Reputable Product or 'Snake Oil?' How to Evaluate Biologicals

Pam Marrone, PhD

All Three Categories of Biologicals are Rapidly Growing

Biopesticides
Biocontrol
Bioprotection

Regulated by the EPA & States

Biostimulants
Crop Enhancement
Stress Reduction

Biofertilizers
Bionutrients

Regulated state by state; National biostimulant standards pending

- Microorganisms, some plant extracts, pheromones, other natural materials and substances
- **Sulfur, copper, pyrethrum, spinosad are NOT biopesticides**

BIOLOGICAL PRODUCTS

Source: DunhamTrimmer®, LLC

BIOSTIMULANTS[1]

MICROBIALS

- NUTRIENT USE EFFICIENCY (NUE) (BIOFERTILIZERS)[2]
- PLANT GROWTH PROMOTION (PGP)

NON-MICROBIAL

- PLANT & SEAWEED EXTRACTS
- AMINO ACIDS
- ORGANIC ACIDS
- INORGANIC COMPOUNDS

1 Biostimulants are products which elicit one or more of the following effects: 1) mitigate abiotic stress; 2) enhance crop quality; 3) improve nutrient assimilation. Their functions are typically classified as NUE (Nutrient Use Efficiency) or PGP (Plant Growth Promotion).

2 Biofertilizers are Microbials used to enhance plant nutrient uptake from soil (NUE).

- N-fixing bacteria make up the largest segment.
- N-fixing bacteria for non leguminous crops make up the fastest growing segment.
- Other NUE microbials include mobilizers and solubilizers or chelators of specific nutrients such as P, K, S, Zn, Fe.

PGP Microbials target other biostimulant properties beyond NUE.

Non-microbial biostimulants may target either NUE or other PGP effects.

- Amino Acids and Seaweed Extracts are the fastest growing segments.
- Seaweed Extracts are a complex mixture of components including plant hormones, phenolic compounds, and other active substances.
- Amino Acid products include peptide fractions.
- Organic acids are mainly humic and fulvic acids used as soil amendments.

BIOCONTROLS

BIOPESTICIDES[3]

- BIOCHEMICALS[4]
  - PLANT EXTRACTS
  - ORGANIC ACIDS
  - PGRs
  - SEMIOCHEMICALS
- MICROBIALS[5]
  - BACTERIA
  - FUNGI
  - PROTOZOA
  - VIRUS
  - YEASTS
  - OTHERS

3 Biopesticides are derived from natural materials such as plants, bacteria and certain minerals. Biopesticides target specific pests and are inherently less toxic than synthetic pesticides.

4 Biochemicals include Plant Extracts (largest by sales volume), Organic Acids, PGRs (plant hormones e.g. cytokinins, auxins, etc), and Semiochemicals (allelochemicals and pheromones).

MACROORGANISMS[6]

- INSECTS
- MITES
- NEMATODES

5 Microbials refer to products based on bacteria, fungi, viruses, and protozoans. Microbials comprise the largest market of biopesticides.

- Bacteria, followed by fungi, make up the largest groups commercially (>90%).
- Biggest challenges relate to product formulation with regard to shelf-life, stability, and performance enhancement.

6 Macroorganisms include insects, mites, and nematodes. Insects & mites are the largest groups.

- Unique in that the live organism is used in the form of eggs, larvae, pupae, or adults.
- The most important challenge in this category is logistics — shipping live organisms that require special care to survive.
- Normally not classified as Biopesticides but rather Biocontrols.

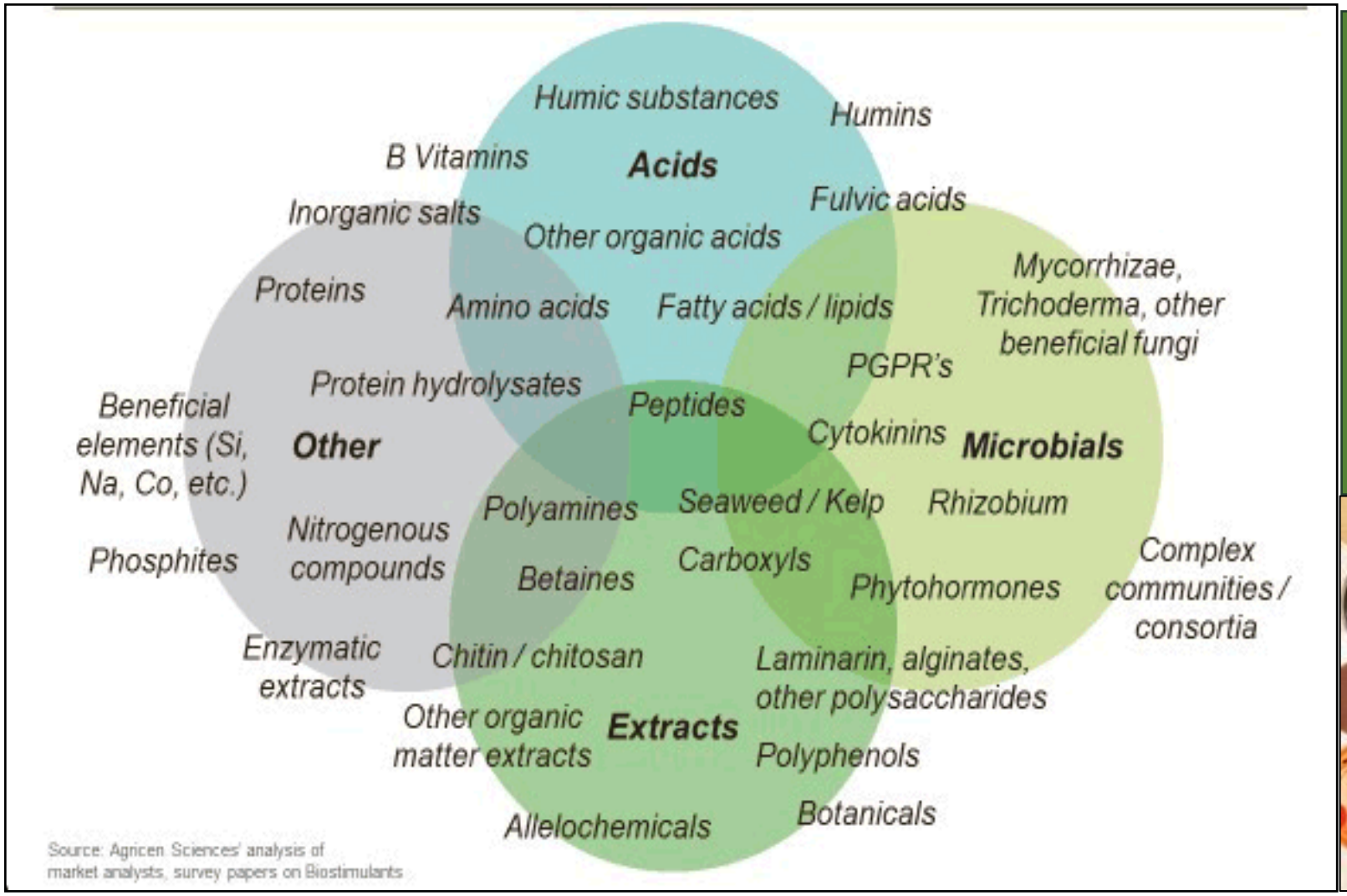
Current National Biostimulant Definition

