



# **Use of Biopesticides for the Management of Vegetable Diseases**

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## Questions I want to address:

- What are biopesticides?
- Why use biopesticides?
- How do biopesticides work?
- Do biopesticides work?



- Biopesticide:
  - EPA Definition:

“Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs.”



- Biopesticide:
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# Biopesticide $\neq$ Organic

Just because a product is a biopesticide doesn't mean it's approved for organic production.

Always verify products are certified for organic production.

Resources:

- USDA National Organic Program (NOP)
- Organic Materials Review Institute (OMRI)



– **Biochemical pesticides** are naturally occurring substances\* that control pests by non-toxic mechanisms.

- Plant extracts (Neem oil, Citrus oil, Seaweed/Kelp extracts, Giant knotweed)
- Hydrogen peroxide
- salts of phosphorous acid\*
  - Accepted by the USDA as a biopesticide, but not labeled for organic production by NOP or OMRI
- Insect sex pheromones



- **Microbial pesticides** consist of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient.
  - *Bacillus* spp. (*Bt* producing strains of *B. thuringensis*)
  - *Pseudomonas* spp.
  - *Streptomyces* spp.
  - *Trichoderma* spp.
  - *Coniothyrium minitans*
  - bacteriophages



- **Plant-Incorporated-Protectants (PIPs)** are pesticidal substances that plants produce from genetic material that has been added to the plant.
  - *Bt* gene from *Bacillus thuringensis*; *Bt* cotton
  - Future genetically modified organisms?





## Why use biopesticides?

- Generally less toxic than conventional pesticides.
- Generally affect only the target pest and closely related organisms.
- Generally effective in 'relatively' small quantities with little residual.
- Generally short or no REI & PHI



## How do they work?

- Modes of Action:

- Antibiosis (Microbial)
- Parasitism & Predation (Microbial)
- Competition (Microbial)
- Contact Inhibition (Biochemical)
- Induced Resistance (Biochemical & microbial)



## How do they work?

### **Antibiosis** (microbial pesticides)

- growth of one organism detrimental to another
- Production of antibiotics and other growth inhibitors
- Examples:
  - *Bacillus* spp., *Pseudomonas* spp., *Trichoderma* spp., *Gliocladium* spp., *Streptomyces* spp., etc...



## How do they work?

### Parasitism/Predation

- *Coniothyrium minitans*
  - Parasite of *Sclerotinia* spp.
- *Trichoderma* spp.
  - Parasite of numerous soilborne fungal pathogens
  - *T. aggressivum* (pathogen of cultivated mushrooms)
- Bacteriophages
  - Viruses that infect and lyse bacteria
- *Paecilomyces* spp. – nematophagous and entomophagous species
  - Parasitic/predatory to certain nematodes and insects



## How do they work?

### **Competition** (Microbial)

- Nutrients
  - Utilize nutrients on leaf surface or at root zone (rhizosphere) that a pathogen requires for initial colonization
- Colonization sites
  - Deny the pathogen access to a particular colonization site on leaf or root surfaces
- Camouflage??
  - Possible that increased microbial activity can camouflage roots from pathogens that rely on specific root signals to initiate germination or to guide movement/growth towards the host



