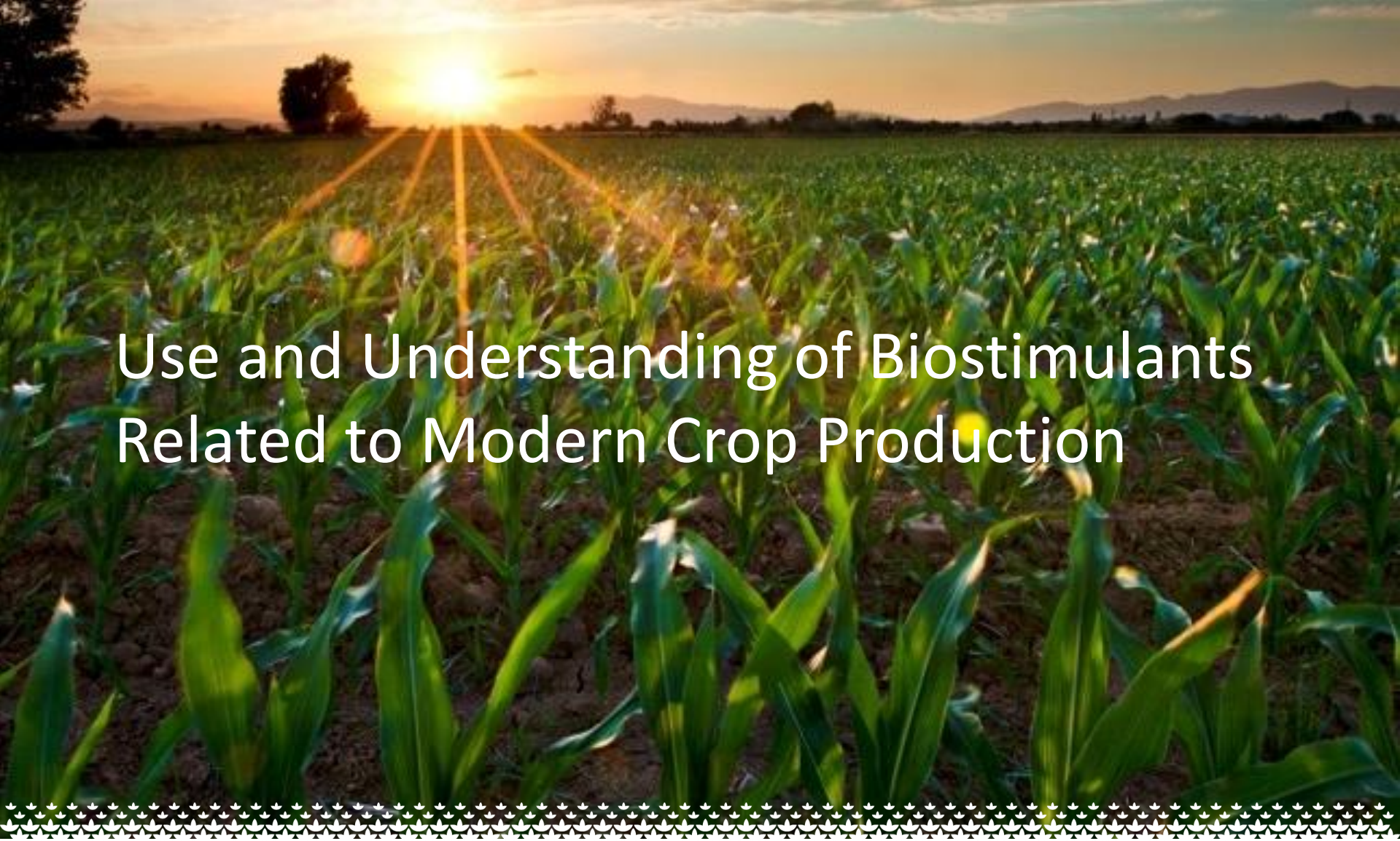


Use and Understanding of Biostimulants Related to Modern Crop Production

Terry A. Tindall , Galen Mooso and Brian Petersen, J.R.
Simplot Company USA

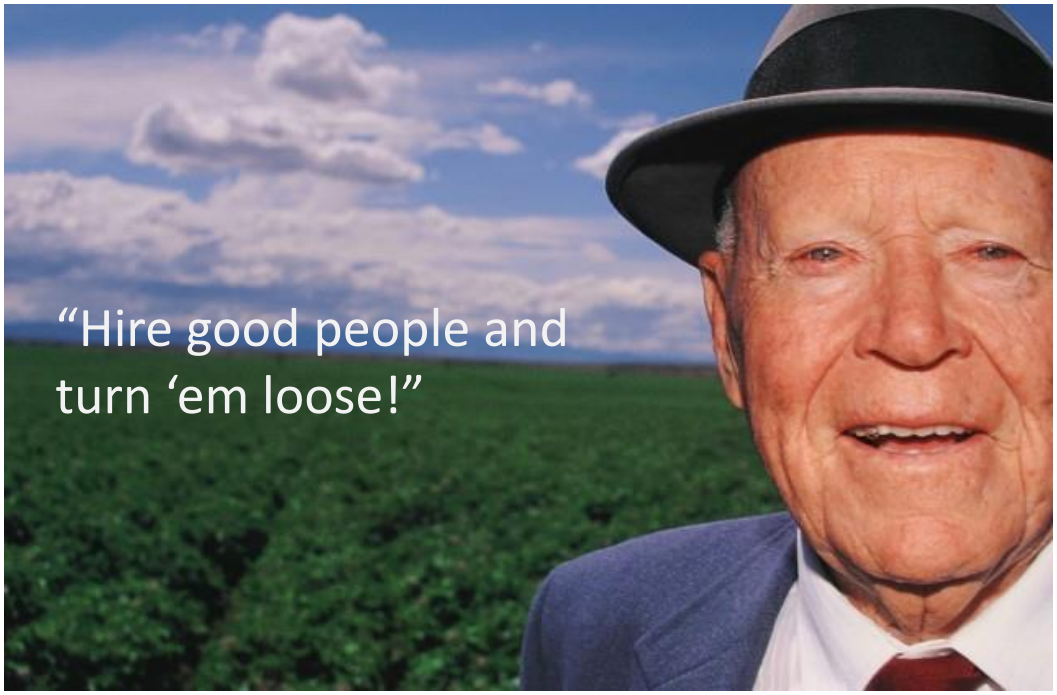
Simplot

Biostimulants and the 4 R's of Nutrient Management

Simplot

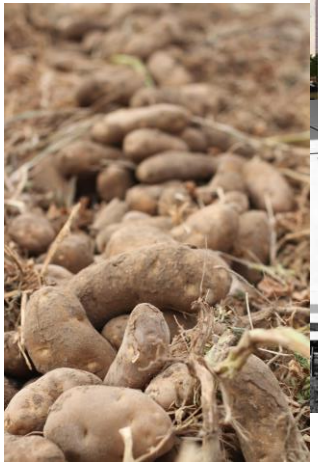
J. R. Simplot

- Founder: J.R. Simplot
- Est. 1929 – J. R. started a produce and livestock business with $80 to his name



The J.R. Simplot Company

- Privately held food & agribusiness firm
- Headquartered in Boise, Idaho
- 10,000 employees worldwide
- Over $6 billion in annual revenue



Who We Are Today

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

4R Nutrient Stewardship

Crop Advisor and His Valuable Growers

What are biostimulants?

Simplot

Biostimulants in Production Agriculture

- Biostimulant definition:
  - The European Biostimulant Industry Council (EBIC), 2013:
    - “Plant biostimulant means a material which contains substance(s) and/or microorganisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to benefit nutrient uptake, nutrient use efficiency, tolerance to abiotic stress, and/or crop quality, independently of its nutrient content.”

