The Future of Liquid Fertilizers

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Director of Agronomy
Nutrien

December 6, 2022

Main Statement

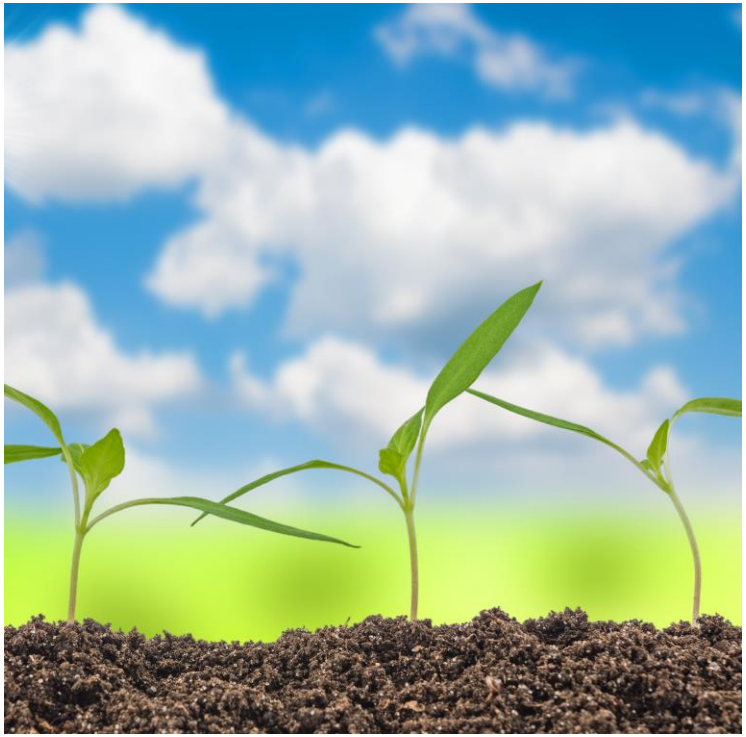
Current Liquid Fertilizers

“New” Novel Ingredients

Fertilizers 2.0/3.0

Biostimulants

- Clarify the marketplace
- Regulatory changes
- Moving forward – **finding the right fit**
- Crucial Questions



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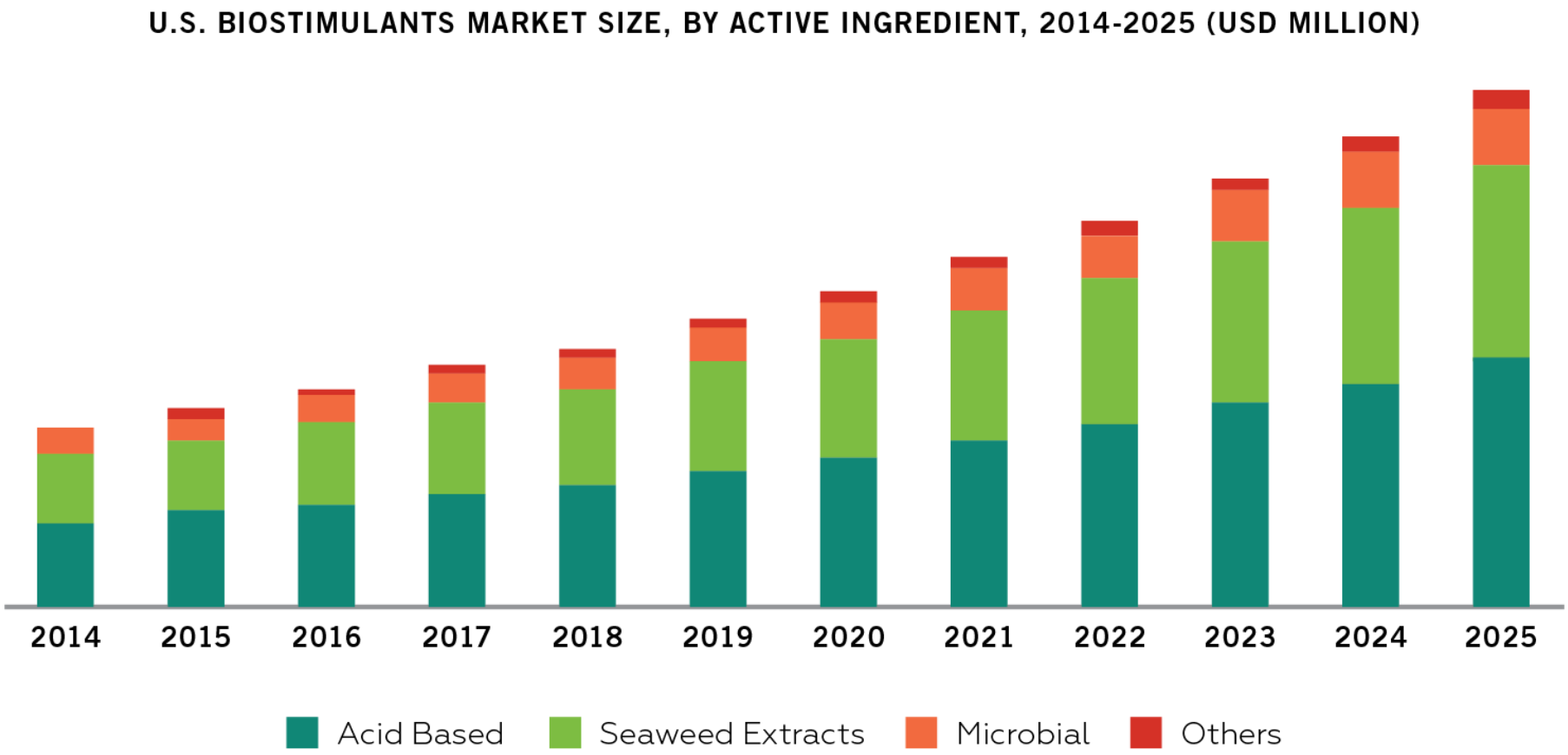
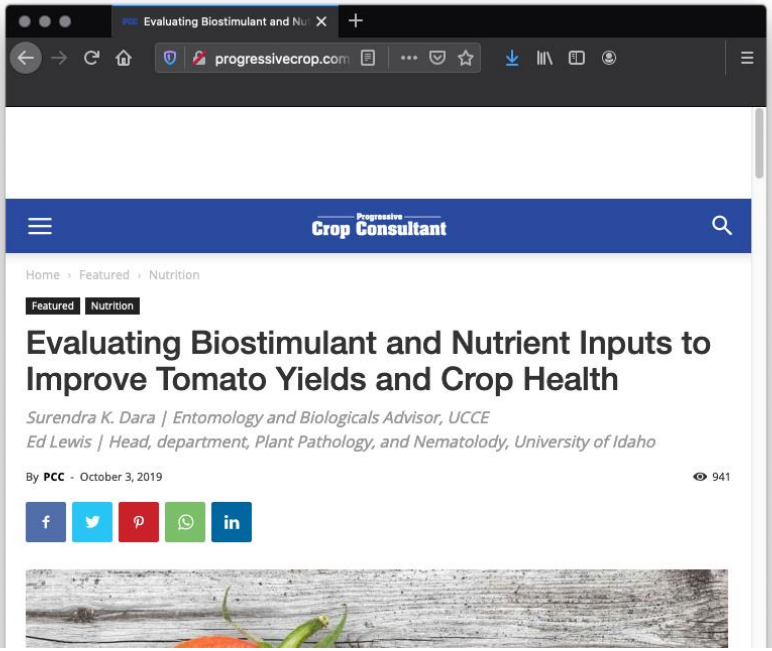
Category Momentum

