



# ***Non-living Substances of Microbial Origin***

***Pam Marrone, PhD  
CEO & Founder***



***Innovative Bio-based Products for Pest Management in Agriculture and Water***

# Safe Harbor Statement



This presentation may include forward-looking statements. These statements reflect the current views of the Company's senior management with respect to future events and financial performance. These statements include forward-looking statements with respect to the Company's business and industry in general, including statements regarding potential market size of Company products, anticipated product development costs, target geographic markets, and future goals. Statements that include the words "expect," "intend," "plan," "believe," "project," "forecast," "estimate," "may," "should," "anticipate", "target", "goals" and similar statements of a future or forward-looking nature identify forward-looking statements for purposes of the federal securities laws or otherwise. Forward-looking statements address matters that involve risks and uncertainties, such as the timing of and costs associated with the launch of products, the difficulty in predicting the timing or outcome of product research and development efforts and regulatory approvals. Accordingly, there are or will be important factors that could cause the Company's actual results to differ materially from those indicated in these statements. The statements made herein speak only as of the date of this presentation.

# Marrone Bio Innovations Corporate Overview

## Company Highlights

- Incorporated in June 2006
- **4** commercially available products, **2** add'l approved & **1** submitted for EPA registration
- 110 employees
- Library of **18,000+** proprietary microorganisms screened against a range of
- Wholly-owned, operational fermentation facility in Bangor, Michigan
- Early in our long-term growth curve
- Listed on NASDAQ as MBII August 2, 2013

## Commercial Products Today



## Marquee Partners / Distributors



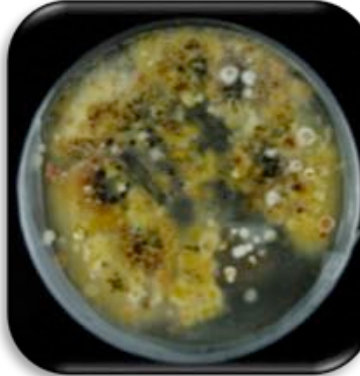
## Robust Pipeline

- Pipeline products: HAVEN™ sun stress anti-transpirant product, two nematicides, a systemic herbicide, a downy mildew fungicide and two biostimulants
- Many more earlier stage candidates across all categories
- 10 US, 20 foreign patents issued; more than 300 patents pending

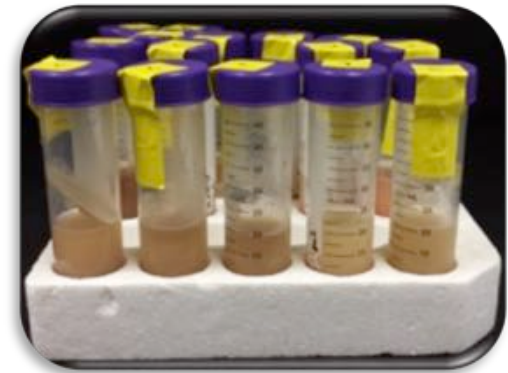
# Discovery: Sourcing and Isolation of Microorganisms



Soil and other types of samples collected, from unique habitats and niches



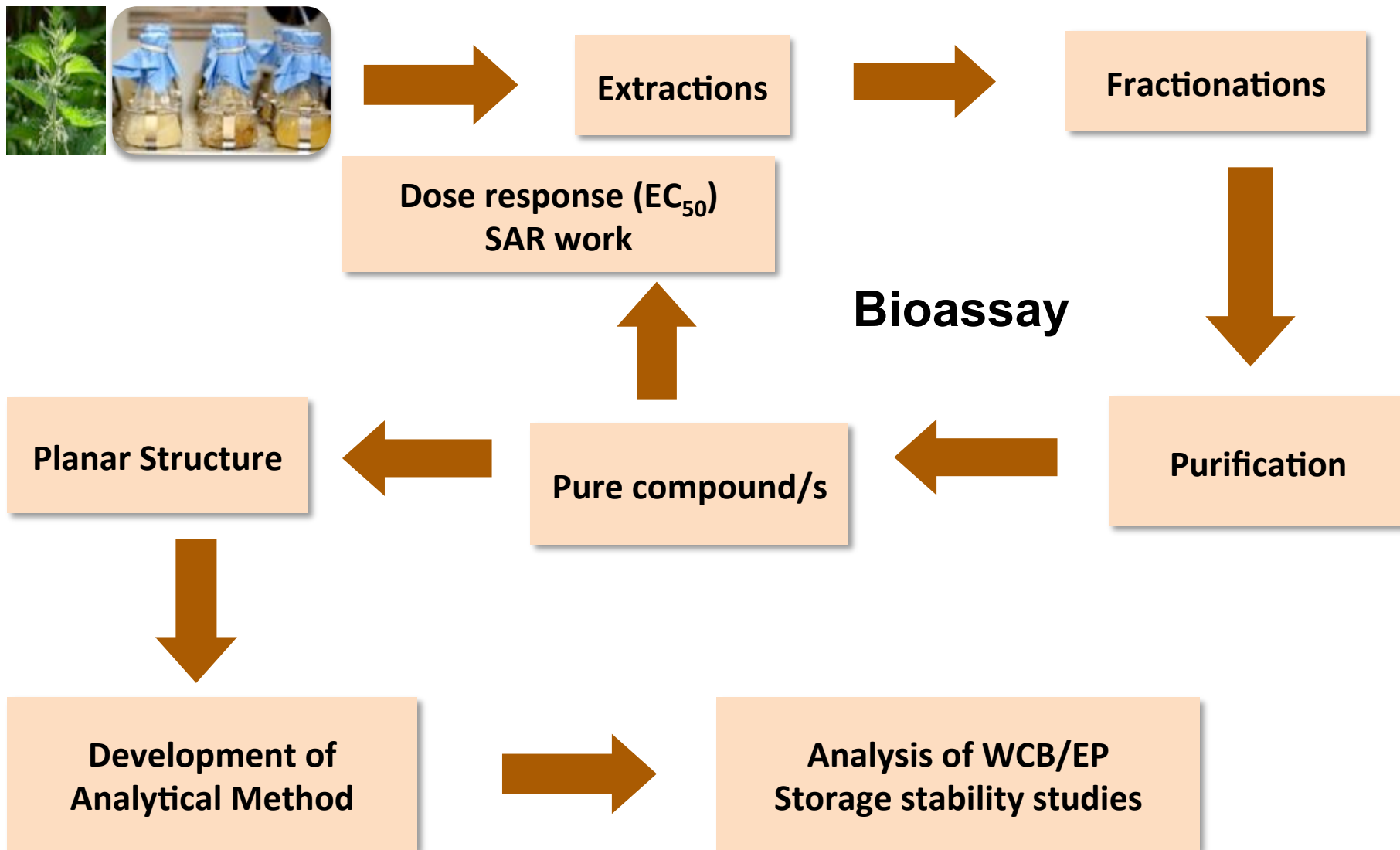
Individual fungal, bacterial, and actinomycete colonies picked from primary plate



