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Serifel® Biofungicide in conventional programs for better disease control and resistance management

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Benefits of biological solutions

- More options for growers to extend the window of protection
- Flexible working practices for re-entry and pre-harvest intervals
- New way to meet evolving consumer expectations and regulatory standards
- Support for resistance management

Important technology for crop protection that complements chemistry-based solutions

What is Serifel® Biofungicide?

An biological fungicide that

- Forms a shield of protection on plants' surfaces to protect against several types of diseases
- Provides a broad-spectrum disease control
- Is the most concentrated biological fungicide on the market due to its pure spore formulation
- Effects disease control through multiple modes of action
- Complements chemistry-based programs with proven resistance management effects

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Serifel® Biofungicide
Protect smart. Grow success.

- Serifel® manages a range of disease organisms including
  - *Botrytis cinerea*
  - *Alternaria solani*
  - Powdery mildew
  - Sour rot
- For foliar on high-value specialty crops in CA including
  - Berries and small fruits
  - Grapes
  - Citrus
  - Pome fruit
  - Cucurbit
  - Fruiting Veg
  - Stone fruit
  - Strawberry
- New crops pending in CA including
  - Leafy veg, brassica veg, bulb, tree nuts, root and tuber

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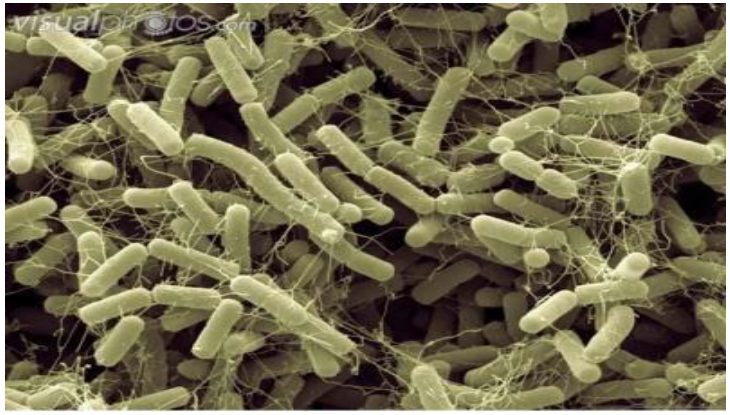
The active ingredient

***Bacillus amyloliquefaciens* strain MBI-600 is**

- A bacterium used to suppress root and foliar diseases caused by fungi and some bacteria
- A spore-forming, rod shaped bacterium that colonizes the developing root and leaf surface of plants



The spores of *Bacillus amyloliquefaciens* strain MBI-600 colonizing the plants surface form a shield of protection against several types of disease

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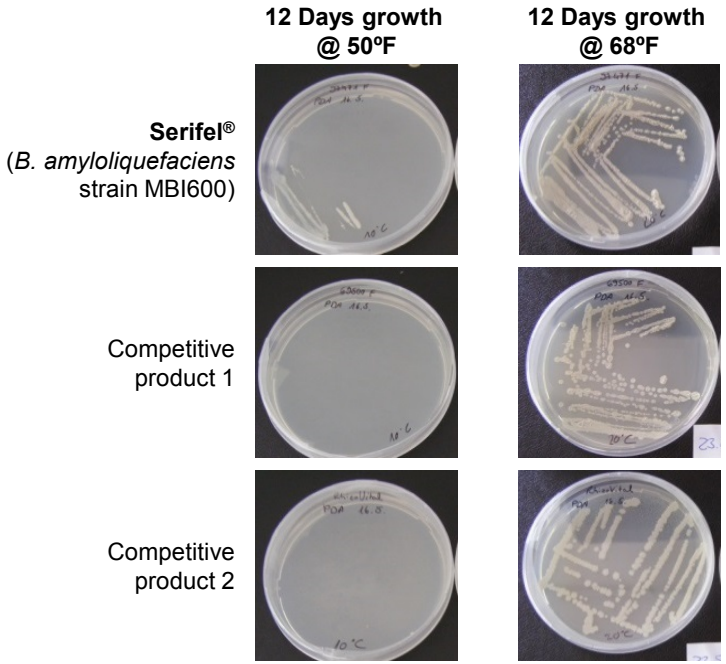
The “head start” advantage

