Practical Use of Cultural Practices and Biopesticides for Effectively Managing Soil-Borne and Foliar Diseases

Part I: Biopesticide Basics

Matthew Krause, PhD.
BioWorks, Inc.

Biological Control in Commercial Greenhouses
6 August 2014
Overview

I. Why even consider using Biopesticides?
II. Biopesticide basics
III. Examples of successful biological control of soilborne diseases
IV. Tips for success with biopesticides
V. Questions and Discussion
Why even consider Biopesticides?

• Resistance management
• Improve efficacy in conventional disease management programs (additional MOAs)
• Can improve profitability
  – Lower cost in use (many)
  – Fewer losses/higher plant quality
  – Greater worker productivity (low REI)
• Improve worker, customer, and plant safety
• Many other reasons
Biopesticide Basics
Biopesticide

A type of *registered* pesticide derived from such natural materials as animals, plants, microorganisms, and certain minerals (US-EPA definition)

- *Plant-Incorporated Protectant*
- *Biochemical Pesticide*
- *Microbial Biopesticide*
Fungal Biopesticides

- **RootShield, RootShield Plus**: soilborne diseases
- **Soilguard**: soilborne diseases
- **Contans**: soilborne diseases
Bacterial Biopesticides

- **CEASE, Serenade, Rhapsody**: foliar and soilborne diseases
- **Double-Nickel**: foliar and soilborne diseases
- **Actinovate**: soilborne diseases
- **Mycostop**: soilborne diseases
Other Biopesticides

• **Viral:** AgriPhage (specific viruses that attack specific bacterial pathogens)

• **Biochemical:**
  – SuffOil-X (light horticultural oil)
  – MilStop, Armicarb (mineral salts)
  – Regalia, Buran (plant extracts)
  – Cyclone (fermentation products)
What do they do?

1. Suppress plant diseases via one or more of modes of action (MOAs)
   - Antagonistic metabolites
   - Competition & exclusion (nutrients and/or niches)
   - Rhizosphere or phyllosphere competence
   - Predation or (hyper)parasitism
   - Non-toxic mechanisms
   - Induced host resistance (SAR, ISR)
Branching to extend the contact with the host
What do they do?

2. Provide effective and safe approaches to plant disease and pest management
   - *Act preventively* rather than curatively (most)
   - Are effective alone at low to moderate disease pressure
   - Can help prevent and overcome pesticide resistance in conventional IPM
   - *Tank-mix compatible* or good *rotation partners*
   - May be used in bio-organic production (many)
What do they do?

3. May provide other beneficial effects
   – *Promote rooting or upper plant growth*
   – *Enhance availability of macro- and micro-nutrients*
   – *Help plants resist or overcome environmental stresses and transplant shock*
   – *Improve soil properties*
   – *Promote other beneficial microorganisms in the rhizosphere or phyllosphere*
Biopesticide Basics

What they do not do

1. Offer 100% protection – no pesticide does
2. Cure diseases (few exceptions)
3. Work in environmental extremes
4. Work at high disease pressure
5. Last indefinitely
   - most have defined shelf lives and storage conditions
   - may require frequent application, especially on foliage
6. Make a bad grower good
Examples of Successful Biocontrol of Plant Diseases
Efficacy of Chemical and Biological Fungicides vs. Pythium Root Rot of Poinsettia

Disease Severity Rating
(1 = Healthy, 5 = Dead Plant)

Days after Infestation with *Pythium aphanidermatum*

R. Georgis, Agrosci LLC, Palo Alto, CA, 2010
Efficacy of Chemical and Biological Fungicides vs. Pythium Root Rot of Hibiscus

Marketability Rating – 58 days
(1 = Dead Plant, 5 = Excellent)

- Non-infested Control
- RootShield Plus WP
- Actinovate SP
- Subdue MAXX
- Infested Control

R. Georgis, Agrosci LLC, Palo Alto, CA, 2010
### Efficacy of various treatments against Rhizoctonia damping-off of pepper

