Ins and Outs of Using Biopesticides for Managing Diseases of Flowers and Herbs

Margery Daughtrey
Cornell University LIHREC

Chemical control = chemical vs. microbe

Biological control = microbe vs. microbe

Great fleas have little fleas upon
their backs to bite ’em,
And little fleas have lesser fleas,
and so *ad infinitum.*
And the great fleas themselves, in
turn, have greater fleas to go on;
While these again have greater
still, and greater still, and so on.

Augustus De Morgan—*A Budget of Paradoxes.* P. 37
1872

Available Biocontrols

Unlike biocontrol of insects, biocontrols for disease mgt are regulated by EPA

Biopesticides – derived from natural materials: animals, plants, fungi, bacteria + certain minerals

Biologicals for Disease Management

✧ Use <u>preventively</u>

✧ Using them is NOT like using a chemical

✧ Different from using insect parasites and parasitoids

EPA Biopesticide Categories:

1. Microbial – beneficial bacteria and fungi included here

How do they work?

Different Modes of Action:

- *Competitive exclusion*

    "First come, first served"
- *Predation*
- *Antagonistic metabolites*
- *Nutrient competition*
- *Stimulate plant defense*

Thus not prone to triggering resistance!

1. Direct Competition

- Biocontrol agent out-competes the pathogen for nutrients and space along the root or leaf surface
- Must be applied preventively and in large numbers
- RootShield, PlantShield, Galltrol-A

2. Antagonism

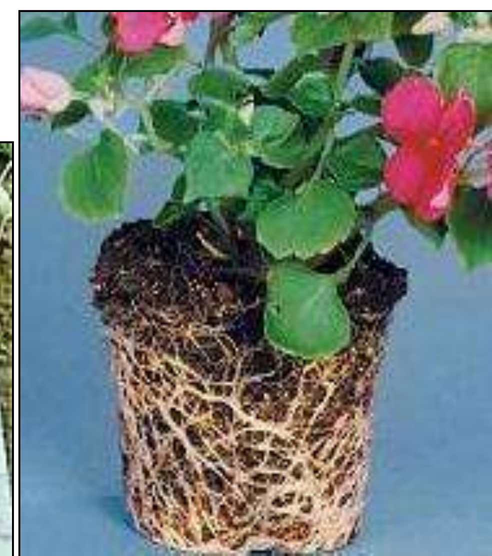
- Biocontrol agent attacks and feeds directly on target organism
- Works well when disease pressure is low
- Must be present at same time or before the pathogen
- RootShield

3. Antibiosis

- Biocontrol agent produces a toxin that kills or inhibits pathogen growth
- Used preventively; once infection occurs toxin is less effective
- SoilGard, MycoStop
- Galltrol-A & NOGALL

4. Enhanced nutrient uptake

- Some biofungicides claim to enhance plant growth even in absence of pathogen
- May increase availability of certain fertilizers by altering pH or exporting enzymes that dissolve insoluble elements
- RootShield, SoilGard

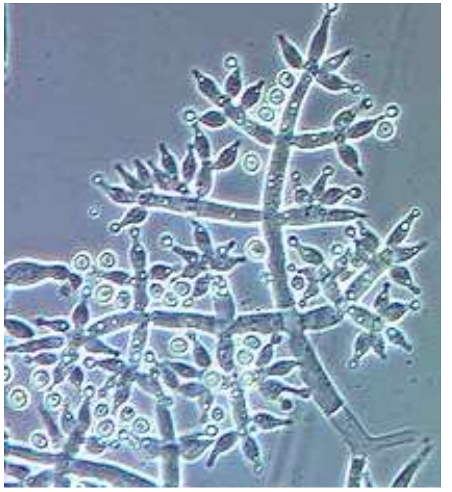


5. Induced resistance

- Triggering of plant defense mechanisms - similar to an immune system
- Inoculate host with a non-virulent strain to trigger resistance response
- Possible use for chestnut blight

FUNGUS VS. FUNGUS

Trichoderma harzianum
Trichoderma virens
Trichoderma asperellum
Trichoderma hamatum
Gliocladium catenulatum

