Measuring Roots With Soft Tissue X-ray Imaging

Dan McDonald
President and Co-founder
Phenotype Screening Corporation

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OUTLINE

- What is soft-tissue X-ray imaging?
- How is soft-tissue X-ray imaging used to image roots?
- How are root traits quantified from X-ray images?
- How is soft-tissue X-ray imaging of roots being used to answer important issues in yield improvement and sustainability?
- Can soft-tissue X-ray imaging results be used in crop optimization modeling and decision tools?

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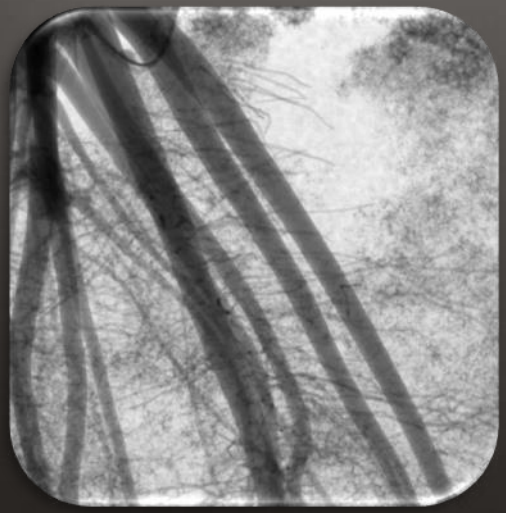
RootViz FS Imaging System

Root Lab



RootViz FS
R&D 100
2007 Winner

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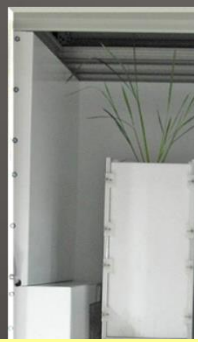
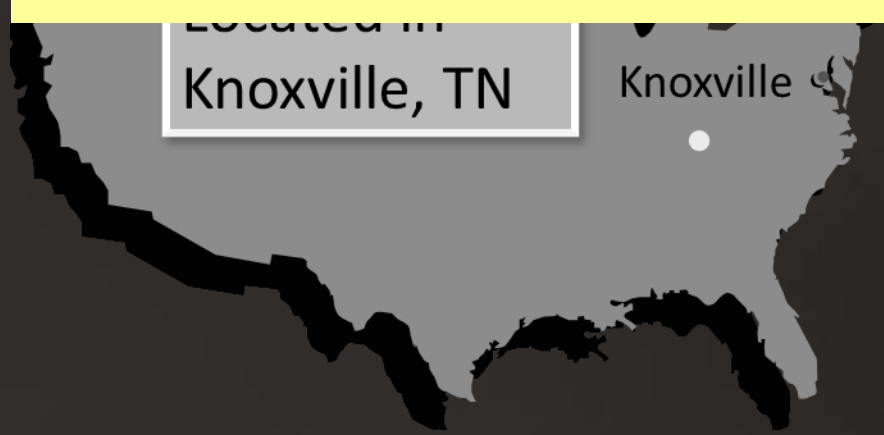
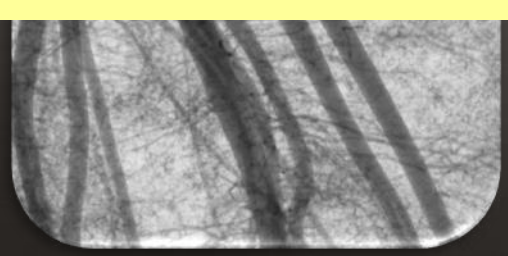


We focus on problems whose solutions are worth tens to hundreds of millions of dollars.





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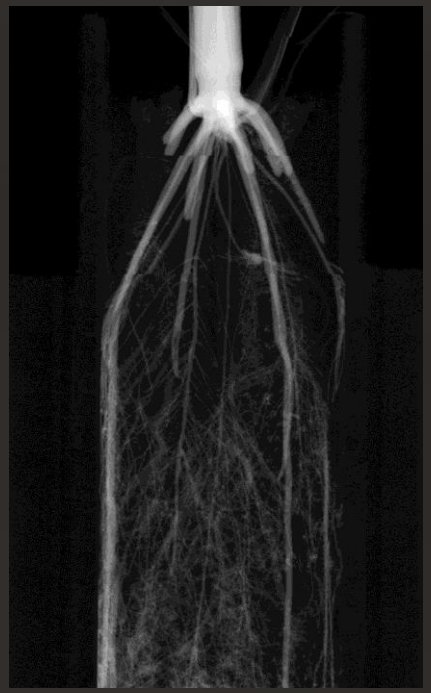
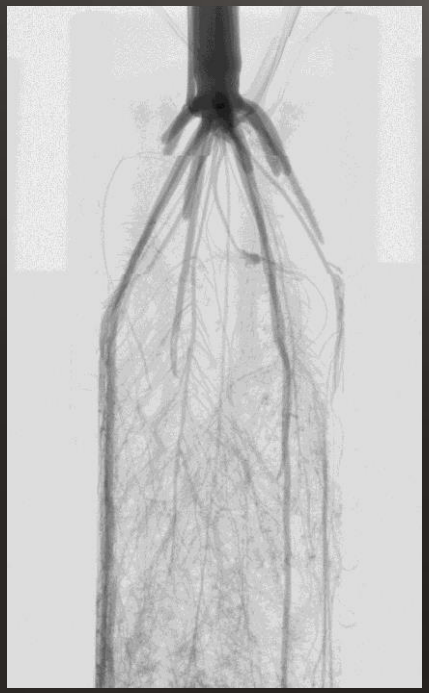
What is Soft-tissue X-ray Imaging?

Medical X-ray Imaging



Soft-tissue X-ray Imaging



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Field Harvested Roots Can Be Complicated to Analyze

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Our Basic X-ray Imaging Concept

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

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How is Soft-tissue X-ray Imaging of Root Systems Accomplished?

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How is Soft-tissue X-ray Imaging Accomplished?

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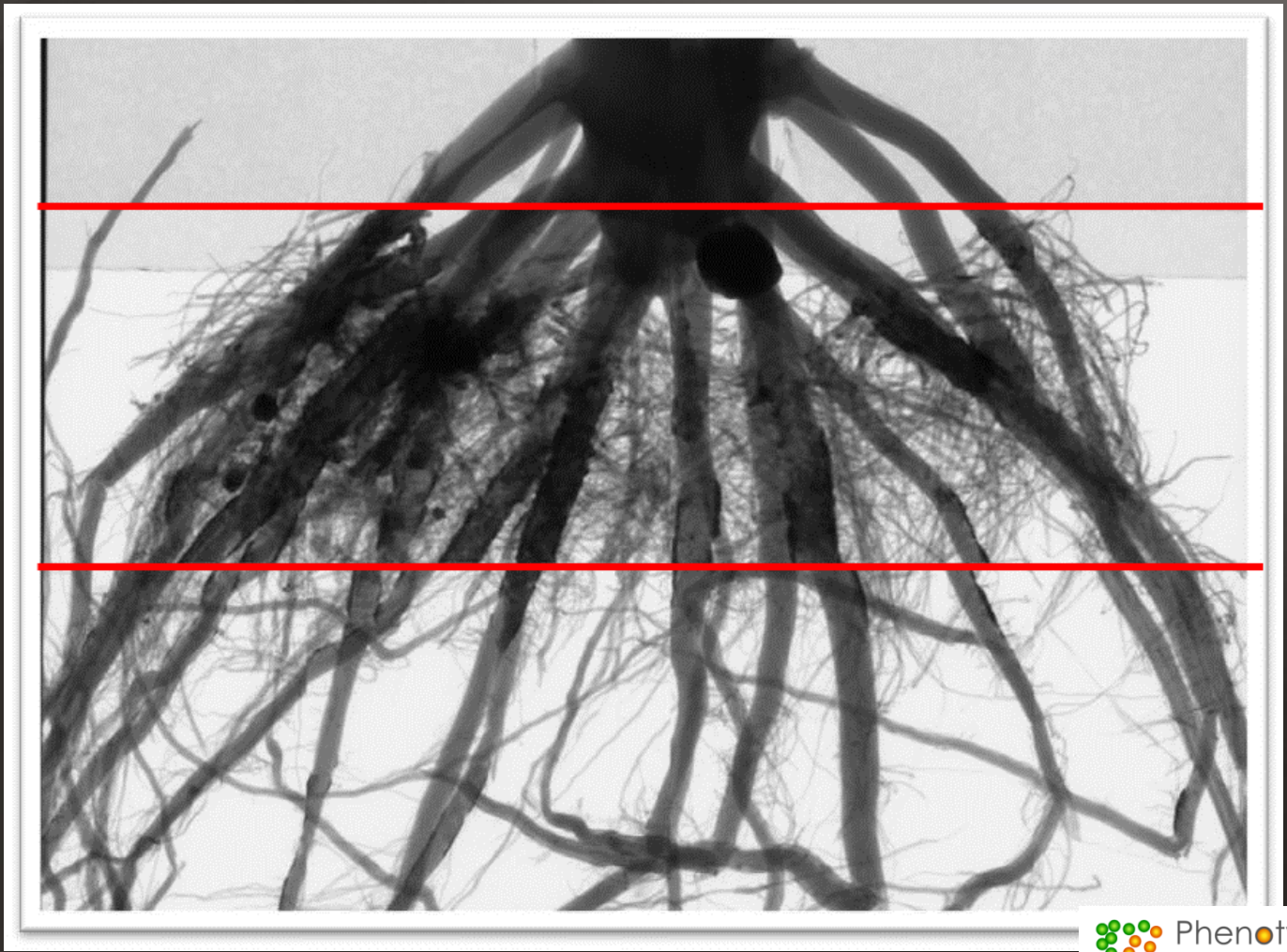
Why Use Soft-tissue X-ray Imaging to Study Plant Roots?



