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Use of Biopesticides for Management of Certain Disease and Insect Pests of Pepper

24th International Pepper Conference
November 5th, 2018

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CELEBRATING 20 YEARS 20th ANNIVERSARY OF SUSTAINABILITY

BioSafe Systems

- *A family-owned manufacturer of biodegradable and reduced risk crop protection products.*
- *Headquartered in East Hartford, CT, USA*
- *Biochemical (Peracetic Acid Based) and Microbial based EPA registered Biopesticides for organic and conventional Agriculture and Horticulture markets.*
- *Currently have 2 EPA registered microbial pesticides for disease and insect control (PVent and BioCeres WP) and 1 Beneficial soil inoculant (TerraGrow)*
- *Products registered in US, Canada and Mexico.*

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Bio-Pesticides: Global and US Trends

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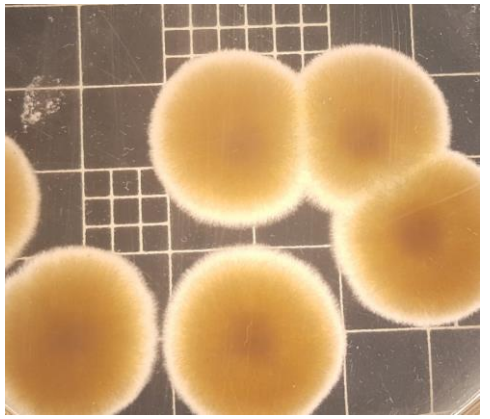

- ✓About $3 Billion market world wide accounting for about 5% of the total crop protection market (Christos & Spyridon, 2017; Marrone, 2014 and Olson, 2015).
- ✓ Increasing by about 10% every year. (Christos & Spyridon, 2017 ; Kumar & Singh, 2015)
- ✓North America (US, Canada and Mexico) shares >40% of world market in biopesticide usage and sales.
- ✓Close to 300 registered Biopesticide Active Ingredients and 1401 active biopesticide product registrations with US EPA as of 2016.
- ✓Fruits and Vegetables takes major chunk of usage of biologicals among all crop groups both on global scale and US due to demands for safe consumption with less pesticide residues.
- ✓Future usage potentially on par with conventional chemical pesticides.

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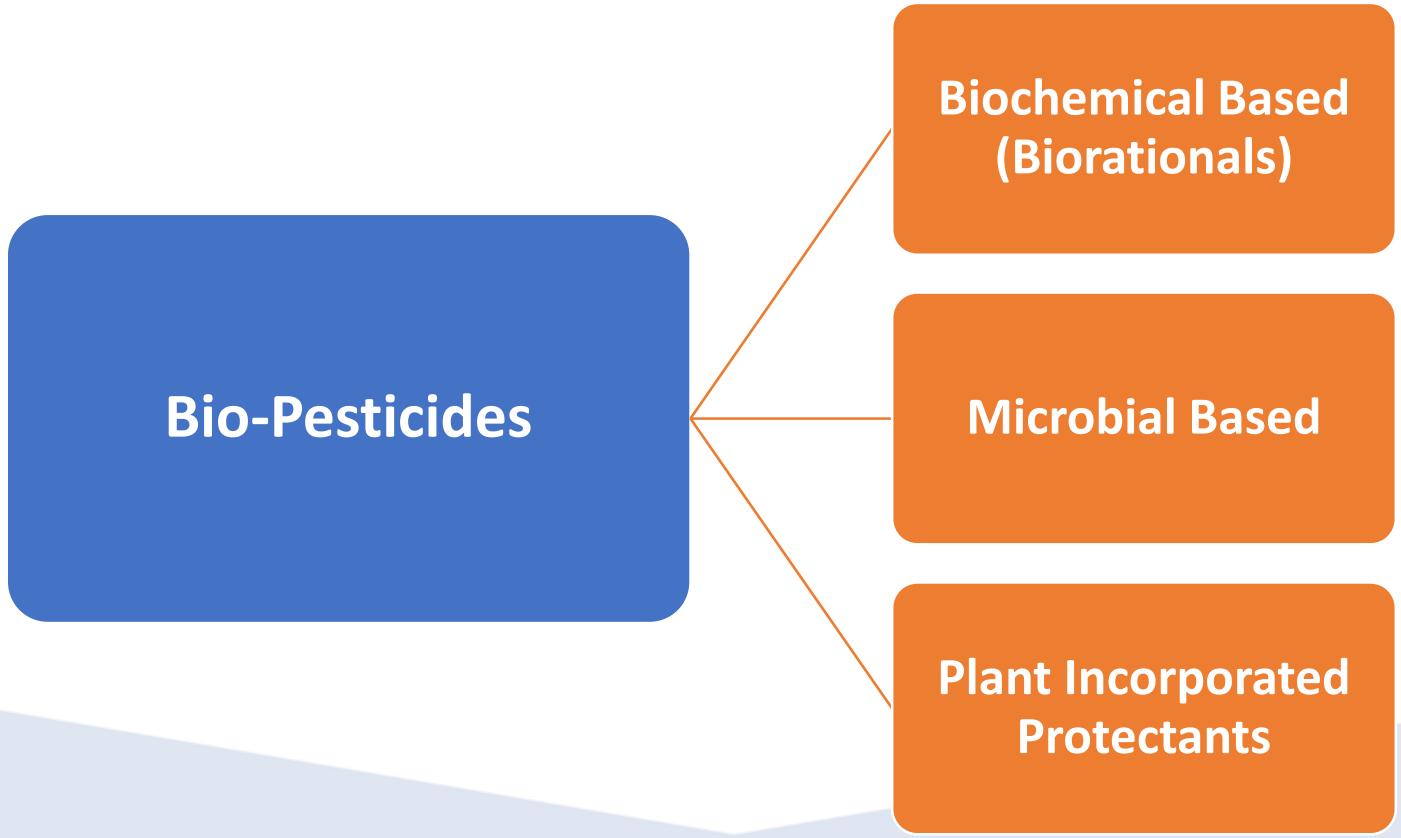
"Biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals"-EPA



