

Biological and biorational fungicides offer control options

By Wade H. Elmer

Take a look at products available on the market and how and why to use them

Several environmentally friendly products, coined as biological or biorational products, are on the market for ornamental- and nursery-disease management. Although there is some overlap in their meaning, there is a consensus that biological products contain living organisms, whereas biorational products are nonliving.

With some exceptions, biological products are marketed for control of soilborne pathogens and improved root health, and biorational products are advertised for suppression of foliar pathogens.

Biological products are “biofungicides” if they are for disease control or “microbial inoculants” if they’re sold to promote plant or soil health. The distinction is often vague and can be based solely on registration with U.S. EPA.

Both biofungicides and microbial inoculants are composed of beneficial organisms selected from natural environments. These fungi, bacteria and actinomycetes have been proprietarily formulated with different additives to enhance their storage life and performance.

Mechanisms of control

Biological products reduce disease by different mechanisms, such as competition, antagonism, antibiosis, enhanced nutrient uptake or by inducing host resistance.

Competition can be an effective mechanism in reducing disease. Before infection can occur, pathogens must make contact with the leaf, flower or root. This space is called the phylloplane (leaf and flower) or rhizosphere (root). These areas provide nutrients through leakage and normal exudation. Both beneficial and deleterious microbes compete for these substrates. Many biological control agents suppress disease by occupying the



The effects of biological fungicides on *Fusarium* wilt of cyclamen. In each photo, the plants on the left were not inoculated and plants on the right were inoculated with *Fusarium* and treated with a biofungicide (Photos B, C and D).

Products available for ornamentals

Product	Type	Organism/Active ingredient	Labeled for	Manufacturer/distributor
Actinovate Plus/M, Actino-Iron	Biofungicide	<i>Streptomyces lydicus</i>		Natural Industries Inc., www.naturalindustries.com
Armcarb 100	Biorational	Potassium bicarbonate	Powdery mildew, downy mildew, <i>Botrytis</i> and <i>Alternaria</i>	Helena Chemical Co., www.helenachemical.com
ATEze	Biological	<i>Pseudomonas chloroaphis</i> Strain 63-28	Suppression of <i>Rhizoctonia solani</i> and <i>Pythium</i> spp.	Agrium U.S. Inc., www.agrium.com
CEASE	Biological	<i>Bacillus subtilis</i> QST 713	Bacterial diseases, powdery mildew, <i>Botrytis</i> , anthracnose, <i>Alternaria</i> and <i>Entomosporium</i>	Bioworks, www.bioworksinc.com
Companion	Biological	<i>Bacillus subtilis</i> (strain GB03)	Diseases caused by <i>Rhizoctonia</i> , <i>Pythium</i> , <i>Fusarium</i> and <i>Phytophthora</i>	Growth Products, www.growthproducts.com.
Fortune Aza	Biorational	Neem oil	Powdery mildew on greenhouse ornamentals	Fortune Biotech, www.fortunebiotech.com
Fungastop (spray)	Biorational	Ascorbic and citric acids, mint oil, citrus pulp, fish oil and glycerol	Broad-spectrum fungal disease control on ornamentals	Soil Technologies Corp., www.soiltechcorp.com
Galltrol-A	Biological	<i>Agrobacterium radiobacter</i> Strain 84	Control of crown gall caused by <i>Agrobacterium tumefaciens</i>	AgBioChem, www.agbiochem.com
JMS Stylet-Oil	Biorational	Paraffinic oil	Blackspot, <i>Botrytis</i> blight, and powdery mildew on roses	JMS Flower Farms, www.stylet-oil.com
Kaligreen	Biorational	Potassium bicarbonate	Powdery mildew in roses and in field and greenhouse ornamentals	Monterey Chemical Co., www.montereychemical.com
Kodiak, Kodiak HB, Kodiak AT	Biological	<i>Bacillus subtilis</i>	<i>Rhizoctonia solani</i> , <i>Fusarium</i> spp., <i>Alternaria</i> spp. and <i>Aspergillus</i> spp.	Gustafson Inc., www.bayercropscience.com/gustafson
MilStop	Biorational	Potassium bicarbonate	Powdery mildew, downy mildew, <i>Botrytis</i> and <i>Alternaria</i> on ornamentals	Bioworks, www.bioworksinc.com
Mycostop	Biological	<i>Streptomyces griseoviridis</i> strain K61	<i>Fusarium</i> spp., <i>Alternaria brassicola</i> , <i>Phomopsis</i> spp., <i>Botrytis</i> spp., <i>Pythium</i> spp. and <i>Phytophthora</i> spp.	AgBio Development, www.agbio-inc.com
Norbac 84C	Biological	<i>Agrobacterium radiobacter</i> strain K84	Crown gall disease caused by <i>Agrobacterium tumefaciens</i>	New BioProducts, www.newbioproducts.com
PlantShield	Biological	<i>Trichoderma harzianum</i> Rifai strain KRL-AG2 (T-22)	<i>Pythium</i> spp., <i>Rhizoctonia solani</i> , <i>Cylindrocladium</i> , <i>Thielaviopsis</i> , <i>Fusarium</i> spp. and <i>Botrytis</i>	Bioworks, www.bioworksinc.com
PreStop, Primastop	Biological	<i>Gliocladium catenulatum</i>	<i>Pythium</i> spp., <i>Rhizoctonia solani</i> , <i>Botrytis</i> spp., <i>Didymella</i> spp.	AgBio Development, www.agbio-inc.com
Rhapsody	Biological	<i>Bacillus subtilis</i> QST 713	Bacterial diseases, powdery mildew, <i>Botrytis</i> , anthracnose, <i>Alternaria</i> and <i>Entomosporium</i>	AgraQuest, www.agraquest.com
Remedy	Biorational	Potassium bicarbonate	Powdery mildew disease in greenhouses	Bonide Products, www.bonide.com
RootShield	Biological	<i>Trichoderma harzianum</i> Rifai strain KRL-AG2 (T-22)	<i>Pythium</i> , <i>Rhizoctonia</i> and <i>Fusarium</i>	Bioworks, www.bioworksinc.com
Soilgard 12G	Biological	<i>Trichoderma virens</i>	<i>Pythium</i> and <i>Rhizoctonia</i>	Certis USA, www.certisusa.com
Sunspray Ultra-Fine Spray Oil	Biorational	Paraffinic oil	Powdery mildew in greenhouses as well as outdoor zinnia, lilac, azalea, phlox and aster	Sunoco, www.sunocolubricants.com
Taegro	Biological	<i>Bacillus subtilis</i> var. <i>amyloliquefaciens</i>	Damping-off and root rot pathogens, especially <i>Rhizoctonia solani</i> and <i>Fusarium</i> spp.	Taensa Inc., www.taensa.com
Triact 70	Biorational	Neem oil	In the greenhouse for control of powdery mildew, downy mildew, leaf spot, <i>Botrytis</i> blight and blackspot on roses	Certis USA, www.certisusa.com
TriCon	Biorational	Sodium tetraborohydrate decahydrate from borax and plant oils	Contact fungicide/insecticide for mycelium and spores, curative properties of powdery and downy mildew	Bioworks, www.bioworksinc.com
ZeroTol/SaniDate/Oxidate	Biorational	Hydrogen peroxide	Control of algae, anthracnose, black spot, <i>Botrytis</i> , downy mildew, <i>Fusarium</i> , <i>Pseudomonas</i> , <i>Pythium</i> , <i>Phytophthora</i> , powdery mildew, <i>Rhizoctonia</i> and <i>Thielaviopsis</i>	BioSafe Systems, www.biosafesystems.com