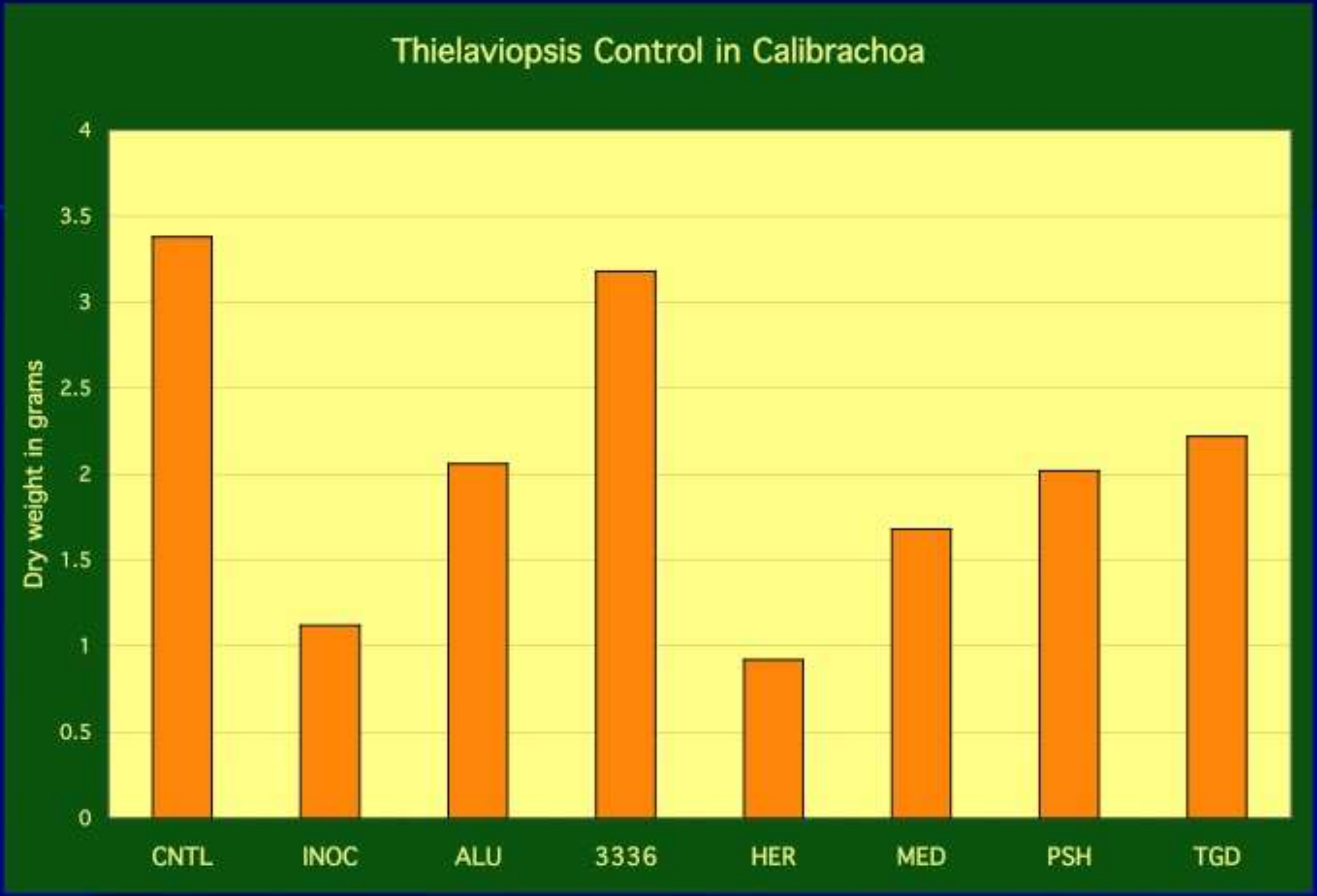


RootShield G, WP-root 0 hr REI OMRI

Trichoderma harzianum T-22

Targets:

Pythium, Rhizoctonia, Fusarium, Thielaviopsis, Cylindrocladium



Thielaviopsis Control in Calibrachoa
Dry weight in grams
0
0.5
1
1.5
2
2.5
3
3.5
4
CNTL
INOC
ALU
3336
HER
MED
PSH
TGD

RootShield Plus+ - G & WP OMRI

Trichoderma harzianum T-22

Trichoderma virens G-41

Targets:

Pythium, Rhizoc, Fusarium,

Thielaviopsis, Cylindrocladium

Suppression of *P. aphanidermatum*

More benefit against *Phytophthora*

REI=0 hr for G&WP; 4 hr if dip or dust WP

BIO-TAM 2.0 – AgraQuest/Isagro

Trichoderma asperellum ICC 012

Trichoderma gamsii G-41 ICC 080

Targets: soilborne diseases

Fusarium, Phytophthora, Pythium, Rhizoc, Sclerotinia, Sclerotium rolfsii, Thielaviopsis, Verticillium, Rosellinia, Armillaria

Can pre-germinate with 24-36 hr pre-trt soak

May pose a risk to beneficial beetles: blocked in some counties. Block Is. *OMRI certified*

Ornamentals and herbs


Sclerotinia

Sclerotium rolfsii

Chrysogonum

Basil

Thielaviopsis

Isagro Label for Bio-Tam:

2.5 – 7.5 oz Bio-Tam 2.0 in 100 gal water
Drench for greenhouse/nursery crops

Up to 4” depth, use 50-100 gal/800 sq ft
If deeper, dose 4-8 oz/ctr or use
100 gal/400 sq ft

7-day pretreatment - chemigation

Asperello– Biobest USA

Trichoderma asperellum- T34 strain

Targets: soilborne diseases

Fusarium, Phytophthora, Pythium, Rhizoc,

pH 6.0-8.0

Temperatures 68-95°, best 77-86°F

ISR, competition, parasitism

Spray media or

Dip roots or

Irrigate with suspension to deliver 5 g/ 1000 pots (0.175 oz) that are 1 L in size (2.1 pints) (Twice if not pre-treated)

Repeat every 2-3 months

Fusarium wilt symptoms

INOC	Asperello	Asperello	Heritage	RootShield G
No	0.01 g/L medium	0.01 g/L medium	Only	1.5 lb/cu yd
Treatment	+drench		One	
	+dip		drench	

Number of mums (out of 32) with advanced Fusarium wilt symptoms at end of trial (mid-June to mid-Aug)

Both Asperello and RootShield G effective against *F. oxysporum* f. sp. *chrysanthemi*

Table 2. Chrysanthemum Final Health Rating and Dry Weights		
	18 Aug Rating[1]	Dry Weights (g) [2]
Treatment		
1. Non-inoculated, non-treated	4.8 a[3]	12.9 ab[3]
2. Inoculated, Non-treated	2.6 cd	9.2 cd
3. ASPERELLO T34 Biocontrol (4 treatments)	3.4 bc	12.0 abc
4. ASPERELLO T34 Biocontrol (preincorp. only)	4.1 ab	14.0 a
5. Heritage 50 WP (drench)	2.3 d	7.9 d
6. RootShield Granules (preincorp. only)	3.3 bc	10.2 bcd

[1] **Plants rated for top quality on a 5-point scale:** 5=good size, good color, 4=one leaf with chlorosis, 3=one wilted branch, 2=more than 1 branch wilted (dying) and 1=dead plant

[2] Plants harvested at the soil line on 18 Aug

[3] Values in a column followed by the same letter are not significantly different (Tukey's HSD, *P*=0.05)