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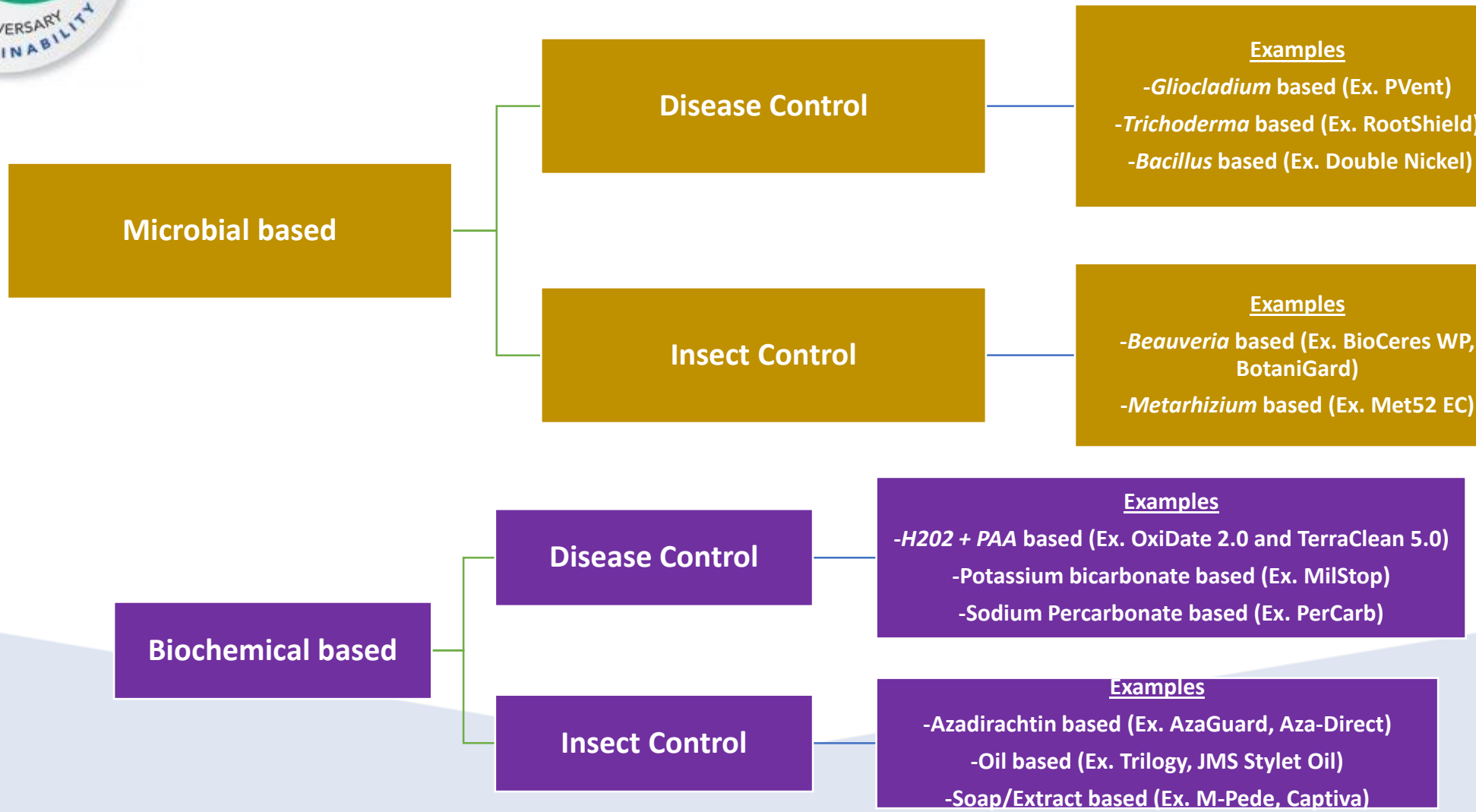
Biopesticides in Peppers



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Biopesticides from BioSafe Systems

Product	Product Type	Active Ingredient(s)	Biopesticide Class
BioCeres WP	Bio-Insecticide	*Beauveria bassiana* Strain ANT-03	Microbial
TerraClean 5.0	Soil Bactericide/Fungicide	27% Hydrogen Peroxide + 5% Peroxyacetic Acid	Biochemical
PerCarb	Foliar Bactericide/Fungicide	Sodium Percarbonate	Biochemical
PVent	Bio-Fungicide	*Gliocladium catenulatum* Strain J1446	Microbial
OxiDate 2.0	Foliar Bactericide/Fungicide	27% Hydrogen Peroxide + 2% Peroxyacetic Acid	Biochemical
AzaGuard	Botanical Insecticide	Azadirachtin	Biochemical
TerraStart	Pre-Plant Soil Bactericide/Fungicide	18.5% Hydrogen Peroxide + 12% Peroxyacetic Acid	Biochemical

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Biopesticide Based on Beauveria bassiana Strain ANT-03