“Plant biostimulant” means a substance or microorganism, or mixtures thereof, that, when applied to seeds, plants, the rhizosphere, soil, or other growth media, act to support a plant’s natural nutrition processes independently of the biostimulant’s nutrient content.

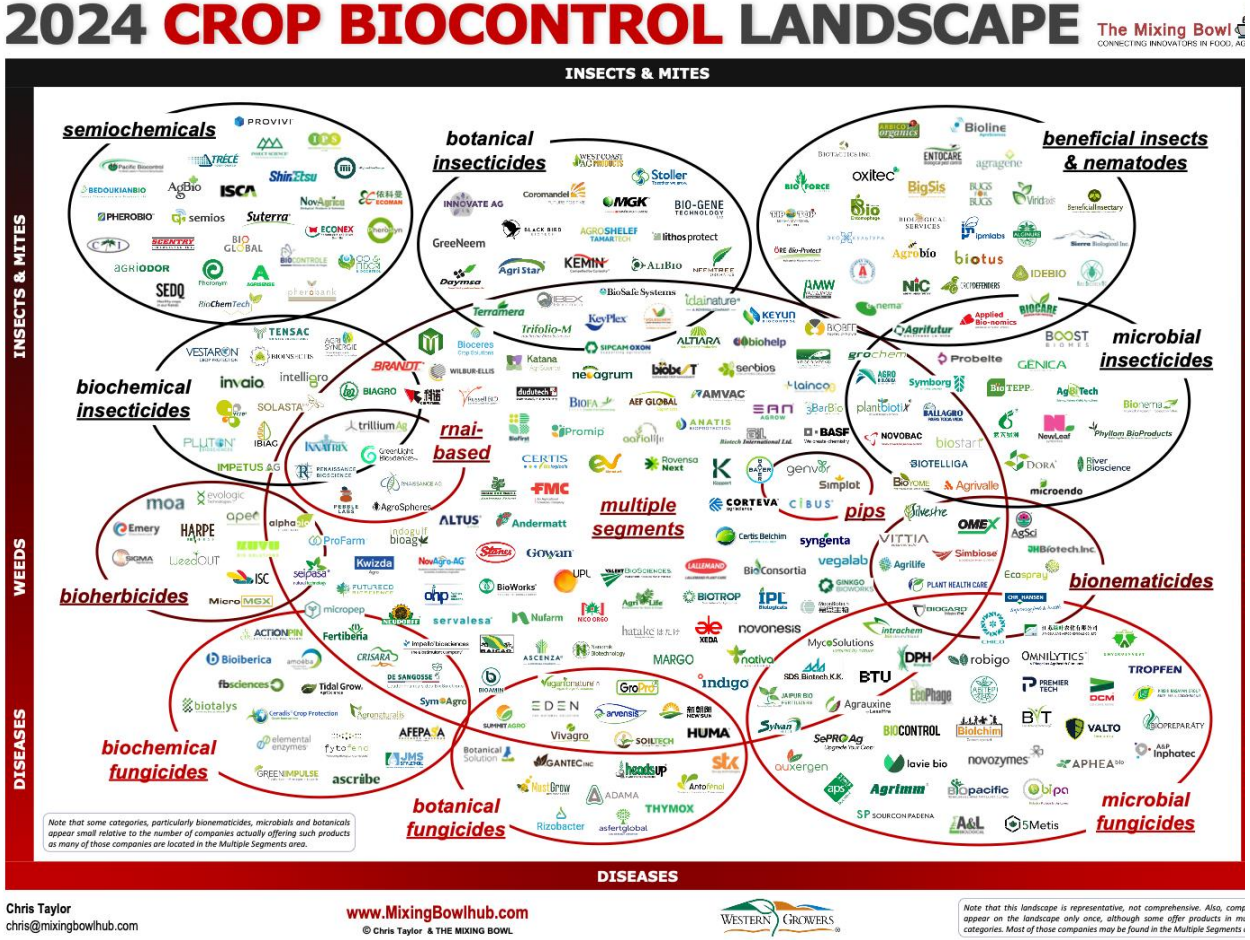
The plant biostimulant thereby may improve nutrient availability, uptake, or use efficiency, tolerance to abiotic stress, and consequent growth, development, quality, or yield.

Acid-based biostimulants like humic and fulvic acids
Seaweed and plant extracts
Beneficial microbial biostimulants

Many Kinds of Natural Substances Can Be Biostimulants



- IAA production
- ACC deaminase
- Siderophore production
- Phosphate solubilization
- N-fixation
- Root colonization
- Hormone increases
- Induced Systemic Resistance
- Systemic Acquired Resistance