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh weight (g)</th>
<th>Percent pre-emergence damping-off</th>
<th>Percent post-emergence damping-off</th>
<th>Percent healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double Nickel LC (CX 9032)</td>
<td>9.1 cde</td>
<td>62.0 c</td>
<td>0.0 a</td>
<td>38.0 c</td>
</tr>
<tr>
<td>Rootshield Home and Garden</td>
<td>14.3 ab</td>
<td>23.5 de</td>
<td>0.0 a</td>
<td>76.6 ab</td>
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<tr>
<td>Rootshield PLUS WP</td>
<td>9.9 bcd</td>
<td>30.8 d</td>
<td>1.6 a</td>
<td>69.3 b</td>
</tr>
<tr>
<td>Rootshield WP</td>
<td>11.9 abc</td>
<td>29.2 d</td>
<td>1.1 a</td>
<td>70.3 b</td>
</tr>
<tr>
<td>Prestop</td>
<td>1.3 fg</td>
<td>94.3 a</td>
<td>0.0 a</td>
<td>5.7 e</td>
</tr>
<tr>
<td>Actinovate</td>
<td>1.9 fg</td>
<td>88.6 ab</td>
<td>0.0 a</td>
<td>11.5 de</td>
</tr>
<tr>
<td>Mycostop</td>
<td>3.6 fg</td>
<td>68.2 abc</td>
<td>0.5 a</td>
<td>31.3 cde</td>
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<tr>
<td>Previcur Flex</td>
<td>2.1 fg</td>
<td>85.4 abc</td>
<td>0.0 a</td>
<td>14.6 cde</td>
</tr>
<tr>
<td>Serenade Soil (4 qt/acre)</td>
<td>3.1 fg</td>
<td>72.4 abc</td>
<td>0.5 a</td>
<td>27.1 cde</td>
</tr>
<tr>
<td>Serenade Soil (6 qt/acre)</td>
<td>0.8 g</td>
<td>90.6 a</td>
<td>0.0 a</td>
<td>9.4 e</td>
</tr>
<tr>
<td>Subtilex</td>
<td>3.1 fg</td>
<td>71.9 abc</td>
<td>1.1 a</td>
<td>27.1 cde</td>
</tr>
<tr>
<td>Banrot</td>
<td>1.8 fg</td>
<td>82.3 abc</td>
<td>1.6 a</td>
<td>17.2 cde</td>
</tr>
<tr>
<td>Phosphite</td>
<td>3.0 fg</td>
<td>69.8 abc</td>
<td>1.6 a</td>
<td>29.2 cde</td>
</tr>
<tr>
<td>Regalia</td>
<td>5.2 efg</td>
<td>62.5 bc</td>
<td>2.1 a</td>
<td>35.4 cd</td>
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<tr>
<td>SoilGard</td>
<td>0.6 g</td>
<td>63.0 c</td>
<td>0.0 a</td>
<td>37.0 c</td>
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<tr>
<td>Non-treated, inoculated control</td>
<td>5.5 def</td>
<td>86.4 ab</td>
<td>1.6 a</td>
<td>12.0 de</td>
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<tr>
<td>Non-treated, non-inoculated control</td>
<td>15.7 a</td>
<td>2.6 e</td>
<td>0.0 a</td>
<td>97.4 a</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>0.6366</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

*Values are the means of four replicate flats; means followed by the same letter are not significantly different at p≤0.05.
Regalia® is effective against powdery mildew and compatible with other products

**Powdery Mildew on Gerbera Daisies**

IR-4 Program  
L. Villavicencio  
Vista, CA, 2010

- Treatments applied on 1= Feb 26, 2= Mar 5, 3= Mar 12.  
- Treatments applied at 100 gal.  
- Disease evaluated on Mar 19.  
- Powdery Mildew: Oidium spp.
Eradication of powdery mildew on Rosemary with biocontrols and wetting agents

- Water: 23.4
- Aliette-16: 31.8
- Heritage-1: 4.4
- Actinovate-6: 14.2
- Cease-1%: 8.4
- Capsil-4: 19.6
- Latron B-4: 8.8
- Nb FoamA-8: 3.8

Number of colonies

[Graph showing number of colonies for different treatments]

www.chasehorticulturalresearch.com
Practical Use of Cultural Practices and Biopesticides for Effectively Managing Soil-Borne and Foliar Diseases

Part II: Cultural and Biological Control of Soil-Borne and Foliar Diseases in Practice

Matthew Krause, PhD.
BioWorks, Inc.

Biological Control in Commercial Greenhouses
6 August 2014
1. Know the enemies
   - Potential pathogens and insect pests
   - Proper diagnosis of diseases (biotic and abiotic)
   - Disease symptoms
   - Pathogen/disease cycles
   - Vectors or sources of pathogens
   - Available treatment options/control methods
   - Limitations/vulnerabilities of pathogens and pests
2. Limit exposure to pathogens via good production practices

- Good sanitary practices
  - Do not re-use container media
  - Thoroughly clean and sanitize containers and flats before re-use
  - Sanitize pruning tools between cuts
  - Keep floors, benches, carts, and work areas clean and free from crop residues

- Minimize physical injury and stresses
3. Reduce favorable conditions for disease development

- *Environmental and microclimate conditions*
  - Temperature
  - RH
  - Lighting

- *Irrigation method and frequency*

- *Irrigation water quality and water management*

- *Soil / growing medium*
  - Quality
  - Proper drainage
4. Start with Healthy Plant Material

