Marrone® Bio Innovations

Advances in Organic Insect, Disease and Nematode Management

Best Use Practices of Biopesticides in IPM Programs and New Products from MBI

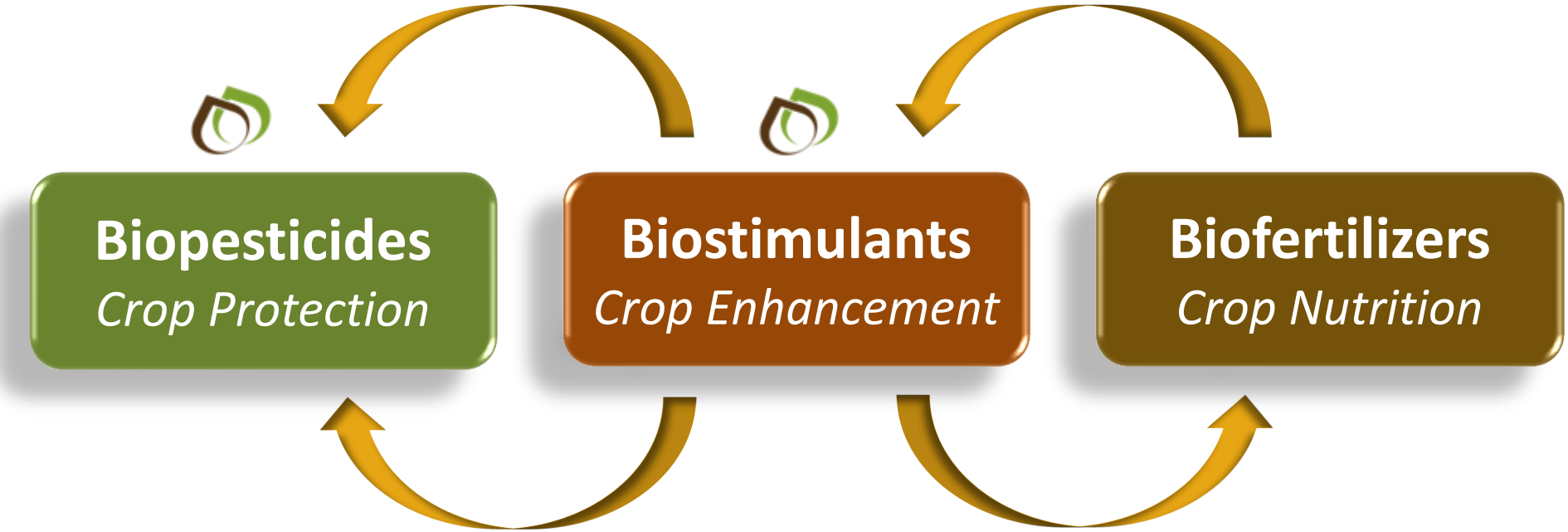
Tim Johnson
VP Field Development and Technical Services

Safe Harbor Statement

This presentation contains forward-looking statements that involve substantial risks and uncertainties. All statements, other than statements of historical facts, included in this press release regarding strategy, future operations and plans, including assumptions underlying such statements, are forward-looking statements, and should not be relied upon as representing the Company's views as of any subsequent date. Such forward-looking statements are based on information available to the Company as of the date of this presentation and involve a number of risks and uncertainties, some beyond the Company's control, that could cause actual results to differ materially from those anticipated by these forward-looking statements, including any difficulty in developing, manufacturing, marketing or selling the Company's products, any failure to maintain and further establish relationships with distributors, competition in the market for pest management products, lack of understanding of bio-based pest management products by customers and growers, adverse decisions by regulatory agencies, and the impact of negative publicity and perceptions around the company's financial restatement. Additional information that could lead to material changes in the Company's performance is contained in its filings with the SEC. The Company is under no obligation to, and expressly disclaims any responsibility to, update or alter forward-looking statements contained in this presentation, whether as a result of new information, future events or otherwise.

This presentation references product shipments, a measure used by the Company that is not defined by, or presented in accordance with, generally accepted accounting principles ("GAAP"), to evaluate various aspects of its business. Product shipments is a non-GAAP financial measure and should be considered in addition to, not as a substitute for, product revenues reported in accordance with GAAP. Product shipments as used in this presentation is defined as product revenues, plus related party product revenues, plus the incremental amount of deferred revenues accrued during the applicable period from product shipments. This calculation specifically excludes changes in deferred revenue related to license revenues and customer deposits, and is intended to approximate the total value of products sold and under contract for sale in a given period. Please refer to the Company's filings with the SEC, including its earnings releases, for a reconciliation of product shipments to product shipments and further discussion of this metric.

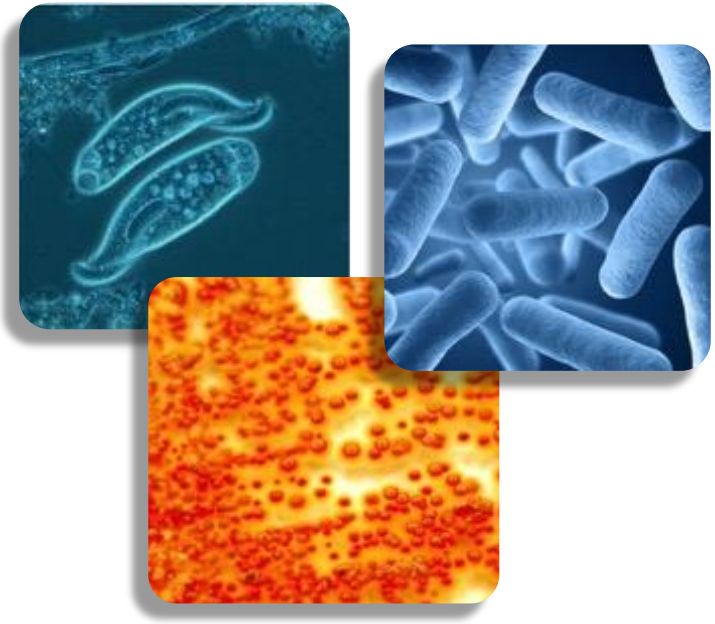
Bio What?



- Many companies offer biostimulants, but fewer venture into biopesticides because of the higher technical and regulatory barriers to entry.

Biopesticide Categories

Microbials



Fungi, Bacteria, Viruses, and Protozoa

Biochemicals

Plant Extracts, Pheromones, Soaps, and Fatty Acids

A 70 year history of safe use of biopesticides
Faster and less expensive EPA registration than synthetic chemicals

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What are Biopesticides? Some Examples

Microbials

Agree®, Dipel®, Javelin®, Deliver®, Biobit®, Crymax®, XenTari®

Serenade®, Sonata®, Ballad®, Double Nickel®, Taegro®, LifeGard®, Stargus®

Grandevo®, Venerate®, Majestene®

Bio-Tam® 2.0, Soilgard®, RootShield®, Actinovate® AG

BotaniGard®, PFR-97™,

CYD-X®, Gemstar® LC, CYD-X HP® Madex® HP

VOTiVO®, MeloCon®, CLARIVA®

Biochemicals

Des-X®, M-Pede®

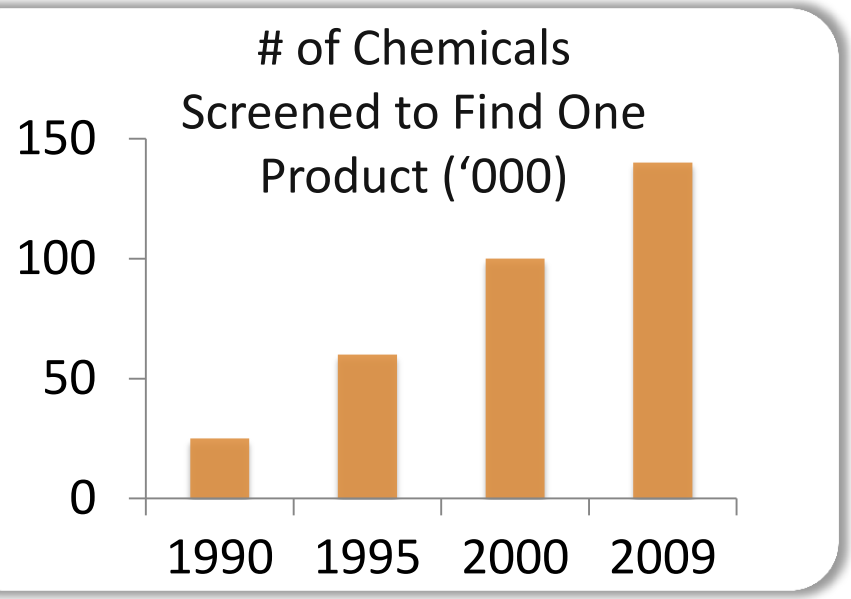
Final-San-O®

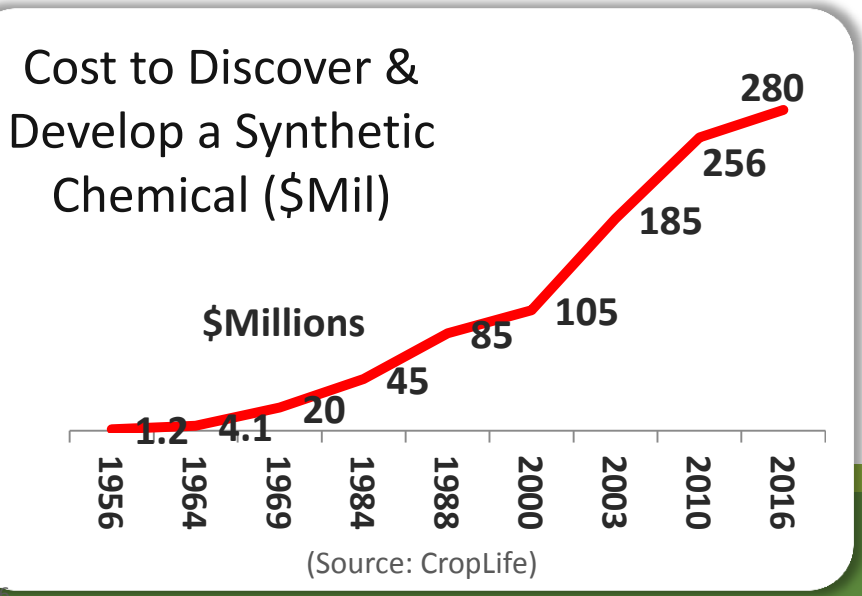
Azatin®, Neemix®, Trilogy®

Regalia®

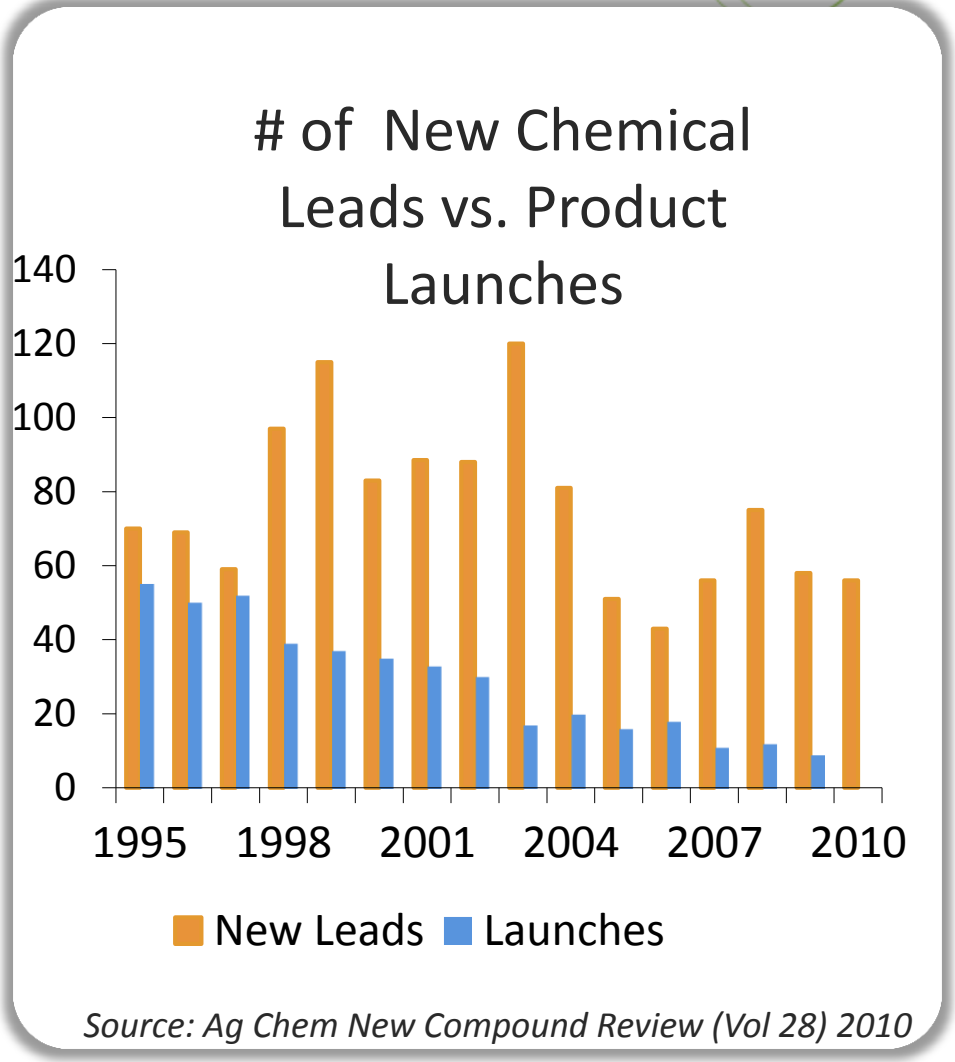
Insect Pheromones for Mating Disruption

Why Microbes?
Fewer New Chemicals – Higher Cost





(Source: CropLife)



Source: Ag Chem New Compound Review (Vol 28) 2010

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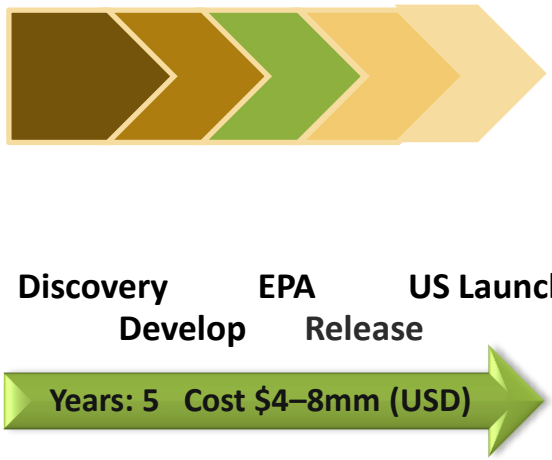
Bringing Biopesticides to Market



- ✓ Shorter statutory timeline for EPA approval of biopesticides
- ✓ Reduced toxicology requirements if no direct toxic effects
- ✓ Shorter development time
- ✓ Add additional $10-20 million for global development

Average Chemical Pesticide

(1) Source: Crop Life America.

