Biopesticides for Vegetable Diseases: What are they and how well do they work?

NOFA NY
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<thead>
<tr>
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<td>Actinovate</td>
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<td>Botector</td>
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<td>M-Pede</td>
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<td>Cease</td>
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<td>Timorex Gold</td>
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<td><strong>Serenade</strong></td>
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<td>Mycostop</td>
<td>Serifel</td>
<td><strong>Neem Oil</strong></td>
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<td>Oso</td>
<td><strong>Sil-Matrix</strong></td>
<td>Zonix</td>
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<tr>
<td>Copper</td>
<td>Mineral oil (JMS Stylet Oil, Tritek)</td>
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<td>Sulfur</td>
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What you can expect today

- Understanding ‘bio-’ terms
- What biopesticides are available?
- Why use biopesticides?
- How do biopesticides work?
- Maximizing success with biopesticides
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What are *biopesticides*?

- **Insects** (and look-alikes)
- **Microbes** (bacteria, fungi, viruses)
- **Nematodes** (tiny worms)

**Control pests**

- Not regulated as pesticides

**Biopesticides** – regulated as pesticides...and also:
- Biofungicides
- Bioinsecticides
- Bioherbicides
- Plant extracts, pheromones & other naturally-occurring biochemicals
- Plant-incorporated protectants (in GMOs)
How are these terms related?

- Nematodes that eat insect pests
- Biocontrol
- Insects that eat insect pests
- Pests
- Controls
- Pesticide
- Includes
- Biopesticide
- Biostimulant
Biopesticide

Pesticide

Biocontrol

Biopesticide

May be:
1) Microbial
2) Biochemical
3) Plant-incorporated protectants

Biostimulant

Include:
- Microorganisms
- Plant, seaweed extract
- Organic substances
- Inorganic substances

These are just some of the possible connections!
Why terms matter

• Pesticides control pests
  – If growing commercially, must only use products* registered as pesticides to manage pests on produce that is sold

• Biostimulant ≠ biopesticide
  – Biostimulants are typically not registered as pesticides and may not be used to control pests

*Here, the term “products” is not meant to include beneficial insects and nematodes. These can be used for pest control, but are not regulated as pesticides.
The label is still the law!

**Personal Protective Equipment**
Applicators and other handlers must wear a long-sleeved shirt and long pants, socks, shoes, waterproof gloves, and protective eyewear, and use a **NIOSH-approved particulate respirator** with any N, R, or P filter with NIOSH approval number prefix TC-84A; or a NIOSH-approved powered air purifying respirator with an HE filter with NIOSH approval number prefix TC-21C. (Repeated exposure to high concentrations of microbial proteins can cause allergic sensitization.)

**ENVIRONMENTAL HAZARDS**
This product is **toxic to aquatic invertebrates**. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.

This product is toxic to certain nontarget terrestrial arthropods. Minimize spray drift away from target area to reduce effects to nontarget insects.

For terrestrial uses: Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate.
One more thing...

- Minimum risk pesticides
  - Defined by EPA
  - Also sometimes referred to as 25(b) products
  - Still pesticides
  - Won’t have pesticide labels in NYSPAD

More info available at:
nyispm.cornell.edu/environment/active-ingredients-eligible-minimum-risk-pesticide-use/
Exemption statement on label

Greenspire Global, Inc. represents that this product is a minimum risk pest control and qualifies for exemption from EPA registration under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

PROMAX

This product has not been registered by the U.S. Environmental Protection Agency. Bio Huma Netics®, Inc. represents that this product is NOP compliant and qualifies for exemption from registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
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Biopesticides - Microbial
(active ingredient is microbe)

Cease. 1.34% *Bacillus subtilis* QST 713 strain. Greenhouse use.
Serenade ASO. 1.34% *Bacillus subtilis* strain QST 713.
Companion. 0.03% *Bacillus subtilis* strain GB03.
Double Nickel 55 LC +WDG. *Bacillus amyloliquefaciens* strain D747.
Serifel. 9.9% *Bacillus amyloliquefaciens* strain MBI 600.
Stargus. 96.4% *Bacillus amyloliquefaciens* strain F727.
Taegro 2. 13% *Bacillus subtilis* var. *amyloliquefaciens* strain FZB24.
Sonata. 1.38% *Bacillus pumilus* strain QST 2808.
LifeGard WG. 40% *Bacillus mycoides* isolate J. Biological Plant Activator.

