Agchem toolbox & the advancement of soft chemistry

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What does “Soft Chemistry” mean to you?

Sustainable

Present or derived from nature

Break down into components already found in nature – no residue

Safer on the environment & reduced human health risk

Biological

Activate or promote natural processes in the plant, soil, or environment

Bio-process production methods (e.g. fermentation, extraction, biochemical synthesis)

Not necessarily “organic”/OMRI, but can be

Agronomic Efficacy

Set efficacy expectations

Compatibility with conventional chemistry and ag inputs is key

In some cases, a replacement for conventional chemistry

Why do we need new “Soft Chemistry” Ag Solutions?

Increasing Pesticide Resistance

- Decrease in conventional chemistry efficacy
- Chemical rotations to reduce pressure of developing new resistance

Fertilizer and Pesticide Overuse

- Fertilizer pools inaccessible to plant
- Risk of run-off and build-up of environmentally toxic levels

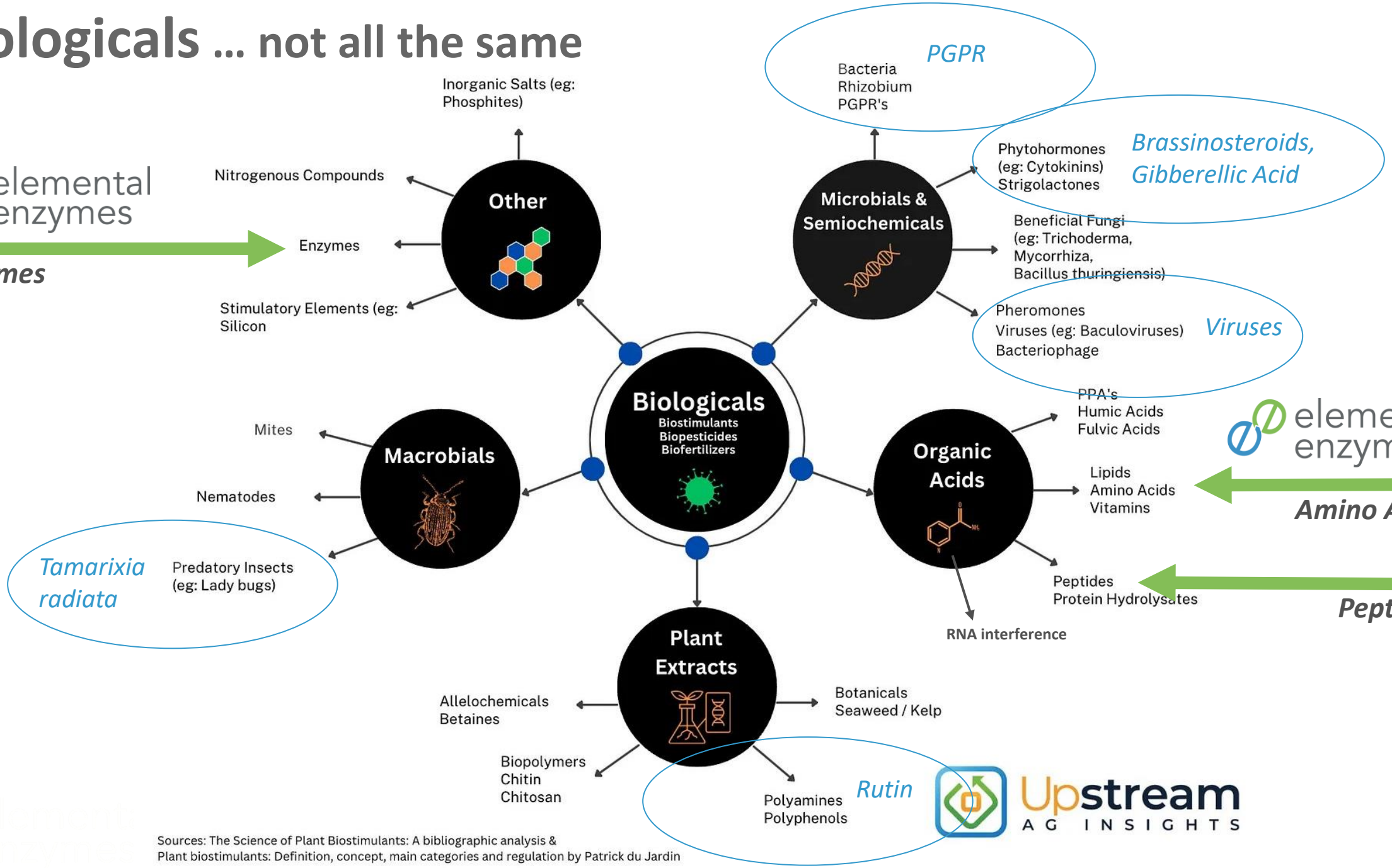
Regulatory Pressures

- Bans or mandated reductions in conventional chemistries
- Export restrictions on residues

Lack of a Solution

- No current agronomic solution or therapy

Biologicals … not all the same



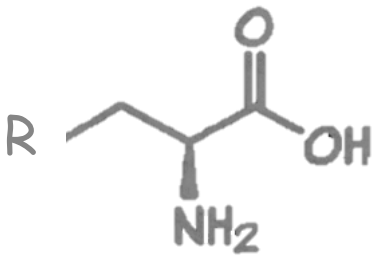
Sources: The Science of Plant Biostimulants: A bibliographic analysis & Plant biostimulants: Definition, concept, main categories and regulation by Patrick du Jardin

Amino acids are nature's "Legos"

