



Microbial Biopesticides for the Control of Plant Diseases in Organic Farming

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Organic farming systems rely on approved practices for the control of plant diseases. Approved practices widely used by organic (and conventional farmers alike) include the use of disease resistant/tolerant cultivars and disease reducing cultural strategies, such as crop rotation and sanitation. In addition, composts and organic mulches can be used to help improve crop health in certain situations. Such practices are the cornerstone of integrated disease management; however, they do not always provide an adequate disease control. While conventional farmers can, and often do, use a wide variety of chemical pesticides, certified organic growers may not. Still, there are a number of optional products that organic farmers can use to reduce the incidence and severity of various plant diseases.

Microbial biopesticides represent an important option for the management of plant diseases. The United States Environmental Protection Agency (EPA) defines biopesticides as, “*certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals.*” Based on the active ingredient, biopesticides are categorized as microbial pesticides, plant-incorporated-protectants (PIPs), and biochemical pesticides. Only the first category is considered in this fact sheet. A variety of other microbial inoculants and related products are produced and marketed, e.g. as “plant strengtheners,” but these are not legally recognized as pest control products and are not considered in this fact sheet.

In general, biopesticides are less toxic, more target specific, and/or decompose faster following application compared to conventional pesticides. All of these features contribute to the idea that application of biopesticides can result in less pollution compared to some of the conventional chemical pesticides. One disadvantage is that the user of biopesticides needs to have a greater understanding about the pest control needs of his or her crop. This is because most biopesticides have a more limited target range than chemical pesticides.

To assist growers in choosing an appropriate microbial biopesticide the following list was developed (Table 1). This list includes microbial biopesticides registered with the US EPA and certified for use in organic agriculture by the Organic Materials Review Institute (OMRI). The crops and diseases for which each product is labeled are tabulated. In addition, efficacy data obtained from independently published reports are summarized. An efficacy rating based on these reports was established based on the comparison between untreated and biopesticide-treated plants in one or more reports. The ratings are categorized as follows: “+” indicates that control of disease or increase in yields was observed, “±” indicates that in some cases there was some positive responses while in other cases there was no response, “o” indicates that neither positive nor negative effect was observed by the use of the product, and “*” indicates that no data are available.

TABLE 1. Microbial Biopesticides for the Control of Plant Pathogens

Disclaimer: The Ohio State University does not guarantee the efficacy or quality of any of these products. By law, it is the pesticide applicator's responsibility to read and follow all current label directions for the specific pesticide being used.

Bactericides				
Biocontrol Organism	Trade Name	Target Disease	Crops	Efficacy^{1,2} (Crop/ Disease)
<i>Bacteriophages of Xanthomonas spp. and Pseudomonas syringae pv. tomato</i>	Agriphage™	Bacterial spot in pepper and tomatoes and bacterial speck in tomatoes	Tomatoes and pepper	Bell Pepper/Bacterial Spot: +
<i>Pseudomonas syringae strain ESC 10</i>	Bio-Save® 10LP ³	Ice inducing bacteria and biological decay	Apples, pears, lemons, oranges, or grapefruit after the fruit is harvested	Sweetpotato/Rhizopus soft rot: +
<i>Pantoea agglomerans strain E325</i>	Bloomtime Biological™ ³	Fireblight (<i>Erwinia amylovora</i>)	Apples and pears	Apple/Fire blight: ±
	Bloomtime Biological™ FD ³	Fireblight (<i>Erwinia amylovora</i>)	Apples and pears	Apple/Fire blight: ±
Fungicides				
Organism	Trade Name	Target	Crops	Efficacy^{1,2}
<i>Streptomyces lydicus WYEC 108</i>	Actinovate® AG	Soilborne pathogens: <i>Pythium spp., Rhizoctonia spp., Phytophthora spp., Fusarium spp., Verticillium spp., Phymatotrichum omnivorum</i> and other root decay fungi. Foliar pathogens: <i>Podosphaera spp., Botrytis spp., Schlerotinia spp., Monilinia spp., Alternaria spp., Peronospora spp.</i> and other foliar fungi.	Ornamentals, leafy and fruiting vegetables, fruits, nuts, berries, grapes, cotton and other row crops, citrus, mint, herbs potatoes and other root crops	*
	Actinovate® SP	Soilborne pathogens: <i>Pythium spp., Rhizoctonia spp., Phytophthora spp., Fusarium spp., Verticillium spp., Phymatotrichum omnivorum</i> and other root decay fungi. Foliar pathogens: <i>Podosphaera spp., Botrytis spp., Schlerotinia spp., Monilinia spp., Alternaria spp., Peronospora spp.</i> and other foliar fungi	Greenhouse, nursery and turf	Pumpkin/Powdery mildew: + Pumpkin/Phytophthora leaf blight: 0 Pepper/Phytophthora foliar blight: +
<i>Bacillus pumilus QST 2808</i>	Ballad® Plus Biofungicide	Rust, powdery mildew, cercospora, and brown spot	Soybeans, cereal crops, and potatoes	Soybean/Asian Soybean Rust: ± Soybean/Target Spot: ± Snap Bean/Ashy Stem Blight : ± Snap Bean/Rust: +
<i>Coniothyrium minitans strain CON/M/91-08</i>	Contans® WG	<i>Sclerotinia minor, Sclerotinia sclerotiorum</i>	Agricultural soils	Snap beans/White mold: ± Snap beans/Gray mold: 0 Lettuce/White mold: ± Lettuce/Lettuce drop: +
<i>Bacillus subtilis GB03</i>	Kodiak® Concentrate Biological Fungicide	Rhizoctonia, Fusarium, Alternaria, Aspergillus, and others that attack the root systems of plants	Cotton, peanuts, soybeans, wheat, barley, peas, and beans	Snap beans/Fusarium Root rot: ± Snap Bean/Rhizoctonia root rot: 0 Pea/Fusarium, Phoma, Pythium: ± Wheat/Fusarium crown rot: 0 Cucumber/Damping off: 0

