Novel fungicide for in-furrow and other soil applications

Sarah Reiter, Denise Manker, Jon Margolis
ABIM 2010
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® 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.
**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
Soil disease control

Activates plant’s defenses

Increases plant activity and growth

Root colonization
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
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.

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Untreated root

Root colonized by SERENADE SOIL

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Images captured 7 days after application
Mode of Action: Root Colonization

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

**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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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

Images captured 7 days after application
Microscopic visualization of armor –
tomato root colonization, 5 days after application

Untreated water control

Root treated with SERENAende SOIL

Fluorescent staining using two different dyes for roots and armor, under confocal microscope.
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.
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
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
Mode of Action: Promoting plant processes

- SERENAIDE SOIL increases photosynthesis

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

ApL3=ADP-Glucose Pyrophosphorylase (starch synthesis)
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
Using SERENADE SOIL in-furrow at planting increases total profit by increasing yield and grading quality.

**Total Yield**

- **SERENADE SOIL 2qt/A**: 42 pounds per plot
- **UTC**: 34 pounds per plot

+13% over UTC

**Potato Quality (size in oz.)**

- **0-4**: SERENADE SOIL 15, UTC 10
- **4-10**: SERENADE SOIL 20, UTC 15
- **10+**: SERENADE SOIL 25, UTC 20

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CPS Research, Moses, Lake, WA – 2009. Means followed by same letter NSD. LSD 0.05. H₂O volume: 10GPA. Grower standard = Black Label Zn 5gal (902041)
Using SERENADE SOIL in-furrow at planting increases total profit by increasing yield and grading quality.

**Total Yield**

<table>
<thead>
<tr>
<th>Pounds per Plot</th>
<th>SERENADE SOIL 2qt/A</th>
<th>UTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>a</td>
<td>b</td>
</tr>
</tbody>
</table>

**Potato Quality (size in oz.)**

<table>
<thead>
<tr>
<th>0-4</th>
<th>4-10</th>
<th>10+</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

CPS Research, Connell, WA – 2009. Means followed by same letter NSD. LSD 0.05 = 6.904. H₂O volume: 10GPA. Grower standard = Black Label Zn 5gal (902042)
Using SERENADE SOIL In-furrow at planting increases total yield

Improvement over untreated control:
- SERENADE SOIL 5.3qt/A: +65%
- SERENADE SOIL 5.3qt/A + Grower standard: +62%
- Grower standard UTC: +19%

Yield (kg per hectare)

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.
SERENA DE SOIL promotes higher yields in potatoes

SERENA DE SOIL
Health, vigor = yield

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

<table>
<thead>
<tr>
<th>Trial location</th>
<th>Yield improvement over the grower standard fungicide treatment</th>
<th>Annual Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td>5.6 tons/ac</td>
</tr>
<tr>
<td>Washington</td>
<td>7 tons/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>5 tons/ac</td>
<td></td>
</tr>
<tr>
<td>Washington</td>
<td>5 tons/ac</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td>2.4 tons/ac</td>
</tr>
<tr>
<td>Colorado</td>
<td>1 ton/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>2 tons/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>3 tons/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>2 tons/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>1 ton/ac</td>
<td></td>
</tr>
<tr>
<td>Colorado</td>
<td>6 tons/ac</td>
<td></td>
</tr>
</tbody>
</table>

Additional grower return = $1072 per acre

Additional grower return = $454 per acre

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

SERENADE SOIL added to transplant H₂O
H₂O volume: 50 GPA. Pantoja Research, King City, CA – 2009.
(902037)
Using SERENADE SOIL in-furrow at planting increases the yield of processing tomatoes

SERENADE SOIL added to transplant H₂O H₂O volume: 50GPA. Pantoja Research, King City, CA – 2009. (902038)
Using SERENADE SOIL in-furrow at transplanting increases total yield of processing tomatoes.

- **Avg. additional grower return**: $512/a
- **% Improvement over UTC**:
  - CA #1: +6%
  - CA #2: +8%
  - CA #3: +13%
  - CA #4: +15%

$80/acre = avg 2009 processing tomato price
Avg New Product = 72 tons/ac; avg UTC = 64 tons/ac (902035, 902036, 902037, 902038)
Chemigation treatments of SERENADE SOIL deliver better results than UTC in every category

<table>
<thead>
<tr>
<th>Measure</th>
<th>% Improvement over standard foliar fungicide program</th>
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<tbody>
<tr>
<td>Marketable yield (25 lb cartons/A)</td>
<td>16%</td>
</tr>
<tr>
<td>Extra large (25 lb cartons/A)</td>
<td>67%</td>
</tr>
<tr>
<td>Avg. fruit set (number of fruit)</td>
<td>61%</td>
</tr>
</tbody>
</table>
Chemigation with SERENADE SOIL during the season results in larger tomato plants and improved yields

S. Zhang, Univ. of Florida, Homestead, FL.  5 weekly soil applications through drip tape. Plots inoculated with Rhizoctonia on Jan. 2, 2009 (after the 1st 3 drip apps were made). Fruit harvested 3/13, 4/3, 4/17
Cucurbits
Using SERENADE SOIL as a drench at planting controls *P. capsici* in squash

Disease Severity

<table>
<thead>
<tr>
<th></th>
<th>SERENADE SOIL</th>
<th>SERENADE SOIL</th>
<th>Ridomil Gold 4EC</th>
<th>UTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2qt</td>
<td>ab</td>
<td>a</td>
<td>ab</td>
<td>b</td>
</tr>
<tr>
<td>4qt</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

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)
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)
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)
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.

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