GROWING KNOWLEDGE

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Once powdery mildew becomes established within a crop, control becomes much more difficult. PHOTO BY SCOT NELSON

Managing powdery mildew with biological fungicides

Interest in natural treatment methods is being driven by concerns over resistance and desire for reduced-risk pest management

BY BRENT W. WARNEKE, CLINT TAYLOR, AND JAY W. PSCHEIDT

It has been a dry and relatively mild winter across much of the region. Rainfall totals are behind normal and temperatures have trended above long-term averages. But winter is slowly giving way to spring, and with budbreak approaching, many crops will soon begin producing new juvenile tissue that requires protection.

That shift in the season is often when powdery mildew begins to show up.

Powdery mildew (PM) can seem to appear almost overnight. What starts as small, inconspicuous colonies on leaves or stems can quickly spread through a crop as spores move easily through the air. Under favorable environmental conditions, infections can increase rapidly and move through a planting faster than many growers expect.

In recent years, managing powdery mildew has become more complicated. Some PM species have developed resistance to commonly used fungicides, limiting the effectiveness of certain products. At the same time, many growers are trying to reduce reliance on conventional chemistries and incorporate lower-toxicity tools into their crop protection programs.

That combination of resistance concerns and interest in reduced-risk pest management has increased attention on biological fungicides as part of integrated disease management programs.

Conditions that favor powdery mildew

Powdery mildew fungi are highly specialized pathogens that form a close association with their host plants. Unfortunately, many of the environmental conditions that promote plant growth also favor disease development.

Powdery mildew outbreaks are

SYSTEMIC RESPONSE AFTER PATHOGEN INFECTION

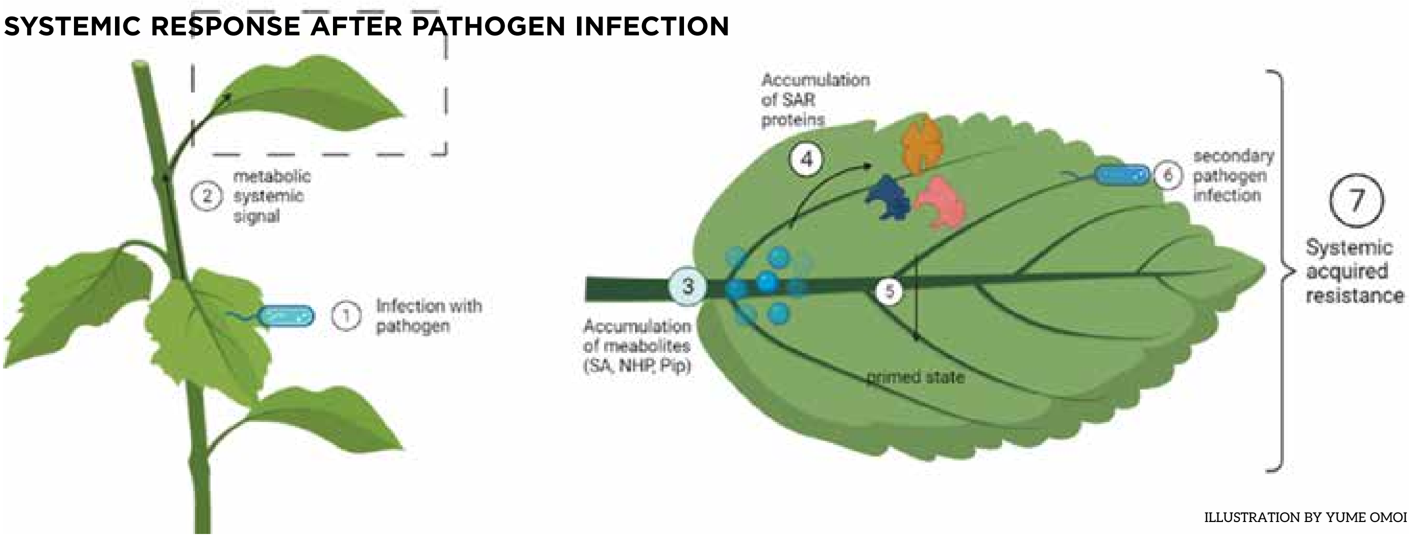

ILLUSTRATION BY YUME OMOI

commonly associated with moderate temperatures, typically between 60–80 F, combined with cool nights and relatively low-light conditions. Dense plant canopies, overcrowded plantings, and poor air circulation can further increase disease pressure by creating favorable microclimates around plant foliage.

Unlike many fungal pathogens, powdery mildew does not require free water on leaf surfaces to infect plants. As a result, disease development can occur even during relatively dry periods.