Water extracts of fermentation broths are used for bioassays



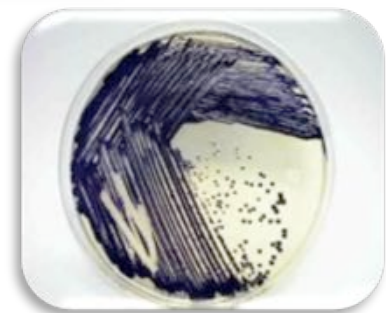
# Natural Product Chemistry



# GRANDEVO® Bioinsecticide

- *Chromobacterium subtsugae* (USDA discovery)
- Proprietary insecticidal compounds produced by the bacteria – different chemical classes each have different mode of action
- NO contact activity (will not kill insects if applied to the cuticle)
- Non-toxic to non-target organisms including bees
- Repellency, feeding cessation (in seconds), reduces reproduction; **very slow kill – huge challenge for assessing efficacy and for development into a product**

 **GRANDEVO®**  
BIOINSECTICIDE



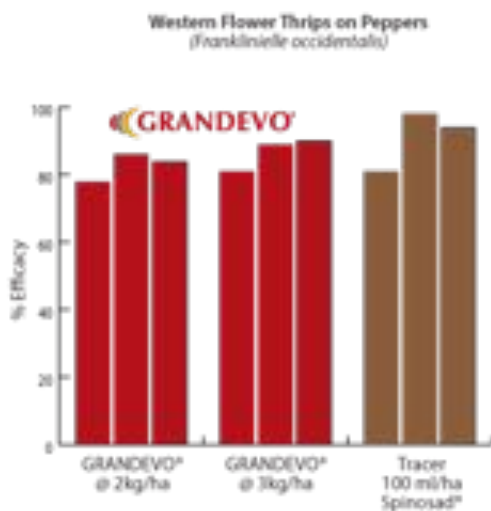
Photos courtesy of: *Lygus* Entomart; *Beet armyworm* Clemson Univ. USDA Cooperative Extension Slide Series Bugwood.org; *Western flower thrip* Frank Peairs, CO St. Univ. Bugwood.org; *citrus leaf miner* Center for Invasive Species Research, UC Riverside; ; *cabbage Looper* RJ Reynolds Tobacco Company, Bugwood.org; *twospotted spider mite* Clemson EDU

# Unique Mode of Action for Residue & Resistance Management in IPM Programs

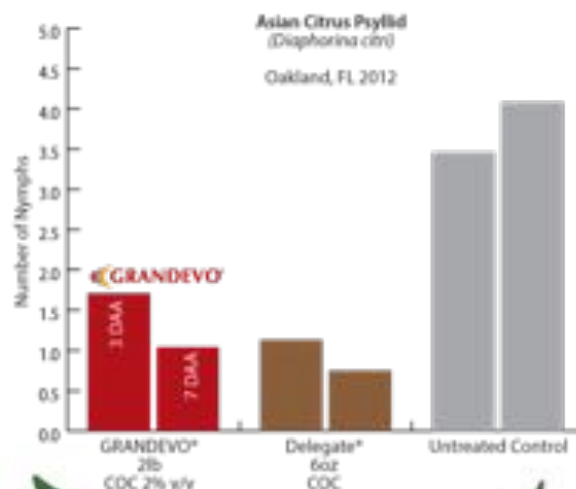
When used before populations explode, **GRANDEVO®** is an asset to IPM programs