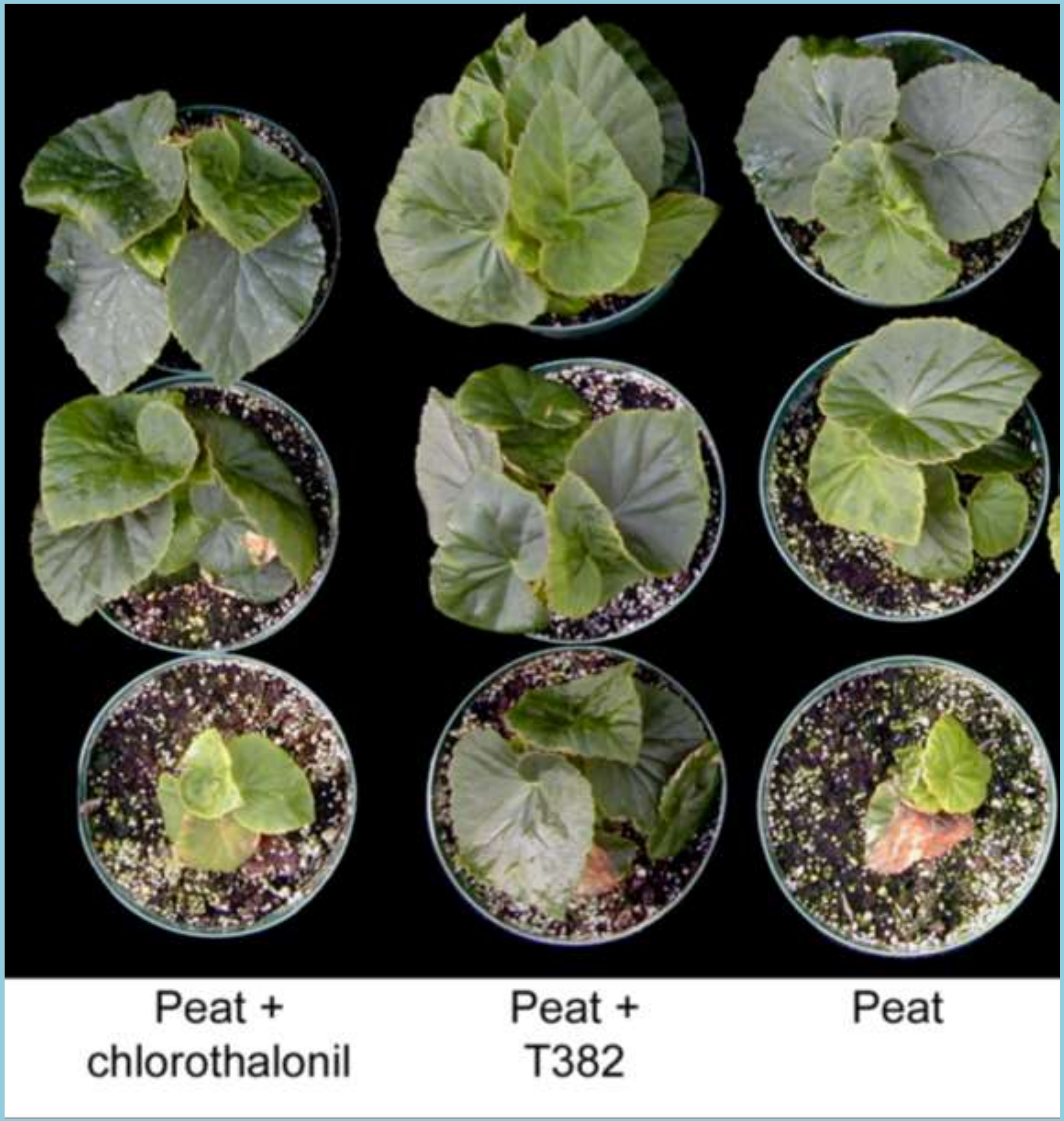
Physiological effects of the induction of resistance by compost or *Trichoderma asperellum* strain T34 against *Botrytis cinerea* in tomato. Fernandez et al. 2014. Biological Control *78*:77-85

35% less Botrytis blight severity in tomato when treated with *T. asperellum* T34