- Formulation allows its spores to adapt more readily to their environment and produce metabolites suited to ambient conditions
- In a lab study, showed greater surface colonization than competitive biologicals by 12 days after application



Serifel® has a head start over competitors, getting to work from the time of application

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Modes of action

1. Physical barrier

Serifel® spores reproduce and occupy space on the plant so disease-causing pathogens have no room to grow

2. Nutrient competition

As Serifel® bacteria continue to grow, there are not enough nutrients to support growth of the disease-causing pathogens

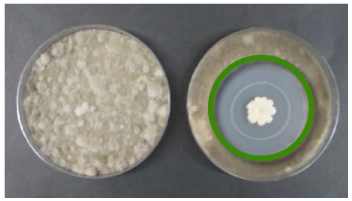
3. Fungicidal metabolites

Once on the substrate, Serifel® spores germinate and produce metabolites (e.g., Surfactin and Iturin) that have fungicidal and bactericidal activity

More spores to outcompete pathogens

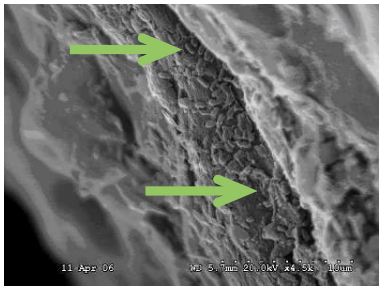
Robust spores grow and reproduce on the surface of the plant to create a zone of protection against a broad range of plant pathogens

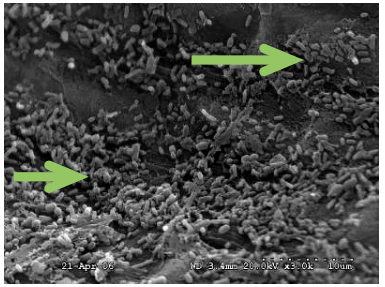
- Competition for limited nutrients
- Key factor is who gets there first
- Early colonizer advantage
- Niche exclusion



Serifel® spores create a **zone of exclusion** where disease cannot grow and germinate

Serifel® spores colonizing a root surface





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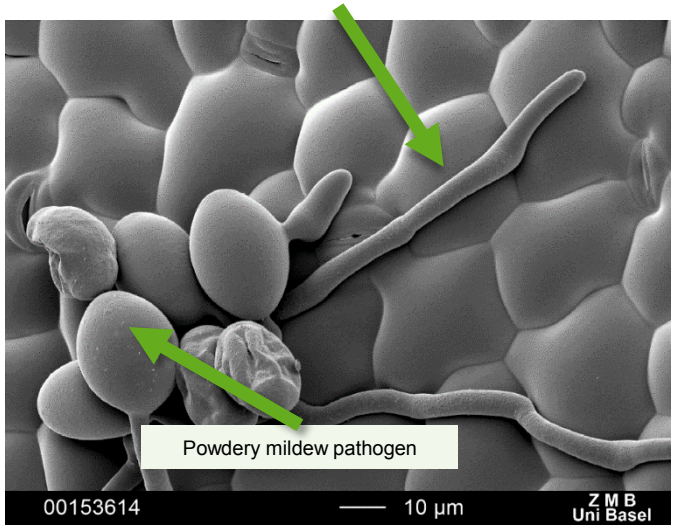
Metabolites at work

