

Biopesticides for Managing Diseases of Leafy Vegetables Organically

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More information at: <http://livegpath.cals.cornell.edu/organic/organic-management-of-vegetable-diseases/>

Following is a list of some biopesticides labeled for disease control in vegetable crops. The active ingredient follows product name. Most products are labeled for managing multiple diseases on many crops. The diseases of leafy vegetables that are specified on these labels are included. The leafy vegetable crop group (EPA group 4-A and 4-B) includes head and leaf lettuce, arugula, endive, celery, fennel, spinach, Swiss chard, radicchio and rhubarb. On some labels asparagus and watercress are listed with these crops; they are among the miscellaneous commodities not assigned to a group under EPA classification. The leafy Brassica greens subgroup (5-B), which includes mustard greens, collards, kale, and bok choy, is grouped with the leafy vegetable group on some labels. Products listed with OMRI (Organic Materials Review Institute) are NOP compliant. Some products were reviewed by a different organization. Check state registration: each product may not be registered in all states. Also, always check with your certifier before purchasing any product. 'No Ag Label' indicates an agricultural label was not found for the product.

Actinovate AG. 0.0371% *Streptomyces lydicus* strain WYEC 108. Labeled for suppressing several soil-borne and foliar diseases which are listed separately from the crops. Pathogens of leafy vegetables in the list for soil treatment and seed treatment are *Fusarium*, *Phytophthora*, *Pythium*, *Rhizoctonia*, and *Verticillium*. Labeled for foliar treatment for powdery mildew, downy mildew, *Anthracnose*, *Sclerotinia*, *Alternaria*, and *Erwinia*. Label indicates to use a non-ionic spreader-sticker. OMRI-listed. EPA Reg. No. 73314-1. Monsanto BioAg (formerly Natural Industries, Inc.).

BacStop. 2.0% thyme, 2.0% clove & clove oil, 1.5% cinnamon, 1.0% peppermint & peppermint oil, and 1.0% garlic oil. Broadly labeled primarily for bacterial diseases; diseases not specified for some crops including leafy vegetables. Exempt from EPA registration. USAgriTech, Inc.

Bio-Tam. 2% *Trichoderma asperellum* strain ICC 012 and 2% *Trichoderma gamsii* strain ICC 080. These beneficial fungi have different modes of action and are active over different temperature ranges (starting at 45°F) and environmental conditions. General label with pathogens and crops listed separately. For soil-borne fungal pathogens. Those that can affect leafy vegetables include *Fusarium*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, and *Verticillium*. OMRI-listed. EPA Reg. No. 80289-9-69592. Isagro USA; distributed by Bayer CropScience (formerly AgraQuest).

Cease. 1.34% *Bacillus subtilis* strain QST 713. Broadly labeled for use on greenhouse vegetables. Labeled for downy mildew, pink rot, powdery mildew, and *Sclerotinia* head and leaf drop in leafy vegetables. OMRI-listed. EPA Reg. No. 69592-19-68539. BioWorks, Inc.

Companion. 0.03% *Bacillus subtilis* strain GB03. Broadly labeled for foliar and soil-borne diseases, including *Alternaria* blight, black root rot, bottom rot, *Fusarium* wilt, gray mold, powdery mildew, *Sclerotinia* lettuce drop, and root rot caused by *Pythium* and *Rhizoctonia* in leafy vegetables. EPA Reg. No. 71065-3. Growth Products, Ltd.

Contans WG. 5.3% *Coniothyrium minitans* strain CON/M/91-08. Soil-applied product for *Sclerotinia sclerotiorum* (white mold pathogen). OMRI-listed. EPA Reg. No. 72444-1. SipcamAdvan.

Double Nickel 55 LC and WDG. *Bacillus amyloliquefacinens* strain D747, 98.8% and 25%, respectively. Broadly labeled for foliar and soil-borne diseases, including bacterial blights, bottom rot, *Cercospora* leaf spot, downy mildew, *Sclerotinia* head and leaf drop, pink rot, powdery mildew, and damping off, root rot and crown rot caused by *Pythium*, *Fusarium*, *Phytophthora*, *Verticillium*, and *Rhizoctonia* in leafy vegetables. OMRI-listed. EPA Reg No. 70051-107 and 108, respectively. Certis USA, LLC.

EF400. 8.2% clove, 8.1% rosemary, and 6.7% peppermint oils. Labeled for downy mildew, powdery mildew, and *Sclerotinia* white mold in leafy vegetables. Exempt from EPA registration. USAgriTech, Inc.