## How do they work?

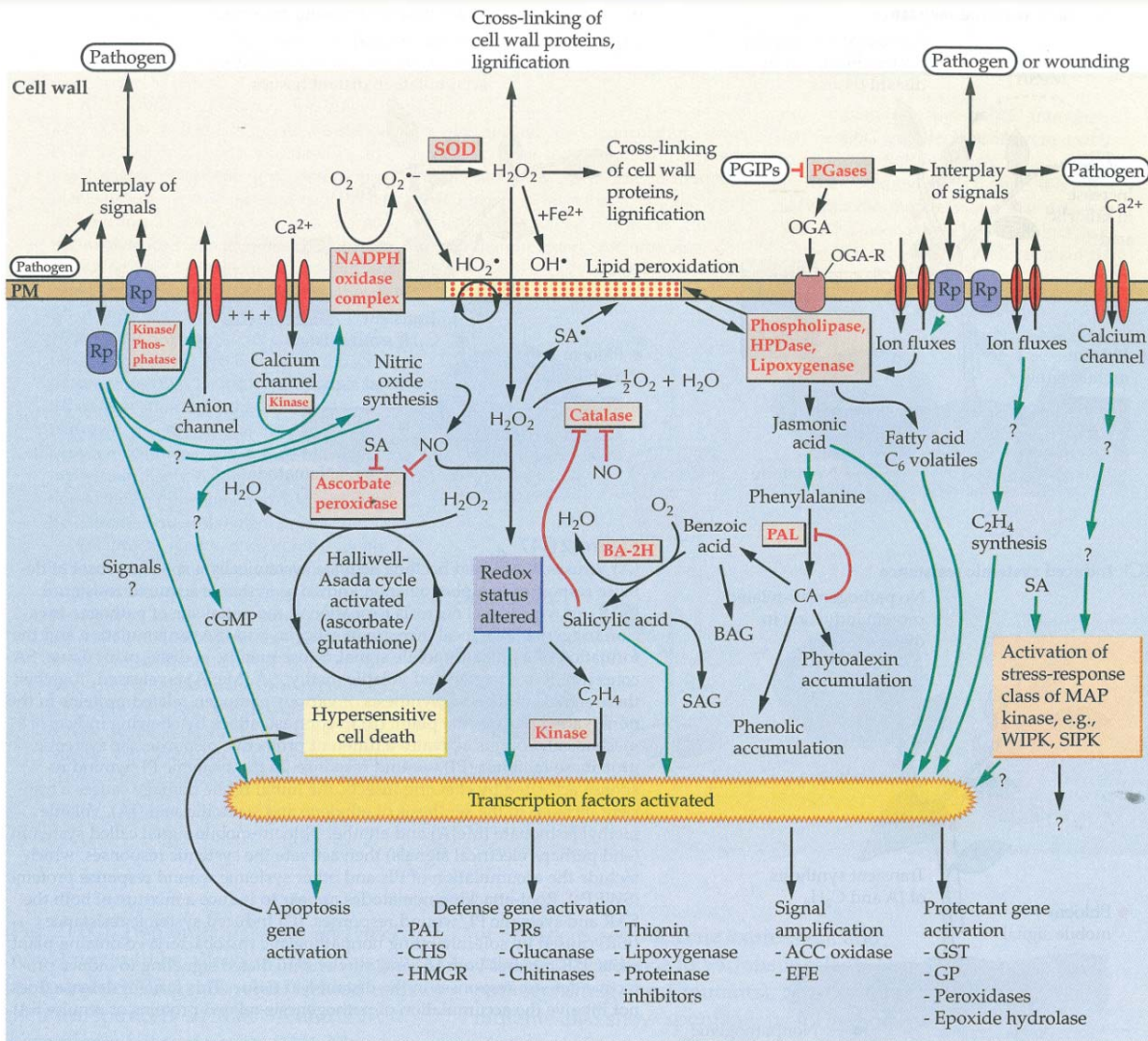
### **Contact Inhibitor** (biochemical pesticides)

- Directly inhibit germination/growth of pathogen propagules
- Disrupt cell integrity
- Often can help dry out active lesions and prevent/slow secondary spread



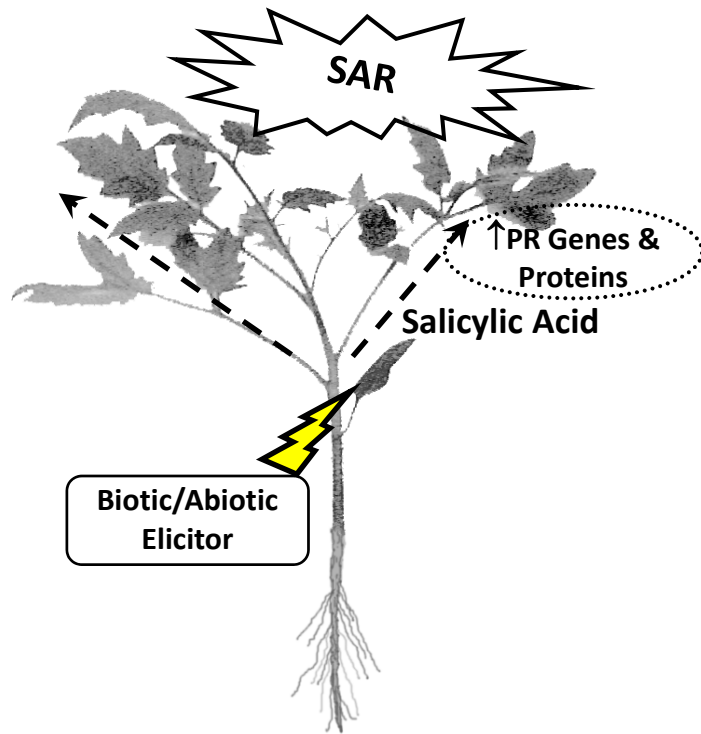
## How do they work?