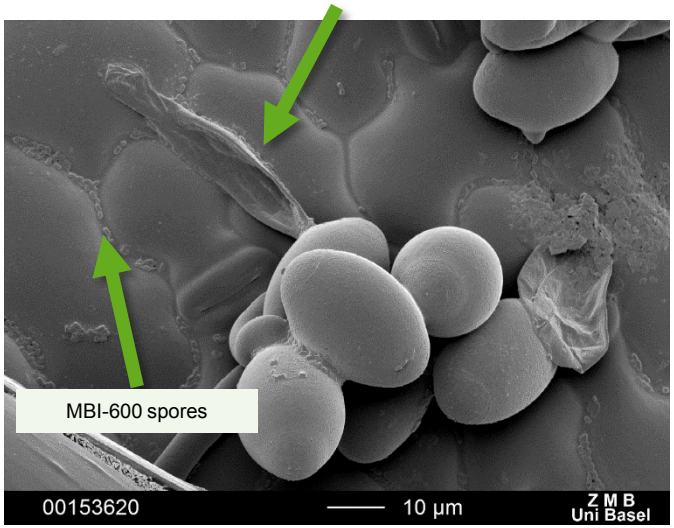
Mycelium of pathogen cell



Emission scanning electron microscope (E-SEM), zoom x 250

The metabolites disrupt (make holes in)
the membranes of the pathogen cells

With a damaged membrane,
the pathogen cell can not function correctly



Emission scanning electron microscope (E-SEM), zoom x 250

Key metabolites have fungicidal and bactericidal activity

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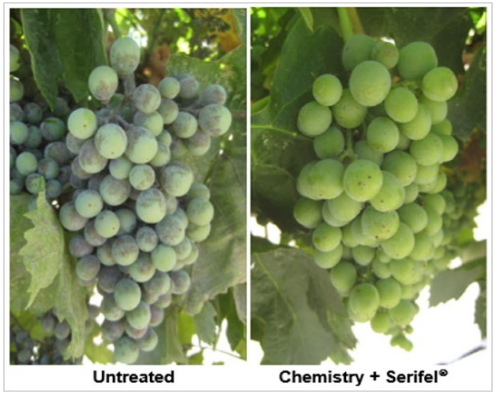
Combines well with chemical crop protection