Biostimulants Market Growth

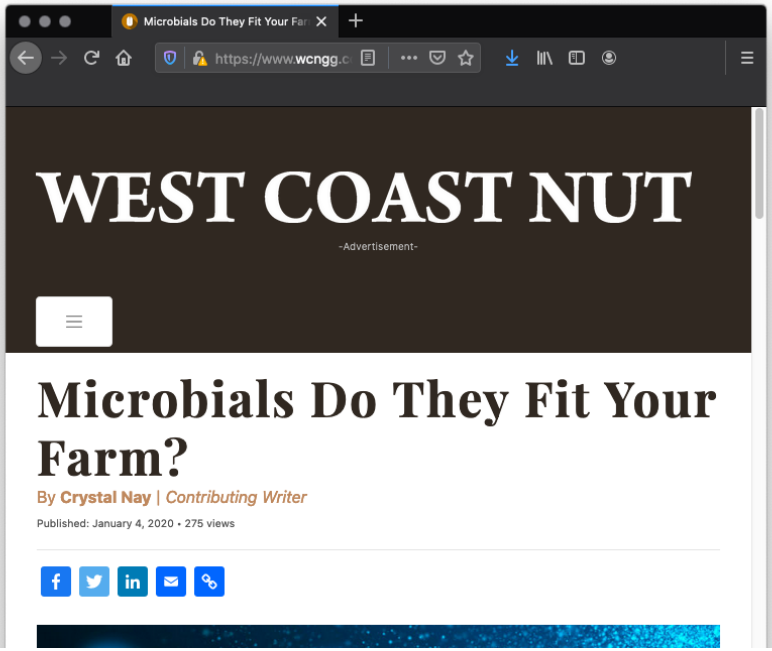


https://www.grandviewresearch.com/industry-analysis/biostimulants-market

Market Interest



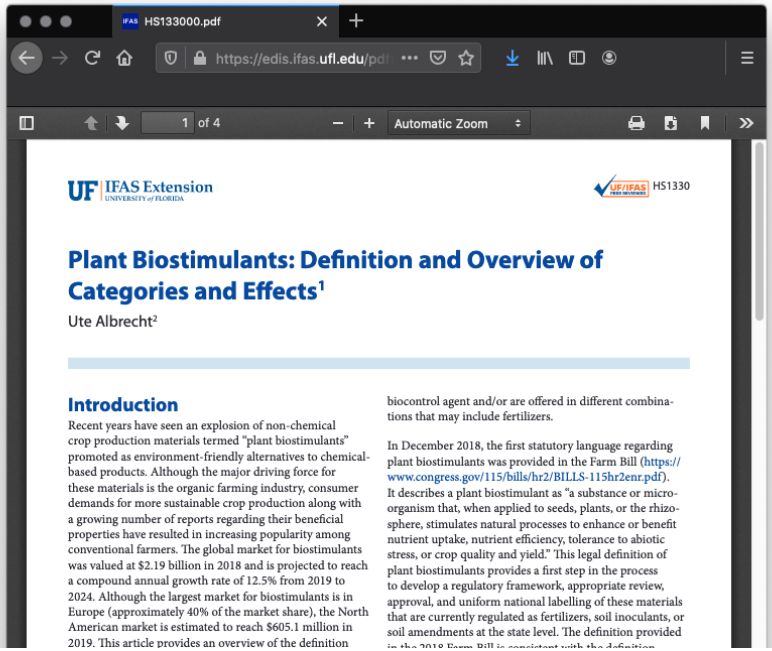
http://progressivecrop.com/2019/10/evaluating-biostimulant-and-nutrient-inputsto-improve-tomato-yields-and-crop-health/



https://www.wcngg.com/2022/01/04/microbials-do-they-fit-your-farm/

Academic & Extension Support

https://link.springer.com/content/pdf/10.1007/s11104-014-2131-8.pdf



https://edis.ifas.ufl.edu/pdffiles/HS/HS133000.pdf

Legislative Positioning – 2018 Farm Bill

SEC. 10111. REPORT ON PLANT BIOSTIMULANTS.

(a) REPORT.—Not later than 1 year after the date of the enactment of this Act, the Secretary shall submit a report to the President and Congress that identifies any potential regulatory, non-regulatory, and legislative recommendations, including the appropriateness of any definitions for plant biostimulant, to ensure the efficient and appropriate review, approval, uniform national labeling, and availability of plant biostimulant products to agricultural producers.