9

Examples of Biostimulants:

- Organic Compounds that have been synthesized for direct plant applications

  Auxins, gibberellins, cytokinins, amino acids and other organic molecules that include materials created in fermentation processes

  Micro-organisms

  Bacteria, Mycorrhizal, Fungi and Spores

  - Humic Acid, Fulvic Acid and other materials based on Leonardite coal

  - 2 Oxoglutaramate—isolated from Glutamate Cycle
  - Other Broad-based Plant Growth Regulators (PGR'S)

What are some experiences using biostimulants?

Simplot

Biostimulants in Production Agriculture

- Positives:
  - Stimulate plant growth
  - Increase input efficiency
  - Reduce plant stresses (abiotic or biotic)
  - Improve yield
  - Improve crop quality
  - Improving Soil Health

- Challenges:
  - People had little/no experience working with biostimulants
  - Needs more research
  - Compatibility with other products
  - Farmer acceptance
  - Local Data—Local crops—Local Research
  - Separate Myths from Sciene
  - These are proprietary IP

Where do you see the greatest promise for use of these types of materials?

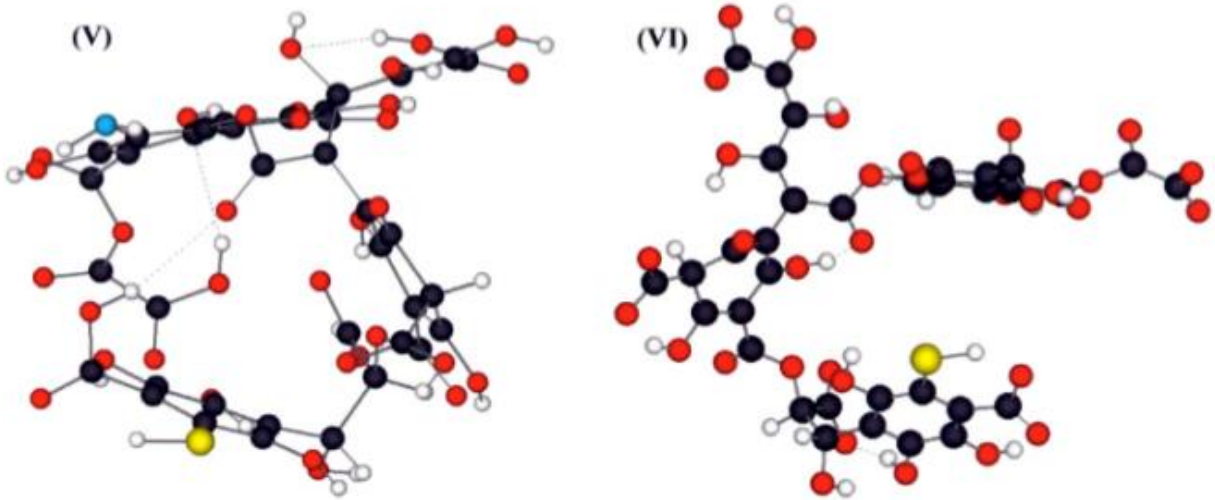
Biostimulants in Production Agriculture

- Low organic soils
- Soils with poor soil fertility and/or quality
- Shifting focus to soil health
- Introduce biostimulants to high value crops
- Crops with high input costs

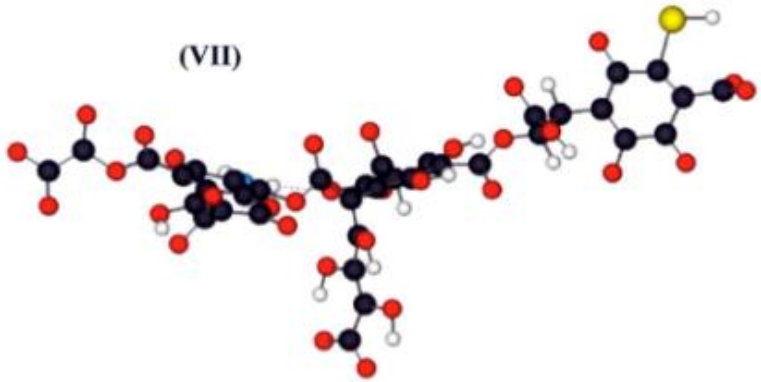
Plant Response to Biostimulants

Humic Acids are classified as a Biostimulants

COOH groups ionized-molecule begins to relax



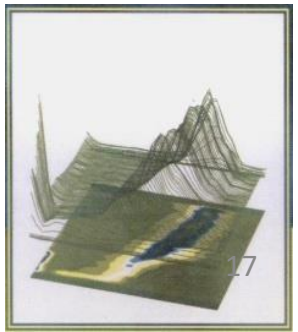
Both COOH and phenolic OH groups ionized molecule completely relaxed



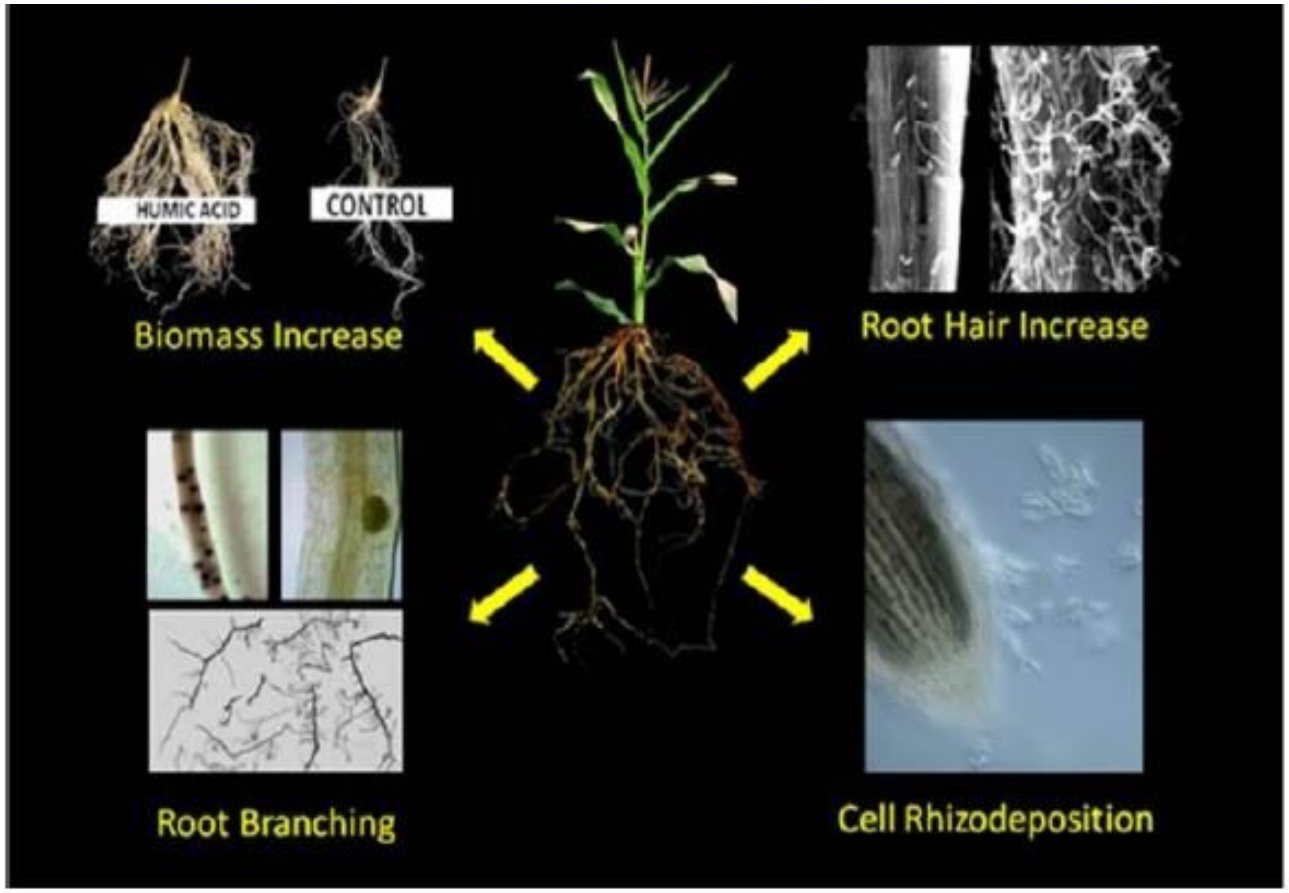
How do they work?
These are the functional groups in Humates

