

Efficacy of Various Biological and Microbial Fungicides - Does That Really Work?

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Many different products have been registered and approved for managing diseases in organically-grown crops in the USA. Active ingredients include botanical oils (e.g. sesame, rosemary, tea tree), plant extracts (giant knotweed, garlic), and chemicals (hydrogen peroxide, potassium bicarbonate, mineral oil). Other products have as their active ingredient a microorganism that acts as a biocontrol agent, directly affecting the pathogen (e.g. Contans), or produces a compound during fermentation that provides control (e.g. Sonata). Some products suppress disease by inducing the plant to activate its defense mechanisms (e.g. Companion, Regalia). There is a long list of crops and diseases on the labels for many organic fungicides, thus growers now have a lot to choose from.

There is, however, limited data on efficacy of these products for specific uses from replicated experiments conducted under field conditions. Efficacy is not a requirement for pesticide registration in the USA. Federal registration decisions are made by the EPA, thus focus is potential negative impact on the environment, including non-target organisms. And additionally, many products for organic agriculture are produced by small companies lacking the resources to support efficacy experiments for all labeled uses. Laboratory tests are conducted to determine pathogen sensitivity. Recognizing the need for efficacy data to promote use of registered biopesticides and to foster develop of new products, the IR-4 program has been running a federally-funded grant program for evaluating new and labeled uses of biopesticides. Most biopesticides are NOP compliant. But there are organic products that are not considered biopesticides (e.g. JMS Stylet-oil) and there are biopesticides not suitable for organic production (e.g. phosphorous acid fungicides).

Below is a list of OMRI-approved products and labeled uses, followed by a list of results from efficacy experiments found. Focus is on efficacy for the product used alone, and on non-copper products. Several treatments tested have been combinations of products including conventional ones. It is important to note that some products have continued to be developed and improved following registration, thus results obtained with an early formulation might not reflect the degree of control obtainable with the current formulation. Additionally, performance of some products is thought to have been negatively affected by the adjuvant used (e.g. Biotune). Other factors that can affect product performance include whether applications were started when there were few or no symptoms, frequency of application, and disease pressure. Most efficacy evaluations have been conducted on crops grown with conventional production practices. Anecdotal results from organic growers are being sought to add to this list.

Actinovate SP. 0.0371% *Streptomyces lydicus*. 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. EPA Reg. No. 73314-1. Natural Industries, Inc.

Cease. 1.34% *Bacillus subtilis* QST 713 strain. Labeled for many diseases on many crops grown in the greenhouse. EPA Reg. No. 69592-19-68539. BioWorks, Inc.

Companion. 0.03% *Bacillus subtilis* GB03. Activates induced systemic resistance in plants. Labeled for several soil and foliar diseases on many crops. EPA Reg. No. 71065-2. Growth Products, Ltd.

Contans WG. 5.3% *Coniothyrium minitans* strain CON/M/91-08. Soil-applied product for *Sclerotinia sclerotiorum* and *S. minor*. Labeled for several crops. EPA Reg. No. 72444-1. Sylvan Bioproducts, Inc.

Copper fungicides. OMRI listed products include Champ WG, Nordox 75 WG, and NuCop HB. Labeled for many fungal and bacterial diseases on many crops.

JMS Stylet-oil. 97.1% Paraffinic oil. Labeled for fungal diseases, aphid-transmitted viruses, and insects on several crops. EPA Reg. No.65564-1. JMS Flower Farms.

Kaligreen. 82% potassium bicarbonate. Labeled for powdery mildew only on many crops. EPA Reg. No. 70231-1. AgBio, Inc.

KeyPlex 350 OR. Combination of defensive proteins (alpha-keto acids) and secondary and micronutrients. Elicits systemic acquired resistance in plants against fungal and bacterial pathogens. EPA approval for organic production. EPA Reg. No. 73512-4. KeyPlex.

Mildew Cure (formerly GC-3 Organic fungicide). 30% cottonseed oil, 30% corn oil, 23% garlic extract. Labeled for powdery mildew on various crops. Exempt from EPA registration. JH Biotech, Inc.

MilStop. 85% potassium bicarbonate. Labeled for powdery mildew and several other diseases on many crops. EPA Reg. No. 70870-1-68539. BioWorks, Inc.

Organocide. 5% sesame oil. Labeled broadly for several fungal diseases and insects. Exempt from EPA registration. Organic Laboratories, Inc.

OxiDate. 27% hydrogen dioxide. Labeled for several diseases on many crops. EPA Reg. No. 70299-2. BioSafe Systems.

Promax. 3.5% thyme oil. Labeled for several soil-borne fungal diseases and nematodes on many crops. Exempt from EPA registration. Bio Huma Netics, Inc.

Proud-3. 4 qt/A. 5.6% Thyme oil. Labeled as a broad-spectrum fungicide, insecticide, and miticide on several vegetable crops. Exempt from EPA registration. Bio Huma Netics, Inc.

Reglia SC. 5% Extract of *Reynoutria sachalinensis*. Boosts the plants' natural defense mechanisms against certain fungal and bacterial diseases. Labeled for use against several fungal and bacterial diseases on several crops. EPA Reg. No. 84059-2. Marrone Bio Innovations, Inc.

