

DOWNY MILDEW

Hit or Miss, But Always Potentially Catastrophic

by Mark Windham and Alan Windham

FEW FLOWERS EVOKE SUCH EXCITEMENT as the first rose of spring to open in a garden. Roses are fun to grow and to share with others. Unfortunately, an outbreak of downy mildew and the denuded bushes it leaves in its wake can dishearten the most avid rosarian and lead novice gardeners to give up their budding hobby. In wholesale nurseries and garden centers, roses in unheated poly-overwintering houses are under threat of downy mildew each season. In this article, we explore what downy mildew is, what it looks like, why it seems to disappear for years only to pop up with devastating effect and how to manage downy mildew so that if it does appear, it can be contained as a minor nuisance. We will end with the ultimate hope for the future — host plant resistance.

What Causes Downy Mildew?

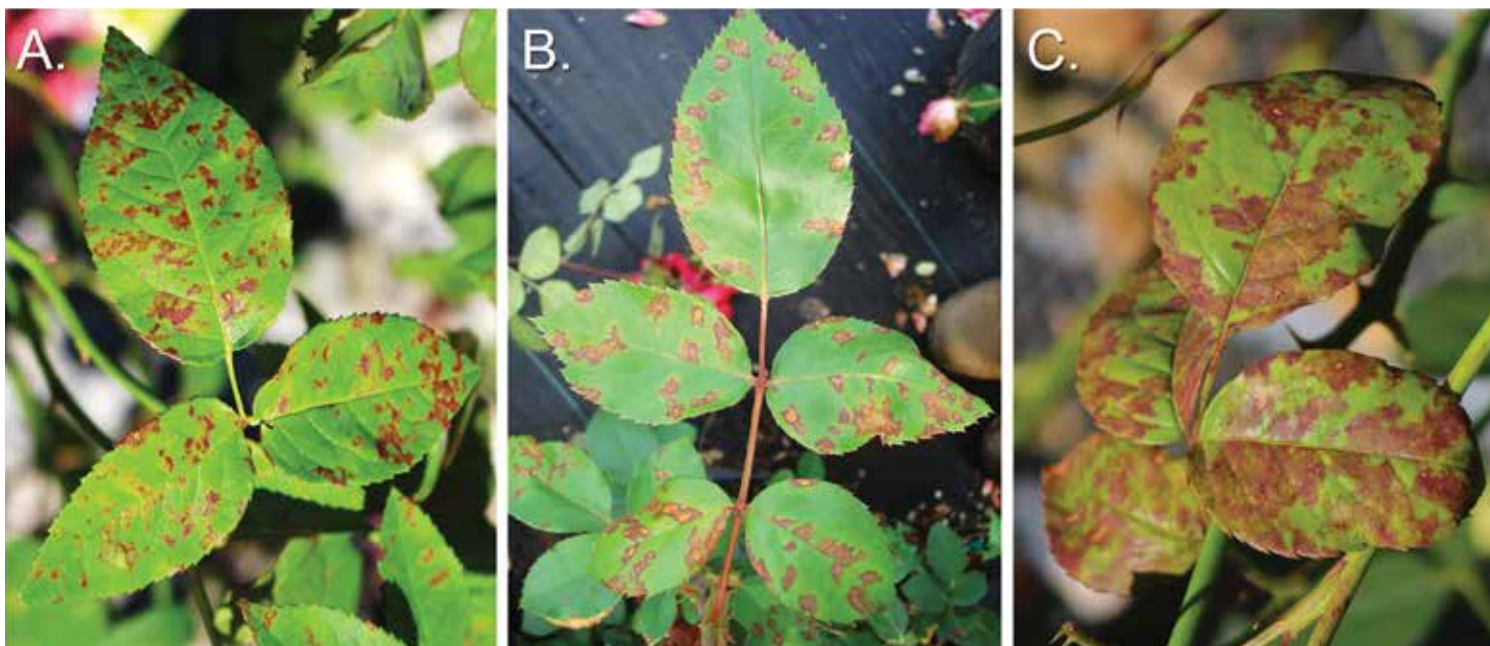
Downy mildew of rose is a foliar disease caused by an obligate (cannot be cultured; only grows on living tissue) parasite, *Peronospora sparsa* Berkley. This organism has some characteristics of fungi (growing by living threads known as hyphae, and reproducing

