

Studying and Understanding Root Architecture: the 5W's How?

Fertility of the Minds

Dan McDonald, President and Co-founder,
Phenotype Screening Corporation

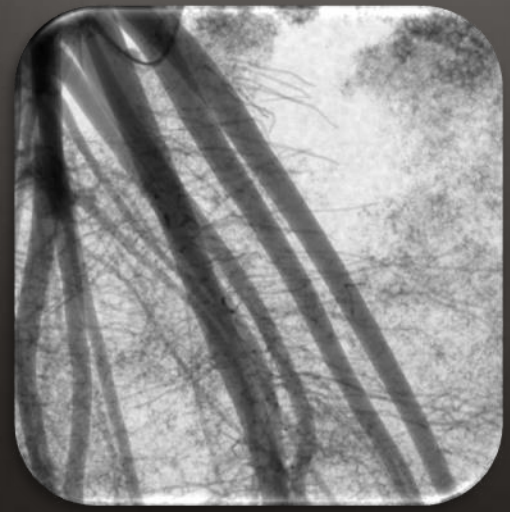
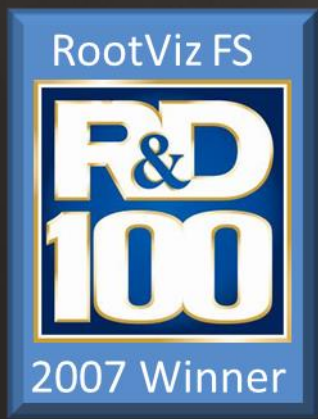
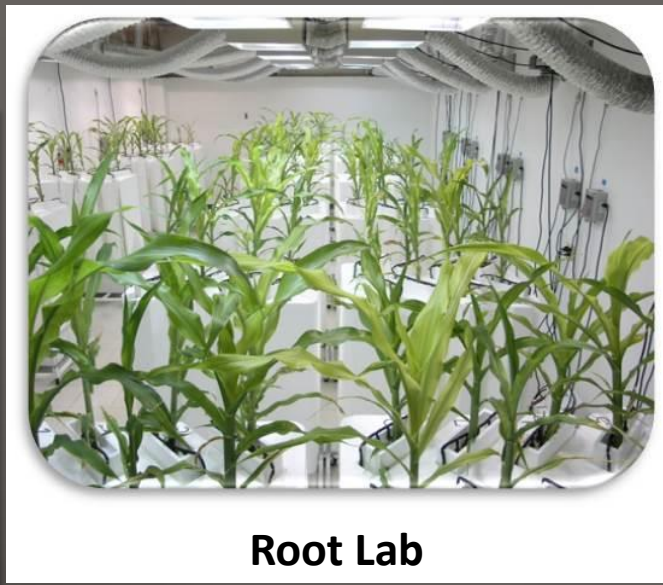
OUTLINE

- Who?
- How?
- When?
- What?
- Where?
- Why?

Who?