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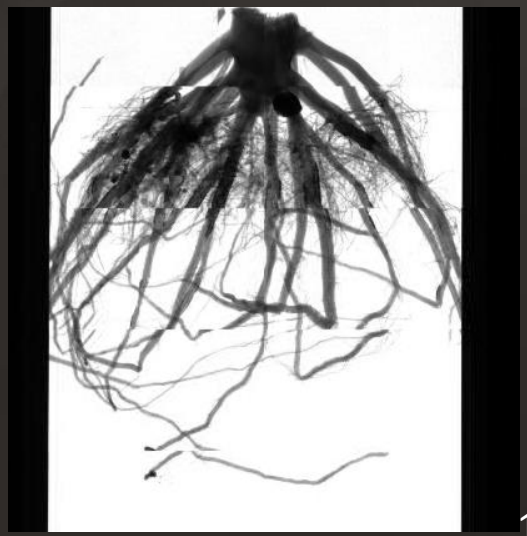
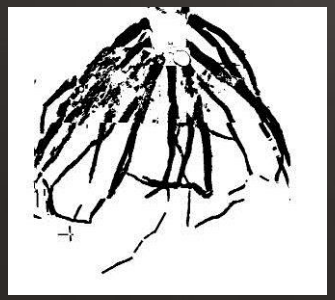
Roots Are Quantified From Soft-tissue X-ray Images

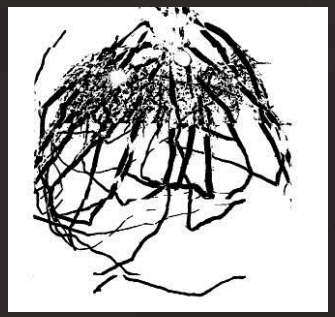


Original X-ray Image
H3Rep1

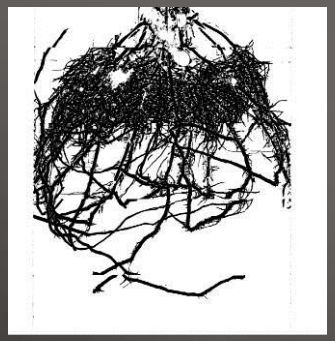
Roots > 2.9mm



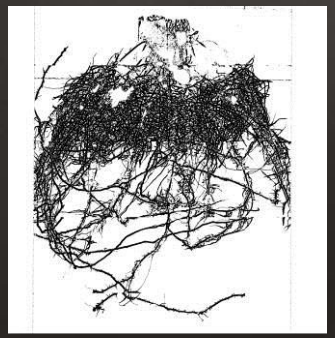
1.45mm < Roots < 10.15mm



0.725mm < Roots < 5.075mm



0.362mm < Roots < 2.54mm



0.181mm < Roots < 1.27mm

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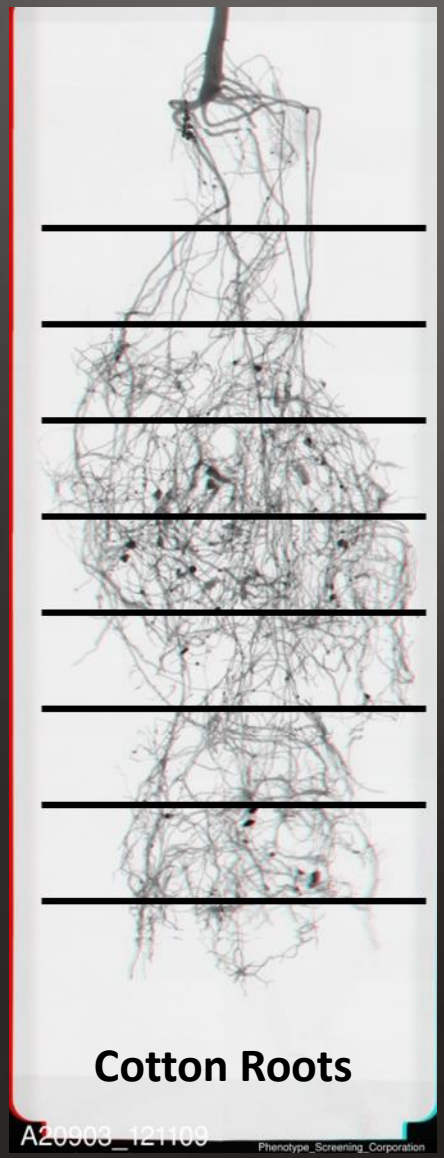
Quantification By Root Depth

- Number of Root Crossings
- Diameter of Root Segments
- Location of Root Segment
- Width of Root System
- Root Crossing Density



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Key Root System Architecture Traits

- Global Traits
  - Projected Root Area
  - Total Root Length/ Total Root Length Density
  - Number of Root / Transect Crossings
- Depth Traits
  - Number of Root Crossings
  - Diameter of Root Segments
  - Location of Root Segment
  - Width of Root System
  - Root System Density

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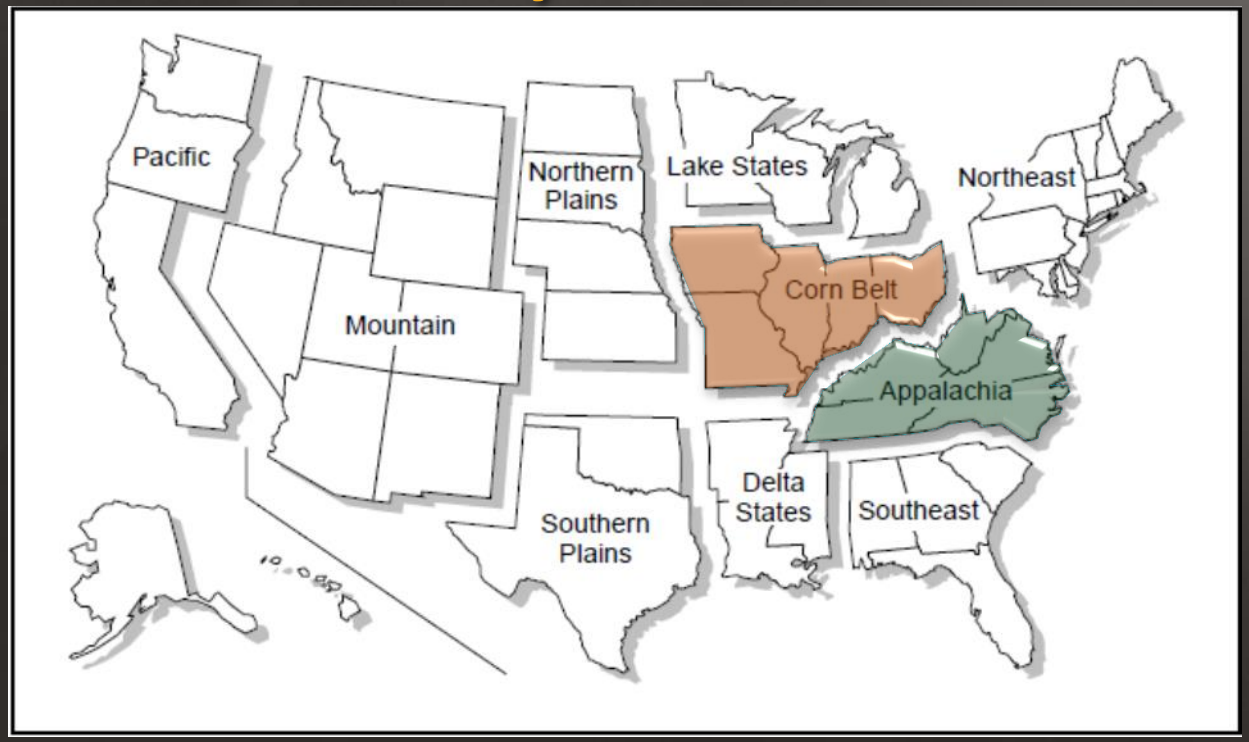
How Is Soft-tissue X-ray Imaging Used to Study Field Harvested Roots?