2024 CROP BIOCONTROL LANDSCAPE
The Mixing Bowl
CONNECTING INNOVATORS IN FOOD, AG
INSECTS & MITES
semiochemicals
botanical insecticides
beneficial insects & nematodes
microbial insecticides
biochemical insecticides
rnai-based
multiple segments
pips
bionematicides
bioherbicides
biochemical fungicides
botanical fungicides
microbial fungicides
INSECTS & MITES
WEEDS
DISEASES
Note that some categories, particularly bionematicides, microbials and botanicals appear small relative to the number of companies actually offering such products as many of those companies are located in the Multiple Segments area.
DISEASES
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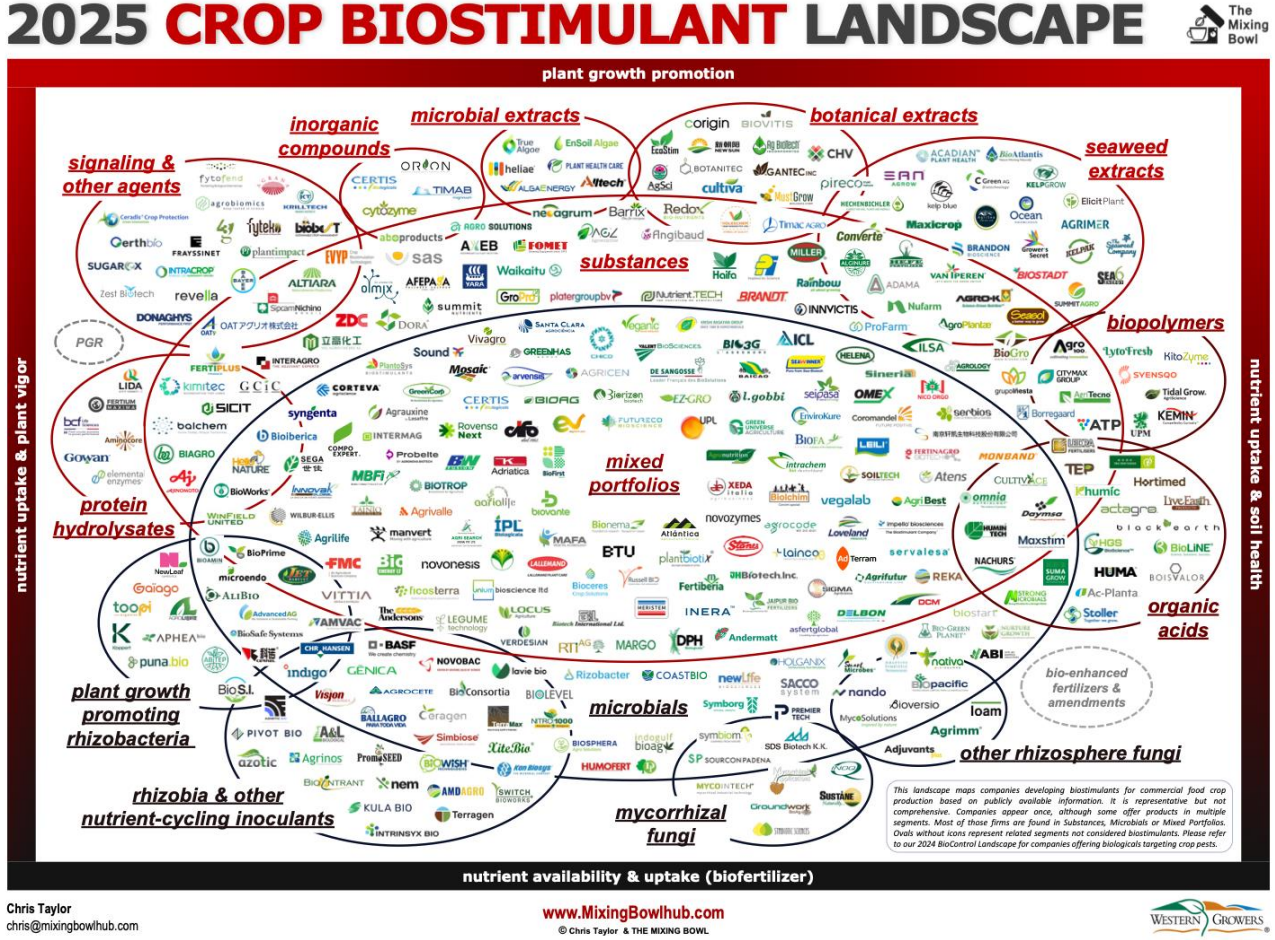
WESTERN GROWERS
Note that this landscape is representative, not comprehensive. Also, comp
appear on the landscape only once, although some offer products in mu
categories. Most of those companies may be found in the Multiple Segments


2025 CROP BIOSTIMULANT LANDSCAPE
The Mixing Bowl
plant growth promotion
inorganic compounds
microbial extracts
botanical extracts
signaling & other agents
seaweed extracts
substances
biopolymers
PGR
nutrient uptake & plant vigor
nutrient uptake & soil health
mixed portfolios
protein hydrolysates
organic acids
bio-enhanced fertilizers & amendments
plant growth promoting rhizobacteria
microbials
other rhizosphere fungi
rhizobia & other nutrient-cycling inoculants
mycorrhizal fungi
This landscape maps companies developing biostimulants for commercial food crop production based on publicly available information. It is representative but not comprehensive. Companies appear once, although some offer products in multiple segments. Most of those firms are found in Substances, Microbials or Mixed Portfolios. Ovals without icons represent related segments not considered biostimulants. Please refer to our 2024 BioControl Landscape for companies offering biologicals targeting crop pests.
nutrient availability & uptake (biofertilizer)
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WESTERN GROWERS

IT'S CROWDED

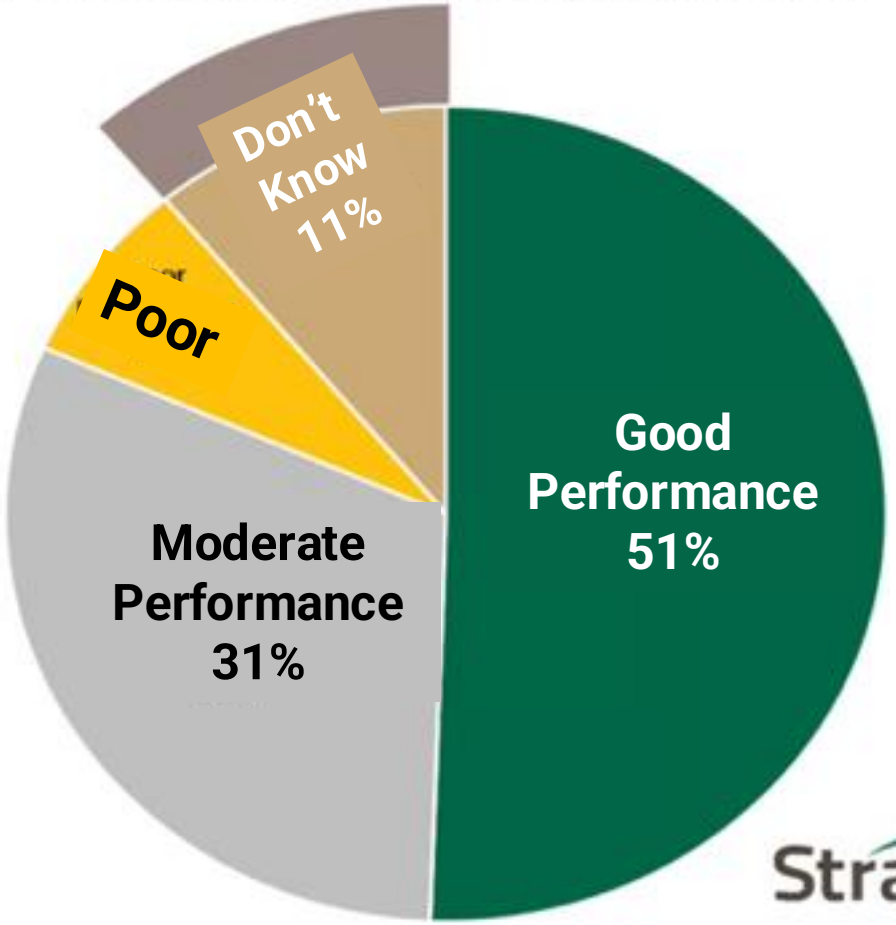
Many Companies Working on N-Fixing and Nutrient Uptake

