The Intersection of Biocontrol and Organics

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Terminology

Biocontrol
Biologicals
Biofungicides (biopesticides)
**Terminology**

Biocontrol = biological control

“method of controlling pests (insects, mites, weeds, plant diseases, etc.) using other organisms.”
Terminology

Biocontrol
Biologicals
Biofungicides (biopesticides)
Biostimulants
Terminology

Biostimulants

First US definition is in draft Farm Bill: “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 and yield.”
USA Pesticide Registration

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

Federal statute that governs the registration, distribution, sale, and use of pesticides in the United States.

Before a pesticide may be sold or distributed in the USA, it must be registered (licensed) with the EPA. Focus of decision: product “will not generally cause unreasonable adverse effects on the environment.”

Some pesticide ingredients are exempt under Minimum Risk Exemption regulations.
Biopesticides

As defined by US EPA (1994):
Pesticides derived from natural materials.

3 Major classes:
- Microbial pesticides
- Biochemical pesticides (naturally occurring substances).
- Plant Incorporated Protectants (GMO)

Most suitable for organic production.
Most have contact activity. Some also induce SAR (systemic acquired resistance).
Microbial Biopesticides
Mode of Action

- Parasitism (Antagonism)
- Competition (Antagonism)
- Toxic metabolites (Antagonism)
- Induced resistance in plant
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.

<table>
<thead>
<tr>
<th>Foliage</th>
<th>Soil</th>
<th>Both</th>
</tr>
</thead>
</table>

Microbial Biopesticides

Similar organisms (*Bacillus*) / different approaches:

- Organism + Compounds produced during fermentation. Lipopeptides damage pathogen cell membranes. Others affect pathogen or induce plant resistance.
- Pure organism (ex. Serifel).
  - *Bacillus* endospore - durable
- Organism does not affect pathogen directly; triggers plant’s natural immune response to pathogens (ex. LifeGard).
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 lydicas* 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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White Mold

- WHITE MOLD

Nematodes

- NEMATODES

Root Rot

- ROOT ROTS
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
What is Contans® WG?

- Attacks and destroys sclerotia in the soil
- Breaks the cycle of white mold
- Reduces sclerotia in the soil by as much as 80-85% each year it is used
- Soil-applied: pre-plant, at planting, after cultivation, or post-harvest

*Source: A.v. Tiedemann, K. Hedke & R. Mogling Dept. of Phytomedicine, Faculty of Agriculture, University of Rostock, Germany*

*C. minitans* forming pycnidia (red arrows) and propagating on a sclerotium
White Mold

sclerotia
Tomato
White Mold

sclerotia
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.

Sil-MATRIX. 29% Potassium silicate.

OxiDate, Zerotol. 27% hydrogen dioxide.

TerraClean 5. 27% hydrogen dioxide + 5% peroxyacetic 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.

  K-Phite. Mono- and di-potassium salts of phosphorous acid.
  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.
Determining Product Organic Acceptability

National Organic Program (NOP) Certifiers

Organizations conducting product review

OMRI (Organic Material Review Institute)
The National Organic Program (NOP) is a regulatory program housed within the USDA Agricultural Marketing Service. We are responsible for developing national standards for organically-produced agricultural products. These standards assure consumers that products with the USDA organic seal meet consistent, uniform standards. Our regulations do not address food safety or nutrition.

Key Activities

- Maintain the list of certified organic operations and help new farmers and business learn how to get certified
- Develop regulations and guidance on organic standards
- Manage the National List of Allowed and Prohibited Substances

NOP manages list of allowed and prohibited substances.
Determining Product Organic Acceptability

National Organic Program (NOP)

Certifiers

Organizations conducting product review

OMRI (Organic Material Review Institute)
About OMRI Listed Products

The OMRI Listed® Seal assures the suitability of a product for certified organic production, handling, and processing under the following conditions:

- For certified organic farmers, the product must be included in the operator's approved organic system (farm) plan.
- Product use must be in accordance with any restrictions described in the *OMRI Products List* under the product's category.

Also, OMRI recommends that users of OMRI Listed® products follow these suggestions:
Download the OMRI Products List

The OMRI Products List® is the most complete directory of products for organic production or processing under the U.S. National Organic Program standards, and includes over 3,500 "OMRI Listed®" products.

- About the OMRI Products List
- Search the OMRI Products List
- Purchase a paper copy of the current OMRI Products List
- Download the OMRI Canada Products List® for production under the Canadian Organic Standards

The OMRI Products List was updated 09/02/2015.

- Complete OMRI Products List - Sorted by Company
  - complete_company.pdf
- Recently OMRI Listed® Products in the last Three Months
  - brand_new.pdf

Crop Products

- Sorted by Category
  - crops_category.pdf
- Sorted by Product Name
  - crops_alpha.pdf
- Supplier Contact Information
  - crops_contact.pdf

Livestock Products
Download the OMRI Products List

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- **About** the OMRI Products List
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Livestock Products
Where to Find Product Labels

http://www.cdms.net/Label-Database

<table>
<thead>
<tr>
<th>Product List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regalia®</td>
</tr>
<tr>
<td>Marrone Bio Innovations</td>
</tr>
<tr>
<td>84059-3</td>
</tr>
<tr>
<td>Regalia® Rx Biofungicide</td>
</tr>
<tr>
<td>Marrone Bio Innovations</td>
</tr>
<tr>
<td>84059-3</td>
</tr>
</tbody>
</table>
Why Use Biopesticides?