Foliage       Soil       Both

List at blogs.cornell.edu/livegpath/organic/organic-management-of-vegetable-diseases/
Biopesticides – Microbial

**Contans WG.** 5.3% Coniothyrium minitans strain CON/M/91-08.

**Majestene.** 94.5% heat-killed *Burkholderia* spp. strain A396 cells and spent fermentation media.

**MeloCon WG.** 6% Paecilomyces lilacinus strain PL251.

**Actinovate AG.** 0.0371% *Streptomyces lydicus* strain WYEC 108.

**Mycostop.** 30% *Streptomyces griseoviridis* strain K61.

**Bio-Tam.** 2% *Trichoderma asperellum* strain ICC 012 and 2% *Trichoderma gamsii* strain ICC 080.

**RootShield.** 1.15% *Trichoderma harzianum* Rifai strain KRL-AG2.

**RootShield Plus.** 1.15% *Trichoderma harzianum* Rifai strain T-22 and 0.61% *Trichoderma virens* strain G-41.

**Prestop.** 32% *Gliocladium catenulatum* strain J1446.

**SoilGard 12G.** 12% *Gliocladium virens* strain GL-21.
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Biopesticides – Microbial

Contans WG. 5.3% Coniothyrium minitans strain CON/M/91-08.
Majestene. 94.5% heated to 80°C for 396 cells and spent fermentation cells.
MeloCon WG. 6% Paecilomyces lilacinus strain PL251.
Actinovate AG. 0.0371% Streptomyces lydicus strain WYEC 108.
Mycostop. 30% Streptomyces griseoviridis strain K61.
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Microbial Biopesticides

**Majestene.** *Burkholderia* spp. strain A396
Heat-killed bacterial organism + spent fermentation media that controls nematodes by contact and ingestion modes of action

**MeloCon.** *Paecilomyces lilacinus* strain PL251
Living soil fungus that attacks (parasitizes) many species of plant parasitic nematodes
Biopesticides – Biochemical

(naturally occurring substances)

**BacStop.** 2% thyme, 2% clove & clove oil, 1.5% cinnamon, 1% peppermint & peppermint oil, and 1% garlic oil.

**Mildew Cure** (formerly GC-3 Organic fungicide). 30% cottonseed oil, 30% corn oil, 23% garlic extract.

**Organocide.** 5% sesame oil. (no ag label)

**Promax.** 3.5% thyme oil.

**Sporatec AG.** 18% rosemary oil, 10% clove oil, and 10% thyme oil.

**Thyme Guard.** 23% thyme oil extract.

**Timorex Gold.** 23.8% tea tree oil.

**Trilogy.** 70% extract of neem oil.

*Most of these are exempt from EPA registration.*
**Biopesticides – Biochemical**

**Regalia.** 5% Extract of *Reynoutria sachalinensis*.

**Kaligreen, MilStop. EcoMate Armicarb O.**  
82 - 85% Potassium bicarbonate.

**M-Pede.** 49% Potassium salts of fatty acids.

**Oso.** 5% Polyoxin D zinc salt.

**Sil-MATRIX.** 29% Potassium silicate.

**OxiDate 2, Zerotol.** 27% hydrogen dioxide.

**TerraClean 5.** 27% hydrogen dioxide + 5% peroxycetic acid.

**KeyPlex 350 OR.** defensive proteins (alpha-keto acids) and secondary and micronutrients.

**SafeStrike.** Blend of natural oils, surfactants, vitamins, minerals, enzymes, antioxidants, and plant hormones.

**Zonix biofungicide.** 8.5% Rhamnolipid biosurfactant.
Biopesticides NOT Acceptable for Organic Production
(synthetic substances)

Oso. 5% Polyoxin D-zinc salt.