An entamopathogenic fungus belonging to order Hypocreales

Occurs naturally in the soils throughout the world

Can attack both larval and adult stages of Insects

BioCeres® WP

Biological Mycoinsecticide

Active Ingredient: ***Beauveria bassiana*** strain-ANT-03

Formulation Type: Wettable Powder (WP)

Contains a minimum of 1.0×10^{10} viable conidia/g gram

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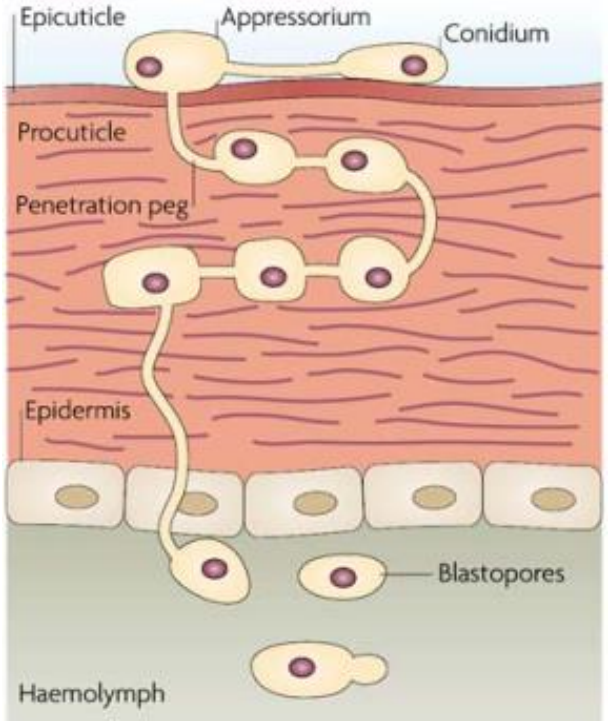
MOA
B. bassiana ANT-03



- Adhesion to the cuticle
- Germination (infection) via enzymatic activity and mechanical pressure
- Penetration of the fungus into the insect
- Multiplication and sporulation

- Infection via contact and ingestion
- Pathogenicity for all development stages including eggs, nymphs anddiapausing insects

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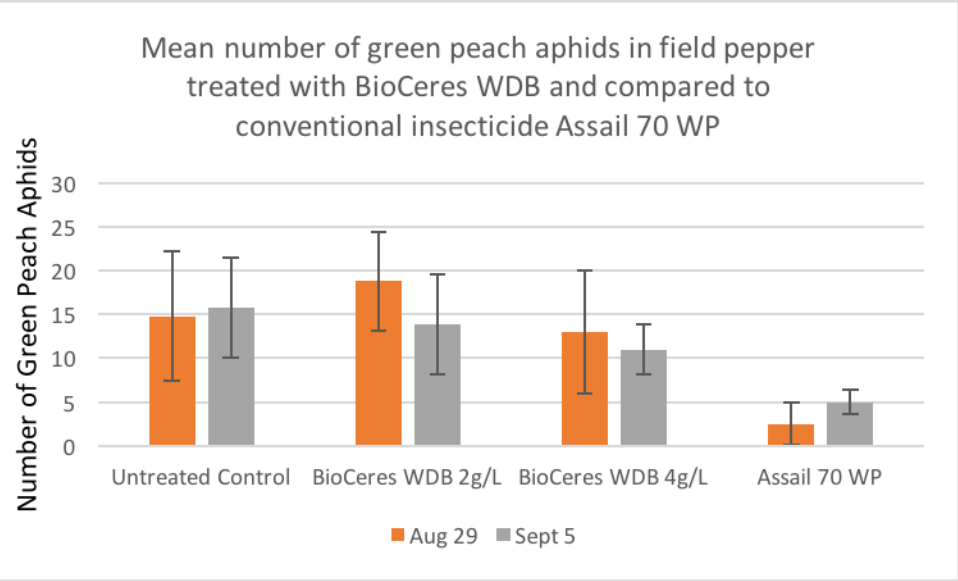
Insect control in Peppers with *B.bassiana* *ANT-03* Biopesticide

Green Peach Aphid Control in Sweet Pepper (cv. 'Revolution'), BC, Canada, 2011



Treatment	Aug 29th		Sept 5th	
	MEAN	±SE	MEAN	±SE
Untreated Control	14.8	7.4	15.8	5.7
BioCeres WDB 2g/L	18.8	5.6	13.8	5.7
BioCeres WDB 4g/L	13	7	11	2.9
Assail 70 WP	2.5	2.4	5	1.4

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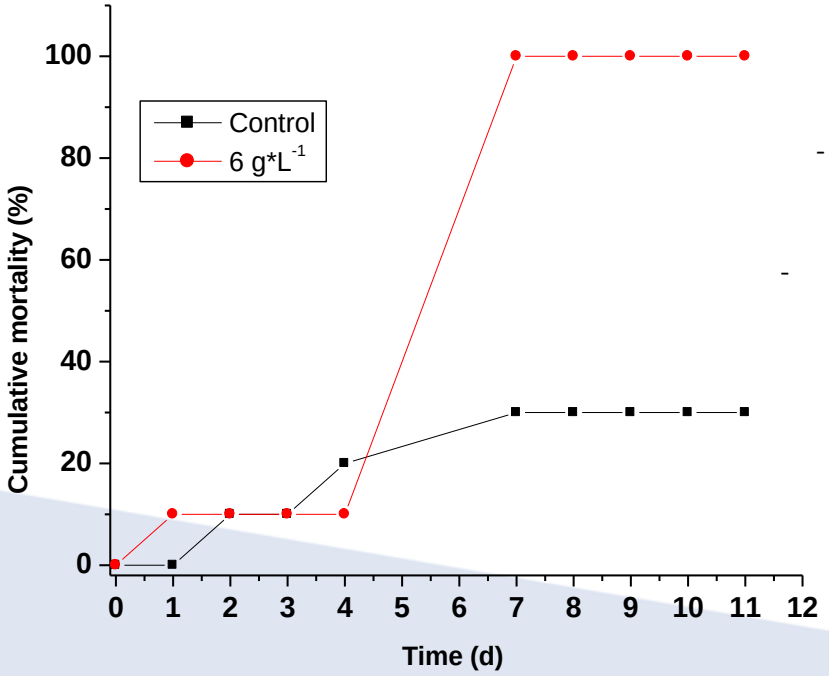
Insect control in Peppers with *B.bassiana* *ANT-03* Biopesticide