Efficacy
Other disease management strategies are unavailable or ineffective
To prevent/manage pesticide resistance
To protect beneficial organisms (e.g., pollinators or natural enemies of pests)
Short REI and PHI
Safer for workers
Reduce conventional chemical pesticide residues on crop
Consumer demands
Environmental responsibility
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
Product Evaluations

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

Document Title
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
News Articles/Disease Alerts

All Vegetables (also see specific vegetables plus herbs below)

All Vegetables - Diseases affecting multiple crops

New Virus of Concern for Several Crops: See It?? Report It!! (2016)

All Vegetables - Insects

- Key Features of the Adult Brown Marmorated Stink Bug by Peter Jentsch (July 2011)

All Vegetables - Organic Disease Management

- Efficacy results from University evaluations of organic products
- Organic Disease Management (LIHREC website)

http://vegetablemdonline.ppath.cornell.edu/NewsArticles/NewsList.htm
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:
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(631) 727-3595
Email: mtm3@cornell.edu

Need help ...
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.

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. Products for: cucurbits | tomatoes | leafy vegetables
- Copper fungicides
- Efficacy results from University evaluations of organic products

Specific Diseases:

- Basil downy mildew
- Late blight in tomato and potato – See also Late blight on tomato photo gallery/information page.

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

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 qt/A) **effective** in one. **Serenade** (3 lb/A) ineffective. Prohyt (4 pt/A) was much more effective. Prohyt (2 pt/A) + Quadris (9 fl oz/A) was excellent. 3 experimental 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). *


**Companion** 1 gal/A ineffective. Preventive. Conventional fungicides also ineffective. (NY, 2010, PDMR 5:V098, MTM).

* 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, 2015, PDMR 11:VO02).

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:VO02).

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).
### Spinach Downy Mildew

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>Affected leaves %</th>
<th>Control %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Procidic 15 fl oz</td>
<td>55</td>
<td>20</td>
</tr>
<tr>
<td>Procidic 20 fl oz</td>
<td>54</td>
<td>22</td>
</tr>
<tr>
<td>Timorex Gold 27.4 fl oz</td>
<td>52</td>
<td>25</td>
</tr>
<tr>
<td>Conventional fungicide</td>
<td>12</td>
<td>82</td>
</tr>
<tr>
<td>(Actigard 0.75 oz)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cucurbit Powdery Mildew – Organic Fungicides

Actinovate
Companion
Double Nickel
LifeGard
Serenade
Serifel
Sonata

Active ingredient:
Microbial
Natural substance
Not biopesticide

copper
sulfur
mineral oil

BacStop
EF400
Kaligreen
M-Pede
Mildew Cure
MilStop
Organocide
OxiDate
Procidic
Regalia
Sil-Matrix
Sporatec
Timorex Gold
Trilogy
Cucurbit Powdery Mildew – Organic Fungicides

Always Effective
- Copper
- Sulfur - best
- Mineral oil

Usually Effective
- LifeGard
- Serenade
- Sonata

Less Effective
- Double Nickel
- Actinovate
- Companion
- Taegro *

Ineffective
- No data found
- MilStop
- Organocide
- OxiDate
- Procidic
- Regalia
- Sil-Matrix
- Sporatec
- Timorex Gold
- Trilogy

* Not labeled for powdery mildew
Contans Efficacy for White Mold

Effective applied before field planting in 5 of 6 studies (*Sclerotinia sclerotiorum*).

Effective applied before field planting in 1 of 3 studies (*Sclerotinia minor*).
Contans Efficacy for White Mold

Effective applied before field planting in 5 of 6 studies (*Sclerotinia sclerotiorum*).

Effective applied before field planting in 1 of 3 studies (*Sclerotinia minor*).

Ineffective tested in high tunnel. Too hot?
Grower success with tomato white mold.
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
Organic Pesticide Use

Before organic farmers can use approved pesticides, they must develop a pest and disease management plan describing how they will first prevent and manage pests without the use of National List inputs.
## Example Efficacy Experiment

<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
## Example Efficacy Experiment

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<td>Bio A + Other B alt Other C</td>
<td>25</td>
</tr>
<tr>
<td>Other D + Other B alt Other C</td>
<td>35</td>
</tr>
<tr>
<td>Bio A</td>
<td>72</td>
</tr>
<tr>
<td>Other B alt Other C</td>
<td>55</td>
</tr>
</tbody>
</table>
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 inducing resistance (LifeGard, Regalia, etc.).
Maximize coverage on leaf underside.
Most have contact activity.
Use short spray interval.
Use adjuvant and check water pH if mfg recommends.
Note expiration date + best storage conditions.
Integrated program often better. Other biopesticides, other organic fungicides, + cultural practices.
Intro Headline

Subsequent Text Here

• Bulleted Text Here
• Bulleted Text Here
• Bulleted Text Here