- Insist on treated or “clean” plant material from suppliers
- When healthy plant material cannot be assured
  - test for known pathogens (via diagnostic kits or plant clinic)
  - treat physically or chemically
  - reject severely diseased/infested plant material
5. Provide proper nutrition management
   - *Deficiencies cause poor plant vigor & yield*
   - *Excesses can lead to*
     *toxicity and stress*
     *greater salinity in soil and irrigation water*
   - *Proper nutrition provides:*
     *balanced growth and vigor*
     *tolerance/resistance to stress and pathogen attack*
1. Select and use biopesticides appropriately
   - *Familiarize yourself with labels, uses, strengths, weaknesses, and compatibilities*
   - *Apply according to label instructions (when in doubt, contact manufacturer or distributor for support)*
   - *Evaluate and optimize use in your setting on a small scale before going all-out*
   - *Consider using with other products in higher disease risk situations: tank mixes and rotations*
   - *Only use registered biopesticide products*
2. General Characteristics of Soil/Root Products

- May act immediately or after a lag period
- Typically act via 2 or more modes of action
- Good distribution and proper concentration are critical
  - Typically not systemic
  - Bacteria require nutrients and free moisture to move, grow
  - Fungi are less dependent on moisture to move but still require nutrients for growth in absence of pathogen
- Activity for 2-12 weeks, depending on the AI
  - Reappplication may still be needed to keep at effective levels
- Compatible with many chemical- and bio-pesticides
3. General Characteristics of Foliar Products

- Act or respond immediately to many fungal and bacterial pathogens
- Good coverage and proper concentration are critical
  - Typically not systemic
- Require frequent reapplication or rotation with other products during disease periods
  - New growth of plant parts
  - Lack nutrients for sustained growth on aerial plant surfaces
  - Environmental degradation or loss (UV, precipitation, etc.)
- Compatible with many chemical- and bio-pesticides
4. Other considerations

- *Proper application method and timing*
  - *Calibration and maintenance of equipment are critical!*
  - *Coverage, coverage, coverage*

- *Effective formulation for the job: WP, WDG, Granular*

- *Storage and shelf life conditions and limits – many are living*

- *Compatibility with other products and practices*

- *Spectrum of activity*

- *Cost in Use*
RootShield® Compatibility

RootShield® is a biological fungicide for the control of many root diseases. The active ingredient is a living microbe (Trichoderma harzianum strain T-22) that protects the plant from pathogens.

The compatibility with RootShield® with other inputs has been tested extensively. The information below is divided into three (3) tables: materials in the first table are fully tank mix compatible; materials listed in the second table can be applied before or after the application of the compound; the third table lists incompatible fungicides. For incompatible fungicides, BioWorks, Inc. recommends that RootShield® be applied 10 to 14 days before or after chemical fungicide application.

*Note: The products listed have been evaluated for their impact on RootShield’s active ingredient. The impact of RootShield® on the listed actives has not been evaluated.

Table 1: Tank Mix Compatibility

<table>
<thead>
<tr>
<th>Fungicides</th>
<th>Active Ingredient</th>
<th>Brand Name</th>
<th>Formulation</th>
<th>Tested Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azoxystrobin</td>
<td>Heritage®</td>
<td>G, TL</td>
<td>3.6 oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Bacillus licheniformis strain 3086</td>
<td>EcoGard® GN</td>
<td>SC</td>
<td>128 fl oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Basalid plus Pyraclostrobin</td>
<td>Pagean®</td>
<td>38% WG</td>
<td>36 oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Captain</td>
<td>Captain® 85 WP</td>
<td>85% WP</td>
<td>0.1 oz/gal</td>
<td></td>
</tr>
<tr>
<td>Chiorothanil</td>
<td>Daconil® Utrex</td>
<td>87.5% WDG</td>
<td>0.56 oz/gal</td>
<td></td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Lorsban® 4E</td>
<td>50% emulsifiable liquid</td>
<td>3.2 fl oz/gal</td>
<td></td>
</tr>
<tr>
<td>Dimethomorph</td>
<td>Stature®</td>
<td>50% FL</td>
<td>12 fl oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Etridiazole and Thiophanate-methyl</td>
<td>Banrot®</td>
<td>40% WP</td>
<td>12 oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Fenamidone</td>
<td>FenStop®</td>
<td>44.4% Liquid</td>
<td>28 fl oz/100gal</td>
<td></td>
</tr>
<tr>
<td>Fludioxonil</td>
<td>Medallion®</td>
<td>50% WP</td>
<td>4.0 oz/100 gal</td>
<td></td>
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<tr>
<td>Ipirenone</td>
<td>Chipco® 26019 Flo</td>
<td>23.3% FL</td>
<td>0.3 fl oz/gal</td>
<td></td>
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<tr>
<td>Ipirenone</td>
<td>Revral®</td>
<td>50% soluble granules</td>
<td>0.04 oz/gal</td>
<td></td>
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<tr>
<td>Metalaxy-M</td>
<td>Subdue® Maxx</td>
<td>21.3% FL</td>
<td>2.6 fl oz/100 gal</td>
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<tr>
<td>Spiretrameat</td>
<td>Kontos®</td>
<td>22.4% SC</td>
<td>2.4 fl oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Streptomycyes lydicus WYEC 108</td>
<td>Actinovate®</td>
<td>SP</td>
<td>12 oz/100 gal</td>
<td></td>
</tr>
<tr>
<td>Thiophanate methyl</td>
<td>Cleary's 3336*</td>
<td>50% wettable Powder; Flowable</td>
<td>1.2 oz/gal</td>
<td></td>
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<tr>
<td>Triadimefon</td>
<td>Bayleton® 25 T&amp;O</td>
<td>25% SG</td>
<td>0.11 oz/gal</td>
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<tr>
<td>Vinlofluron</td>
<td>Ronlin® DF</td>
<td>50% WP</td>
<td>0.04 oz/gal</td>
<td></td>
</tr>
</tbody>
</table>