- **Induced Resistance** (Biochemical & microbial)
  - A physiological “state of enhanced defensive capacity” elicited by specific environmental stimuli, whereby the plant’s innate/basal defenses are potentiated against subsequent biotic challenges.

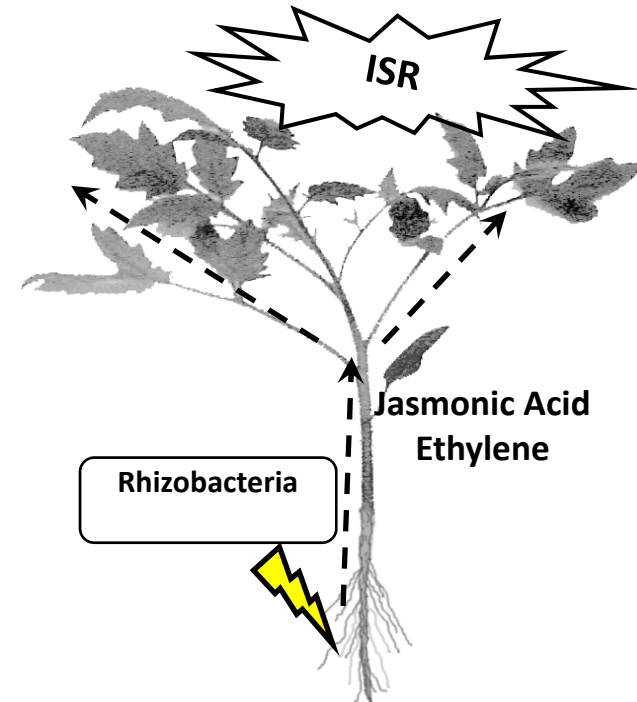


Plants are not defenseless. The difference between resistance and susceptibility is due to the timing of pathogen recognition and the expression of defenses.





Systemic Acquired Resistance (SAR)



Induced Systemic Resistance (ISR)

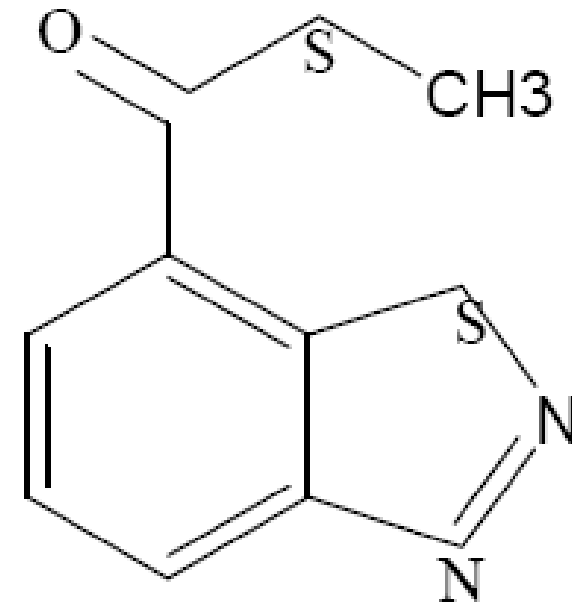
**There are two well characterized states of induced resistance:**

- Systemic Acquired Resistance (SAR)
- Induced Systemic Resistance (ISR)



## ACIBENZOLAR-S-METHYL (ACTIGARD)

- Synthetic elicitor of SAR
- First marketed for the control of powdery mildew on small grains
- No direct effect on pathogens
- Limited mobility in the plant
- Carboxylated byproduct elicits the plant's defenses
- **Actigard is not a biopesticide**, but is the best example of a commercially viable defense elicitor available at the moment



Acibenzolar-S-methyl



## Do biopesticides work?

- Efficacy of products varies...
  - Target pathogen?
    - Works well against some pathogens, but not others...
    - Products are not curative!!!
  - Environment?
    - Efficacy is limited, especially under conditions that are highly conducive to severe disease
  - Crop/cultivar?
    - Has not been looked at, but there is some evidence for this in the literature based on model plant/crop systems
  - Timing?
    - Again, these are not curative.... Products are best utilized in a preventative manner when integrated with other pest control strategies (cultural and chemical)
  - May not be economical; depends on the specific operation