Repeated outbreaks can weaken plants, reduce growth, and ultimately impact production quality. For growers managing large plantings, even moderate levels of disease can translate into significant economic losses.

A management tool

A number of effective fungicides are available for managing powdery mildew, including both conventional and biological products. Like most disease management tools, fungicides are most effective when used preventatively, before visible symptoms develop.

Once powdery mildew becomes established within a crop, control becomes much more difficult.

Successful programs depend on good spray coverage and consistent application intervals. Most products should be applied at 7–14-day intervals, with shorter intervals when environmental conditions strongly favor disease development.

Biological fungicides represent a broad category of products derived from naturally occurring organisms or natural compounds. These materials have become increasingly important in many production systems, particularly where resistance management, environmental concerns, or regulatory pressures limit the use of certain conventional fungicides.

COMING IN MAY'S DIGGER:
A closer look at biofungicies in nursery production

Broadly speaking, biological fungicides fall into two main groups.

The first group consists of biocontrol agents (BCAs) — products that contain living microorganisms as the active ingredient. These organisms interact directly with plant pathogens and interfere with their ability to infect host plants.

The second group includes products derived from plant or microbial extracts, often referred to as botanicals or biorationals. These materials typically contain compounds that inhibit pathogen growth or stimulate plant defense responses.

Many growers incorporate biological fungicides into their programs as part of a broader integrated pest management approach.

How biological fungicides work

Biological fungicides suppress plant pathogens through several different mechanisms.

One of the most common mechanisms is competition or exclusion. When beneficial microorganisms colonize plant surfaces, they occupy space and consume resources that would otherwise be available to pathogens. By establishing themselves on leaves and stems before the pathogen arrives, these organisms can make infection more difficult.

Another important mechanism is antibiosis, in which the biological control organism produces compounds that inhibit pathogen growth. These antimicrobial compounds may be produced directly on the plant surface or may already be present in the product formulation.

Some biological fungicides also trigger plant defense responses. When plants detect certain microbial compounds, they activate biochemical pathways that strengthen their defenses against infection. These responses may include increased production of protective compounds or changes in cell wall structure that make it harder for pathogens to penetrate plant tissues.

In practice, many biological fungicides rely on a combination of these mechanisms. Because of this multi-faceted mode of action, most biological products are considered to have a low risk of resistance development, making them attractive components of long-term disease management programs.

Challenges in evaluating biological products

Despite their potential advantages, biological fungicides can be challenging to evaluate in research trials.

In our work with grape powdery mildew (GPM), disease pressure in small research plots is often extremely high. Under these conditions, biological fungicides used alone frequently fail to provide adequate control. This makes it difficult to distinguish among products or accurately assess their performance.

At the other extreme, disease pressure in commercial vineyards can be relatively low, making it equally difficult to measure treatment differences.

To better evaluate biological products under meaningful conditions, our research explored a different approach: integrating biological fungicides into reduced-rate sulfur programs.

Tank mixing with sulfur

Sulfur has long been one of the most reliable tools for managing powdery mildew. However, growers interested in reducing synthetic inputs or improving resistance management are increasingly exploring ways to incorporate biological fungicides alongside traditional materials.

Our recent research examined the use of biological fungicides tank-mixed with below-label-rate sulfur in season-long spray programs. The goal was to determine whether combining these materials could improve disease control compared to sulfur alone.

The results were encouraging.

Several biological fungicides provided improved control when used in combination with sulfur. For example, Theia tank-mixed with sulfur reduced powdery mildew severity on fruit by 31–38% compared with sulfur alone.

Similarly, Serenade® ASO combined with sulfur resulted in significantly lower disease levels.

Other treatments, including Double Nickel® plus humic acid and Serifel® tank mixes, also reduced disease compared with the sulfur-only control.

These findings suggest that biological fungicides may be particularly effective when integrated into existing management programs rather than used as stand-alone products.

Lessons from variable-rate sprayers

Another factor influencing fungicide performance is spray application technology.

Variable-rate sprayers are increasingly used in specialty crop production because they can reduce pesticide use and improve application efficiency by adjusting spray volume based on canopy size.

However, our research found that this technology can influence the effectiveness of certain biological fungicides.

For example, the product LifeGard performed less effectively when applied using a variable-rate sprayer. These sprayers often apply lower spray volumes early in the season when canopy density is low. Reduced spray volume can result in fewer biological organisms reaching plant surfaces, reducing the product's effectiveness.

When LifeGard was applied without the variable-rate adjustment — using a standard application volume — powdery mildew control improved.

