

Biopesticides for Certified Organic Production: Efficacy Summaries Based on Data from PDMR 2000-2009

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Different agricultural practices, such as the use of rotation, cover crops, disease resistant varieties, and good seed bed preparation have been applied to control pests and pathogens. However, such practices are not always sufficient protection from crop losses. Because of this, many certified organic growers turn to biopesticides to insure and/or enhance their abilities to grow and market high-quality produce. Approved organic products for plant disease control include many EPA-registered biopesticides. Such products have been developed to control numerous plant diseases and provide useful tools for growers to decrease the incidence and/or severity of plant diseases.

Biopesticides that can be used by organic growers can be classified as either microbial or biochemical, based on the active ingredient. Microbial pesticides include live organisms (i.e. beneficial bacteria, fungi, nematodes and viruses) and their fermentation product, as the active ingredient. The biochemical pesticides include plant extracts, pheromones, plant hormones, natural plant-derived regulators, clay, potassium bicarbonate and enzymes as the active ingredient. In this fact sheet, only microbial pesticides and biochemical pesticides are discussed. Biopesticides are used primarily as preventative measures, so they may not perform as quickly as some synthetic chemical pesticides. However, biopesticides are generally less toxic to the user and non-target organisms, making them desirable and sustainable tools for disease management. While their use is not overly complicated, the application of some biopesticides may require a higher level of understanding and knowledge of the diseases that they are designed to control. As with any disease management program, proper timing and application are essential to ensuring efficacy.

The following lists are a summary of publicly available data on efficacy of commercially available, EPA-registered, and OMRI-approved biopesticides for plant disease control. *Disclaimer: Listing of a product does not constitute an endorsement or guarantee of yield responses by the authors or The Ohio State University.* Because product formulations can change over time, check with your certifier before applying any biopesticide product to ensure that it is acceptable for use on certified organic land. And, always follow the product label instructions when applying any biopesticide.

The efficacy ratings presented below are based on the results of one-year field studies published between 2000 and 2009 in the Plant Disease Management Reports (<http://www.plantmanagementnetwork.org/pub/trial/pdmr/>). These ratings are based on a comparison between untreated controls and the application of each product independently. Efficacy ratings are scaled as follows: □+ Evidence for disease control and/or yield increase, □± Evidence for disease control is mixed with some reports showing positive results and others not, □o No obvious response to treatment in one or more published reports, and □* no data available in the selected PDM reports.

Microbial biopesticide products labeled for bacterial disease control

Biocontrol Organism	Trade Name	Target Disease	Crops	Efficacy ^{1,2}
Bacteriophages of <i>Xanthomonas spp.</i> and <i>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</i> strain ESC 10	Bio-Save® 10LP3	Ice inducing bacteria and biological decay	Apples, pears, lemons, oranges, or grapefruit after the fruit is harvested	Sweetpotato/Rhizopus soft rot: +
<i>Pantoea agglomerans</i> strain E325	Bloomtime Biological™ 3	Fireblight (<i>Erwinia amylovora</i>)	Apples and pears	Apple/Fire blight: ±
	Bloomtime Biological™ FD3	Fireblight (<i>Erwinia amylovora</i>)	Apples and pears	Apple/Fire blight: ±