Actigard. Plant activator.

Phosphorous acid fungicides.

- Fosphite. Mono-and di-potassium salts of phosphorous acid.
- Fungi-Phite. Mono-and di-potassium salts of phosphorous acid.
- Rampart. Mono-and di-potassium salts of phosphorous acid.
- pHorsepHite. Mono potassium phosphate and mono potassium phosphite.
- ProPhyt. Potassium phosphite.
- Phostrol. Mono-and dibasic sodium, potassium, and ammonium phosphites.
Other Organic Fungicides

Copper. Several products including
  Previsto. 5% copper hydroxide.

Sulfur. Several products including
  Microthiol Disperss. 80% sulfur.

JMS Stylet-Oil. 97.1% paraffinic (mineral) oil.

Tritek (Saf-T-Side). 80% petroleum oil.

SuffOil-X. 80% mineral oil.
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Why use biopesticides?
Why use biopesticides?

• Disease cannot be effectively managed with cultural practices alone.

• Efficacy

• Give you more tools for pest management

• Alternative to copper; reasons sought:
  - Degradable; cannot persist in environment; environmentally responsible
  - Short REI/PHI
  - Worker safety
  - Crop pesticide residues
AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for protection of agricultural workers on farms, forests, nurseries and greenhouses and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours without required PPE.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is:
- Coveralls
- Chemical-resistant gloves made of any waterproof material
- Shoes plus socks
- Protective eyewear

Exceptions: Nordox (12 hr), Cueva (4 hr)
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How biopesticides control plant diseases

1. Eat pathogens
2. Poison pathogens
3. Exclude pathogens
4. Induce resistance to pathogens
5. Promote growth/stress tolerance
Biopesticide modes of action

• **Eat**
  - consume/parasitize the pathogen

• Example:
  – Contans (*Paraconiothyrium minitans* strain CON/M/91-08)
  – MeloCon (*Paecilomyces lilacinus* strain PL251)
  – Etc.
Biopesticide modes of action

• **Poison**
  - produce/contain a compound that harms the pathogen

• Examples:
  – Actinovate (*Streptomyces lydicus* WYEC 108)
  – Milstop (potassium bicarbonate)
  – Timorex Gold (tea tree oil)
  – Etc.
Biopesticide modes of action

- **Exclude pathogens**
  - growing on the plant, leaving no room (or nutrients) for the pathogen

- Examples:
  - Actinovate (*Streptomyces lydicus* WYEC 108)
  - Double Nickel (*Bacillus amyloliquefaciens* strain D747)
  - Serifel (*Bacillus amyloliquefaciens* strain MBI 600)
  - Etc.
Biopesticide modes of action

- **Induce resistance**
  - “turn on” plants’ natural defenses so they’re ready for attack

- **Examples:**
  - LifeGard (*Bacillus mycoides* isolate J)
  - Regalia (giant knotweed extract)
  - Taegro 2 (*Bacillus subtilis* var. *amyloliquefaciens* FZB24)
  - Etc.
Biopesticide modes of action

• **Promote growth/stress tolerance**
  - healthier plants are more resilient to disease (and other stresses)

• Examples:
  – RootShield (*Trichoderma harzianum*)
  – Serenade (*Bacillus subtilis* QST 713)
  – Sil-Matrix (potassium silicate)
  – Etc.
How biostimulants work:

- Improve soil quality
  - Water holding
  - Aeration
  - Structure
  - Promote healthy soil microbe populations
- Improve plant access to nutrients
- Stimulate plant defenses/stress tolerance
- Improve root growth
- Improve product quality (e.g., fruit quality)

Must not be used to control pests!
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Organic Management of Vegetable Diseases

Know what diseases occur in New York

- Photo gallery: Vegetable diseases observed on Long Island
- Organic Production Guides for Vegetables
- Commercial Vegetable Management Guidelines for NY – covers diseases and insect pests occurring in N.Y.