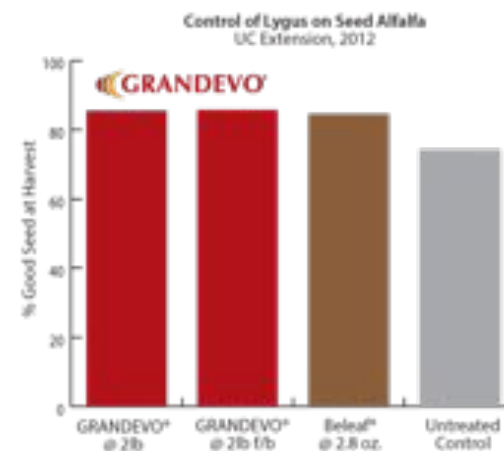
## Thrips on Peppers



## Asian Citrus Psyllid



## Lygus on Seed Alfalfa

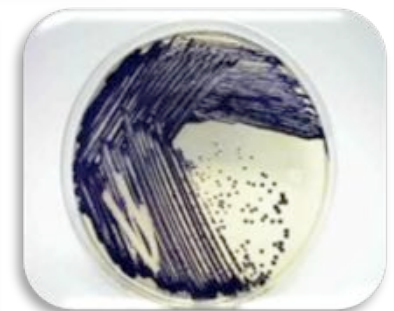




# GRANDEVO® Bioinsecticide Registration Status

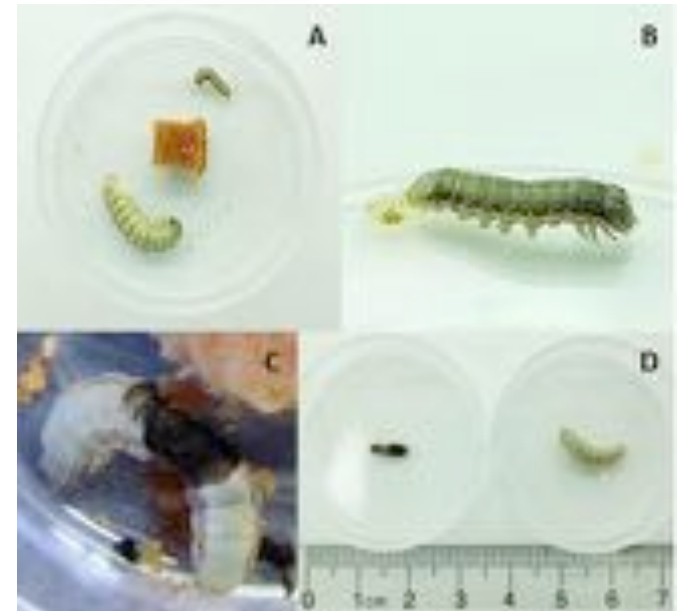
- Non-spore former so cells die off in the formulation
- Registered in the US by the EPA
- Submitted to Mexico; Brazil for emergency use
- EU Dossier completed
- Successful meeting with Ctgb (Netherlands) – green light for submission as a microbial
- Expecting that more information will be required by the authorities on the compounds
- Violacein (the purple pigment) already has extensive toxicological information published

 **GRANDEVO**®  
BIOINSECTICIDE



Photos courtesy of: *Lygus* Entomart; *Beet armyworm* Clemson Univ. USDA Cooperative Extension Slide Series Bugwood.org; *Western flower thrip* Frank Peairs, CO St. Univ. Bugwood.org; *citrus leaf miner* Center for Invasive Species Research, UC Riverside; ; *cabbage Looper* RJ Reynolds Tobacco Company, Bugwood.org; *twospotted spider mite* Clemson EDU

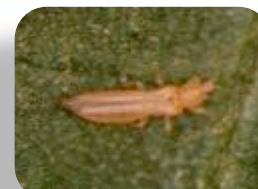
- New bacterial species of *Burkholderia*.
  - Cordova-Kreylos, et al. "Isolation and Characterization of *Burkholderia rinojensis* sp. nov., a non-Bcc soil bacterium with insecticidal and miticidal activity." *Applied and environmental microbiology* (2013): AEM-02365.
- Product is killed cells
- Several active compounds, different chemical classes, some novel, found in the whole cell broth
- Slow kill – disrupts cuticle melanization
- Active on contact and by ingestion; broad spectrum—sucking and chewing insects, mites, and flies
- Nontoxic and nonpathogenic to rats, fish, birds, *Daphnia*, and beneficial insects, including bees



Photos courtesy of: *Pepper weevil* Alton N Sparks, Univ of GA, Boxwood.org; *Beet armyworm* Clemson Univ. USDA Cooperative Extension Slide Series Bugwood.org; *Western flower thrip* Frank Peairs, CO St. Univ. Bugwood.org; *Cabbage Looper* RJ Reynolds Tobacco Company, Bugwood.org; *Twospotted spider mite* Clemson EDU

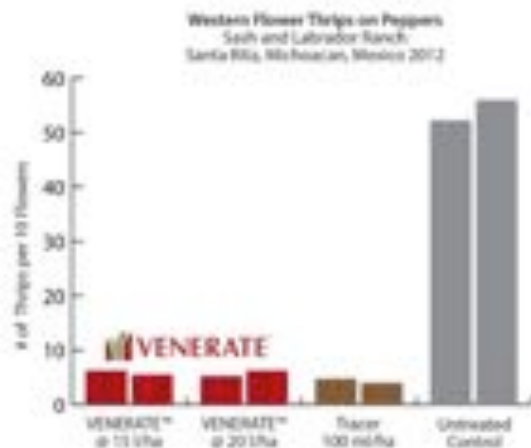
# For IPM Programs Without Residues or Risk of Resistance; Safe to Bees & Other Beneficials