Production Regions

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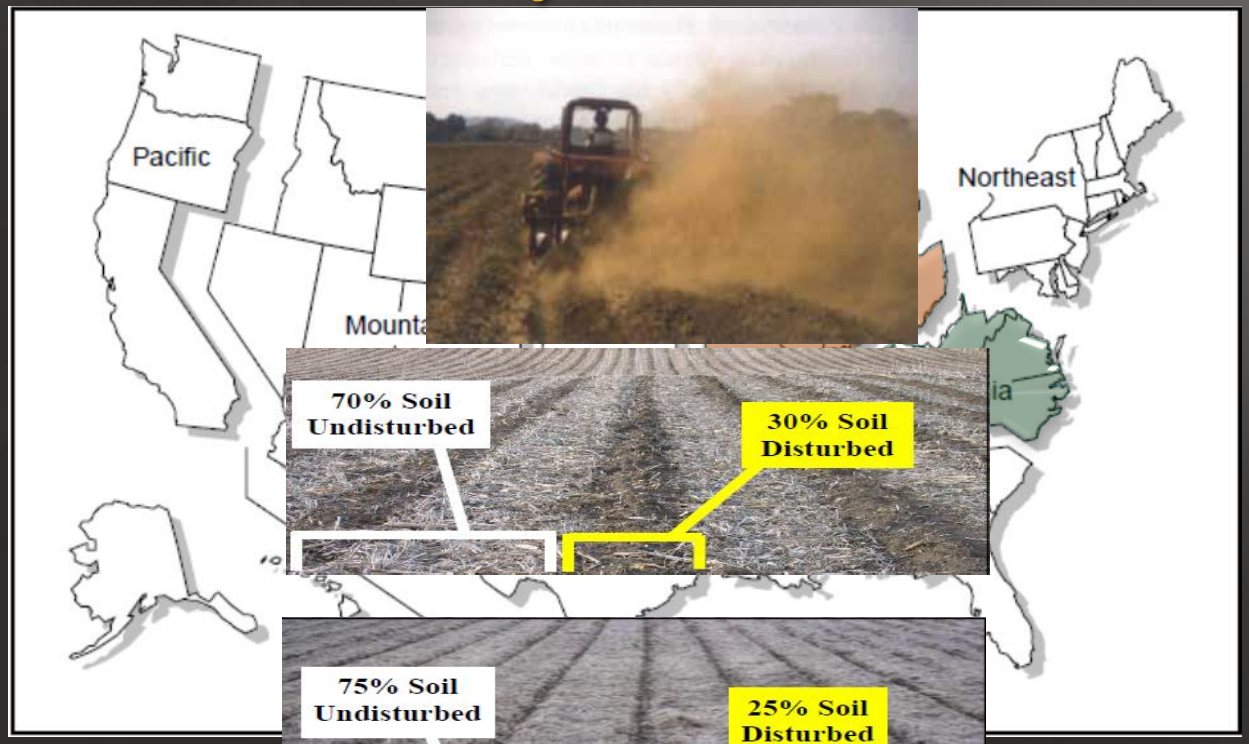

Tillage Conditions

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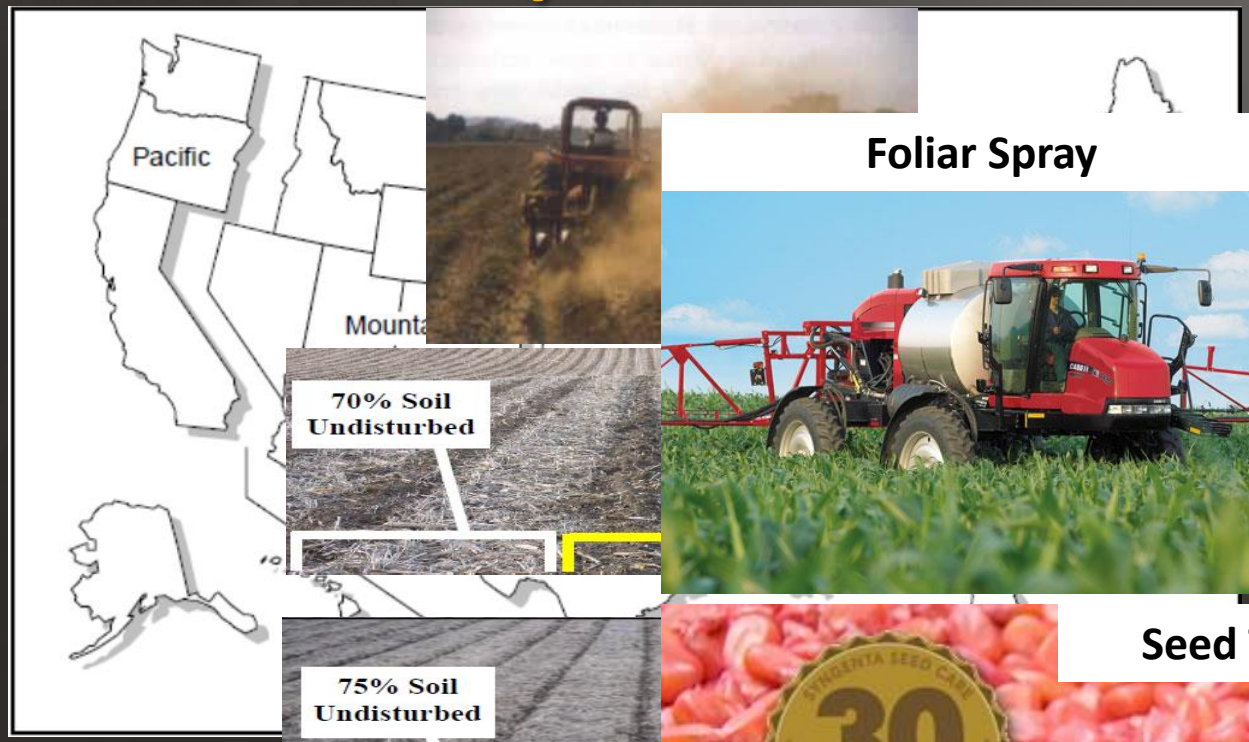
How Is Soft-tissue X-ray Imaging Used to Study Field Harvested Roots?