Contact:
Margaret McGrath
Associate Professor
Long Island Horticultural Research & Extension Center
Riverhead, NY 11901-1098
(631) 727-3595
Email: mtm3@cornell.edu

Need help ...
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Obtain accurate diagnosis.

Plant Disease Diagnostic Laboratories:

- Long Island
- Upstate NY
- Other States

Resources on management prepared by Meg McGrath:

General:

- Biology basics: plant diseases and management
- General management guidelines
- Overview of guidelines for common diseases

Specific Management Practices and Tools:

- Resistant varieties
- Hot-water treatment for seed-borne pathogens
- Biopesticides: General information | Presentation at BiocontrolsEast in 2018
  Products for: cucurbits | tomatoes | leafy vegetables
- Copper fungicides
- Efficacy results from University evaluations of organic products

Specific Diseases:

- Downy mildew diseases: article, presentation
- Basil downy mildew
- Late blight in tomato and potato – See also Late blight on tomato photo gallery/information page.
- Phytophthora Blight: Biopesticides

Other resources on management

- Organic Production Guides for Vegetables
- Resource Guide for Organic Insect and Disease Management
- Video: Identifying and Scouting for Late Blight on Organic Farms
- Searchable database of downloadable organic and conventional pesticides registered in New York (except products exempt from registration)
- Searchable database with federal labels for most organic and conventional fungicides
- Lists of products approved for use in organic production by OMRI
  The OMRI Products List booklet can be downloaded at this webpage. To search for specific products in the on-line database, click on ‘Search’ in the bottom left section of the webpage.
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Sources of Efficacy Data

Other growers

Manufacturer

Researchers:

Plant Disease Management Reports
IR-4 Biopesticide Program
eOrganic Web Site
Resource Guide for Organic Disease and Insect Management
A merger of the APS online publications
F&N Tests and B&C Tests

2017 Volume
Plant Disease Management Reports, Volume 11

2016 Volume
Plant Disease Management Reports, Volume 10

2015 Volume
Plant Disease Management Reports, Volume 9

2014 Volume
Plant Disease Management Reports, Volume 8

2013 Volume
Product Evaluations

Plant Disease Management Reports, Volume 1

2006 Volumes
- F&N Tests, Volume 61
- B&C Tests, Volume 21

2005 Volumes
- F&N Tests, Volume 60
- B&C Tests, Volume 20

2004 Volumes
- F&N Tests, Volume 59
- B&C Tests, Volume 19

2003 Volumes
- F&N Tests, Volume 58
- B&C Tests, Volume 18

2002 Volumes
- F&N Tests, Volume 57
- B&C Tests, Volume 17

2001 Volumes
- F&N Tests, Volume 56
- B&C Tests, Volume 16

2000 Volumes
- F&N Tests, Volume 55

Plant Disease Management Reports

2017 Volume
- F&N Tests, Volume 61

2016 Volume
- F&N Tests, Volume 60

2015 Volume
- F&N Tests, Volume 59

2014 Volume
- F&N Tests, Volume 58

2013 Volume
- F&N Tests, Volume 57

PDMR Volume 11 - Evaluation of SAR compounds alone and in combination with a protectant for control of lettuce downy mildew.

PDMR Volume 6 - Evaluation of fungicides and bactericides for the control of foliar and fruit diseases of processing tomatoes, 2011.

PDMR Volume 6 - Evaluation of products for the control of gray mold in greenhouse tomatoes, 2011.
Evaluation of fungicides and bactericides for the control of foliar and fruit diseases of processing tomatoes, 2011.