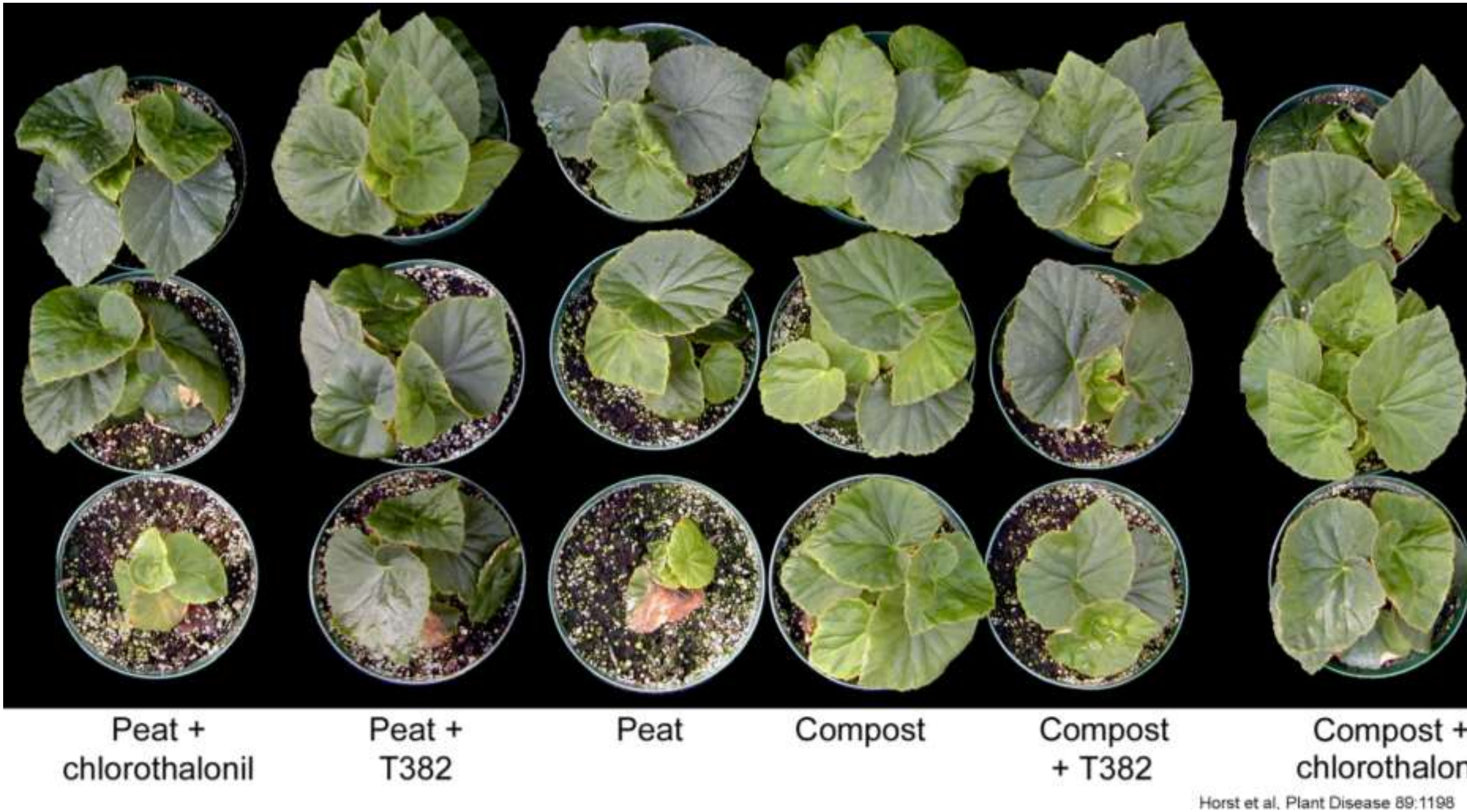
Trichoderma hamatum, T384

Benefit against Botrytis in begonias

Promising Results! Horst et al. OSU



Suppression of Botrytis Blight of Begonia



Gliocladium catenulatum J1446

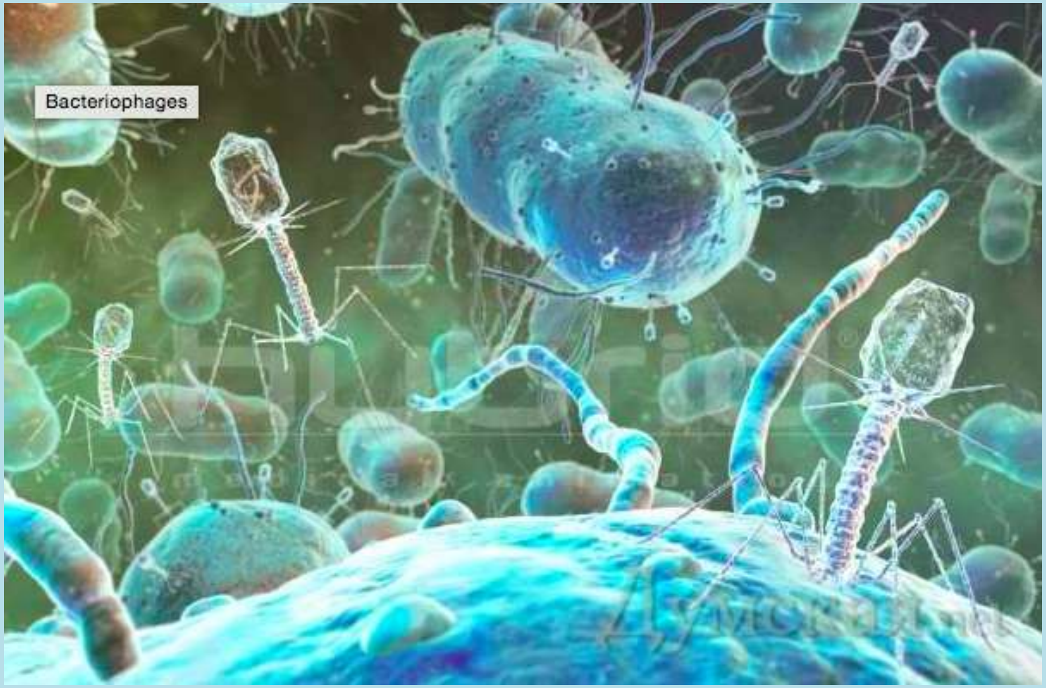
Pre-Stop Biofungicide Powder

- Alternaria, Cladosporium, Fusarium, Penicillium, Phytophthora, Plicaria, Pythium, Rhizoctonia and Verticillium,
- certain storage diseases caused by Helminthosporium and Rhizoctonia, as well as certain foliar diseases caused by Botrytis and Didymella on greenhouse or field grown vegetables, herbs, ornamentals, tree and forest seedlings and turf.

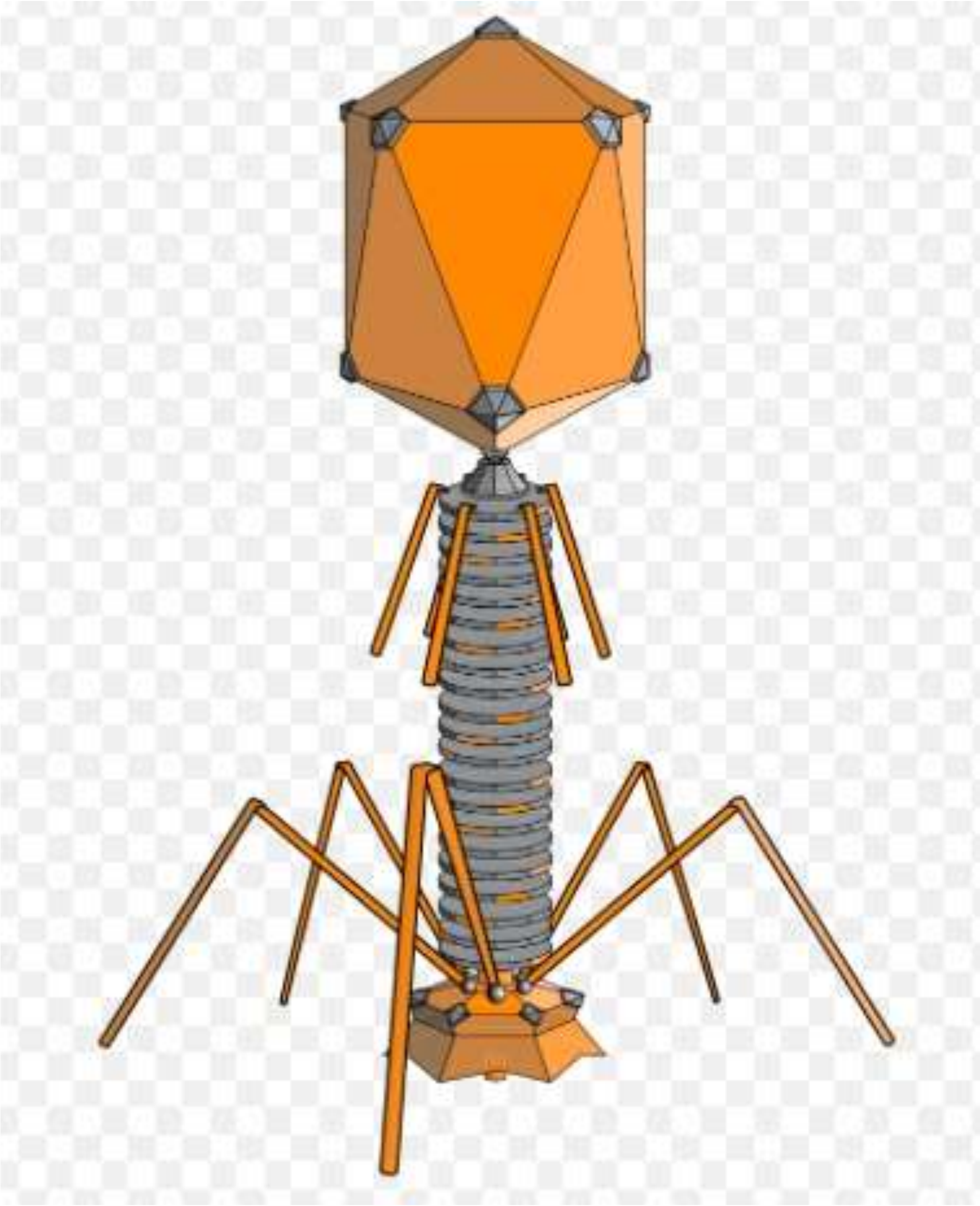
- 3.5 oz/0.5 cu yd mixed in pre-planting
- Store below 77
- Use within 3 weeks
- Drench w/in 3-6 weeks
- Drench only on some leafy veg plants and herbs; can spray oranmentals

