



# SERENADE<sup>®</sup> SOIL

Novel fungicide for  
in-furrow and other soil applications

Sarah Reiter, Denise Manker, Jon Margolis  
ABIM 2010



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# SERENADE<sup>®</sup> SOIL

## Introduction

New fungicide designed to protect young plants against the profit-robbing effects of soil diseases like *Pythium*, *Rhizoctonia*, *Fusarium* and *Phytophthora*.

Applied at planting, SERENADE<sup>®</sup> SOIL quickly builds a disease protection zone around the seed. As the seedling grows, the beneficial bacteria in SERENADE SOIL continue to grow, expanding the disease protection zone and attaching themselves, like armor, to the roots of the plant.



# SERENADE<sup>®</sup> SOIL

## Features and Benefits

### Performance:

- Proven yield increases across numerous crops, soil types, years of study
- Based on the well-known active ingredient in SERENADE fungicide, proven in 8+ years of grower use

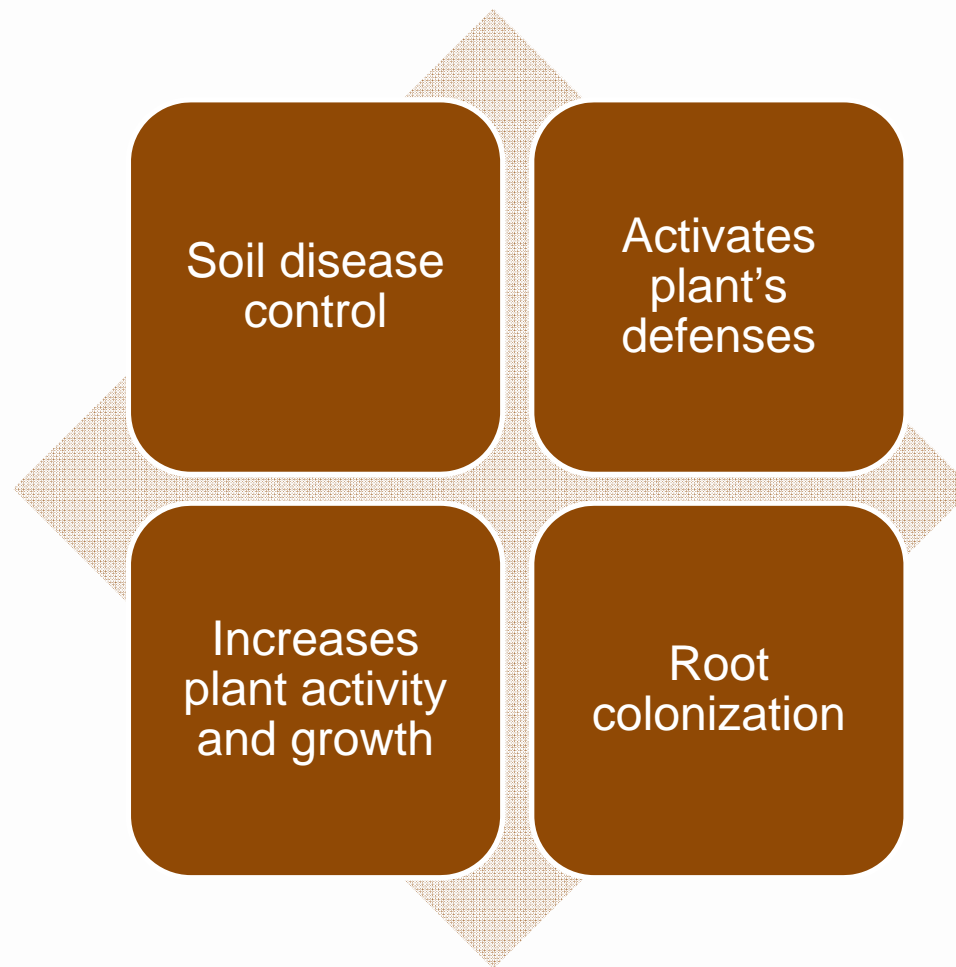
### Flexibility:

- Easily tank-mixed with other in-furrow products and applied through existing equipment
- Unique mode of action (FRAC group 44) for the best defense against the development of resistance

### Value:

- No residue or MRL concerns – sell your crops into even the most restrictive markets

# SERENADE<sup>®</sup> SOIL





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## Mode of Action

The beneficial bacteria in SERENADE SOIL act as small factories, releasing important secondary metabolites that:

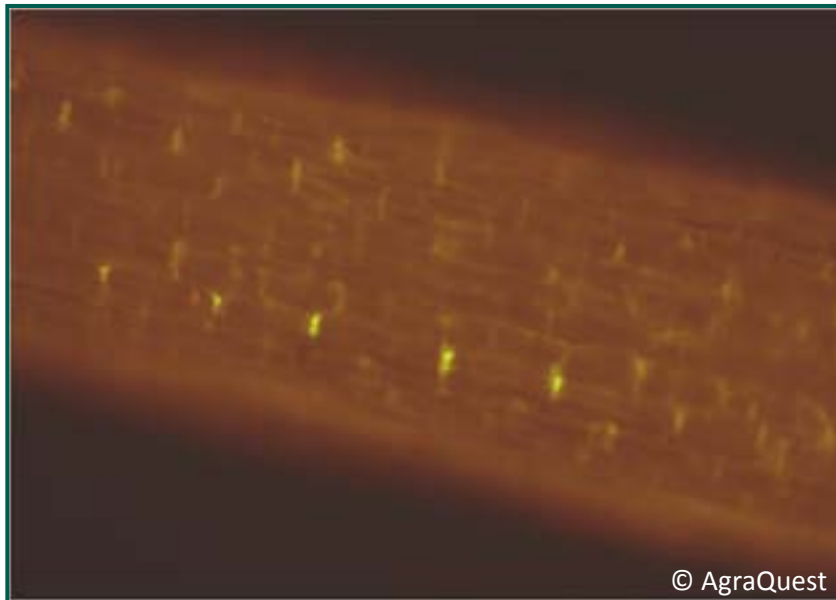
- Control soil diseases:
  - Lipopeptides tear holes in fungal cell membranes
    - Yet extremely safe to plants
  - Anti-bacterial compounds target bacterial cell walls
- Activate the plant's own defense mechanisms
- Promote growth processes and confer stress resistance

# SERENADE SOIL

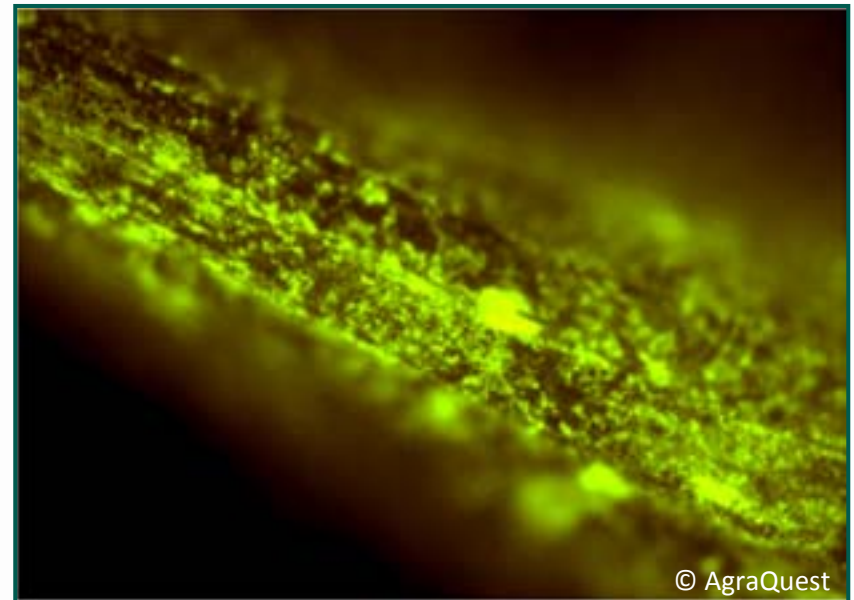
## Mode of Action: Root Colonization

The active ingredient in SERENADE SOIL – *Bacillus subtilis* strain QST 713 – is a master of root colonization.

In this microscopic image, *B. subtilis* strain QST 713 spores are visible through the use of fluorescent tagging.



Untreated root



Root colonized by SERENADE SOIL

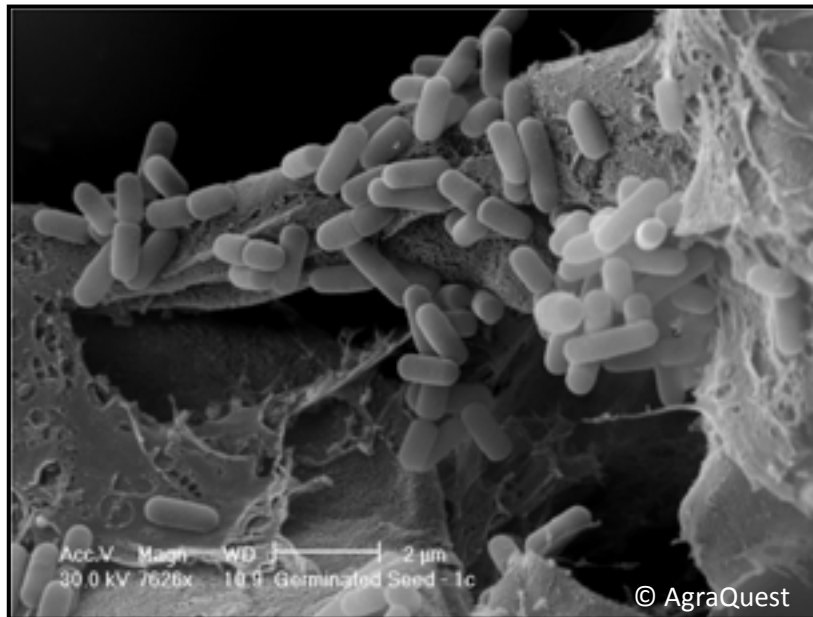
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# SERENADE SOIL

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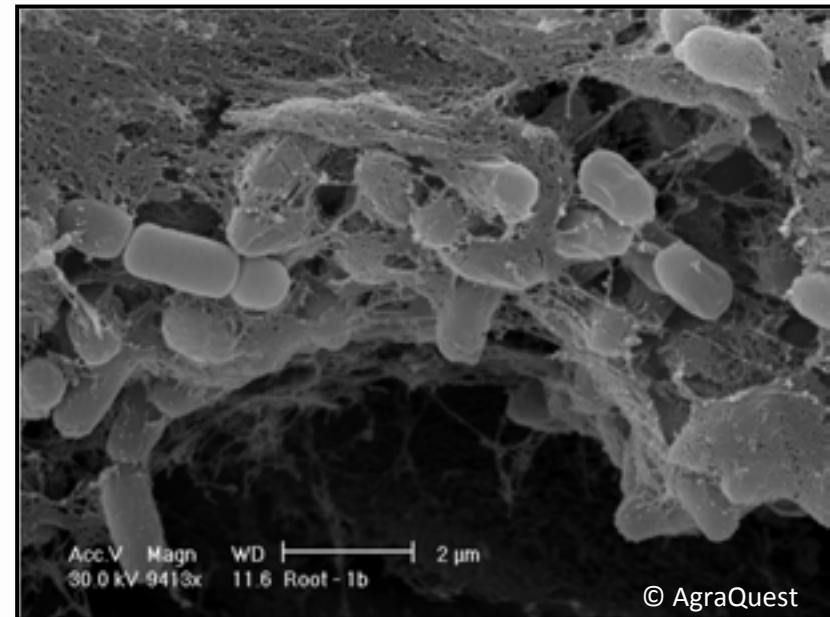
Seed surface



Spores of *B. subtilis* strain QST 713 colonizing the surface of the seed.