RootViz FS Imaging System

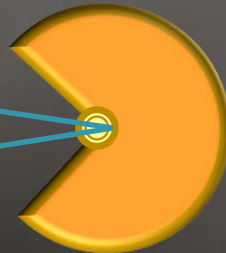


How?: Our X-ray Imaging Concept

X-ray
Camera



X-ray
Generator

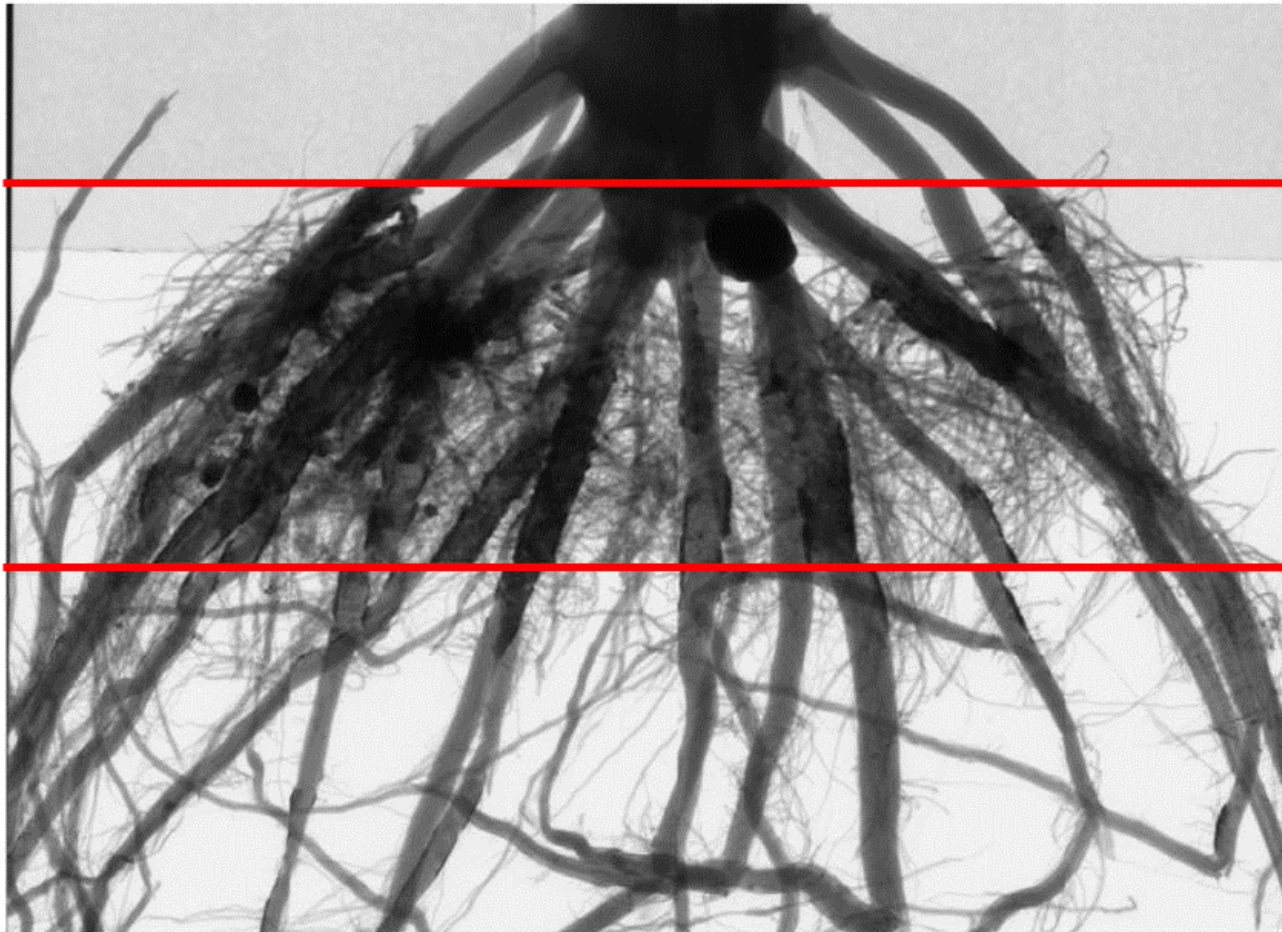


Very low
energy X-rays
(10Kev) allow
for soft-tissue
imaging.



Phenotype Screening
CORPORATION
enabling discovery

How is the Entire Root Volume Captured in a Single Image?



All roots in the measurement volume are captured in the image; even roots normally hidden by other roots.

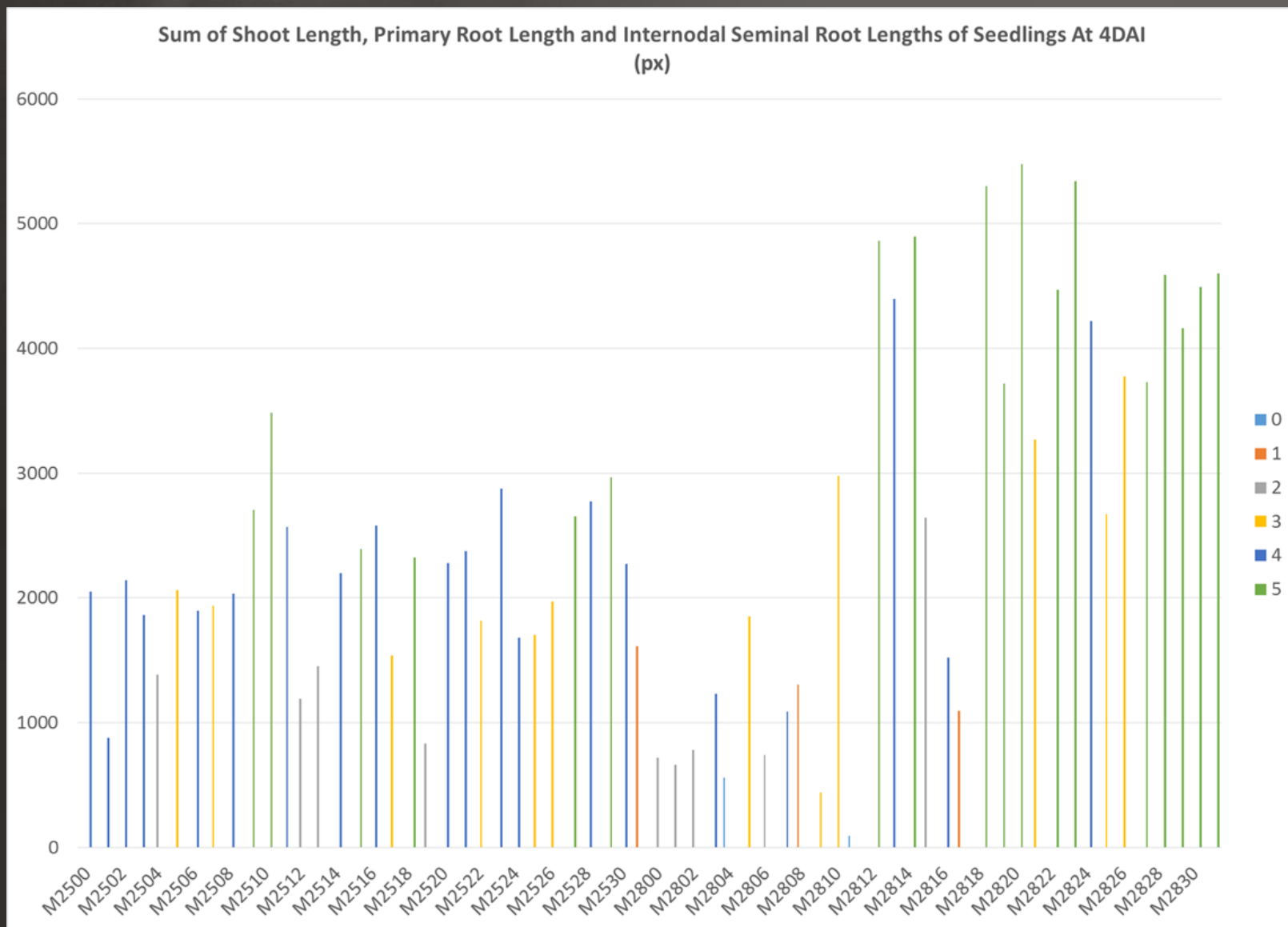


When?

- Seed (Internal Structure, Viability, Vigor)
- Germination (Water Uptake Dynamics)
- Emergence (Seedling Vigor, Phenology, Plasticity)
- Vegetative Growth (Root System Architecture)
- Reproductive Stage (RSA Foundation)
- Product Development, Processing and Handling