## Do biopesticides work?

- REI/PHI

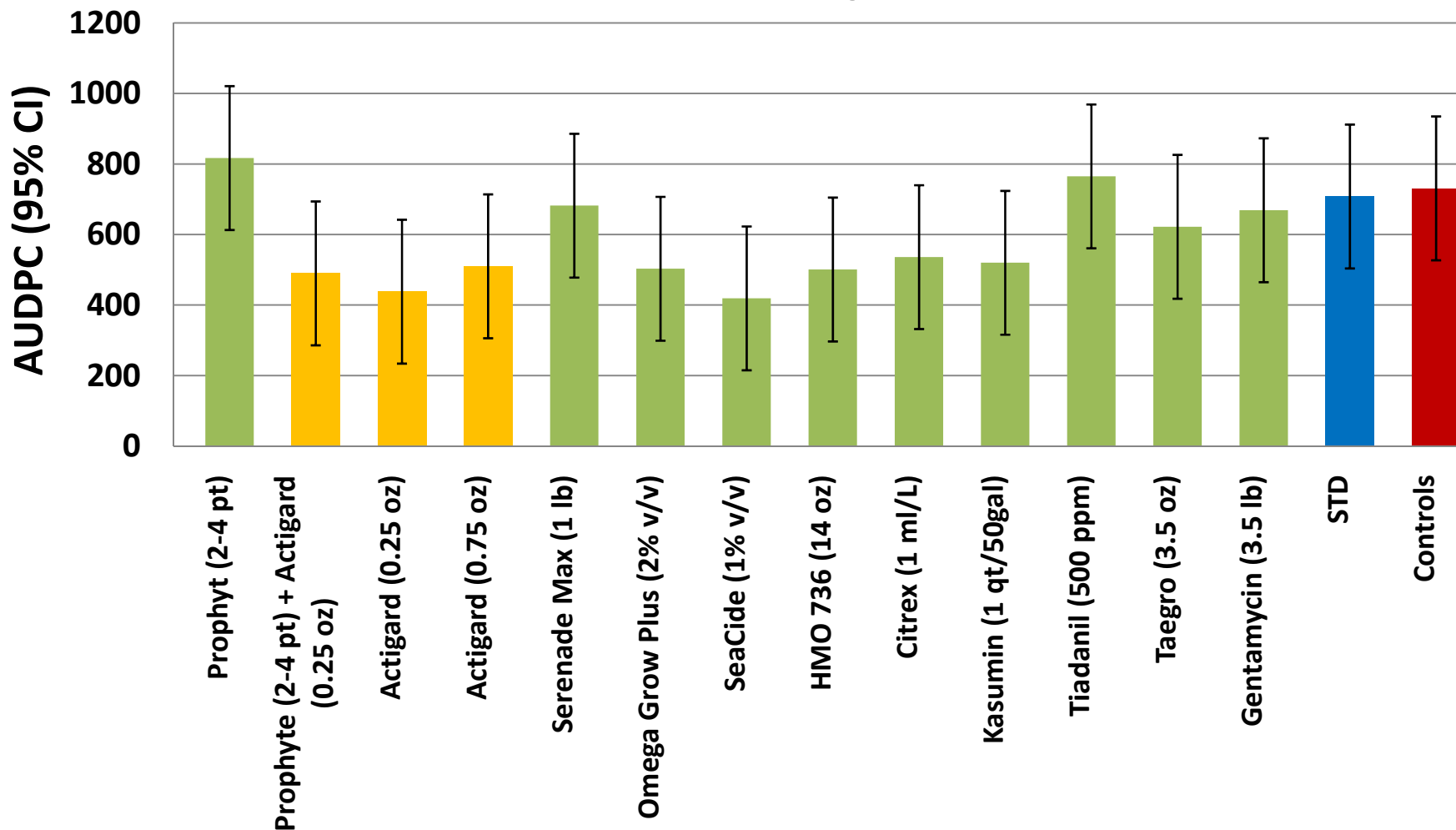
- Generally have no or minimum re-entry intervals or post-harvest intervals.
- Useful for during harvesting, when many conventional products are prohibited