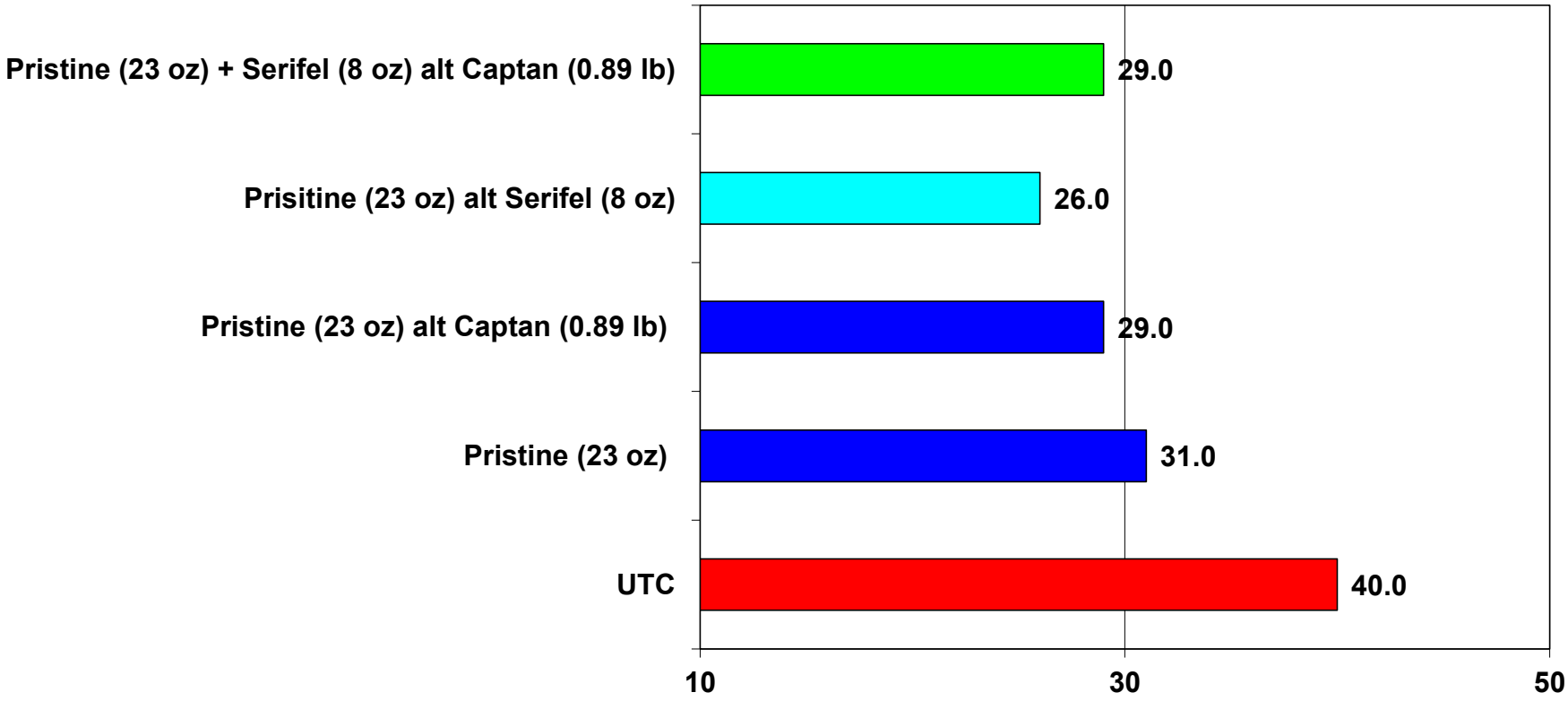
In combination with chemical crop protection, Serifel® creates a complementary effect and increases sustainability of crop protection chemistries



Extensive field trials show:

- Provides similar or better disease control when added to a conventional program
- Prolongs longevity of classic chemistries by helping delay development of resistance
- Proven to manage some diseases resistant to chemical fungicides (e.g., *Botrytis* and *Alternaria*)
- Can help lower chemical residues (MRLs) and improve spray program sustainability index