(b) CONSULTATION.—The Secretary shall prepare the report required by subsection (a) in consultation with the Administrator of the Environmental Protection Agency, the several States, industry stakeholders, and such other stakeholders as the Secretary determines necessary.

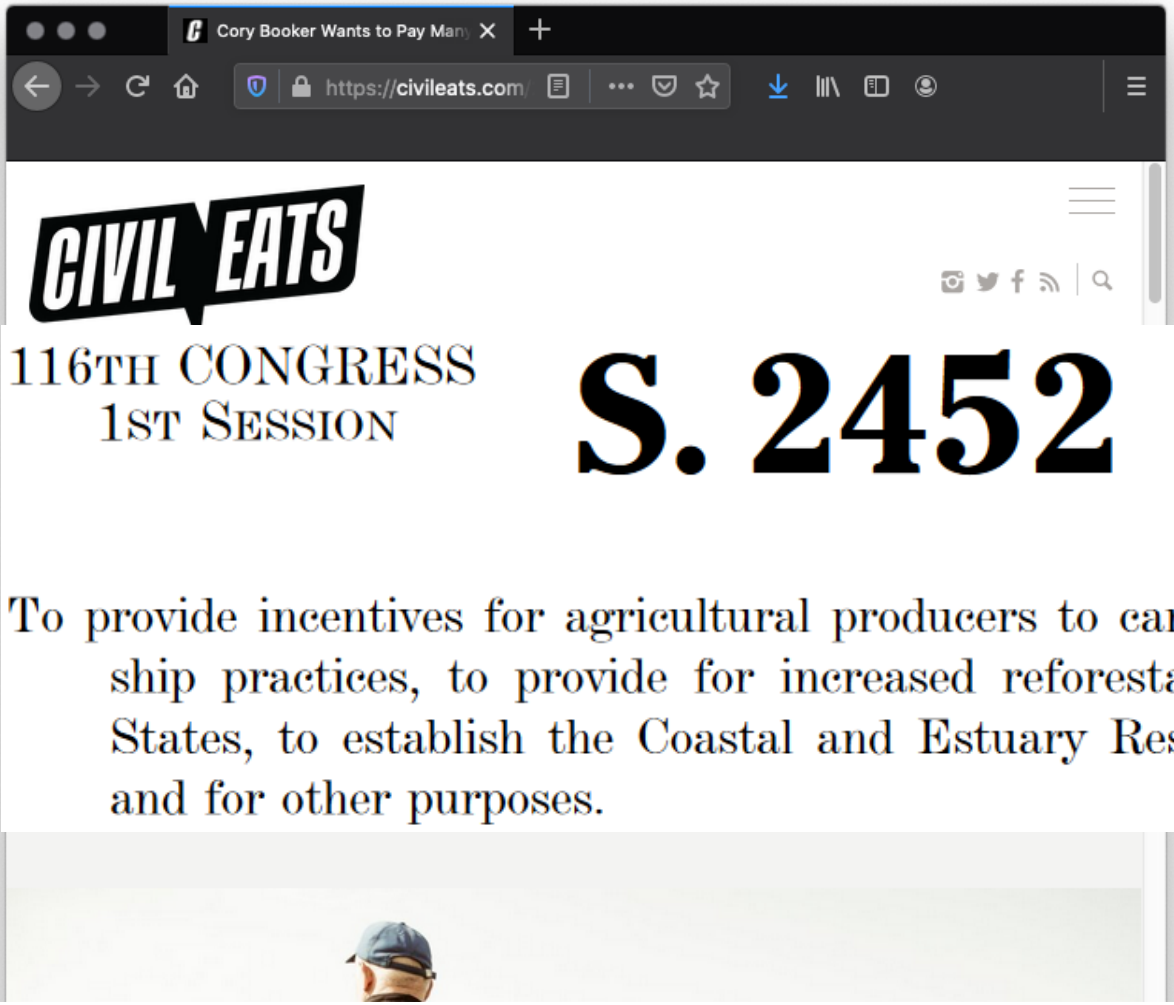
(c) PLANT BIOSTIMULANT.—For the purposes of the report under subsection (a), the Secretary—

(1) shall consider "plant biostimulant" to be a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield; and

(2) may modify the description of plant biostimulant, as appropriate.

https://www.congress.gov/115/bills/hr2/BILLS-115hr2enr.pdf

Legislative Positioning - Continued



https://civileats.com/2019/08/08/cory-booker-wants-to-pay-many-more-farmers-to-practice-carbon-farming/

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Challenges for Category

December 6, 2022

What are Biostimulants?