Saf-T-Side. 80% petroleum oil. Only labeled as an insecticide and miticide on vegetable crops; powdery mildew and rust on other crops. EPA Reg. No.48813-1. Clawel, division of Brandt Consolidated.

Serenade Max. 14.6% *Bacillus subtilis* strain QST 713. Labeled for many diseases on many crops. AgraQuest. EPA Reg. No.69592-11.

Sonata. 1.38% *Bacillus pumilus* strain QST 2808. Labeled for several diseases on many crops. AgraQuest. EPA Reg. No. 69592-13.

Sporatec AG. 18% rosemary oil, 10% clove oil, and 10% thyme oil. Labeled for several bacterial and fungal diseases on many crops. Exempt from EPA registration. Clawel, division of Brandt Consolidated.

Sulfur fungicides. OMRI listed products include Microthiol Disperss, THAT Flowable Sulfur, and Yellow Jacket Sulfur 80 DF. Labeled for powdery mildew as well as mites on several crops and a few other diseases on select crops.

T-22 HC (formerly PlantShield HC). 1.15% *Trichoderma harzianum* Rifai strain KRL-AG2. Protects plant roots against fungal pathogens. Apply to seed, transplants, or soil mix. EPA Reg. No. 68539-4. BioWorks, Inc.

Trilogy. 70% clarified hydrophobic extract of neem oil. Labeled for several diseases and insects. EPA Reg. No. 70051-2. Certis USA L.L.C.

Yield Shield. 0.28% *Bacillus pumilus* GB34. Seed treatment labeled on several crops for *Rhizoctonia*, *Fusarium* and other fungi that attack roots. EPA Reg No. 264-985. Bayer CropScience.

Carrot

Alternaria leaf blight and Cercospora leaf spot. Sporan provided limited control.

Celery

Pythium root rot. ZeroTol (hydrogen dioxide) ineffective.

Collard

Downy mildew. Sonata (2 qt/A) ineffective.

Garlic

White rot. Contans ineffective applied at planting.

Lettuce

Downy mildew. Oxidate (76 fl oz/A) provided limited control.

Sclerotinia drop. Contans effective in 2 experiments; against *Sclerotinia sclerotiorum* but not *S. minor* in one experiment where both pathogen tested separately. Serenade ineffective in one experiment.

Cucurbit Crops

Anthracnose. Actinovate 6 oz/A + Latron ineffective.

Downy mildew. Sonata (2-4 qt/A) + Biotune provided low to moderate control in 3 experiments; ineffective in 1 experiment. In another experiment, all products were effective based on at least one assessment: Sporatec AG (1 qt/A) and Organocide (1 oz/gal) + NuCop HB (1 lb/A) were most effective; Actinovate (12 oz/A), Regalia SC (0.5%), Serenade MAX (3 lb/A), Sonata ASO (4 qt/A), Taegro (3.5 oz/100 gal), and Timorex Gold (0.75%) were also effective.

Gummy stem blight. Serenade (3 qt/A) + Biotune ineffective.

Phytophthora blight. Companion (3 qt/A) ineffective.

Powdery mildew. Almost all products tested have been effective, including sulfur (Microthiol Disperss (4 lb/A), copper, Actinovate (3-6 oz/A), Companion (32 fl oz), Eco E-Rase (0.5%), Kaligreen (4 lb/A), Milstop (2.5 lb/A), Organocide (2 oz/gal), Regalia (1%), Serenade MAX (2 lb), Sonata ASO (4 qt/A). Microthiol Disperss and Organocide were among the most effective.

Pepper

Bacterial spot. Actinovate ineffective. Serenade Max (1 lb/A) ineffective.

Potato

Scab, silver scurf, black scurf. Plant Shield provided inconsistent control when applied to cut seed day before planting or sprayed onto stems and then irrigated plus applied to foliage (4 treatments tested).

Tomato - field

Bacterial spot. Regalia SC (0.5 and 1%) as effective as a conventional fungicide program with Kocide 2000, Maneb, and Bravo. Actinovate ineffective. Serenade Max (1 lb/A) + Sonata (1 qt/A) + Biotune ineffective; disease pressure high in this study.

Bacterial canker. Serenade Max (1 lb/A) + Kocide 2000 + Biotune ineffective. Disease pressure high and limited control achieved with conventional treatment.

Powdery mildew. Almost all products tested have been effective: Actinovate (12 oz/A), Regalia, Companion (0.5 gal/A), Sporatec AG (2 pt/A), Organocide (2 oz/gal), and copper (Kocide 3000).

Septoria leaf spot. Actinovate (12 oz/A), Regalia (0.5%), Companion (0.5 gal/A), Sporatec AG (2 pt/A) when applied with Saf-T-Side (1.5%), Organocide (2 oz/gal), and copper (Kocide 3000).

Tomato – high tunnel and greenhouse

Botrytis gray mold and leaf mold. OxiDate effective and similar to Kocide 3000. It was applied every 7-10 day.

Botrytis gray mold. Serenade Max (2.5%) was effective; PlantShield HC was not.

Please Note: Before obtaining a product confirm state registration and organic approval with certifier. The specific directions on fungicide labels must be adhered to. Any reference to commercial products, trade or brand names, is for information only; no endorsement is intended.