Tillage Conditions

Foliar Spray

Germplasm Traits

Seed Treatments

Treatment Systems

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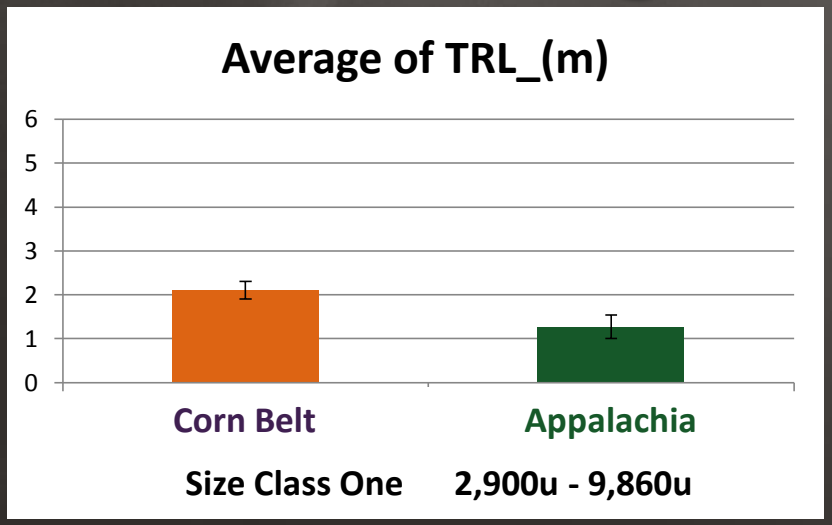
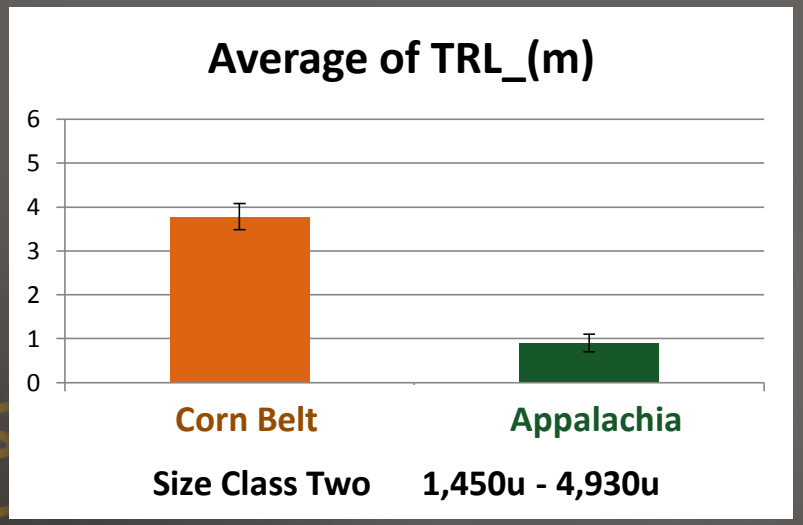
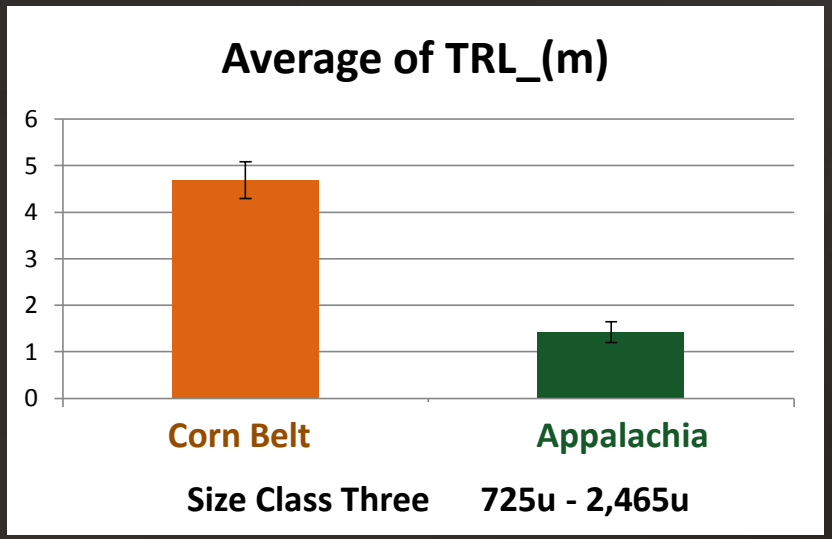
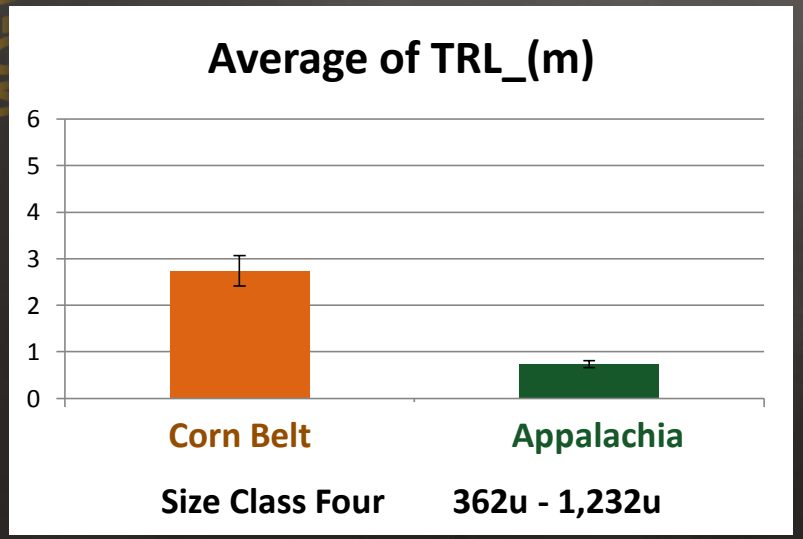
Production Regions Did Affect Root Traits





PRODUCTION REGIONS
NO-TILL, R1





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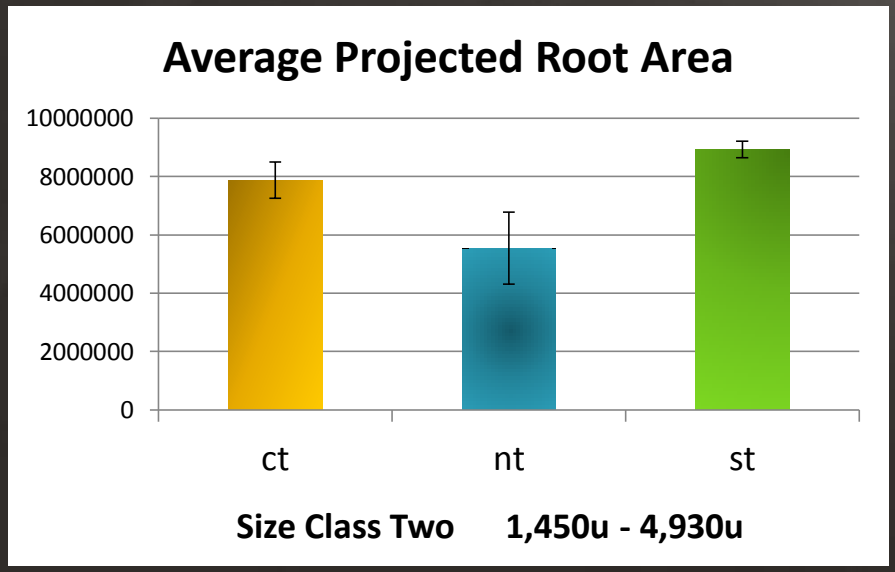
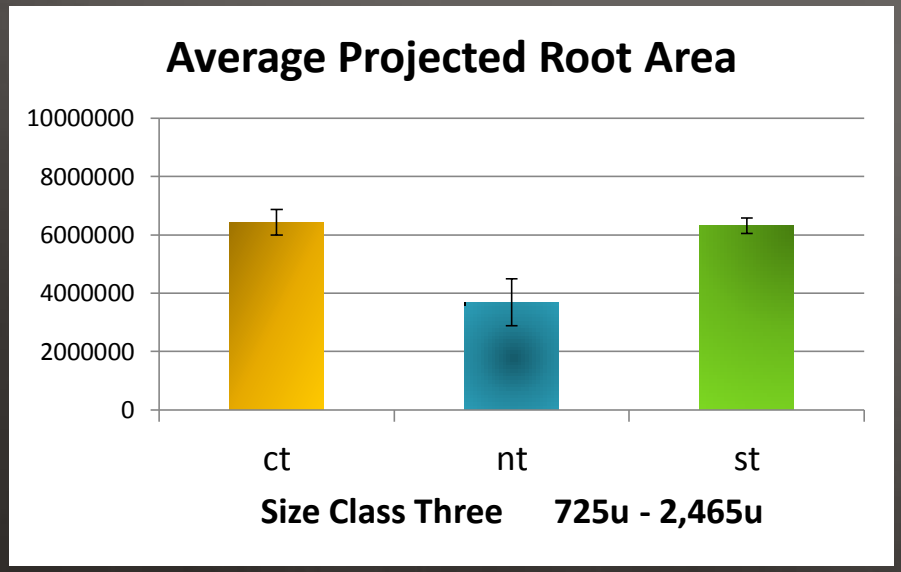
Tillage Conditions Affect Root Traits

Analysis Across Regions





Size Class Two; 1,450u - 4,930u

The three tillage types had significant effects on roots of this size. Strip-till favors roots of this size while no-till does not.

Size Class Three 725u - 2,465u

Only no-till had a significant effect on roots of this size. No-till does not favor roots of this size.