Serifel® Biofungicide for Strawberry Botrytis Control
New York



Average Percent Incidence of Botrytis on Fruit

23/1 DAT/DALT

1 trial – NY

Begin apps at 20% bloom. 7 day interval. 50 gal/A

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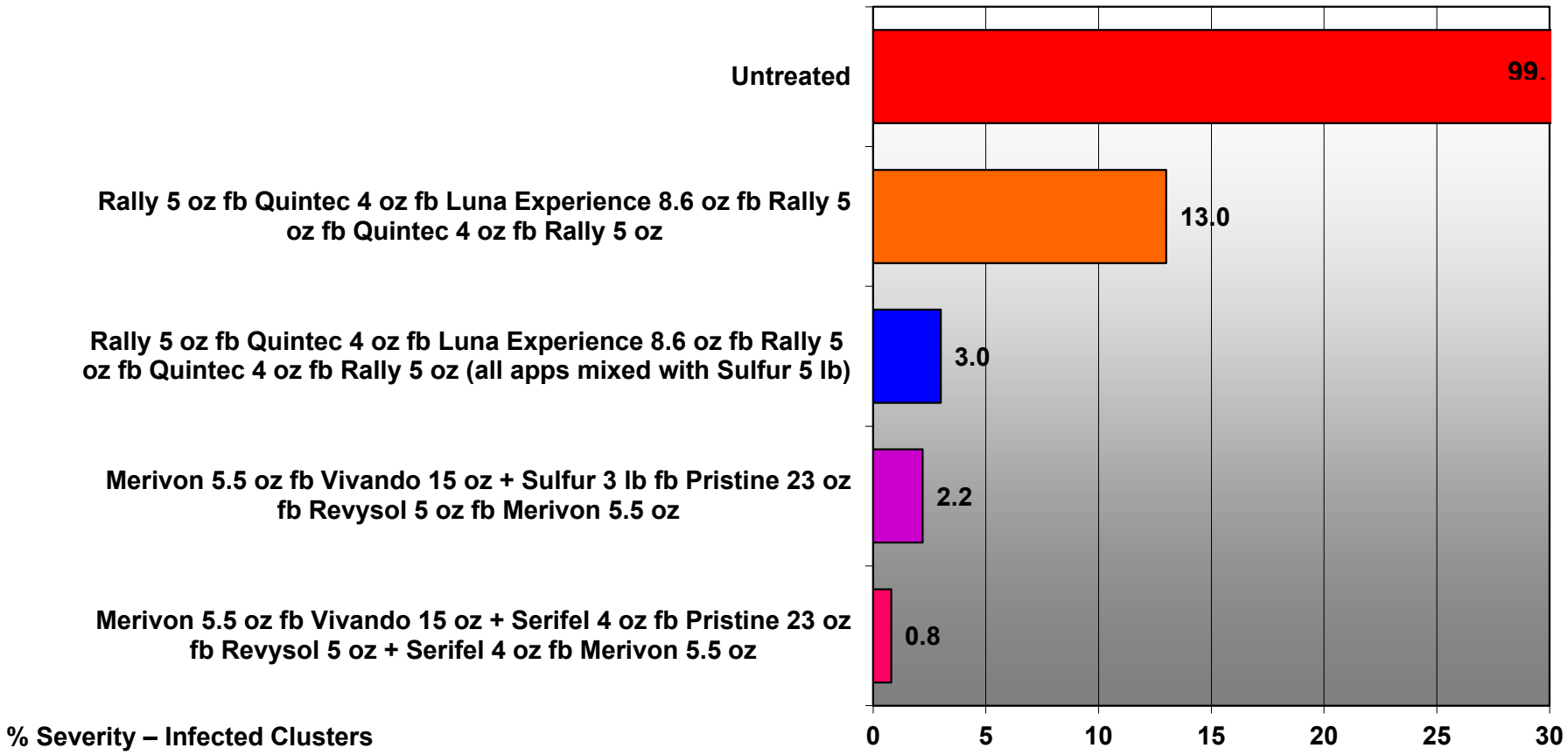
Serifel® Biofungicide – Grape Powdery Mildew Control

2018 Larry Bettiga – UCCE, Soledad, CA



Trial Location: Lone Oak Vineyards, Gonzales, CA. Variety: Chardonnay. Application dates: May 1, May 15, May 29, June 12, June 26, July 10. Evaluations taken on July 11, 2017. All treatments (except Merivon) had surfactant Dyne-Amic at 0.125% v/v. Applications of Stylet Oil were made on March 20, April 3, April 10, April 18, April 24.

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Serifel®Biofungicide – Grape Powdery Mildew Control – Fruit
Hughson, CA