VIRUSES vs. BACTERIA
Various bacteriophages

e.g. LISTEX by Micreos is made up of bacteriophages that can kill the *Listeria monocytogenes* bacteria on meat.



Viruses that vie with bacteria



bacteriophage

Experimentally…

Potato tuber rot by *Pectobacterium*
Reduced by spray of rotted tuber goop
1925 Kotila and Coons

Stewart's wilt of corn – *Pantoea stewartii*
Thomas, 1935
Reduced disease from 18% to 1.4% by treating corn seed

Bacterial spot on peach seedlings – *Xanthomonas pruni*
Civerolo and Keil, 1969
86 – 100% reduction of disease

But bacteriophages…

- break down in UV light… UV-A, UV-B
- have a narrow spectrum of activity
- can be subject to resistance development

Maybe use <u>as part of IPM program</u>

Ralstonia solanacearum – **cause of a vascular wilt disease of many plants**

Ralstonia solanacearum Race 3, Biovar 2

Osteos
Plus
Ralstonia
Plus
Erwinia

Paper submitted following 2015 season (Weibel et al.):

A *Ralstonia solanacearum* strain from Guatemala infects diverse flower crops, including new hosts *Vinca* and *Sutera*, and causes symptoms in geranium (*Pelargonium hortorum*), African daisy (*Osteospermum ecklonis*), and mandevilla (*Mandevilla*)

Benefit 3 d pre- or when inoculated with pathogen

From Jones, et al., 2012

&

Podovirus J2
From Thailand

But bacteriophages…

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Maybe use as part of IPM program

Existing BIOCONTROL PRODUCTS often promise help with soilborne diseases, PLUS:

Powdery mildew

Anthracnose

Bacterial leaf spot

Rhizoctonia stem rot

Gray mold (Botrytis)

Rust

Fungal spots e.g. Black spot, Septoria, Alternaria, Cercospora, Myrothecium

BIOCONTROL PRODUCTS (bacterial)

Mycostop - *Streptomyces griseoviridis* K61 – AgBio OMRI – Greenhouse ornamentals. From peat.

Actinovate SP – *S. lydicus* WYEC 108 – Nat'l Industries OMRI – GH, Nursery, Turf

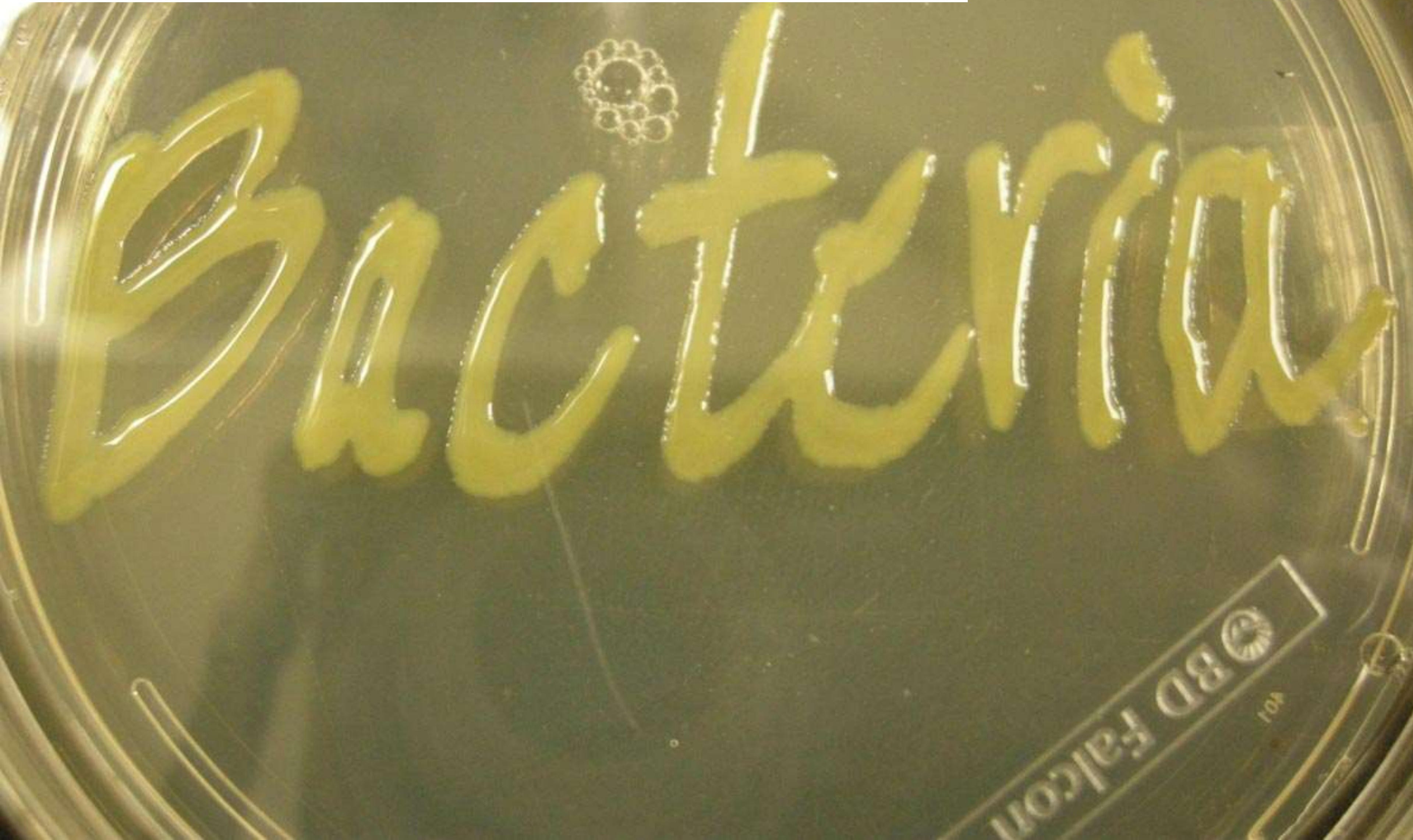
Cease - *Bacillus subtilis* QST713 – Bioworks OMRI