by spores). However, *P. sparsa* is not a fungus and is a member of the Oomycota, which also includes economically important plant pathogens including *Pythium* and *Phytophthora* species and the white rusts. Members of the Oomycota are more closely related to diatoms and brown algae than they are to fungi. In addition to infecting rose, *P. sparsa* also parasitizes blackberries, dewberries, boysenberries, wild brambles (all *Rubus* species), cherry laurels (*Prunus laurocerasus*) and pineapple guava (*Feijoa sellowiana*). Isolates from blackberry have been used to infect roses and the roses developed typical symptoms of downy mildew.

Symptoms of Downy Mildew

Initial symptoms of downy mildew can be variable (Figure 1). On leaves, lesions can be red, maroon, purple or black. Leaf veins appear to confine the lesions giving the lesions an angular appearance. Leaf symptoms can appear in three days after initial infection. In time, lesions can become necrotic and the necrotic tissue infested (occupied) with other fungi, including *Botrytis* species that can move from colonizing dead tissue

Figure 1. Three rose cultivars (A. 'Zephirine Drouhin', B. 'Double Knock Out', and C. 'Graham Thomas') symptomatic for infections by *Peronospora sparsa*. Symptom expression can be cultivar dependent and color of lesions can vary from red to maroon, to purple to black. Lesions are often limited by leaf veins and may become necrotic and infested with *Botrytis* spp.



to infecting green tissues outside the lesion. Defoliation can start in three-to-four days after infection and sometimes defoliation is the first symptom associated with downy mildew infections (Figure 2). Leaflets drop rapidly from many rose cultivars. Defoliation may be more severe in some cultivars than in others. Rosarians can inspect their roses on Friday morning and feel all appears well, go out of town for a weekend trip and walk in their gardens on Monday afternoon only to find a disaster in progress as plants are defoliating.

Signs of Downy Mildew

As symptoms are the host response to disease, signs are the physical and visible presence of the pathogen. Mycelia (a collection of hyphal strands and spores) of *P. sparsa* may be seen as faint and sparse white patches on lesions the lower leaf surfaces of symptomatic leaves (Figure 3). Viewing with a dissecting microscope reveals the hyphal strands and spores of *P. sparsa* (Figure 4A). Increased magnification under a compound microscope reveals the spores to be lemon-oval shape and numerous (Figure 4B). Hyphae of *P. sparsa* have been observed growing systemically in rose leaf tissues, stems, buds and sepals. Sexual reproductive structures (oospores) have been found in stems and roots. The presence of oospores in stems is indicative that *P. sparsa* is homothallic (does not need a different genetic strain to mate), but evidence has not been confirmed genetically.

Disease Cycle and How the Environment Affects It

Peronospora sparsa overwinters as hyphae in stems and canes of infected bushes. During periods of cool, wet spring weather, *P. sparsa* will sporulate on the cane surface and the spores will blow to young leaves. Multiple research studies have found that temperature affects how fast roses can become infected. When roses were inoculated at 50°, 60° and 68°F, it took eight, six, and four hours, respectively, for plants to become infected. When plants were inoculated and held at 40°F for 10 days, no symptoms of downy mildew developed. However, once the plants were returned to room temperature, the plants developed symptoms of downy mildew and *P. sparsa* sporulated (developed spores). Therefore, the plants became infected at 40°F, but the latent period (infected, not showing symptoms) was extended. Isolates of *P. sparsa*, collected from different hosts and from different geographical areas, may vary in their response to temperature. Relative humidity can also affect downy mildew epidemics. When the sun sets, the air cools rapidly and relative humidity spikes, often to 90 percent or higher. Roses are unaffected by