First Author: Sally Miller, OARDC/OSU

Additional Authors: J.R. Mera

Section: Citrus, Tropical, Vegetable, and Misc. Crops

Keyword(s): Evaluation of fungicides and bactericides for the control of foliar and fruit diseases of processing tomatoes;

Geographical location: Ohio; United States

Products Tested: MBI-10605A; Regalia Max; MBI10620B; Kocide 3000; Manzate Pro-Stick; K-Phite; Manzate

Active chemical(s): Experimental Product; Reynoutria sachalinensis extract; Experimental Product; Copper hydroxide; Mancozeb; Monopotassium phosphite and dipotassium phosphite.; Manganese, Zinc, Ethylene bisdithiocarbamate
**Efficacy Data - What to look for**

Laboratory or field study
Replicated experiment or observational
Inoculated or natural infection
Disease pressure; spreader row
Preventive or after symptoms seen
Comparisons meaningful
Conventional standard
Mean comparison letters
## Example Efficacy Experiment 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>88 a</td>
</tr>
<tr>
<td>Bio A + Other B alt Other C</td>
<td>65 a</td>
</tr>
</tbody>
</table>

Bio = biopesticide  
Other = other organic or conventional fungicide

a) Does Bio A + Other B alt Other C control disease? Why?  
b) What can you conclude about efficacy of Bio A alone?
### Example Efficacy Experiment 2

<table>
<thead>
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</tr>
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<tbody>
<tr>
<td>1-Non-treated control</td>
<td>88 a</td>
</tr>
<tr>
<td>2-Bio A + Other B alt Other C</td>
<td>25 c</td>
</tr>
<tr>
<td>3-Other D + Other B alt Other C</td>
<td>35 c</td>
</tr>
<tr>
<td>4-Bio A</td>
<td>72 a</td>
</tr>
<tr>
<td>5-Other B alt Other C</td>
<td>55 b</td>
</tr>
</tbody>
</table>

**a) Which treatment should you use for comparison to know if Bio A improves disease control when used with other organic fungicides? Why?**

**b) Does Bio A improve control? Why?**

**c) Would you recommend Bio A to a friend? How and why?**
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- Resistant varieties
- Hot-water treatment for seed-borne pathogens
- Biopesticides: General information | Presentation at BiocontrolsEast in 2018
  Products for: cucurbits | tomatoes | leafy vegetables
- Copper fungicides
- Efficacy results from University evaluations of organic products

Specific Diseases:

- Downy mildew diseases: article, presentation
- Basil downy mildew
- Late blight in tomato and potato – See also Late blight on tomato photo gallery/information page.
- Phytophthora Blight: Biopesticides

Other resources on management

- Organic Production Guides for Vegetables
- Resource Guide for Organic Insect and Disease Management
- Video: Identifying and Scouting for Late Blight on Organic Farms
- Searchable database of downloadable organic and conventional pesticides registered in New York (except products exempt from registration)
- Searchable database with federal labels for most organic and conventional fungicides
- Lists of products approved for use in organic production by OMRI
  The OMRI Products List booklet can be downloaded at this webpage. To search for specific products in the on-line database, click on ‘Search’ in the bottom left section of the webpage.
## Organic Management of Vegetable Diseases

Know what diseases occur in New York

- Photo gallery: Vegetable diseases observed on Long Island

### Biopesticides: General information | Presentation at BiocontrolsEast in 2018

- **Products for:** cucurbits | tomatoes | leafy vegetables

### Copper fungicides

### Efficacy results from University evaluations of organic products

- Upstate NY
- Other States

### Resources on management prepared by Meg McGrath:

#### General:

- Biology basics: plant diseases and management
- General management guidelines
- Overview of guidelines for common diseases

#### Specific Diseases:

- Downy mildew diseases: article, presentation
- [Basil downy mildew](#)
- Late blight in tomato and potato – See also Late blight on tomato photo gallery/information page.
- Phytophthora Blight: Biopesticides

### Other resources on management

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Efficacy of Organic Fungicides for Vegetable Diseases

Fungicides listed by crop grouping and disease, then by product. Effective products in bold. Almost all results are from Plant Disease Management Reports (PDMR), some one of its precursors, Fungicide & Nematicide Tests. References to studies include state and year of study. Reports almost always published following year. All field studies with weekly spray schedule except where noted.

CTE = Conventional treatment effective.