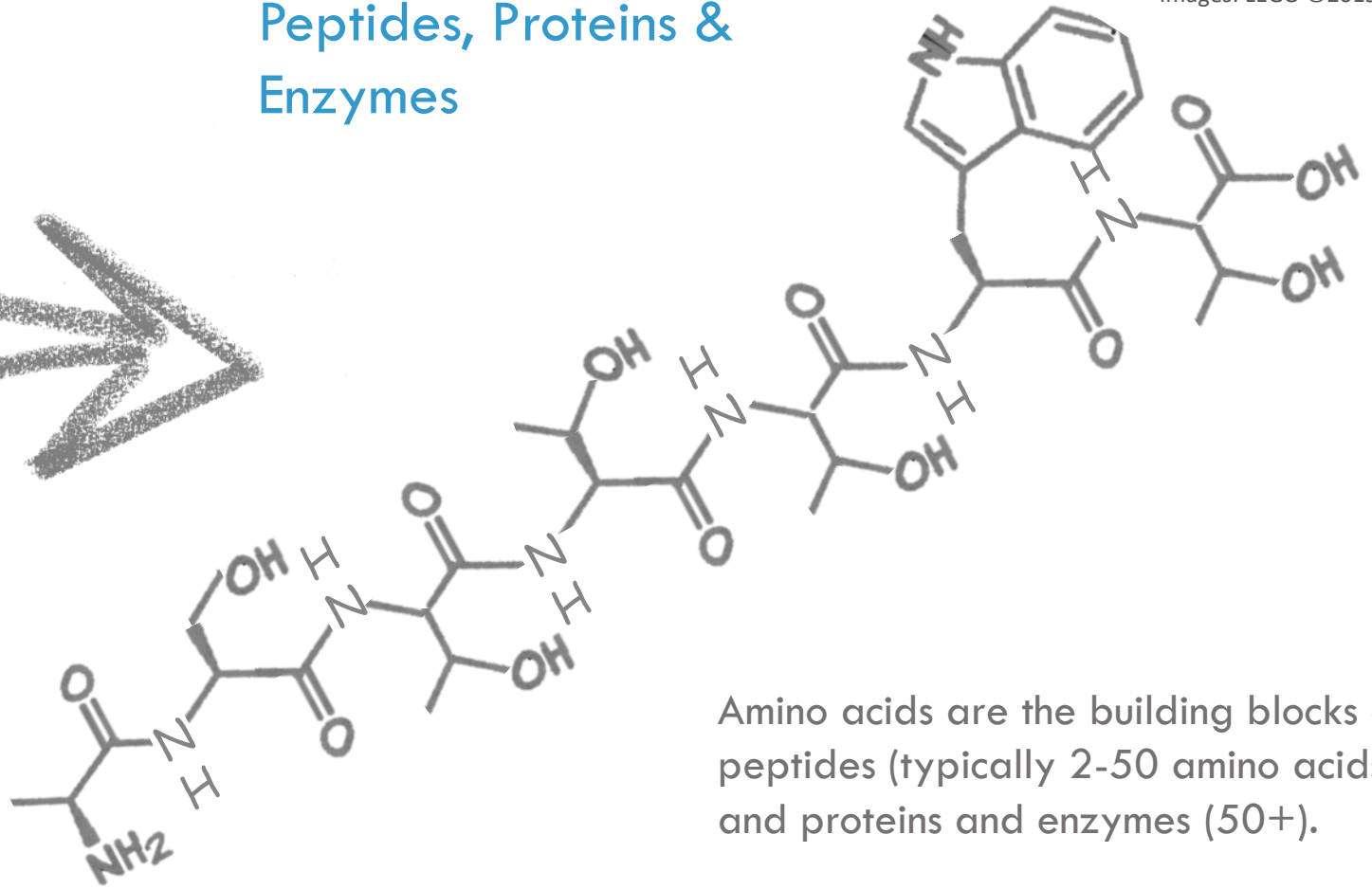
Elemental Enzymes develops products with enzymes, peptides, and natural biochemistries – all made from amino acids

Images: LEGO ©2015 ©2024

Amino Acid



Peptides, Proteins & Enzymes

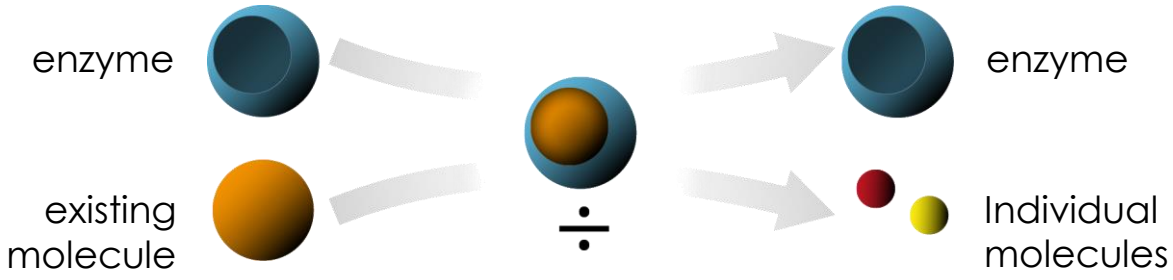


Amino acids are the building blocks of peptides (typically 2-50 amino acids), and proteins and enzymes (50+).

Enzymes
Think of them as little factories for your soil

How enzymes work

Enzymes act as catalysers of chemical reactions.