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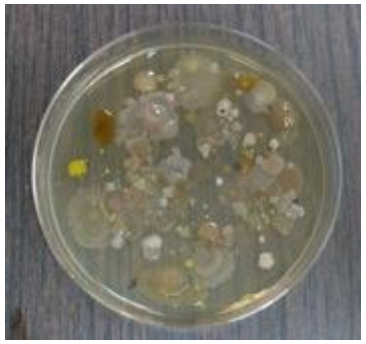
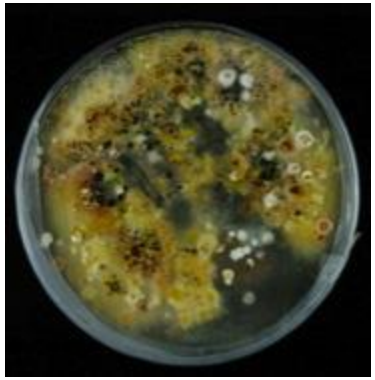
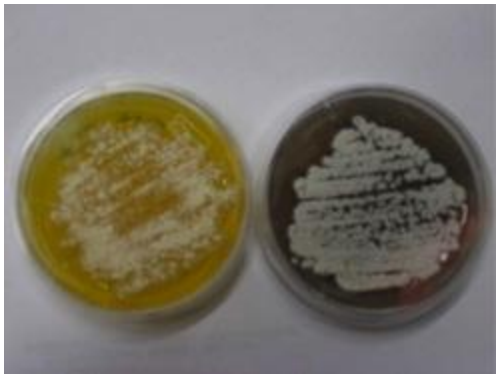
Microorganisms Isolated From Unique Habitats and Geographies

Samples from around the world from habitats of high biodiversity are cultured on specific media - Internal isolations and external collections





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



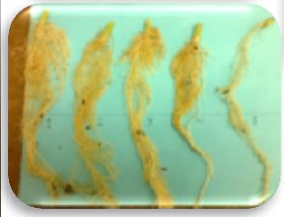
Purity is confirmed on separate plates

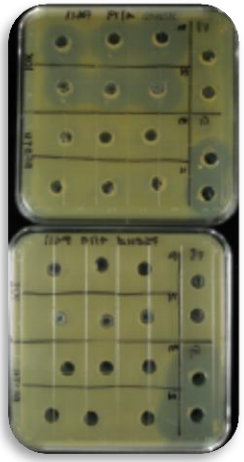
Water extracts of fermentation broths are used for bioassays

Primary Screens

Insecticide	Fungicide	Herbicide	Nematicide	Algaecide	Bactericide	Biostimulants
Lygus *Beet armyworm* Corn rootworm	*Botrytis cinerea* *Phytophthora capsici*	Crabgrass Lettuce	*Meloidogyne spp.*	*Chlamydomonas reinhardtii*	*Xanthomonas campestris* *Pseudomonas syringae*	*Tomatoes, Corn, Radish, Soy & Others*






Product and Process Development

Develop user-friendly formulations (lab & pilot facilities)

Develop and scale manufacturing processes (lab, pilot & mfg. facilities)

Conduct field trials

Develop data for the regulatory submission

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How to Maximize Your Product's Effectiveness – Some Abiotic and Biotic Variables

- Water pH
- Water hardness
- Water volume/dilution
- Spray droplet size
- Adjuvant effect
- Impact on beneficials
- Impact on pollinators
- Tank-mix partners
- Application timing
- Application interval

We have to read the labels!

Compatibility

The state of being compatible; in which two or more things are able to exist or perform together in combination without problems or conflict.

Is your biopesticide compatible with your water?

pH matters, near neutral is almost always best

Water hardness matters, too many ppm has negative effect. >1000 ppm decreases the efficacy of Grandevo DF

Chlorination matters

Compatibility

The state of being compatible; in which two or more things are able to exist or perform together in combination without problems or conflict.

Is the product you are going to use compatible with all those other products you are thinking of adding to the tank?

Compatibility

Hint: this is bad

Actual Tank-mix – Apple Pre-bloom in Michigan

1. Water conditioning agent
2. Captan® 80WG @ 2 lbs.
3. Prevam® @ 1 pint
4. KoverAll® @ 3 lbs.
5. Rally® 40WSB @ 4 oz.
6. Warrior® @ 5.1 oz.
7. VitaZyme® @ 1 pint
8. BoronXtra® @ 4 oz.
9. ZincRush® @ 1 pint
10. Imidacloprid® 4F @ 3.2 fl. oz.
11. CS2005® @ 1 pint

What could possibly go wrong?

5 lb. 11 oz. dry products, 40 fl. oz. liquid products in 30 GPA

Remember Your Mixing Order

Water Conditioners, WP, DF, WDG, Flowables, Micro-emulsions, EC, Soluble liquid concentrates, Crop Oils, Adjuvants

No hot mixes! Water goes into the tank first. Making a slurry with WP and DFs prior to adding to the water tank can be beneficial.

What Type of Biopesticide Are You Applying? Is the A.I. "Dead or Alive"?

- Insect viruses are sensitive to high temperatures (>86 F). Keep refrigerated or frozen until use. Use non-chlorinated water near pH 7.

- Fungal-based products may be sensitive to tank-mixing with fungicides. PFR-97™can be applied with copper fungicides but not within 5 days of other chemical fungicides (tank-mixing is not allowed). *Trichoderma* products have mixing limitations.

Putting Together a Game Plan

- Put together your game plan before the crop is planted or breaks dormancy
- Sustainable versus Certified Organic
- Research product labels
- What are the key pests?
- Research trial data, both university and company provided

Putting Together a Game Plan

- Ask questions. Company reps are there to help you. Use company help lines (internet).
- Beware of tripping hazards – water quality, improper tank mixes
- Do not wait until it is too late

MBI Products

REGALIA® BIOFUNGICIDE

The industry's 1st effective plant-extracted fungicide; Increases yields/quality on multiple crops

STARGUS™ BIOFUNGICIDE

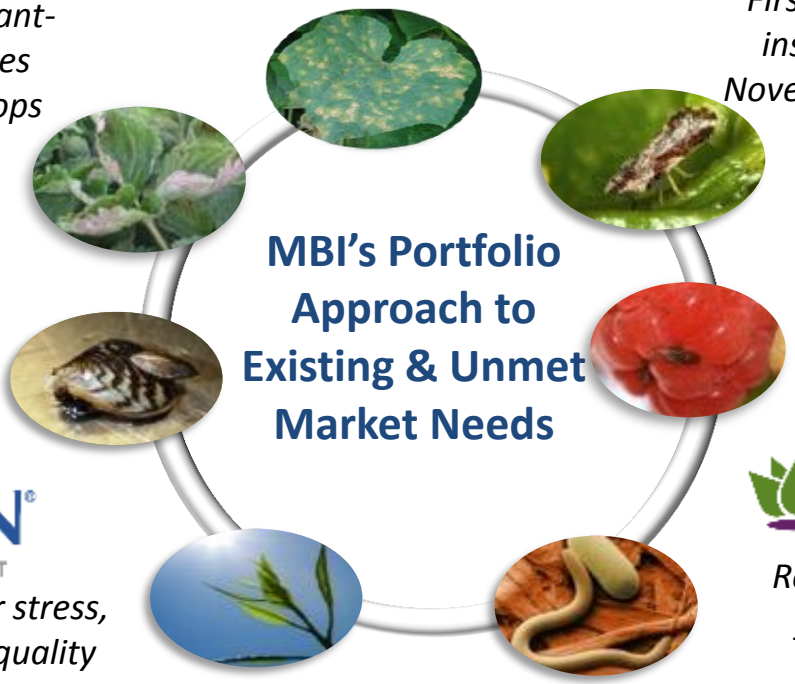
Breakthrough efficacy against downy mildews, white molds & Botrytis

GRANDEVO® BIOINSECTICIDE

First broad spectrum microbial insecticide since Bt (50+ yrs); Novel chemistry & mode of action

ZEQUANOX® Invasive Mussel Control

Industry's only biological solution for invasive mussels; highly effective & selective



VENERATE® BIOINSECTICIDE

New species of insecticidal bacteria with novel compounds as potent as the best chemicals

HAVEN® ANTI-TRANSPIRANT

Reduces sun & water stress, increasing yields & quality

MAJESTENE® BIONEMATICIDE

Reduces a broad spectrum of root-feeding nematodes to increase yields/quality

MBI also distributes these biological products in the U.S.

JET-AG® BIO-TAM®

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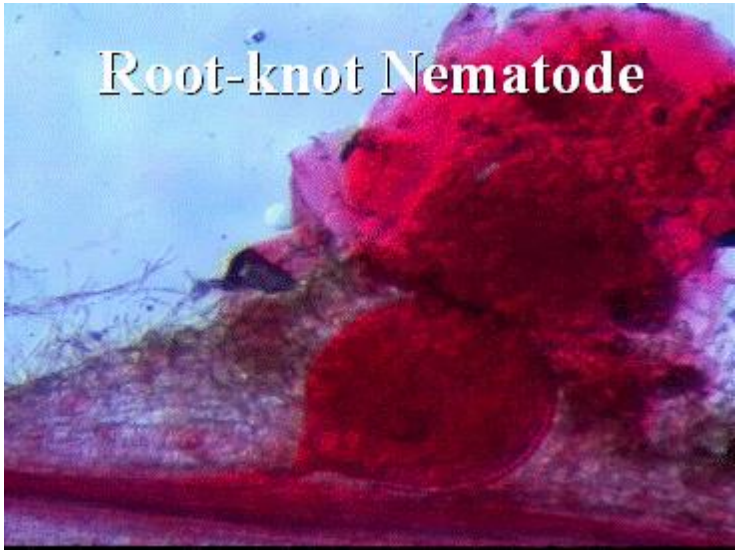
The Challenge of Nematode Management

Nearly invisible pest complex
Damage is not always visible
Difficult and expensive to sample

Plant Parasitic Nematodes are Often Described by Their Shape



Human Activity Often Spreads Nematodes

smart. natural. solutions.

NEMATODES

- Nematodes spread slowly
- Nematodes travel few meters year
- Spread anything moves soils
- equipment, animals
- dust storms, irrigations, floods

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smartnaturalsolutions.com

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MAJESTENE®

BIONEMATICIDE

Burkholderia rinojensis strain A396

- New species of *Burkholderia* isolated from soil by MBI scientists
  - Active by exposure and by ingestion
  - Product contains **heat-killed cells** and spent fermentation media
- Broad spectrum—sucking and chewing insects, mites, certain weevils and most soil-dwelling nematodes
- Same organism is used to manufacture Venerate XC