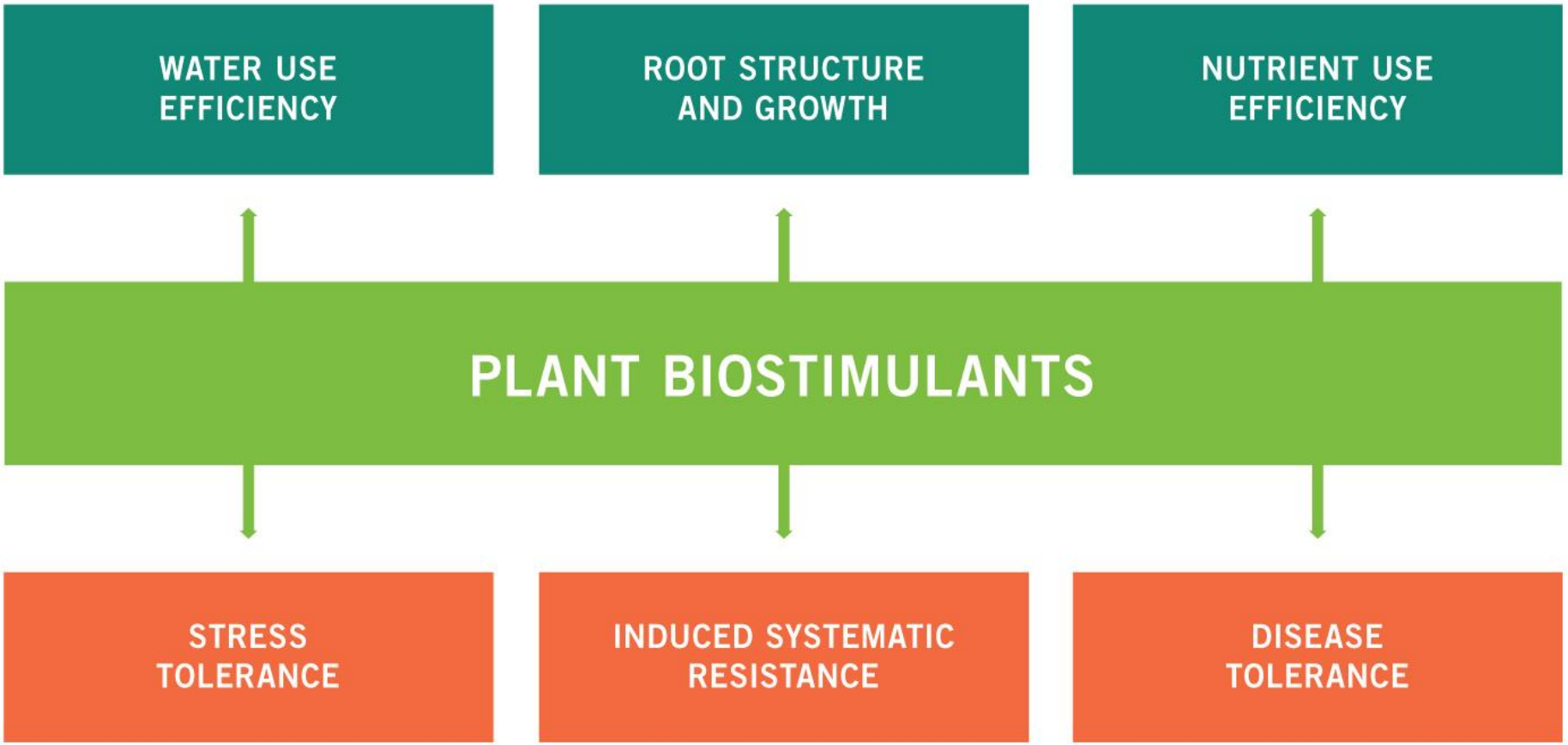
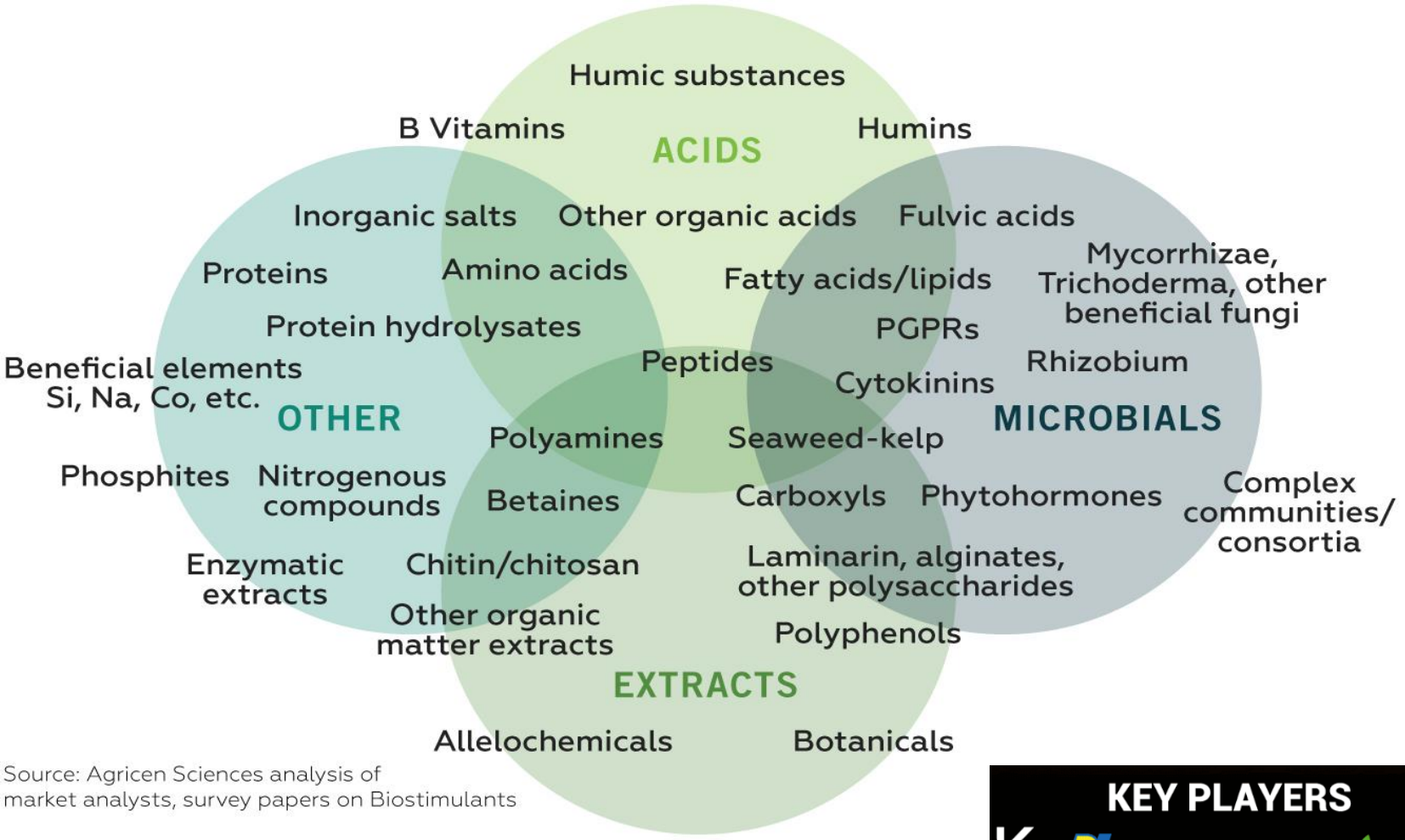


Figure 1. Biostimulant effects on plants.

