew (including Alette), and all of the wetting agents we have tested can control powdery

mildew. The strobilurins will be integral partners in both powdery mildew and downy mildew prevention rotation programs, and new products like cyazofamid will eventually be important for downy mildew.

I find the difficulty in controlling powdery mildew on miniature rose perhaps the most interesting since I had previously believed that powdery mildew in general was relatively easy to control. I was willing to admit that the rose disease was the most difficult, but now I really have to sympathize with miniature rose producers. Powdery mildew, at least on some miniature rose cultivars, cannot be stopped when the weather is conducive to disease — short of using a dumpster.

One final word of warning — Watch out for mildews! 

Figure 5. Efficacy of some products for downy mildew diseases on bedding plants.

Treatment	Type of product	Rate per 100 gal.	Pansy	Snapdragon	Blue Salvia	Stock
Alette	Phos-acid	16 oz.	E	VG	VGE	E
Alude	Phos-acid	32-64 oz.	—	—	VGE	—
Compass O	Strobilurin	4 oz.	E	—	—	—
Cygnus	Strobilurin	3.2 oz.	VG	E	—	—
Heritage	Strobilurin	2 oz.	VG	—	—	—
Insignia	Strobilurin	2, 4 oz.	VGE	—	—	—
Milstop	Potassium bicarbonate	2.5-5 lb.	—	—	—	VGE
pHortress	Phos-acid	48-64 oz.	—	VG	VGE	—
Phyton 27	Copper	20-30 oz.	—	—	VG	—
Rhapsody	Biological	128-192 oz.	—	—	—	S
Stature DM	Dimethomorph	3.2 oz.	E	—	—	—
Vital	Phos-acid	64-96 oz.	—	VGE	—	—
Unnamed	Cyazofamid	2.1-3.5 oz.	—	—	—	E

S=some control, VG=very good control, VGE=very good to excellent control and E=excellent control.

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