**VENERATE® performs well against ...**

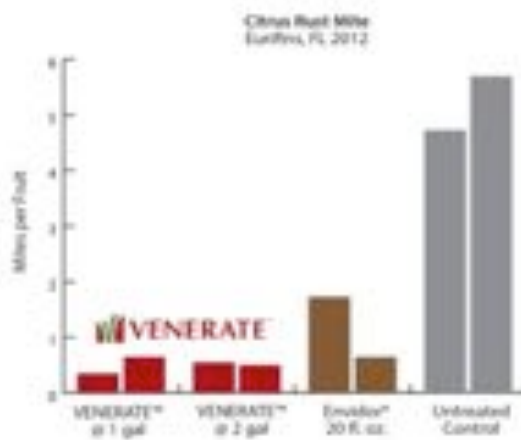


*... and provides excellent control of...*

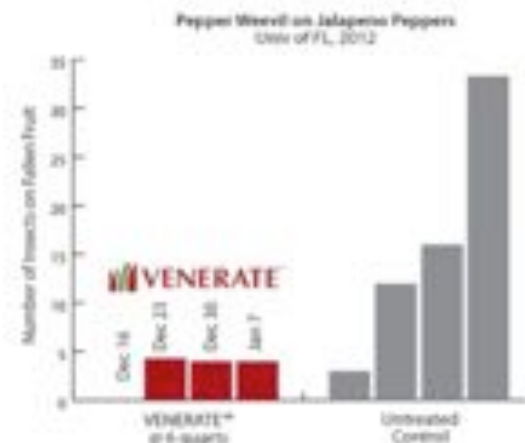
## Thrips



## Citrus Rust Mites

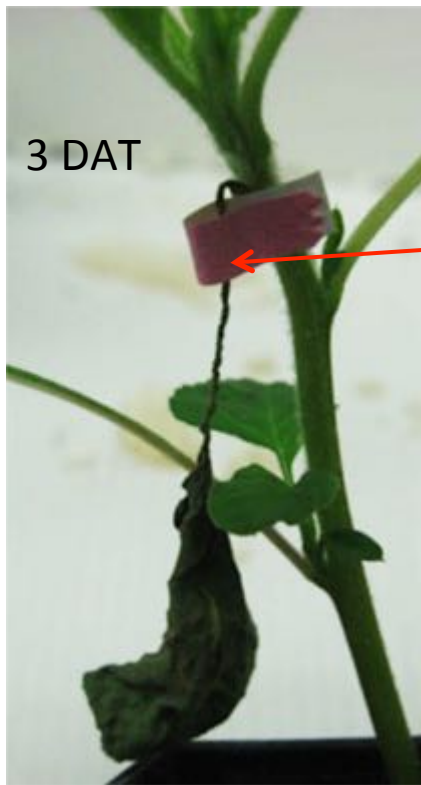


## Pepper Weevils



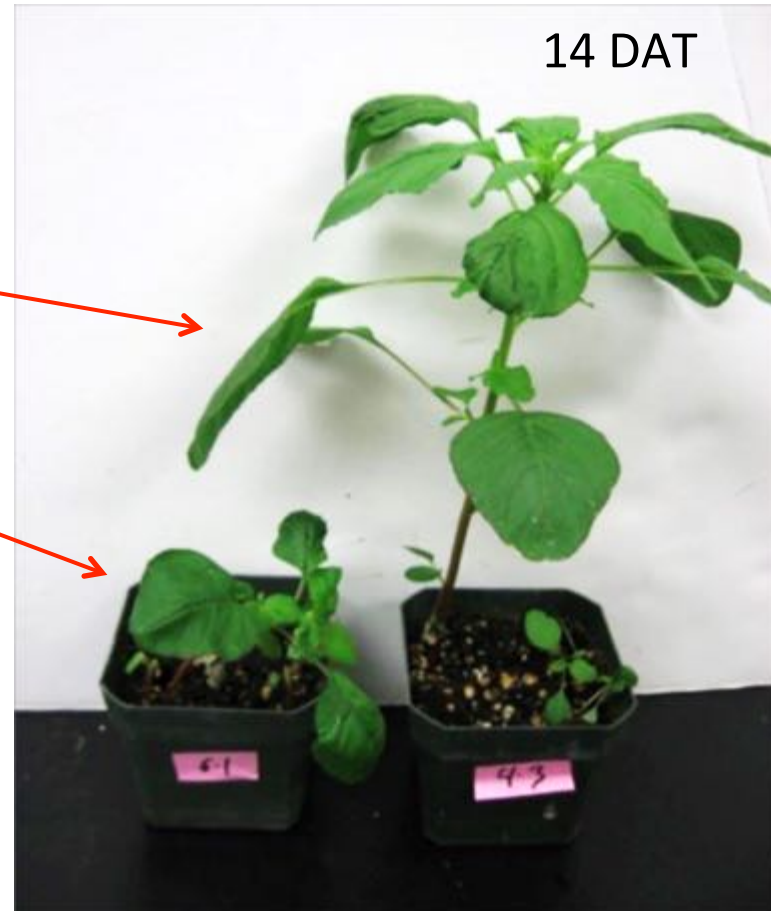
# MBI-010 Systemicity (Pigweed) – Xylem Mobility