Albrecht 2019

Marketplace Noise



Source: Agricen Sciences analysis of market analysts, survey papers on Biostimulants

https://www.bpia.org/solutions-provided-by-biological-products-biostimulants/#acid-based-biostimulants

Biostimulant Market Size, Growth, Share | 2022 - 27 (mordorintelligence.com)

Infographics - Biostimulants Market (fortunebusinessinsights.com)

Marketplace Maturity

Market Concentration

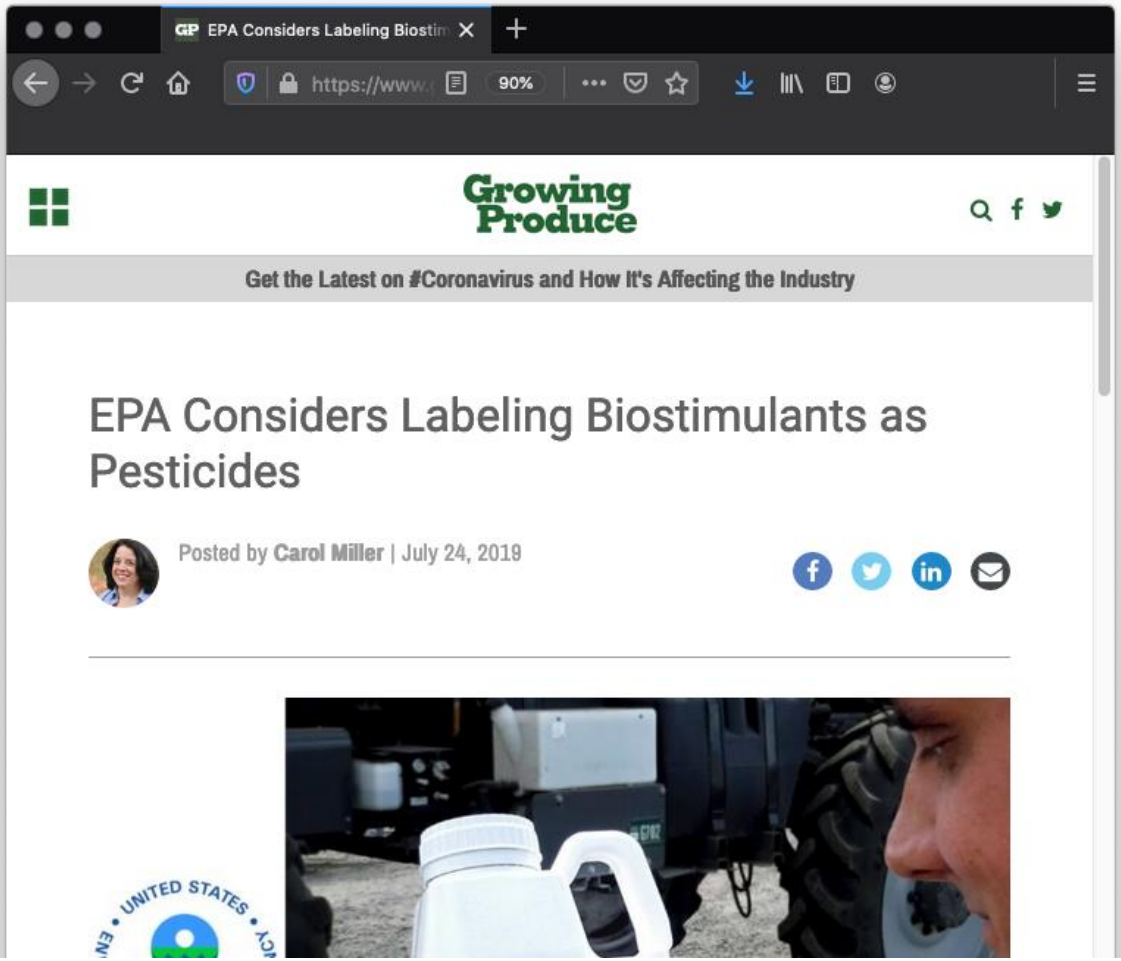
BAU

Consolidated- Market dominated by 1-5 major players

Source: Mordor Intelligence

Biostimulant Market Size, Growth, Share | 2022 - 27 (mordorintelligence.**com**)

Challenges for Category



https://www.growingproduce.com/vegetables/epa-considers-labeling-biostimulants-as-pesticide/

Making Progress

117TH CONGRESS
2D SESSION

H. R. 7752

Date	All Actions
06/08/2022	Referred to the Subcommittee on Biotechnology, Horticulture, and Research. Action By: Committee on Agriculture
05/12/2022	Referred to the House Committee on Agriculture. Action By: House of Representatives
05/12/2022	Introduced in House Action By: House of Representatives

BILLS-117hr7752ih.pdf (govinfo.gov)

Unanswered Questions

- **Problem**: *What exactly is a biosimulant?*
- Unclear definition - pg. 419 pf 2018 Farm Bill
- EPA Draft Guidance – 2019 - **Table 4** list of ingredients (pg. 11)
- Clear up what product label language claims and FIFRA categories
- **Conflation of ingredients** - PGRs, ag chem, and fertilizers
- **Alignment issues** - USDA, EPA, and a variety of state regulators
- Clarify international standards and pathways to market

Question for Audience

How do we **innovate** liquid fertilizers with **new and novel** ingredients?