Fungicides				
Organism	Trade Name	Target	Crops	Efficacy ^{1,2}
<i>Trichoderma harzianum</i> <i>Rifai strain KRL-AG2</i>	Plant Shield® HC Biological Foliar and Root Fungicide	Fusarium, Pythium, and Rhizoctonia	Cucurbit vegetables, flowers, bedding plants, ornamentals, fruiting and leafy vegetables, Cole crops, hydroponic crops, pome fruits, shade house, outdoor nursery, stone fruit, and tree nuts	Dry beans/Fusarium Root Rot: ± Snap beans/Rhizoctonia Root Rot: o Tomato/Grey mold: o Potato/Silver Scurf: + Potato/Black Scurf: o Geranium/Black Leg Disease: o Gladiolus/Fusarium root rot: o African Daisy/Powdery mildew: ±
	RootShield® Granules	Fusarium, Pythium, and Rhizoctonia	Flowers, bedding plants, ornamentals, fruiting vegetables, herbs and spices, hydroponic crops, leafy vegetables, cole crops, pome fruits, stone fruits, and tree nuts	Myrtle/Leaf milkwort: + Potato/Rhizoctonia canker and Black scurf: o Gladiolus/Fusarium corm rot: o Tomato/Bacterial speck: ±
<i>Bacillus subtilis strain</i> <i>QST 713</i>	Serenade® Garden Disease Control Concentrate	Bacterial spot, powdery mildew, rust, gray mold, leaf blight, scab, and more	Fruits, vegetables, and flowers	*
	Serenade® Garden Disease Control Ready to Use	Bacterial spot, powdery mildew, rust, gray mold, leaf blight, scab, and more	Vegetable, fruit, nuts, ornamentals plants, annual and perennial flowering plants, tropical foliage, trees, and shrubs	*
	Serenade® MAX™	Fire Blight, Botrytis, Sour Rot, Rust, Sclerotinia, Powdery Mildew, Bacterial Spot and White Mold	Vegetables, fruit, nut, and vine crops	Blueberry/Anthracnose fruit rot: + Blueberry/Mummy berry: ± Cranberry/Fruit rot: o Apple/Fireblight: o Apple/Flyspeck: o Apple/Sooty blotch: o Apple Black pox: o Apple/Brooks fruit spot: o
	Serenade® Wettable Powder Biofungicide	Fire Blight, Botrytis, Sour Rot, Rust, Sclerotinia, Powdery Mildew, Bacterial Spot, and White Mold	Vegetables, fruit, nut, and vine crops	Apple/Fire blight: o Red Raspberry: Fruit rot: o Grape/Bunch rot and Powdery mildew: + Turnip greens/bacterial leaf spot: o Hydrangea/Powdery mildew: + Pansy/Cercospora leaf spot: + Pumpkin, Cantaloupe, and Honeydew/Powdery mildew: + Lettuce/Lettuce drop: ± Lettuce/Powdery mildew: + Broccoli/Downey mildew: +
	Serenade® ASO	Fungi and bacteria that cause scab, powdery mildew, sour rot, downy mildew, and early leaf spot, early blight, late blight, bacterial spot, and walnut blight diseases	Food crops including cherries, cucurbits, grapes, leafy vegetables, peppers, potatoes, tomatoes, and walnuts	Cranberry/Cotton ball: ± Spinach/Stemphylium leaf spot: o Snap bean/Rhizoctonia root rot: o Radish/Hypocotyl root rot and Clubroot: ±