Let's look at some examples

Maize Seedling Phenenes and Vigor



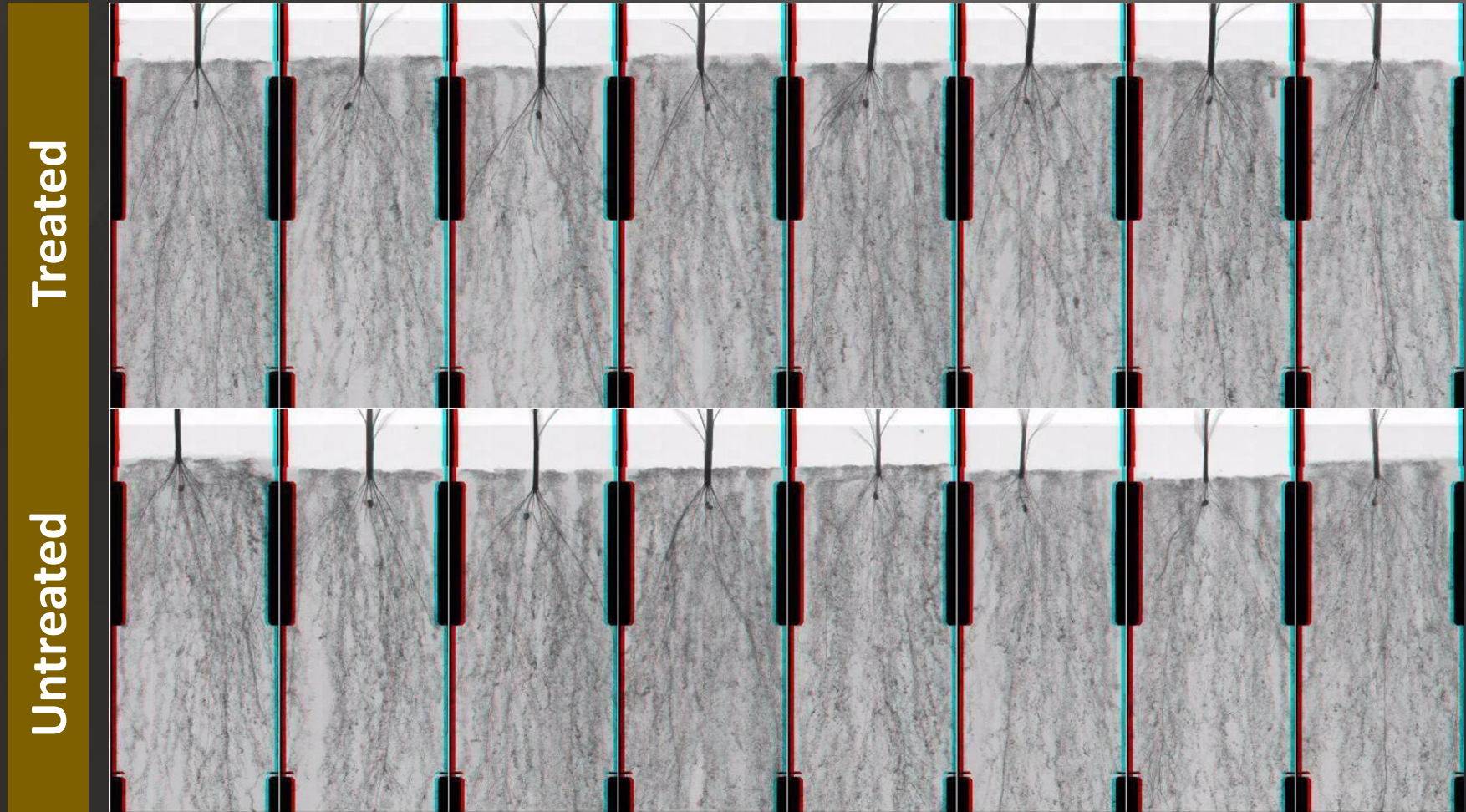
What?

- Plant Height
- Stalk Diameter
- Chlorophyll Content
- Vegetative Development Stage
- Dry Biomass
 - Shoot, Leaves
 - Fruit
 - Root
- RSA
 - Global Traits
 - Depth Traits

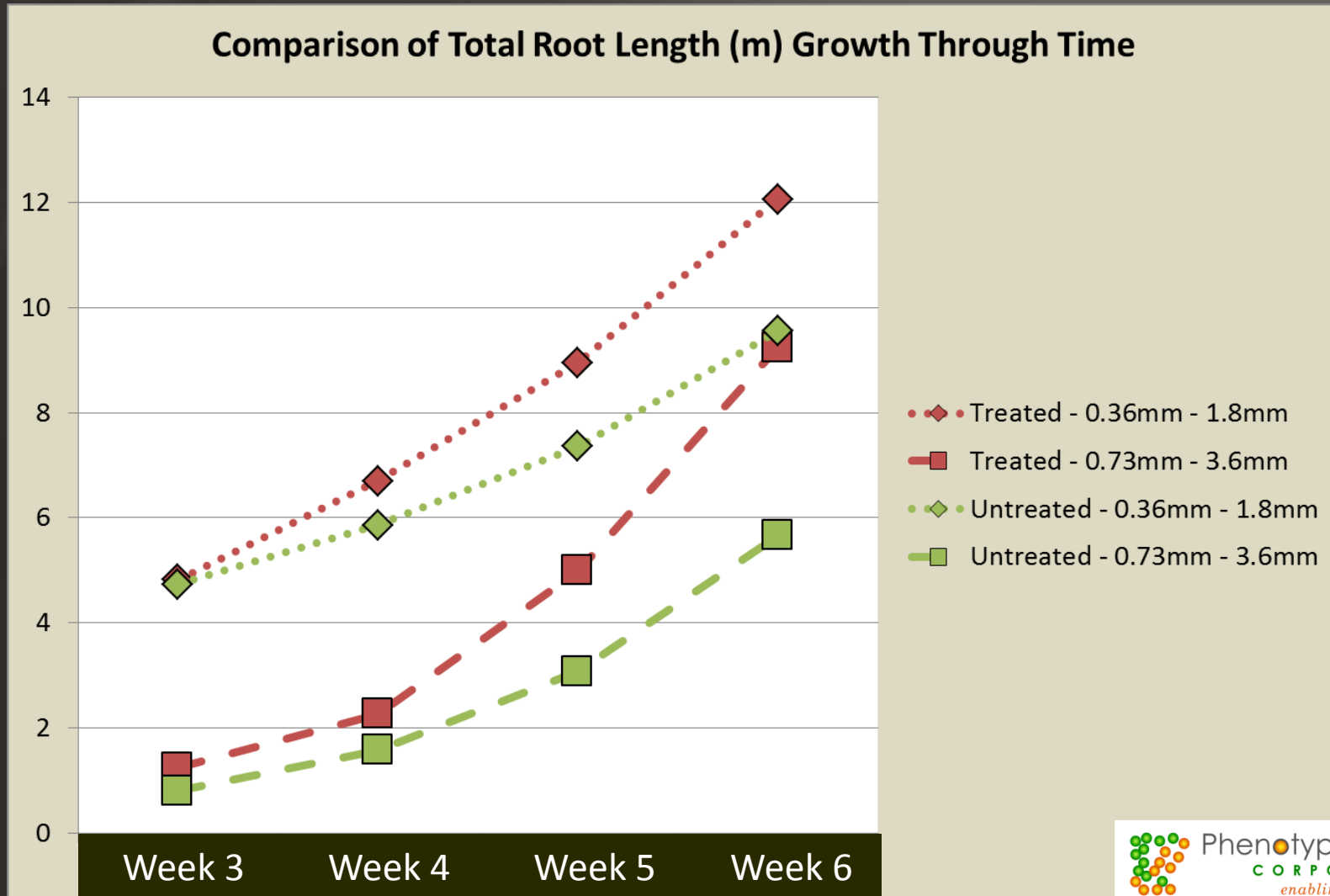
Each Root Size Class Has a Unique Shape and Distribution