HERBS - Basil

Downy mildew

2 GH exps. Actinovate (12 oz/A) effective in both. Regalia SC (1% v/v), Companion (32 fl oz/A), and Sonata (4 pt/A) effective in one. Serenade (3 lb/A) ineffective. Prophet (4 pt/A) was much more effective. Prophet (2 pt/A) + Quadris (9 fl oz/A) was excellent. 3 experimentalts also examined. FL, 2010, PDMR 6:V059.

Actinovate 12 oz/A + Induce moderately effective (FL, 2007, PDMR 2:V068). *

Actinovate 10 oz/A + ThermX70 slightly effective at 1 of 2 sites. Preventive schedule. (CT, 2011, PDMR 6:V073). *

Actinovate 10 oz/A + ThermX70 ineffective, 2 sites. Preventive schedule. Also ineffective applied in alternation with OxiDate (CT, 2012, PDMR 7:V045). *


* In CT trials, symptoms were confirmed during third week of treatments in 2011, second in 2012. Mean ratings for basil receiving best treatment (MilStop) were 1.6 and 2.0 versus 2.4 for non-treated basil at both sites. The rating scale used was based on percent leaf area with sporulation: 1 = <10%, 2 = 10-50%, and 3 = >50%.

* In IL trial, all organic treatments tested were ineffective; conventional treatments were all very effective (9 provided complete control).

* In FL trial in 2007 some conventional treatments provided effective control.

* In FL trial in 2016 treatments were applied to susceptible (Large Leaf) and resistant (Eleanora) varieties. Treatments were applied twice weekly starting at 1-2 true-leaf stage. Disease pressure was extreme from the start.
Spinach  Downy mildew

Actinovate  AG 12 oz/A effective, Taegro better, see that entry for more information. Actinovate + Taegro same as Actinovate alone (CA, 2015, PDMR 10:V016).

Oxidate 2.5% v/v effective applied with surfactant (Aquasil), as effective as Cueva; not considered commercially acceptable. (CA, 2016, PDMR 11:V017)

Oxidate 1 gal/A ineffective applied weekly starting when incidence was <1%. CTE (OK, 2007, PDMR 2:VO56).

Procidic 12 and 15 fl oz/A limited efficacy applied at emergence and 9 and 16 days later. CTE. (AZ, 2016, PDMR 11:V002).

Taegro 5.2 oz/A effective, better than other organic trts, but none “reduced downy mildew to an acceptable level for fresh market standards”; disease pressure relatively high. (CA, 2015, PDMR 10:V016).

Timorex Gold 27.4 fl oz/A limited efficacy perhaps because not truly preventive; symptoms seen 2 days after first of 2 applications. CTE. (AZ, 2016, PDMR 11:V002).

Cueva 2% effective, Taegro better, see that entry for more information. Cueva applied with Actinovate or Taegro slightly but not signif better than Cueva alone (CA, 2015, PDMR 10:V016).
Cucurbit Powdery Mildew – Organic Fungicides

Active ingredient:
Microbial
Natural substance
Not biopesticide

BacStop
EF400
Kalogreen
M-Pede
Mildew Cure
MilStop
Organocide
OxiDate
Procidic
Regalia
Sporatec
Sil-Matrix
Timorex Gold
Trilogy

copper
sulfur
mineral oil
Cucurbit Downy Mildew – Organic Fungicides

Active ingredient: Microbial Natural substance Not biopesticide

copper

Actinovate
Double Nickel
LifeGard
Serenade
Sonata

BacStop
EF400
MilStop
Organocide
OxiDate
Regalia
Sporatec
Timorex Gold
Trilogy
Zonix
Cucurbit Powdery Mildew – Organic Fungicides

Actinovate
Companion
Double Nickel
LifeGard
Serenade
Sonata
Taegro 2

BacStop
EF400
Kaligreen
M-Pede
Mildew Cure
MilStop
Organocide
OxiDate
Procidic
Regalia
Sil-Matrix
Sporatec
Timorex Gold
Trilogy

copper
sulfur - best
mineral oil

No data found
Always Effective
Usually Effective
Less Effective
Ineffective
Cucurbit Downy Mildew – Organic Fungicides

- Actinovate
- Companion *
- Double Nickel
- LifeGard
- Serenade
- Sonata
- Taegro *

**No data found**
- Always Effective
- Usually Effective
- Less Effective
- Ineffective

**copper**

* Not labeled for downy mildew

- BacStop
- EF400
- MilStop
- Organocide
- OxiDate
- Regalia
- Sil-Matrix *
- Sporatec
- Timorex Gold
- Trilogy
- Neem oil
- Zonix
Biopesticides - Maximizing Success

Plant diseases can be difficult to manage, especially when conditions are favorable.