## Bio-pesticide Trials

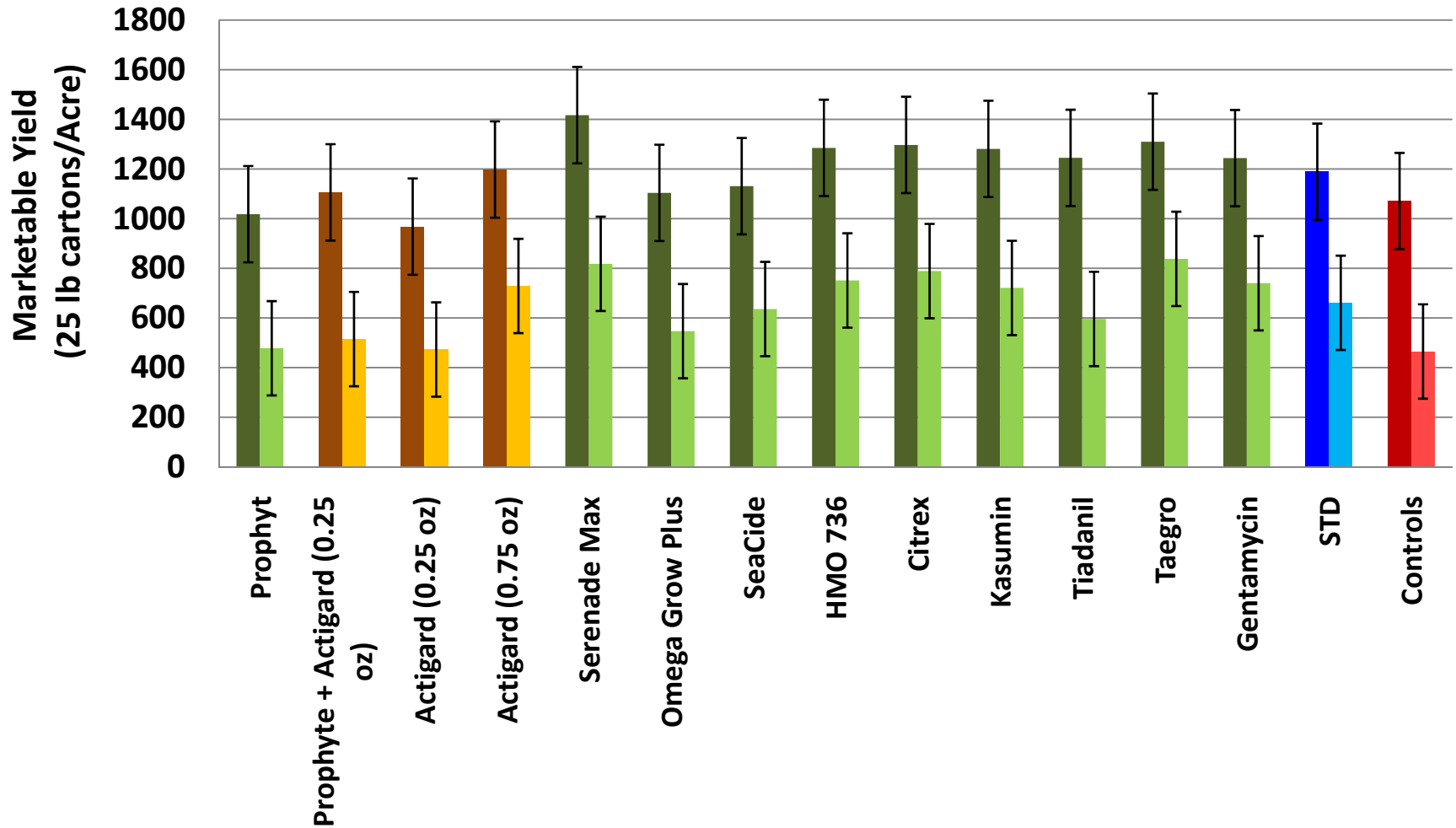


- **Standard (STD):**
  - Cuprofix Ultra 40D & Penncozeb 75DF
- **Antibiotics:**
  - Kasumin & Gentamycin
- **Biochemical Pesticides:**
  - Prophyt, SeaCide, Citrex, Omega Grow Plus, & Sporan
- **Microbial Pesticides:**
  - Actinovate, Sonata, Serenade Max & Taegro
- **Plant Defense Elicitor:**
  - Actigard, Prophyt\*, HMO-736 (Vacciplant), & Tiadanil

## Fall 2008 – Bacterial Spot - Tomato



## Fall 2008 – Bacterial Leaf Spot





## Key for success...

### – Not curative!

- Need to be used in a preventive manner.

### – Integration!

- There are no silver bullets.
- Biopesticides need to be integrated with other pest management strategies.

### – Pathogen identification!

- Proper diagnosis is key to controlling any disease.





Resources for locating information relative to the effectiveness of many biopesticides from actual field studies:

– Plant Disease Management Reports

<http://www.plantmanagementnetwork.org/pub/trial/pdmr/>

– GCREC Vegetable Pathology Website

<http://gcrec.ifas.ufl.edu/VegetablePathology.htm>