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

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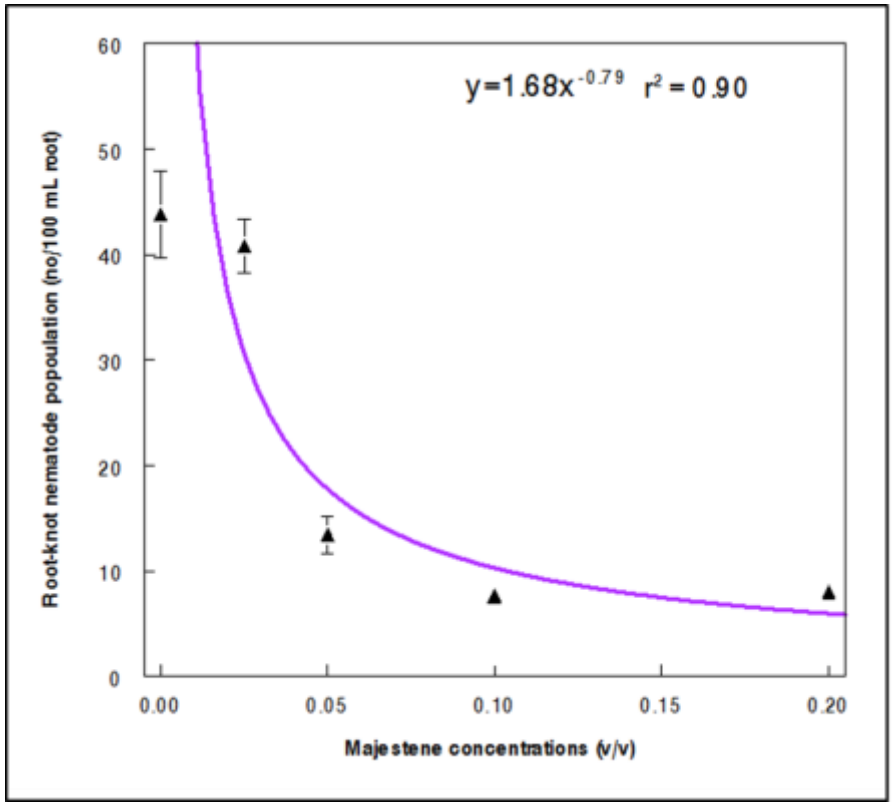
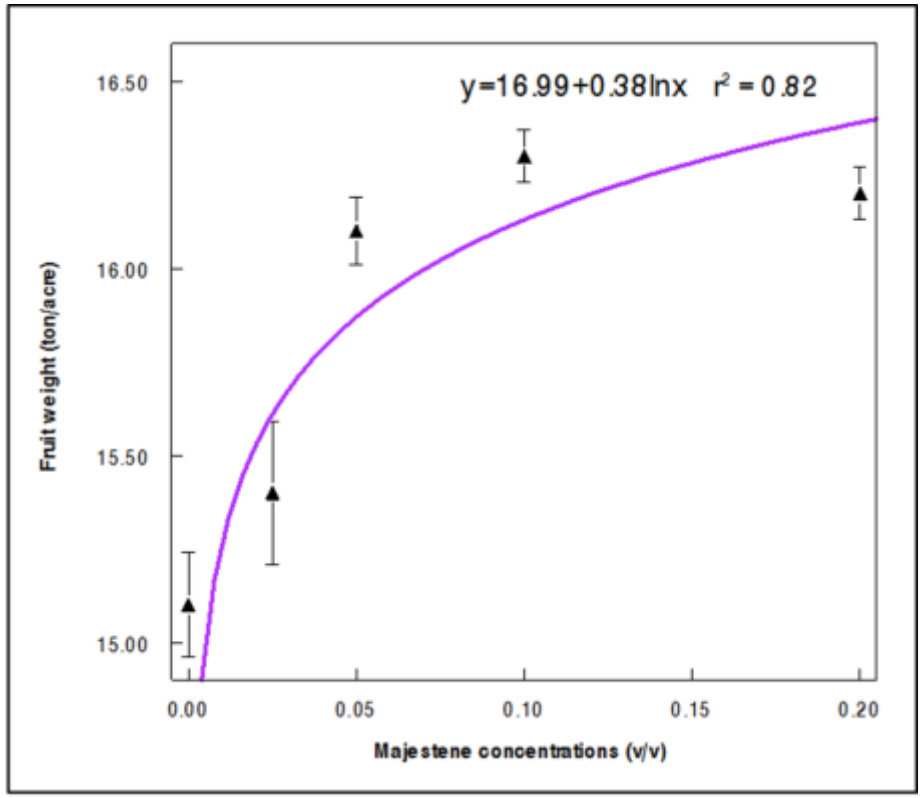
Burkholderia rinojensis strain A396

- Key crops in California are cucurbits, fruiting vegetables and strawberries with others in development – nut trees, grapes
- Activity on:
  - Reduces egg mass formation
  - Prevents juvenile to adult molting
  - Direct mortality of free living stages, J2s
  - Typical use rate of 2 gallons/acre via drip irrigation followed by 1 or 2 more applications at 1-2 gallons during the season

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

Effects of Concentration on Majestene Performance



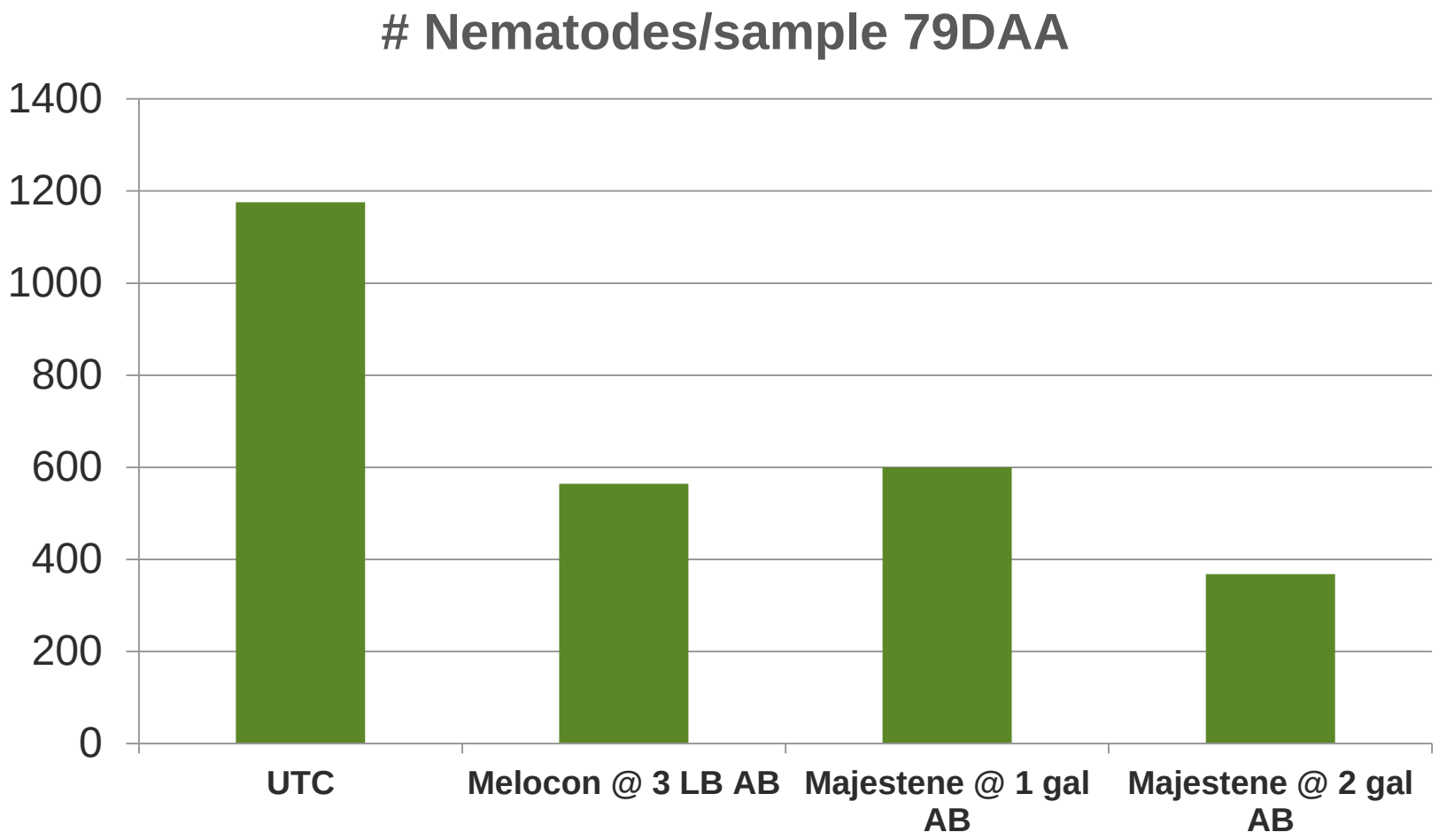


MAJESTENE™ BIONEMATICIDE

- Flexibility, can be applied multiple times in-season or at planting
- No posting requirements, short REI and PHI
- Good worker safety
- Residues exempt from tolerances for export crops
- Broad spectrum
- Excellent shelf-life formulation, tank-mix compatible

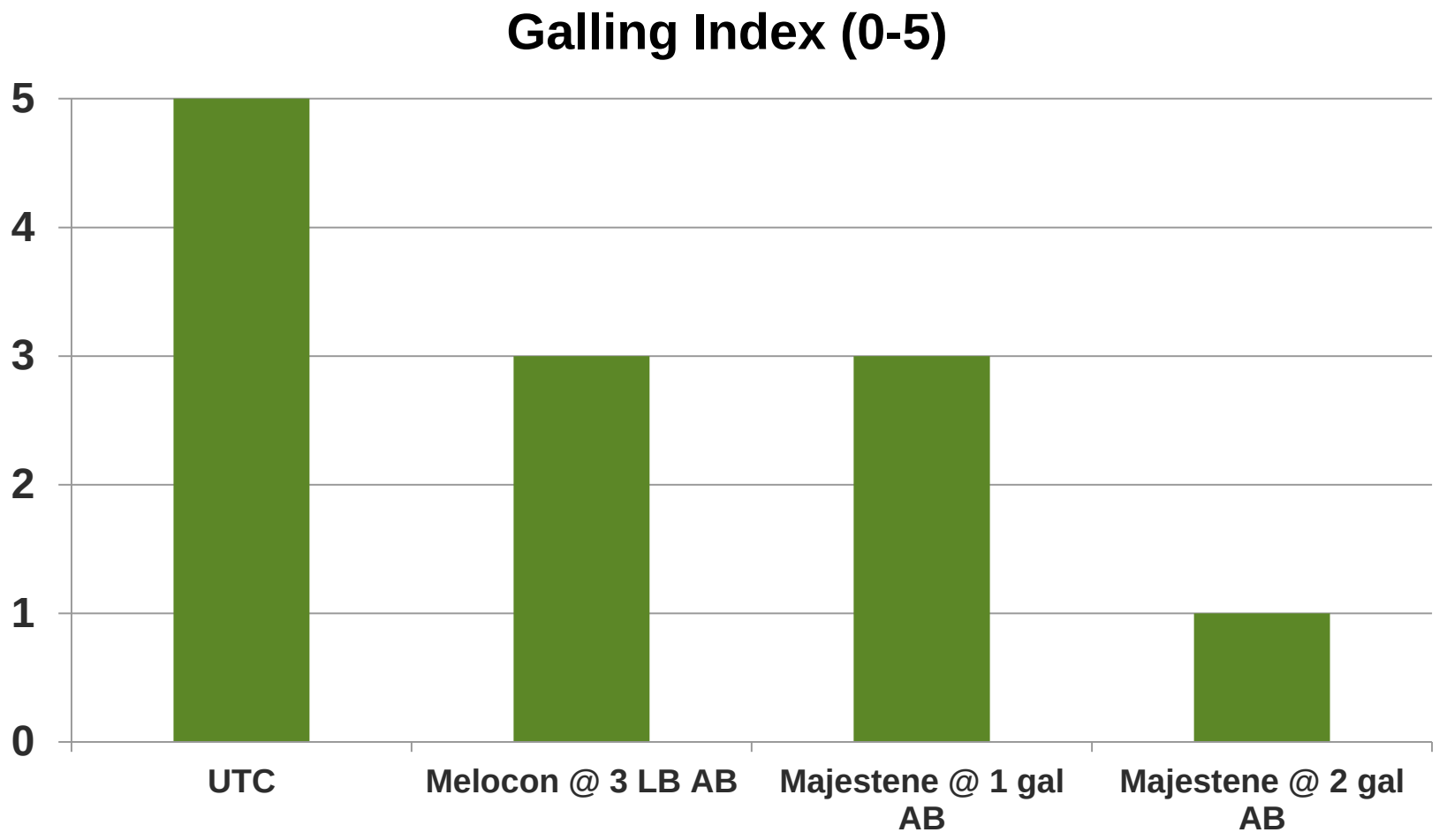
Strawberry Demo, Plant City, FL

Root-knot Nematode Control on Squash – 2016



A= at planting, B=28 days after planting
Biological Applied Research, 16-028TBJ

Root-knot Nematode Control on Squash – 2016



A= at planting, B=28 days after planting
Biological Applied Research, 16-028TBJ

Best Use Recommendations

- Sub-surface drip, in-furrow and drench applications are most effective
- Apply at the end of a drip irrigation cycle
- Use of an adjuvant to enhance soil penetration will improve performance
- Maintain a lethal concentration of 0.05 – 0.2% v/v in drip irrigation or 1-2% v/v in drench applications (transplanting berries and trees)

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GRANDEVO®
BIOINSECTICIDE

VENERATE®
BIOINSECTICIDE

Grandevo WDG - *Chromobacterium subtsugae* strain PRAA-T[1]

- New species of bacteria, *Chromobacterium subtsugae* isolated from US forest soil by the USDA-ARS
  - Dead bacteria plus cell-associated compounds
- Rapid cessation of feeding & reproduction of many insects and mites, also active against soil-dwelling nematodes
- First EPA registration and product launch as an insecticide in 2014 – GRANDEVO DF
- Now available as a WDG





Photo courtesy of: Bugwood.org; *twospotted spider mite*

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VENERATE® XC – *Burkholderia rinojensis* strain A396

- Discovered in MBI's discovery screen; isolated from soil; not related to pathogenic species
- Active by exposure and by ingestion
- Product contains heat-killed cells and spent fermentation media

- Broad spectrum—sucking and chewing insects, mites, and certain weevils and flies
- Easy on pollinators and beneficials;
- EPA registered; U.S. launch in 2014