Treating **one** petiole/plant kills leaf quickly and subsequently stunts entire plant



Water

MBI-010

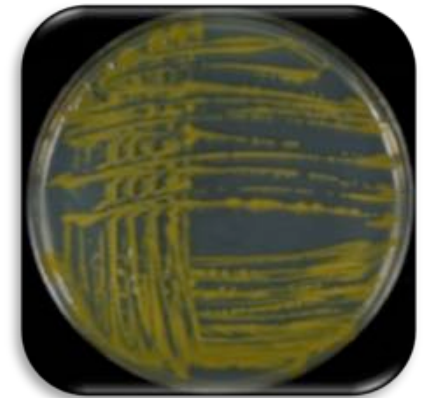


MBI-010 is xylem-mobile

# MBI 302 Bio-Nematicide

(*Flavobacterium* sp. H492 – novel species)

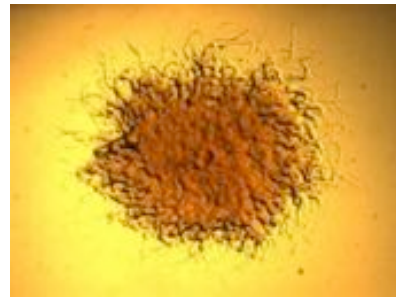
- Product is dead bacteria, but not deliberately killed
- Wide-spectrum nematicidal activity against plant parasitic nematodes, such as *Belonolaimus longicaudatus*, *Heterodera glycines*, *Meloidogyne incognita*, *Pratylenchus* sp., *Rotylenchulus reniformis*.
- Activity observed in whole cell broth, cell pellet, and supernatant
- Identified a polyketide compound in part responsible for the nematicidal activity
- Full EPA package, including toxicology prepared – just needs formal species ID of the microbe



# The Genus *Flavobacterium*



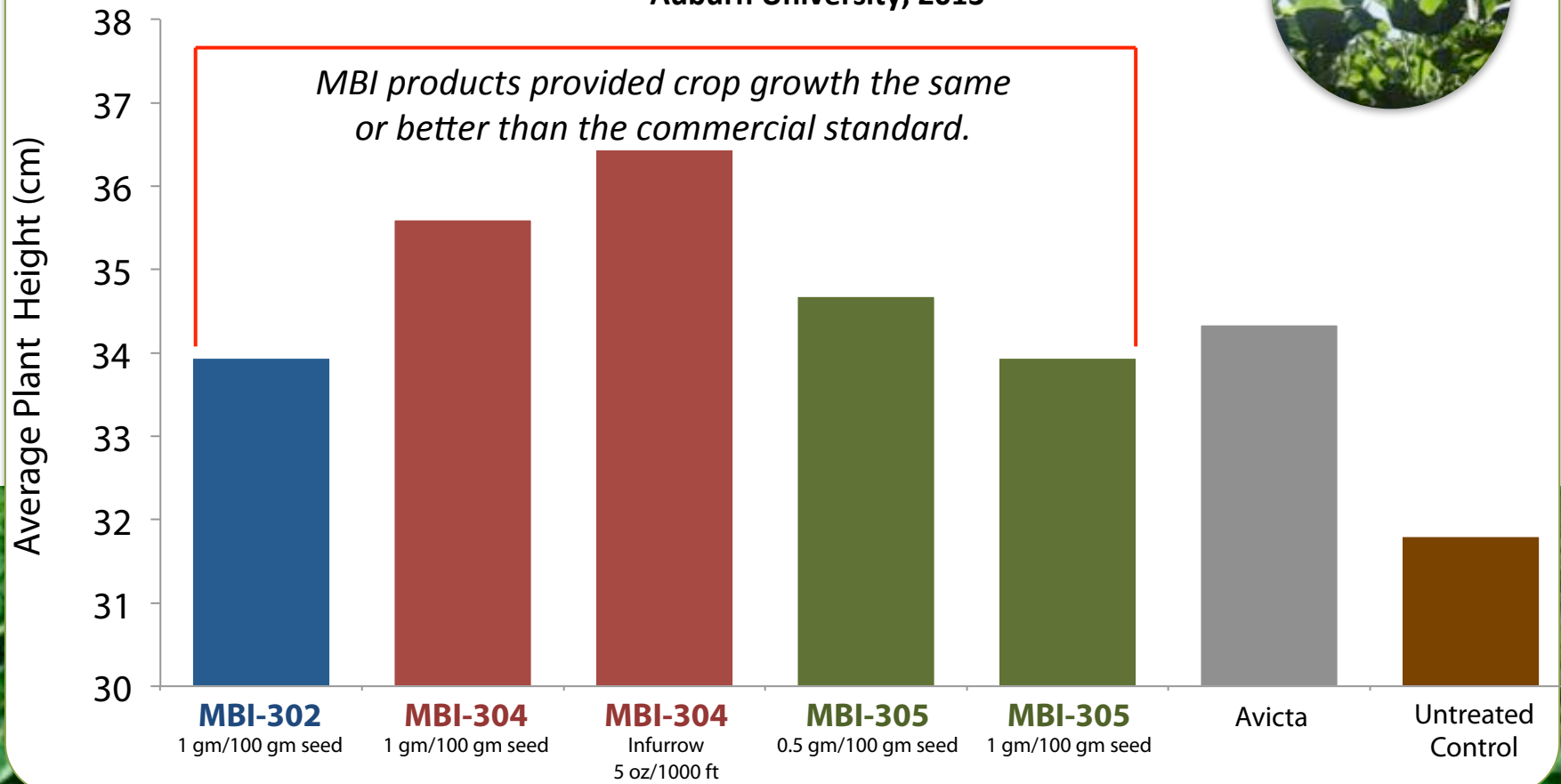
- Gram negative, rods, most are catalase positive, strictly aerobic.
- Widely distributed in nature: fresh to salt water, soils, microbial mats, fish, algae, microbial mats.
- Prefer cool to cold environments and are psychrotolerant
- Biotechnological applications due to cold active enzymes
- Strict aerobic metabolism, oxidase positive
- Some species are known fish pathogens (salmon and rainbow trout):
  - *F. columnare*
  - *F. branchiophilum*
  - *F. hydatis*
  - *F. johnsoniae* → opportunistic “soft rot” in plants
  - *F. psychrophilum*
  - *F. succinicans*
- Normal bacterial flora in fish surface, gills, guts and eggs.