Images captured with SEM (scanning electron microscope) on tomato seeds (1 day after app) and roots (7 days after app). ©AgraQuest

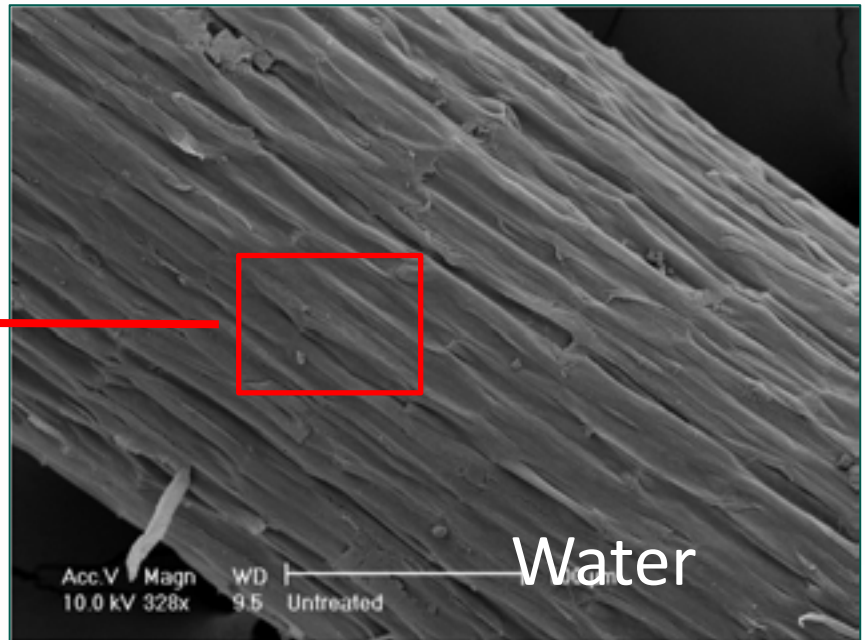
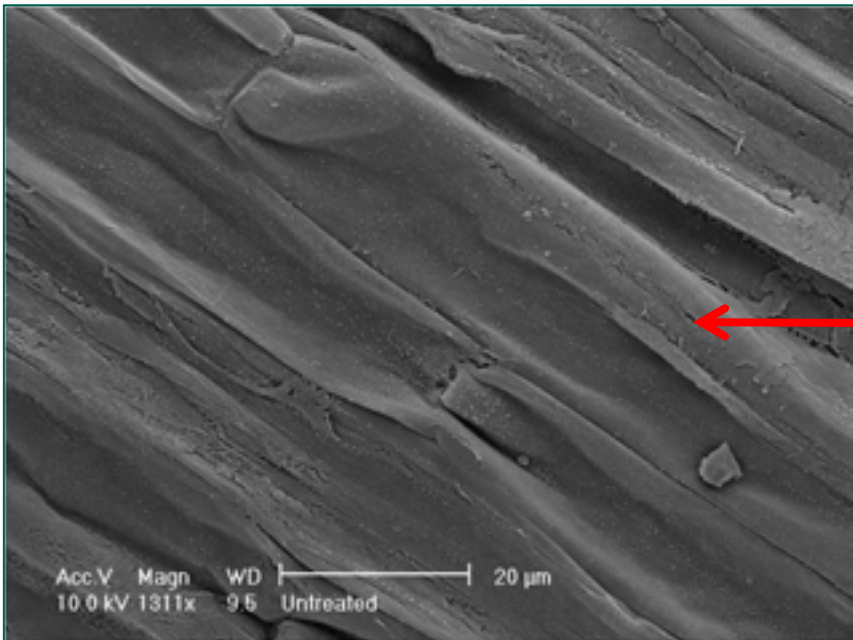
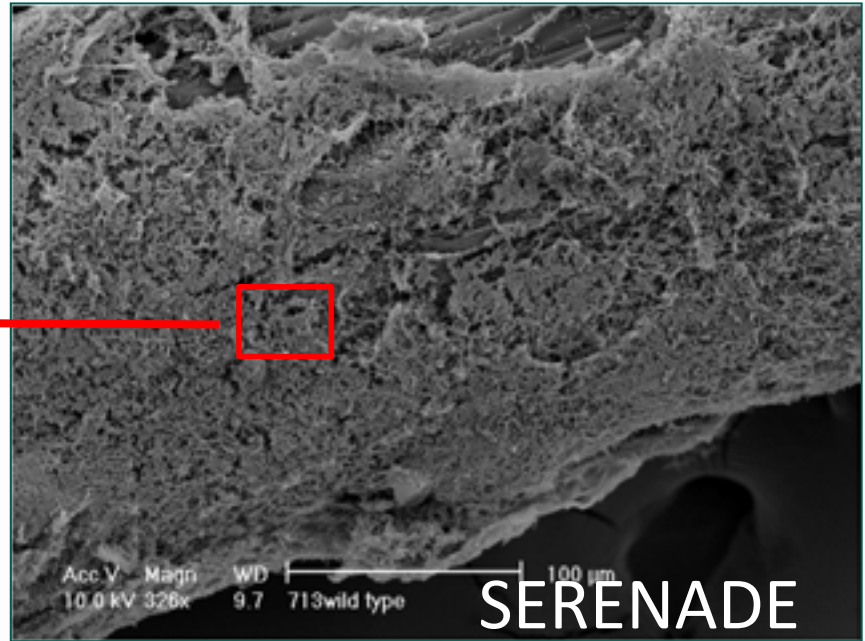
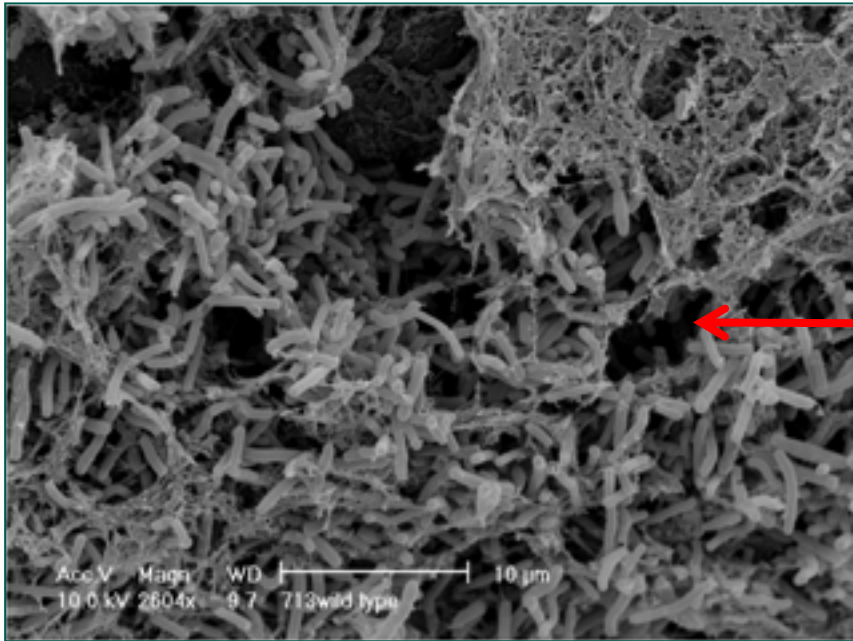
Roots



Spores of *B. subtilis* strain QST 713 colonizing the roots. The dense biofilm which grows as the roots grow to serve as armor from soil diseases is clear.

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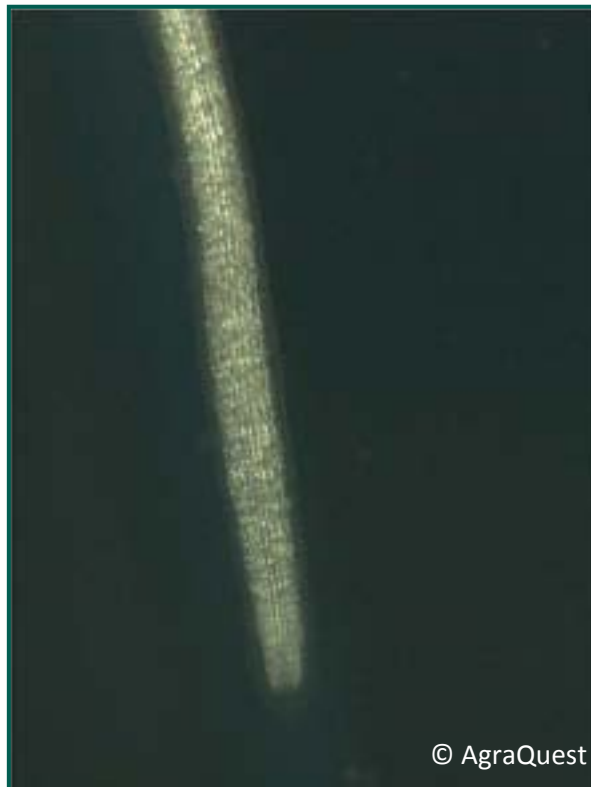




# SERENADE SOIL

## Mode of Action: Root Colonization

Root colonization occurs quickly and thoroughly, developing armor around the roots that protects them from soil diseases