COMPANY	PRODUCT(S)	COMMERCIALLY AVAILABLE	ACTIVE(S)
CORTEVA agriscience	Utrisha-N	Yes	*Methylobacterium symbioticum*
PIVOT BIO	PROVEN 40, RETURN, G3	Yes	*Kosakonia sacchari and Klebsiella variicola*
Sound	SOURCE	Yes	maltol lactone + flavenoids
azotic	Envita	Yes	*Gluconocetobacter diazotrophicus*
INTRINSYX BIO	Juno, Rosetta	Yes	*Curtobacterium salicis* and *Pseudomonas siliginis*
TerraMax	MicroAZ-ST	Yes	*Azospirillum spp.*
Koppert	Agriflora PRO	Yes	*Bacillus subtilis & B. amyloliquefaciens*
Kula Bio	Kula-N	Yes	*Xanthobacter autotrophicus*
syngenta	Vixeran, NUELLO® iN	Yes (UK)	*Azotobacter salinestris*
Nutrien	NFINITY	Yes (2025)	Unknown (3-way MoA)
BioConsortia Mosaic	-	Not commercial	*paenibacillus polymyxa*
switch bioworks	NA	Not Commercial	*NA*
JOYN BIO	Bayer Crop Science/Ginkgo Bioworks JV	Not Commercial	*NA*

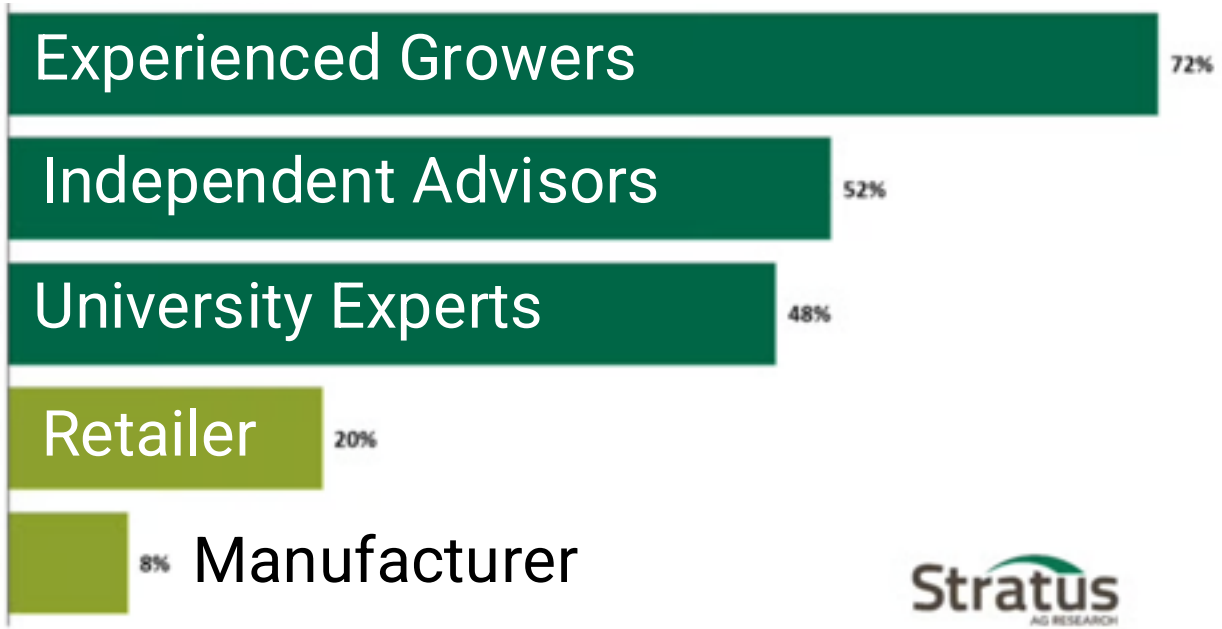
Upstream

Stratus Survey on Biostimulants
Nice to have but not essential for US Growers

Retailer Assessment of Biostimulant Brand Performance



Sources of Biostimulant Information % ranked #1 or #2



What Did You Like Best About Your Experience With Biologicals?

- Ease of use and the boost in yield were the best aspects of using biologicals

CURRENTLY USE

What Did You Like Least? N=185

- The cost and the extra work were the most maligned aspects

CURRENTLY USE

(ONLY if answered NO in Used Biological in the Past) Why Have You Chosen Not To Use Any Of These Product Types? N=270

Producers who have never used biologicals believe they are not proven, or have a lack of knowledge on the subject