Companion Biological Fungicide (2-3-2 L)– *B. subtilis* GB03 - ISR, antibiotic + auxin-like metabolites 0-4 hr REI Growth Products (not OMRI)

DoubleNickel 55 Biofungicide (*Bacillus amyloliquefaciens* D747) Certis OMRI (5 MOA)

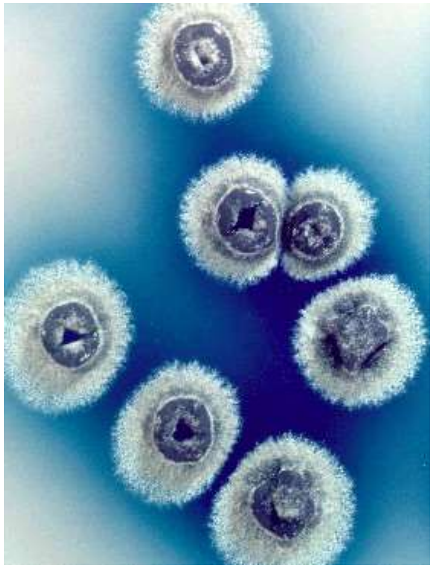
And Triathlon BA *B. amy.* D747 OHP OMRI

Bacterial biocontrols vie with bacterial AND fungal pathogens



BACTERIA VS. FUNGUS

Bacillus subtilis
Bacillus amyloliquefaciens
Streptomyces griseoviridis
Streptomyces lydicus



ESPECIALLY GOOD against PM

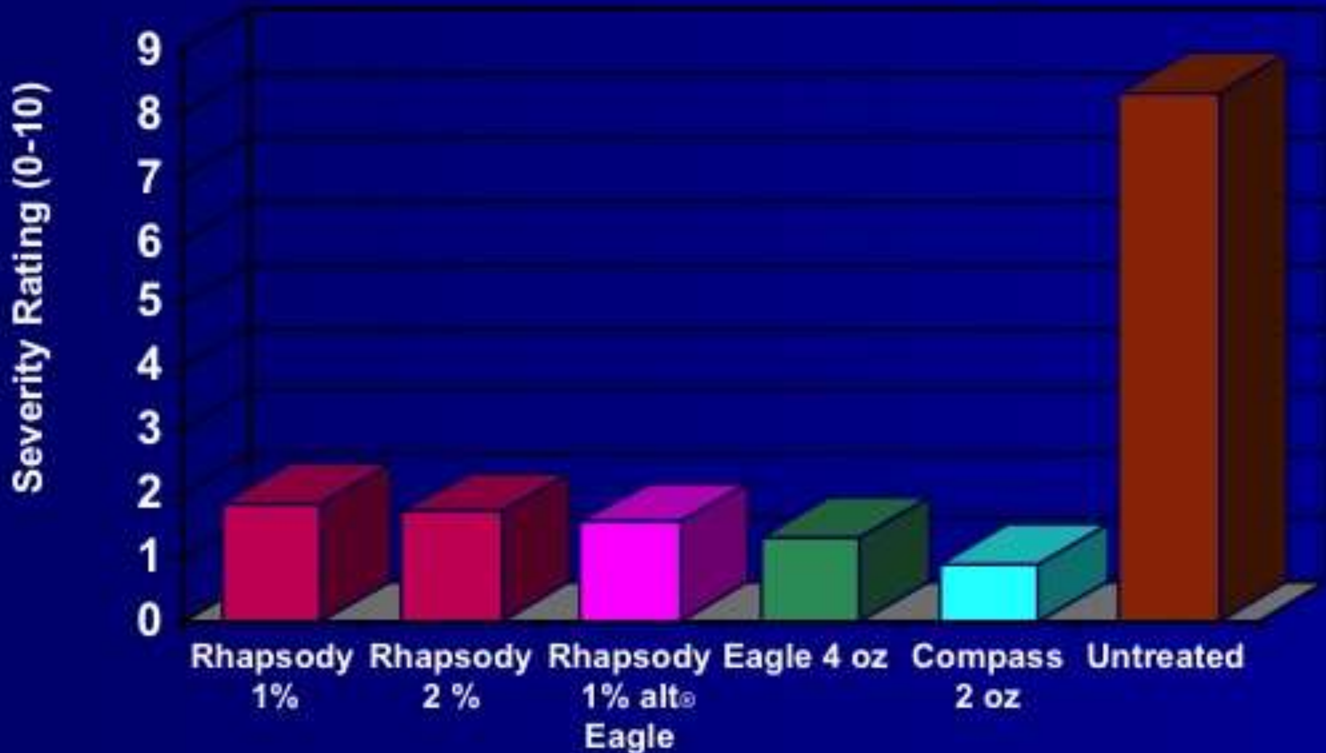
Gerbera leaf coated with powdery mildew fungus