Untreated tomato root tip

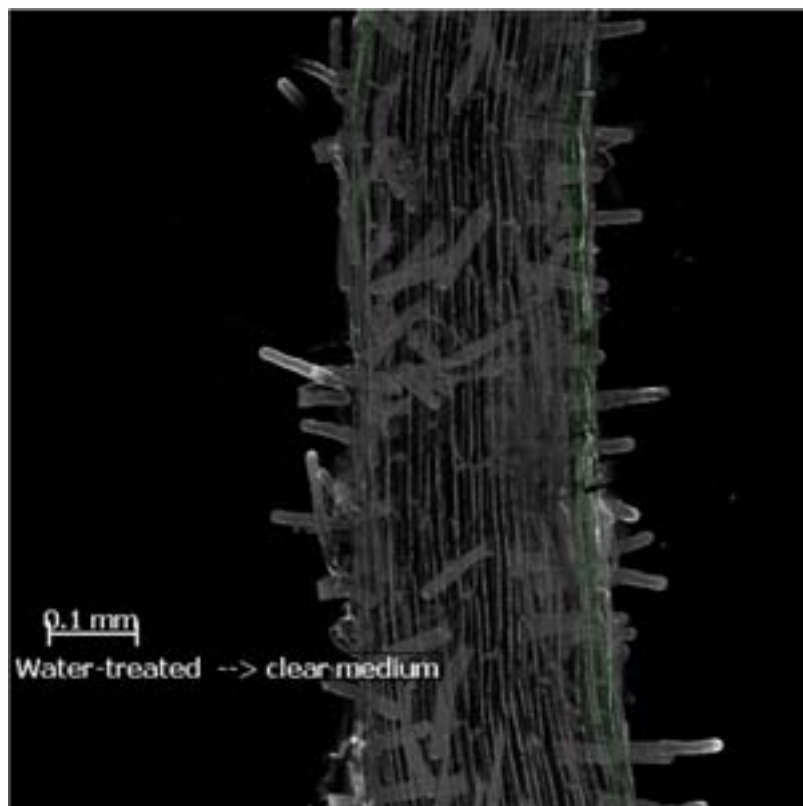


Root tip surrounded by armor  
created by SERENADE SOIL

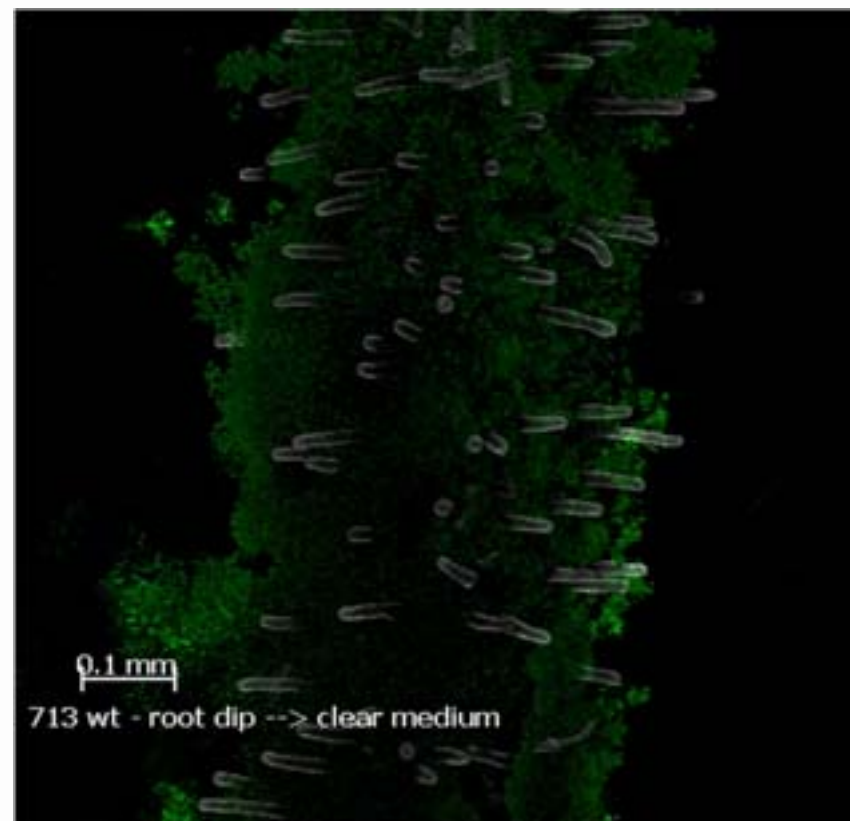
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# SERENADE SOIL

## Microscopic visualization of armor – tomato root colonization, 5 days after application



Untreated water control



Root treated with SERENADE SOIL

Fluorescent staining using two different dyes for roots and armor.,  
under confocal microscope.

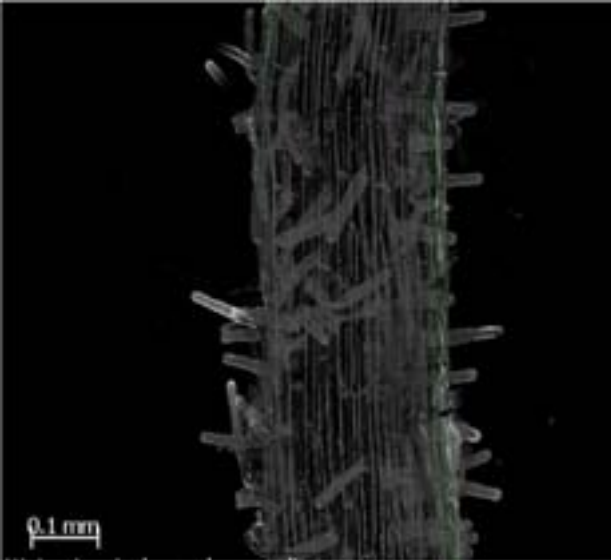
# SERENADE<sup>®</sup> SOIL

Germinated tomato seeds dipped into a QST713 suspension and placed into ½ strength MS medium. After 5 days, the roots were visualized under microscopy in order to observe colonization.

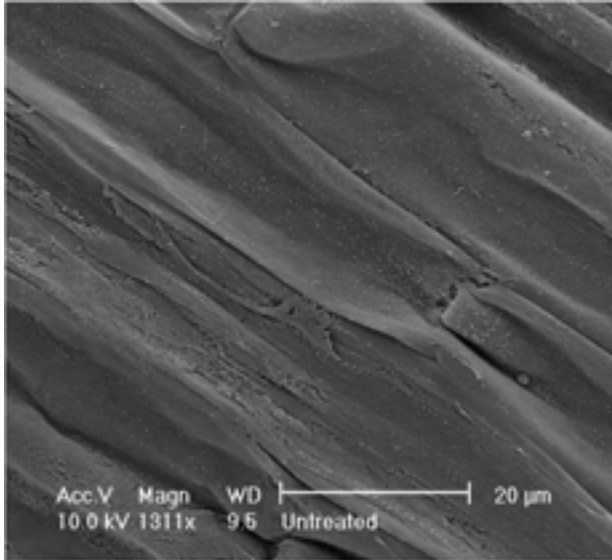
Untreated water control



Digital Microscopy

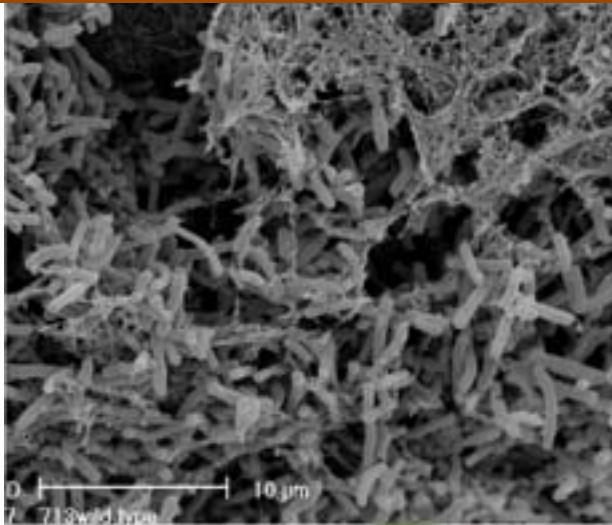
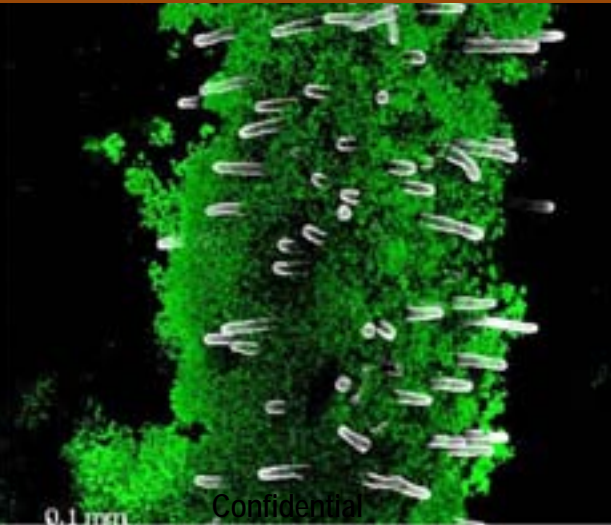


Fluorescence Microscopy



Scanning Electron Microscopy

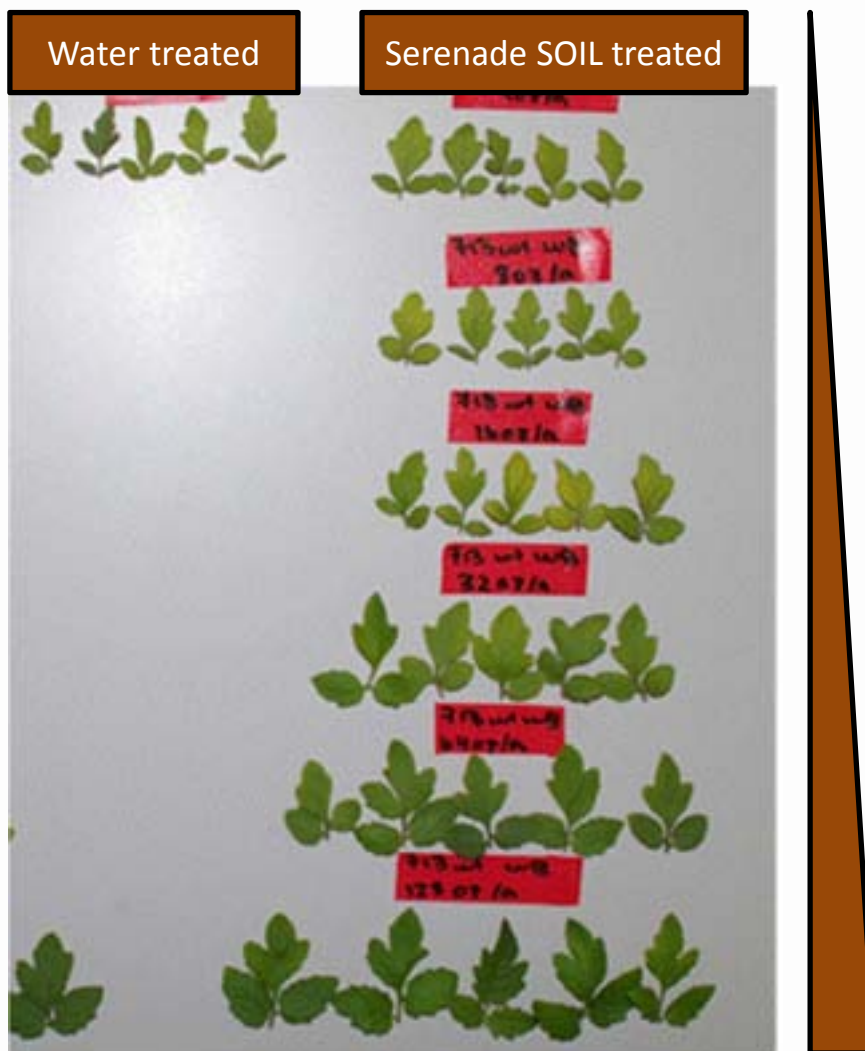
Serenade SOIL





# SERENADE SOIL

## Mode of Action: Plant Growth Promotion effect



Serenade SOIL increases plant growth:

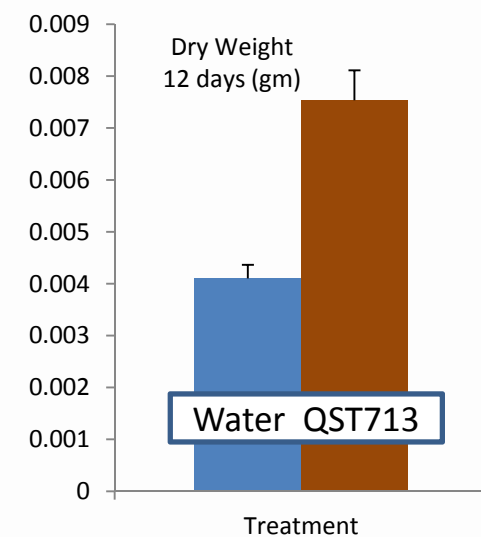
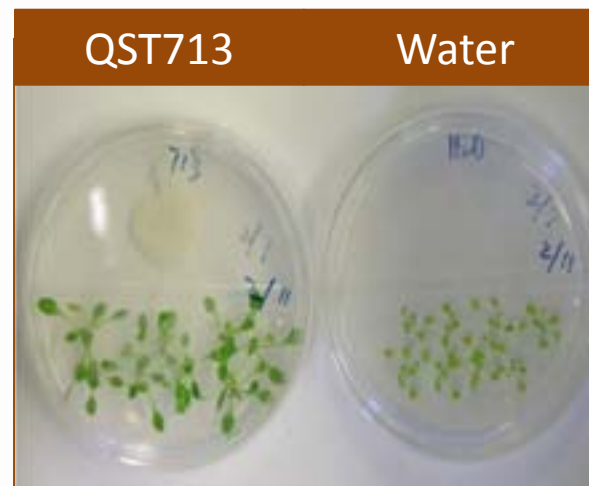
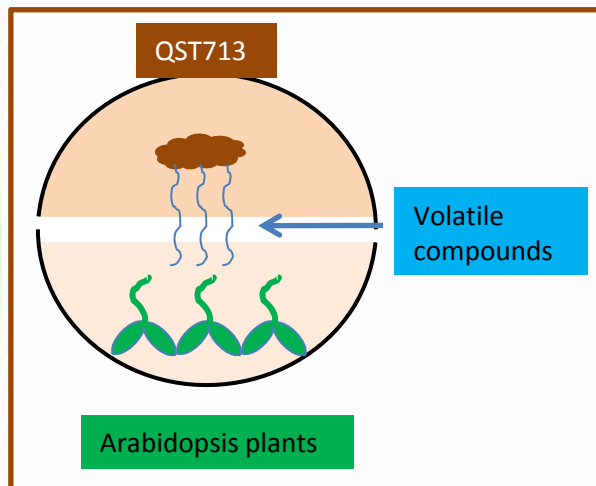
- Dose related:
  - Larger leaf surface area as the rate/acre of Serenade SOIL increases

AQ – 2010: tomato seeds, single at-planting application, potting soil, evaluation at 28 days

# SERENADE SOIL

## Mode of Action: Plant growth promotion effect

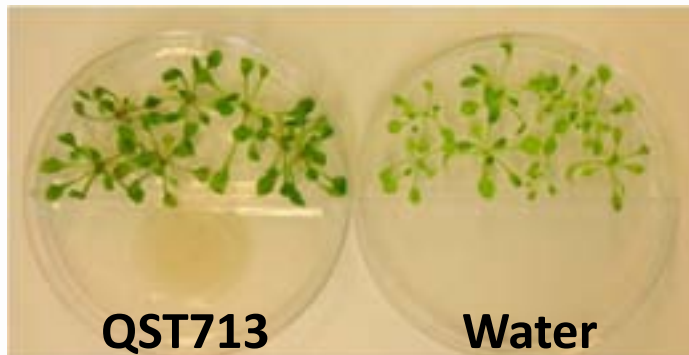
- SERENADE SOIL produces volatile substances that promote plant growth
  - 2,3-butanediol: volatile compound known to trigger plant growth promotion
    - The biosynthetic pathway is conserved in QST713 and the metabolite is present in Serenade SOIL



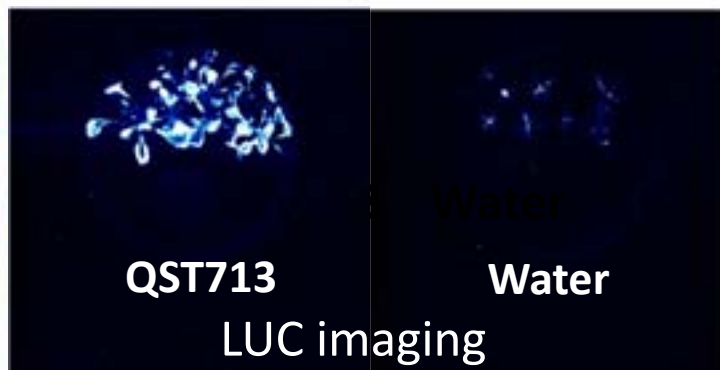
# SERENADE SOIL

## Mode of Action: Promoting plant processes

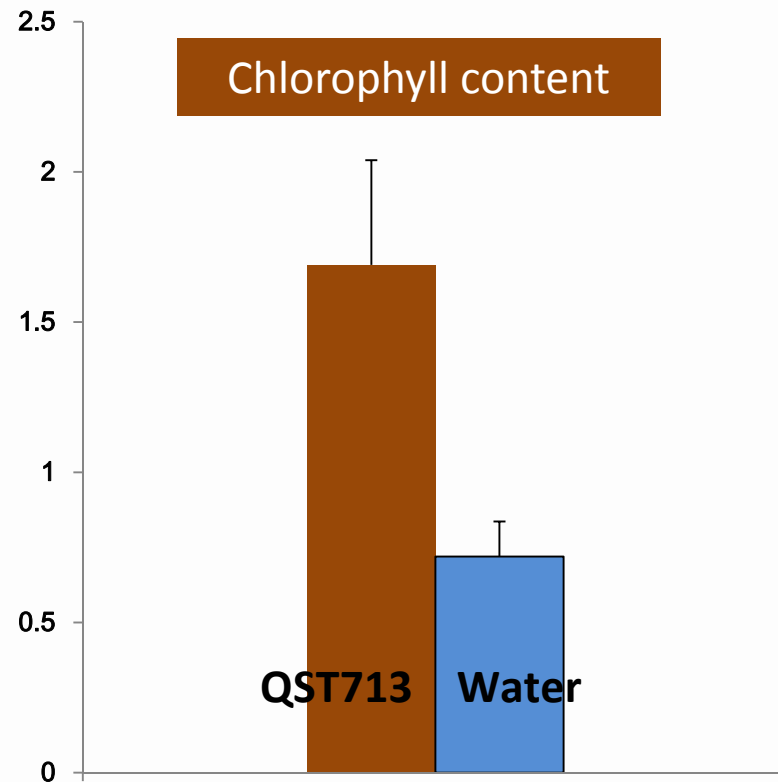
- SERENADE SOIL increases photosynthesis



ApL3::LUC transgenic plants:  
(14 days after treatment)



ApL3=ADP-Glucose Pyrophosphorylase (starch synthesis)





# SERENADE<sup>®</sup> SOIL

## Application

- In-furrow:
  - SERENADE SOIL can be applied directly to the furrow at planting just before the seeds or seed pieces are covered
- Drench:
  - SERENADE SOIL can be applied as a chemigation drench at planting, during or after seeding, during or after transplanting or throughout the season.
- SERENADE SOIL can be tank-mixed with other ag chem products in your program and can be applied through existing equipment.



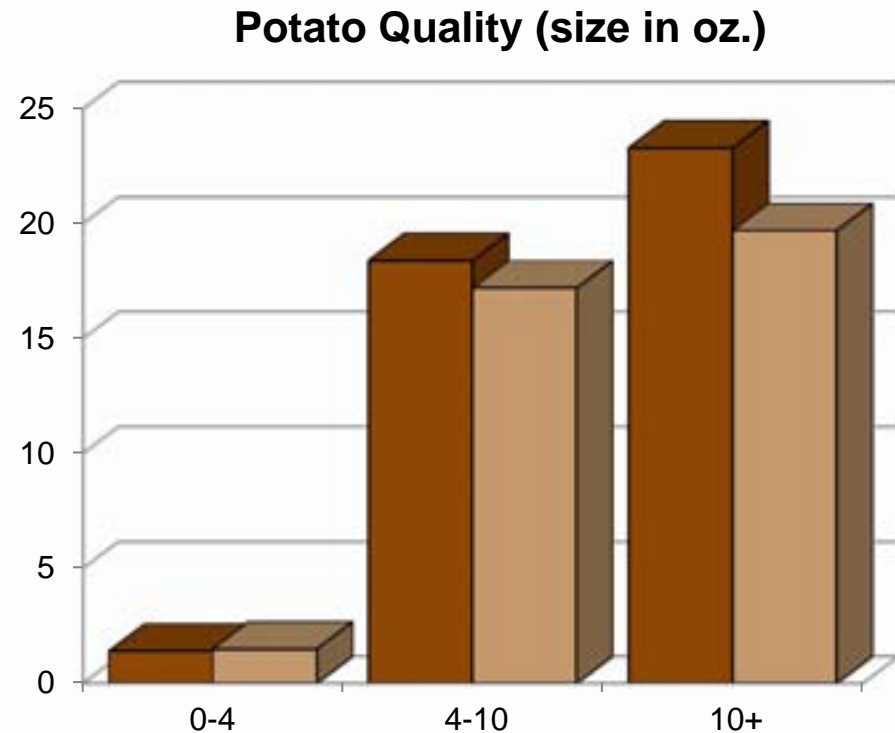
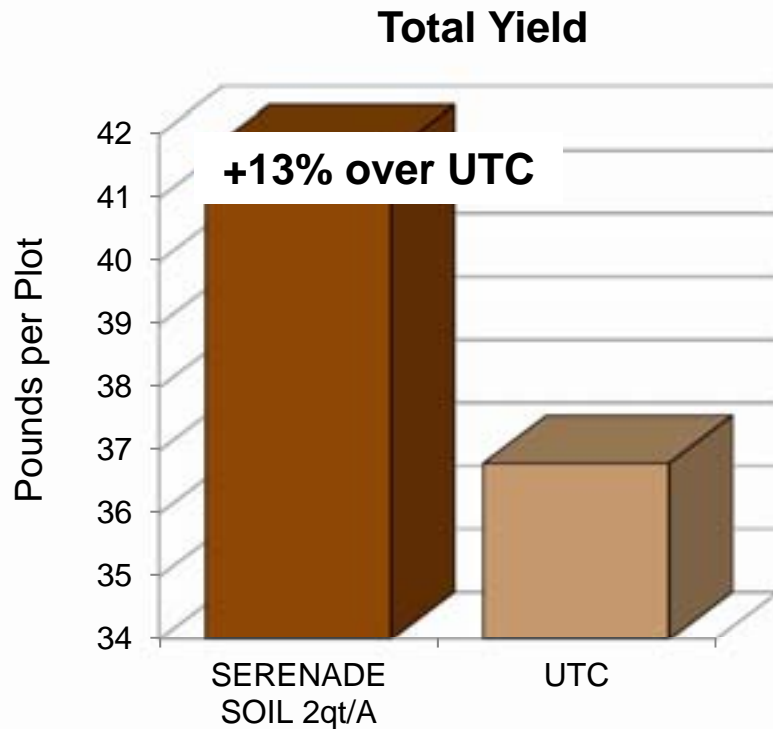
# Field Performance: Potatoes, Tomatoes and Cucurbits



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# SERENADE SOIL

Using SERENADE SOIL in-furrow at planting increases total profit by increasing yield and grading quality