Fungicides				
Organism	Trade Name	Target	Crops	Efficacy ^{1,2}
<i>Trichoderma virens</i> (formerly <i>Gliocladium virens</i>)	SoilGard 12G ³	Pythium, Rhizoctonia, and Root rots	Ornamental and food crop plants grown in greenhouses, nurseries, interiorscapes, and outdoors	Geranium/Root rot: o Gladiolus/Fusarium Corm Rot: o Poinsettia/Pythium root rot: + Azalea/Phytophthora root rot: o Potato/Black scurf: + Potato/Rhizoctonia and Streptomyces: o Snap Beans/gray mold: ± Snap Beans/white mold: o Cucumber/Damping off: o
<i>Bacillus pumilus</i> QST 2808	Sonata®	Fungal pests such as molds, mildews, blights, and rusts	Many food and non-food crops, including trees susceptible to sudden oak death syndrome. For use outdoors, including nurseries, landscapes, and rights-of-way, and for use in greenhouses	Lima Beans/White mold: o Lettuce/Powdery mildew: + Lettuce/Lettuce drop: ± Broccoli/Downey mildew: + Pumpkin/Powdery mildew: o Radish/Downey mildew: + Radish/Clubroot and Rhizoctonia hypocotyl root rot: o
<i>Trichoderma harzianum</i> Rifai strain KRL-AG2	T-22™ HC	Fusarium, Pythium, and Rhizoctonia	Agronomic field and row crops, alfalfa, hay and forage crops, bulb crops, cucurbits, fruiting vegetables, herbs, spices, leafy vegetables, cole crops, legumes, root crops, small grains and tuber crops	Soybean/Rhizoctonia solani and drought: o
	T-22™ Planter Box	Fusarium, Pythium, and Rhizoctonia	Agronomic field and row crops, alfalfa, hay and forage crops, bulb crops, cucurbits, fruiting vegetables, herbs, spices, leafy vegetables, cole crops, legumes, root crops, small grains and tuber crops	Pea/Root rot: ± Bean (Baby Lima)/Root rot: o Pea/Root Rot: o
<i>Bacillus pumilus</i> GB34	Yield Shield® Concentrate Biological Fungicide	Rhizoctonia and Fusarium	Legumes	Soybean/Root rot: o Soybean/Rhizoctonia damping off: o Snap beans/Root rot: o
<i>Bacillus subtilis</i> QST 708	Rhapsody®	Fungal and bacterial diseases; Brown Patch, Anthracnose, and Dollar Spot	Turf, ornamentals, trees, shrubs, flowers, bedding plants, tropical plants, seedlings, conifers, fruity and leafy vegetables, and bulbs	Creeping bent grass/Dollar spot, abiotic stress, Brown patch and Anthracnose: o Annual bluegrass (60%) and Creeping Bentgrass (40%)/ Anthracnose: + Tall Fescue/Pythium blight and Gray leaf spot: o Geranium/Botrytis blight: + Dogwood/Powdery mildew: + Dogwood/Cercospora leaf spot and Spot Anthracnose: o

¹ The efficacy ratings are based on the results of studies published between 2000 and 2007 in the Plant Disease Management Network reports (<http://www.plantmanagementnetwork.org/>). These ratings are built on a comparison between untreated controls and the application of each product independently.

² + Evidence for disease control and/or yield increase, ± mixed results, o no obvious response to treatment, and * no data available in the selected PDM reports.

³ Products not registered in the state of Ohio.

Additional Resources

American Phytopathology Society (APSnet): APS is a global community of researchers that provide valuable information about plant health.

<http://www.apsnet.org/>

National Organic Program: The federal regulatory agency that normalizes the organic food.

<http://www.ams.usda.gov/nop/indexNet.htm>

National Pesticide Information Retrieval System (NPIRS): A collection of pesticide databases managed by the Center for Environmental and Regulatory Information (CERIS) at Purdue University (IN).

<http://ppis.ceris.purdue.edu/npublic.htm>

National Sustainable Agriculture Information (ATTRA): An information service organization that provides technical assistance for extension agents, farmers, and educators involved in sustainable agriculture.

<http://www.attra.org/>

Ohio Department of Agriculture (ODA): The state agency that provides regulatory protection to producers, agribusinesses, and the consuming public in Ohio.

<http://www.ohioagriculture.gov/>

Organic Food and Farming Education and Research Program (OFFER): A group of researchers from The Ohio State University that offer research and education for organic production, processing, and marketing.

<http://oardc.osu.edu/offer/>

Organic Review Materials Institute (OMRI): An institution that evaluates and certifies products for use in certified organic productions, handling, and processing.

<http://www.omri.org/>

OSU Fruit Pathology Laboratory: A research and extension laboratory at The Ohio State University that provides information about diseases in fruits crops (several fact sheets available).

<http://www.oardc.ohio-state.edu/fruitpathology/>

OSU Vegetable Pathology Laboratory: A research and extension laboratory at The Ohio State University that provides information about diseases in vegetable crops (several fact sheets available).

<http://www.oardc.ohio-state.edu/millerlab/>

OSU Research in Biological Control of Plant Diseases Laboratory: A research laboratory at The Ohio State University dedicated to the understanding of biological control agents in several crops.

<http://oardc.osu.edu/mcspaddengardenerlab/>

United States Department of Agriculture/Organic Farming: A subdivision of the U.S. Department of Agriculture with information about organic agriculture.

<http://www.ers.usda.gov/Briefing/Organic/>

U.S. Environmental Protection Agency/Biopesticides: A subdivision of the EPA that provides information about the biopesticides available and the regulation process.

<http://www.epa.gov/pesticides/biopesticides/>

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