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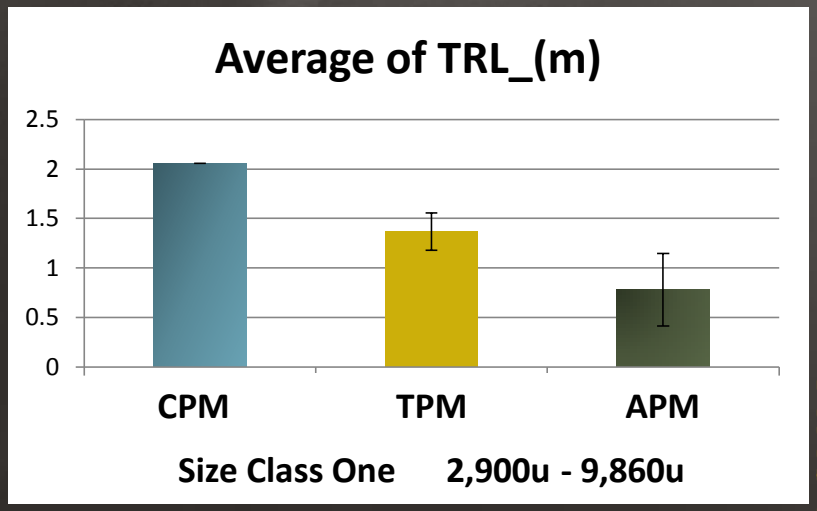
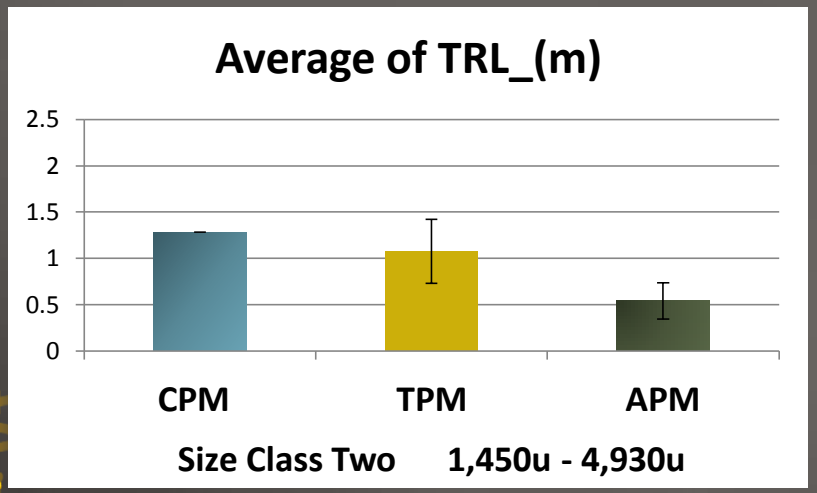
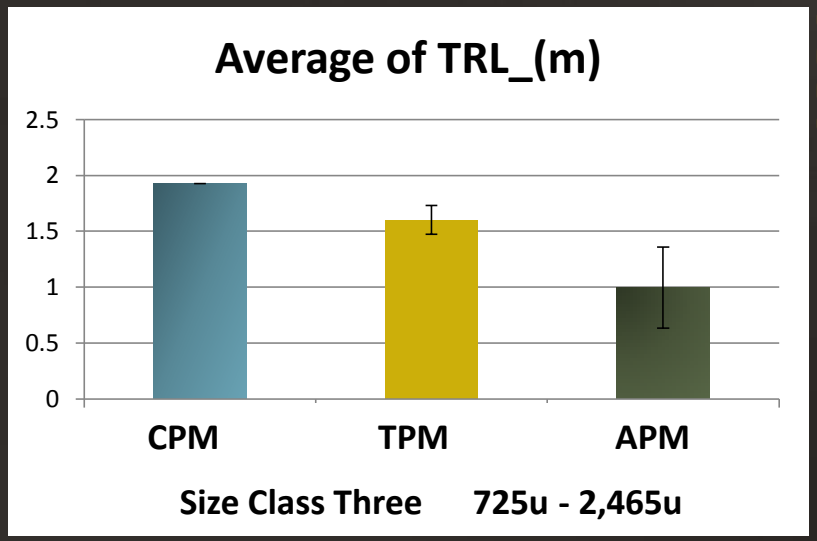
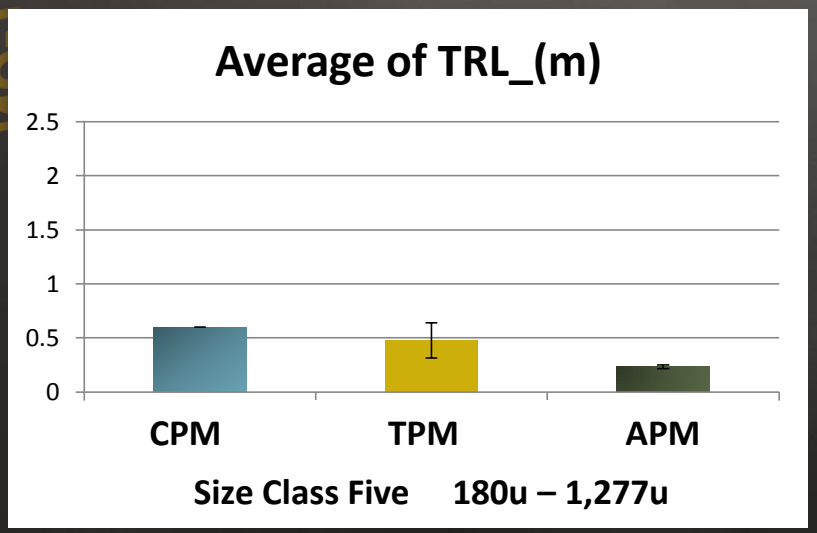
Treatment Systems Did Effect Root Traits





APPALACHIA
NO-TILL, R1





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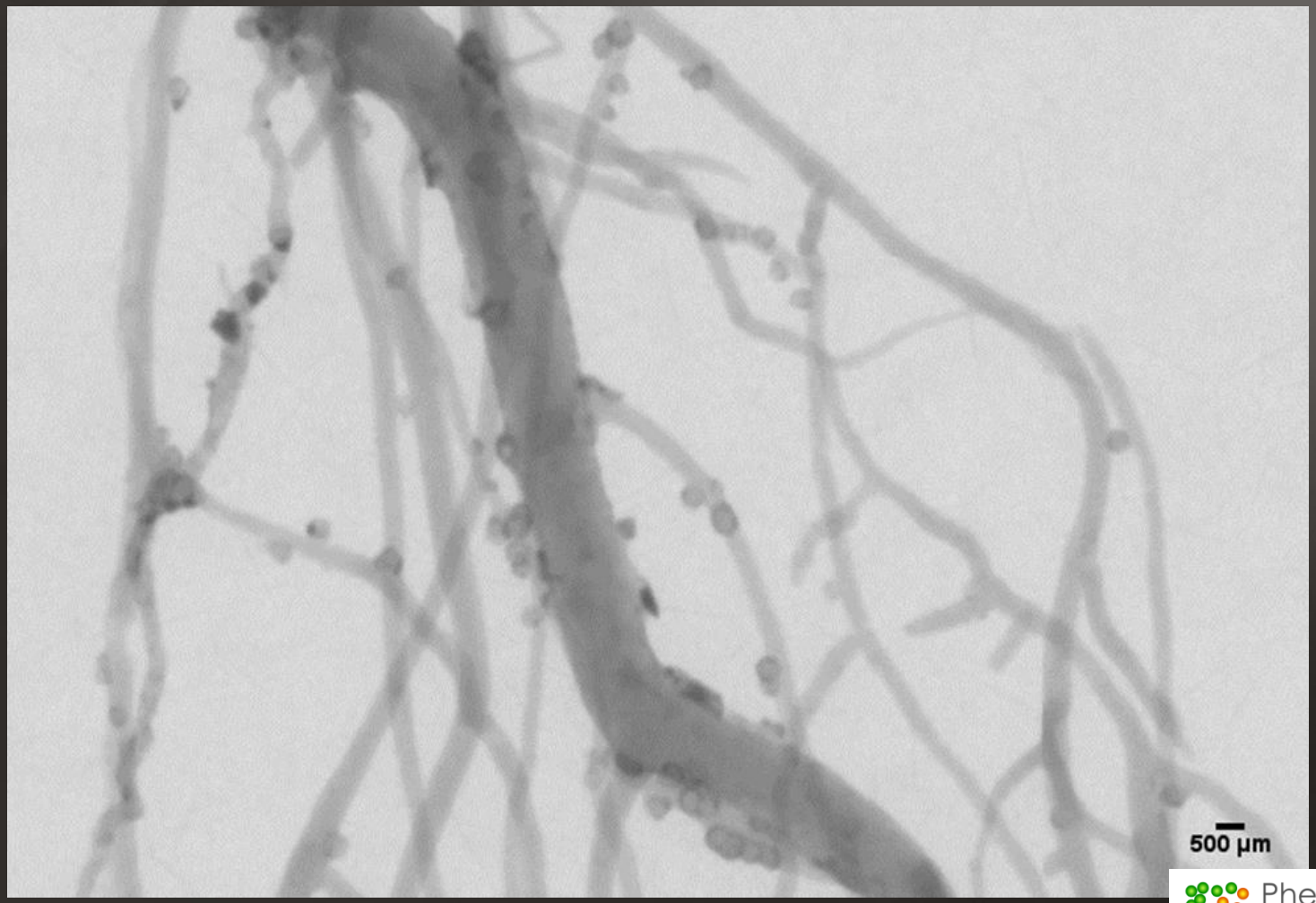
Soft-tissue X-ray Imaging Is Used For Nematode Resistance Screening