# Soybean Seed Treatments – Plant Height



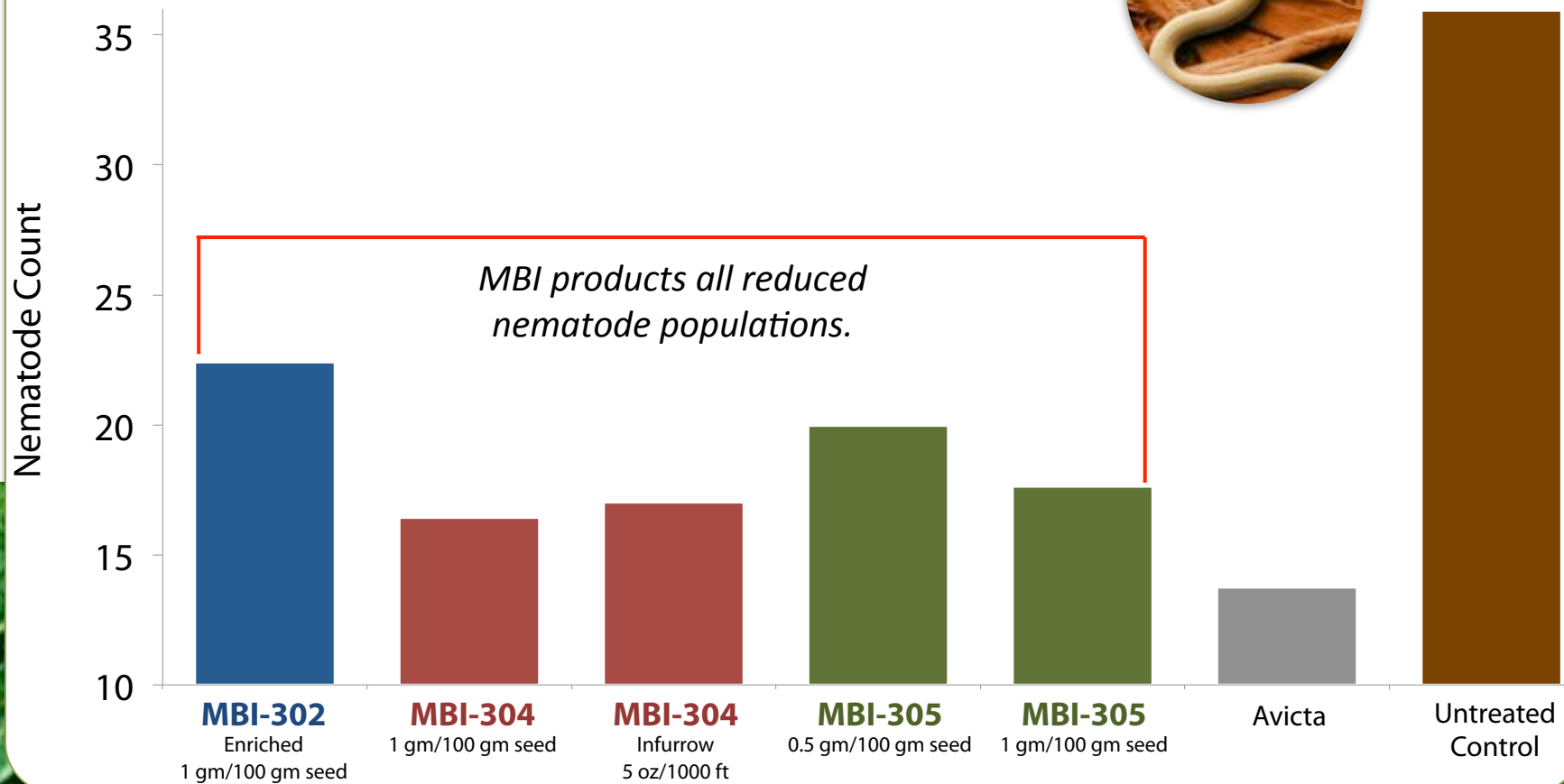
**Soybean Cyst Nematode Control  
(*Heterodera glycines*)  
Average Plant Height (cm)  
Auburn University, 2013**



- Treatments applied at planting on Jun 3.  
- Treatments evaluated on July 30.