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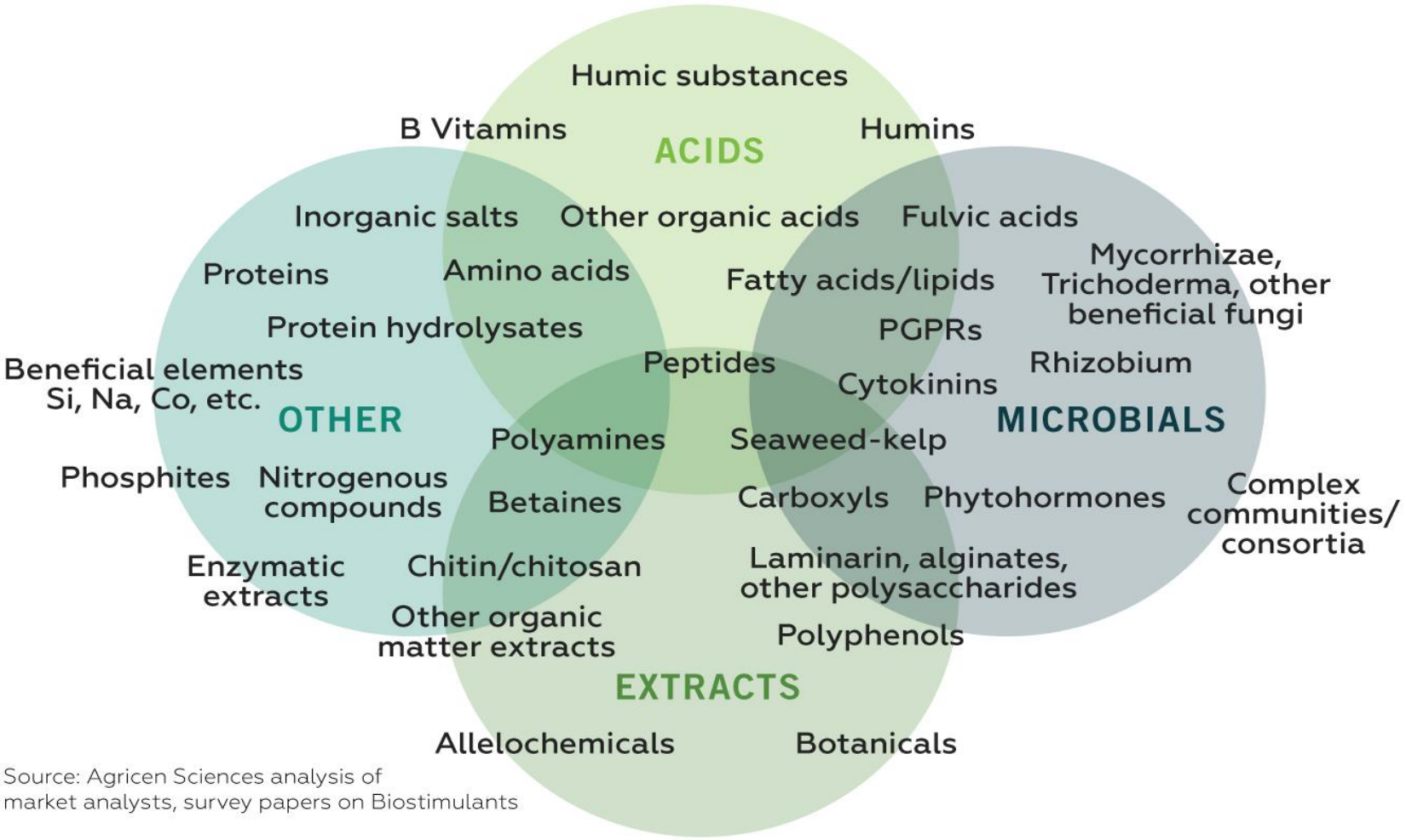
Which New Ingredient Do I Pick?

Marketplace Noise



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Some Ground Rules

- New active ingredients have **utility**
- **Species identity** determines role in soil:
  - Living inoculants
- **Carbon chemistry** determines function in soil:
  - Size
  - Charge
  - C:N ratio
  - Macromolecule diversity - *food sources*

Inoculant Cheat Sheet - Fungi

Yeasts/protein mixes – nutrient delivery source for plants (amino acids, NPK, etc.)

***Trichoderma* species** – a beneficial **fungus** that helps protect the plants against pathogens

Mycorrhizae – a beneficial plant/**fungal** symbiosis that help trees get more water and phosphate

Plant Production and Protection Division: Soil biological management with beneficial microorganisms (fao.org)

Inoculant Cheat Sheet - Bacteria

Bradyrhizobia – nodule forming, living **bacteria** that helps with N fixation on legumes.

Azospirillium/Klebsiella – free-living **bacteria** that helps with N fixation on *non-legumes*

Bacillus species – **bacteria** that helps with pathogen control and nutrient availability

Pseudomonas species – **bacteria** that helps with pathogen control and nutrient availability

Aspergillus species **- bacteria** that produce enzymes that break down hard-to-digest plant fibers

Plant Production and Protection Division: Soil biological management with beneficial microorganisms (fao.org)

Challenges with Inoculants

- **Viability** is a concern
- **Living vs. spore form**
- Sensitive to fluctuations in environment – **moisture, temperature, UV, competition**
- Some labs can help **confirm label CFU** count
- Challenges with **mixing and compatibility** in the field

- **Key question: how alive is your product?**

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Non-living Carbon Products: Spotlight on Food Sources, Organic Acids, Enzymes & Seaweeds