Carboxyl	$-CO_2H$
Phenol	-OHp
Hydroxyl	-OHa
Ketone	-C=O
Ester	O=C-O-R
Ether	-C-O-C-
Amine	$-NH_2$,-NH, -N

Using hydrolysis methods, we replace Hydrogen and make them more functional, enhancing CEC, buffering, chelation, and complexation.



HS & Plant Health



Root architecture, root hair, root exudate and enzyme production by HS

Luciano et al

Leondard Coal to Humic Substances by Advanced Extraction System

Humic Substance
- Source
- Concentration
- Size (molecular wt.)

Plant
- Species
- Age

*Seed Germination

*Shoot Development

*Seedling growth

*Root Initiation and Development

*Enhanced Metabolic Activity

*Enhanced adsorption of macro- and micro-nutrients (e.g. NO_3^-)

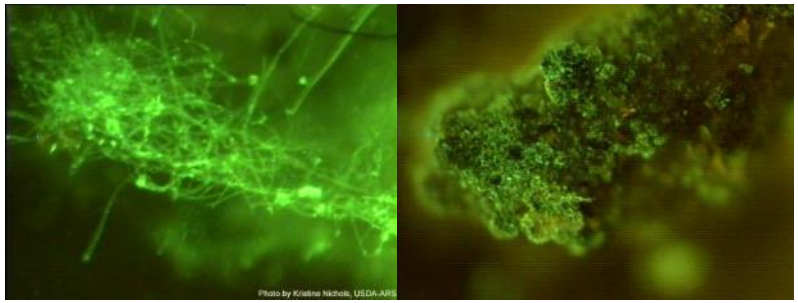
HS Influences Soil and Plant Health

BETTER TECHNOLOGY

Liquid Fertilizer combinations

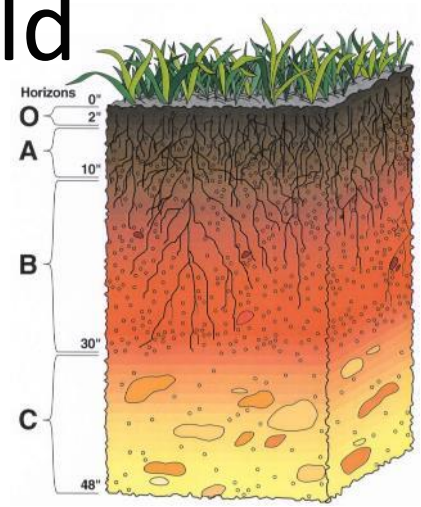
Organic Acids

Humic Substances -
Helps Soil Microbes
& Glomalin Formation



Glomalin (bright green) is a sticky substance that creates tiny soil aggregates.

These physical bonds will create good soil aggregate and impact yield



Fluid Fertilizers and Bio-Stimulants—Tindall Experiences

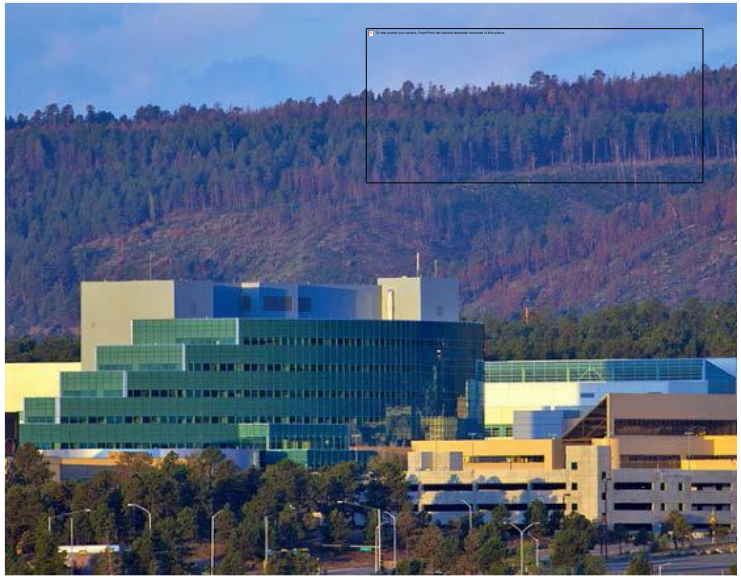
- Combine well documented Biostimulants with low salt liquids
- Explore independent third party research
- Incorporate positive technologies into local farming systems—first on Simplot Land and Livestock farms—
- Incorporate into retail crop advisors customers

BETTER TECHNOLOGY

Combined with Liquid Fertilizer

UNIQUE TECHNOLOGY FOR ENHANCED NUTRIENT **UPTAKE AND ASSIMILATION**

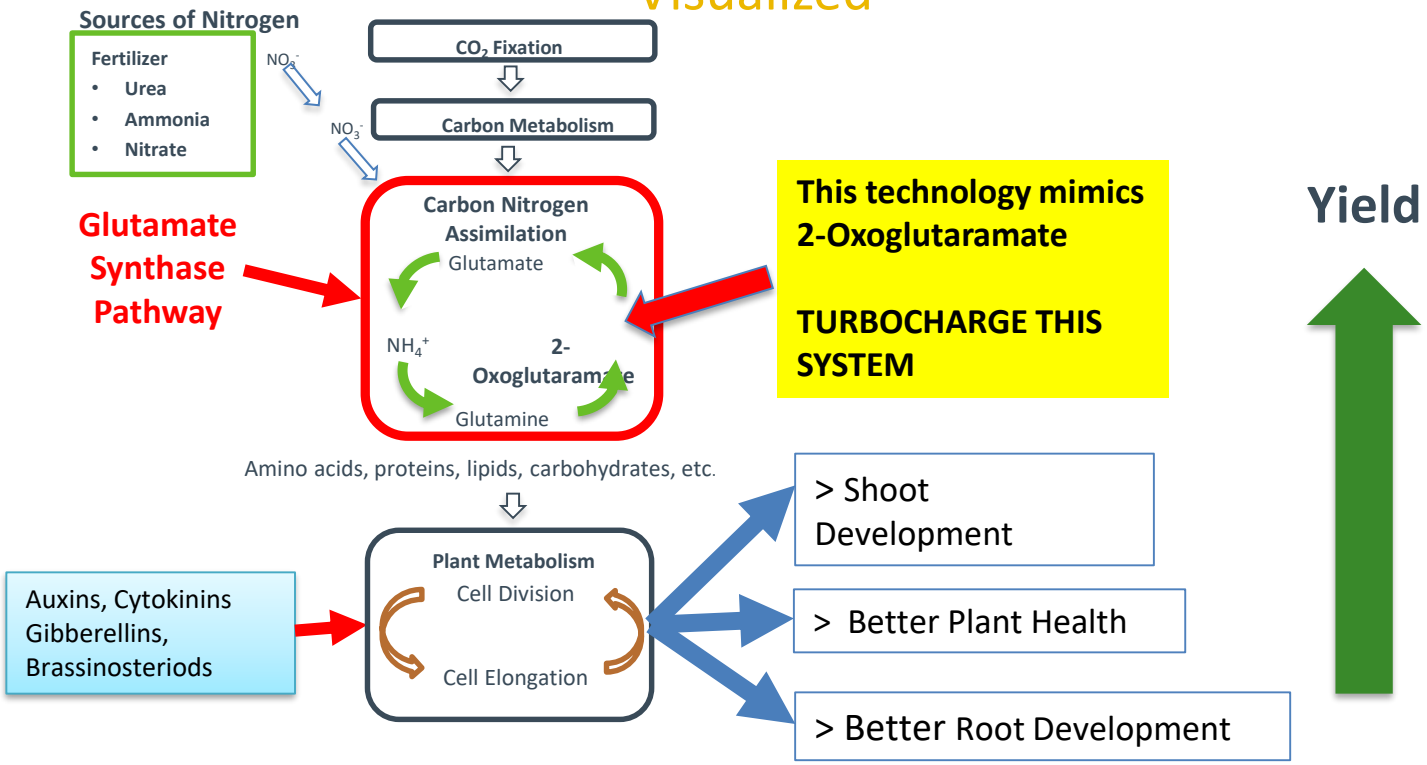
- Los Alamos National Laboratory
  - Dr. Pat J. Unkefer
  - Dr. Thomas J. Knight
- Works from INSIDE the plant
- Optimizes uptake of nutrients
- Increases utilization of Nitrogen and Carbon
- Peer reviewed scientific discovery
- Patented technology