A similar pattern was observed with micronized sulfur. Powdery mildew con-

BIOFUNGICIDE PRODUCTS AND THEIR CHARACTERISTICS

Product	Active ingredient (%AI)	Formulation and manufacturer	Mode(s) of action
Amyloshield	*Bacillus amyloliquefaciens* strain PTA-4838 (74.81%)	Wettable granule, Mychorrhizal Applications (Grants Pass, Oregon)	Antibiosis, exclusion/competition, SAR activator
Aviv	*Bacillus subtilis* strain IAB/BS03 (0.08%)	Soluble liquid, Summit Agro (Durham, North Carolina)	Antibiosis, exclusion/competition, SAR activator
Double Nickel (Triathlon BA)	*Bacillus amyloliquefaciens* strain D747 (98.85%)	Liquid concentrate, Certis USA (Columbia, Maryland)	Antibiosis, exclusion/competition, SAR activator
Lifegard	*Bacillus mycoides* isolate J (40%)	Water-dispersable granule, Certis Biologicals (Columbia, Maryland)	SAR activator
Serifel (Bacilrid)	*Bacillus amyloliquefaciens* strain MBI 600 (11%)	Wettable power, BASF (Research Triangle Park, North Carolina)	Antibiosis, exclusion/competition
Serenade ASO (Cease or Rhapsody)	*Bacillus subtilis* strain QST 713 (1.34%)	Liquid concentrate, Bayer Cropscience (Research Triangle Park, NC)	Antibiosis, exclusion/competition, SAR activator
Sonata	*Bacillus pumilis* strain QST 2808 (1.38%)	Aqueous suspension, Wilbur-Ellis (Denver, Colorado)	Antibiosis, SAR activator
Stargus	*Bacillus amyloliquefaciens* strain F727 (96.4%)	Marrone Bio Innovations (Davis, California)	Antibiosis, exclusion/competition, SAR activator
Theia	*Bacillus subtilis* strain AFS032321 (100%)	Dry flowable, Certis Biologicals (Columbia, Maryland)	Antibiosis, exclusion/competition, SAR activator

trol was reduced when sulfur was applied using the variable-rate system. However, when the concentration of sulfur in the spray tank was increased or the spray volume applied per leaf area was increased, disease control improved to levels comparable to applications made without sensor-based adjustments.

These observations highlight an important practical consideration.

When using contact fungicides or biological products, variable-rate sprayers may require higher concentrations or greater spray volumes per unit leaf area to maintain effective disease control.

Tank mixing and compatibility considerations

Modern crop production often involves applying multiple products in the same spray tank. Tank mixing can improve efficiency and reduce labor costs, but compatibility among products must be considered carefully.

In some cases, compatibility between biological fungicides and other crop protection products is well documented. In other situations, compatibility data are limited or unavailable.

Our testing has shown both positive and negative effects of tank mixing on the viability of biological control organisms. Sulfur, however, appears to be compatible with many biological products in simple jar tests and in field applications.

Many biological fungicides labeled for powdery mildew management contain Bacillus species as the active ingredient (see Table 1). Several products used in ornamental and specialty crop production fall into this category.

Key takeaways for growers

Biological fungicides can play an important role in powdery mildew management programs, particularly when used as part of an integrated strategy.

Based on our research and field experience, several practical guidelines stand out:

- Apply biological fungicides preventatively, before disease symptoms appear.
- Maintain 7–14 day spray intervals, shortening intervals when disease pressure is high.
- When using variable-rate sprayers, increase spray concentration or spray volume per leaf area to compensate for reduced application volumes.
- Ensure thorough spray coverage.
- Always follow label recommendations when mixing or applying products.

A final observation

One interesting observation from powdery mildew research is that water alone can sometimes reduce disease severity compared with untreated plants.

In certain systems, including rose powdery mildew, frequent applications of water alone — applied every three to seven days — can provide commercially acceptable levels of control.

Adding an adjuvant that reduces surface tension can further improve effectiveness by helping water spread across leaf surfaces.

This observation also highlights an important lesson: some materials that appear effective may be benefiting from improved spray coverage rather than providing strong biological activity on their own.

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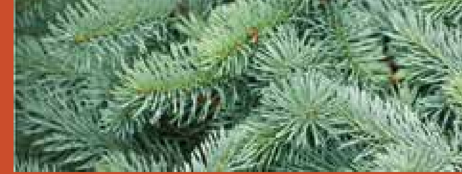

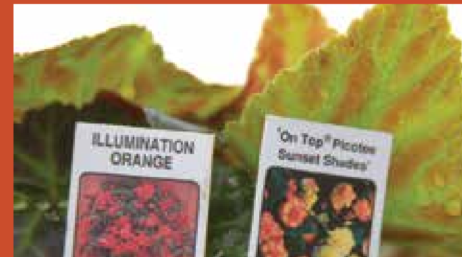

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