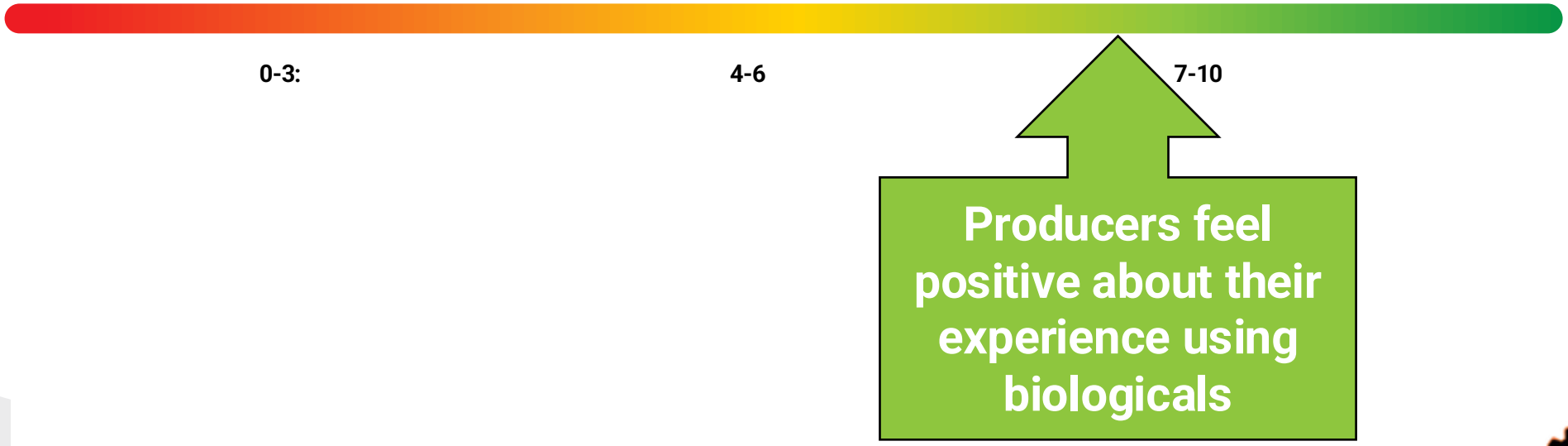
NEVER USED

When Farmers Learn How to Use Biologicals, They Score Them Highly

Biological user-farmers rate their experience with biologicals a 7.14/10, showing a positive perception

CURRENTLY USE

On a scale of 0-10, with 0 being “terrible” and 10 being “fantastic” how would you rate your experience with biological products? N=185



STRATOVATION GROUP

"The chemical is doing all the hard work" [in the rotation or tank mix]

"I used that biological 5 years ago and it did not work so I won't use it again."

"The chemical did not work so I thought I'd try your biological." [for the first time]

"I'll put you on my organic acres where I need more solutions."

<u>University Research report:</u>
"The biological did not statistically separate from the untreated so it was not effective."
[Note the chemical was the same as the untreated but was not reported as ineffective!]

How to Tell Snake Oil from Reputable Products

- **EPA** Registered?
- **Not EPA** registered?

- **Read the label** – how specific is it? How much information about use instructions?
- What is the **science** behind the product, how does it work?
- How many **field trials**? Size? Where? Results? Consistency?
- How many microorganisms? If there are 500 or 800 species, why do they have so many species?
- How do they test the **Quality Control** of the product?
- Do they test for heavy metals, human pathogens, other microorganisms?

Maximizing Product Effectiveness

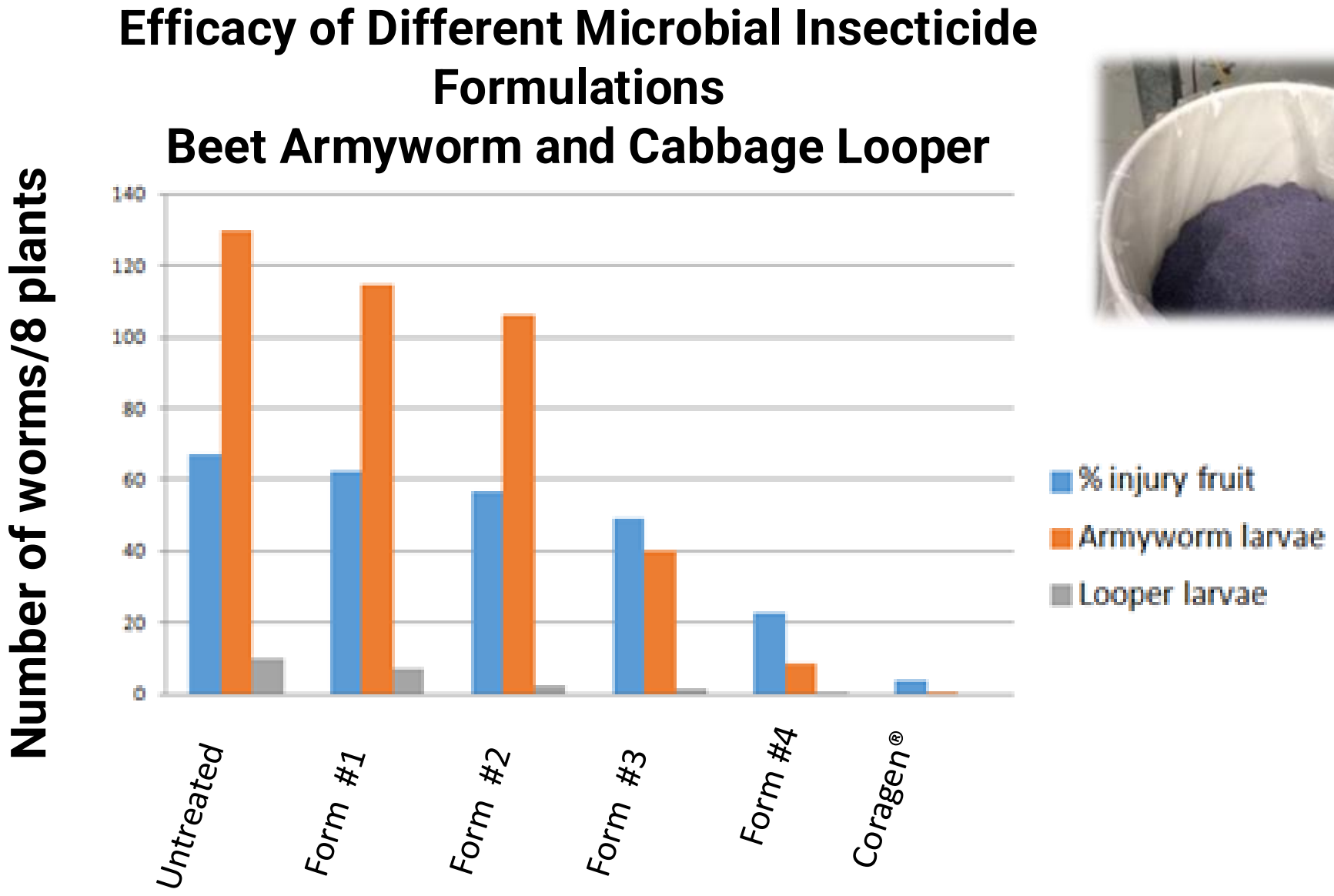
Understand the Mode of Action!