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

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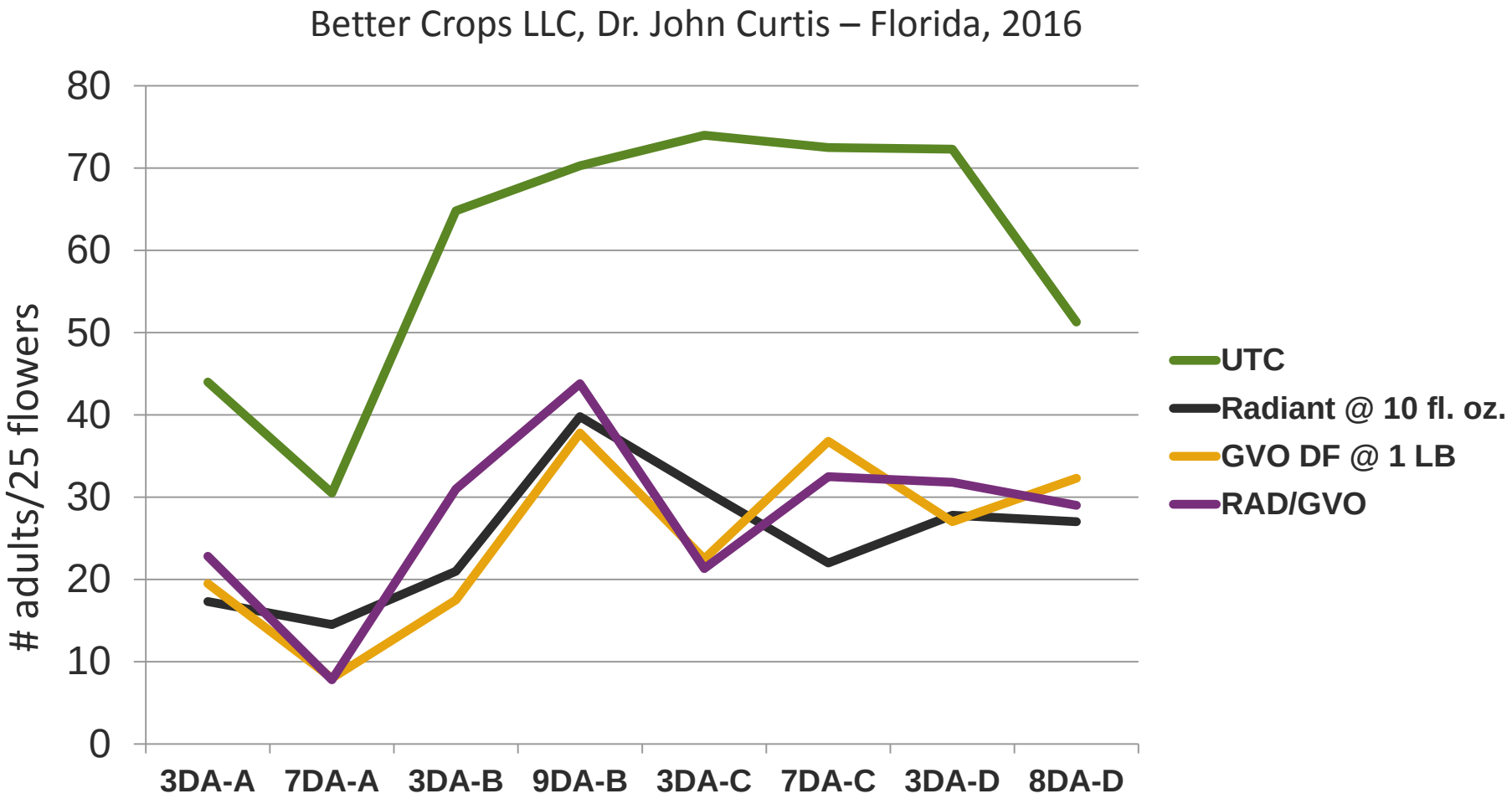
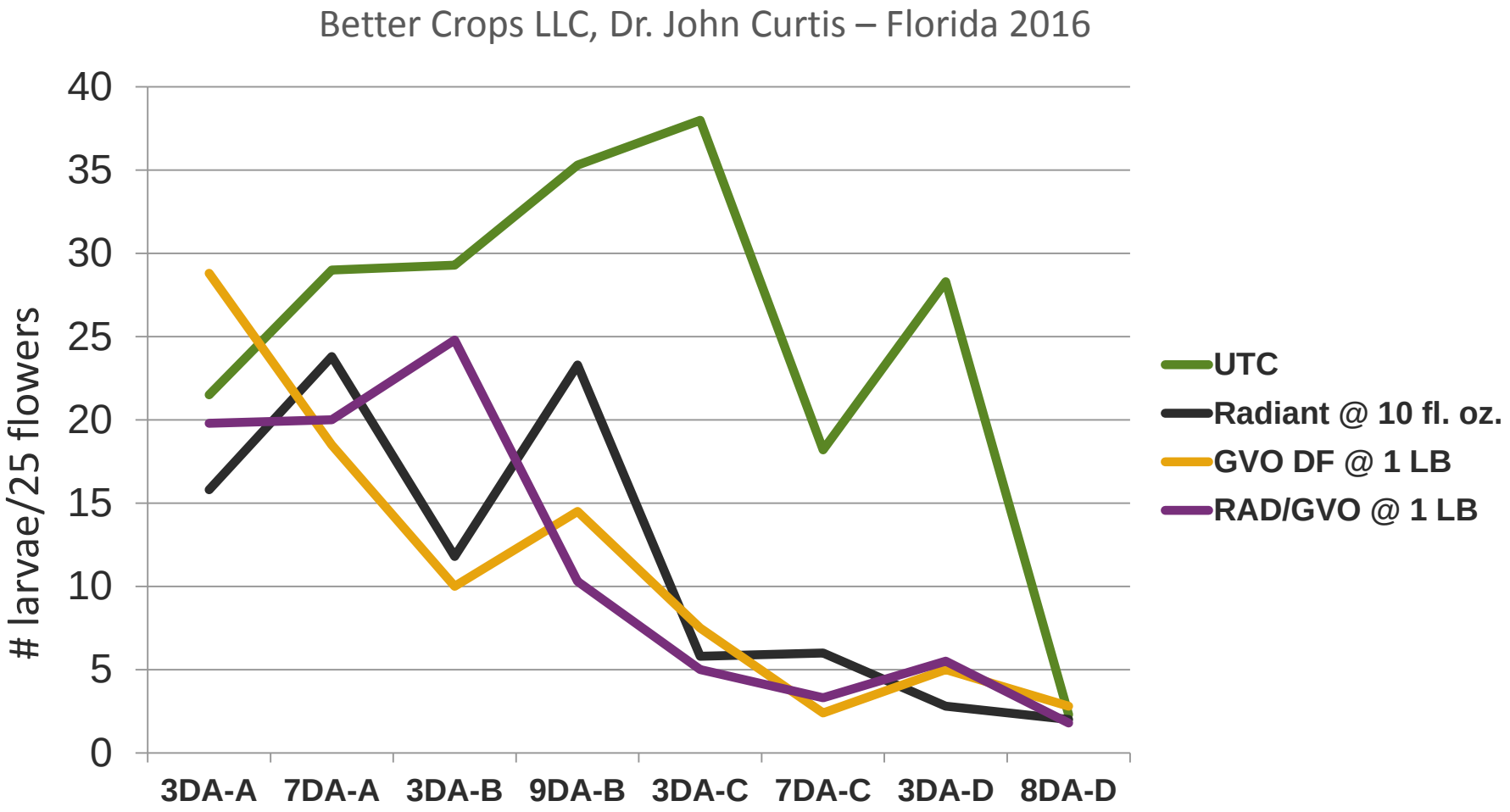
Radiant® Rotations for Control of Western Flower Thrips on Strawberry



Application dates: 3/26, 4/2, 4/11, 4/18 in 570 L/HA.

Radiant® Rotations for Control of Western Flower Thrips on Strawberry



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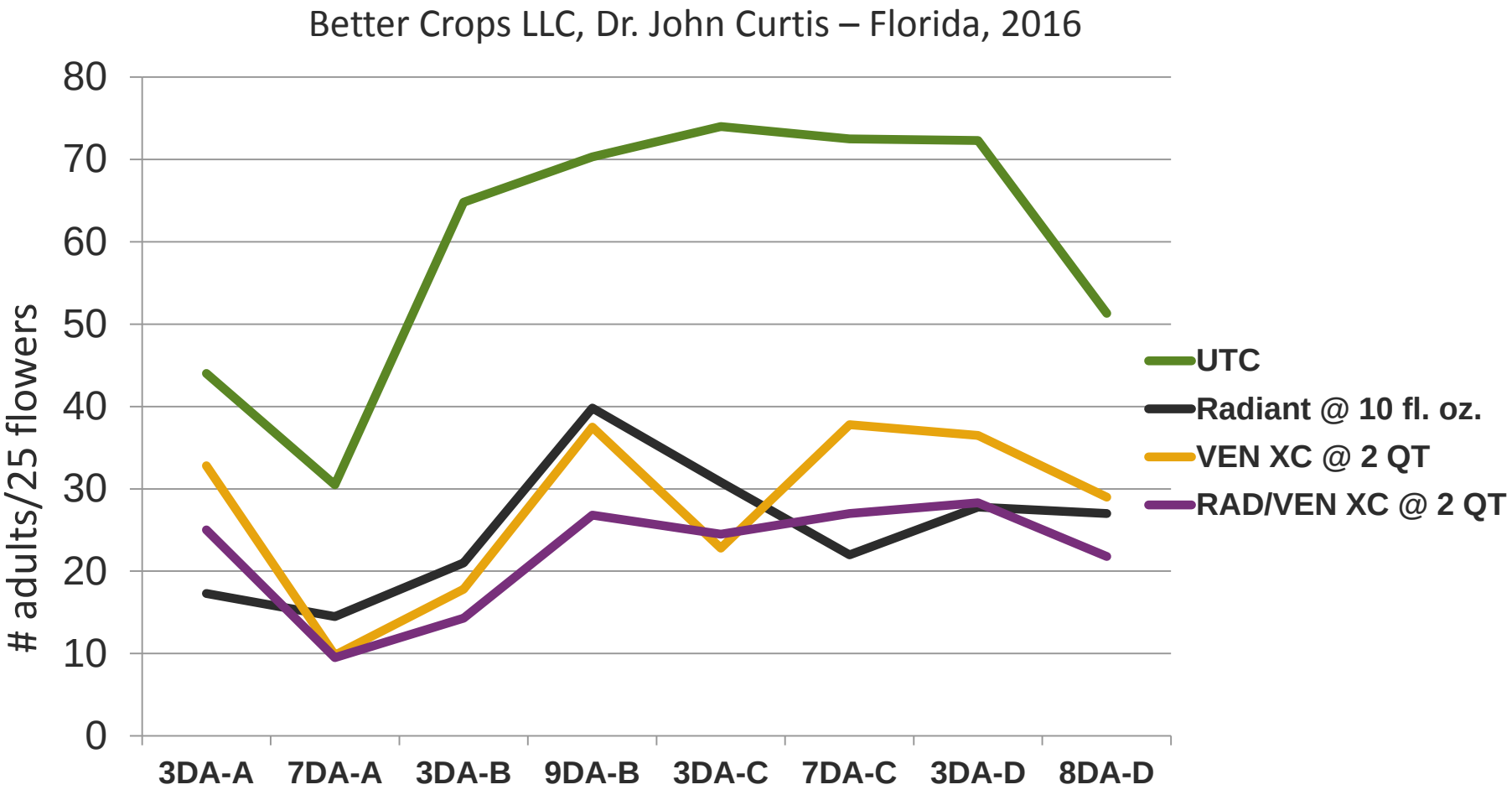
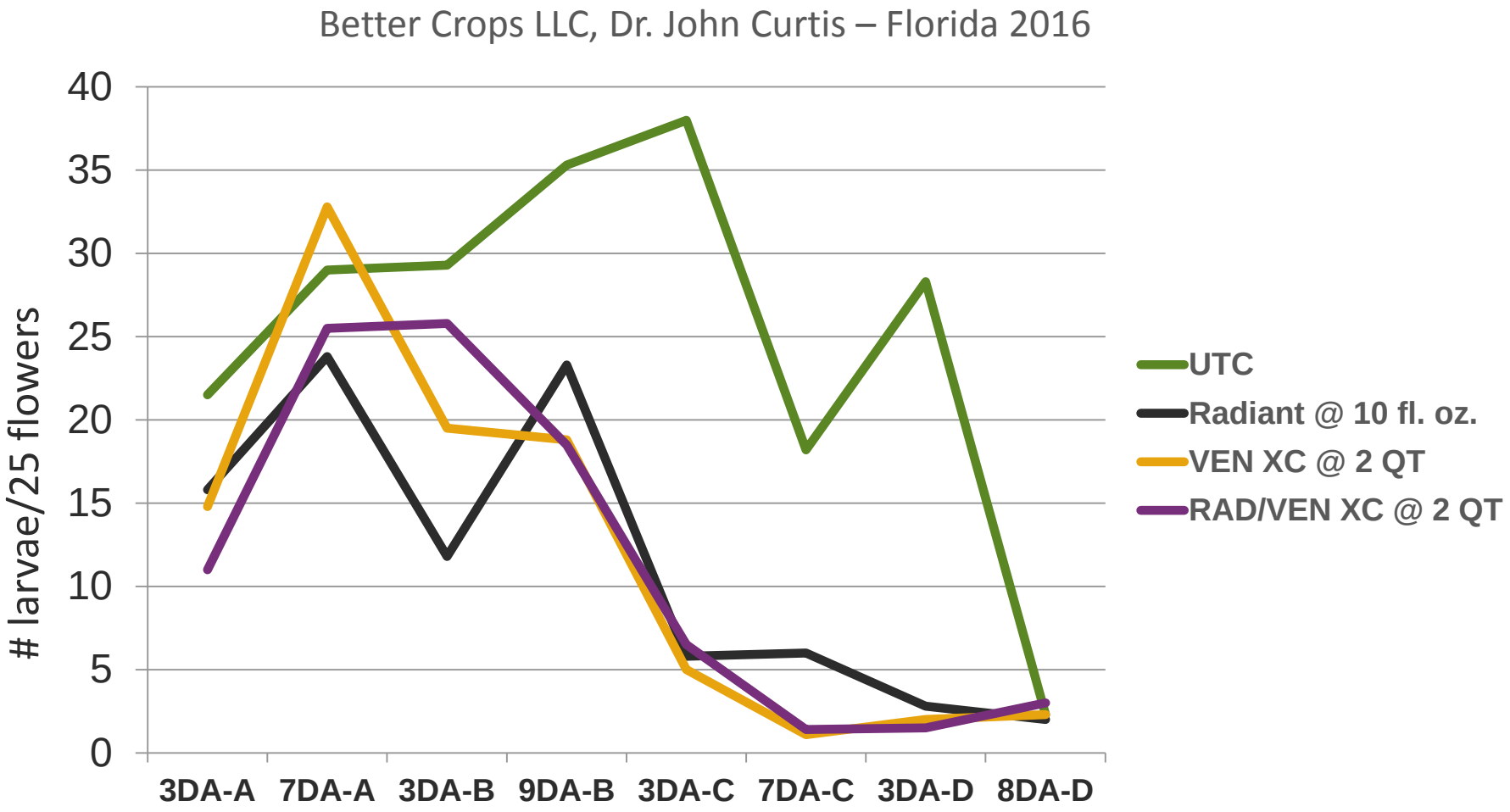
Radiant® Rotations for Control of Western Flower Thrips on Strawberry



Application dates: 3/26, 4/2, 4/11, 4/18 in 570 L/HA.