PM on Torenia

PM on New Guineas

Rhapsody (=Cease) vs. Powdery Mildew on Hydrangea

Williams, University of GA, 2003, severe non-inoculated trial

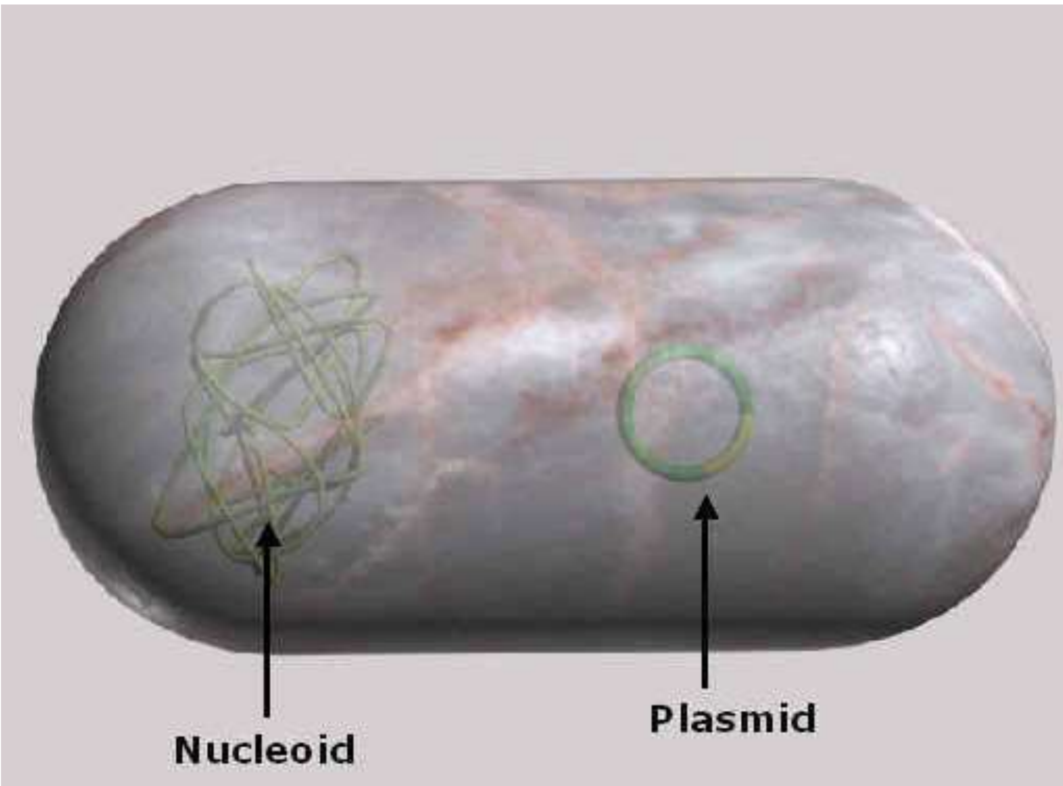


Material used/100 gal of spray solution; applied 8 times on 7 day schedule.
* Results statistically different from untreated at P=0.05

BACTERIA vs. BACTERIA

Agrobacterium radiobacter

Agrobacterium tumefaciens



Sforza and Lacy

M. Putnam

Plasmid DNA has the "disease genes"

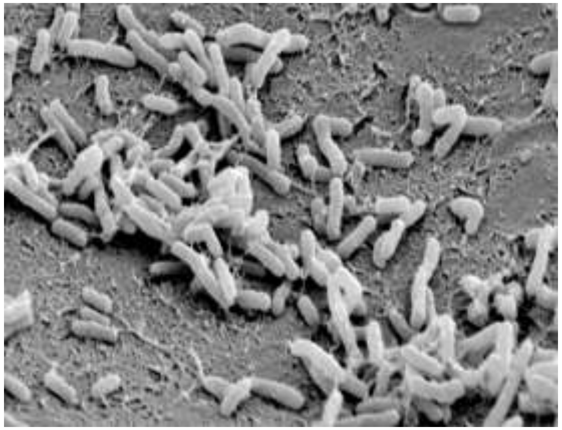
Crown gall disease
Agrobacterium tumefaciens

R. Wick

M. Putnam

NOGALL , Galltrol-A

- *Agrobacterium radiobacter,* K1026 and Kerr 84 strains, respectively
- Control *Agrobacterium tumefaciens* (crown gall)
- Works by competition and antibiotic production
- For use on some nonfood & non-bearing woody plants and ornamentals