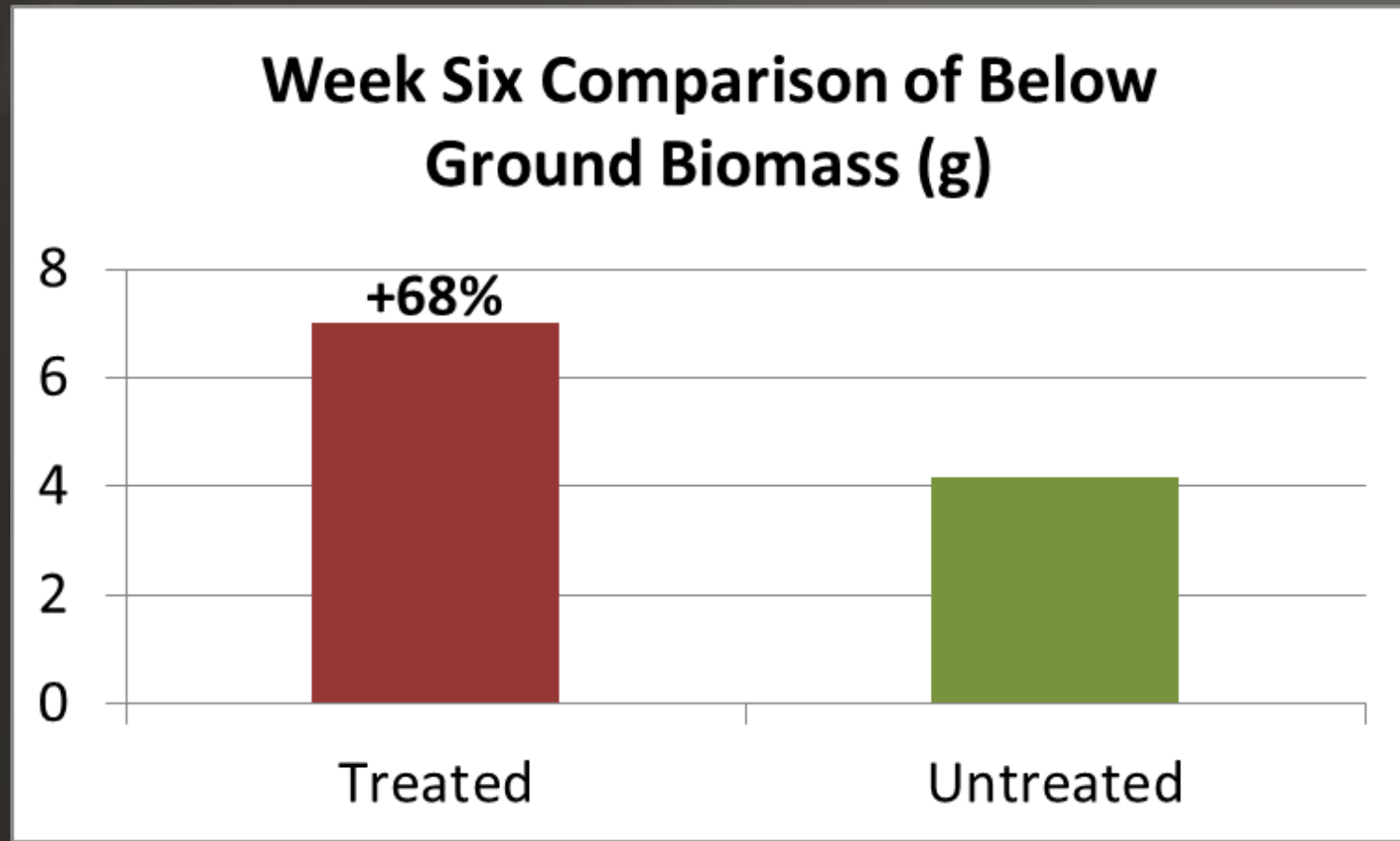
Soft-tissue X-ray Imaging Used to Compare Root Development Over Time



Quantification From X-ray Images to Study Root Development Over Time



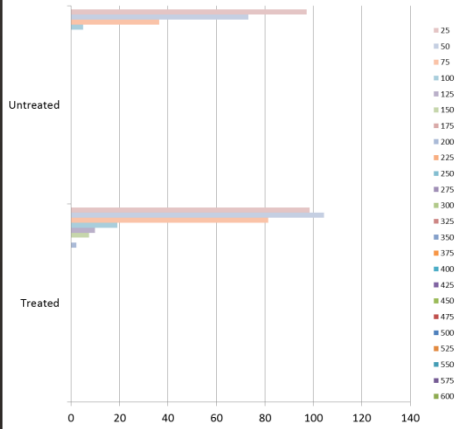
Comparison of End of Experiment Root System Dry Weight Biomass



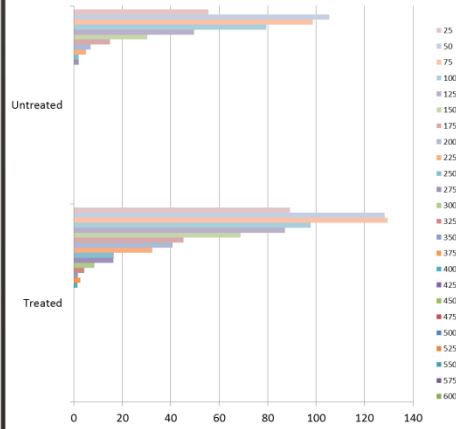
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Total Root Cross-sectional Area by Depth