available sites along the plant root or leaf and prevent pathogens from invading the tissue. These biological controls generally need to be applied in high densities before the pathogen is present.

Antagonism can involve direct parasitism whereby the biological controls attack and feed on the pathogen. This mode of action is probably less frequent than other mechanisms of suppressing disease. The biological

controls must be present in the rhizosphere or leaf at the same time or before the pathogen appears.

Antibiosis involves the production of secondary metabolites (toxins) that will inhibit growth of a pathogen. These compounds inhibit the pathogen by preventing germination or restricting its growth in the rhizosphere or on the phylloplane. Biological controls may not necessarily have to be present in high numbers,

but they need to exert their antibiotic effect before infection occurs.

Many biological control agents also can improve growth and suppress disease by **increasing nutrient availability**. This could explain why treated plants are larger than untreated plants even when a pathogen is absent. By altering pH or by exporting enzymes that dissolve insoluble elements, these biological products increase the availability of certain fertilizers. This mode

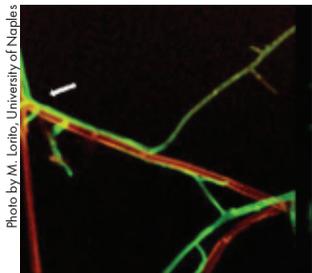


Photo by M. Loric, University of Naples
An example of competition by the fungus (*Trichoderma harzianum* Rifai Strain T-22, active agent of PlantShield HC) that is stained green competitively colonizing a root



Photo by Ilan Chet, Hebrew University of Jerusalem
An example of parasitism showing hyphae of *Trichoderma harzianum* Rifai Strain T-22, (active agent of PlantShield HC) invading the hyphae of the pathogen *Rhizoctonia solani*.

of action has not received as much attention as other mechanisms, but may become important in nutrient-deficient soil mixes.

Researchers have noted that

some biological products can trigger the plant to turn on its own **defense mechanisms**. Studies have found that plants exposed to certain biological products will produce salicylic acid (a derivative of common aspirin), which, in turn, travels to other parts of the plant and signals these tissues to activate their natural defense mechanisms. This is a new mechanism with great promise for disease control.

Why results vary

Today, growers use many biological products with variable results. Evidence suggests that these results may be due to differences in the crop, potting mix, soil pH, fertilizer regimes and disease pressure.

Highly susceptible plants may not respond to biological products as well as more tolerant crops. Potting mixes may contain composted bark amendments that harbor their own microflora and may interact with the biological. The alkalinity (or acidity) of the irrigation water may also increase (or decrease) soil pH to levels where the biological products are less effective. If high fertility levels persist, *Pythium* can

cause severe damage regardless of whether or not a biological is present. Efforts to understand how all these factors influence the efficacy of each product will allow growers to use them better.

Biorationals are formulated as solutions, wettable powders and emulsifiable concentrates. Like biological products, they can also have different modes of action, but most function in a manner similar to chemical fungicides and have direct effects on the pathogen. Most prevent spore germination, but some retard spore production and growth. Some products may also induce resistance in the plant and may provide protection to other plant parts. Biorationals, as well as biologicals, have the greatest efficacy when used preventively.

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