Microbial biopesticide products labeled for Fungal disease control

Biocontrol Organism	Trade Name	Target Disease	Crops	Efficacy ^{1,2}
<i>Streptomyces lydicus</i> WYEC 108	Actinovate® SP	Soilborne pathogens: <i>Pythium spp.</i> , <i>Rhizoctonia spp.</i> , <i>Phytophthora spp.</i> , <i>Fusarium spp.</i> , <i>Verticillium spp.</i> , <i>Phymatotrichum omnivorum</i> and other root decay fungi. Foliar pathogens: <i>Podosphaera spp.</i> , <i>Botrytis spp.</i> , <i>Sclerotinia spp.</i> , <i>Monilinia spp.</i> , <i>Alternaria spp.</i> , <i>Peronospora spp.</i> and other foliar fungi	Greenhouse, nursery and turf	Pumpkin/Powdery mildew: + Pumpkin/Phytophthora leaf blight: o Pepper/Phytophthora foliar blight: +
	Actinovate® AG	Soilborne pathogens: <i>Pythium spp.</i> , <i>Rhizoctonia spp.</i> , <i>Phytophthora spp.</i> , <i>Fusarium spp.</i> , <i>Verticillium spp.</i> , <i>Phymatotrichum omnivorum</i> and other root decay fungi. Foliar pathogens: <i>Podosphaera spp.</i> , <i>Botrytis spp.</i> , <i>Sclerotinia spp.</i> , <i>Monilinia spp.</i> , <i>Alternaria spp.</i> , <i>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	*
<i>Bacillus pumilus</i> QST 2808	Ballad® Plus Biofungicide	Rust, powdery mildew, <i>cercospora</i> , 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</i> strain CON/M/91-08	Contans® WG	<i>Sclerotinia minor</i> , <i>Sclerotinia sclerotiorum</i>	Agricultural soils	Snap beans/White mold: ± Snap beans/Gray mold: o Lettuce/White mold: ± Lettuce/Lettuce drop: +
<i>Bacillus subtilis</i> GB03	Kodiak® Concentrate Biological Fungicide	<i>Rhizoctonia</i> , <i>Fusarium</i> , <i>Alternaria</i> , <i>Aspergillus</i> , and others that attack the root systems of plants	Cotton, peanuts, soybeans, wheat, barley, peas, and beans	Snap beans/ <i>Fusarium</i> Root rot: ± Snap bean/ <i>Rhizoctonia</i> root rot: o Pea/ <i>Fusarium</i> , <i>Phoma</i> / <i>Pythium</i> : ± Wheat/ <i>Fusarium</i> crown rot: o Cucumber/Damping off: o
<i>Trichoderma</i>	Plant Shield® HC	<i>Fusarium</i> , <i>Pythium</i> , and <i>Rhizoctonia</i>	Cucurbit vegetables, flowers, bedding plants,	Dry beans/ <i>Fusarium</i> Root Rot: ±

<i>harzianum Rifai</i> strain KRL-AG2	Biological Foliar and Root Fungicide		ornamentals, fruiting and leafy vegetables, Cole crops, hydroponic crops, pome fruits, shade house, outdoor nursery, stone fruit, and tree nuts	Snap beans/ <i>Rhizoctonia</i> Root Rot: o Tomato/Grey mold: o Potato/Silver Scurf: + Potato/Black Scurf: o Geranium/Black Leg Disease: o Gladiolus/ <i>Fusarium</i> root rot: o African Daisy/Powdery mildew: ±
	RootShield® Granules	<i>Fusarium, Pythium, and Rhizoctonia</i>	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/ <i>Rhizoctonia</i> canker and Black scurf: o Gladiolus/ <i>Fusarium</i> corm rot: o Tomato/Bacterial speck: ±
<i>Bacillus subtilis</i> strain QST 713	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, <i>Botrytis</i> , Sour Rot, Rust, <i>Sclerotinia</i> , 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, <i>Sclerotinia</i> , 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/ <i>Cercospora</i> 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/ <i>Rhizoctonia</i> root rot: o Radish/Hypocotyl root rot and Clubroot: ±
<i>Trichoderma virens</i> (formerly <i>Gliocladium</i> <i>virens</i>)	SoilGard 12G3	<i>Pythium, Rhizoctonia, and Root</i> rots	Ornamental and food crop plants grown in greenhouses, nurseries, interiorscapes, and outdoors	Geranium/Root rot: o Gladiolus/ <i>Fusarium</i> Corm Rot: o Poinsettia/ <i>Pythium</i> root rot: + Azalea / <i>Phytophthora</i> root rot: o Potato/Black scurf: + Potato/ <i>Rhizoctonia</i> and <i>Streptomyces</i> : o Snap Beans/gray mold: ± nap 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	<i>Fusarium, Pythium, and Rhizoctonia</i>	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:0
	T-22™ Planter Box	<i>Fusarium, Pythium, and Rhizoctonia</i>	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
	RootShield® WP	<i>Pythium, Rhizoctonia, Fusarium, Thielaviopsis and Cy lindrocladium</i>	berries and small fruits; bulb crops; citrus fruits; additional leafy vegetables and cole crops; tree nuts; root crops and tuber crops)	Geranium/Blackleg; <i>Pythium</i> sp.+ Potato/Rhizoctonia canker + Potato/black scurf 0
<i>Bacillus subtilis</i> QST 708	Rhapsody®	Fungal and bacterial diseases; Brown Patch, <i>Anthracnose</i> , 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/ <i>Cercospora</i> leaf spot and Spot Anthracnose: o
<i>Bacillus pumilus</i> GB34	Yield Shield® Concentrate Biological Fungicide	<i>Rhizoctonia</i> and <i>Fusarium</i>	Legumes	Soybean/Root rot: o Rhizoctonia damping off: o Snap beans/Root rot: o