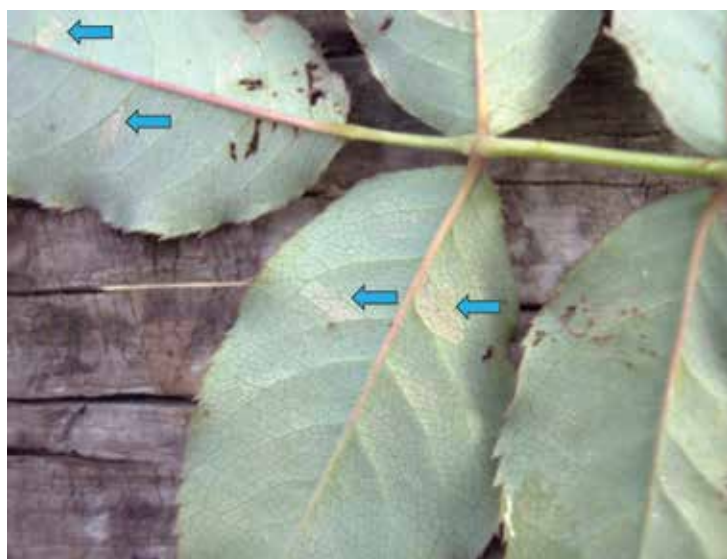


Figure 2: Defoliation from downy mildew can be rapid and severe. Defoliated plants, even if they recover, may have smaller canes. Young canes may die due to *Botrytis* species which were first saprophytic on the necrotic tissues and then infected small canes.

Figure 3: Signs (physical presence of pathogen) are sparse and hard to see with downy mildew. Look for faint, white patches limited by veins on the back of leaflets.

downy mildew when the humidity is below 85 percent. Spores are most likely to be released in early morning hours.

The hit and miss nature (here one year, but maybe not for several more, only to appear again) of downy mildew can therefore be explained based on several variables. The first is did the initial source of the pathogen overwinter on roses in the garden or on roses nearby (a neighbor's roses or wild *Rosa* or *Rubus* species in vacant lots or in woods)? The second is how long did cool, wet weather persist in the spring once roses began to leaf out? The longer the period of conducive