- Water pH/hardness
- Water volume/dilution
- Spray droplet size
- Adjuvant effect
- Tank-mix partners
- Temperature effects
- Rainfastness
- Impacts on beneficials
- Application timing/interval

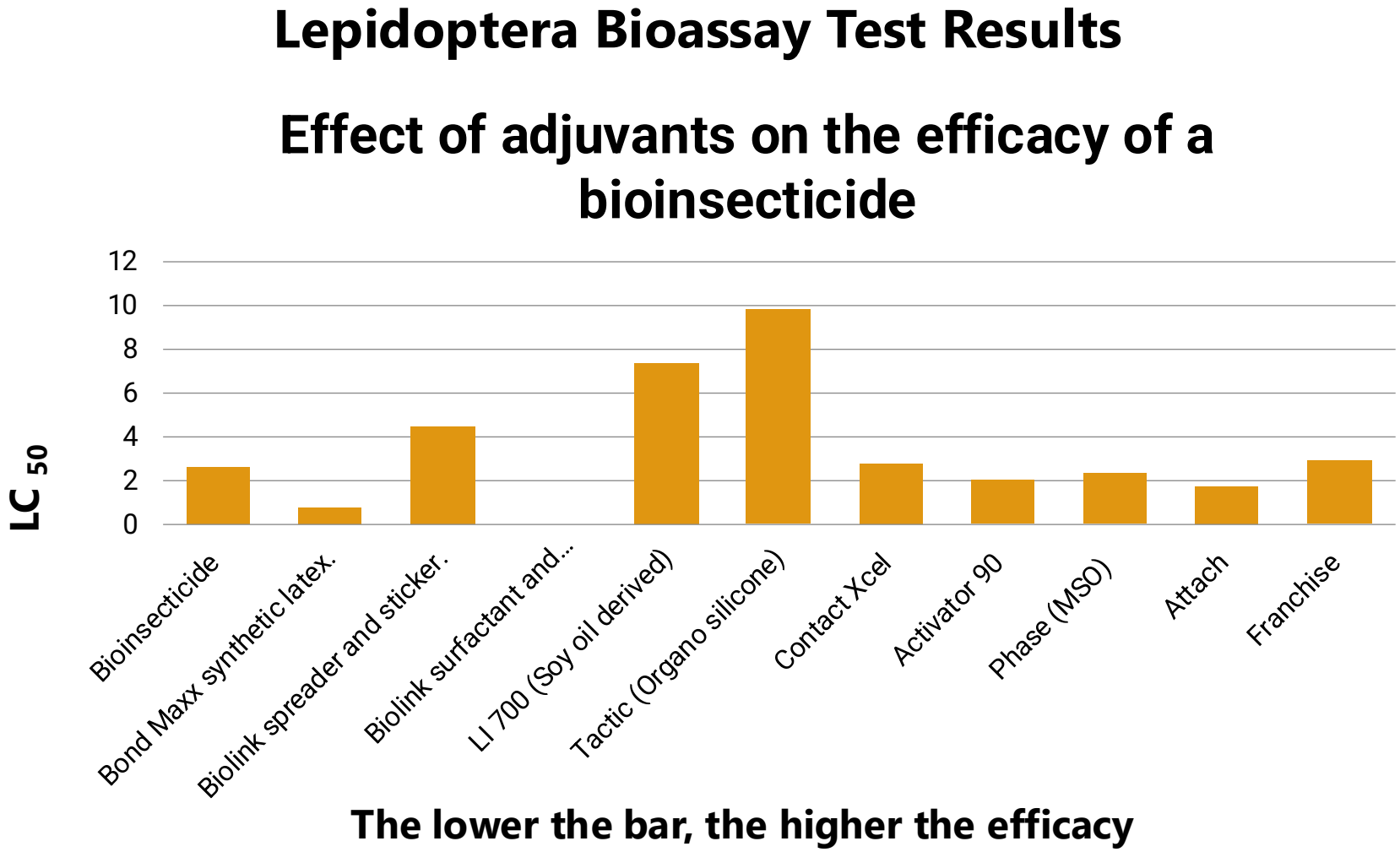
Treat now

Not now

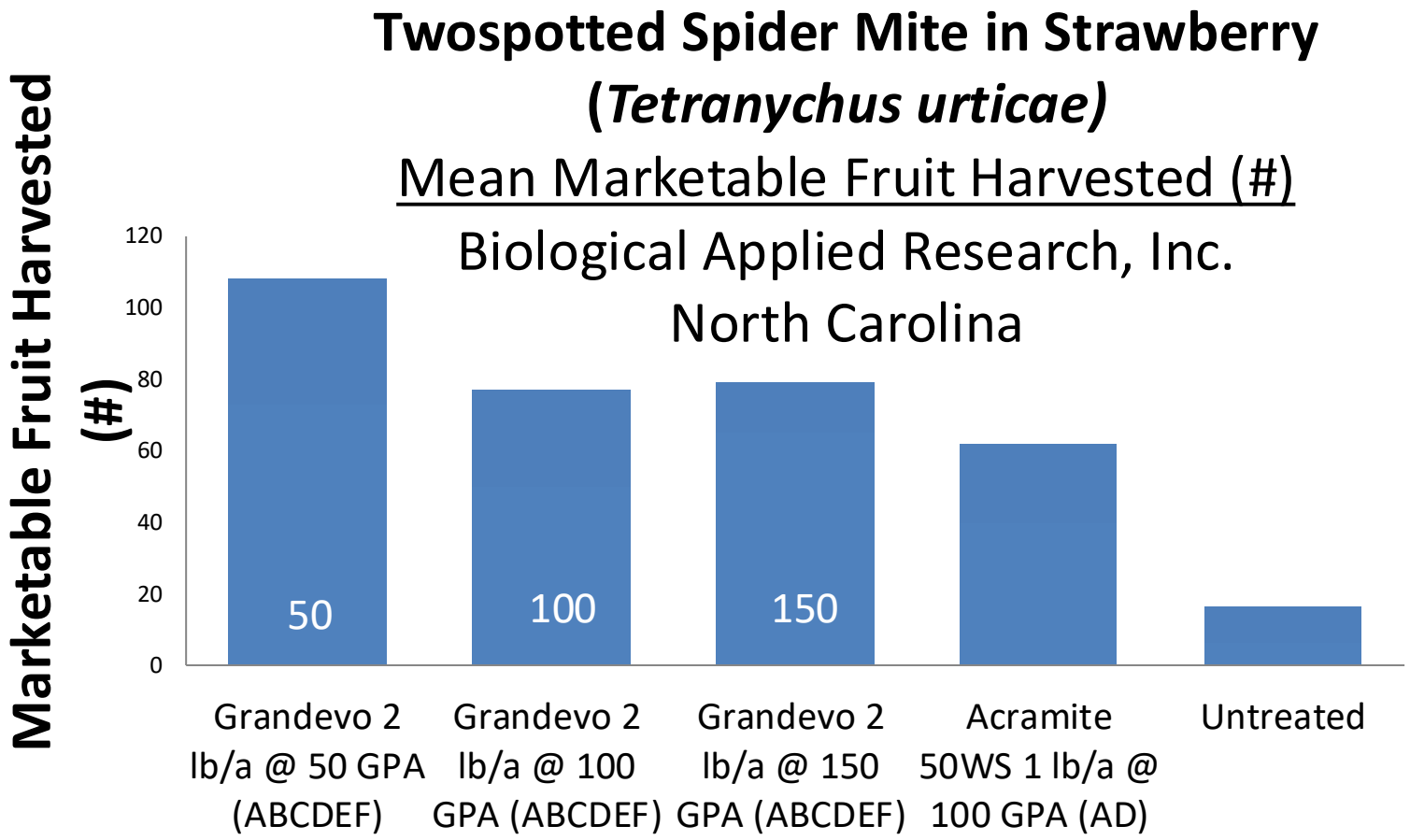
Formulation Can Make or Break a Biopesticide