Biochemical biopesticide products labeled for fungal/oomycete disease control

Trade Name	Ingredient	Manufacturer	Target Crop	Target Disease	Efficacy ^{1,2}
Garlic Barrier®	Garlic Oil	Garlic Research Labs, Inc	Cucurbit crops, forage crops, fruiting vegetables, herbs, kiwi, leafy vegetables, legume vegetables, nut trees, ornamentals,peanuts, pome fruit trees, root and tuber vegetables, small fruits and berries, stone fruit trees,sugarcane, sunflowers, tropical fruits, turfgrass	Brown spot, insect infestation	Tomato/ early blight 0
Green Light® Neem Concentrate	Neem Oil	Green Light Company	Vegetables, fruits, nuts and spices	Powdery mildew, rust, anthracnose, leaf spot and other diseases	Crapemyrtle / cercospora leaf spot 0 dogwood/powdery mildew + dogwood/spot anthracnose 0 dogwood/cercospora leaf spot ±
Trilogy®	Neem Oil	Certis USA	Citrus, tree fruits, cucurbits, bulb, cole and leafy vegetables, legume and fruiting vegetables, root and tuber vegetables, small fruits and berries , herbs and spices, cereal and grains, nuts, corn , alfalfa, cotton	Alternaria, anthracnose, early blight, leaf blight, botrytis, greasy spot, leaf spot, post bloom fruit drop, powdery mildew, molds, scabs, rusts, shothole	Tomato/early blight 0 bean, snap/white mold; gray mold ± grape/ powdery mildew 0 pumpkin/ powdery mildew ± almond/ brown rot + almond/ scab 0 sweet cherry/ powdery mildew ±

Triact® 70EC	Neem Oil	Certis USA	Citrus, tree fruits, cucurbits, bulb, cole and leafy vegetables, legume and fruiting vegetables, root and tuber vegetables, small fruits and berries , herbs and spices, cereal and grains, nuts, corn , alfalfa, cotton	Alternaria, anthracnose, early blight, leaf blight, botrytis, greasy spot, leaf spot, post bloom fruit drop, powdery mildew, molds, scabs, rusts, shothole	Poinsettia/powdery mildew +
Actino Iron®	Iron	Actino Iron®	Food and fiber crops, ornamentals, landscape plants, tree seedlings for transplanting to the forest	Soil borne plant root rot and damping-off disease	Snapdragon/root rot +
ECO E-RASE®	Jjoba Oil	IJO Products, LLC	Garden and commercial vegetables and crops	Powdery Mildew and whitefly	Pumpkin/ powdery mildew ±
SeaCide®	Fish Oil	Omega Protein, Inc	Field crops, orchards, vineyards, and greenhouse	Black spot, powdery mildew and greasy spot	Tomato/late blight, bacterial spot 0 tomato/bacterial spot; early blight + summer squash/powdery mildew ±
Heads Up® Plant Protectant	Extract of Chenopodium quinoa saponins	Heads Up Plant Protectants	Soybeans, potato, tomato, peas, beans, and wheat	Soil borne plant root rot and damping-off disease	Peas/ root rot + tomato/ early blight +
Promax™	Thyme Oil	Bio Huma Nectics, Inc	Crops, ornamental plants, and turf	Fungal disease	Pumpkin/ phytophthora blight ± squash/ phytophthora blight ±
Proud 3™	Thyme Oil	Bio Huma Nectics, Inc	Crops, ornamental plants, and turf	Fungal disease	Turnip greens/bacterial leaf spot 0 pumpkin/phytophthora blight ± squash/phytophthora blight ±
Organic JMS Stylet-Oil®	Paraffinic Oil	JMS Flower Farms, Inc	Grape, tree fruit, grass seed, and vegetable crops	Powdery mildew and botrytis bunch rot	Pumpkin/powdery mildew + tomato/Powdery mildew 0 bacterial speck Septoria leaf spot 0 strawberry/leaf spot 0 phomopsis/ leaf blight 0 black burrant/white pine blister rust +
PureSpray™ Green	Petroleum Oil	Petro-Canada	Apples and pears, almonds, apricots, cherries, nectarines, peaches, pistachio, plums, prunes, avocados, citrus, grapes, olives, tropical fruit, ornamental fruits, vegetable crops	Powdery mildew	Grape/powdery mildew 0
Saf-T-Side®	Petroleum Oil	Brandt Consolidated	Apples and pears, almonds, apricots, cherries, nectarines, peaches, pistachio, plums, prunes, avocados, citrus, grapes, olives, tropical fruit, ornamental fruits, vegetable crops	Powdery mildew, black spot, and rust	Cucumber/downy mildew ± apple/powdery mildew ± almond/brown rot, scab : +