Bioassay on Pepper Weevil, 2016



- All cadavers showed fungal outgrowth (*B. bassiana*) after 24-48 hours incubation at 27 C in moist chamber;
- After 7 days post-treatment, 100 % mortality of Adults was recorded.

N	Treatment	Concentration (g/L)
1	Control (water)	0
2	BioCeres WP	6

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Insect control in Other Crops with *B.bassiana ANT-03* Biopesticide

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Sweet Potato Whitefly Control in Zucchini Squash (cv. 'Radiant'), UFL, FL, 2017

Product/Formulation	No of Adult Whitefly per Sampled Leaf				
	2-Nov	9-Nov	16-Nov	22-Nov	29-Nov
Untreated	0.35 a	0.30 a	3.83 a	1.95 a	1.40 a
Treatment # 2	0.15 bc	0.05 b	2.13 b	0.85 cd	0.78 b
Treatment # 3	0.13 bc	0.13 b	0.75 d	0.60 d	0.40 bc
Treatment # 4	0.15 bc	0.08 b	1.08 cd	0.75 cd	0.28 c
Treatment # 5	0.10 bc	0.10 b	1.87 bc	1.70 ab	0.53 bc
Treatment # 6	0.23 ab	0.05 b	1.75 bc	1.18 bcd	0.28 c
BioCeres WP-3 Lbs/A	0.08 bc	0.10 b	1.75 bc	1.78 ab	0.60 bc
Treatment # 7	0.03 c	0.18 ab	1.98 bc	1.23 bc	0.28 c
Treatment # 8	0.05 c	0.10 b	2.30 b	0.93 cd	0.63 bc

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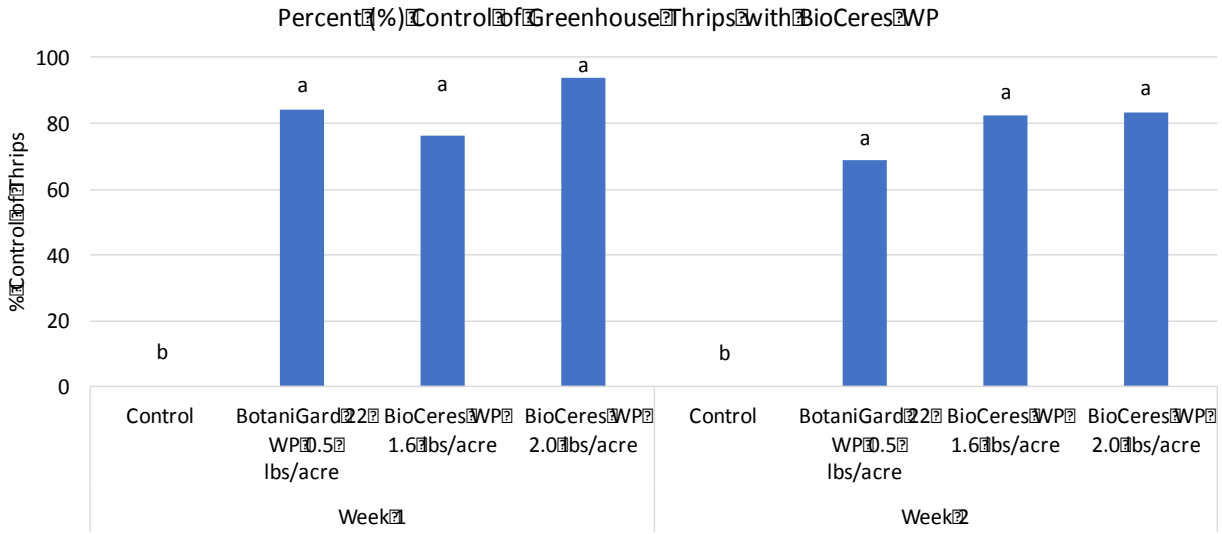
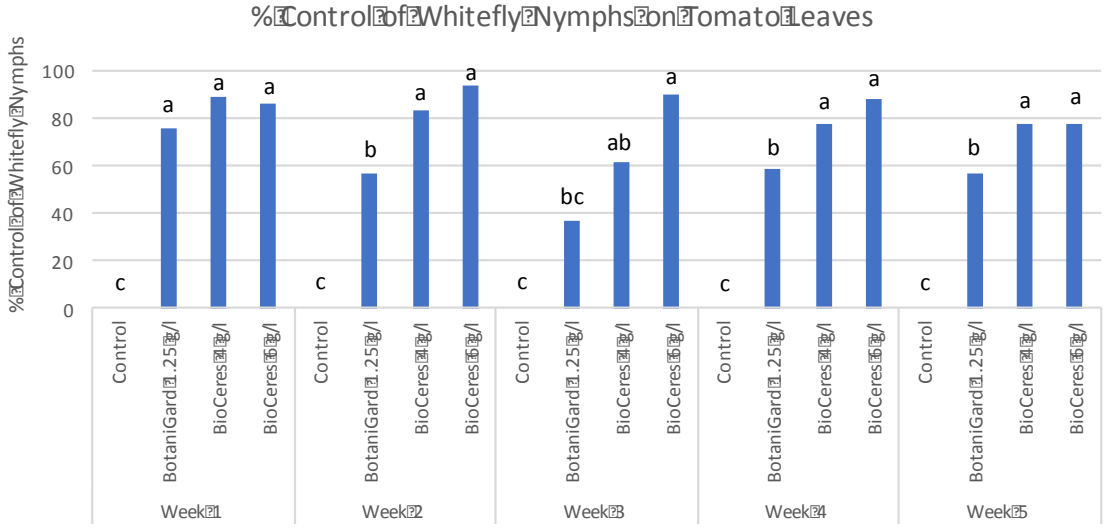
Insect control in Other Crops with *B.bassiana ANT-03* Biopesticide