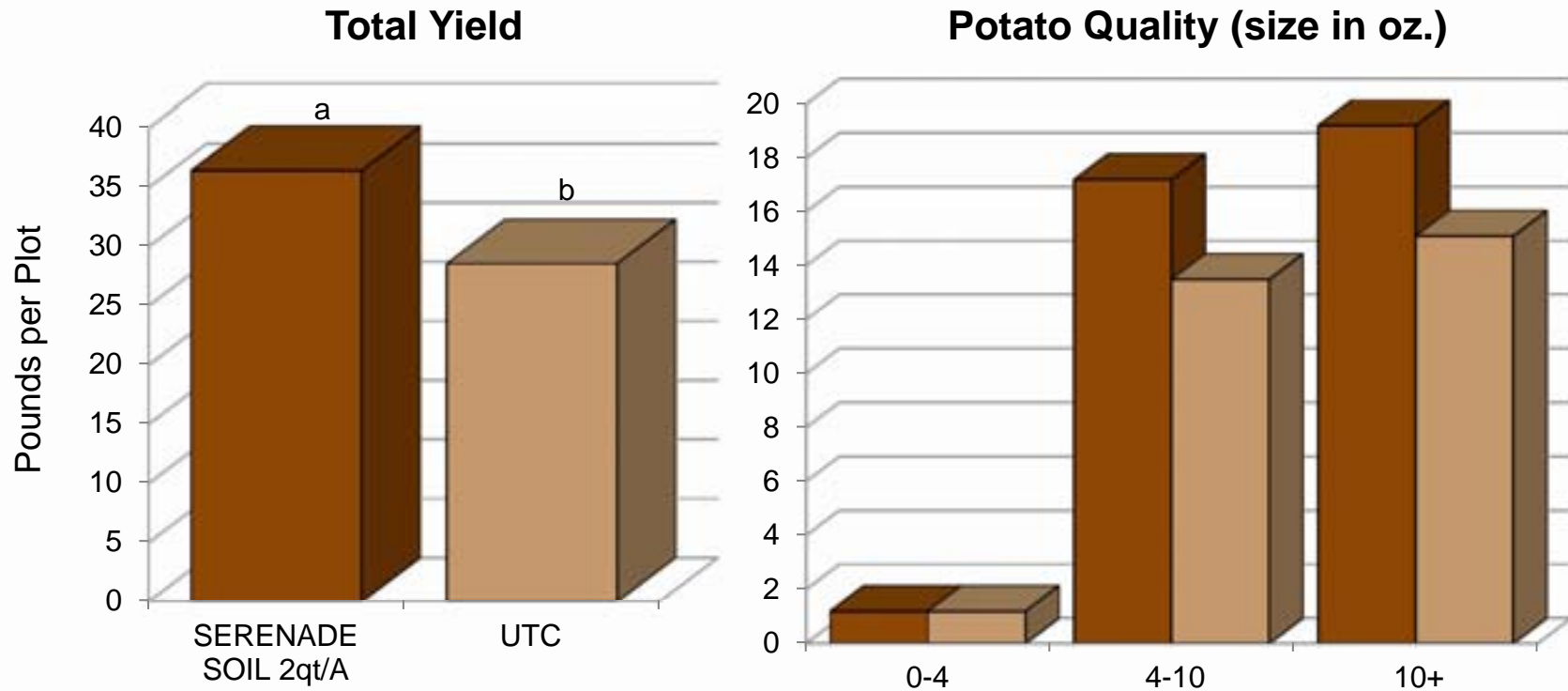
CPS Research, Moses, Lake, WA – 2009. Means followed by same letter NSD. LSD 0.05. H<sub>2</sub>O volume: 10GPA. Grower standard = Black Label Zn 5gal (902041)

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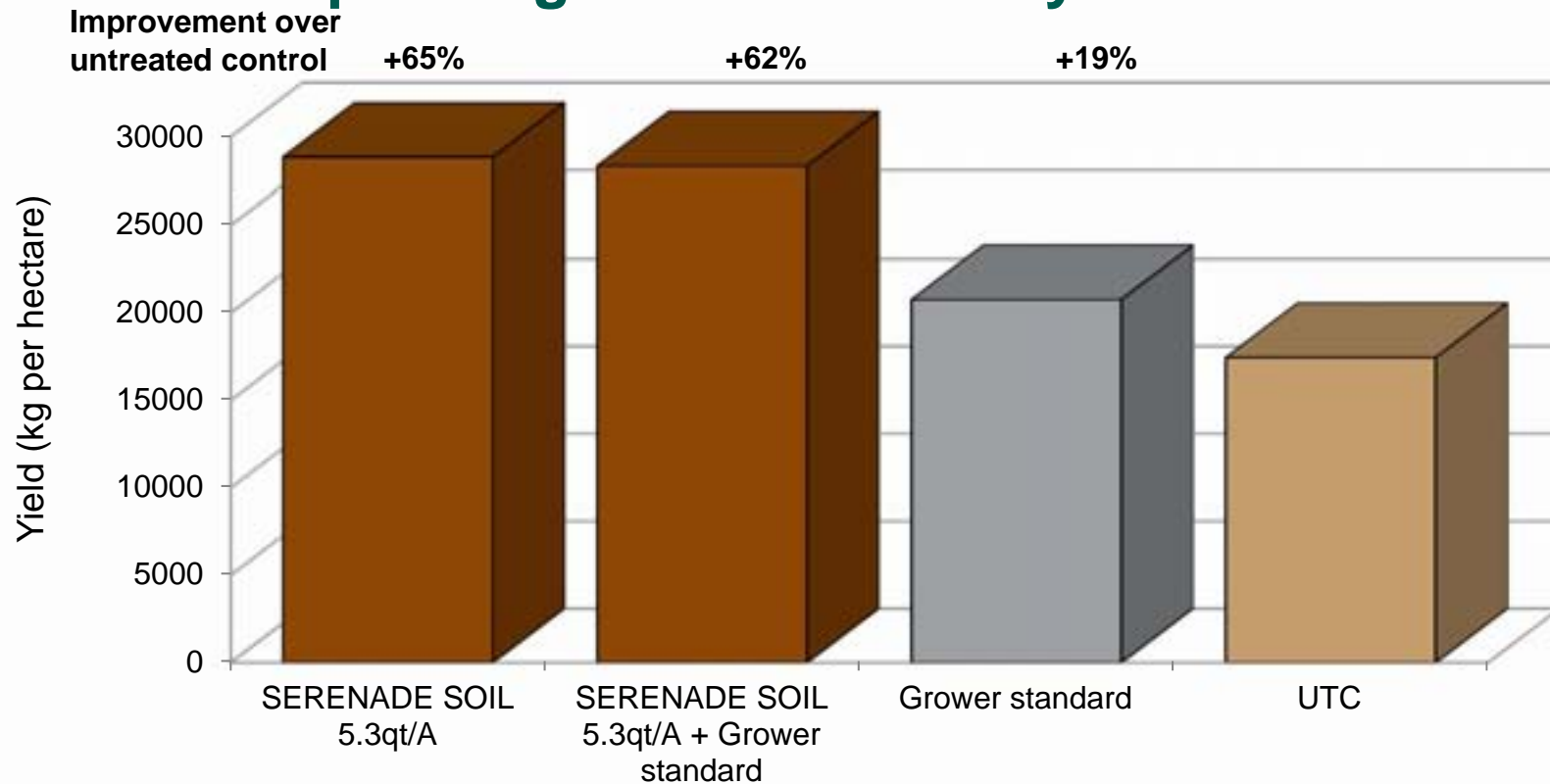


CPS Research, Connell, WA – 2009. Means followed by same letter NSD. LSD 0.05 = 6.904. H<sub>2</sub>O volume: 10GPA. Grower standard = Black Label Zn 5gal (902042)



# SERENADE SOIL

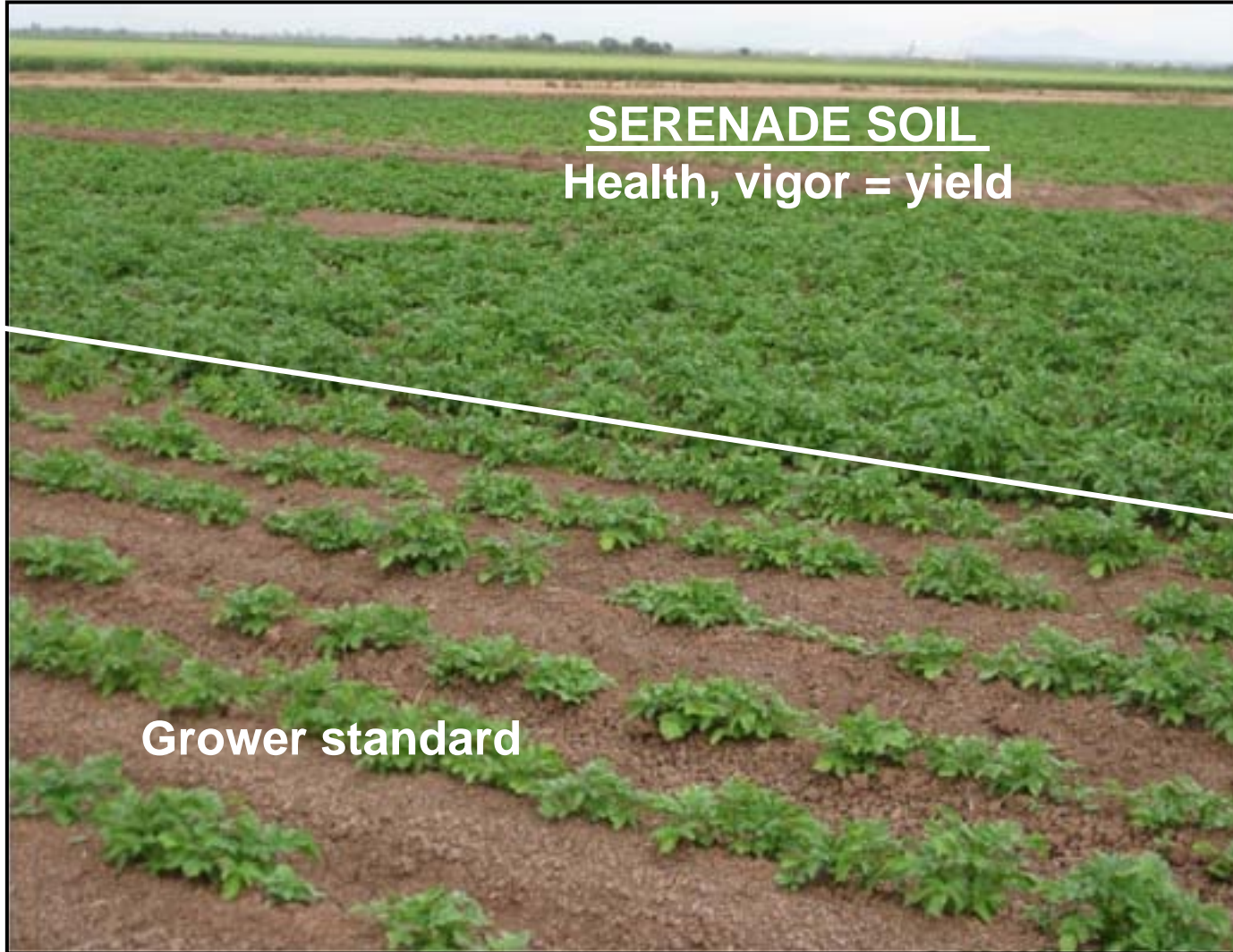
## Using SERENADE SOIL In-furrow at planting increases total yield



AQ trial, Northern Sinaloa, MX – 2009. Grower standard = Rizolex (tolclofos-methyl) 5 kg + Tecto (thiabendazole) 1 kg. Converted from SERENADE MAX at 3 kg/H