Obtain information on past performance.

Most effective for powdery mildews.

Biopesticides do not have curative activity.

Best to use **preventive spray program** especially with products that induce resistance (LifeGard, Regalia).

Maximize coverage on leaf underside.

Most have contact activity.

Use **short spray interval**.

Note expiration date + best storage conditions.

Integrated program often better. Other biopesticides, other organic fungicides, + cultural practices.
Check Compatibility!

Additional sources for compatibility information on your handout from:
- BASF
- Biobest
- Koppert

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**BotaniGard®**

**Tank Mix Compatibility**

<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Active Ingredient</th>
<th>Maximum Tested Rate</th>
<th>Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actinovate SP®</td>
<td><em>Streptomyces lydicus</em> WYEC 108</td>
<td>24 oz/100 gal</td>
<td>Yes</td>
</tr>
<tr>
<td>Acrobat®</td>
<td>Dimethomorph</td>
<td>20 oz/100 gal</td>
<td>Yes</td>
</tr>
<tr>
<td>Alieete WDG®</td>
<td>Fosetyl-Al</td>
<td>5 lb/100 gal</td>
<td>Yes</td>
</tr>
<tr>
<td>Alude®</td>
<td>Mono- and di-potassium salts of phosphorous acid</td>
<td>12.75 oz/100 gal</td>
<td>4 Days B/A²</td>
</tr>
</tbody>
</table>

Storage matters

PESTICIDE STORAGE
Store in its original container below 73 °F (23 °C) in a dry, locked place, out of the reach of children and out of direct sunlight. Do not use or store near heat or open flame. Use product within one year and by the expiry date noted on the label.

Note: contains live spores that may be harmed by storage at high temperatures or held as a water suspension for more than 24 hours. See storage and disposal section for more information.

STORAGE
To maintain shelf life, store in a refrigerator or in a cool, dry area. Keep container tightly closed when not in use. Avoid prolonged exposure to direct sunlight or temperatures exceeding 85°F.

Some shelf life info from UConn: http://ipm.uconn.edu/documents/view.php?id=1106
Questions?

...and watch out for Spotted lanternfly!

Report to:
• spottedlanternfly@dec.ny.gov
• iMapInvasives

Learn more at:
https://nysipm.cornell.edu/environment/invasive-species-exotic-pests/spotted-lanternfly/
The following were distributed as handouts:
How are these terms related?

- Nematodes that eat insect pests
- Insects that eat insect pests
- Pesticide
- Biocontrol
- Pests
- Biostimulant
- Biopesticide

Relations:
- Pesticide includes Biopesticide
- Pests controls Nematodes that eat insect pests
- Pests includes Biocontrol
• **Biocontrol**: using beneficial organisms to reduce populations of pest organisms

• **Pesticide**: “substance or mixture of substances used to kill pests or prevent or reduce damage from pests”  (Cornell Pesticide Management Education Program)

• **Biostimulant**: “a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality ”  (Agriculture Improvement Act of 2018, aka 2018 Farm Bill)

• **Biopesticide**: “certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals”  (EPA)
  – **Microbial** – active ingredient is microorganism (fungi, bacteria, viruses, protozoa); living organism, or organism byproduct
  – **Biochemical** – substances that occur in nature and control pests; include plant extracts & chemicals
  – **Plant-incorporated protectants** – genes and proteins produced in genetically engineered plants