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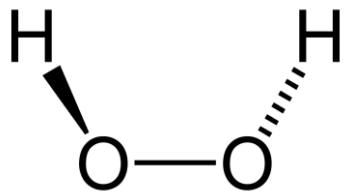
Biopesticide Based on H202 + PAA

TerraClean® 5.0



Hydrogen Peroxide (H2O2)

EPA Registered Soil Bactericide/Fungicide

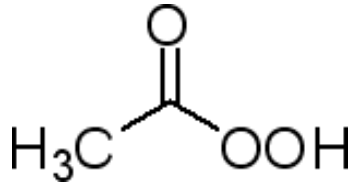
A.I: 27.0% H202 + 5.0% PAA

Approved for use in Organic production systems

Contact kill (No systemic activity)

Zero-Hour REI and PHI

Can be applied through Drip and Sprinkler Irrigation systems



Peroxyacetic Acid (PAA)

MOA

Hydrogen Peroxide and Peroxyacetic Acid works by oxidizing soil Bacterial/Fungal cells/spores with which they come into contact. Damage to cellular macromolecules including lipids, proteins and nucleic acids occur upon oxidation.

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Sustainable Soil Treatment Program with H202 + PAA for SB Plant Disease Control

BioSafe Systems

CONCEPT

Biochemical Based

Ex. Activated Peroxide (H202/PAA) based products-Sanitizes the soil root zone of the pathogens/microbiome and helps with better colonization of a follow up microbial based biopesticide application through reduced competition

Pre/At Plant

Biochemical Based (H202+PAA)

At/Post Plant

Post-Plant

Microbial Based/Biochemical Based (H202 + PAA)

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Treatment Program with H202/PAA + Bacillus/Trichoderma based Beneficial Soil Inoculant for Phytophthora Blight Control in Peppers

(HR, CA-2016)

Trt #	Treatment Name	Rate	Rate Unit	Application Timing Code	Application Timing Description	% Total Mortality from Phytophthora Blight
1	Grower Standard (G.S)	-	-	-	-	7.8 a
2	TerraClean 5.0/G.S.	2	gal/a	AB	A=transplant or close, B=A+10	2.3 ab
	TerraClean 5.0/G.S.	1	gal/a	CDEF	CDEF, 3,6,9,12 weeks	
3	Terra-Clean 5.0/G.S.	2	gal/a	A	A=transplant or close, B=A+10	0.0 b
	TerraGrow/G.S.	1.5	lb/a	BCDEF	CDEF, 3,6,9,12 weeks	
4	Ridomil/G.S.	1	pt/a	ACE	At transplant and every 3 week	3.3 ab
	Phosphite Fungicide/G.S.	2	qt/a	BDF		

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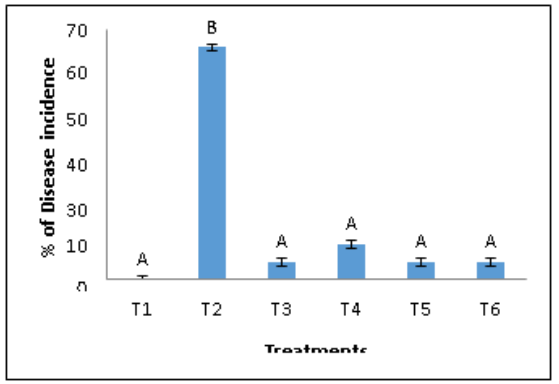
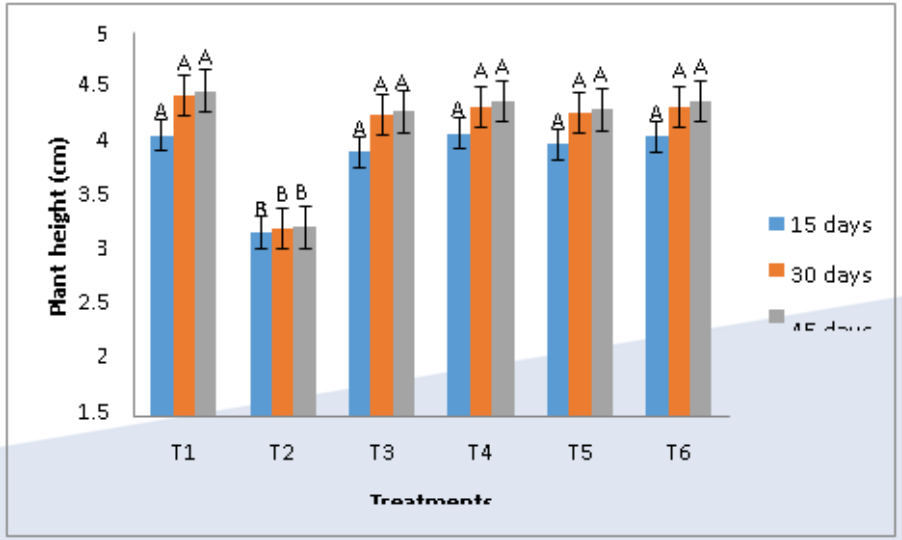
Treatment Program with H202/PAA + Bacillus/Trichoderma based Beneficial Soil Inoculant for Phytophthora Root Rot Control in Citrus Seedlings (TAMU, TX-2018)