BETTER TECHNOLOGY

Liquid Fertilizer

Mode of Action Visualized



Plants Must Optimize N Use - Their Limiting Resource

Sense it. Quantify it. Scale Metabolism and Growth Accordingly.

2. GS, the First Common Step

3. Sensing uses Uniqueness - Unusual structures

GPT

Glutamate → Glutamine (GS)

2-Oxoglutaramate

1. Multiple N Sources

NH_3

Fertilizer

NO_3

Fertilizer

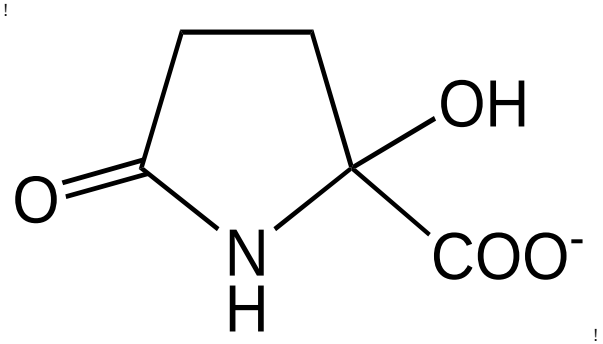
Soil

N_2 Fixation

N_2

4. Pool Size must Reflect N Assimilation

Signal Metabolite: 2-Oxoglutaramate

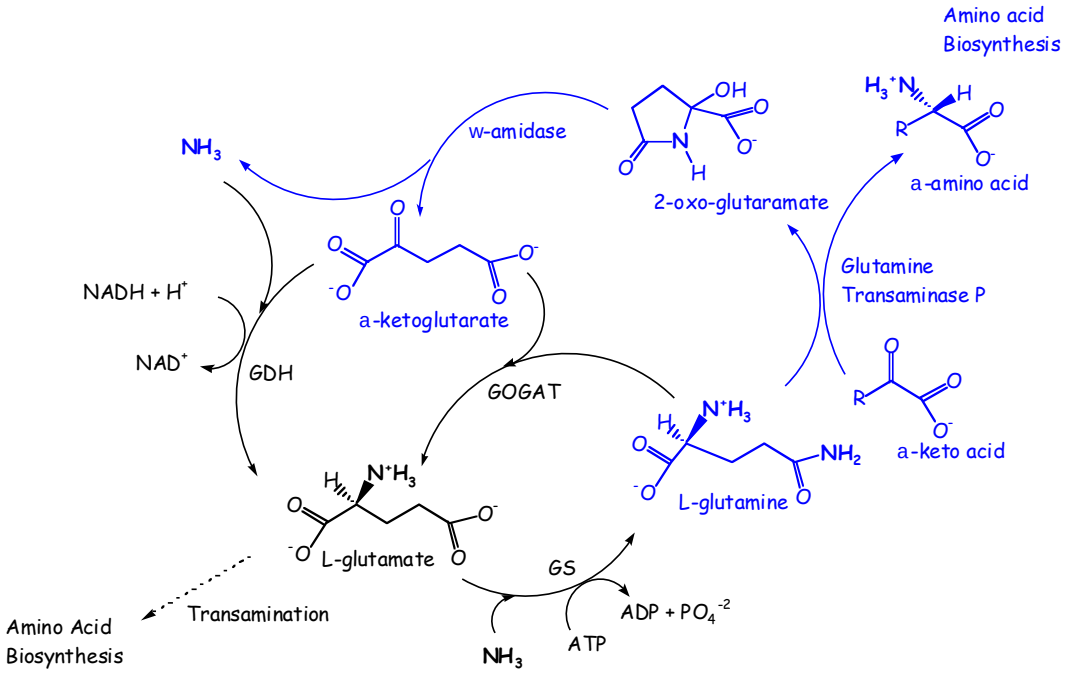


2-Oxoglutaramate

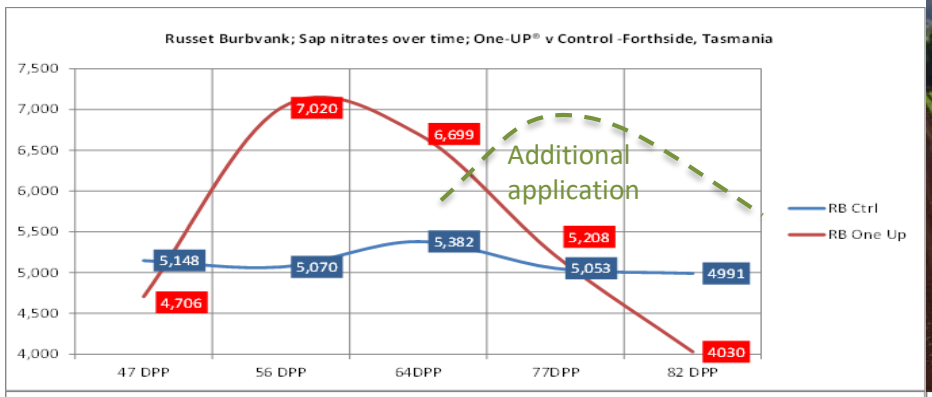
Unique to ω-amidase pathway

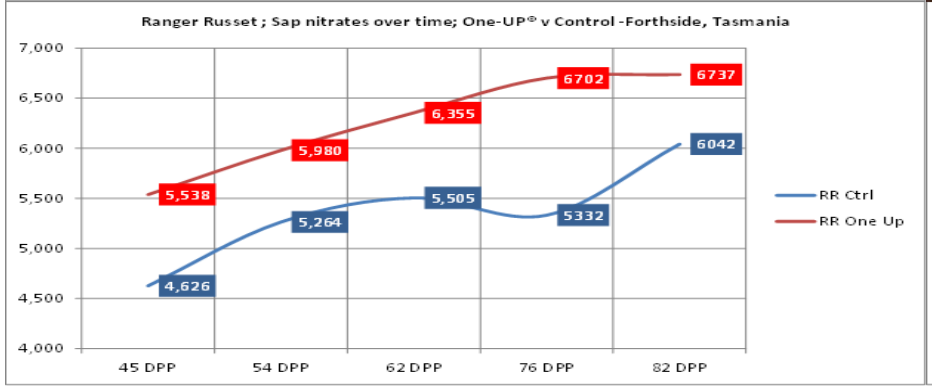
Unusual structure
Not
- Amino acid, or
- Sugar or
- Nucleic acid or
- Hormone, analog of known structure