Untreated

Elevate 16 oz

Elevate 16 oz + Serifel 8 oz

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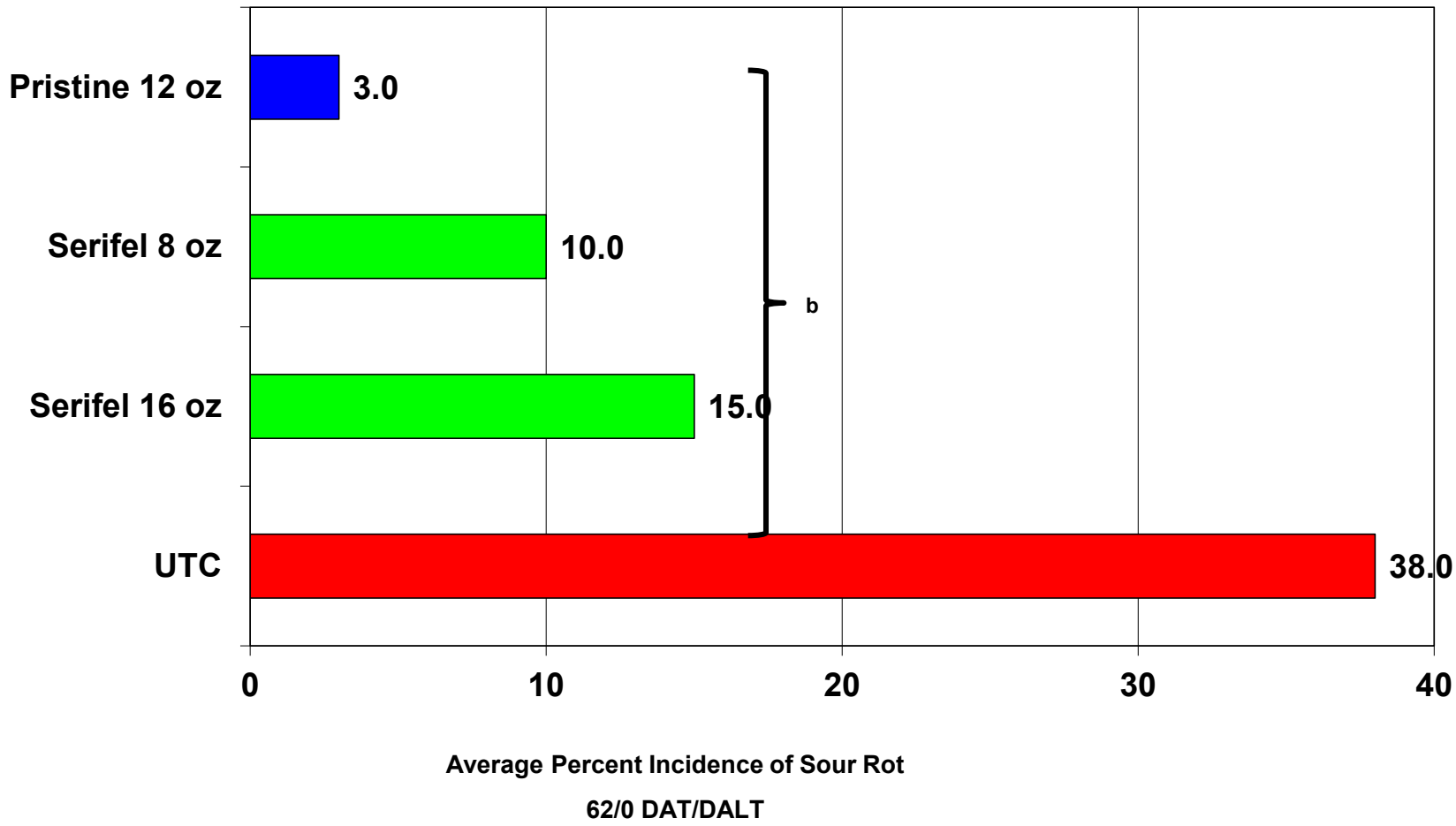
US Serifel®Biofungicide - Grape Sour Rot Control
Lamont, CA