CEASE® Compatibility

CEASE® is an excellent tank-mix or rotational partner in your disease control program, proving the benefits of improved efficacy, resistance management, and food, worker, and environmental safety.

CEASE® (Bacillus subtilis, strain QST 713) has been tested for physical compatibility with dozens of commonly used pesticides, nutrients, and adjuvants, and was found to be physically compatible with nearly all inputs. Make applications of tank mix solutions as soon as possible after mixing.

<table>
<thead>
<tr>
<th>Insecticide Compatibility</th>
<th>Active Ingredient(s)</th>
<th>Physical Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avid®; Varsity®</td>
<td>Abamectin</td>
<td>Yes</td>
</tr>
<tr>
<td>Conserve® SC, Spintox®, Success®</td>
<td>Spinosad</td>
<td>Yes</td>
</tr>
<tr>
<td>Deltis® Pro DF, Javelin®</td>
<td>Bacillus thuringiensis</td>
<td>Yes</td>
</tr>
<tr>
<td>Merit®, Provado® 75 WP, Marathon®</td>
<td>Imidacloprid</td>
<td>Yes</td>
</tr>
<tr>
<td>Pounce, Ambush</td>
<td>Permethrin</td>
<td>Yes</td>
</tr>
<tr>
<td>SulfOil® X</td>
<td>Mineral Oil</td>
<td>Yes</td>
</tr>
<tr>
<td>BotaniGard® 22WP, BotaniGard® ES, Mycostrol® O</td>
<td>Beauveria bassiana, strain GHA</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjuvant Compatibility</th>
<th>Physical Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond®</td>
<td>Yes</td>
</tr>
<tr>
<td>Colter®</td>
<td>Yes</td>
</tr>
<tr>
<td>Hasten®</td>
<td>Yes</td>
</tr>
<tr>
<td>Hyper-Active®</td>
<td>Yes</td>
</tr>
<tr>
<td>Inta®</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinetic®</td>
<td>Yes</td>
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<tr>
<td>NuFilm®</td>
<td>Yes</td>
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<tr>
<td>Quest®</td>
<td>Yes</td>
</tr>
<tr>
<td>R-11®</td>
<td>Yes</td>
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<tr>
<td>R-56®</td>
<td>Yes</td>
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<tr>
<td>Silwet® L77</td>
<td>Yes</td>
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<tr>
<td>Spray-Aide®</td>
<td>Yes</td>
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<tr>
<td>Sylvad® 369</td>
<td>Yes</td>
</tr>
<tr>
<td>Tactic®</td>
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<table>
<thead>
<tr>
<th>Nutrients Compatibility</th>
<th>Physical Compatibility</th>
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</thead>
<tbody>
<tr>
<td>Fish Oil</td>
<td>Yes</td>
</tr>
<tr>
<td>Nutri-phile®</td>
<td>Yes</td>
</tr>
<tr>
<td>Nutri-phile® PK</td>
<td>Yes</td>
</tr>
</tbody>
</table>

To find out more about the BioWorks family of products, please contact us at 800-877-5643 or visit www.bioworksinc.com. © 2012 BioWorks, Inc.
A Word on Composts and Compost Teas

• Highest quality composts can provide added support to soilborne biopesticides
  – Obtain from reputable producers
• Suggested composted materials
  – Yard waste compost
  – Aged conifer barks
  – Hardwood bark composts
  – Horse and Cattle Manure Composts
  – Vermicompost??
Notes about Compost Extracts and Teas

• Compost teas/extracts *can* help provide soluble organic nutrients to roots and foliage
• Avoid compost extracts and teas fermented with sugars and molasses
  – Human and plant health risks: actually amplify human and plant pathogens
• Disease control (including induced resistance) is inconsistent – otherwise commercial products would be registered and available
Questions and Discussion
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