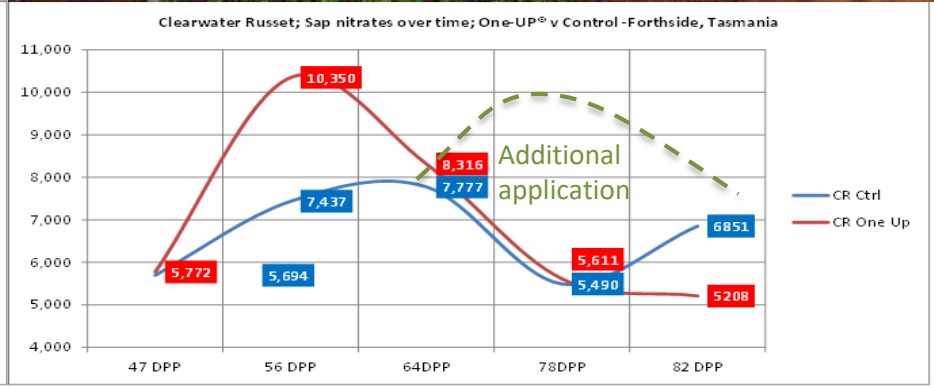
N Assimilation, 2-Oxoglutaramate & ω-Amidase Pathway - Not previously known in plant N metabolism