Kaligreen. 82% potassium bicarbonate. Labeled only for powdery mildew. OMRI-listed. EPA Reg. No. 11581-2. Arysta LifeScience North America LLC.

KeyPlex 350 OR. 0.063% yeast extract hydrolysate from *Saccharomyces cerevisiae*. Combination of defensive proteins (alpha-keto acids) and secondary and micronutrients. Elicits systemic acquired resistance in plants against fungal and bacterial pathogens. Labeled for general disease control in vegetables. EPA approval for organic production. EPA Reg. No. 73512-4. KeyPlex.

LifeGard WG. 40% *Bacillus mycoides* isolate J. Biological Plant Activator. Labeled for anthracnose, downy mildew, gummy stem blight, and powdery mildew. OMRI-listed. EPA Reg. No. 70051-119. Certis USA, LLC.

MeloCon WG. 6% *Paecilomyces lilacinus* strain PL251. This soil fungus parasitizes many types of plant parasitic nematodes, including root knot and root lesion, without adverse impact on beneficial nematodes. OMRI-listed. EPA Reg. No. 72444-2. Certis USA, LLC.

Mildew Cure (formerly GC-3 Organic fungicide). 30% cottonseed oil, 30% corn oil, 23% garlic extract. Labeled only for powdery mildew in lettuce and spinach. OMRI-listed. Exempt from EPA registration. JH Biotech, Inc.

MilStop. 85% potassium bicarbonate. Broadly labeled including anthracnose, Alternaria leaf spot, Botrytis gray mold, Cercospora leaf spot, powdery mildew, and Septoria leaf spot in leafy vegetables. OMRI-listed. EPA Reg. No. 70870-1-68539. BioWorks, Inc.

M-Pede. 49% Potassium salts of fatty acids. Labeled for powdery mildew and several insects and mites in leafy vegetables. OMRI-listed. EPA Reg. No. 10163-324. Gowan Co.

Mycostop. 35% *Streptomyces griseoviridis* strain K61. Mycostop can be incorporated in potting mix, applied as a seed treatment, used as a transplant dip, and applied to soil as a spray, drench, or through drip irrigation. It is labeled for control of seed rot, root and stem rot, and wilt caused by *Fusarium*, *Alternaria*, and *Phomopsis* of container-grown vegetables and damping-off and early root rot of vegetables in the field. OMRI listed. EPA Reg. No. 64137-5. Verdera Oy.

Organocide. 5% sesame oil. Labeled broadly for several fungal diseases and insects. OMRI-listed. Exempt from EPA registration. No Ag Label. Organic Laboratories, Inc.

OxiDate. 27% hydrogen dioxide. Broadly labeled including brown rot, Botrytis (gray mold), downy mildew, early blight, late blight, powdery mildew, rust, and *Phytophthora* in leafy vegetables. OMRI-listed. EPA Reg. No. 70299-2. BioSafe Systems, LLC.

Prestop. 32% *Gliocladium catenulatum* strain J1446. Broadly labeled primarily for application to soil for several seed and soil pathogens, and also to foliage for select crops. Current formulation can only be applied as drench into growing substrate for leafy vegetables. New formulation expected in 2016 will permit use on edible plant parts thus also enabling label expansion. OMRI-listed. EPA Reg. No. 64137-11. Verdera Oy. U.S. Distributor: AgBio Inc.

Procidic. 3.5% Citric acid. Labeled for gray mold and white mold in lettuce. Previously marketed as Citrex. Procidic was reviewed and determined to be NOP compliant by Washington State Dept of Ag. Exempt from EPA registration. Greenspire Global, Inc.

Promax. 3.5% Thyme oil. Protective and curative soil fungicide and nematicide for control of soil-borne diseases and plant parasitic nematodes on a broad range of crops. OMRI-listed. Exempt from EPA registration. Bio Huma Netics, Inc.

Regalia. 5% Extract of *Reynoutria sachalinensis*. Boosts the plant's natural defense mechanisms against certain fungal and bacterial diseases. Broadly labeled including bacterial blight/rot, downy mildew, Cercosora leaf spot, late blight, pink rot, powdery mildew, Sclerotinia head and leaf drop, and white rust in leafy vegetables. OMRI-listed. EPA Reg. No. 84059-2. Marrone Bio Innovations, Inc.

RootShield WP and Granules (formerly T-22 HC and PlantShield HC). 1.15% *Trichoderma harzianum* Rifai strain KRL-AG2. Protects plant roots against fungal pathogens such as *Rhizoctonia*, *Pythium*, and *Fusarium*. The biocontrol fungus accomplishes this by growing on roots and releasing enzymes that dissolve the cell wall of many fungal pathogens, which it consumes. OMRI-listed. EPA Reg. No. 68539-3 and -7 for Granules and WP formulations, respectively. BioWorks, Inc.