Radiant® Rotations for Control of Western Flower Thrips on Strawberry-2016

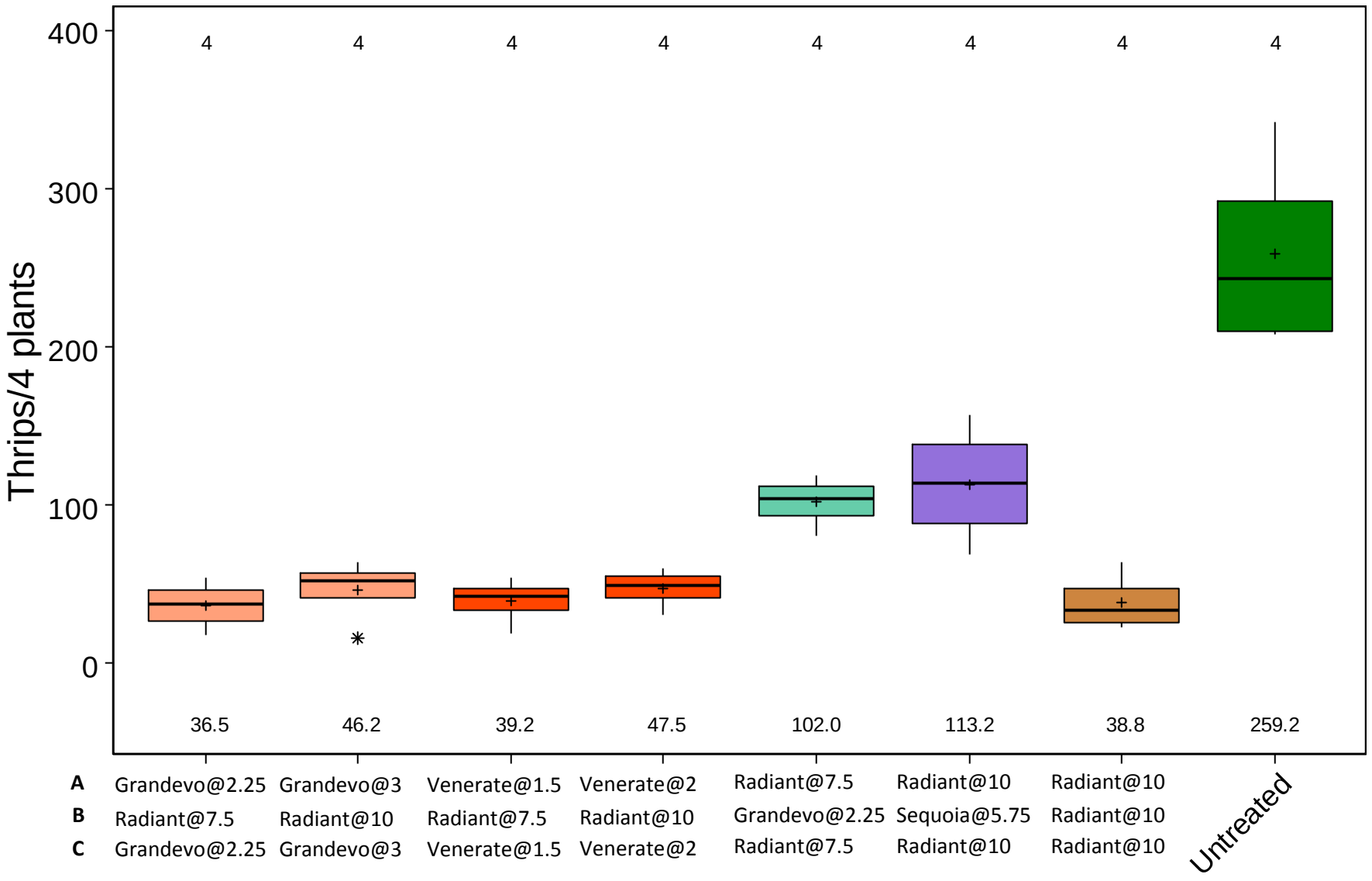


Application dates: 3/26, 4/2, 4/11, 4/18 in 570 L/HA.

NA16A5B013 - Radiant-Marrone

Thrips Larvae (FRANOC) - 3 DAA-C

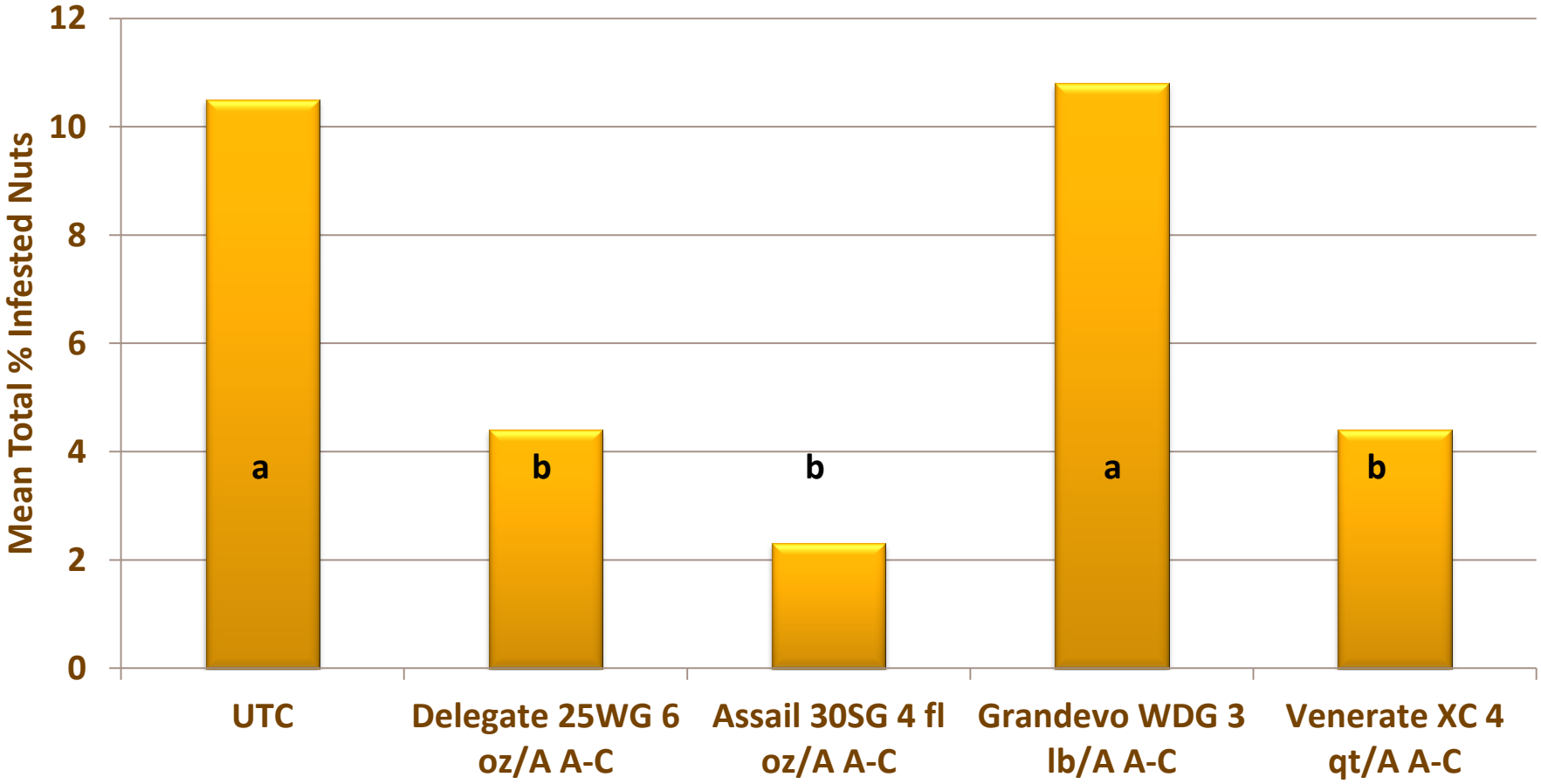
CHK16011



Venerate XC

Against Walnut Husk Fly (*Rhagoletis completa*) on Walnut

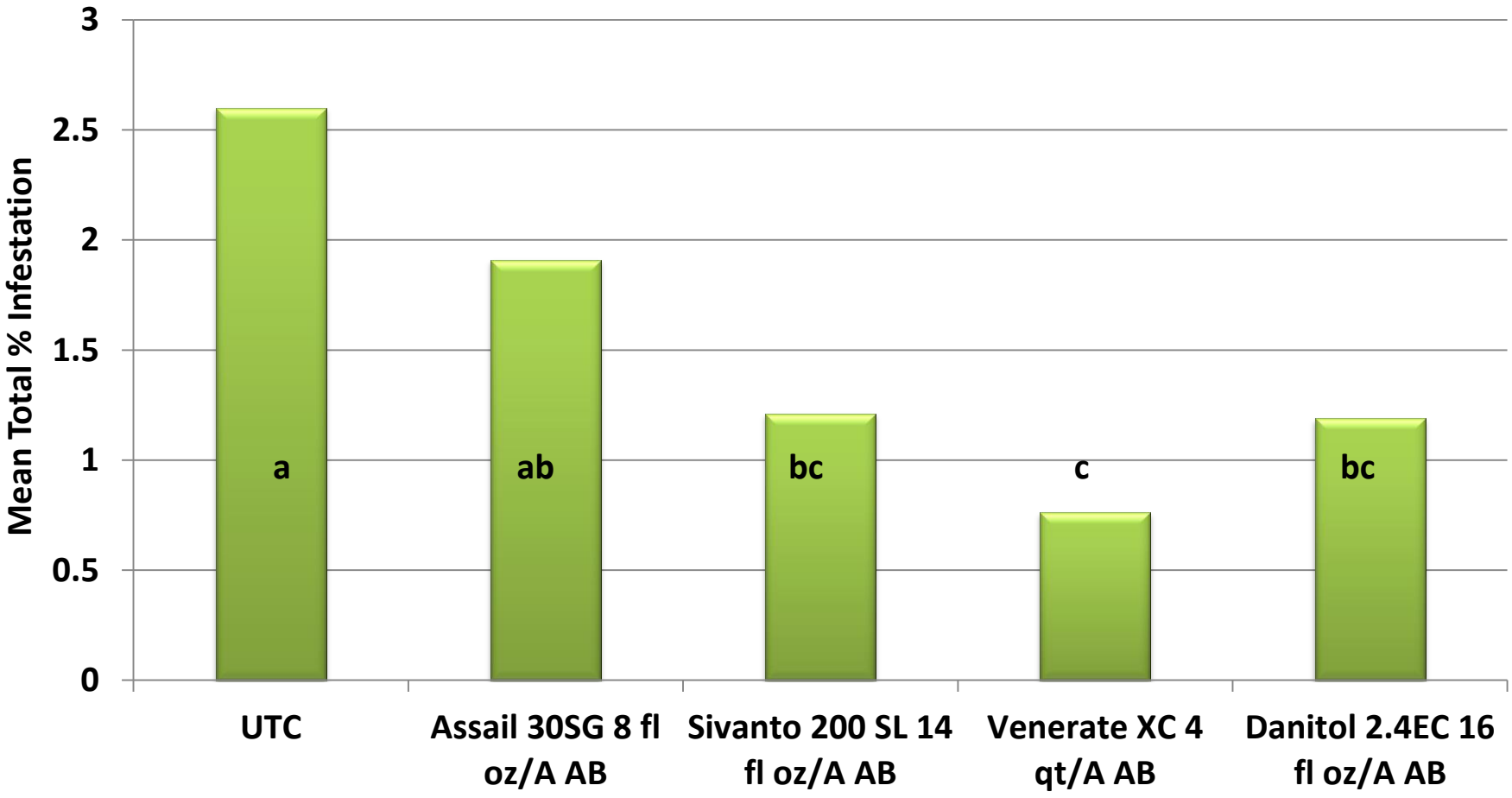
Robert Van Steenwyk, UC Berkeley. 2016. Hollister, Ca.