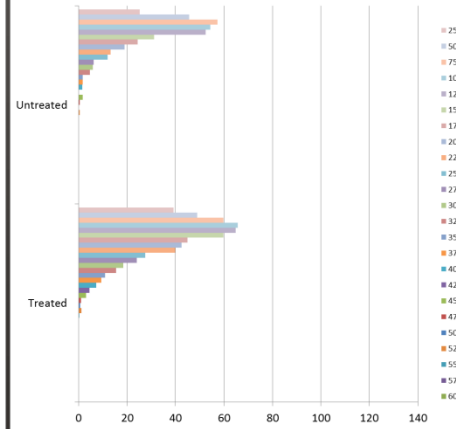
Total Root Cross-sectional Area (mm²) by Depth (mm)
Size Class 1, Week Six



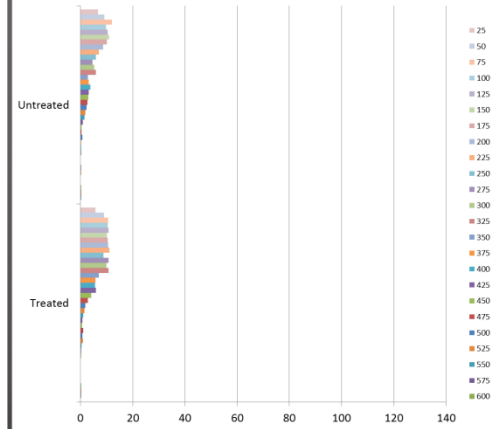
Total Root Cross-sectional Area (mm²) by Depth (mm)
Size Class 2, Week Six



Total Root Cross-sectional Area (mm²) by Depth (mm)
Size Class 3, Week Six



Total Root Cross-sectional Area (mm²) by Depth (mm)
Size Class 4, Week Six



Large Roots

Coarse Roots

Medium Roots

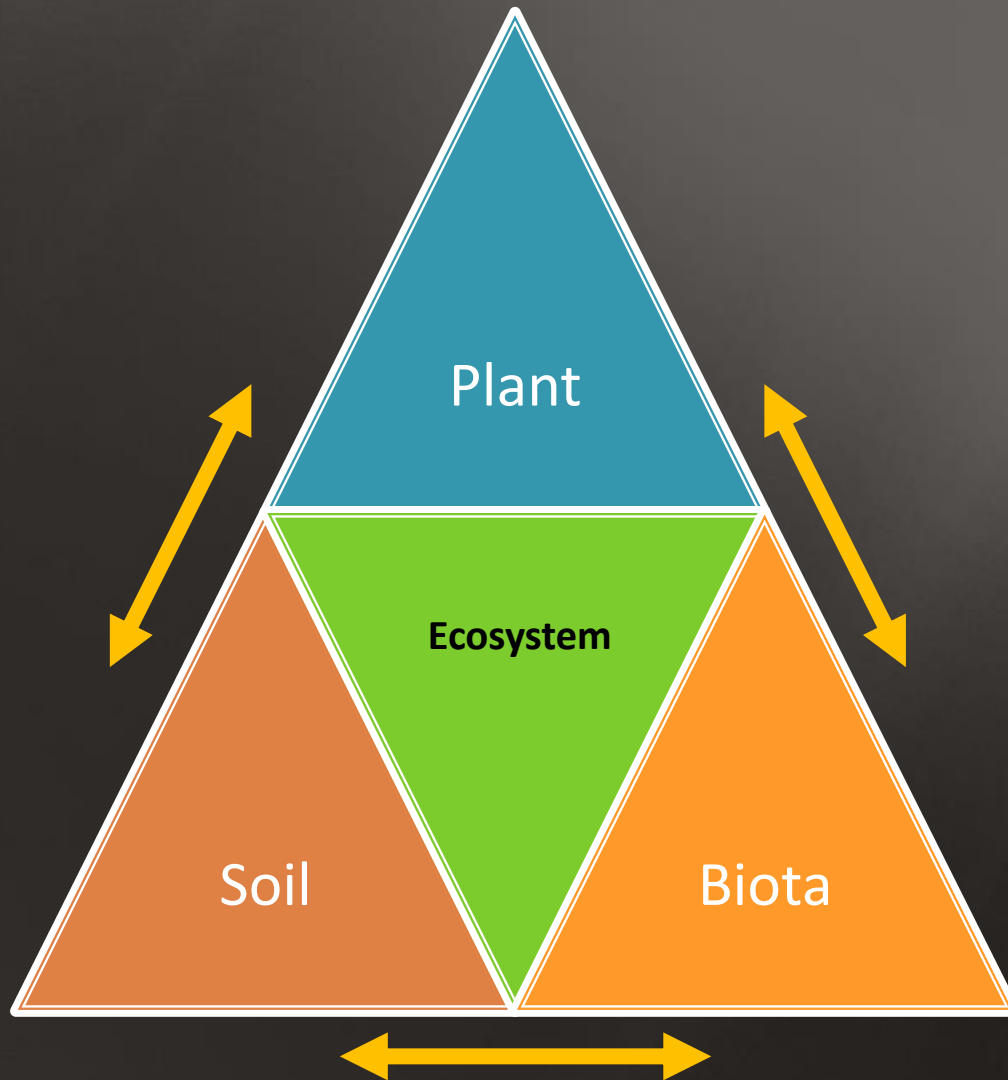
Fine Roots

Top Graphs Untreated
Bottom Graphs Treated

Where?

- Field
- Greenhouse
- Root Lab
- Germination paper, gels

Roots Operate in Dynamic Environment



Why?