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Feed the Microbiome

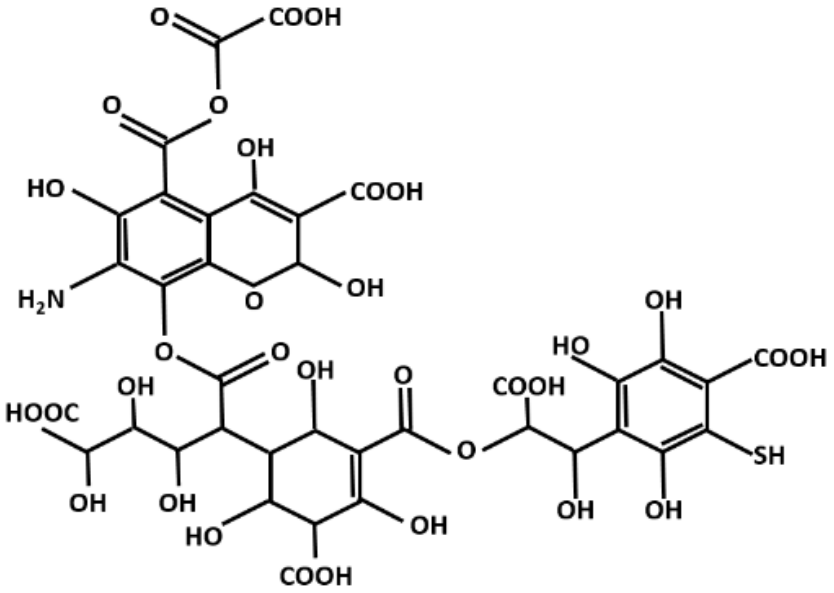
From: Kallenbach et al. 2016 Nature Comm.

Images of sugar-treated model soils over time (a); the far-left panel is an uninoculated sterile kaolinite and sand mixture, and the far-right panel is the same mixture, inoculated and treated with **weekly glucose additions for 15 months.**

Lots of sources: molasses, sugars, microalgae, etc.

Fulvic Acids

- Smaller than humic acids and honey colored
- High CEC (**500-600!**) – holds nutrients like humic acids
- Nutrient **carrier** into plant
- Stimulates plant roots



What is Fulvic Acid – Fulvic Force

https://soilsolutions.net/humic-acid-vs-fulvic-acid/
http://www.earthgreen.com/humic-vs-fulvic-acids
https://pubchem.ncbi.nlm.nih.gov/compound/5359407#section=2D-Structure

Seaweeds & Kelps

- Old technology to improve soil
- **Macro-algae** – brown algae *Ascophyllum nodosum is common*
- Complex, variable extracts
- Plant growth promoting
- Helps with plant stress tolerance
- **Plant response well studied**
- **Regulatory path looks rough**

Exact mechanism needs work

Van Oosten et al. 2017

Enzymes

Phosphatase

Breakdown insoluble phosphate into available P

Enzymes - a substance produced by a living organism that acts as a catalyst to bring about a specific biochemical reaction

http://www.m.elewa.org/JAPS/2013/18.2/3.pdf; http://web.mit.edu/12.000/www/m2015/2015/microbial_background.html

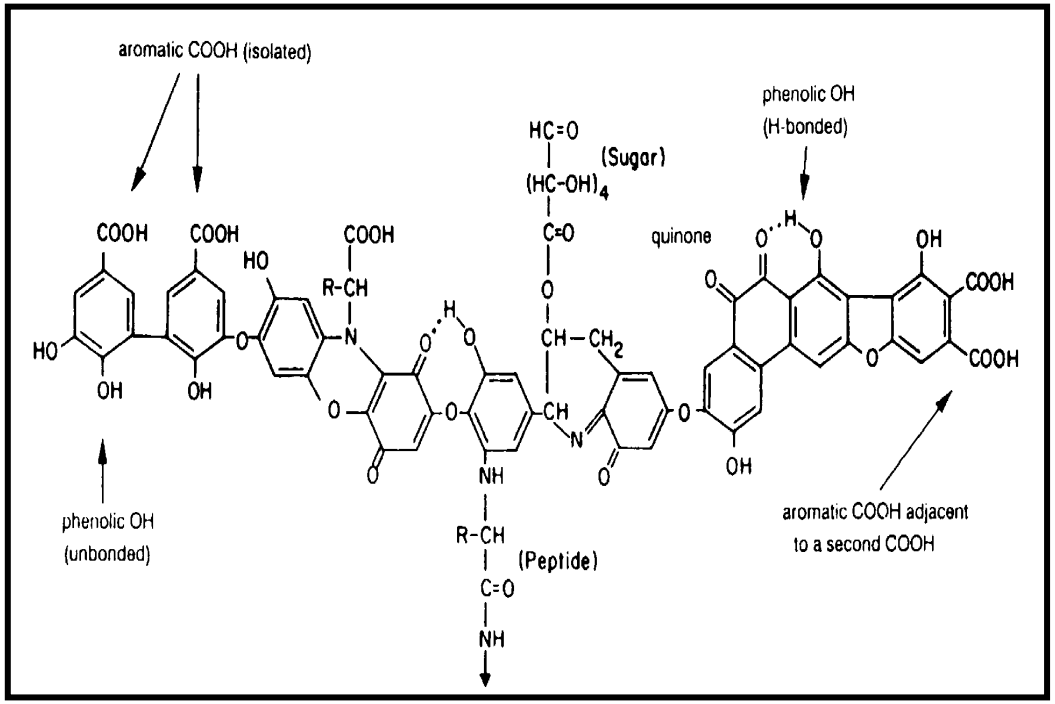
Specific Enzymes = Specific Action

- Protease
- β glucosidase
- Amidase & Urease
- Phosphatase & Sulfatase

- **Protein breakdown**
- **Cellulose breakdown**
- **N cycle**
- **P and S release**

Yang et al. 2012 – Soil Enzyme Activities and Soil Fertility Dynamics

Humic Acids



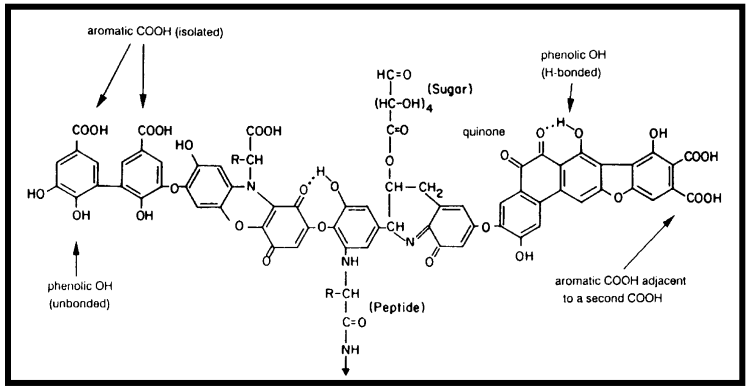
F. J. Stevenson, Humus Chemistry, 1994, 289