# Soybean Seed Treatments – Nematode Counts

Soybean Cyst Nematode Control  
(*Heterodera glycines*)  
Nematode Count  
Auburn University, 2013



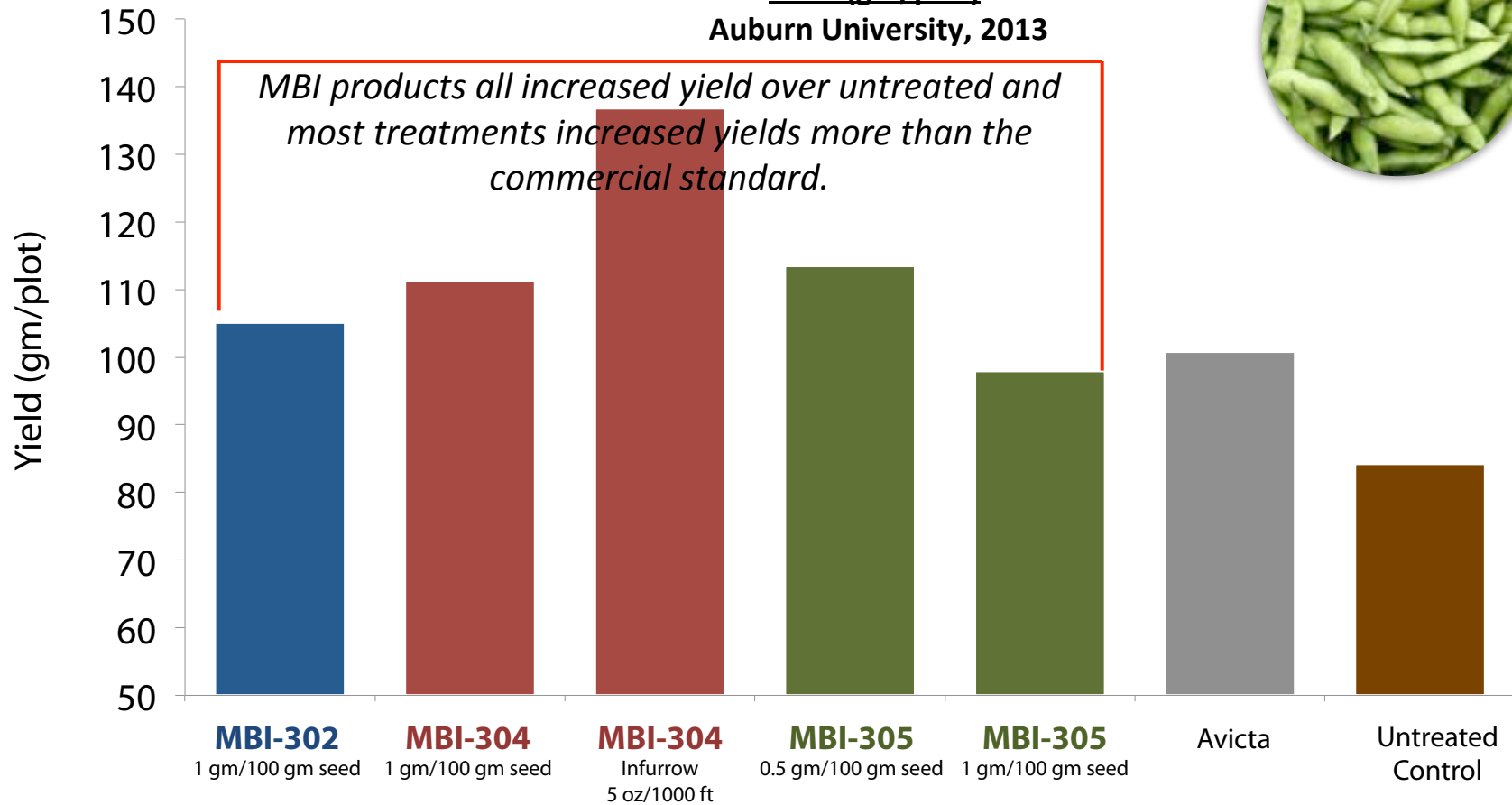
- Treatments applied at planting on Jun 3.  
- Treatments evaluated on July 30.



# Soybean Seed Treatments – Yield



**Soybean Cyst Nematode  
(*Heterodera glycines*)  
Yield (gm/plot)  
Auburn University, 2013**



- Treatments applied on Jun 3.  
- Yield evaluated on Oct 8.