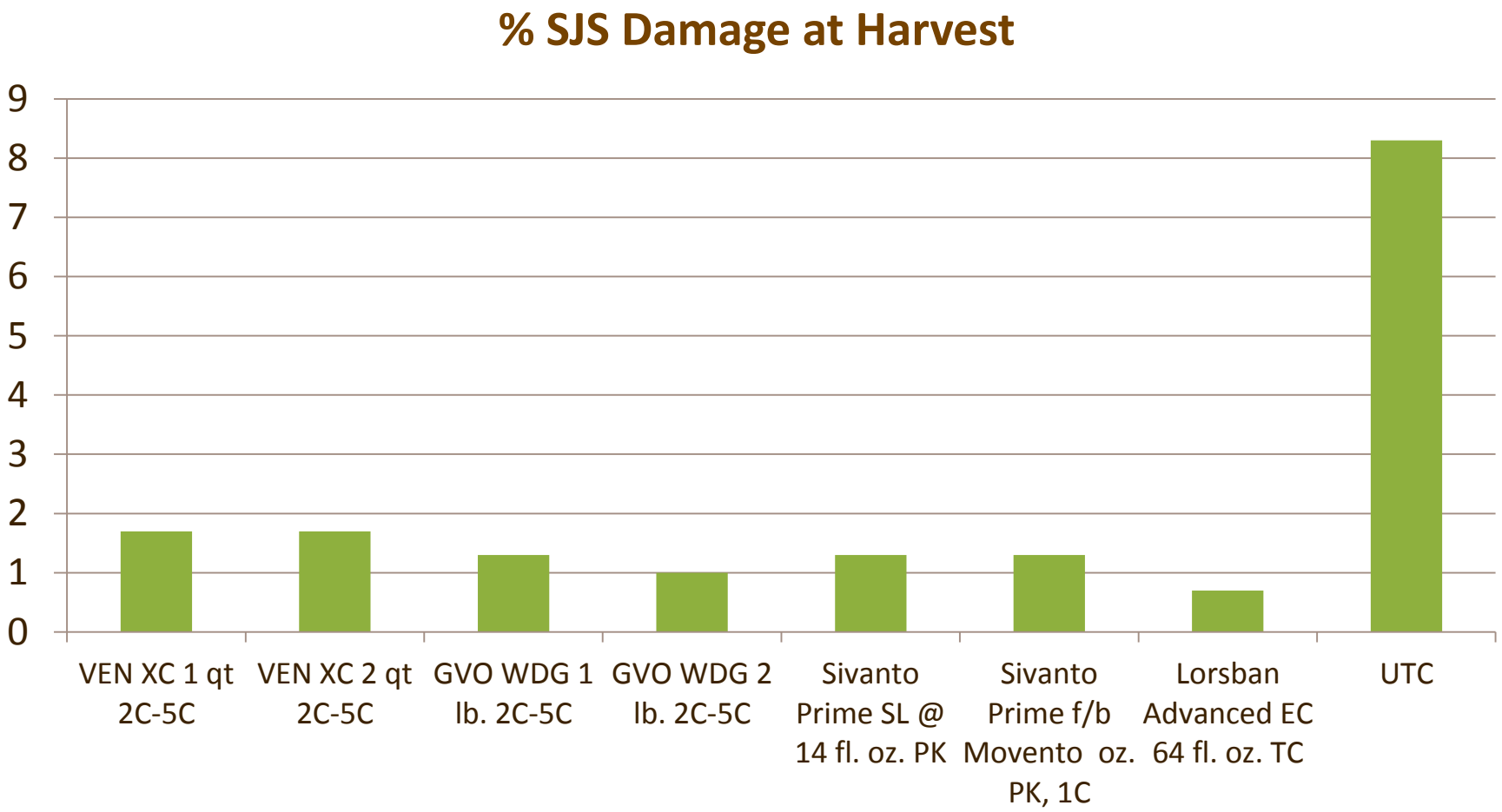
Venerate XC

Against Olive Fruit Fly, *Bactrocera oleae*

Dr. Lightle, UCCE, Corning, CA



San Jose Scale Control on Apples – New York



Dr. Art Agnello, Cornell University. Sivanto and Movento applications included LI-700.

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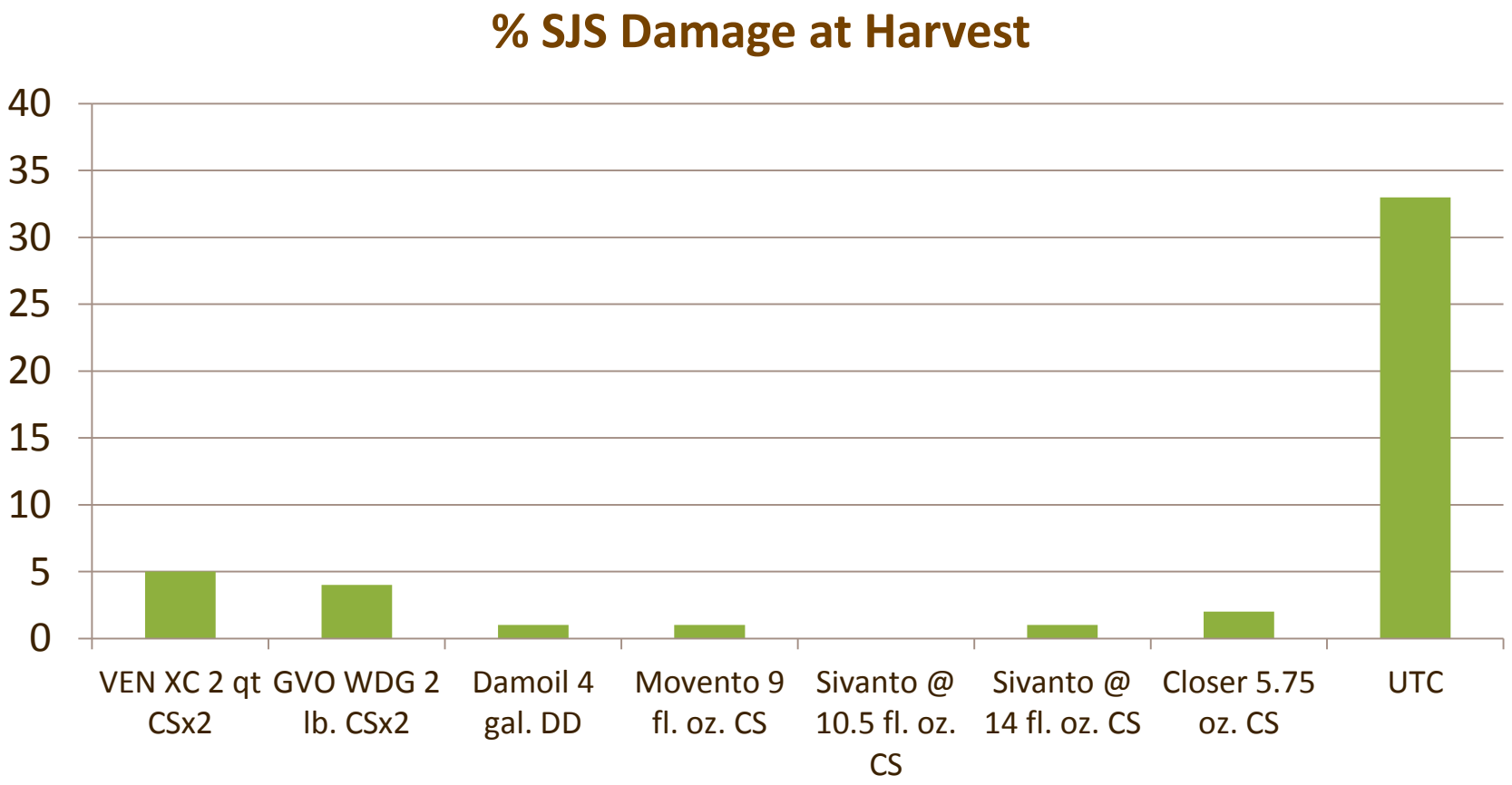
San Jose Scale Control on Peaches – New Jersey



Dr. Anne Nielsen, Rutgers, Bridgeton, NJ. Season total of crawlers/5 cm tape in UTC = 657.

It’s all about timing - neither Grandevo or Venerate are knockdown insecticides, both work best when applied early to sucking pests

Treat now

Not now

STARGUS™
BIOFUNGICIDE

AMPLITUDE
BIOFUNGICIDE

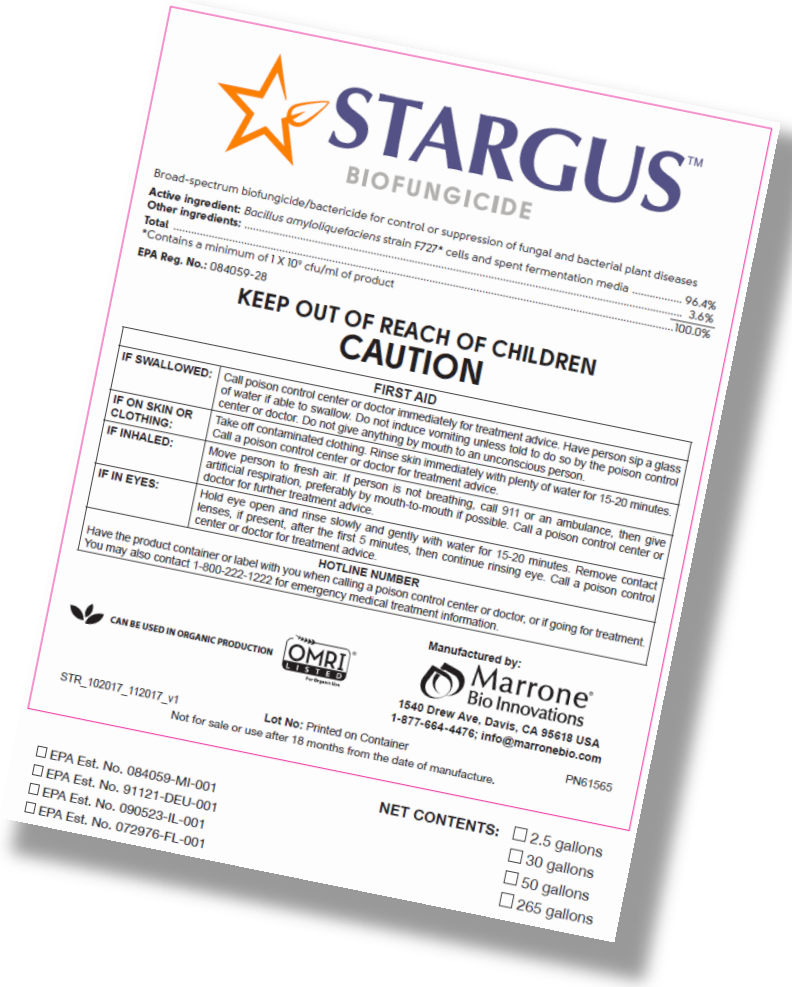
MBI-110 *Bacillus amyloliquifaciens* strain F727

Foliar control of white molds (*Sclerotinia*), downy mildews, and *Phytophthora* plus applications for soil-borne diseases. Early in development of data on stone and pome fruit.

STARGUS™ bio-fungicide. What is it?

STARGUS™ is a….

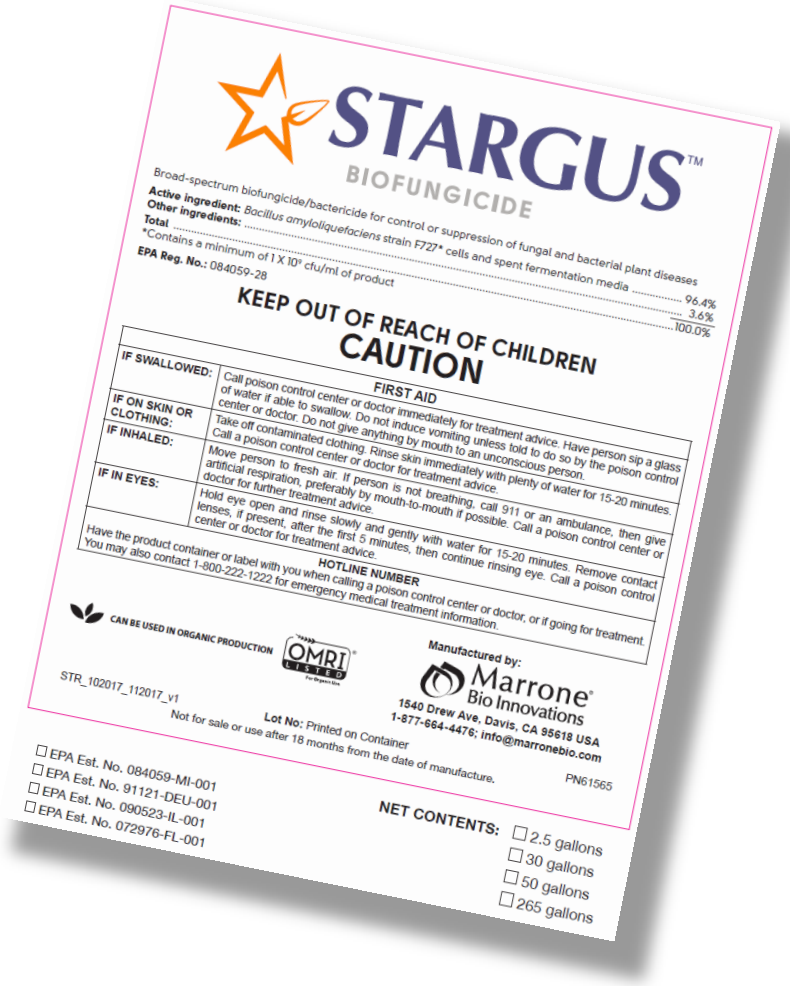
- Liquid fungicide used at 1-4 qt/acre
- Active ingredient is a unique isolate of *Bacillus amyloliquifaciens* strain F727
- Broad spectrum and preventive biofungicide from peptides produced during fermentation
- Controls certain foliar and soil borne diseases



STARGUS™ bio-fungicide. What is it?

