

Should you use biofungicides?

The process of selecting a biofungicide takes time and research, but knowing what to look for makes the task much easier.

By Kevin Hattori

Growers who have recently attended a greenhouse trade show, read a trade magazine or checked their mailbox are well aware that biological fungicides or biofungicides are being talked and written about regularly. The small but rapidly growing number of commercial biofungicides available has many growers wondering what these products are and how they work.

With so many companies making product claims, the decision about whether or not to incorporate biofungicides into a production program can seem daunting. What exactly are biofungicides? What can they do? What effects will incorporating biological fungicides have on a greenhouse operation? The process of selecting a biofungicide does take time and research, but knowing what to look for will make the task infinitely easier.

What's a good biofungicide?

Many plant pathologists feel that bacteria rather than fungi are better candidates for development of commercial biological fungicides since they can be used in conjunction with chemical fungicides without fear of harming beneficial organisms.

Another important consideration is whether or not the microbes are spore producing ("gram positive"). Because "gram negative" bacteria are always in a live, active state, they have a very short shelflife and extremely specific storage requirements. When gram-positive bacteria are faced with unfavorable conditions, however, they enter a dormant/spore state. They become



Photo courtesy of Jean Williams-Woodward

Pythium root rot on pansy.

active again when the conditions for their survival are favorable.

A successful biological fungicide must also be formulated in a manner that favors both the activity and survival of the microbes it contains. For example, Companion from Growth Products is a liquid with no special handling or storage requirements and a shelflife of more than two years. The majority of biofungicide manufacturers have accomplished product stability through powder- or granular-based formulations that

require mixing. Most of these products have special storage and handling requirements (like refrigeration, short shelflife, etc.) to ensure the viability of the microbes.

Practicality is key

A good biofungicide must be versatile. It must be able to be used on a wide range of plants and be effective against a variety of disease pathogens. Successful products must exhibit some residual (lasting effects). They must also be safe. Any grower will attest to the fact that each hour spent waiting for a restricted-entry interval to end is an hour's worth of valuable time (and potential profit) wasted. In general, U.S. EPA-approved biofungicides have short REIs (four hours or less).

Biologicals offer other ancillary benefits that include improved root growth and development. Unlike chemical fungicides, biofungicides are comprised of all-natural materials. They do not contain chemical salts and phytotoxicity is not a concern.

Potential applications

One of the most common application strategies of microbial products is to increase the population and activities of beneficial microbes on and around plant tissue. Using the analogy of a parking lot filled to capacity, any new arrivals (disease pathogens) will be unable to find open spaces, and will be forced to "find somewhere else to park."

Another application consideration being explored is the use of biological fungicides in combination with reduced rates of chemical fungicides while achieving equal, and in some cases, better results than when the products are used alone. These synergistic results are possible when certain beneficial microbes weaken

the pathogenic fungi's resistance.

An example of this synergy is the beneficial bacteria *Bacillus subtilis* GB03, which produces an antibiotic that creates "pinholes" in pathogenic fungi's cell walls. In their weakened state, the fungi are easy prey for chemical fungicides. This two-tiered attack on a pathogen can lead to less frequent applications of single-mode chemicals and less chemical-resistance problems.

Modes of action

Since biofungicides are generally preventive (rather than curative), it is best to apply them early in the production cycle before the pathogen attacks. Early application gives the beneficial microbes in the biofungicide a chance to colonize, enabling them to out-compete and/or attack the pathogen successfully defending the plant against disease.

Biological fungicides differ from chemical fungicides in their modes of action. Chemical fungicides generally have two modes of action. The first is by contact, where the chemical product must come into direct contact with the pathogen. The second mode of action is systemic, where the plant absorbs the chemical. The pathogen is then negatively affected when it attacks the plant.

Since biological fungicides are living organisms, they have modes of action that are distinct from those of chemicals. Some biofungicides contain microbes that are antagonistic and parasitic to pathogenic fungi. Quite literally, the beneficial microbes attack and feed off of the invading fungi.

The beneficial microbes in other biological fungicides have broad-spectrum properties, including the production of antibiotics and/or enzymes. These exudates adversely

affect and essentially kill pathogenic fungi. In their weakened state, the pathogens are far more susceptible to the effects of chemical fungicides. Many growers find that a two-tiered (chemical/biological) attack on pathogenic fungi leads to fewer applications of chemical fungicides.

U.S. EPA registration

To be legally classified as a biological fungicide, a product must be registered with the U.S. EPA (see the table above). Each product is tested to prove the products' safety to human and animal health and to the environment, as well as its efficacy. Extremely strict quality control must be followed during this testing. This ensures that the product contains what it claims and does what it's supposed to.

Costs incurred during U.S. EPA registration process are significant. The average registration cost for a biological fungicide is \$300,000-\$3 million. The process is also time-consuming, requiring two to four years. The race to develop viable biofungicides is comprised mainly of startups and smaller companies.

Looking ahead

The market for biological fungicides is expected to expand due in part to concerns with resistance to existing chemical fungicides, societal concerns about the environment and increasing government regulations/restrictions. Understanding biofungicides and what they can do will enable growers to make informed decisions about how best to incorporate these valuable tools of nature into their production practices.

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U.S. EPA-registered biological fungicides for greenhouses

Product	Active ingredient	Effective against	Application method	Special storage required	Formulation	Restricted-entry interval	Mode of action	Manufacturer	Shelflife	Reapplication interval	Use with chemical fungicides
Companion	<i>Bacillus subtilis</i> GB03	Soil-borne diseases	Drench, irrigation, spray	No	Liquid	4 hours	Antibiotics/broad spectrum properties	Growth Products Ltd.	2 years+	2-4 weeks	Yes
PlantShield	<i>Trichoderma harzianum</i> T-22	Soil-borne, foliar diseases	In medium, drench, irrigation	Yes	Granular and wettable powder	0	Parasitism	BioWorks Inc.	6-12 months if refrigerated	10-12 weeks	No
Mycostop	<i>Streptomyces griseoviridis</i> K-61	Soil-borne diseases	Drench, spray and irrigation	Yes	Powder	4 hours	Antibiotic	AgBio Inc.	1 year if un-opened and refrigerated	3-6 weeks	Yes
SoilGard	<i>Gliocladium virens</i> GL-21	Soil-borne diseases	In medium (prior to seeding)	Yes	Granular	4 hours	Necrophytic parasitism	Olympic Horticultural Products	1 year if stored in cool dry place	4 weeks	No
Taegro	<i>Bacillus subtilis amyloliquefaciens</i> FZB24	Soil-borne diseases	Drip, drench, not irrigation	Yes	Powder	4 hours	Enzyme production	Taensa Inc.	1 year shelflife once opened if refrigerated	2-3 weeks	Yes
AQ-10 Biofungicide	<i>Ampelomyces quisqualis</i> M-10	Powdery mildew	Spray	Yes	Granular	4 hours	Specialized hyperparasitism	Ecogen Inc.	10 months	7-14 days	No