# SERENADE SOIL

SERENADE SOIL promotes higher yields in potatoes



Field Trial, North Sinaloa - 2009



# SERENADE SOIL

## Large-scale grower demos confirm the yield benefits of SERENADE SOIL applied in-furrow

Trial location	Yield improvement over the grower standard fungicide treatment	Annual Average
<b>2008</b>		<b>5.6 tons/ac</b>
Washington	7 tons/ac	Additional grower return = \$1072 per acre
Colorado	5 tons/ac	
Washington	5 tons/ac	
<b>2009</b>		<b>2.4 tons/ac</b>
Colorado	1 ton/ac	Additional grower return = \$454 per acre
Colorado	2 tons/ac	
Colorado	3 tons/ac	
Colorado	2 tons/ac	
Colorado	1 ton/ac	
Colorado	6 tons/ac	

Fields are state-coded to protect confidentiality  
 2008 market year average potato price = \$9.46/cwt. Demos conducted on center pivots (100-125 acres)





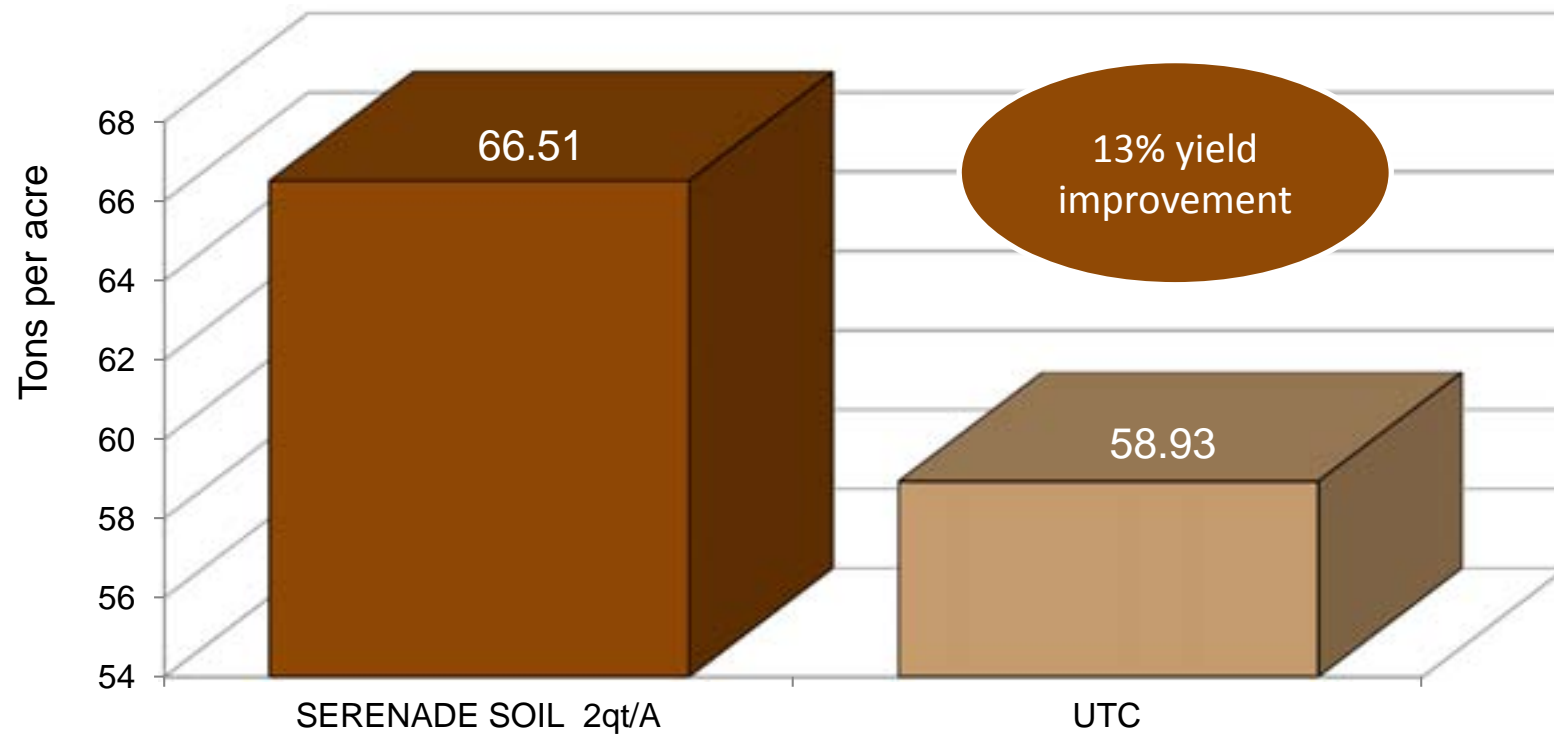
# Tomatoes



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# SERENADE SOIL

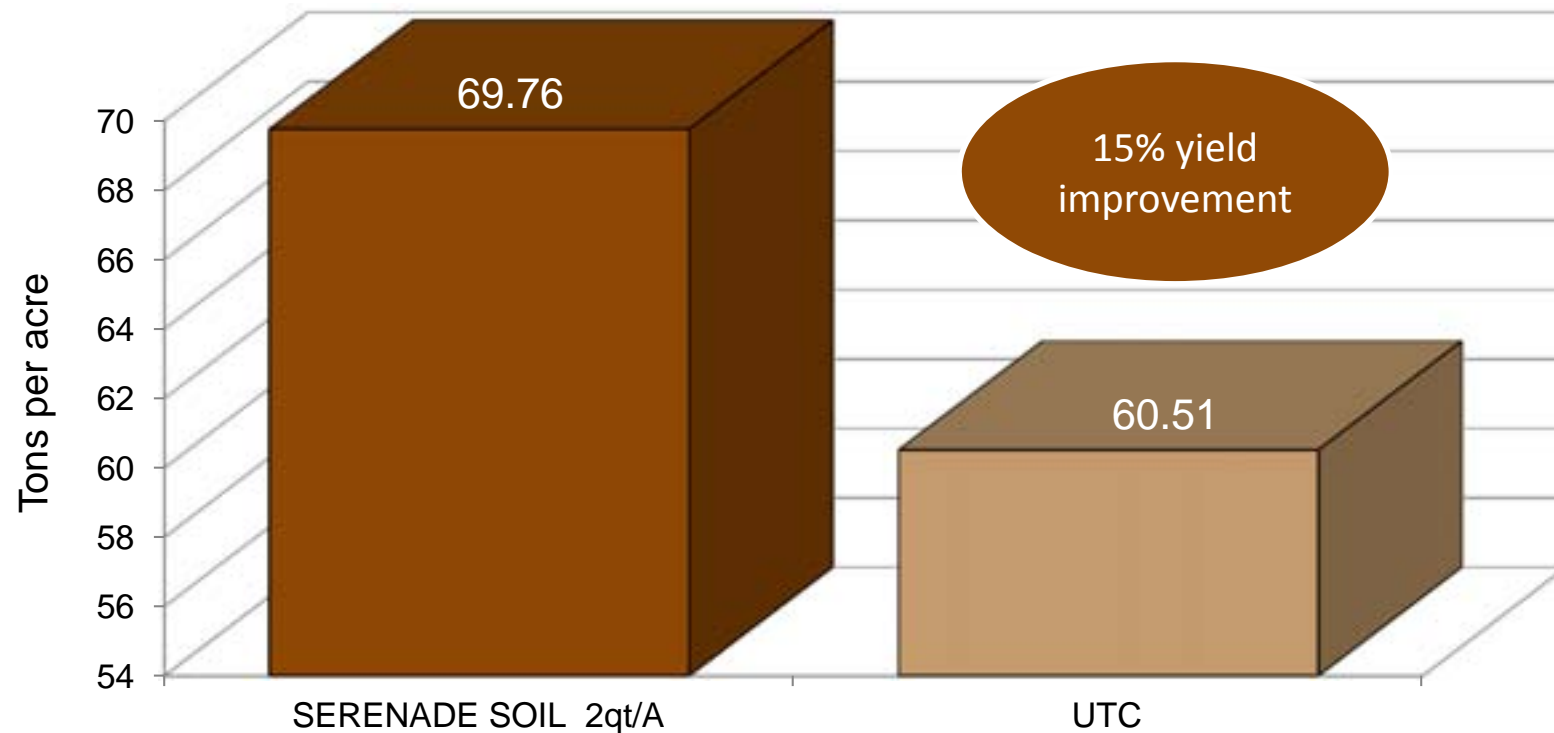
Using SERENADE SOIL in-furrow at planting increases the yield of processing tomatoes



SERENADE SOIL added to transplant H<sub>2</sub>O  
H<sub>2</sub>O volume: 50GPA. Pantoja Research, King City, CA – 2009.  
(902037)

# SERENADE SOIL

Using SERENADE SOIL in-furrow at planting increases the yield of processing tomatoes

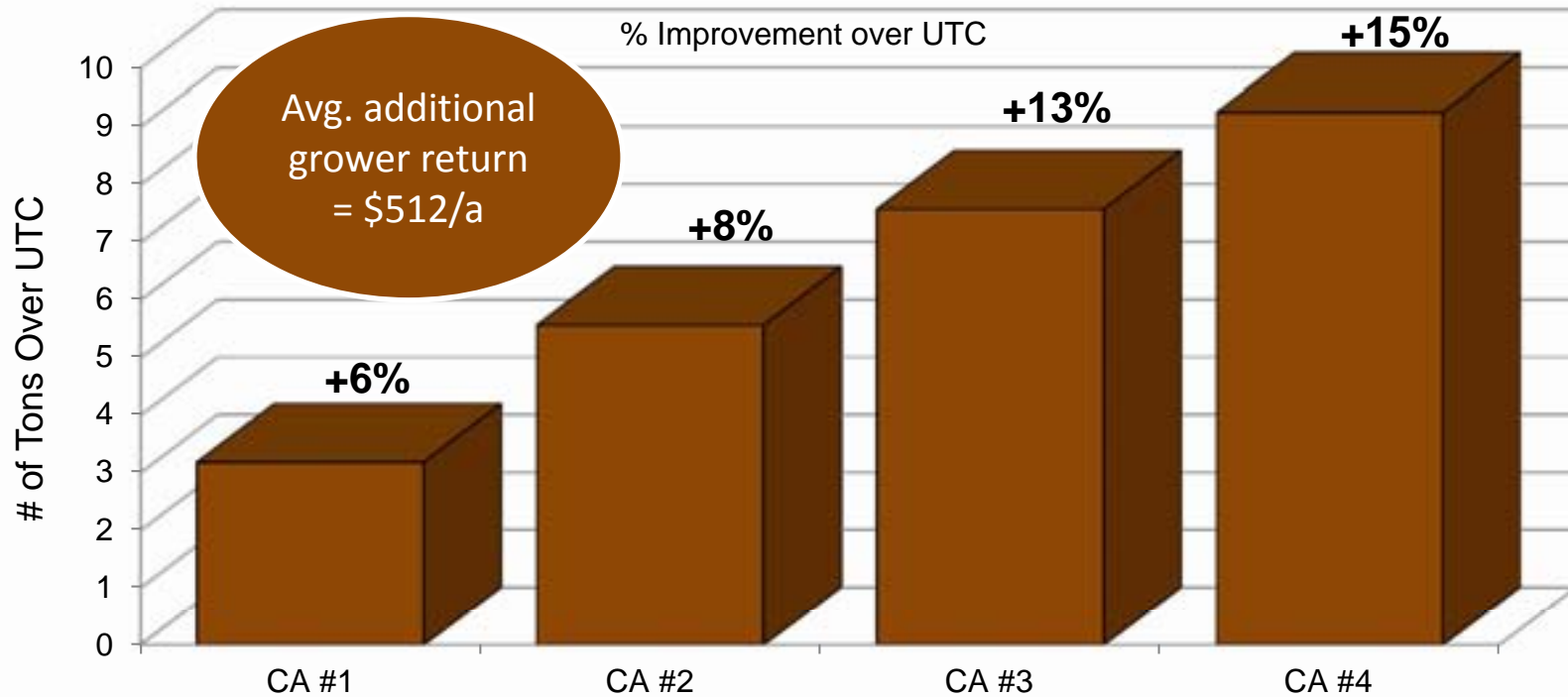


SERENADE SOIL added to transplant H<sub>2</sub>O  
H<sub>2</sub>O volume: 50GPA. Pantoja Research, King City, CA – 2009.  
(902038)