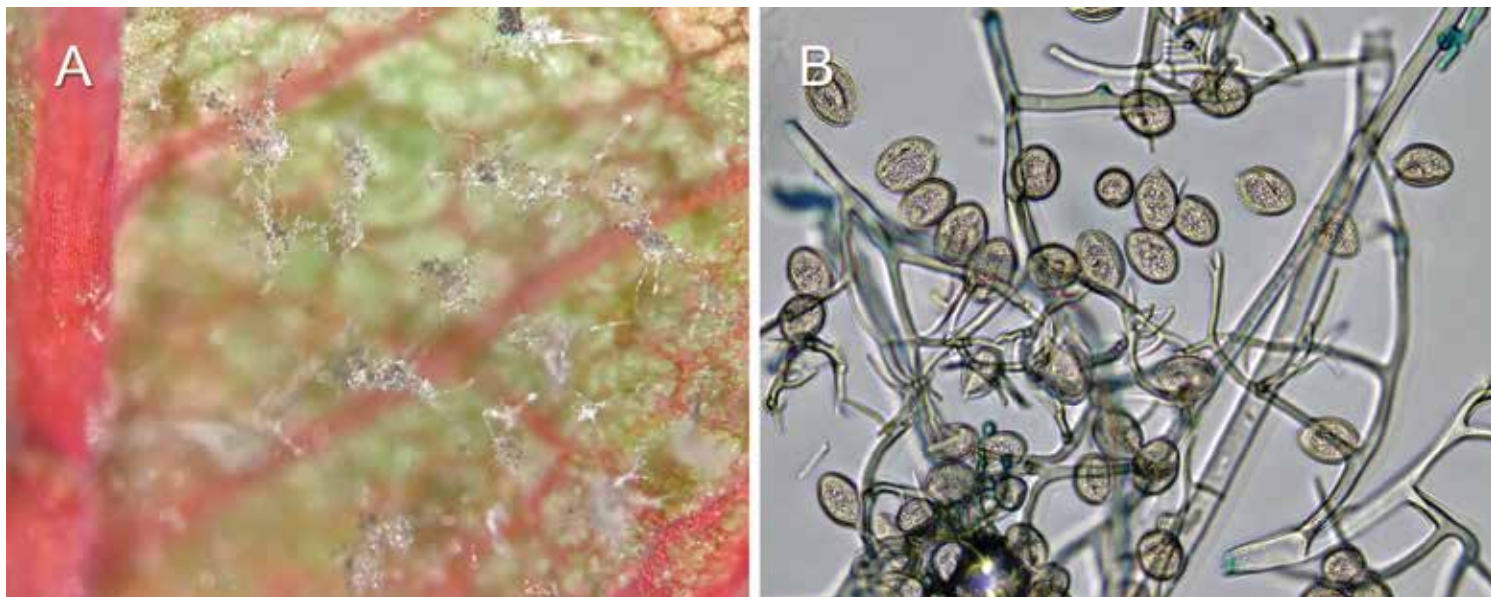


Figure 4. Magnification of white patches on fungal growth on back of rose leaves (A) reveal hyphal strands and spores. Using higher magnification (B), with you can clearly see the lemon-shaped to oval spores (sporangia) of *Peronospora sparsa*, which can become windborne.

weather, the more likely a downy mildew outbreak will be (assuming that the pathogen is present).

Disease Management

Cultural control for downy mildews are commonly recommended. Reducing plant density by pruning the plant for optimum air flow and orienting rose beds to promote better wind flow are often recommended for control of downy mildew. These techniques may be effective in areas where the window for optimum weather conditions for the development of downy mildew is relatively short. However, if optimum weather conditions persist, these techniques will probably have little effect on the outcome of epidemic development. One researcher found that downy mildew incidence was reduced by 50 percent by using sub-irrigation instead of overhead irrigation. Irrigation is recommended after rose foliage dries in late morning hours. The use of drip irrigation and soaker hoses, though recommended, will not alone stop a downy mildew epidemic. One cultural control that does have an impact on downy mildew epidemics is the removal of inoculum sources. Pruning out diseased foliage, picking up diseased foliage and inspecting new plants for downy mildew to avoid bringing the disease into the garden are all excellent ways to reduce *P. sparsa* inoculum (spores) in the garden. The reduction of inoculum may push the start of the epidemic in a garden back into the spring when temperatures are warmer and thus the danger of downy mildew is reduced.

A preventative program for downy mildew in areas where conducive conditions often persist will rely on

the use of pesticides (Table 1). Unfortunately, bio-soft products such as plant extracts and biological pesticides have not proven effective in trials. The rapid disease cycle (five days) may make control difficult for contact pesticides such as *mancozeb* and liquid copper if sprayed on a 14-day schedule on rapidly growing foliage during periods of leaf expansion. Contact pesticides may be more effective if care is taken to obtain good coverage of the lower leaf surface where *P. sparsa* would be sporulating. Some researchers have found strobilurins to be effective for downy mildew control whereas other researchers have not found these products to be as effective for downy mildew of rose as they are for other downy mildews. Compounds such as liquid copper can be toxic to rose foliage if the rate is too high. Therefore, before using any product, we recommend that you contact your local Extension office to see what is effective and legal for you to use in your area.

Disease Resistance

All cultivated roses are susceptible to downy mildew. However, some state extension services list Rugosa roses as being less susceptible than other roses. If environmental conditions, that are conducive for disease development, persist, Rugosa roses will fail when confronted with downy mildew. Researchers in Germany screened 183 wild rose accessions for resistance to multiple isolates of *P. sparsa* and found 19 accessions to be resistant to downy mildew. Resistant accessions have been crossed with selected ornamental rose cultivars and some crosses were successful in segregating downy mildew resistance into the F_1 progeny. Although

TYPE OF COMPOUND ¹	TRADE NAME	HOMEOWNER LABEL ²
Strobilurins such as azoxystrobin	<i>Heritage</i>	NO
Fosetyl-al	<i>Aliette</i>	NO
Cxazofamid	<i>Segway</i>	NO
Phosphorous acid	<i>Agri-fos</i>	YES
Mancozeb	<i>Dithane</i>	YES
Copper	<i>Liquid Copper</i>	YES

Table 1. Selected pesticides that are effective for rose downy mildew.