Degrading enzymes break molecules apart

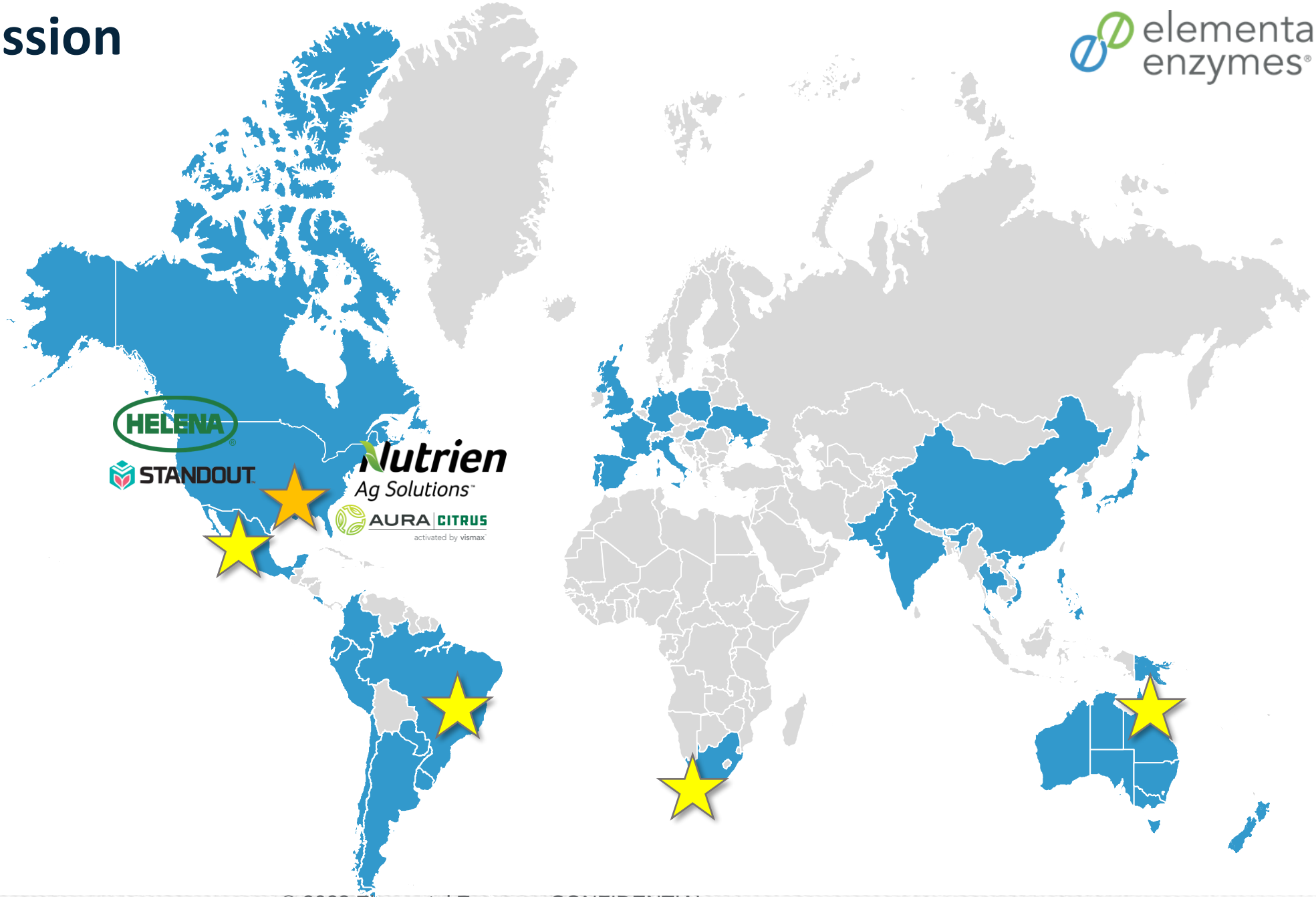
A Global Mission

36+ Countries
40+ Unique Crops

Citrus products launched - US

Citrus product development

Anticipated 11-16% annual growth in Biopesticides market globally



Flg22-Bt Peptide

New Active Ingredient
Section 3 US EPA Registration

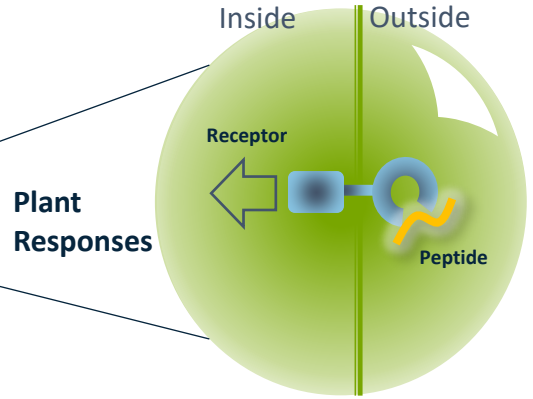
A unique flagellin peptide from an acrystalliferous *Bacillus thuringiensis* strain that is a **broad-spectrum** activator of plant immunity

Classification: biochemical **indirect fungicide/bactericide**

Highly **consistent and systemic** MOA, with long-lasting reprogramming of the target plant

Patented by Elemental Enzymes Ag & Turf

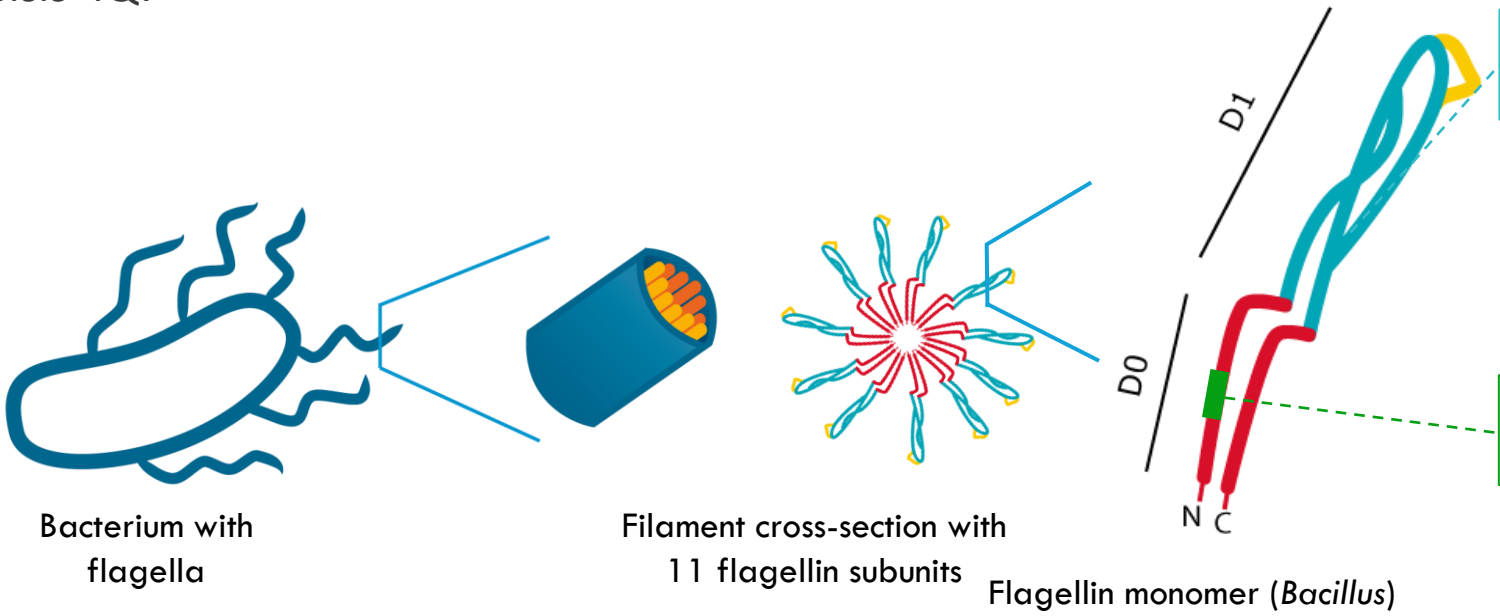
Active on over **50 bacterial and fungal pathogens** across 30 major world crops. 500+ replicated trials to date.