Choice of Adjuvant Affects Efficacy of a Microbial Bioinsecticide



Bioinsecticide Performance vs Carrier Volume – Much Better Control with Less H_2O



How Can No-Till Farmers Select The Right Biologicals?

- **Application method:** Often biologicals can match a farmer's preferred method, meaning no additional equipment purchase is required.
- **Complementary strains:** Just because a product has more strains in it, doesn't mean that it is a better product.
- **CFU count and application rate:** Look for products with a high CFU count and lower application rate.
- **Trial data:** Does the product have 3rd-party, randomized, replicated data to back claims? What are the success rates of the trials, and are they statistically significant?
- **Compatibility data:** Are mixture/compatibility restrictions clear? Tank use instructions?
- **Shelf-stable:** The product should be formulated to remain shelf-stable and provide clear instructions about the shelf-life of the product.

*Adapted from Locus Ag

Looking at the Field Data

- How many **field trials**? Size? Where? Results?
- **Consistency** of the data**? "Win rate"** percentage?
- Do they know **when it works** and when it **does not**?
- Standalone small plot data are useful but not the whole story.
- **On farm demos** in real world integrated programs can provide powerful information.
- **Marketable yield/quality (ROI)** is the most important measure (vs. only using insect/nematode/weed/leaf spot counts).

Fertilizer Institute Biostimulant Certification

Certified Biostimulant is based on the United States Biostimulant Industry Guidelines, which provides criteria for the proper documentation of evidence to support efficacy testing methods, composition, and safety.

AgroLiquid
Biodyne
Bioline
Brandon Bioscience
Cosmocel
Hello Nature USA
Kula Bio
Timac Agro
Valent Bioscience
Verdesian

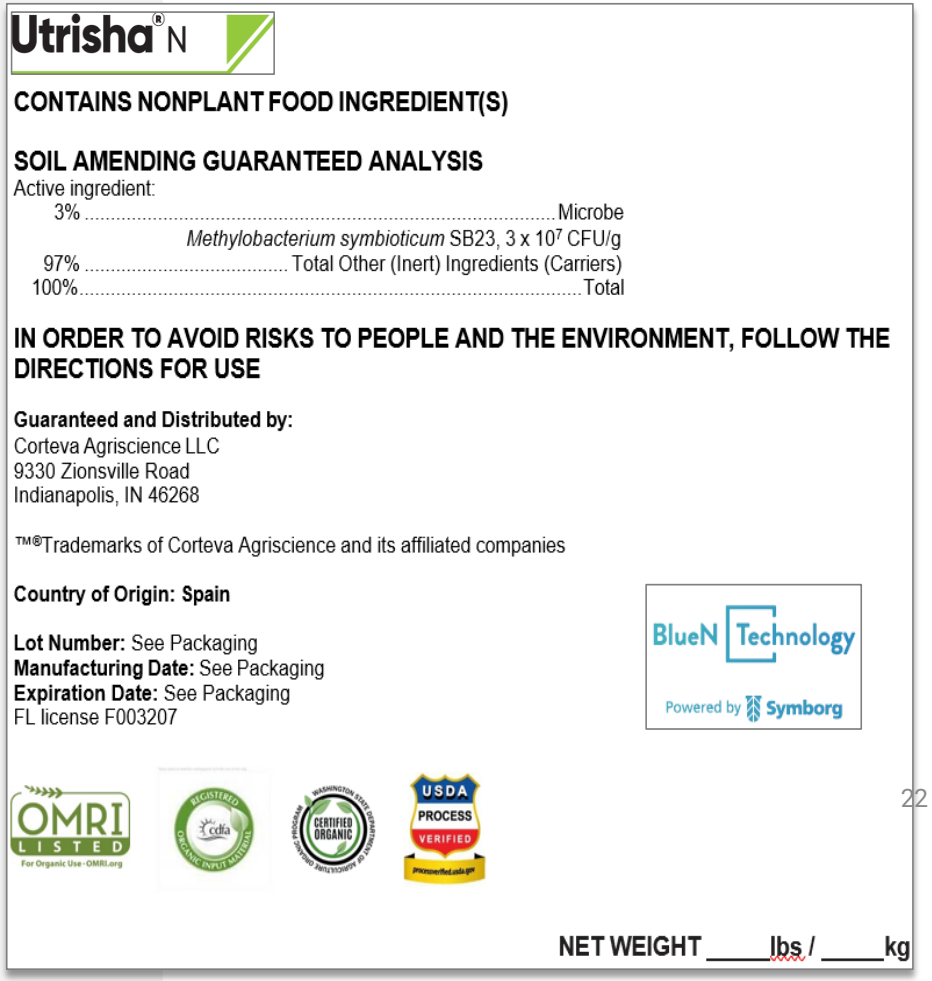
USDA Certification for ”Process Verified” Biostimulant

Slide from Terry Stone, BPIA March 2024 meeting, Washington, DC

Utrisha N/ Blue N PVP & Process Points

Assure farmers that **USDA validated quality management systems and process points** Corteva established to **indicate the quality of Utrisha N,** specifically:

1. Confirm identity of bacteria claimed on label
2. Confirm quantity of bacteria claimed on label
3. Confirm presence of contaminant bacteria[1], heavy metals[2], and total aromatic hydrocarbons[3] are equal to or below stated limits
4. Confirm mechanism of action/activity of Methylobacterium symbioticum SB23



Utrisha® N

CONTAINS NONPLANT FOOD INGREDIENT(S)

SOIL AMENDING GUARANTEED ANALYSIS

Active ingredient:

3%	Microbe *Methylobacterium symbioticum* SB23, 3 x 10^7 CFU/g
97%	Total Other (Inert) Ingredients (Carriers)
100%	Total

IN ORDER TO AVOID RISKS TO PEOPLE AND THE ENVIRONMENT, FOLLOW THE DIRECTIONS FOR USE

Guaranteed and Distributed by:
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Indianapolis, IN 46268

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Country of Origin: Spain

Lot Number: See Packaging
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BlueN Technology
Powered by Symborg

OMRI LISTED
For Organic Use · OMRI.org

NET WEIGHT _____lbs / _____kg

22

22

CORTEVA™ agriscience

[1] Microbial pathogens – *Salmonella spp*. (Absence in 25g), *Listeria monocytogenes* (Absence in 25g), *Escherichia coli* (Absence in 1g), and *Staphylococcus aureus* (≤10 CFU/g). [2] Heavy metals – Inorganic Ar(s≤40 ppm), Cd (≤1.5 ppm), Co (total) (≤1.0 ppm), Cu (≤600 ppm), Pb (≤120 ppm), Hg (≤1.0 ppm), Mo (≤1.0 ppm), Ni (≤50 ppm), Se (≤0.5 ppm), and Zn (≤1500 ppm). [3] Total Aromatic Hydrocarbons – Polycyclic Aromatic Hydrocarbon (PAH) – (≤ 6.0 ppm). Note: Methodologies follow already accepted methods such as EPA, ISO, or AOAC

Will a Yelp for Biologicals Help Farmer Confidence?

Find the best ag biologicals

"AgList is the only independent platform that helps farmers discover and endorse biologicals"

- "AgList is built for farmers, by farmers. A place where you can
- Discover biologicals other growers are using successfully
- Read and share honest endorsements from farmers who use the product
- Save time and effort by finding what works without all the guesswork
- But AgList isn't just for farmers—it's also a game-changer for biological companies."

- "If you're a bio company, AgList is the platform to showcase your products, build trust through grower endorsements, and make it easier for farmers to find and choose you.
- By listing your products on AgList, you're giving growers the confidence they need to try something new—and that confidence is backed by the experiences of other farmers in their area."

Delivery Systems to Farmers Improve Reliability for Some Microbial Products

MERISTEM CROP PERFORMANCE

Delivering live, in-field biologicals through the patented BIO-CAPSULE™ Technology platform.

3BarBio

indigo

CLIPS, the dry powder application system for bulk seed box containers allows for reliable application of dry powder formulations,

MyLand

Finds microalgae on the farm then grows those strains in a unit installed on the farm

Helping Growers Understand What is in Their Soil and the Effect of Inputs on Soil Health

RHIZE BIO

"The Rhize Soil Health Test is a low-cost, high tech soil testing approach that decodes the complexity of the soil microbiome to reveal biodiversity, functionality, resistance, bio control, hormone production, stress adaptation, and nutrient cycling potential. Using the RhizeBio™ proprietary technology, it is now possible to improve the biological health of your soil."

TRACE GENOMICS

"Utilizing soil science, genomics and machine learning, we measure the bacteria and fungi in your soil that cause disease and cycle nutrients. We then combine those measurements with soil chemical characteristics to provide customers with a window into the health and productivity of their soil."

BIOME MAKERS

"We are a global agtech company with the most advanced technology for modelling soil functionality to enhance the productivity of arable soils and to recover our soil health worldwide.

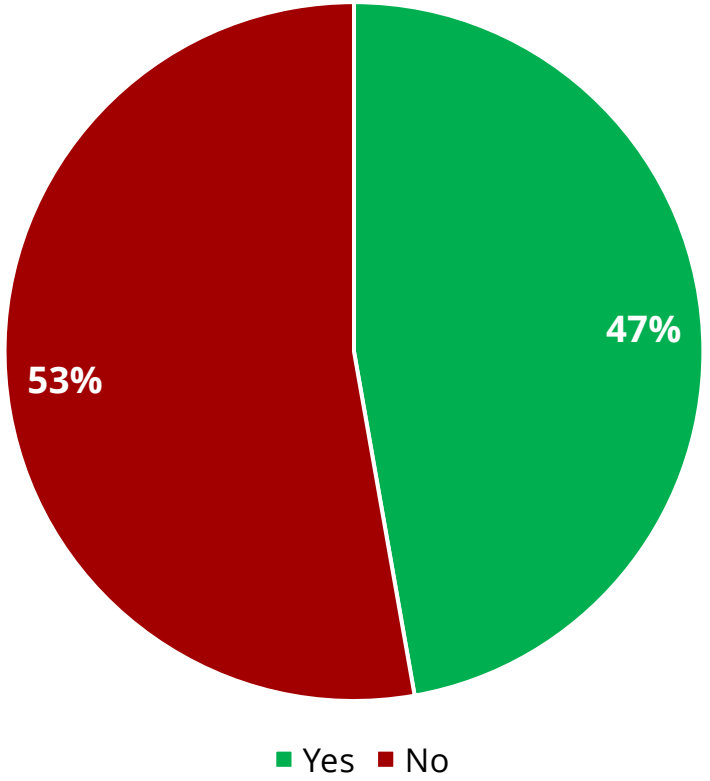
We measure the biological quality of the soil and deliver agronomic insights to optimize farm operations."

Have you been educated about biologicals? Such as the benefits, limitations, or available options?

Overall

Education on biologicals is still lacking and is one of the major things holding acceptance back

EDUCATION
EDUCATION
EDUCATION



In any survey, the percentage of farmers who say they they are not educated about biologicals has remained at ~50% **for the past 5 years**

NCAT ATTRA SUSTAINABLE AGRICULTURE

https://attra.ncat.org

American Society of Agronomy

https://www.agronomy.org

Upstream

https://upstream.ag

SOIL HEALTH INSTITUTE

https://soilhealthinstitute.org

AgFUNDER

https://agfunder.com

Marrone PG (2025) Increasing the use of biological pesticides in integrated pest management programs. Frontiers of Insect Science 5:1552361. https://doi.org/10.3389/finsc.2025.1552361

QUESTIONS?

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