COTTON/RENIFORM NEMATODE

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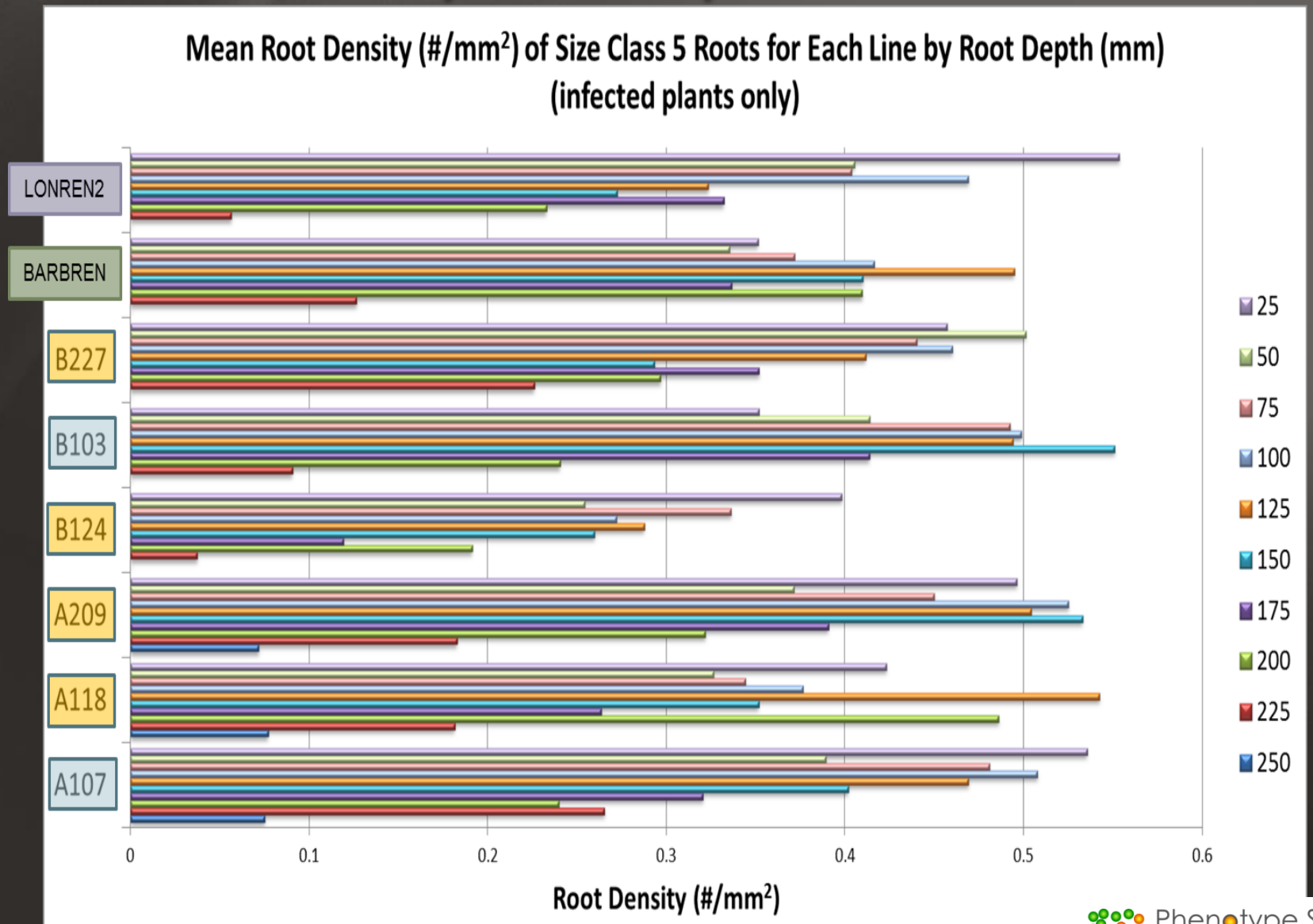
Root Density vs. Depth of Cotton Plants



COTTON/RENIFORM NEMATODE

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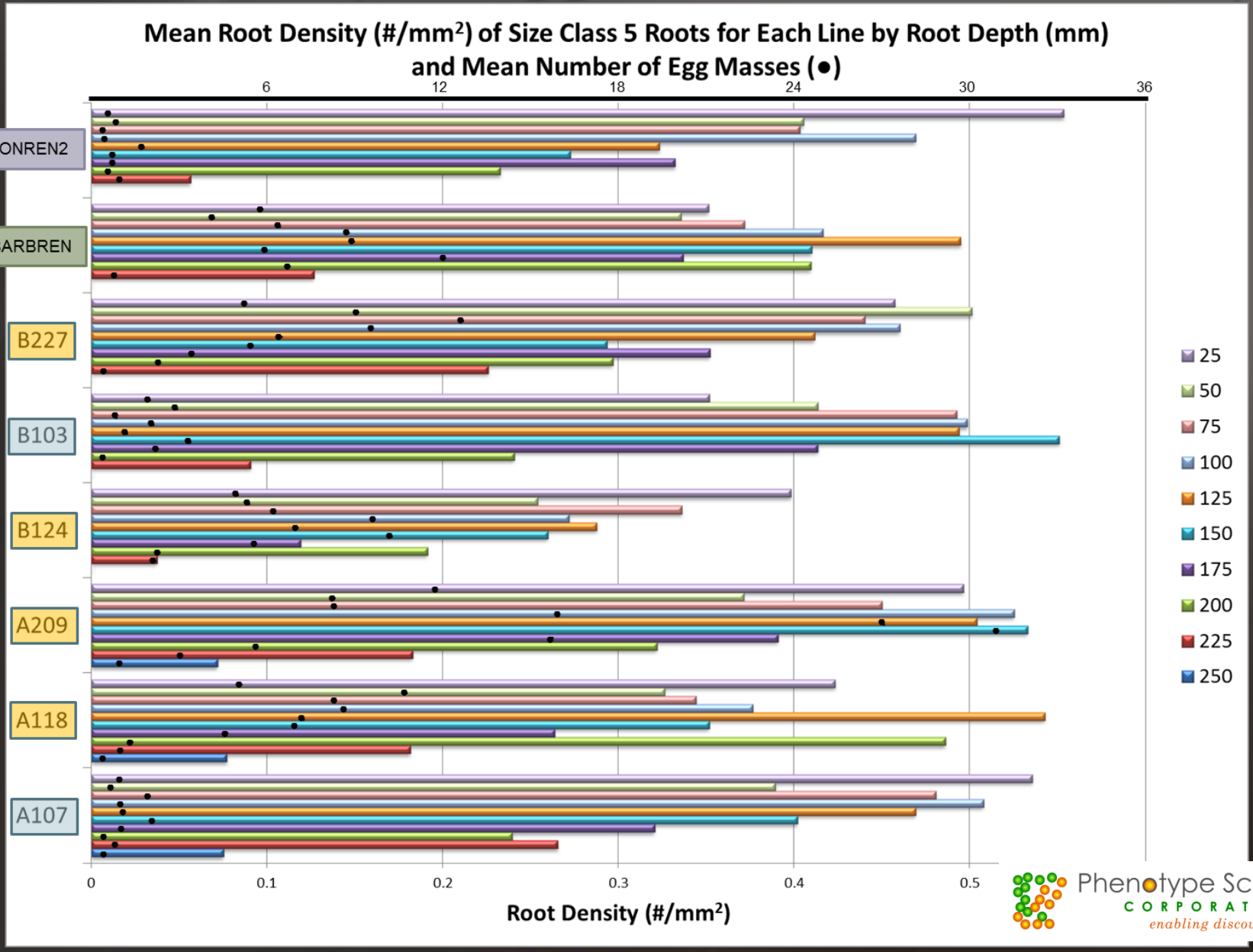
Root Density & Egg Mass Count vs. Depth