Upregulation of genes and pathways that increase plant immunity

Vismax® Mode of Action

The Vismax® technology active is Flg22-Bt, a naturally occurring 22-amino acid peptide derived from flagellin protein (fliC) from acrystalliferous *Bacillus thuringiensis* BT013A, a version of the common lab strain *Bacillus thuringiensis* 4Q7



D1 domain: Critical for binding & activation of metazoan flagellin receptor TLR5 (Ref. 1-3)

Flg22-*Bacillus thuringiensis*: 22 amino acid fragment within D0 domains

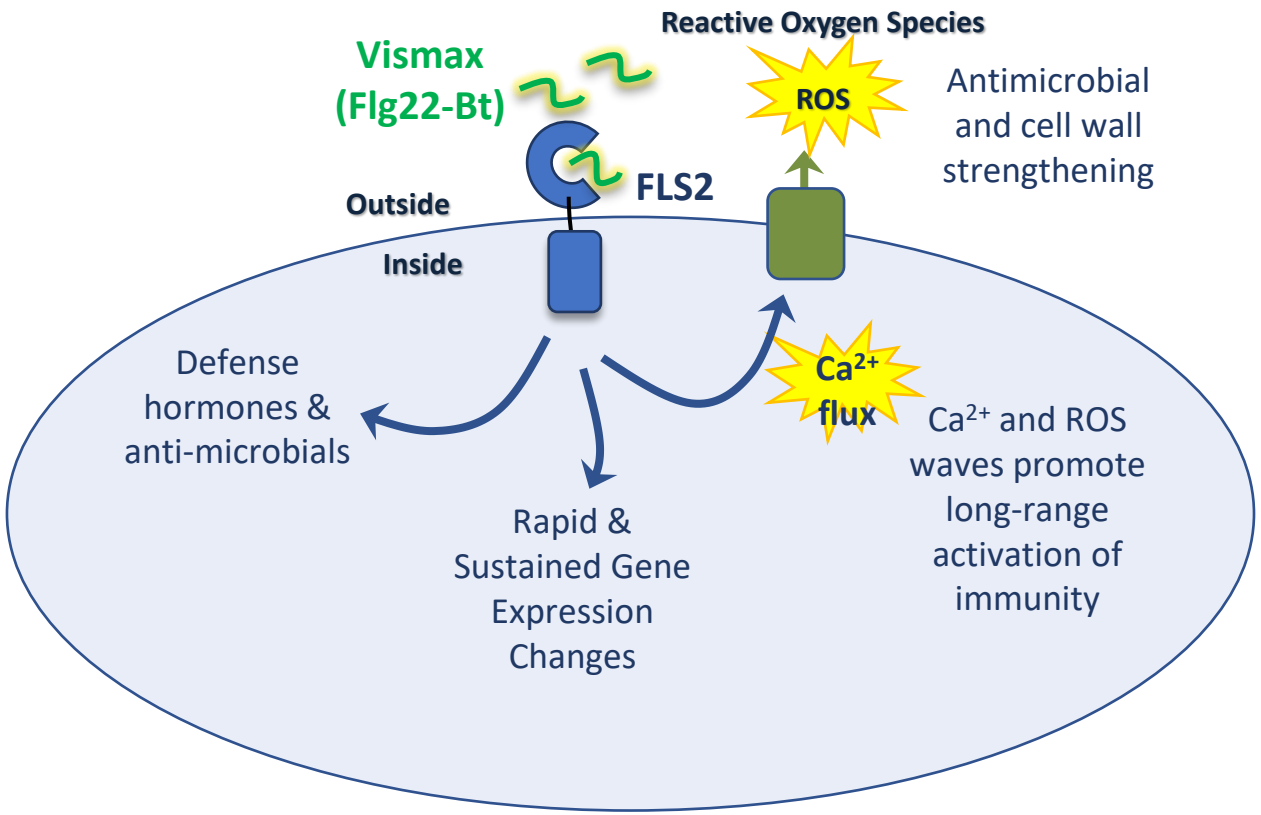
- **Flg22 has no known targets outside of the plant receptor Flagellin-Sensing 2 (FLS2)**

References:
[1]Yoon et al 2012 *Science* 17:859-864; [2]Song et al 2017 *Scientific Reports* 7:40878; [3]Kim et al 2018 *Scientific Reports* 8:5814.

Figure adapted from SURF - Synthetic Units for Redirecting Functionalities

Vismax® activates the plant immune system via FLS2

- Vismax® binds to the FLS2 receptor with high affinity to **activate multiple defense pathways** for pathogen growth restriction
- FLS2 is present in a wide variety of plants
- Priming of the plant immune system by Vismax® protects the plant from a broad range of biotic and abiotic stresses, thereby enhancing plant growth
- Unlike other immune activators, **Vismax® causes no cell death nor phytotoxicity**
- **New class of fungicide/bactericide**

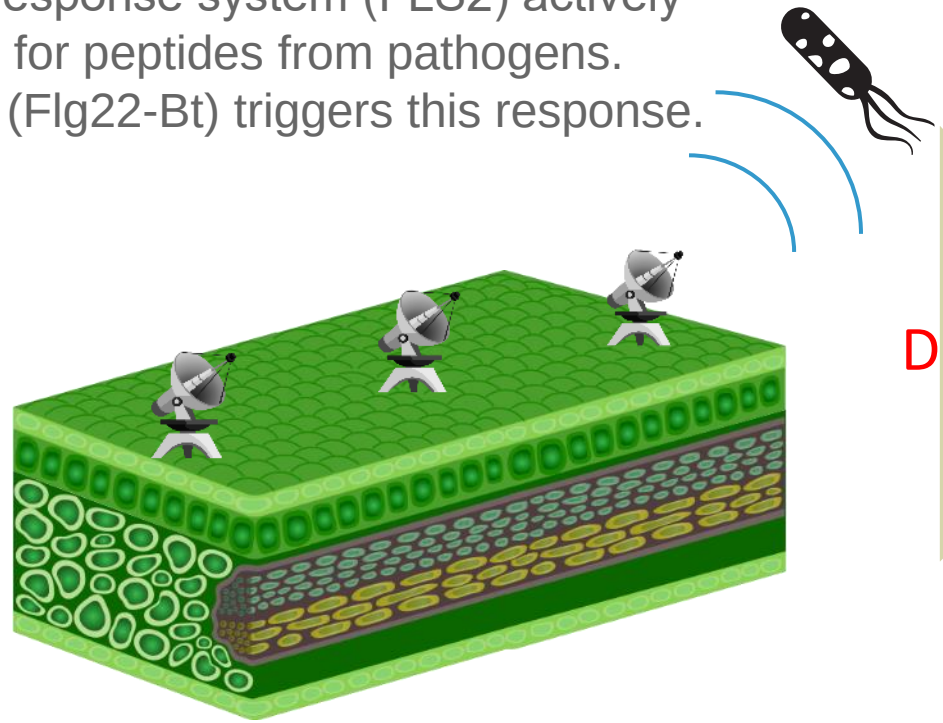


Why Signaling Peptides?