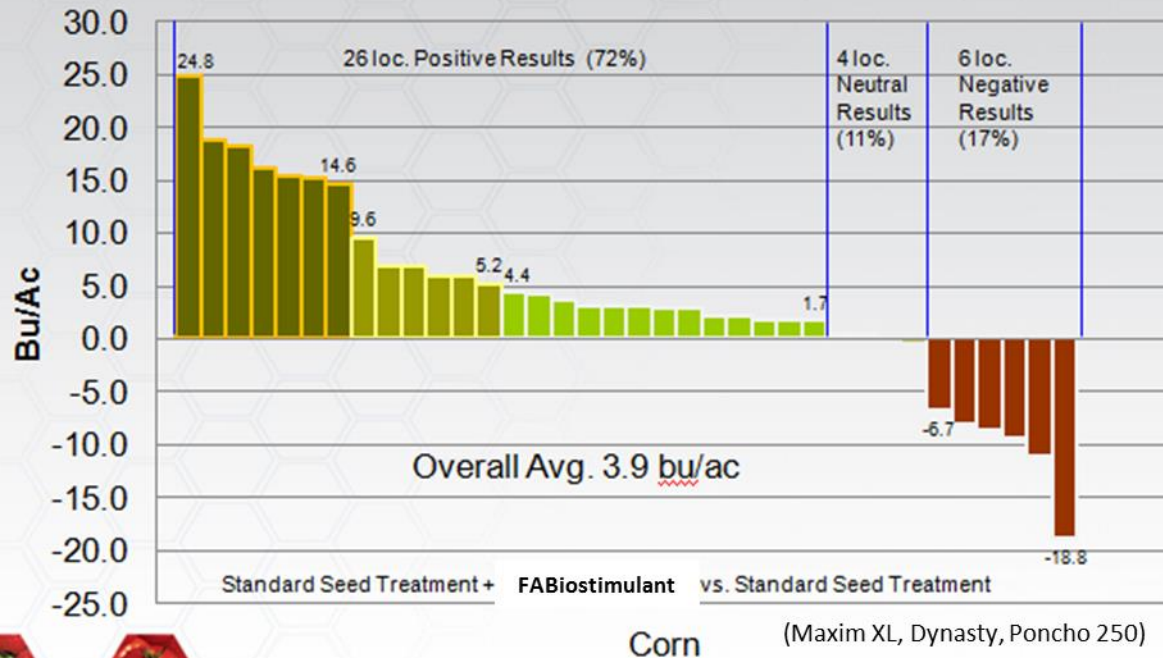
- Germplasm Improvement
- Process Improvement
- Agronomic Practice Improvement
- Treatment Enhancements

Let's look at an example

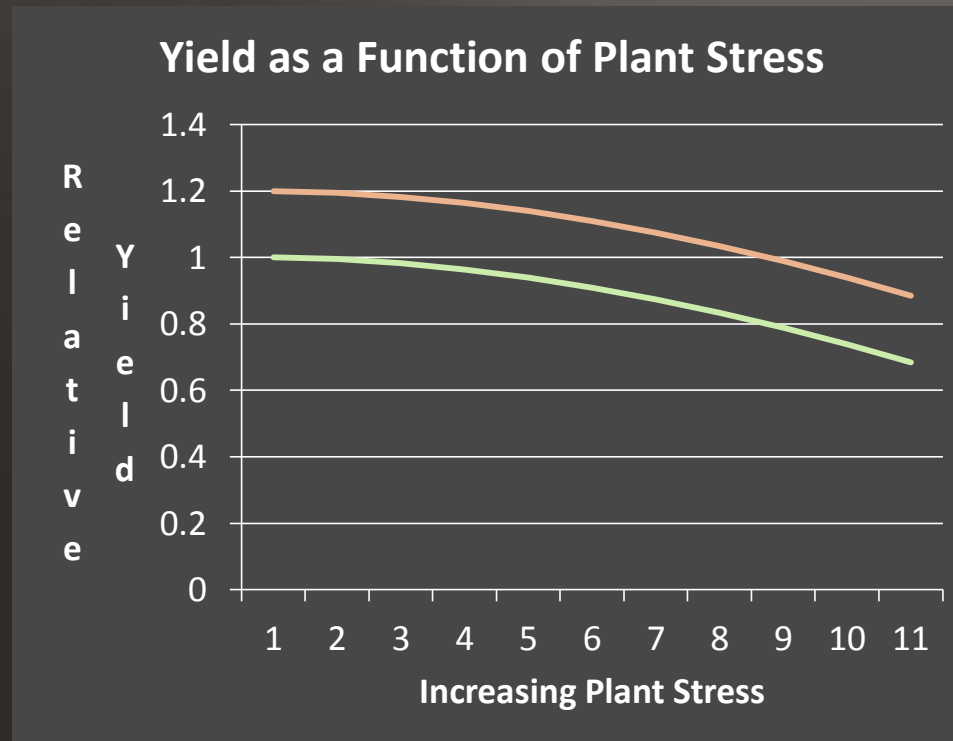
G x E x M

Why? Interpretation of Field Trial Results

Formulation A Biostimulant Seed Treatment Corn – (36 trials)