RootShield Plus WP. 1.15% *Trichoderma harzianum* Rifai strain T-22 and 0.61% *Trichoderma virens* strain G-41. See previous product. OMRI-listed. EPA Reg. No. 68539-9. BioWorks, Inc.

Serenade ASO. 1.34% *Bacillus subtilis* strain QST 713. This bacterium colonizes roots when applied to soil and produces compounds that affect pathogens directly and triggers metabolic pathways to activate the plant's natural defenses and modulate growth. Labeled for anthracnose, bacterial blight and leaf spot, *Botrytis* spp., downy mildew, powdery mildew, *Sclerotinia* head and leaf drop, and white rust in leafy vegetables and for soil diseases caused by *Fusarium*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinia*, and *Verticillium*. Serenade ASO has replaced Serenade Soil and Serenade Opti. Previous product names and formulations: Serenade, Serenade Max, Serenade Optimum. OMRI-listed. EPA Reg. No. 264-1152. Bayer CropScience.

Serifel. 9.9% *Bacillus amyloliquefacinens* strain MBI 600. Supplemental label has bacterial leaf spot. OMRI-listed. EPA Reg. No. 71840-18. BASF Corporation.

SoilGard 12G. 12% *Gliocladium virens* strain GL-21. Generally labeled for damping-off and root rot pathogens in field and greenhouse production. OMRI-listed. EPA Reg. No. 70051-3. Certis USA, LLC.

Sonata. 1.38% *Bacillus pumilus* strain QST 2808. Labeled for downy mildew and powdery mildew in leafy vegetables. OMRI-listed. EPA Reg. No. 264-1153. Bayer CropScience (formerly AgraQuest).

Taegro ECO. 13% *Bacillus subtilis* var. *amyloliquefaciens* strain FZB24. Labeled for diseases caused by the soil-borne pathogens *Rhizoctonia* and *Fusarium* in many crops including some leafy vegetables. OMRI-listed. EPA Reg. No. 70127-5. Syngenta Crop Protection (formerly Novozymes Biologicals, Ind.)

Tenet WP. Same as Bio-Tam. OMRI-listed. EPA Reg. No. 80289-9. Isagro USA; distributed by SipcamAdvan.

Thyme Guard. 23% thyme oil extract. Labeled generally for diseases caused by all pathogen groups and also insect pests. Determined to be NOP compliant by Washington State Dept of Ag. Exempt from EPA registration. Agro Research International.

Timorex Gold. 23.8% tea tree oil. Labeled generally for several diseases. Those occurring in leafy vegetables include anthracnose, bacterial diseases, *Botrytis* gray mold, *Cercospora* leaf spot, downy mildew, powdery mildew, and diseases caused by *Sclerotinia*. OMRI-listed. EPA Reg. No. 70051-2. Stockton USA, LLC.

Trilogy. 70% clarified hydrophobic extract of neem oil. Labeled generally for several insects and diseases. Labeled diseases that occur in leafy vegetables include *Alternaria*, anthracnose, downy mildew, early blight, leaf blight, *Botrytis* (gray mold), leaf spot, rust, and powdery mildew. OMRI-listed. EPA Reg. No. 70051-2. Certis USA, LLC.

Zonix biofungicide. 8.5% Rhamnolipid Biosurfactant. Kills zoospores, which is one spore type produced by Oomycete pathogens which cause diseases such as downy mildew in some in leafy vegetables. OMRI-listed. EPA Reg. No. 72431-1. PropTera, LLC.

Below are some organic fungicides in addition to copper and sulfur that are not biopesticides:

JMS Stylet-oil. 97.1% paraffinic oil. Labeled for several insect pests, viruses vectored by aphids, and some fungal diseases in several crops including *Alternaria* leaf spot (blight) and powdery mildew in celery and lettuce. OMRI-listed. EPA Reg. No. 65564-1. JMS Flower Farms, Inc.

TriTek. 80% mineral oil. Labeled only for insect pests in lettuce; also labeled for powdery mildew in other crops. OMRI-listed. EPA Reg. No. 48813-1. Previously named Saf-T-Side. Brandt Consolidated, Inc.

Please Note: The specific directions on fungicide labels must be adhered to -- they supersede these recommendations, if there is a conflict. If you are farming organically, before purchase make sure product is registered in your state and approved by your certifier. Any reference to commercial products, trade or brand names is for information only; no endorsement is intended.

Up-dated 9-21-17.