- T1-Untreated-Uninoculated
- T2-Untreated-Inoculated
- T3-Ridomil Gold
- T6-TerraClean 5.0 followed by TerraGrow





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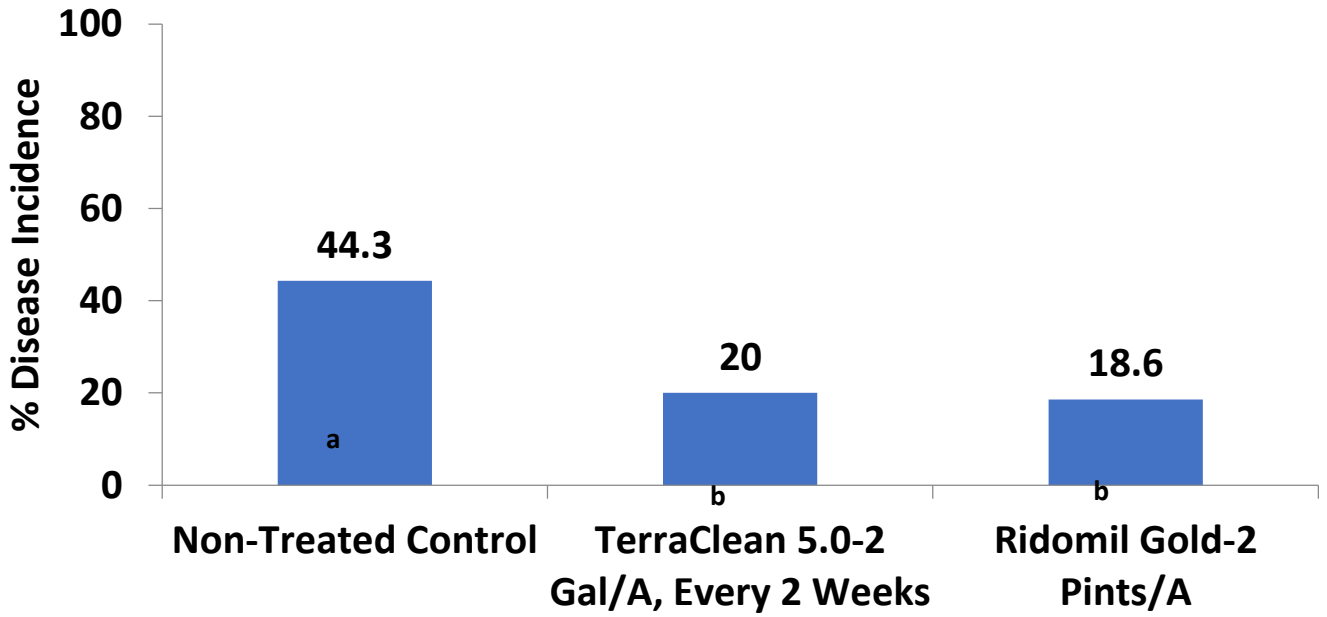
Treatment Program with H202/PAA for Phytophthora Blight Control in Tomato

(UGA, GA-2009)



Treatment	Application Schedule
Non-Treated Control	None
TerraClean 5.0-2 Gal/A, Every 2 Weeks	Pre-Plant, Post-Transplant, Once every 2 weeks, Total 5 applications
Ridomil Gold-2 Pints/A	Pre-Plant

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Biopesticide Based on Sodium Percarbonate

PerCarb® TerraCyte®PRO ALGAECIDE/FUNGICIDE

Broad Spectrum Plant Bactericide/Fungicide

Sodium Carbonate Peroxyhydrate*: 85.00%

Contains 27.60% Hydrogen Peroxide by weight

Labeled for control of major foliar diseases on field grown crops, tree crops, berries, small fruits, vine crops and greenhouse vegetable and ornamental crops.

MOA

Hydrogen Peroxide works by oxidizing Bacterial/Fungal cells/spores with which they come into contact. Damage to cellular macromolecules including lipids, proteins and nucleic acids occur upon oxidation.
The sodium carbonate also play a role in inhibiting development of fungal mycelium and spores through changes in pH and osmotic pressure of the microbial cells.