Why? An Ideal Treatment

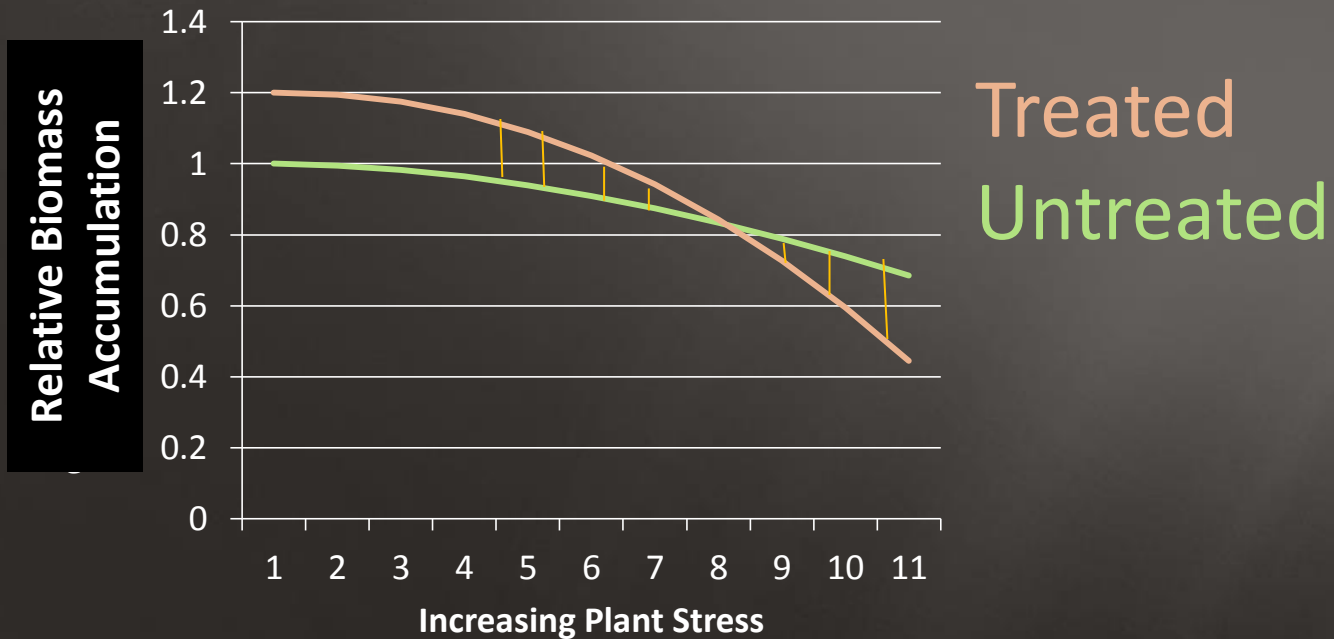


Treated
Untreated



Our Hypothesis About This Biostimulant

Biomass Development as a Function of Stress



Shape of curve will vary by formulation and:

Species

Hybrid or variety

"Technology traits"

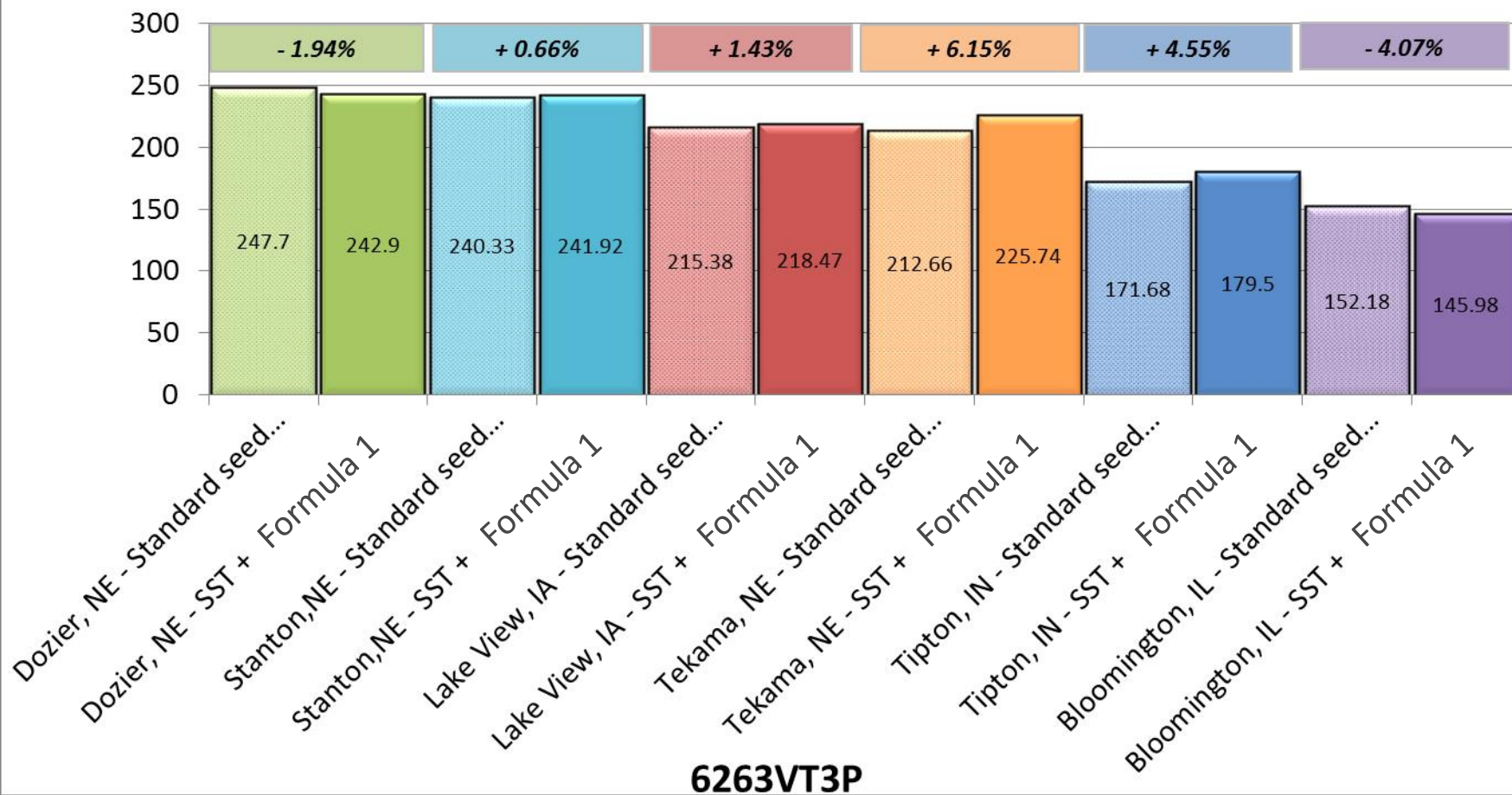
"Seed protection treatments"