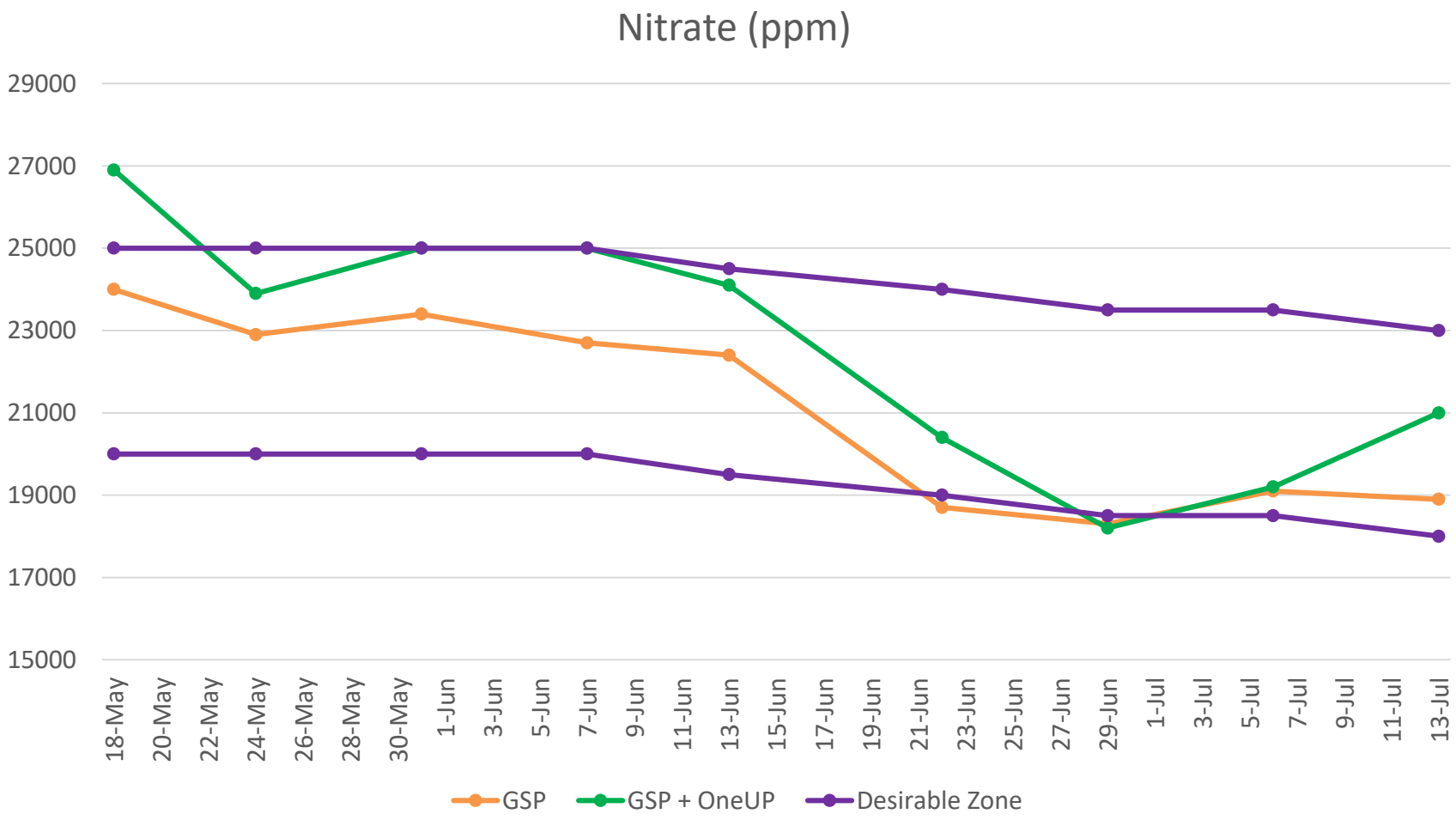
OneUP – Potatoes - Tasmania



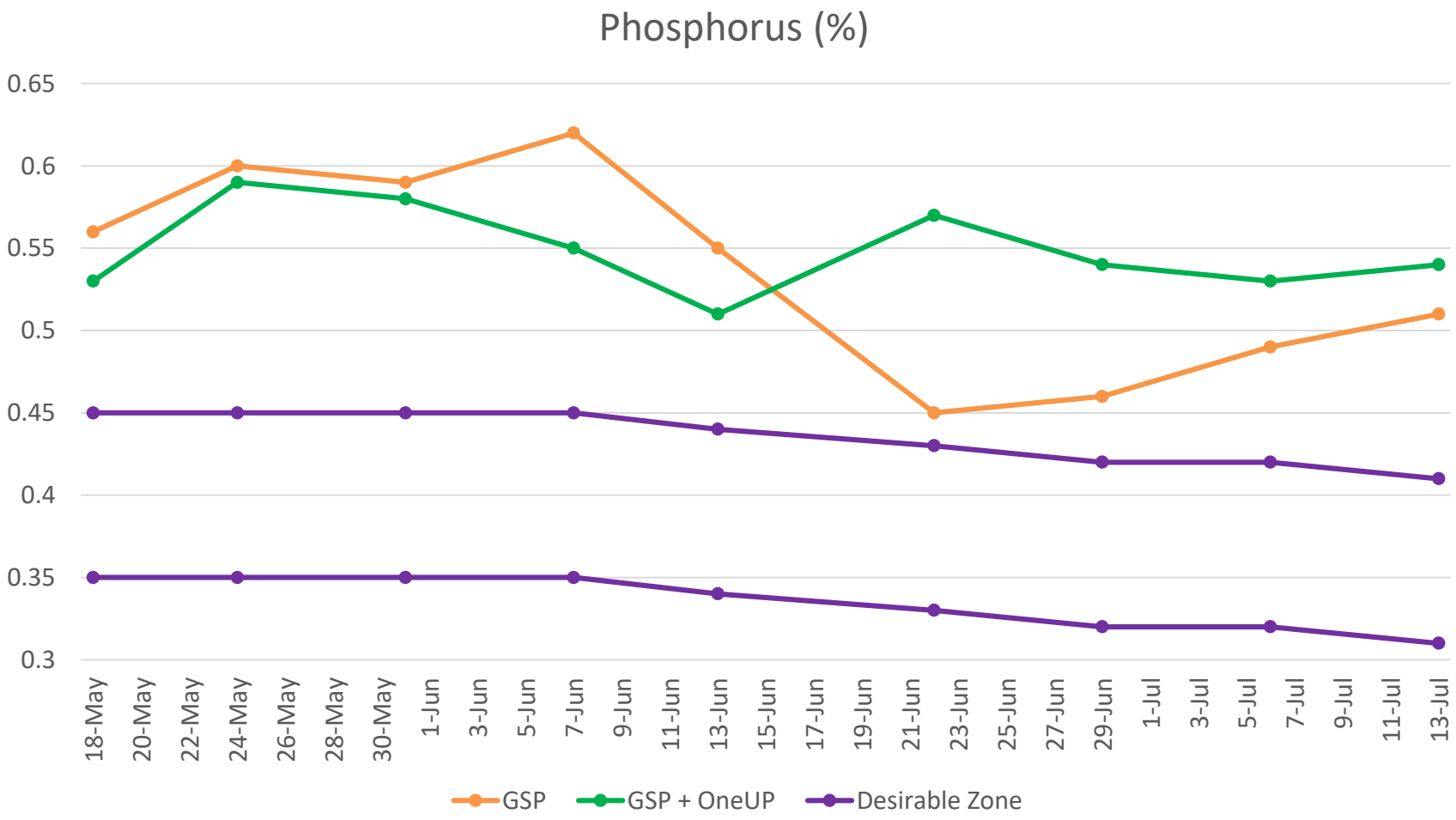




Nitrate – N—Potato Petiole Grandview ID Ranger Potatoes—JRS L and L Farms--2018



Phosphorus – Potato Petiole Grandview ID—JRS L and L Farms--2018



BETTER NUTRIENTS

OneUP ™ Liquid Fertilizer 4-14-5 +Zn and Cu

Soluble, low salt, nutrients

- Ability to use near the seed in early season, in-furrow applications
- Both soil and foliar applications for added versatility
- Compatible with many fertilizers and crop protection products
- Ortho and Poly Phosphates improves compatibility and phosphate uptake
- Potassium to support vital plant processes
- Can be injected through drip and pivot irrigation systems
- Applied with high pressure commercial applicators.

Using Adsorption Isotherms to Determine Plant Available Phosphorus of Enhanced Efficiency Fertilizers Biostimulant on an Acidic and Basic Soils

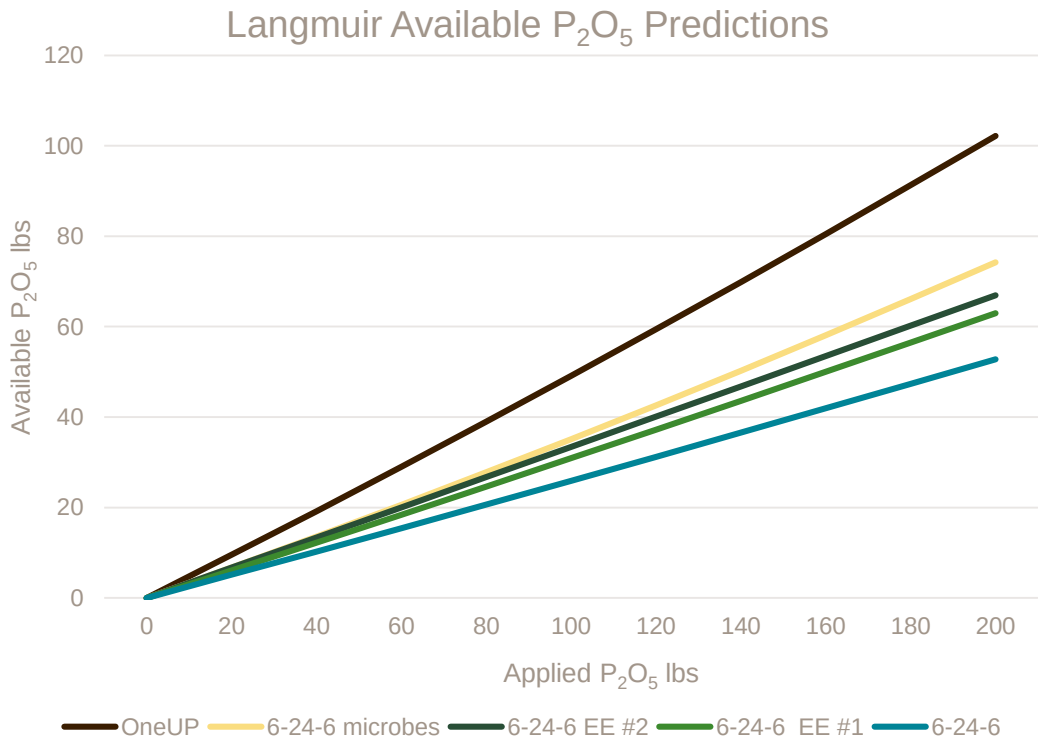
By:

Brigham Young University of Idaho—Jared Williams--2018

Predicted Phosphate Availability – BYI-Idaho

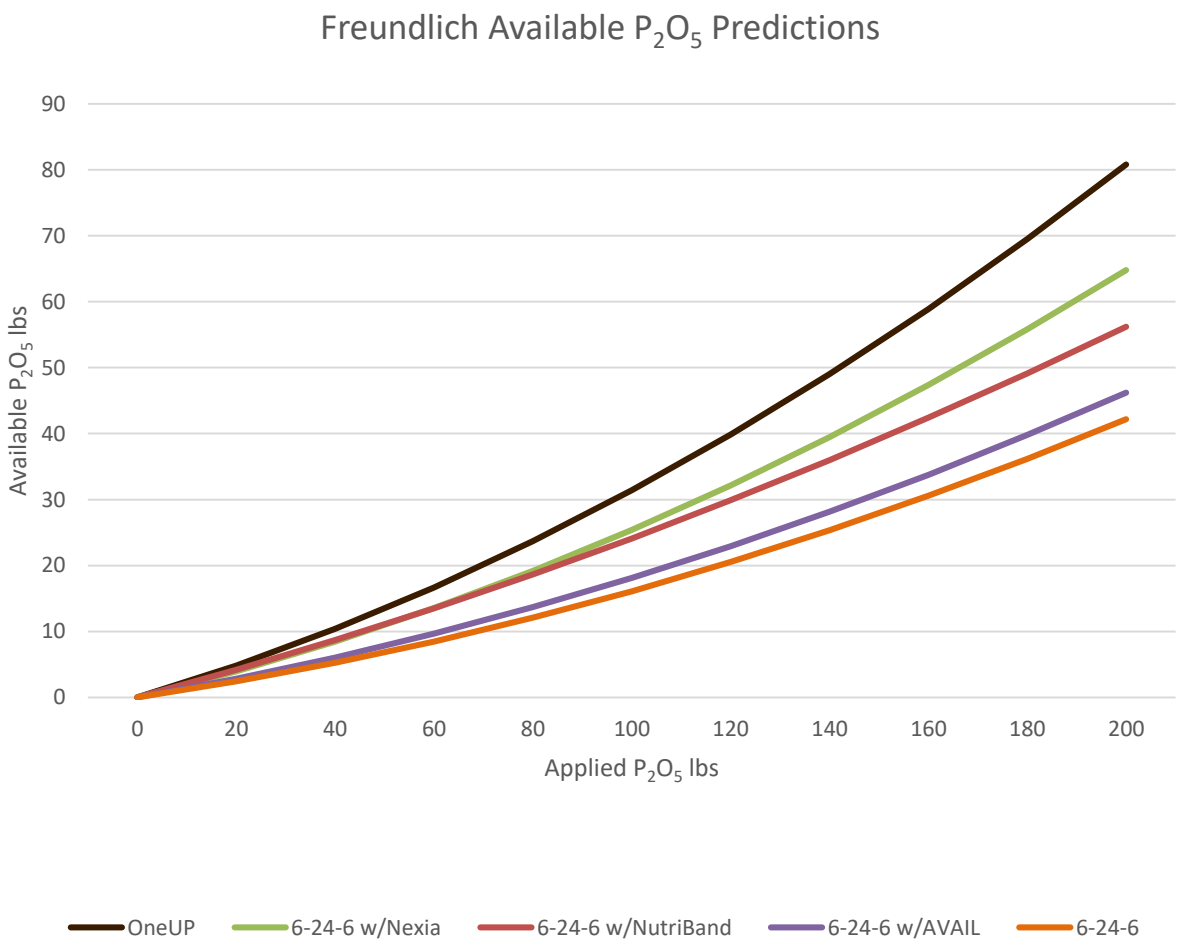
Phosphate isotherm studies indicate Biostimulants can provide nearly twice as much available phosphate as an unprotected phosphate source.