Directs the Plant to Desired Response that results in reduction of disease without sacrificing growth or yield.

Exceptionally Safe, Directed Action, Sustainable, Little to no residues, No off-target effects

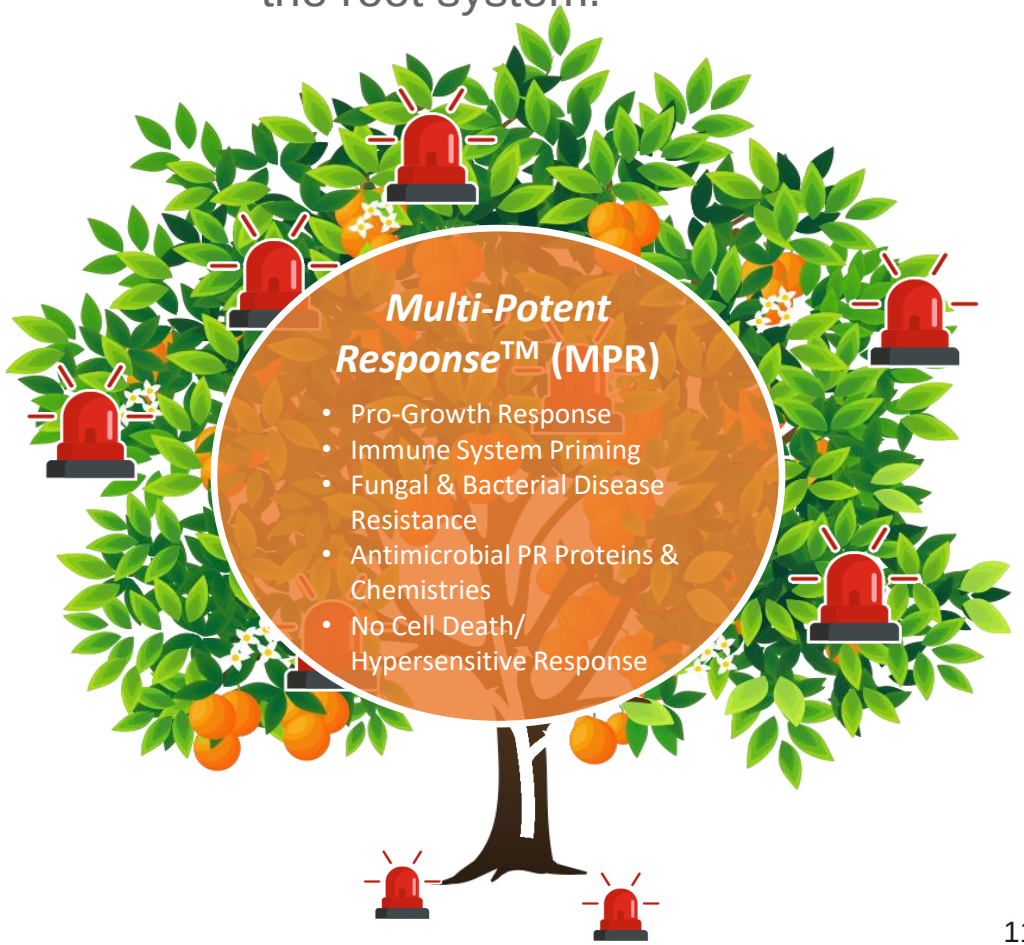
Plant's response system (FLS2) actively looks for peptides from pathogens. **Vismax®** (Flg22-Bt) triggers this response.



Detection!

Vismax® immune response triggered across the plant.

Signal moves <u>systemically</u> throughout plant, including to the root system.



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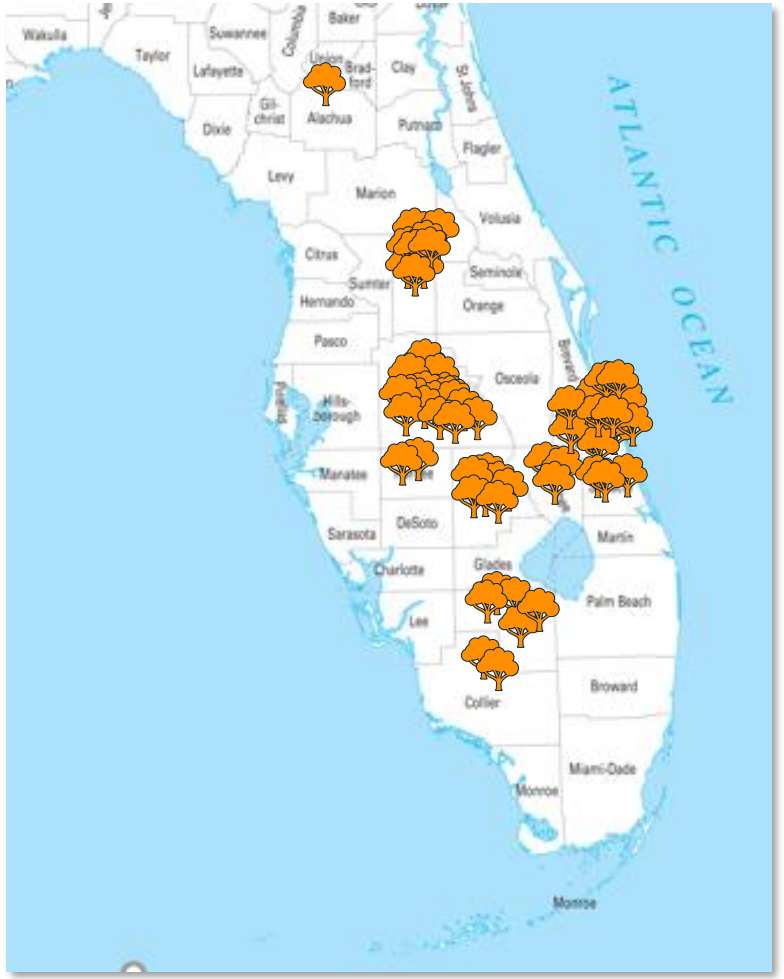
Florida Citrus