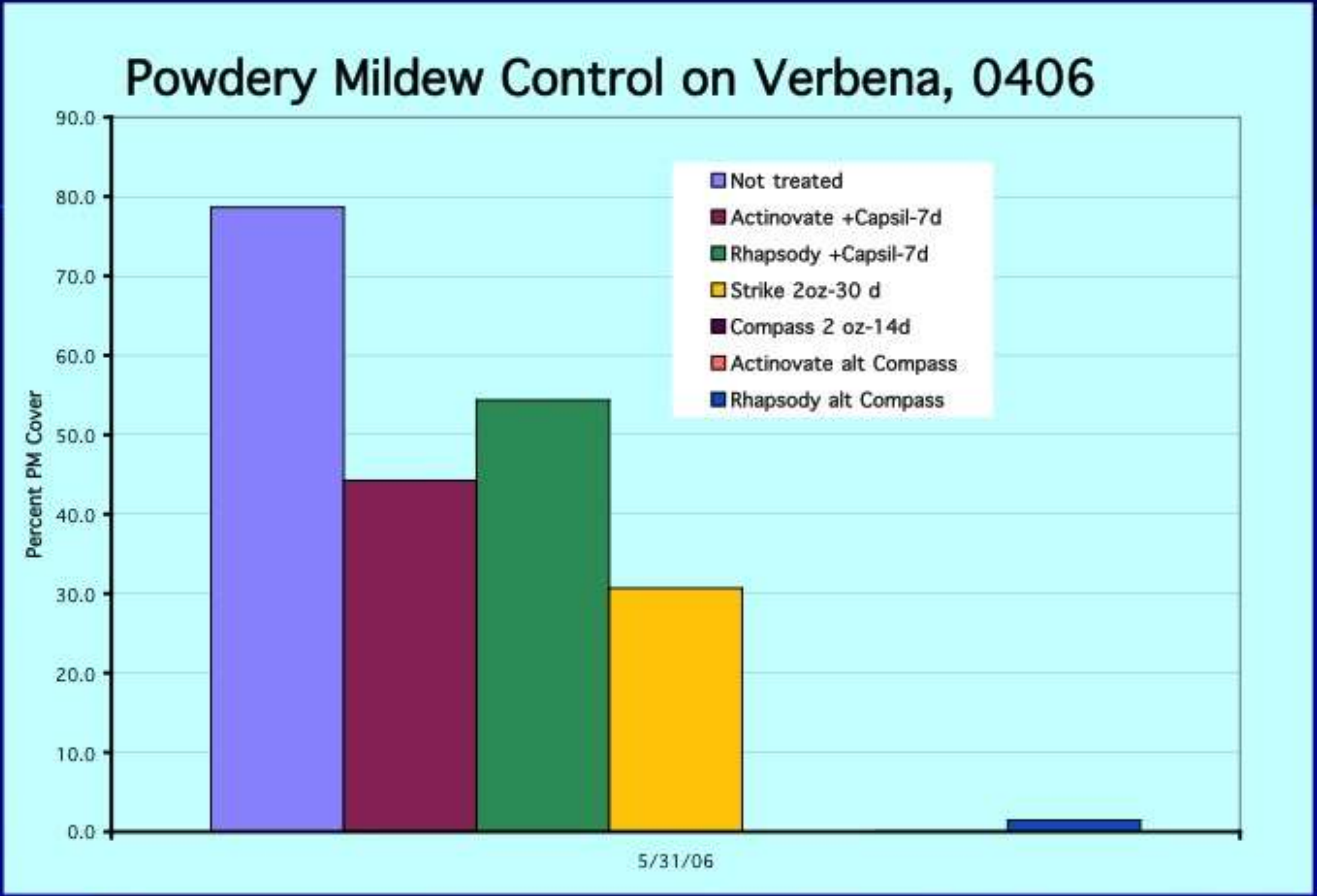


BACTERIA vs. BACTERIA

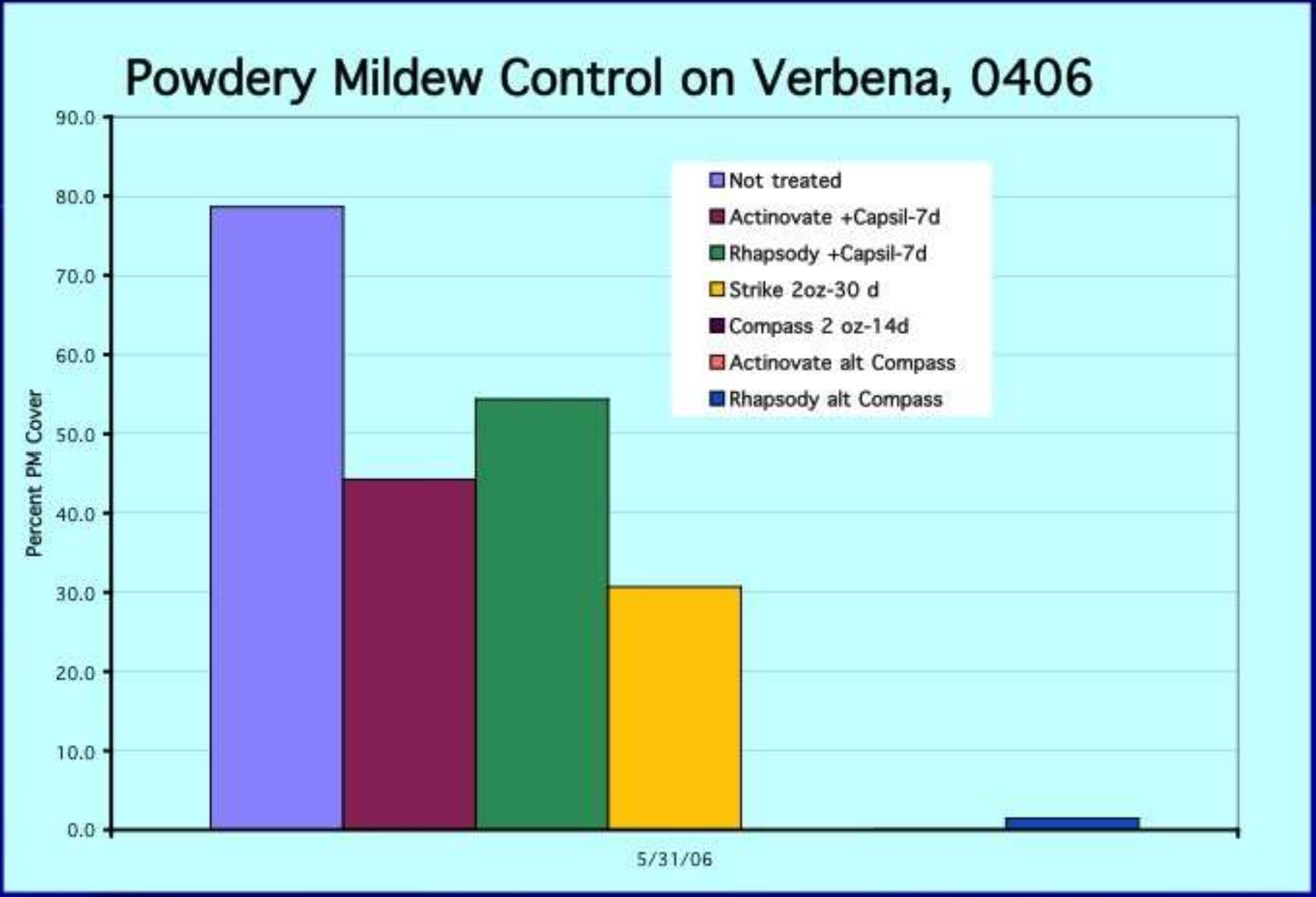
Bacillus subtilis
Bacillus amyloliquefaciens

Bacterial leaf spot of zinnia –
Xanthomonas campestris* pv. *zinniae
***pesky…*an opportunity to try out a biocontrol?**

Streptomyces and *Bacillus* against PM



Streptomyces and *Bacillus* against PM



Brunnera


Brunnera – foliar nematode

Nematode

Nematode-trapping fungus