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PerCarb®

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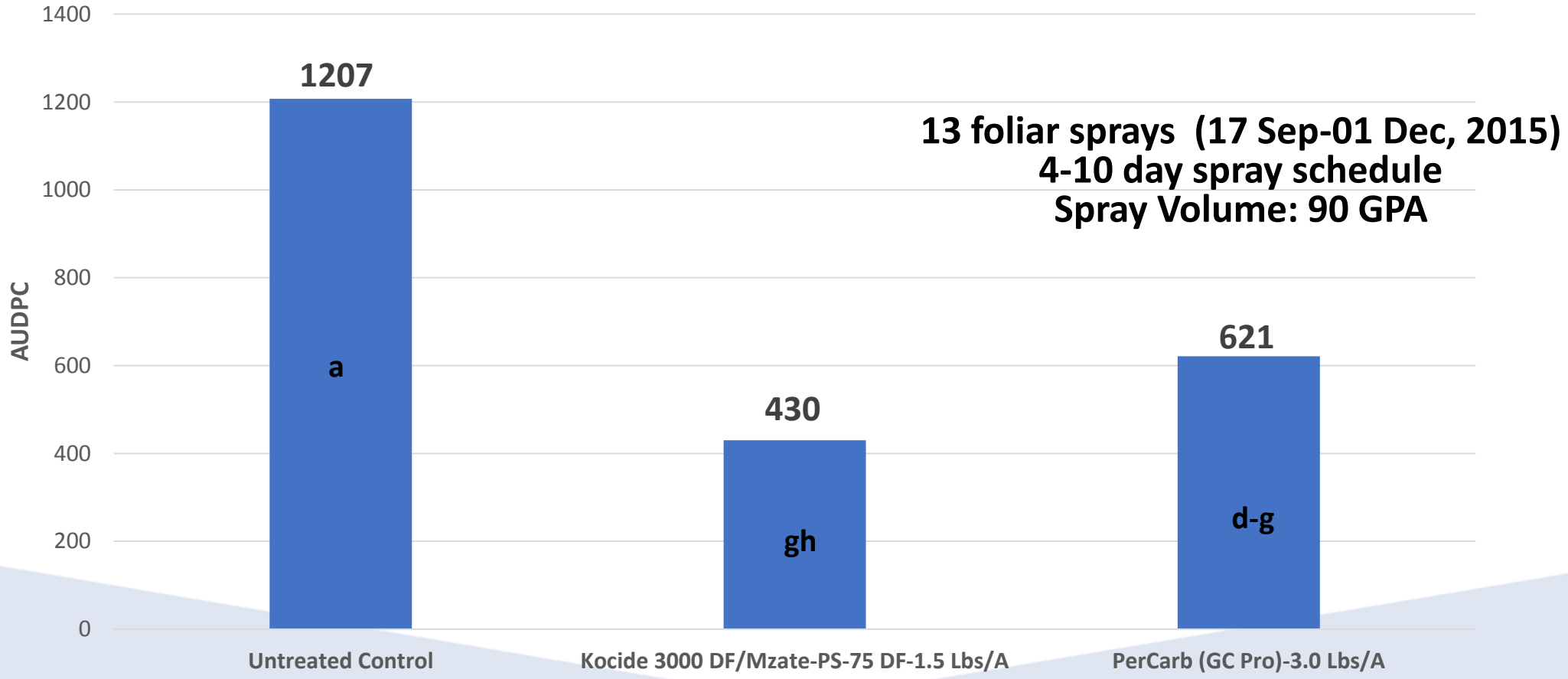
Tomato Bacterial Spot,UFL,2015



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TerraCyte® PRO
ALGAECIDE/FUNGICIDE

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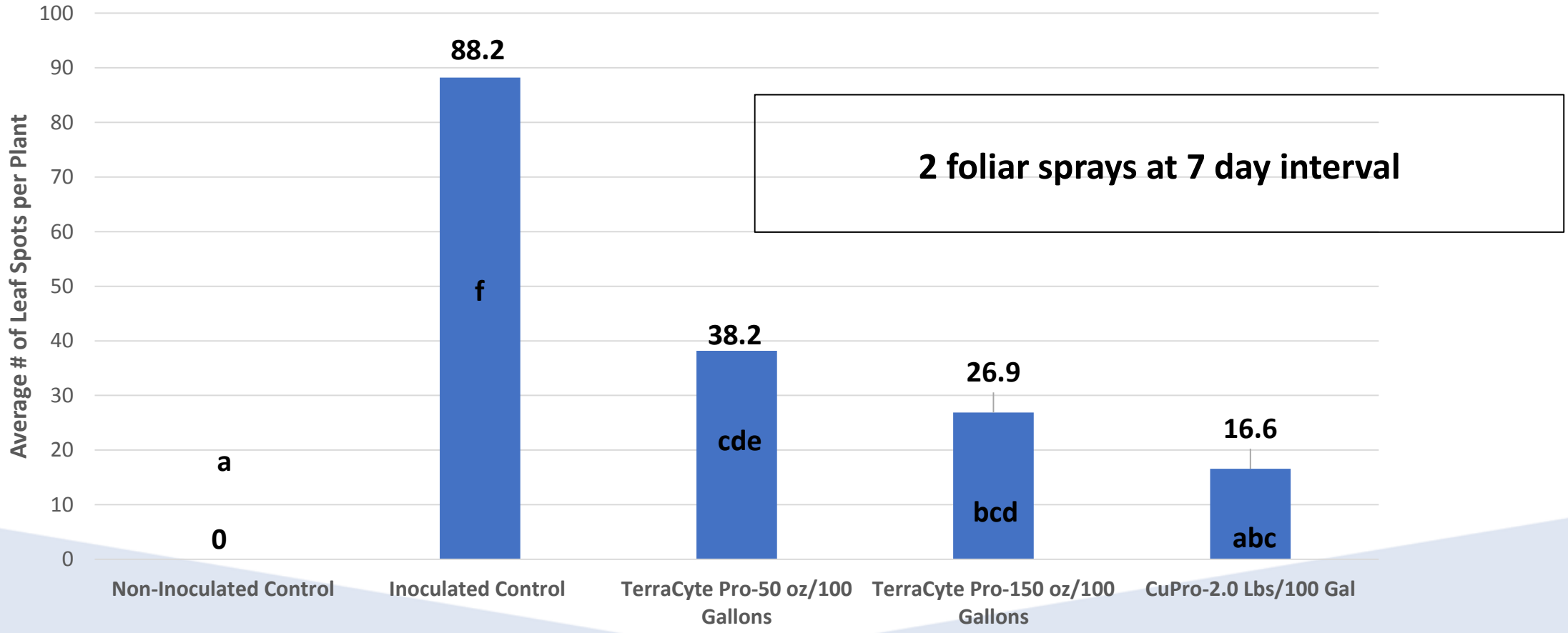
Xanthomonas LS of Geranium, 2016