Dedicated to helping the citrus industry since 2016:
Over 100+ citrus replicated trials performed or underway globally



Replicated Trial Florida Locations
95+% Incidence in all EE Florida Trials for HLB

Orange
- Valencia
- Vernia
- Hamlin
- Midsweet
- Temple
- Navel
- Cara Cara
- Valquarius
- EV1/EV2

Lemon
Minneola Tangelos
Grapefruit
- Ruby Red
- Ray Ruby
- Red

Tangerine
- Tango
- Bingo

Pummelo

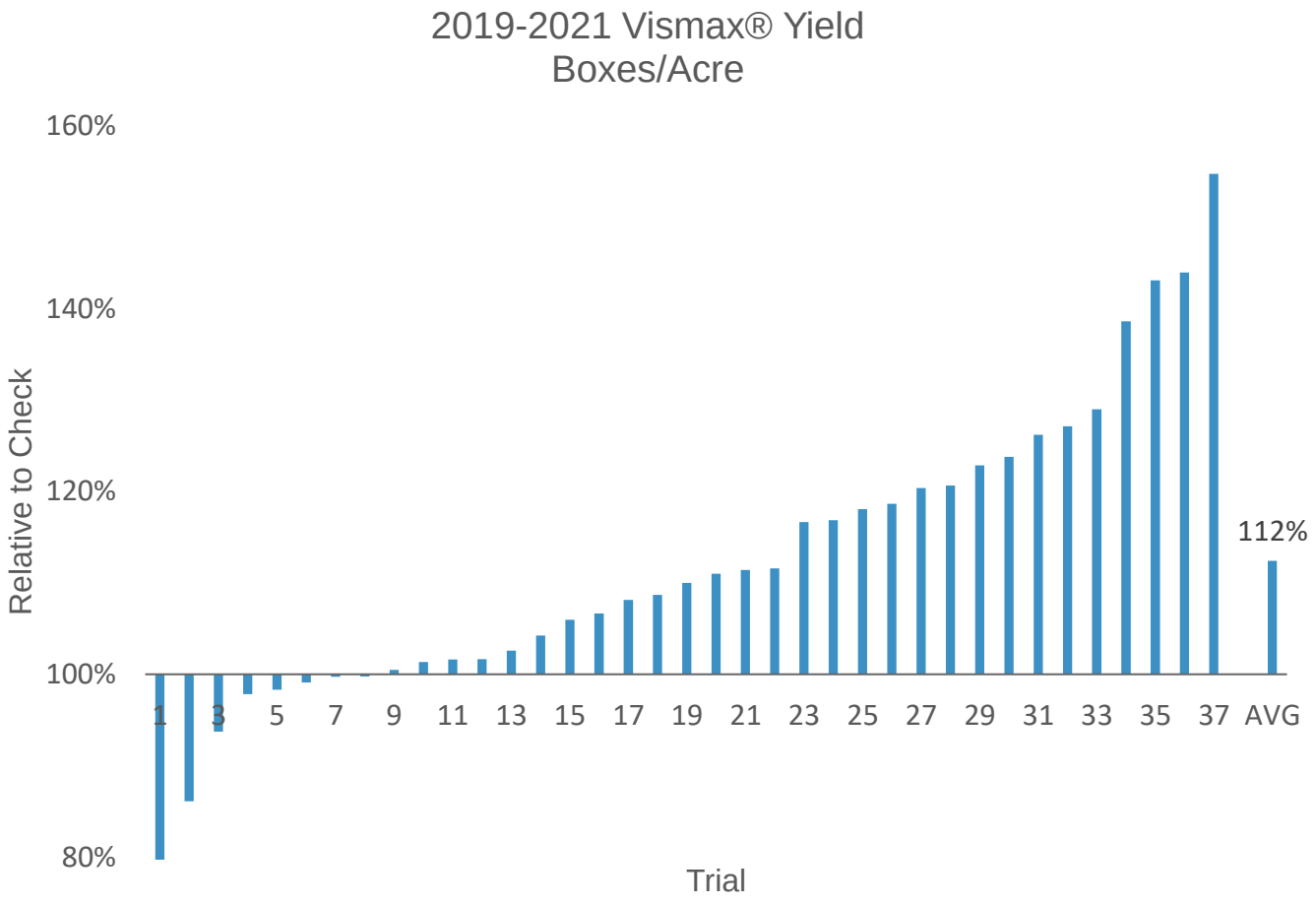
<u>75+ treatments</u> tested on citrus groves in Florida under replicated trials, Vismax® is the consistent winner of the trials

Vismax® Increases Yield and health of citrus trees

1-2 applications, Spring and Fall Flush, Florida Sites

When applied as a foliar spray, Vismax®:

- ✔ Increases yield by 12%
- ✔ Reduces pre-harvest fruit drop by 6.5%
- ✔ Produces more symmetrical fruit
- ✔ Improves canopy health



