

# Biopesticides for Managing Diseases of Cucurbits Organically

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

Biopesticides are defined by EPA as pesticides derived from natural materials. There are three types. Biochemical pesticides contain naturally occurring substances that control pests. Substances that control diseases include potassium bicarbonate, hydrogen dioxide, phosphorous acids, plant extracts, and botanical oils. Microbial pesticides contain microorganisms that function as biocontrol agents, affecting the pathogen directly or indirectly through the compounds they produce. Plant-incorporated protectants or PIPs are the least common type of biopesticide. These are pesticidal substances produced by plants that contain genetic material added to the plant often through genetic engineering. The genetic material and the protein it encodes, but not the plant itself, are regulated by EPA. Examples are virus-resistant varieties producing the virus coat protein, which covers virus particles after infection preventing their replication. More information about biopesticides plus lists of active ingredients and products are on the web at <http://www.epa.gov/opbtpd1/biopesticides/index.htm>. There are also biopesticides for managing weeds and insect pests.

Biopesticides have advantages. Their activity generally is targeted to pests and closely related organisms, and they are usually inherently less toxic than conventional pesticides, thus they do not have the same potential to affect birds, beneficial insects, and mammals (there are exceptions, so check the label when this is a major reason for choosing biopesticides). And thus they typically have short REI and PHI. They generally decompose fast and sometimes are effective in small quantities, thus exposure is lower and potential pollution problems are avoided. Recognizing that biopesticides tend to pose fewer risks than conventional pesticides, EPA has been encouraging their development and use. EPA generally requires less data to register a biopesticide than a conventional pesticide, but enough data about the composition, toxicity, degradation, and other characteristics of the pesticide to ensure that the product will not have adverse effects on human health or the environment. EPA can conduct the registration process more quickly with biopesticides, often taking less than a year, compared with an average of more than 3 years for conventional pesticides. To facilitate their registration, the Biopesticides and Pollution Prevention Division was established in the Office of Pesticide Programs in 1994. Some biopesticides are defined as minimum risk pesticides through FIFRA Section 25(b) rule because their active and inert ingredients are generally recognized as safe (GRAS). These consequently are exempted from the regulation requirements of FIFRA and thus can be used on any labeled crops for any target since they do not need to be registered as a pesticide. 'Exempt from EPA registration' is stated on the label of these products.

Limited data on efficacy of biopesticides can be considered their main disadvantage. Data documenting efficacy is not considered when making decisions about registration of pesticides in the USA. Many biopesticides are produced by small companies lacking the R & D funds to support field trials to obtain efficacy data by experienced university and other independent researchers. To help fill this gap, the IR-4 Biopesticide and Organic Support Program funds grants to obtain efficacy information for biopesticides in development as well as those already registered. These funded projects help the program meet its objective, which is to further the development and registration of biopesticides for use in pest management systems for specialty crops (which include all vegetables) or for minor uses on major crops. Information about this program, plus databases of labels and projects are at: <http://ir4.rutgers.edu/biopesticides.html>.

Most biopesticides are approved for organic production and most products approved for organic production are biopesticides, thus they have a logical excellent fit for managing diseases in organic crops. However some formulations are not approved, which can be due to inerts. For example, the potassium bicarbonate products EcoMate Armicarb O, Kaligreen and MilStop are approved whereas Armicarb is not. Also, some biopesticidal substances are not allowed under NOP (National Organic Program), for example phosphorous acids and genetically-engineered PIPs. Additionally, there are important organic fungicides that are not biopesticides, including mineral oils, copper, and sulfur. Biopesticides break down in the environment, thus there is no

concern about build-up in soil as with copper, which is an element. However, biopesticides generally do not have the breadth of activity, efficacy, or residual activity of copper; thus it is important to obtain information about these factors and to know the target disease(s) when selecting biopesticides. The earlier in disease development that applications are started, the more effective the product will be. This is not unique to biopesticides. Fungicides cannot eradicate established lesions.

Some biopesticides, notably Regalia and Serenade, have induced plant resistance as a mode of action. These need to be applied before infection for this activity to be effective.

Several biopesticides have proven effective for diseases affecting vegetable crops. Powdery mildew is perhaps the easiest foliar disease to manage with biopesticides. It can be controlled with several different biopesticides, including botanical oil (Organocide, Mildew Cure, etc), potassium bicarbonate (Kaligreen, MilStop), and microbials (Actinovate, Serenade, Sonata, etc).