# SERENADE SOIL

## Using SERENADE SOIL in-furrow at transplanting Increases total yield of processing tomatoes



\$80/acre = avg 2009 processing tomato price  
Avg New Product = 72 tons/ac; avg UTC = 64 tons/ac  
(902035, 902036, 902037, 902038)

# SERENADE SOIL

**Chemigation treatments of SERENADE SOIL deliver better results than UTC in every category**

Measure	% Improvement over standard foliar fungicide program
Marketable yield (25 lb cartons/A)	16%
Extra large (25 lb cartons/A)	67%
Avg. fruit set (number of fruit)	61%

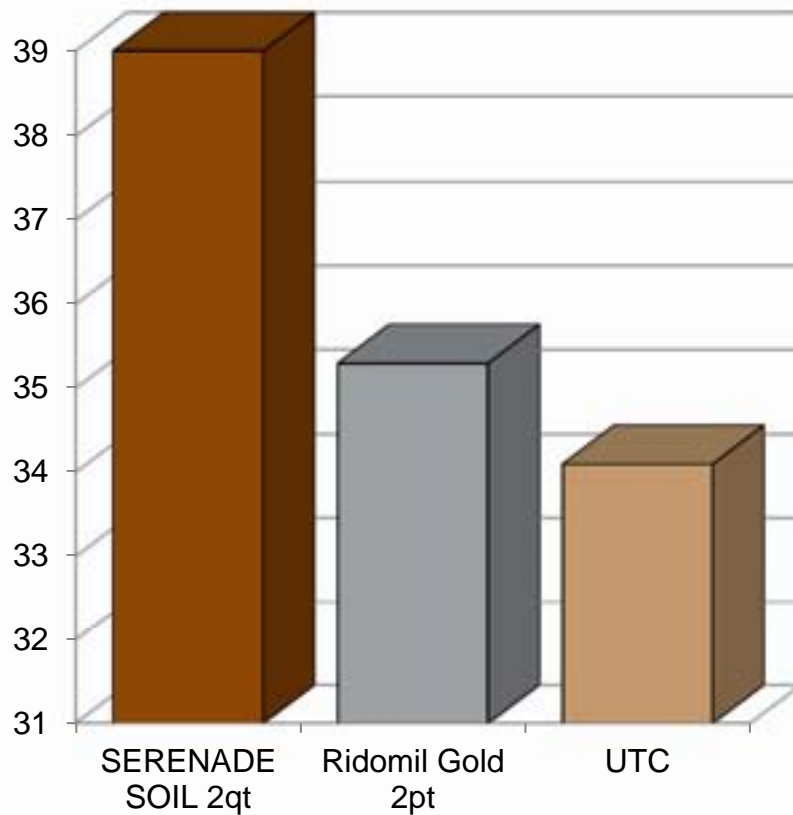
Vallad, Univ. of Florida, FL – 2008. Chemigation applications made every 7 days for 9 applications. All plots included standard foliar program. (80316)



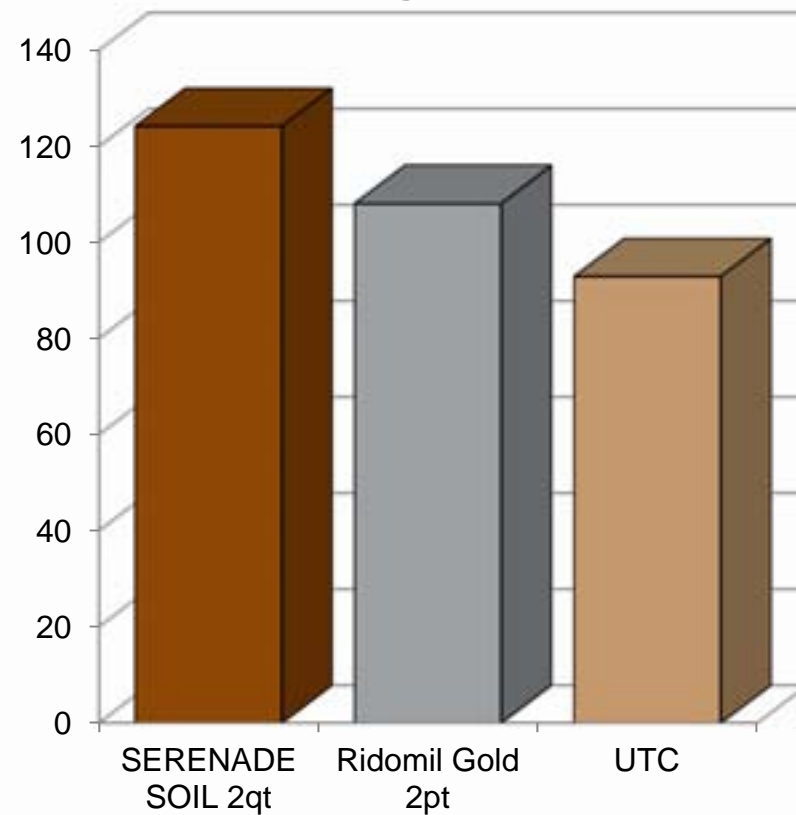
# SERENADE SOIL

Chemigation with SERENADE SOIL during the season results in larger tomato plants and improved yields

Plant size (cm)



Yield (kg per plot)



S. Zhang, Univ. of Florida, Homestead, FL. 5 weekly soil applications through drip tape. Plots inoculated with Rhizoctonia on Jan. 2, 2009 (after the 1<sup>st</sup> 3 drip apps were made). Fruit harvested 3/13, 4/3, 4/17