COTTON/RENIFORM NEMATODE

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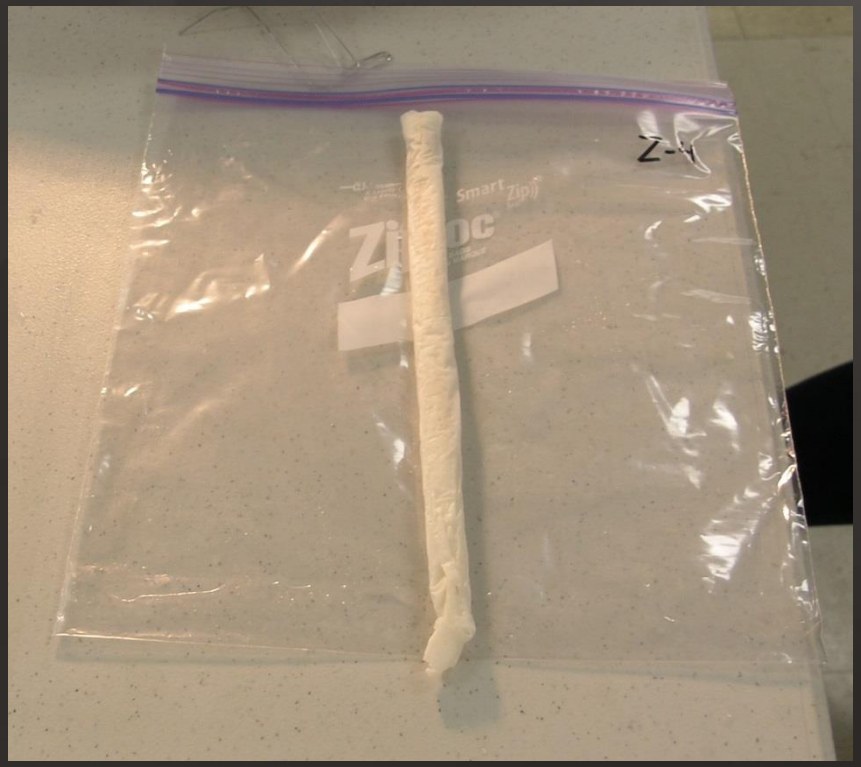
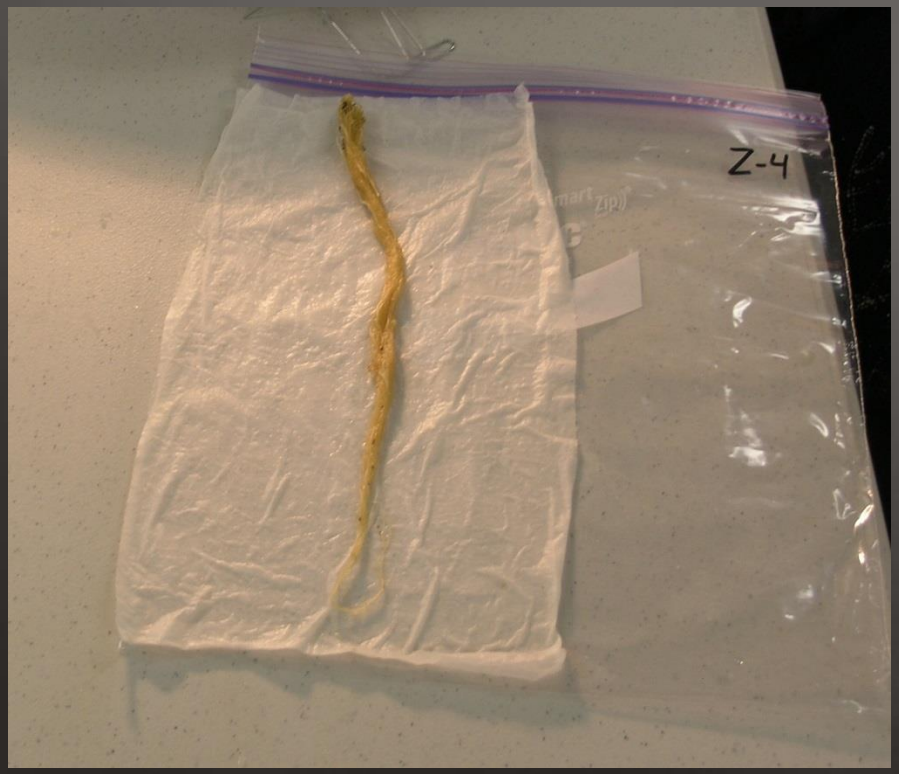
Sometimes Manual Intervention is Required to Achieve Good Images





Rolled Washed Roots of Wheat Seedling

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Sometimes Manual Intervention is Required to Achieve Good Images

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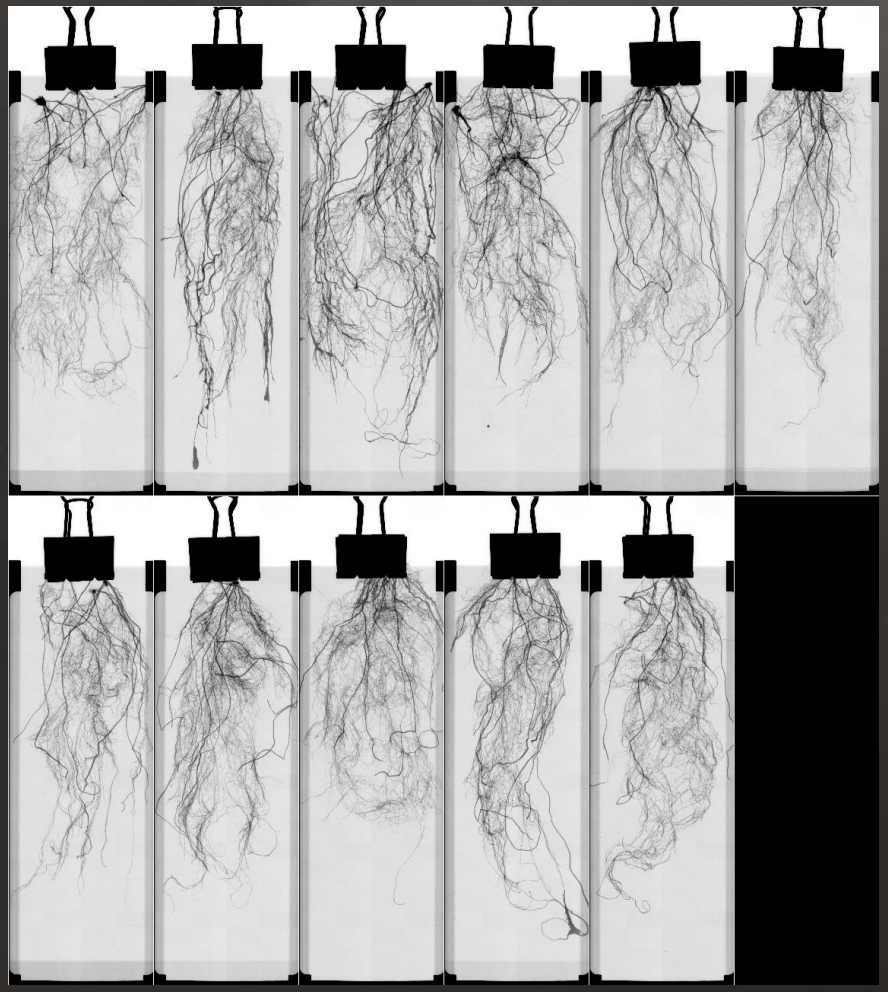
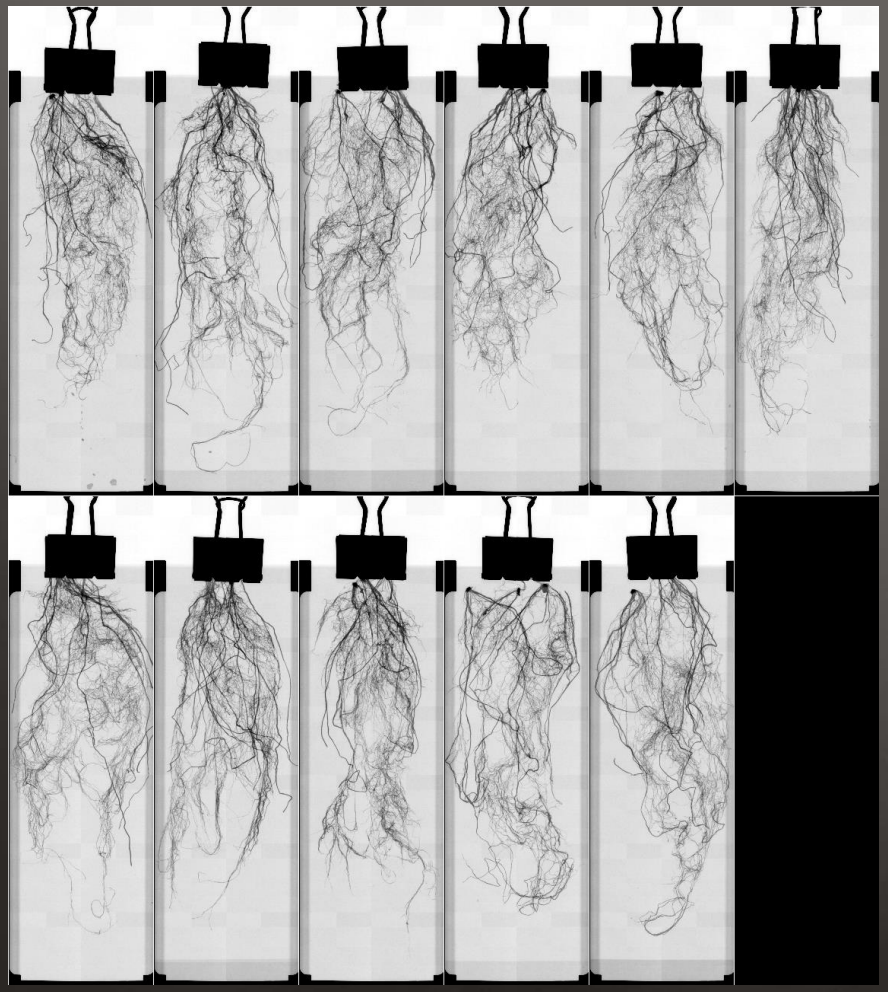
Effect of Microbials on Wheat Seedlings