Grape Variety – French Columbard

3 apps; pre-bunch close, bunch close, preharvest

All trts with 0.0625% Induce

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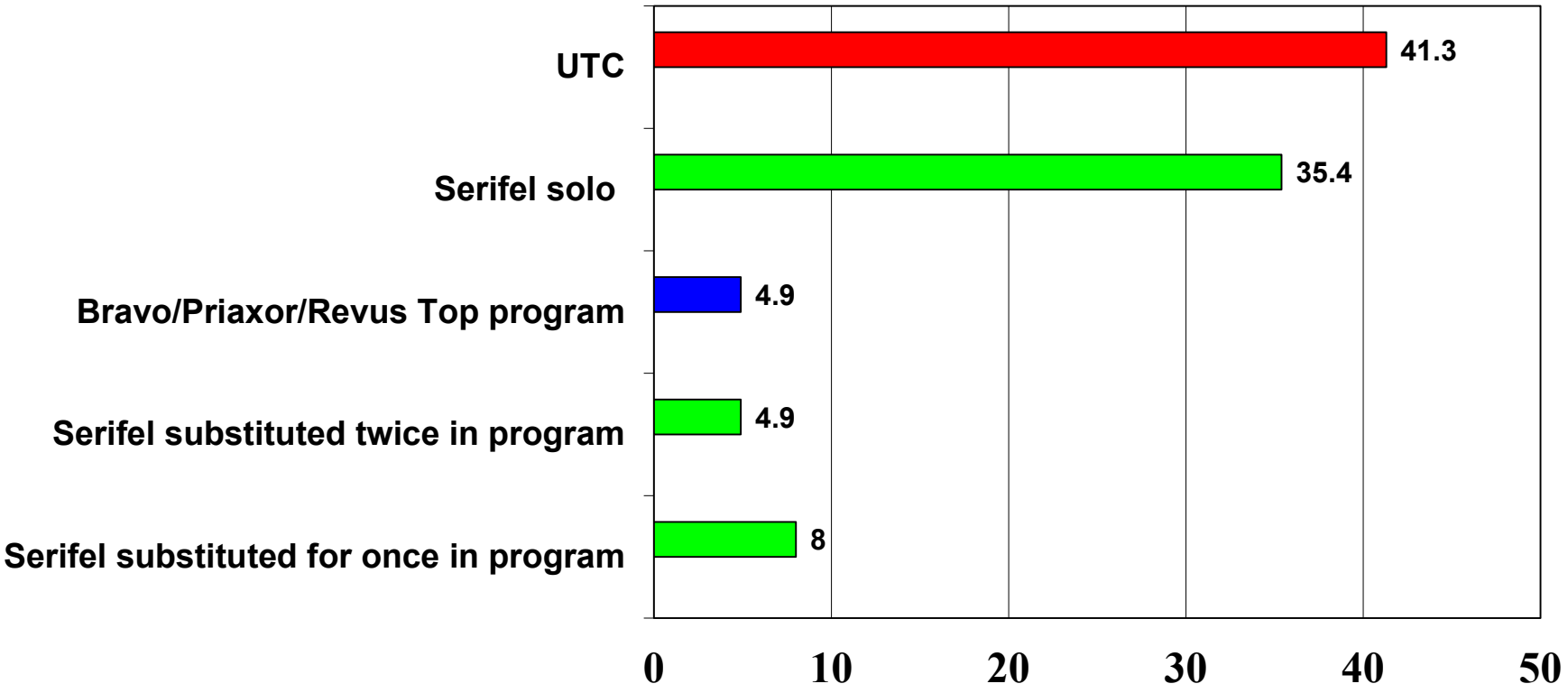
Serifel®Biofungicide – Tomato Early Blight Control
2015 New York and Florida (n=2)



Average Percent Severity on Leaves

42/7 DAT/DALT

8 applications on 7 day schedule. Base non-biological program = Bravo WS 1.5 pt oz A, D & G; Priaxor 4 oz B, E & H; Revus Top 7 oz C & F – all with Induce 0.125%

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Serifel®Biofungicide – Tomato Early Blight Control