- Dual charge (+/-)
- Large size
- *Poor food choice*

Promotes:

- Nutrient retention (**high CEC**)
- Physical Structure

Using Humic Acids for N Management



NO_3^- NH_4^+

https://udextension.s3.amazonaws.com/factsheet/wp-content/uploads/2015/01/N-loss.jpg

F. J. Stevenson, Humus Chemistry, 1994, 289

- Humic acids **reduced peak urea → ammonia gas loss by ~68%** (Ahmed et al. 2006)
- Humic acids slowed down conversion of **ammonium → nitrate** (Dong et al. 2009)
- Humic acids soils leached **~54%-60% less nitrate** (Liu et al. 2009)

Challenges with Non-living Products

- Variance in quality and efficacy
- **Will it blend?**
- Laundry list of label claims – **what does it do best?**
- Logistics at all levels – *need for agitation?*
- **Biostimulant/fertilizer mixtures**

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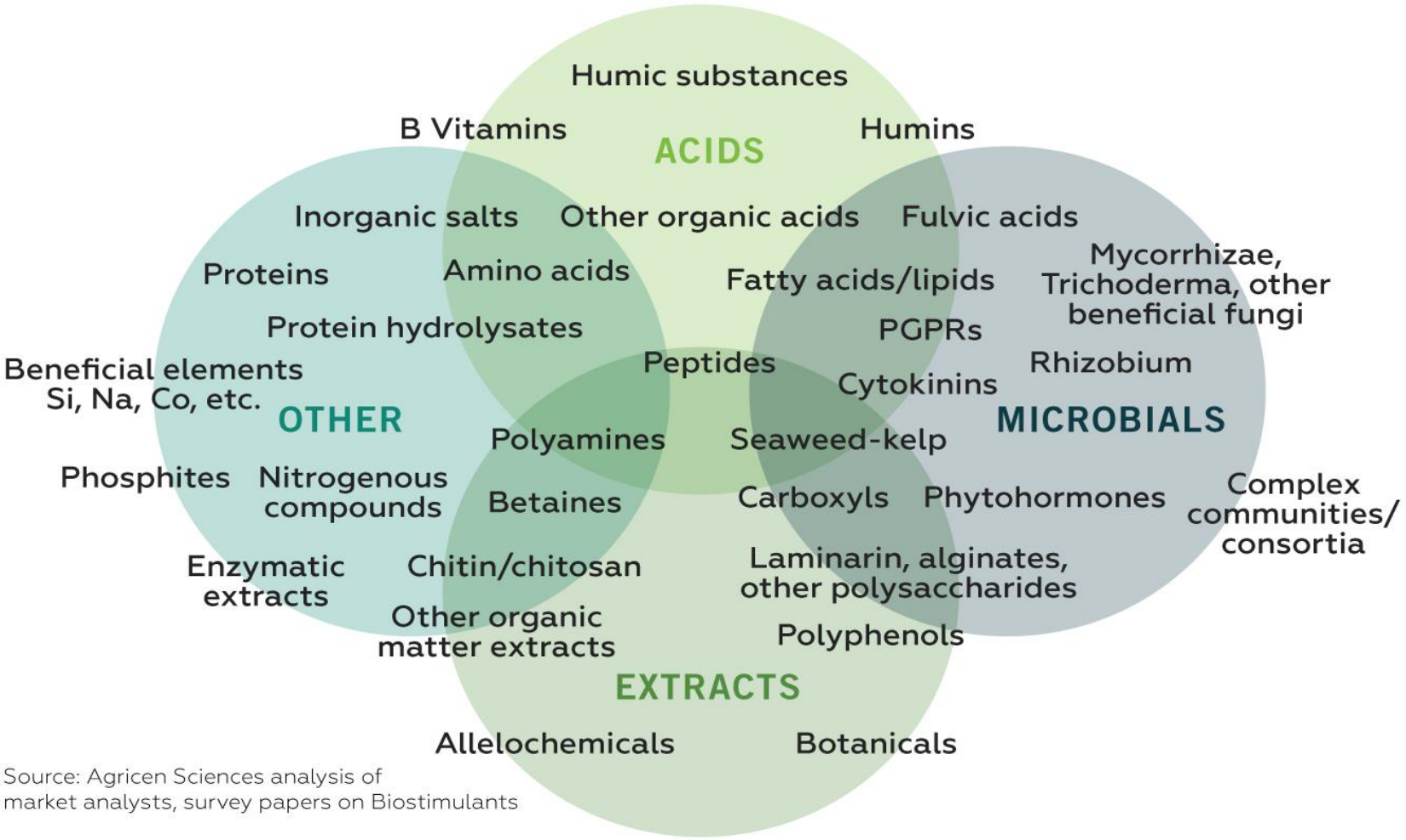
Closing Statements

Marketplace Noise



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Crucial Questions for Suppliers and Growers

Robust Trial Data?

Clear MOA?

Probability of +ROI?

Patents and IP?

Regulatory Future?

Portfolio Fit?

VC $ Source?

Moving Forward

- Consultants/advisers are crucial **for translating MOA** into product selection – **the 'WHY'**
- **Nuanced functionality/crowded marketplace**
- **Watch out for wild claims**
- Start with the **end goal** in mind
- Focus on blending and in-can options
- **Unknowns for blend safety**
- Proposed regulatory changes are sure to **shake things up**

More Resources

- Academic review
- Complete Academic Overview (600+ pages
- UF Extension Article

http://progressivecrop.com/2020/07/making-sense-of-biostimulants-for-improving-your-soil/

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Thank You!

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