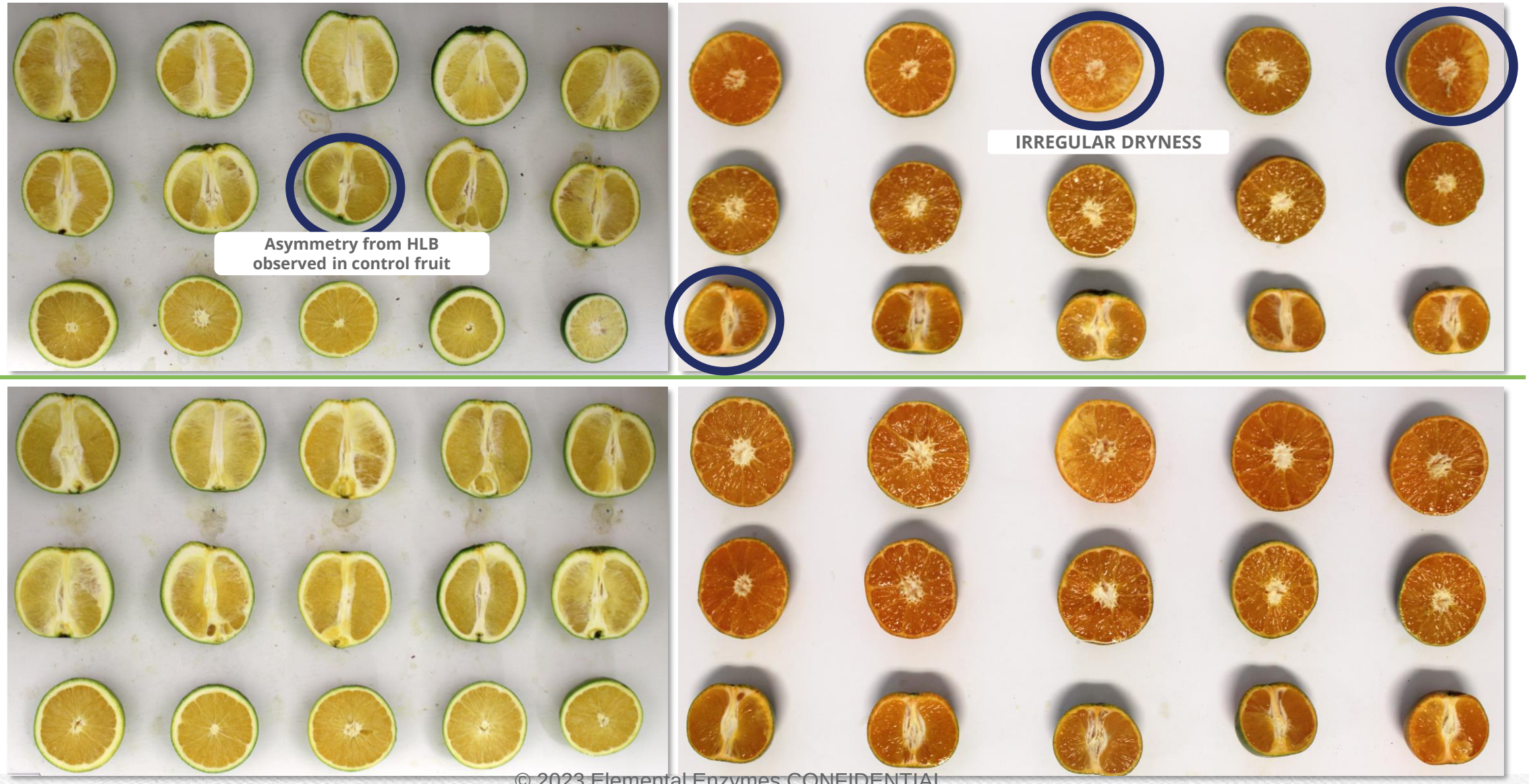
Improved Fruit Quality in Vismax® Treated Trees

Reduction in irregular dryness and asymmetry

Navels | Tangerines

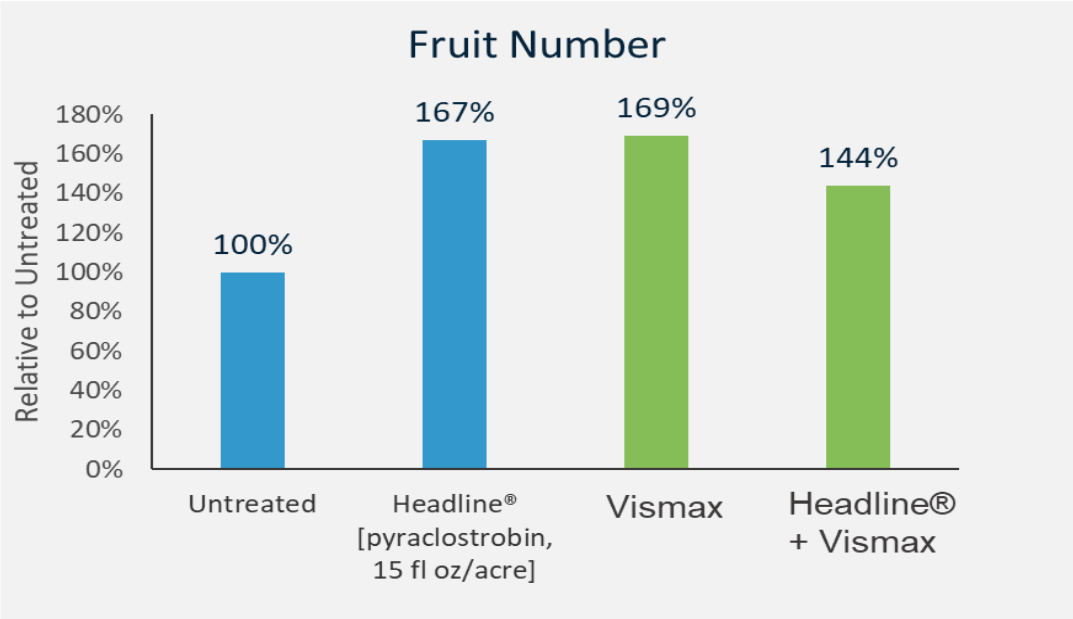
Control

Vismax®



Vismax® Provides Broad Spectrum Protection Against Fungal and Bacterial Diseases

Post Bloom Fruit Drop [PFD] (*Colletotrichum acutatum*)



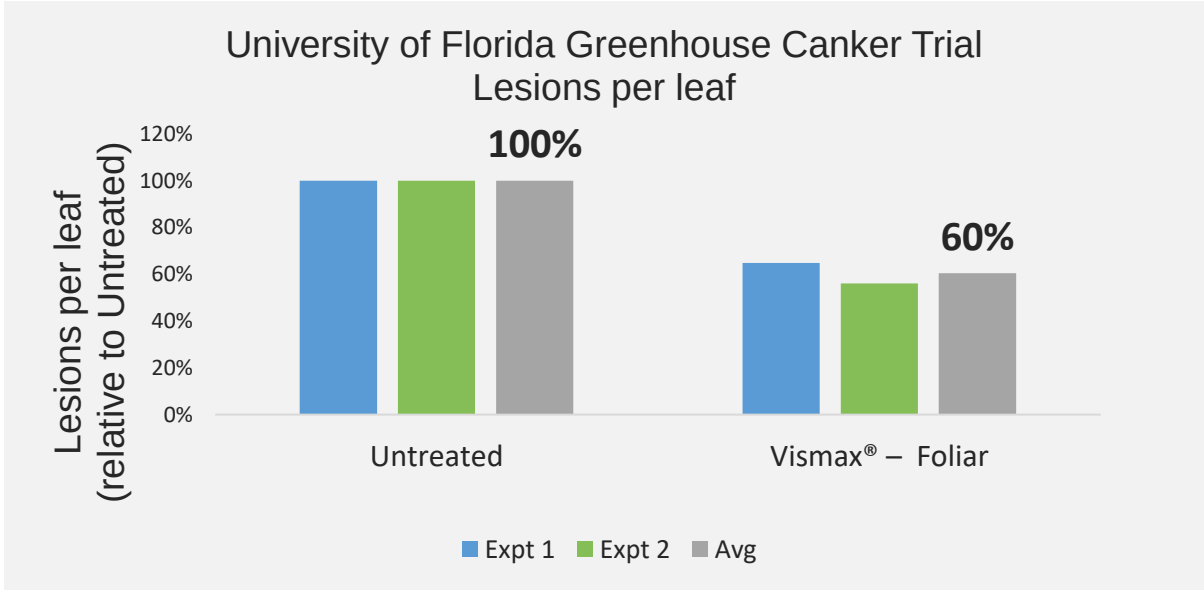
3 months after treatment a single application of Vismax® showed a reduction in PFD buttons and an increase in fruit retention.