STARGUS™ is

- 4 hour REI
- 0 days to harvest PHI
- Exempt from residue tolerances
- NOP compliant and OMRI listed
- Broad tank-mix compatibility



STARGUS™
BIOFUNGICIDE

Broad-spectrum biofungicide/bactericide for control or suppression of fungal and bacterial plant diseases

Active ingredient: *Bacillus amyloliquefaciens* strain F727* cells and spent fermentation media 96.4%
Other ingredients: 3.6%
Total 100.0%
*Contains a minimum of 1 X 10^9 cfu/ml of product

EPA Reg. No.: 084059-28

KEEP OUT OF REACH OF CHILDREN

CAUTION

FIRST AID	
IF SWALLOWED:	Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING:	Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
IF INHALED:	Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.
IF IN EYES:	Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

HOTLINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or if going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.

CAN BE USED IN ORGANIC PRODUCTION OMRI LISTED

Manufactured by:
Marrone Bio Innovations
1540 Drew Ave, Davis, CA 95618 USA
1-877-664-4476; info@marronebio.com

STR_102017_112017_v1

Lot No: Printed on Container

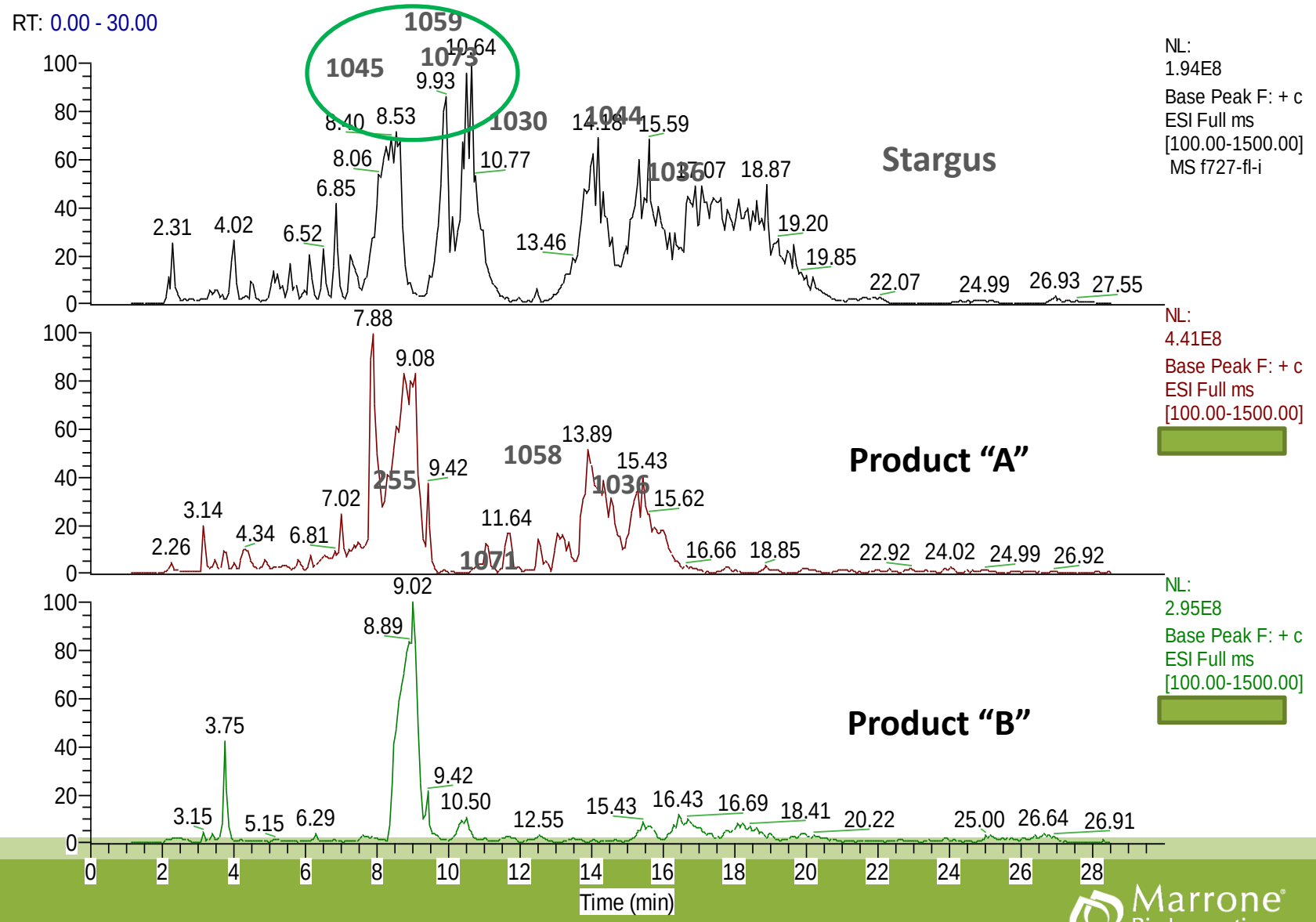
Not for sale or use after 18 months from the date of manufacture.

PN61565

☐ EPA Est. No. 084059-MI-001
☐ EPA Est. No. 91121-DEU-001
☐ EPA Est. No. 090523-IL-001
☐ EPA Est. No. 072976-FL-001

NET CONTENTS: ☐ 2.5 gallons ☐ 30 gallons ☐ 50 gallons ☐ 265 gallons

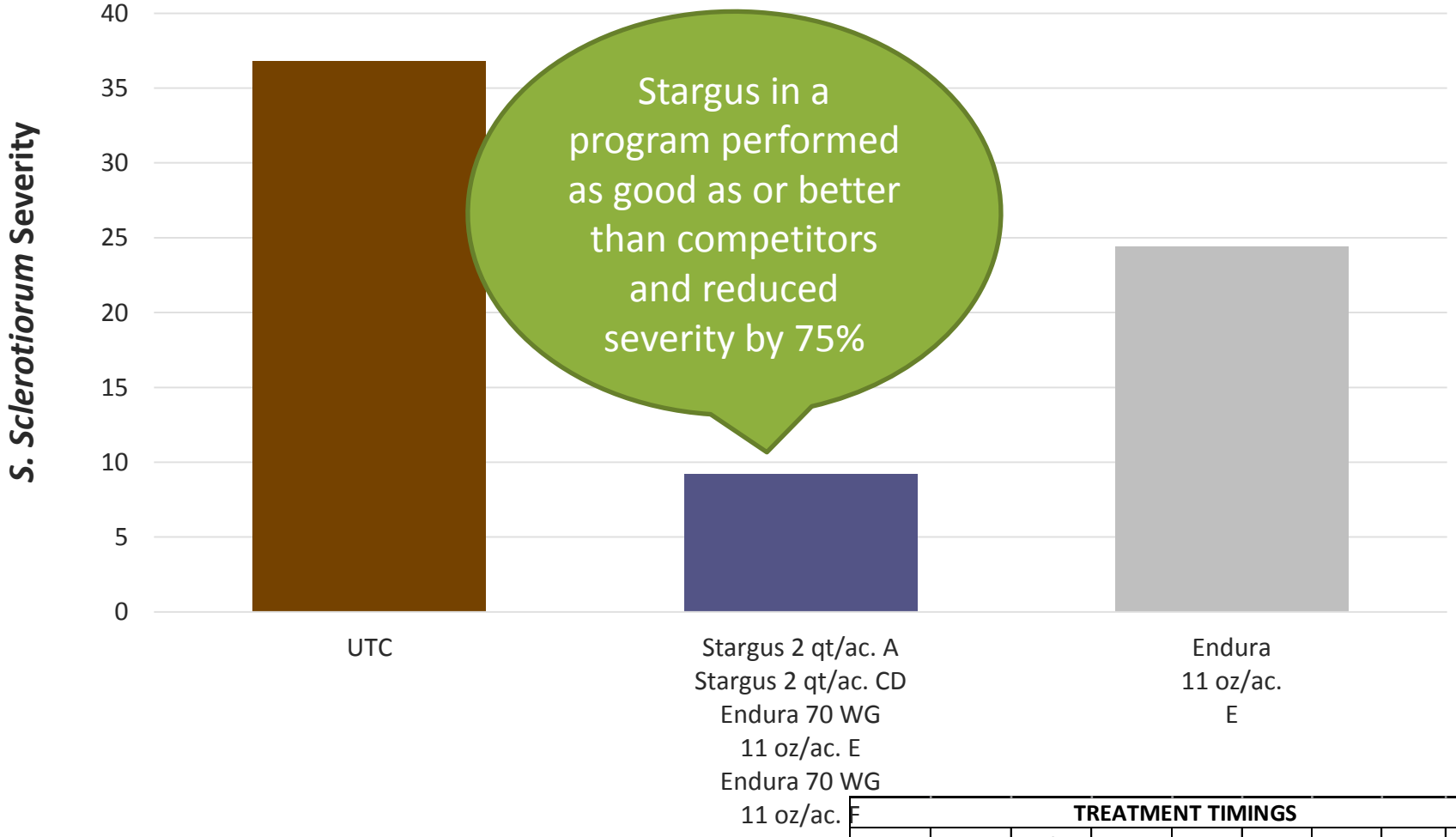
Comparison of STARGUS™ with two other *Bacillus*-based Biofungicides



Marrone Bio Innovations

Stargus™ Against *Sclerotinia sclerotiorum* on Lettuce

Dr. Mike Matheron, University of Arizona 2017

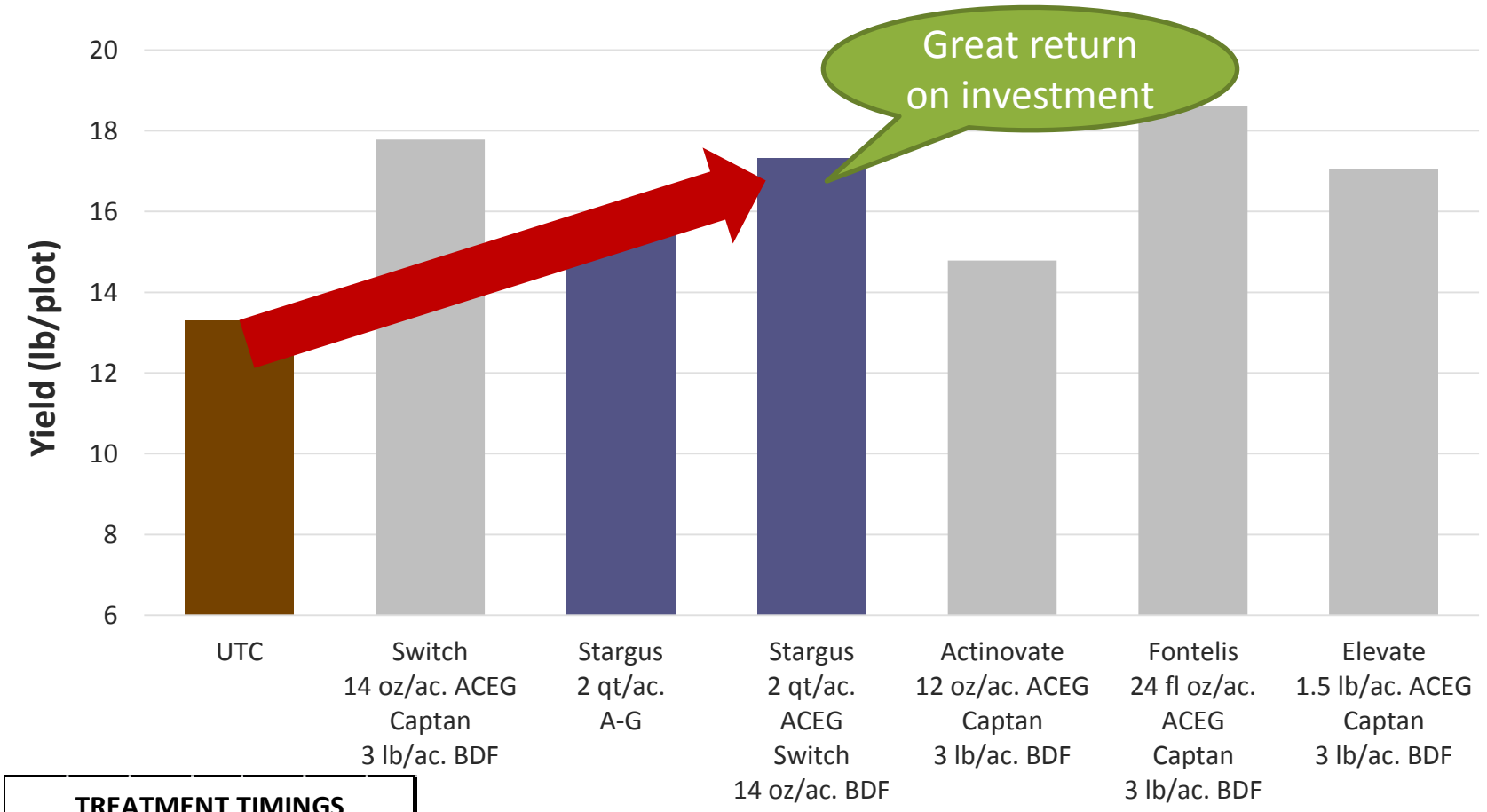


TREATMENT TIMINGS								
A	B	C	D	E	F	G	H	I
15-Nov	22-Nov	16-Dec	23-Dec	12-Jan	19-Jan	23-Jan	3-Feb	13-Feb