Seed vigor

Type, magnitude and duration of external stress

Yield Results Ordered by Site Stress

2013 Field Sites and Yield Data Ordered by Increasing Stress



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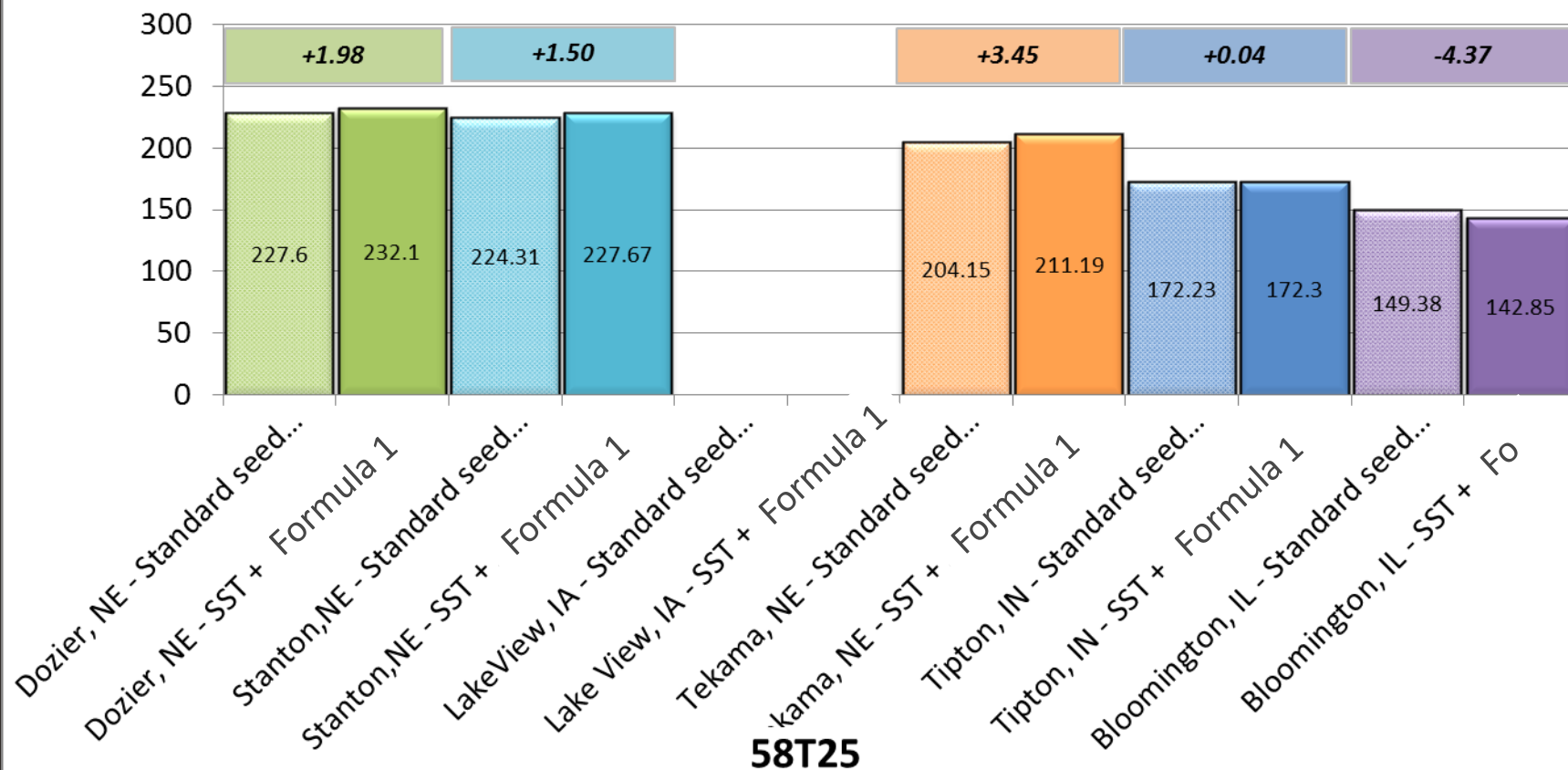
Low

Increasing Site Stress

High

Yield Results Ordered by Site Stress

2013 Field Sites and Yield Data Ordered by Increasing Stress



58T25

Low

Increasing Site Stress

High



2012 Drought Stress Across States

Least Stress

>>>>

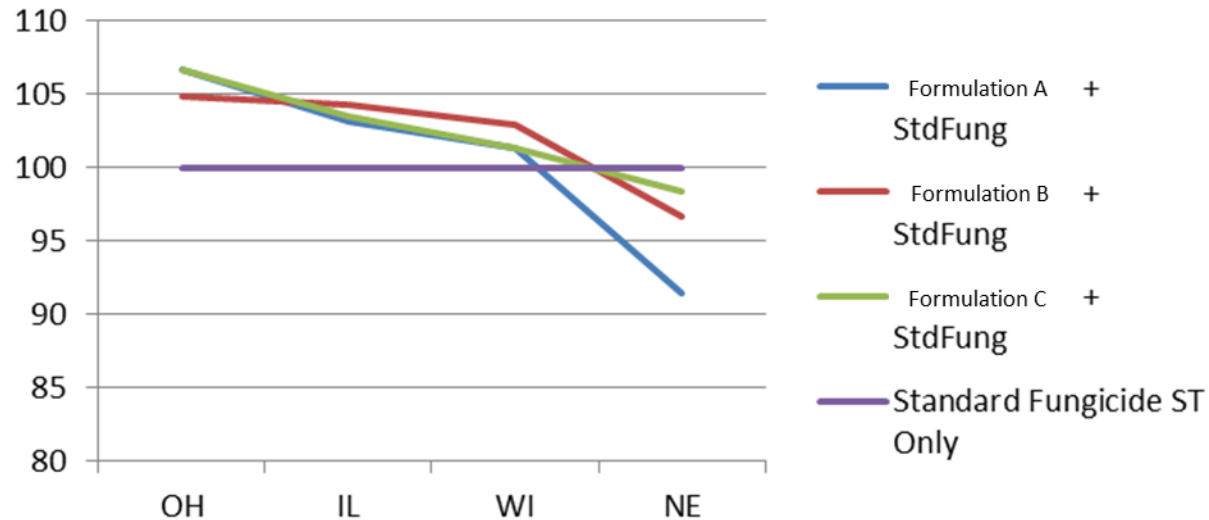
Most Stress

OH

IL,
WI

NE

Yields for Formulations Normalized To Untreated



In Conclusion:

- Root system architecture is best understood in terms of both space and time.
- The RSA represents a cost / benefit ratio to the plant.
- The root system represents the most genetic plasticity of all the plant organs. (Opportunistic)
- Plants “react” via internal chemical communication. They are naïve communicators.

E x G x M



THANK YOU!