Untreated

Serifel 8 oz/A

Serifel substituted for conventional spray early

Conventional Program

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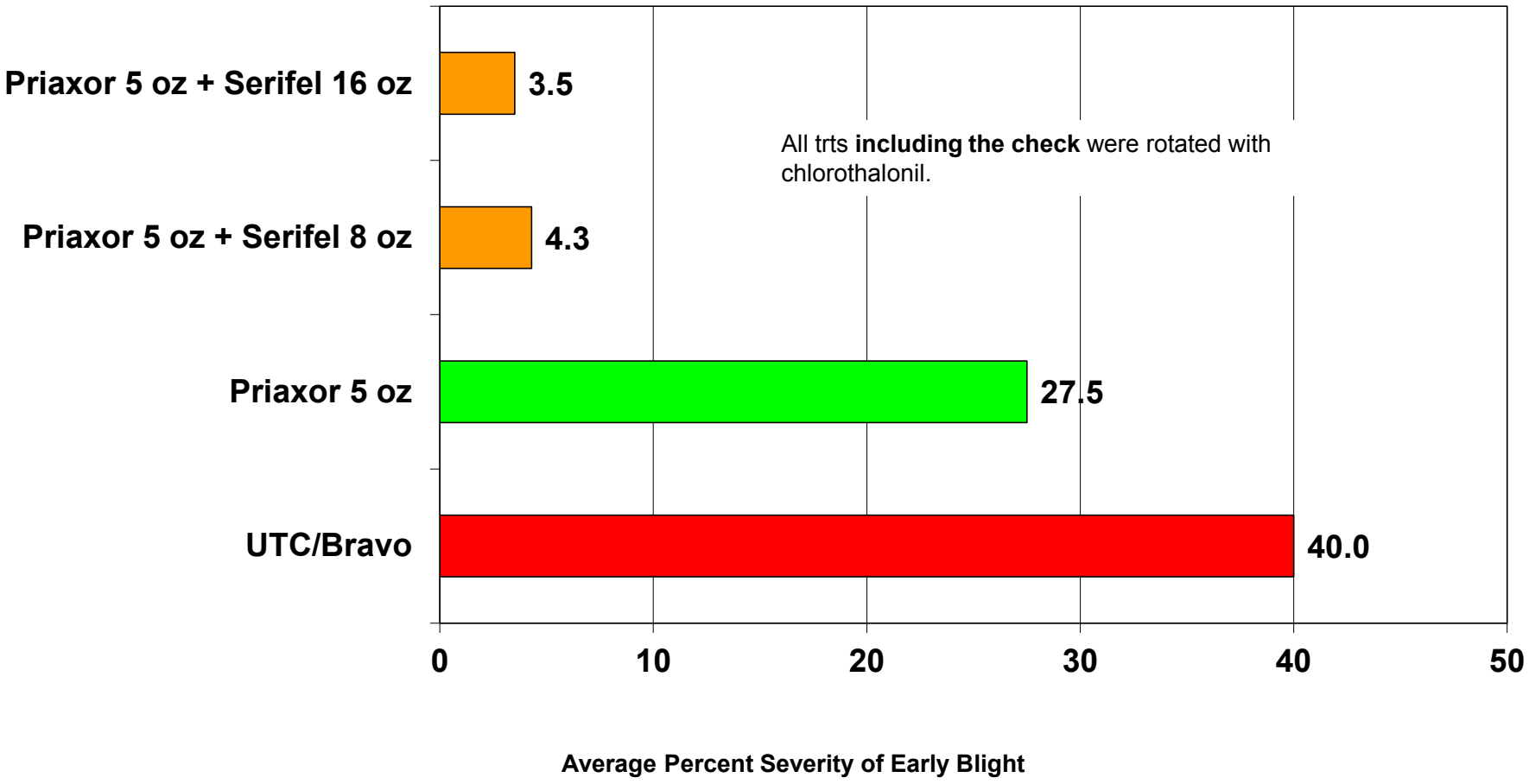
Serifel® Biofungicide for Potato Early Blight Control

2015 Mike Hubbard - Bonners Ferry, ID



1 trial – Mike Hubbard. 6 apps, begin prior disease. Apps B & D contained Bravo. All treatments include Induce at 0.125% v/v

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Benefits of biological solutions

- Option for existing program to provide additional disease protection
- Support for resistance management
- Flexible working practices for re-entry and pre-harvest intervals

Important technology for crop protection that complements chemistry based solutions

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