# Invasive Mussels Cause \$ Billions in Economic & Environmental Damage



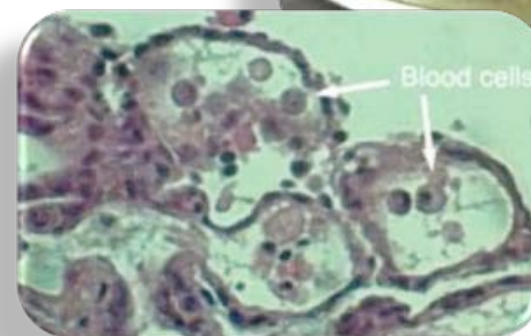
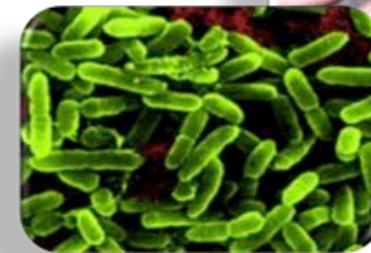
# About Zequanox

ZEQUANOX<sup>®</sup>  
Invasive Mussel Control

- Active ingredient discovered by research team seeking environmentally-friendly alternative to chemical control
- Derived from killed cells of the common soil microbe, *Pseudomonas fluorescens* strain CL145A (Pf CL145A)
- Controls mussels in all life stages; one 6 hr treatment is effective (70-100% kill)
- Highly selective toward zebra/quagga mussels
- Effective in a broad range of water conditions and temperatures
- Noncorrosive to infrastructure and equipment



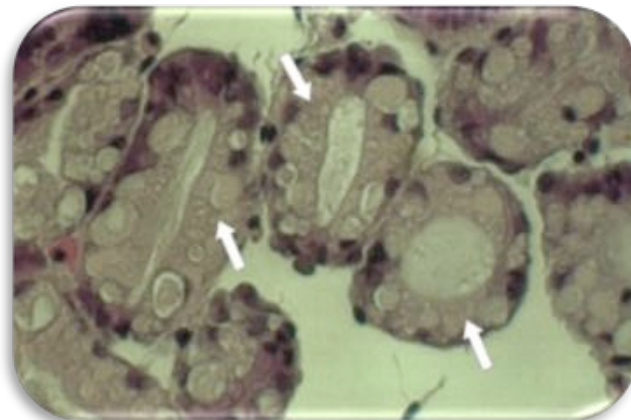
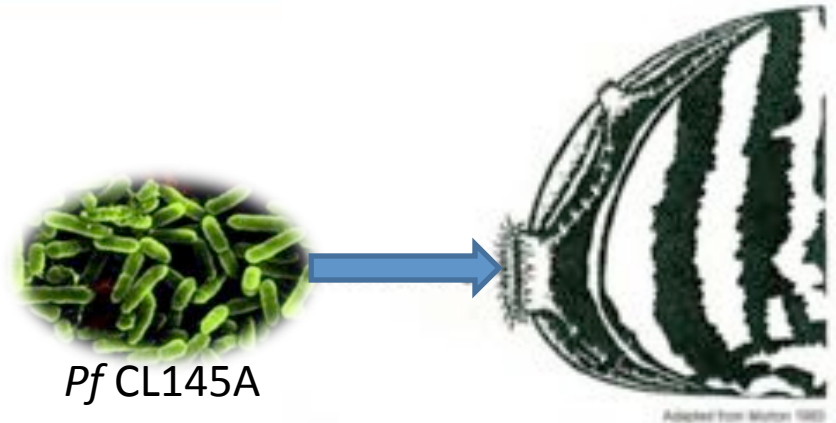
NEW YORK State Museum



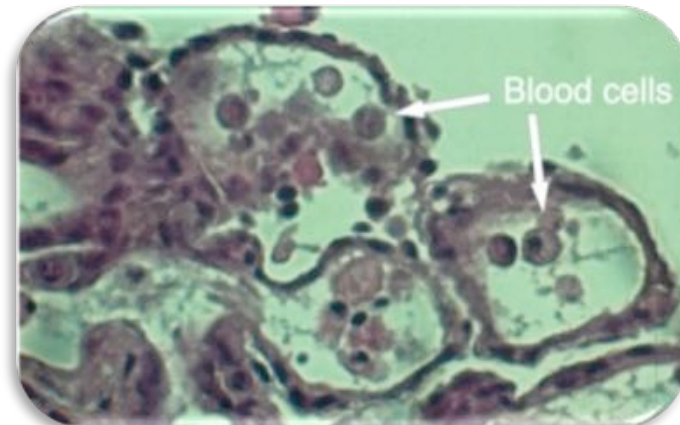
# How it Works



- Mussels perceive Zequanox as a food source and continue feeding during treatment
- Dead *Pf CL145A* cells contain compounds that destroy epithelial cells in the mussels' digestive system, causing hemorrhaging and death



In healthy mussels, epithelial cells (arrows) appear as a thick layer lining the tubules of the digestive gland.



Following treatment, epithelial cells are destroyed. Blood cells are abundant as the digestive gland hemorrhages.

# Zequanox at Work – Rapid Response in MN

- Christmas Lake, MN
- Zequanox Invasive Mussel Control
- Zebra mussels discovered August 2014 at public boat launch
  - Quarantined area with barriers
- Zequanox selected as rapid response tool
  - Dept. of Natural Resources, Minnehaha Creek Watershed District, City of Shorewood
- Zequanox treatment occurred Sept. 8, 2014
  - Within barriers around public boat launch
  - 100% control after 11 days



# Registration Status



- US EPA Registrations
  - Enclosed systems (defined inlet/outlet) – March 2012
    - Examples: conveyance water, power plant cooling systems, industrial service water, golf course irrigation systems, etc.
  - Recreational and Environmental Rehabilitation – June 2014
    - Examples: lakes, reservoirs, rivers, etc.
- Classified as tolerance-exempt by US EPA
- Waters can be used for recreation and other contact activities immediately after treatment
- Europe submitted as a killed microbial
  - Requires more work on the proteins and analytical methods for protein detection





# QUESTIONS?

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