Differences can be observed between technologies evaluated.

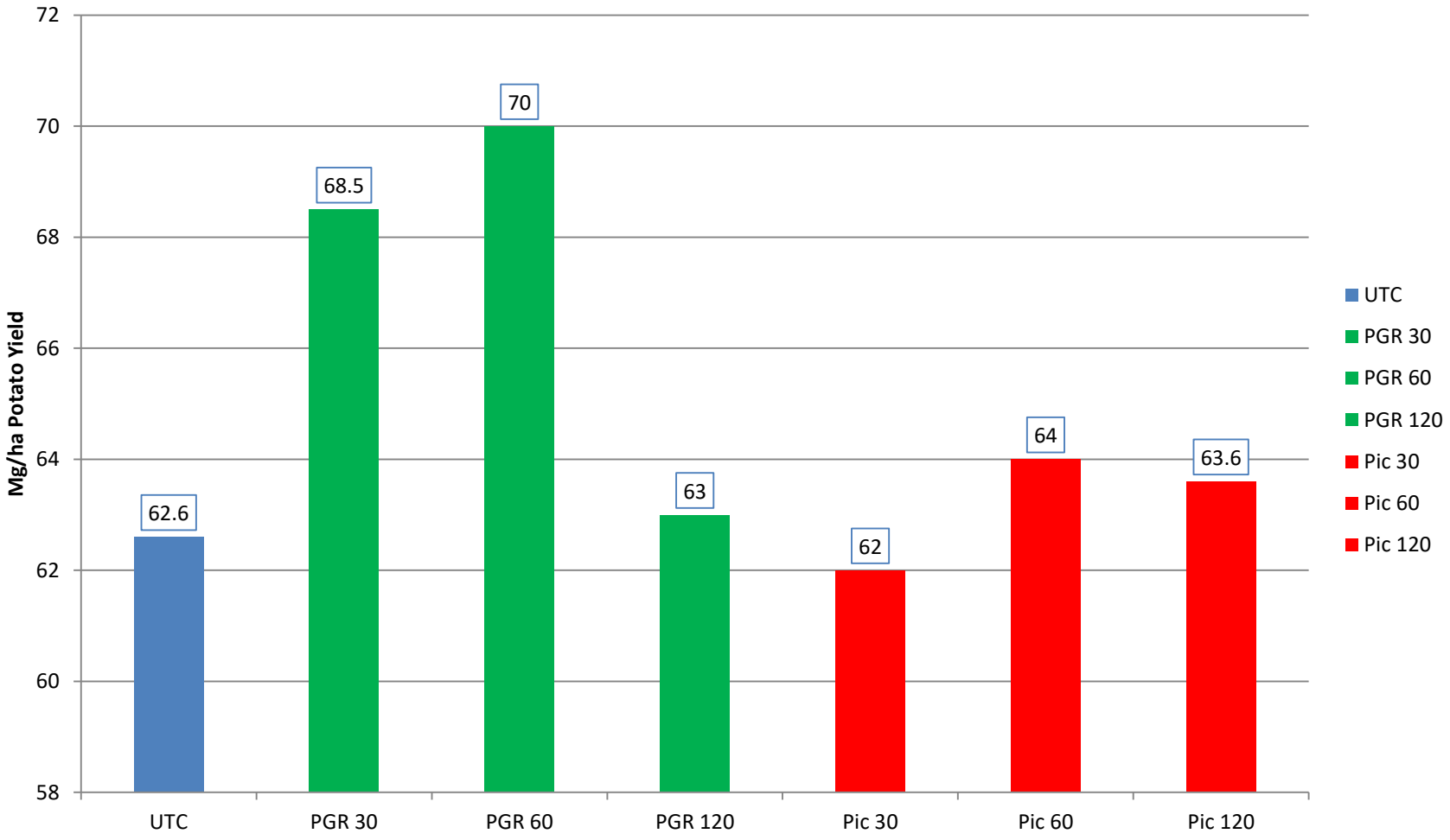


2018 – Williams – BYU-I

Predicted Phosphate Availability – BYI-Idaho



Biostimulant Impacts on Potatoes—2017 Idaho—Variety Dependent!



BYUI--2017

Why are some biostimulants recommended over another?

Simplot

Biostimulants in Production Agriculture

- Reputable brand/company
- Trust
- Loyalty
- Repetition and research to back up data

What does it take to move a biostimulant into an area where they have not been used before?

Simplot

Biostimulants in Production Agriculture

- Education
- Direct help with applications and collecting/interpreting data
- Research to backup applications
- Follow up
- Offering field trials
- Evaluation about benefits of the product in that area

On the business side and in your current position, what does it take to move biostimulants forward with your trusted grower?

Simplot

Biostimulants in Production Agriculture

- Providing/interpreting data
- Economics
- Grower field trials
- Consistent agronomic response
- Trusted Research in local area combined with field demonstrations
  - Same principles that the USDA Extension Service (Morrill Act) based on.

How important are the following: Agronomy responses, profitability to the patent holders, profitability to CCA as well as distribution network?

Simplot

Biostimulants in Production Agriculture

- Agronomy response #1
  - Needs to be of benefit to grower in order to implement.
  - Reputable Trusted – Independent 3rd Party
- Profitability to CCA #2
  - Almost as important as profitability to grower
    - The material has to be worth his extra time and effort needs to be rewarded

Biostimulants in Production Agriculture

- How Important…

- #3—Profitability to patent holder
  - Needs to be of benefit to grower in order to implement.
  - Reputable Trusted –Independent 3rd Party

- #4—Profitability to distribution Channel
  - Selling direct, selling through channels
    - Like distribution chains
    - Each touch within the market chain—needs to bring **VALUE**
    - Warehousing, transportation, agronomics, education—all important to CCA trying to market the biostimulants to trusted customers.