• **Biofungicide**: a biopesticide that controls fungal (or water mold) diseases

(I would print this on the back of slide 4 to help audience with activity)
Question 1. At the right are some results from a hypothetical trial testing the efficacy of a spray program to control disease.

a) Can you conclude from these results that when the biopesticide ‘Bio A’ is applied with organic fungicide ‘Other B’, and this mixture is rotated with the organic fungicide ‘Other C’, this treatment effectively controls the disease? Why or why not?

b) Can you conclude anything about the efficacy of the biopesticide Bio A, when used alone?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-treated control</td>
<td>88 a</td>
</tr>
<tr>
<td>Bio A + Other B alt Other C</td>
<td>65 a</td>
</tr>
<tr>
<td>Bio = biopesticide</td>
<td></td>
</tr>
<tr>
<td>Other = other organic fungicide</td>
<td></td>
</tr>
</tbody>
</table>

Question 2. At the right are results from another trial testing different products for disease control. As above, Bio A is biopesticide, and Other B-D are other organic fungicides.

a) If you want to know whether Bio A improves disease control when used with other organic fungicides, which treatment(s) should you compare it to? Why?

b) Does Bio A improve disease control compared to using only organic fungicides Other B and Other C? Why or why not?

c) Based on these results, would you recommend to a friend that he or she use the biopesticide Bio A? If so, how? If not, why?

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Non-treated control</td>
<td>88 a</td>
</tr>
<tr>
<td>2 - Bio A + Other B alt Other C</td>
<td>25 c</td>
</tr>
<tr>
<td>3 - Other D + Other B alt Other C</td>
<td>35 c</td>
</tr>
<tr>
<td>4 - Bio A</td>
<td>72 a</td>
</tr>
<tr>
<td>5 - Other B alt Other C</td>
<td>55 b</td>
</tr>
</tbody>
</table>
Useful websites about biopesticides

Compatibility resources for biocontrols

- Koppert provides a database where you can search for compatibility information for their products: [www.koppert.com/side-effects/](http://www.koppert.com/side-effects/)
- Biobest provides pesticide compatibility information for insect, mite and nematode biocontrol organisms (not disease biocontrol) - [www.biobestgroup.com/en/side-effect-manual](http://www.biobestgroup.com/en/side-effect-manual). If you are releasing or conserving biological control insects or mites, check that the biopesticide you are planning to use is compatible with them.

Efficacy of biological products

- Meg McGrath (Plant Pathology & Plant Microbe Biology, School of Integrative Plant Science, Cornell University) has summarized efficacy of biopesticides and organic products on vegetable and herb crops: [http://blogs.cornell.edu/livegpath/organic/organic-management-of-vegetable-diseases/](http://blogs.cornell.edu/livegpath/organic/organic-management-of-vegetable-diseases/). Also at this site she has a general list of biopesticides registered in NY plus lists for select crops and the labeled diseases.
- Resources from the New York State Integrated Pest Management Program on organic pest management, including efficacy data of some biocontrols and other useful information: [nysipm.cornell.edu/environment/organic-ipm](http://nysipm.cornell.edu/environment/organic-ipm)
- The NYS IPM program (and collaborators) summarized what is known about minimum risk pesticides (a.k.a. 25(b) products), including how they work, their risks, and their efficacy. [nysipm.cornell.edu/environment/active-ingredients-eligible-minimum-risk-pesticide-use/](http://nysipm.cornell.edu/environment/active-ingredients-eligible-minimum-risk-pesticide-use/)
- Amara Dunn (New York State Integrated Pest Management Program) summarized efficacy data for biopesticides on greenhouse, nursery, and ornamental crops. A few other products are included (e.g., some that are exempt from EPA registration). This is not an exhaustive summary of all university-based trials, and new information may be added over time. It is formatted as a spreadsheet so that you can sort the information by product, active ingredient, disease, etc. [nysipm.cornell.edu/environment/biocontrol/biocontrol-resources](http://nysipm.cornell.edu/environment/biocontrol/biocontrol-resources) (under “Related Links” on right of page)

Explanation of terms: biocontrol, biopesticide, biostimulant