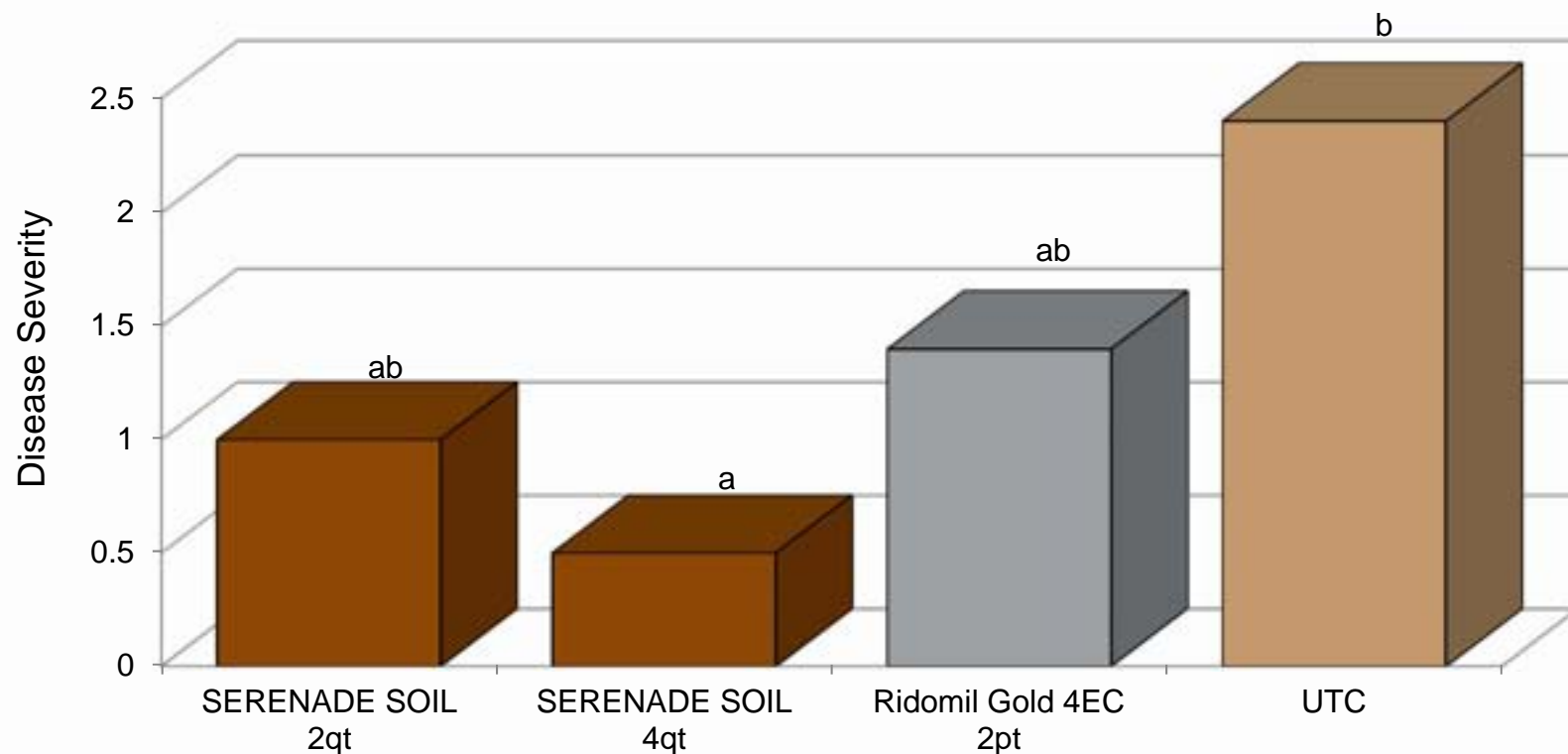
# Cucurbits



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# SERENADE SOIL

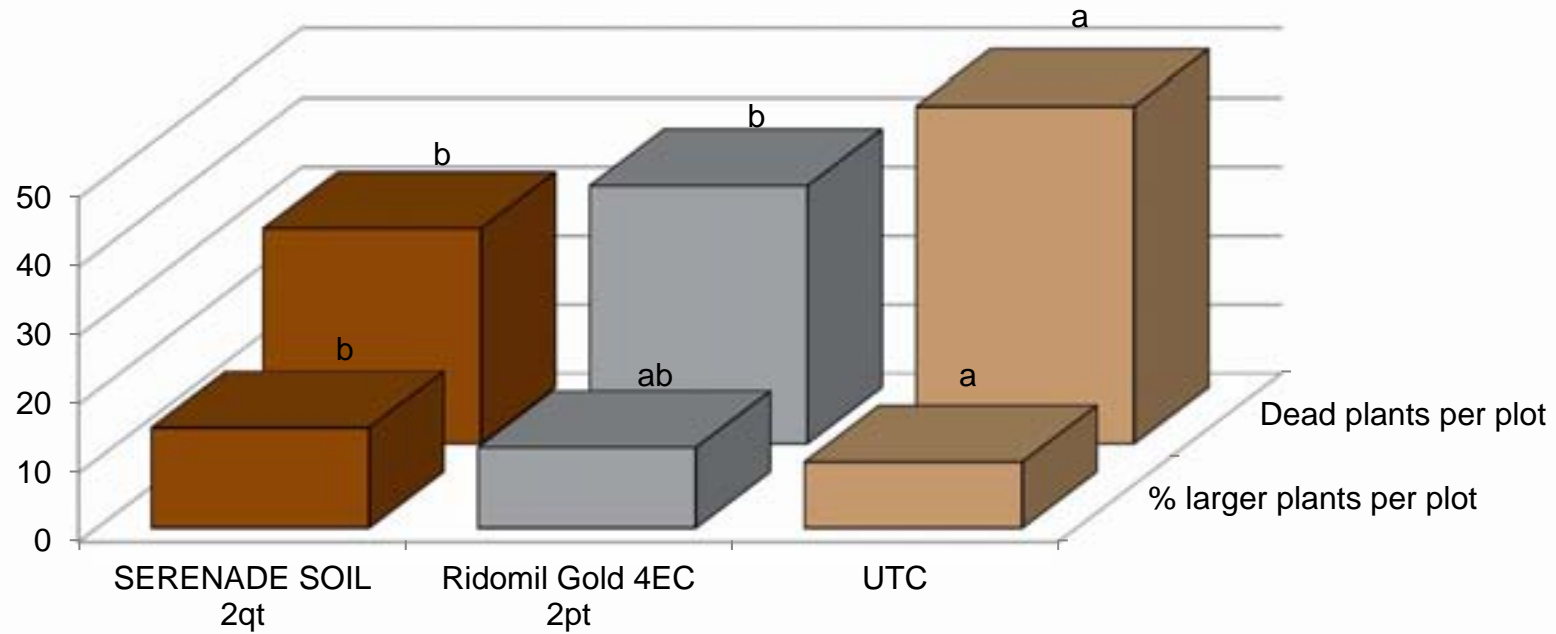
## Using SERENADE SOIL as a drench at planting controls *P. capsici* in squash



Zhang, Univ. of Florida, FL – 2009. 0 = no visible symptom, 1 = small brownish lesion at the base of stem, 2 = stem lesions extend to cotyledons or the lesion has girdled the stem causing plant collapse, 3 = plants have collapsed with all leaves wilted or turned yellow except for the young leaves, 4 = plants have completely collapsed, and 5 = plants are dead. (904130)

# SERENADE SOIL

Using SERENADE SOIL as a drench at planting and throughout the season controls *Pythium* in cucurbits and improves crop quality

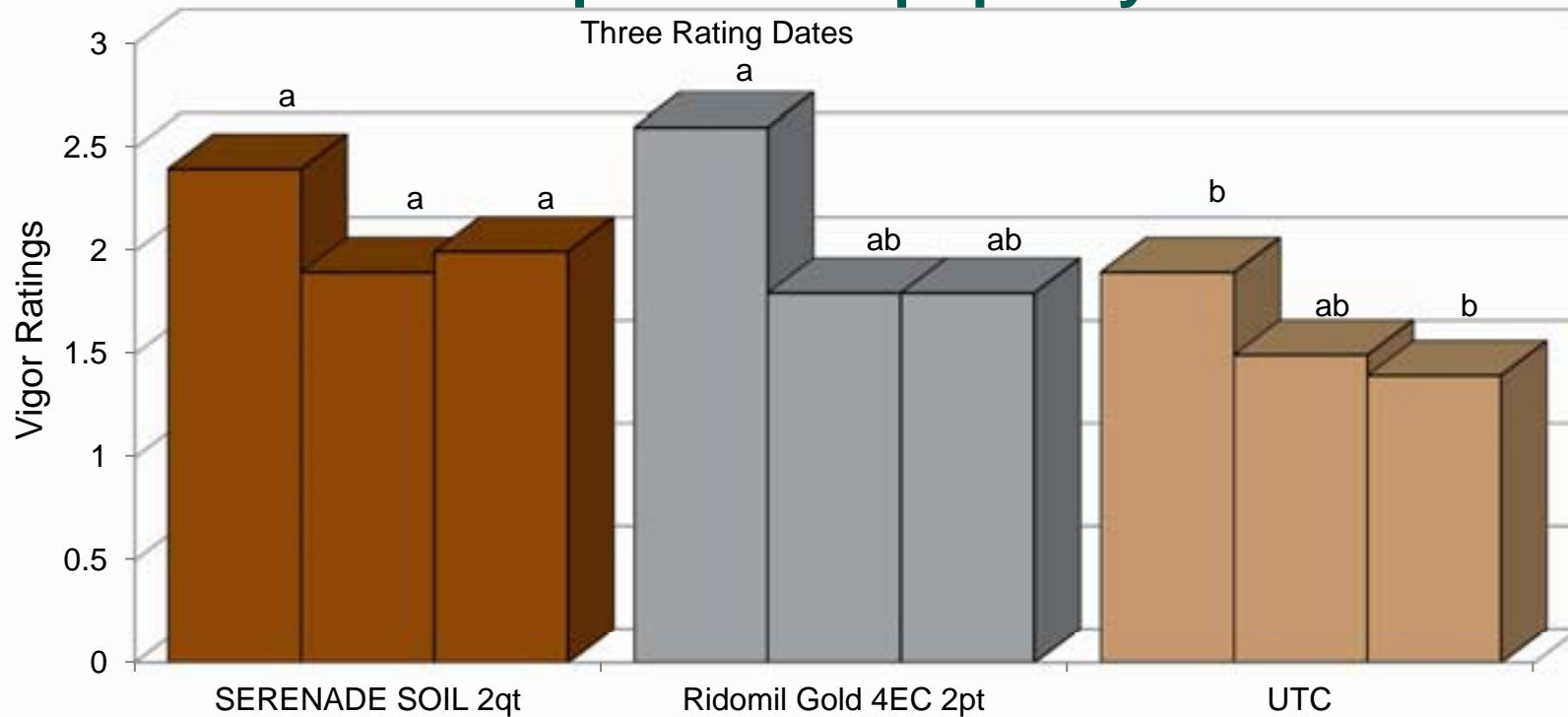


Zhang, Univ. of Florida, FL – 2008. Drip applications made immediately following planting and every 7 days. Inoculated field study (80319)



# SERENADE SOIL

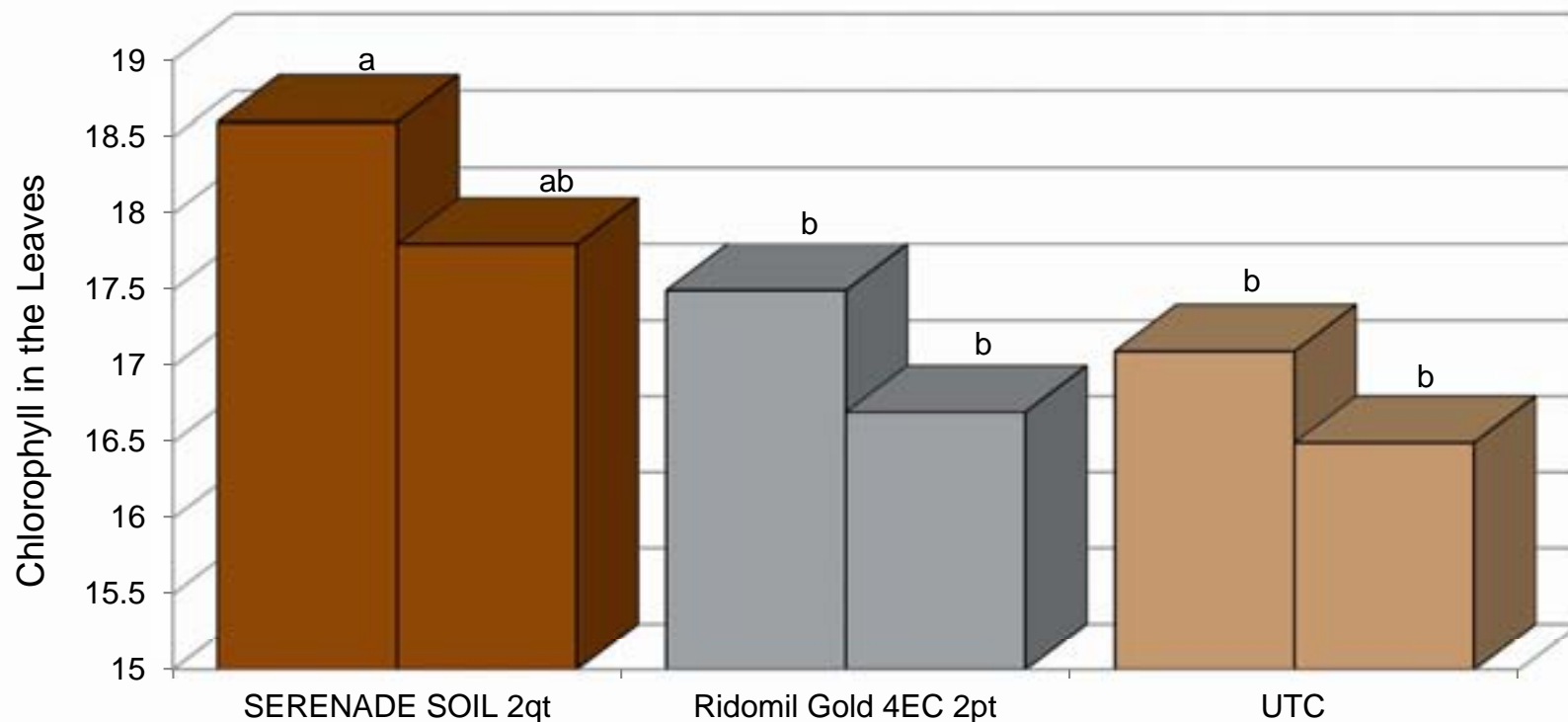
Using SERENADE SOIL as a drench at planting and throughout the season controls *Pythium* in cucurbits and improves crop quality



Zhang, Univ. of Florida, FL – 2008. Drip applications made immediately following planting and every 7 days. Inoculated field study. Three rating dates. (80319)

# SERENADE SOIL

Using SERENADE SOIL as a drench at planting and throughout the season improves crop quality



Zhang, Univ. of Florida – 2008. Drip applications made immediately following planting and every 7 days. Inoculated field study. Chlorophyll readings on two dates. SPAD reading was taken using a Minolta Chlorophyll Meter (80319)





# Thank you

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The SONATA and BALLAD products are covered by U.S. Patent Nos. 6245551, 6586231, and 6635245 and by patents in numerous other countries.

Products comprising the *Muscodor* fungus are protected by U.S. Patent No. 6,911,338 and are the subject of numerous pending patent applications worldwide.

AgraQuest owns the following product registrations: SERENADE MAX - EPA Reg. No. 69592-11; SERENADE ASO - EPA Reg. No. 69592-12; SONATA - EPA Reg. No. 69592-13. These products are also registered in numerous other countries worldwide.







SERENADE<sup>®</sup>  
SOIL

SERENADE<sup>®</sup>  
ASO

SERENADE<sup>®</sup>  
MAX

BALLAD<sup>®</sup>  
PLUS

SONATA<sup>®</sup>

RHAPSODY<sup>®</sup>

REQUIEM<sup>®</sup>

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