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Biopesticide Based on *Gliocladium catenulatum*

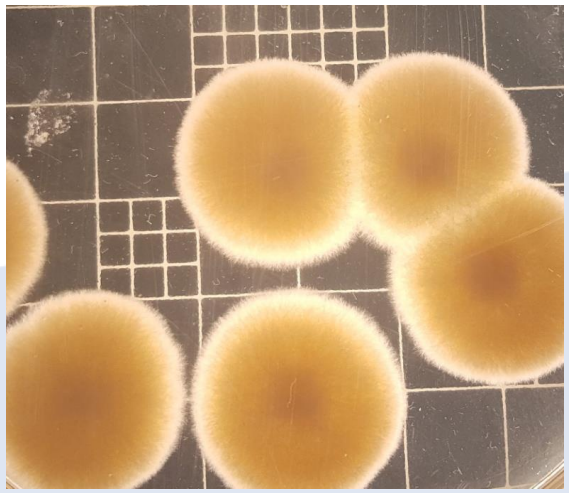
PVent®

BIOLOGICAL FUNGICIDE

Active Ingredient: ***Gliocladium catenulatum*** strain J1446…..93.0%

Contains a minimum of 1 X 10^9 CFU/g

Formulation Type: Wettable Granule (WG)



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MOA

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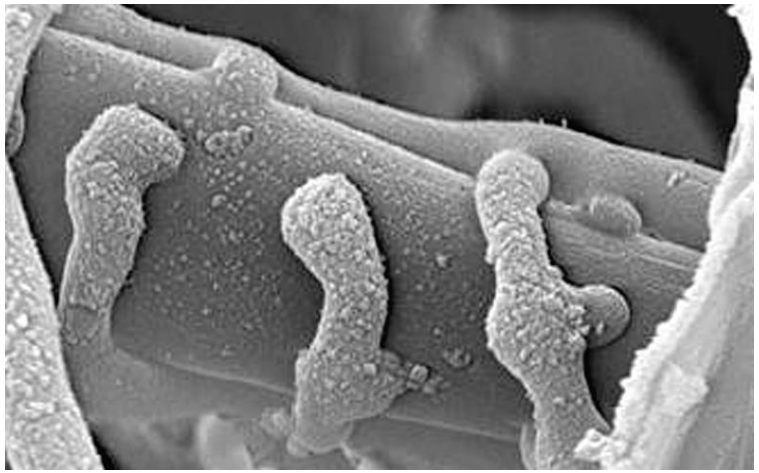
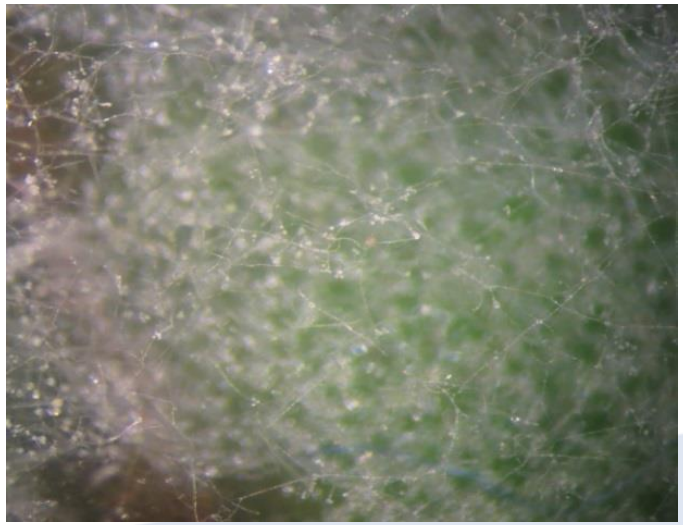


Antagonistic against many fungal pathogens

✓**Hyperparasitism**
✓**Enzyme activity on fungal structures-Chitinases and β-1,3-glucanenzymes**
✓**Colonization of root and foliar surfaces**
✓**Competition for nutrients and space**
✓**Induced Resistance**



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Available Studies on Foliar/Soil Borne/Root Diseases

- ✓ -Phytophthora Root Rot in Caneberries (Raspberries), Geranium
- ✓ -*Pythium (*Cucumbers and Basil)
- ✓ -*Fusarium* (Basil and Cucumber)
- ✓ -*Macrophomina* Charcoal Rot (Strawberry)
- ✓ -*Verticillium* (Strawberry)
- ✓ -Anthracnose (Blueberry)
- ✓ -Botrytis Grey Mold (Tomato)
- ✓ -Gummy Stem Blight (Cucumbers)

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Thank You

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