PFD Buttons (UF-IFAS)

Untreated Control | Flg22-Bt Peptide

Citrus Canker (*Xanthomonas citri*)

In 2 of 2 trials, a single application of Vismax® significantly reduced canker lesions compared to UTC (Dr. Evan Johnson, PhD)



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Brazil Citrus

Brazil Vismax® Citrus Trials Results

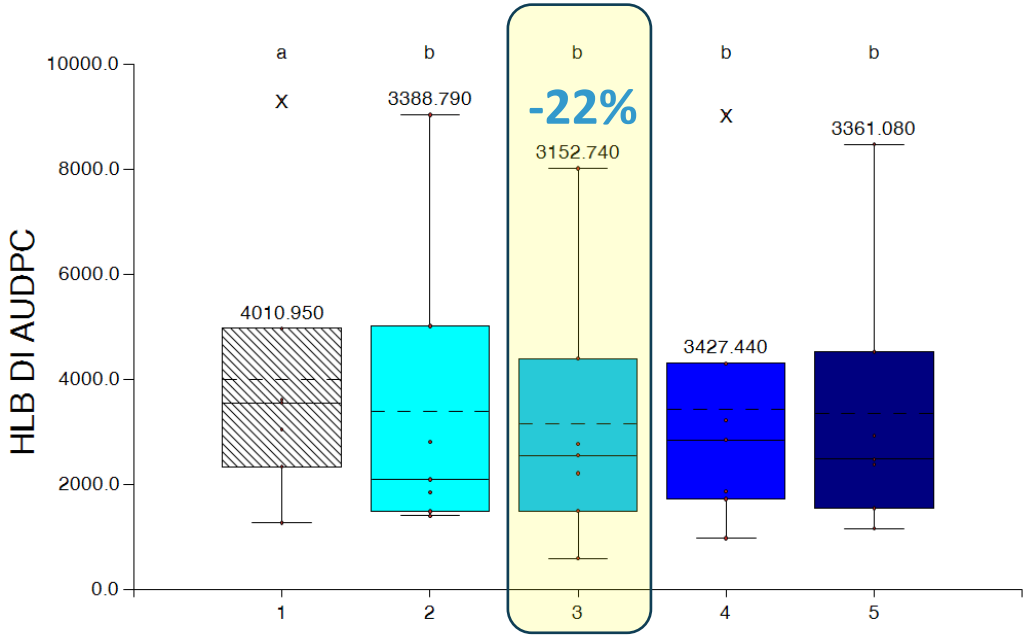
Sweet Orange Varieties: Hamlin, Pera Rio, Lima Sorocaba (7 sites)
2 apps, Spring + Fall flush

HLB Disease Indexing: all rates statistically lowered disease index
Yield: 0.2% rate statistically increased yield
Fruit Drop: all rates reduced pre-harvest fruit drop

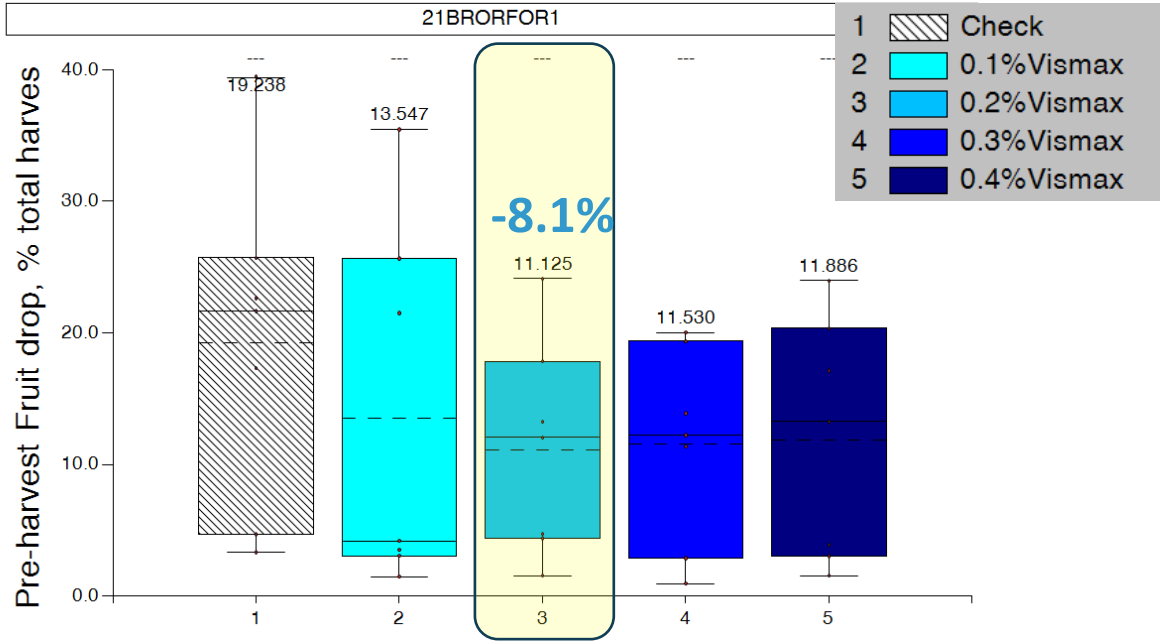
Yield, 0.2% Rate

- **+15.5% Yield kg/tree**
- **+17.2% Yield Pounds-Solids**
- **+22.4% Fruit Count**

Disease Index (AUDPC)



Pre-harvest Fruit Drop



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vismax®

- NO Residues
- NO Off-target effects
- NO Ecotoxicity
- NO Phytotoxicity

- Long Lasting Response
- 1-2 Applications/Year

- Broad-Spectrum effects on multiple fungal and bacterial pathogens per crop

Thank You.

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