OneUP in Cotton

Dryland Cotton – Stiles Farm – Texas A&M

Treatment	Lint lbs/ac	Loan Value cents/lb	Lint Value Dollars/ac	$ Increase/ac	B:C Ratio
GSP	361.8	53.39	$193.50		
+ 2 OneUP	461.0	53.79	$247.80	$54.30	5:1
+ 3 OneUP	401.0	53.85	$216.50	$23.00	1.3:1

Irrigated Cotton – Snook Farm – Texas A&M

Treatment	Lint lbs/ac	Loan Value cents/lb	Lint Value Dollars/ac	$ Increase/ac	B:C Ratio
GSP	812.3	52.98	$431.00		
+ 2 OneUP	887.3	54.36	$482.30	$51.30	5:1
+ 3 OneUP	758.0	52.59	$399.80	-$31.20	-2:1

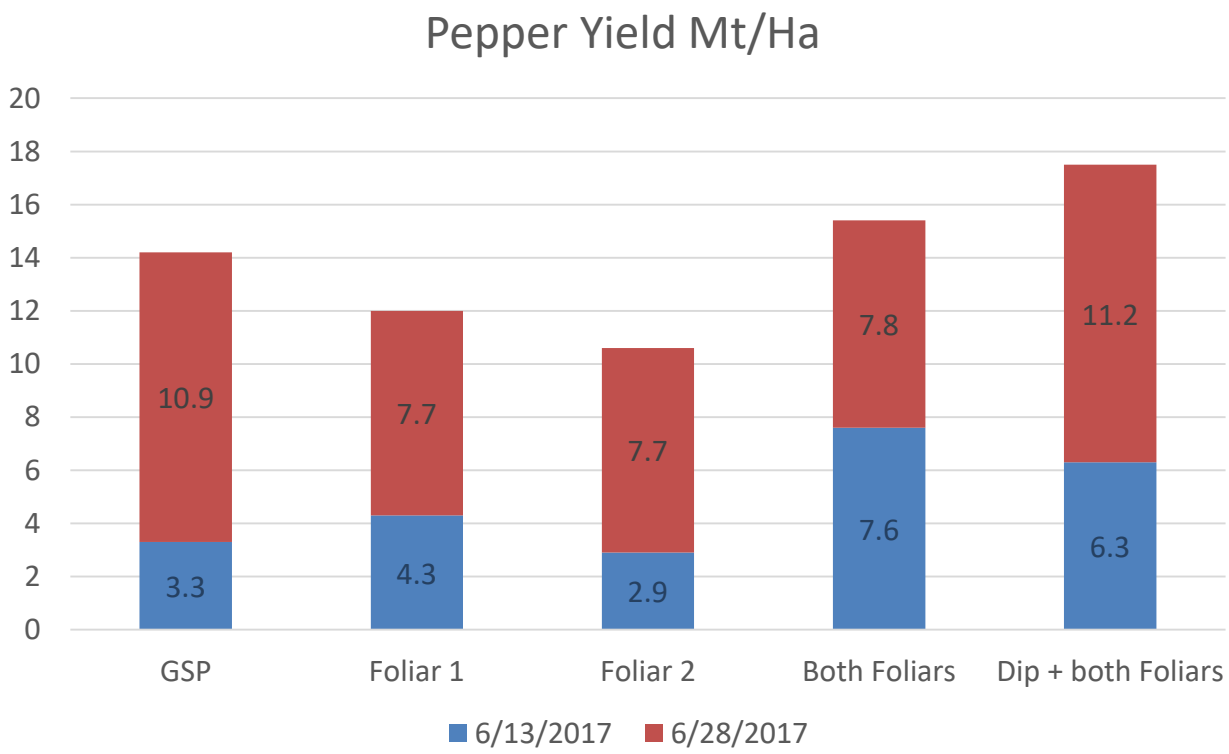
1st application of OneUp was 1 qt/acre made at herbicide application

2nd application of OneUp was 2 qts/acre 20 days after the first application

3rd application of OneUp was 2 qts/acre 20 days after the 2nd application

B:C ratio is based on OneUP @ $14.00/gallon

OneUP in Chile Peppers



- Foliar 1
  1qt/acre of OneUP 2 weeks after transplant
- Foliar 2
  1qt/acre of OneUP at first bloom
- Transplant Dip
  1 qt of OneUP in 26.75 gallons of water.

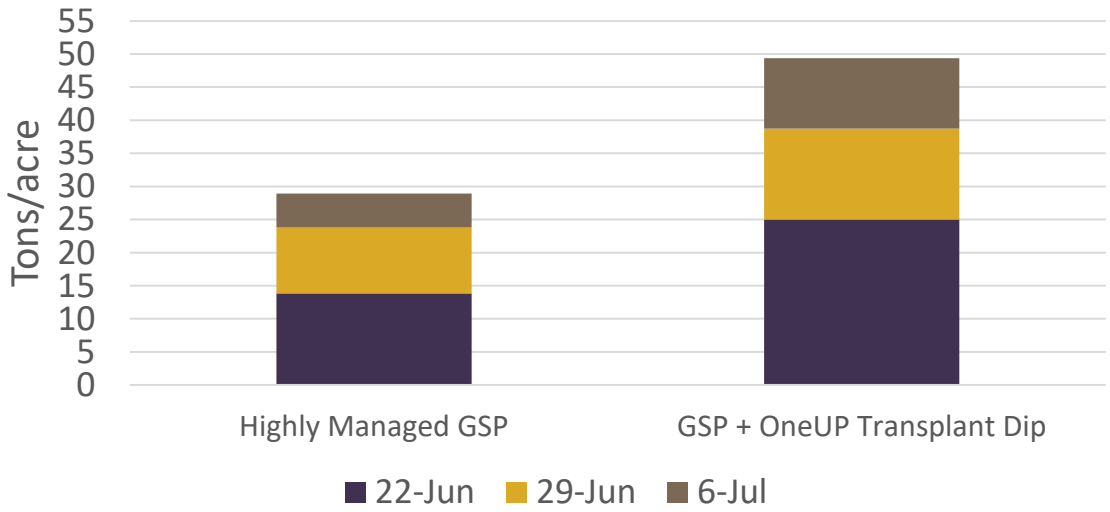
1st Harvest 6/13/17
2nd Harvest 6/28/17

Sanchez – University of Arizona

In multiple harvest crops the OneUP treatment provided the largest yield increase on the earlier harvests. 1 qt of OneUP in 26.75 gallons of water.

A BETTER NUTRIENT FORMULATION

- More Yield
- Earlier harvest
- Transplant Dip
  1 qt of OneUP in 26.75 gallons of water.



2018 – Sanchez – University of Arizona

What surprises you about the advancements of biostimulants over the past 5 to 10 years?

Simplot

Biostimulants in Production Agriculture

- The large amount and diversity of biostimulant products that are on the market
- Large Multi-National Companies are entering the market—Koch, Yara, Simplot, Kingenta, Nutrien--etc
  - This allows greater economics and investments into new technologies
- Surprising that biostimulants aren't widely recommended
  - Maybe due to lack of marketing and position, research etc.
- Greater Legitimacy into this space

Biostimulants into Developing Countries—what does it take to move these materials forward?

Biostimulants Take Home--Tindall

- Agronomically Responsive
- Local Data is Important and a pre-requisite at the beginning—
- Money needs to be made across business model
- Simple to use and fits into existing program (applied in combination with crop protectant.
- Use 3rd party independent researcher as well as demonstrations
- Education—start early and continue—Repeat –Repeat—Repeat
- Researcher—do not be “thinned skin”!!

- Move to next generation of Biostimulants where appropriate—be patient.

Biostimulant Applications in Indonesia Forestry—Eucalyptus—2017

QUESTIONS?

Terry.Tindall@Simplot.com