¹These compounds are used for examples and are not endorsements of these products over other compounds or trade names that may be equally effective.

²Homeowner labels vary from state to state and in some states, county to county. Check with your local county Extension staff before using any pesticide. The use of pesticides by homeowners that do not have a homeowner label may be in violation of state and federal laws.

rose genetics is very complicated (*Rosa* species and ornamental cultivars can be diploid, triploid, tetraploid, etc.), advances in disease resistance in roses is being heighten by use of such technologies as marker assisted breeding, transgenic approaches and even with designer nucleases. Although resistance to downy mildew will be introduced into ornamental worthy roses, the time frame for such an achievement will likely be years to decades.

Conclusions

Downy mildew is an important disease of roses through much of the world. The disease is hit or miss due and is dependent on the presence of initial inoculum and the narrow window for a conducive environment. Control of the disease is obtainable by integrating cultural and chemical control strategies. Resistance to downy mildew has been identified, but is not currently available in commercial rose cultivars. Downy mildew has been an issue with cultivated roses for more than 150 years when the Reverend Dr. Miles Berkeley who described downy mildew of rose and published the following in the report in the *Gardener's Chronicle* (London) in 1862: "the house in which the plants are stored should be well ventilated ... and that no more water is given than absolutely necessary, while care is taken that this should go as little on the leaves as possible". What he said in 1862, is still valid today.

About The Authors

Mark and Alan are professors of plant pathology with the University of Tennessee. Mark is also a member of the American Rose Society and a past president of the Holston Rose Society in Knoxville, Tennessee. Mark and Alan have another brother, Gary, who is also a plant pathologist and between the three of them, they

have more than a century of plant pathological experience. Their wives forbid them to discuss "shop" when we are all together unless the brothers go outside. Mark and Alan can be contacted via email: mwindham@utk.edu and awindham@utk.edu, respectively.

Selected References and Additional Reading on Downy Mildew of Rose

- Aegerter, B. J., J. J. Nunez and R. M. Davis. 2003. Environmental factors affecting rose downy mildew and development of a forecasting model for a nursery production system. *Plant Dis.* 87:732-738.
- Beckerman, J. 2009. Downy mildew. Purdue Extension. BP-68-W. <https://www.extension.purdue.edu/extmedia/BP/BP-68-W.pdf>.
- Breese, W. A., R. C. Shattock, B. Williamson and C. Hackett. 1994. In vitro spore germination and infection of cultivars of *Rubus* and *Rosa* by downy mildew from both hosts. *Ann. Appl. Biol.* 125:73-85.
- Horst, R. K., and R. Cloyd. 2007. *Compendium of Rose Diseases and Pests*, 2nd Ed. The American Phytopathological Society, St. Paul, MN.
- O'Neil, T. M., D. Pye and T. Locke. 2002. The effect of fungicides, irrigation and plant density on the development of *Peronospora sparsa*, the cause of downy mildew in rose and blackberry. *Ann. Appl. Biol.* 140:207-214.
- Salgado-Salazar, C., N. Shiskoff, M. Daughtrey, C. Palmer and J. A. Crouch. 2018. Downy mildew: a serious disease threat to rose health worldwide. <https://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-12-17-1968-FE>
- Schulz, D. F., and T. Debener. 2009. Downy mildew in roses: strategies for control. *Acta Hort.* 870:163-170. <https://doi.org/10.17660/ActaHortic.2010.870.21>
- Shires, M. and K. Ong. 2018. Downy mildew of rose. <https://agrillifeextension.tamu.edu/library/landscaping/downy-mildew-of-roses/>
- Windham, M. T., and A. S. Windham. 2014. Downy Mildew of Rose. *American Nurseryman* May:16-17.