Marrone Bio Innovations

Stargus™ Against *Botrytis* in Strawberries

Cal Poly San Luis Obispo 2017

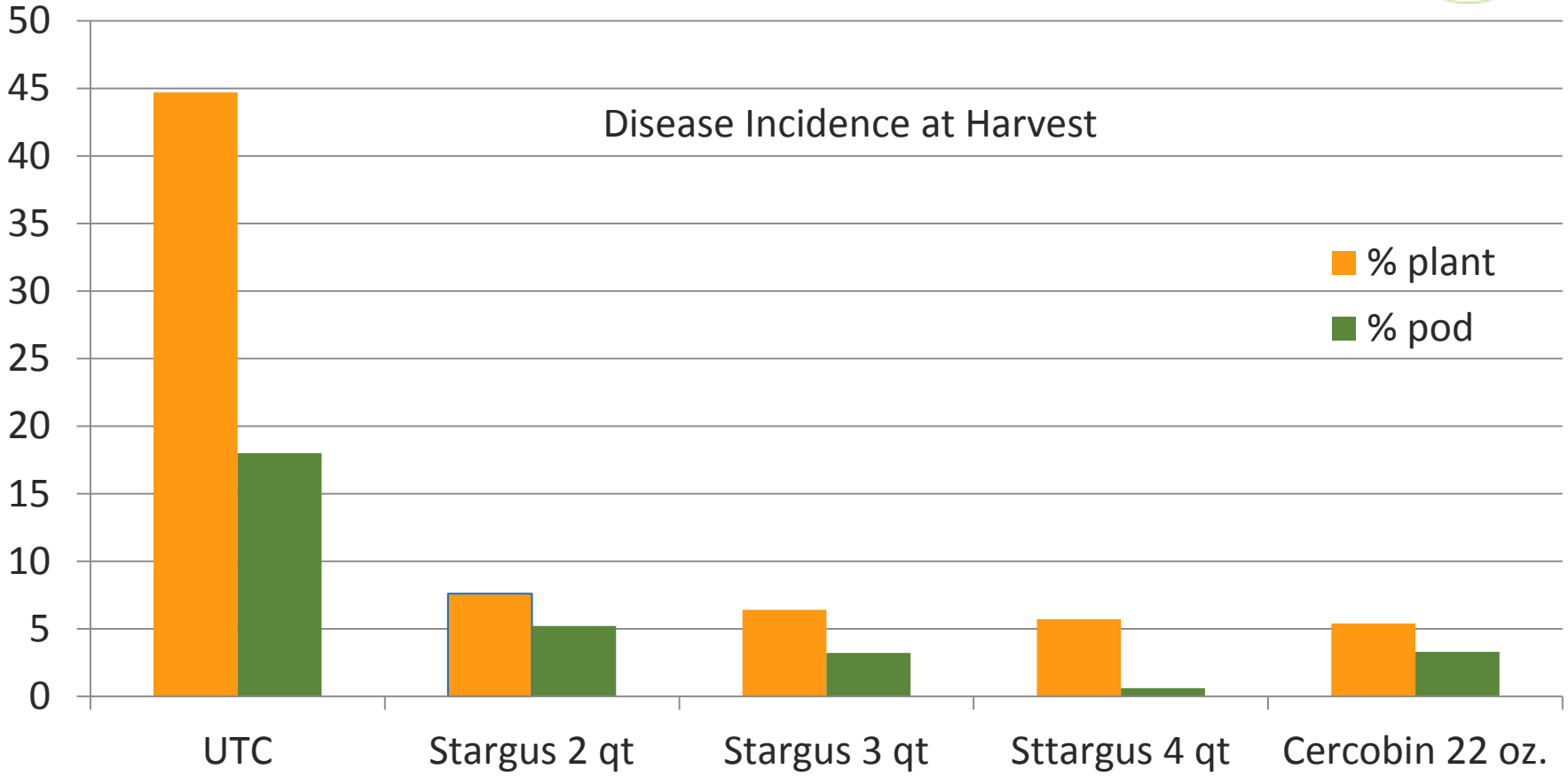


TREATMENT TIMINGS						
A	B	C	D	E	F	G
3/17	3/23	3/30	4/6	4/14	4/26	5/3

Marrone Bio Innovations

Control of White Mold on Snap Beans

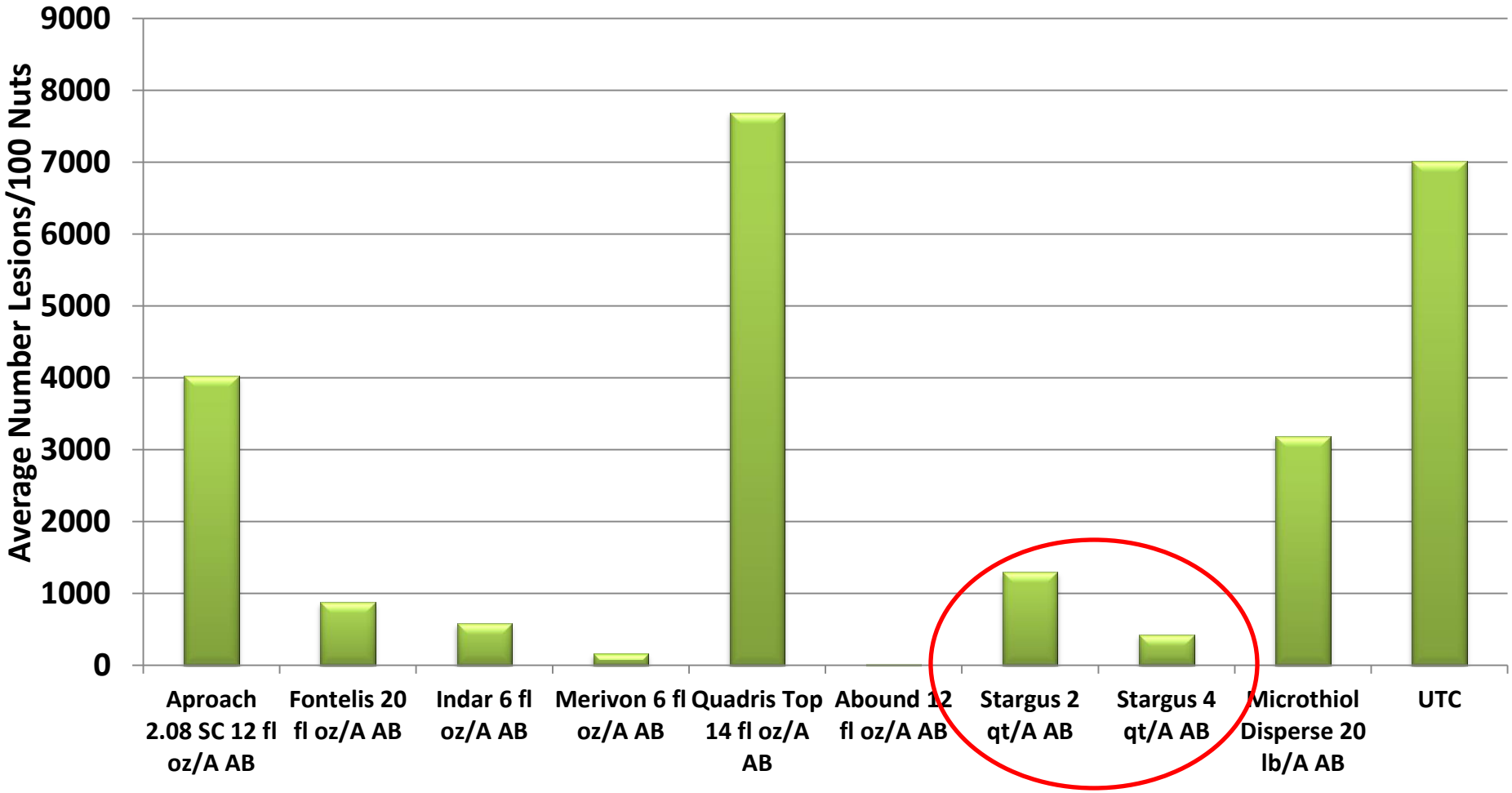
Dr. S. Pethybridge, Cornell U. - 2017



Two applications at 28 GPA at 10% and full bloom (7/26 and 8/1). Plots artificially inoculated.

Stargus for Control of Almond Scab - Preliminary

Brent Holtz, UCCE, Parlier, CA



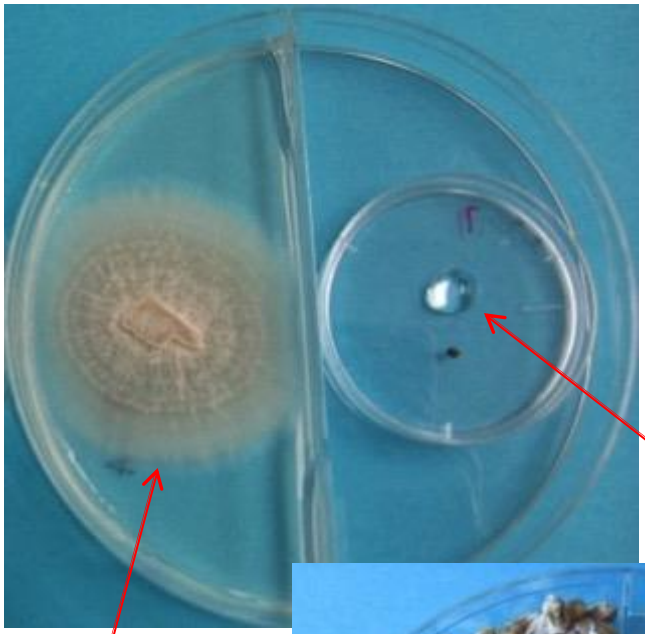
Marrone Bio Innovations

Muscodor albus Biofumigant – MBI-601

- Endophytic fungus (new genus) isolated from various trees by Dr. Gary Strobel at Montana State University
- **EPA registered under trade name ENNOBLE™**
- U.S. Commercial launch pending
- California registration pending
- Inhibits and kills a broad range of soil inhabiting fungi, bacteria, nematodes and insects
- Produces a benign mixture of >10 volatile compounds: ester, alcohols and acid derivatives

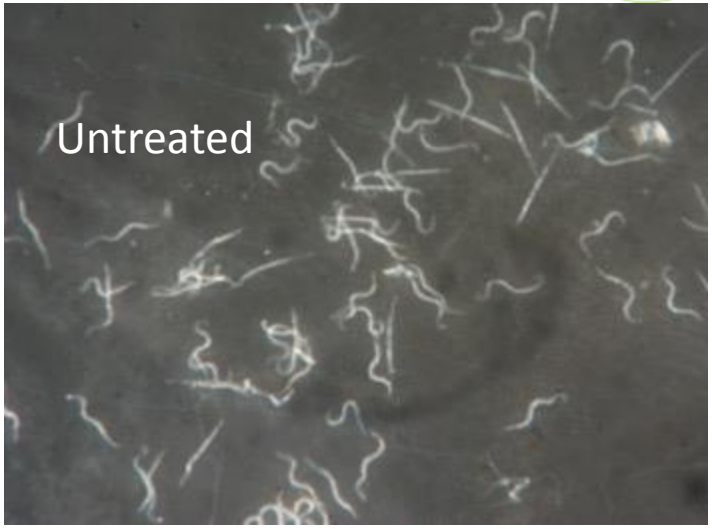
Muscodor volatiles completely kill Fusarium

MBI-601 Kills Plant Parasitic Nematodes



Muscodor strain grown on PDA medium

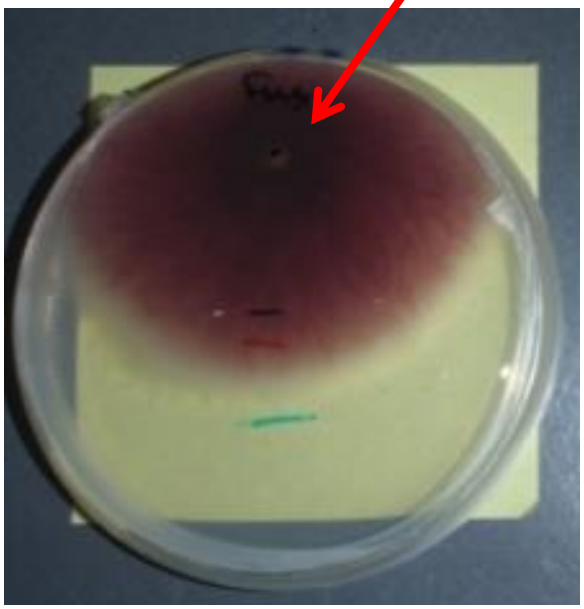
Muscodor strain grown on barley grains



Marrone Bio Innovations

Growth inhibition of plant pathogen by MBI-601

Fusarium colonies



Fusarium – untreated control

Fusarium – *M. albus* strain SA13

The Future is Bright

The Rate of New Product Introduction is Accelerating

- ✓ Innovative products are targeting new pests that have been difficult to control
- ✓ Biopesticides offer flexibility, can be applied multiple times without worry about illegal residues
- ✓ Short re-entry intervals
  - 4 hour REIE
  - Tolerance Exempt – No Maximum Residue Levels (MRL)
  - Residues exempt from tolerances for export crops
  - No Plant-back restrictions
- ✓ NOP Compliant
- ✓ Require a higher level of attention but the result is worth it!

Marrone® Bio Innovations

EcoFarming Conference

smart. natural. solutions.

January 2018 • NASDAQ: MBII

Boost yield and quality

Manage resistance

Harvest flexibility

Worker-friendly