Following is a list of some biopesticides labeled for disease control in vegetable crops. The active ingredient follows product name. For products labeled for managing multiple diseases on many crops, labeled diseases of cucurbit crops are included to provide some information about the breadth of activity. Products listed with OMRI (Organic Materials Review Institute) are NOP compliant. 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 foliar and soil-borne diseases on many crops; diseases and crops listed separately. The biocontrol agent colonizes roots, protecting them from pathogens and making minerals and micronutrients more available to plants, which thus are more vigorous and larger. For best results with applications to foliage, 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 including bacterial leaf spot, bacterial wilt, bacterial fruit blotch, downy mildew, and powdery mildew in cucurbits. Recommended used with EF400 for these and some other diseases. 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. They are effective for diseases caused by *Phytophthora capsici*, *Rhizoctonia*, *Pythium* and *Verticillium*. General label. 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 angular leaf spot, anthracnose, bacterial fruit blotch, downy mildew, gummy stem blight, and powdery mildew in cucurbits. 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 bacterial wilt, gummy stem blight, powdery mildew, damping-off, crown and root rot, Phytophthora blight, and Fusarium wilt in cucurbits. 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. SipcamaAdvan.

**Double Nickel 55 LC and WDG.** *Bacillus amyloliquefacinens* strain D747, 98.8% and 25%, respectively. Broadly labeled for foliar and soil-borne diseases, including downy mildew, gummy stem blight, powdery mildew, damping-off, crown and root rot, Monosporascus vine decline, and charcoal rot in cucurbits. OMRI-listed. EPA Reg No. 70051-107 and 108, respectively. Certis USA, LLC.

**EF400.** 8.2% clove, 8.1% rosemary, and 6.7% peppermint. Broadly labeled including downy mildew and powdery mildew in cucurbits. Exempt from EPA registration. USAgritech, Inc.

**Kaligreen.** 82% potassium bicarbonate. Labeled 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 with specific mention of bacterial leaf spot in tomato. 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. Federally registered Jan 2017; not registered in NYS yet.

**Majestene.** 94.5% heat-killed *Burkholderia* spp. strain A396 cells and spent fermentation media. Bionematicide for root-knot, lesion, and other parasitic nematodes. Controls by contact and ingestion. OMRI-listed. EPA Reg. No. 84059-14. Marrone Bio Innovations, Inc.

**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 for powdery mildew. OMRI-listed. Exempt from EPA registration. JH Biotech, Inc.

**MilStop.** 85% potassium bicarbonate. Broadly labeled including Alternaria leaf spot, anthracnose, downy mildew, powdery mildew, scab, and Septoria leaf spot in cucurbits. OMRI-listed. EPA Reg. No. 70870-1-68539. BioWorks, Inc.

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

**Mycostop.** 30% *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 Alternaria, anthracnose, downy mildew, gummy stem blight, leaf spot, Phytophthora, powdery mildew, and root rots in cucurbits. 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 and before fruiting. 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 damping-off, foliar diseases caused by fungal and bacterial pathogens, and post-harvest diseases. 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 Alternaria blight, anthracnose, Cercospora leaf spot, downy mildew, gummy stem blight, Phytophthora blight, and powdery mildew in cucurbits. 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 the fungal pathogens *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 angular leaf spot, anthracnose, downy mildew, gummy stem blight, and powdery mildew and for soil diseases caused by *Rhizoctonia*, *Pythium*, *Fusarium*, *Verticillium* and *Phytophthora*. 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.

**Sil-Matrix.** 29% potassium silicate. Labeled for powdery mildew in cucurbits. OMRI-listed. EPA Reg. No. 82100-1. PQ 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. 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. 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 SipcamaAdvan.

**TerraClean 5.** 27% hydrogen dioxide and 5% peroxyacetic acid. Generally labeled for control of soil-borne plant diseases such as those caused by *Fusarium* (root rot), *Phytophthora* (blights, rots), *Pythium*, and *Rhizoctonia* on any crop. It penetrates soil to kill and suppress pathogens, and it releases vast amounts of oxygen that stimulates root development, nutrient uptake, and thus plant growth. OMRI-listed. EPA Reg. No. 70299-13. BioSafe Systems, Inc.

**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, including anthracnose, bacterial diseases, downy mildew, and powdery mildew in cucurbits. 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, including *Alternaria*, anthracnose, downy mildew, leaf spot, and powdery mildew in cucurbits. OMRI-listed. EPA Reg. No. 70051-2. Certis USA, LLC.

**Zonix.** 8.5% Rhamnolipid Biosurfactant. Kills zoospores, which is one spore type produced by Oomycete pathogens which cause diseases such as late blight and downy mildews. 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 transmitted by aphids, and some fungal diseases in several crops including *Alternaria* leaf spot, gummy stem blight, and powdery mildew in cucurbits. OMRI-listed. EPA Reg. No. 65564-1. JMS Flower Farms, Inc.

**TriTek.** 80% mineral oil. Labeled for several insect pests and powdery mildew in several crops including cucumber, melon, and squash. 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.*

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