Biofungicides

What are Biofungicides?

Biofungicdes are formulations of living organisms that are used to control the activity of plant pathogenic fungi and bacteria. The concept of biofungicides is based upon observations of natural processes where beneficial microorganisms, usually isolated from soil, hinder the activity of plant pathogens. Biocontrol microorganisms are free-living fungi, bacteria, or actinomycetes that are active in root, soil, and foliar environments. These microorganisms produce a wide range of antibiotic substances, parasitize other fungi, compete with other fungi, and induce localized or systemic resistance to a variety of plant pathogens. The use of composts and suppressive growing medium, which both contain living microorganisms, to ameliorate disease is another example of this disease management option.

How Biofungicides Work

- **Rhizosphere Competence** - The most successful of the strains of biocontrol microorganisms exhibit rhizosphere competence, the ability to colonize and grow in association with plant roots. They can colonize entire root surfaces for several months. Here they effectively compete with plant pathogens for nutrients, infection sites, and space. Competition for glucose in the soil is involved in disease suppression. Biofungicide species also metabolize seed and root exudates that normally stimulate pathogen germination or zoospore attraction.
- **Parastitism** - Parasitism, the ability of species to attack and consume plant pathogens, has been well studied. Mycoparasitism of biocontrol microorganisms includes directed growth, contact and binding, coiling of hyphae around the host fungus, penetration and degradation. Production of cell wall degrading enzymes is almost always part of the process.
- **Antibiosis** - Antibiosis occurs when one microorganism produces molecules that directly affect other organisms negatively by toxicity or growth inhibition. These compounds are called antibiotics and are commonly produced by a wide range of soil dwelling microorganisms in the course of their growth. A familiar antibiotic, streptomycin, is produced by *Streptomyces* species which are classified as actinomycetes or filamentous bacteria.
- **Inducing Metabolic Changes** - An important mechanism of biocontrol microorganisms is the ability to induce metabolic changes in plants that increase their resistance to a wide range of plant pathogenic microorganisms (fungi and bacteria). Systemic Acquired Resistance (SAR) improves the plant response to pathogen attack by priming the metabolism of plant defense compounds. This capacity to induce resistance to a wide

range of diseases in a variety of plants appears to be widespread. Enhanced resistance is systemic because disease resistance occurs at sites distance from the location of the biocontrol microorganisms.

- **Plant Growth Promotion** - A final way in which these organisms act is through plant growth promotion. Beneficial root-colonizing microorganisms promote plant growth and productivity. Many resistance-inducing fungi and bacteria promote both root and shoot growth in the absence of disease causing fungi. In the greenhouse industry, biofungicides are applied preventively to growth media or as a seed treatment for disease control and can be as effective as chemical fungicides. Biofungicides are safer for growers, more persistent, and less expensive. When applied as seed treatment, biofungicides increase root development in a number of plants and improve drought resistance. Improvements in plant growth result from effects on soil microflora and direct effects on the plant. Biofungicides can also improve nutrient uptake (copper, phosphorous, iron, and manganese).

Biofungicides Used in Greenhouse Production

Plant Shield, Root Shield, PreStop, SoilGard, and T-22 PlanterBox are commercial formulations of *Trichoderma* species and the closely related *Gliocladium* species. Species of *Trichoderma* are the best studied of all biocontrol organisms. These species are also abundant in many types of compost and are the most frequently isolated soil fungi from all temperate and tropical soils. The production of antibiotics by these species is well documented. In fact, *Trichoderma* species have been found to be highly resistant to a variety of toxins and antibiotics produced by soil microorganisms, antimicrobial compounds produced by plants, and even chemical fungicides. This makes these fungi active colonizers of toxic environments and a strong competitor.

Companion and Cease are bacteria in the species *Bacillus*. Many biofungicides that consist of bacteria are labeled mainly for soilborne diseases, though there are some that are also labeled for foliar diseases like leaf spots, powdery mildew, and downy mildew. See table. Other bacteria are termed Plant Growth Promoting Rhizobacteria (PGPR) and while not strictly biofungicides, their growth promoting effects can contribute to disease tolerance. Actinovate, Actino-Iron, and MycoStop are composed of species of *Streptomyces*, an actinomycetes or filamentous bacteria. They are labeled for both root and foliar diseases. *Agrobacterium radiobacter* 84 (Galltrol A) is registered for control of Crown Gall (*Agrobacterium tumefaciens*) and there are also a few *Pseudomonas* species present in some biofungicides (Blight Ban and Bio-Save 10 LP).

How to Use Biofungicides

The most effective use of biofungicides is as a preventive treatment in growing media or as a seed treatment. They can be mixed into the growing media prior to planting or applied as a drench immediately after transplanting, making sure that

the entire soil volume is treated. For foliar applications, the biofungicides must be in place before pathogen infection as their action is purely protective. They must be reapplied frequently both to protect new growth and to ensure that effective populations of the microorganisms are present. Because biofungicides consist of living organisms, they may have different storage, shelf life, and handling requirements than conventional fungicides. Most biofungicides have short reentry intervals (0-4 hours).

TRADE NAME	ORGANISM	DISEASES	REGISTERED CROPS
Actinovate	*Streptomyces lydicus*	Powdery mildew, Downy mildew, *Botrytis*, *Rhizoctonia*, *Pythium*, *Phytophthora*	Most greenhouse ornamentals, vegetable transplants.
Cease	*Bacillus subtillis* QST 713	*Rhizoctonia*, *Pythium*, *Phytophthora, Fusarium*	Most greenhouse ornamentals, vegetable transplants.
Companion Liquid	*Bacillus subtillis* GB03	Leaf spots, Powdery mildew, *Botrytis*, bacterial diseases, *Rhizocotonia*, *Pythium, Phytophthora*	Most greenhouse ornamentals, vegetable transplants.
Contans WG	*Coniothryium minitans*	*Sclerotinia sclerotiorum, S. minor*	Most greenhouse ornamentals, vegetable transplants & herbs. Soil treatment.
Galltrol	*Agrobacterium radiobacter* K84	*Agrobacterium tumefaciens*	Ornamental nursery stock. Soil treatment.
MycoStop	*Streptomyces griseoviridis*	*Botrytis*, *Rhizoctonia*, *Pythium*, *Phytophthora, Alternaria*	Most greenhouse ornamentals, vegetable transplants.
Plant Shield, Root Shield, T-22 Planter Box	*Trichoderma harzianum*	*Rhizoctonia*, *Pythium*, *Fusarium*, *Cylindrocladium*, *Thielaviopis*	Most greenhouse ornamentals, vegetable transplants.
Prestop WP	*Gliocladium catenulatum* JII446	*Botrytis*, *Rhizoctonia*, *Pythium*, *Phytophthora, Fusarium, Verticillium*	Most greenhouse ornamentals, vegetable transplants.
Regalia	*Reynoutria sachalinensis*	*Botrytis*, Leaf Spots, Powdery Mildew, bacterial diseases, *Rhizoctonia*, *Pythium*, *Phytophthora, Fusarium, Verticillium*	Herbs and spices. Soil treatment. Plant health promoter.

TRADE NAME	ORGANISM	DISEASES	REGISTERED CROPS
SoilGard	*Gliocladium virens* GL-21	*Rhizoctonia, Pythium*	Most greenhouse ornamentals, vegetable transplants.