Formulation X



Formulation Y

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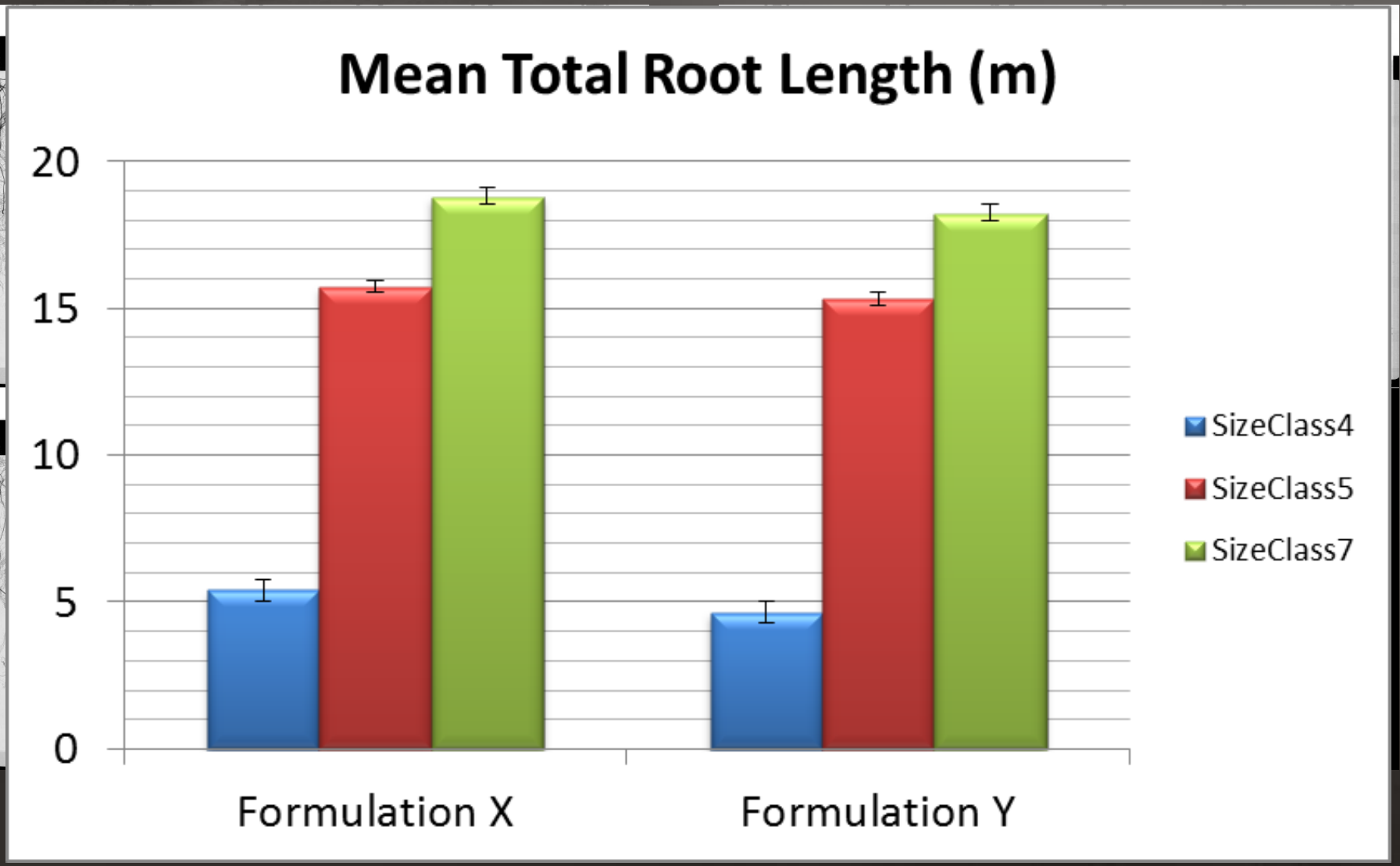
Effect of Microbials on Wheat Seedlings



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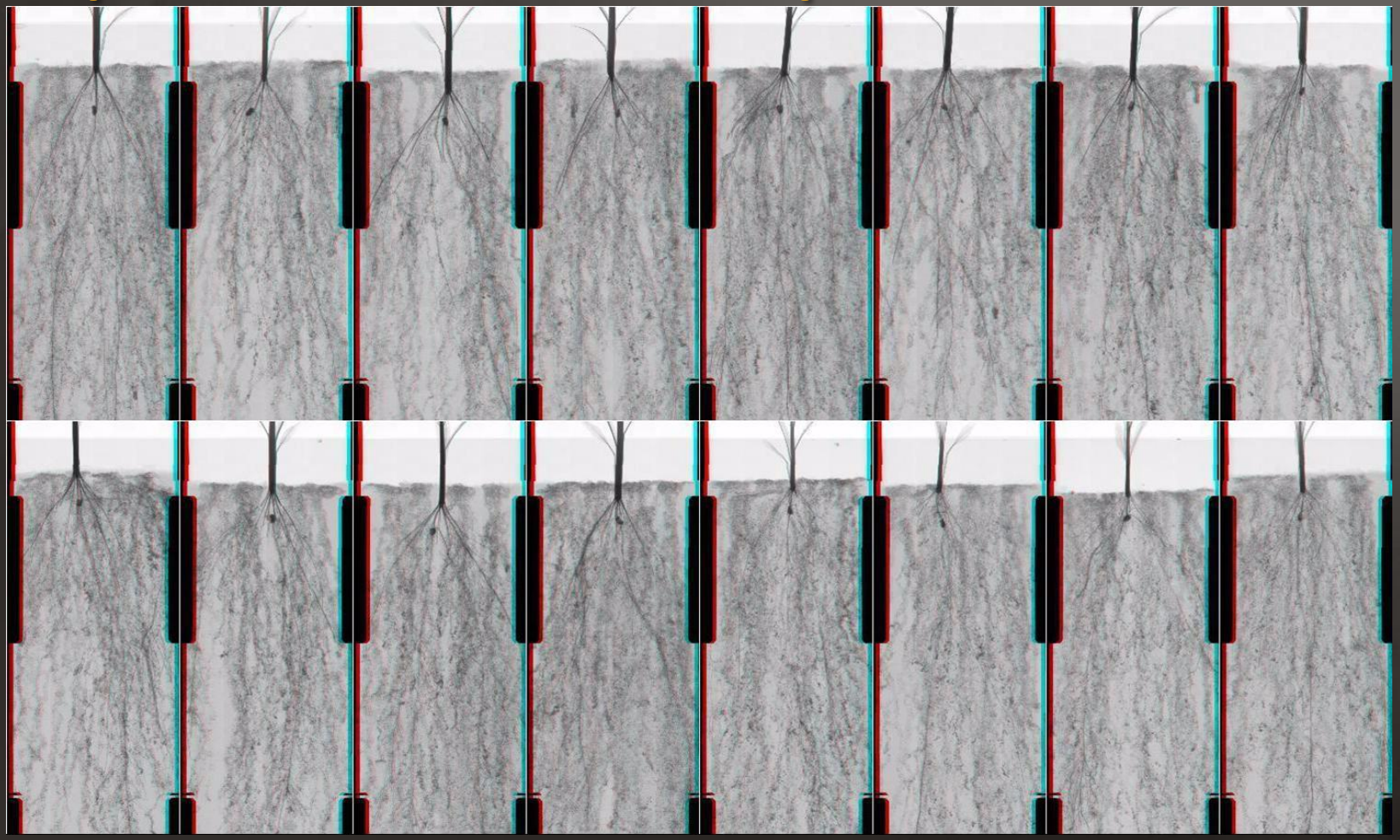
Soft-tissue X-ray Imaging Used to Compare Root Development Over Time

Treated

Untreated



Video

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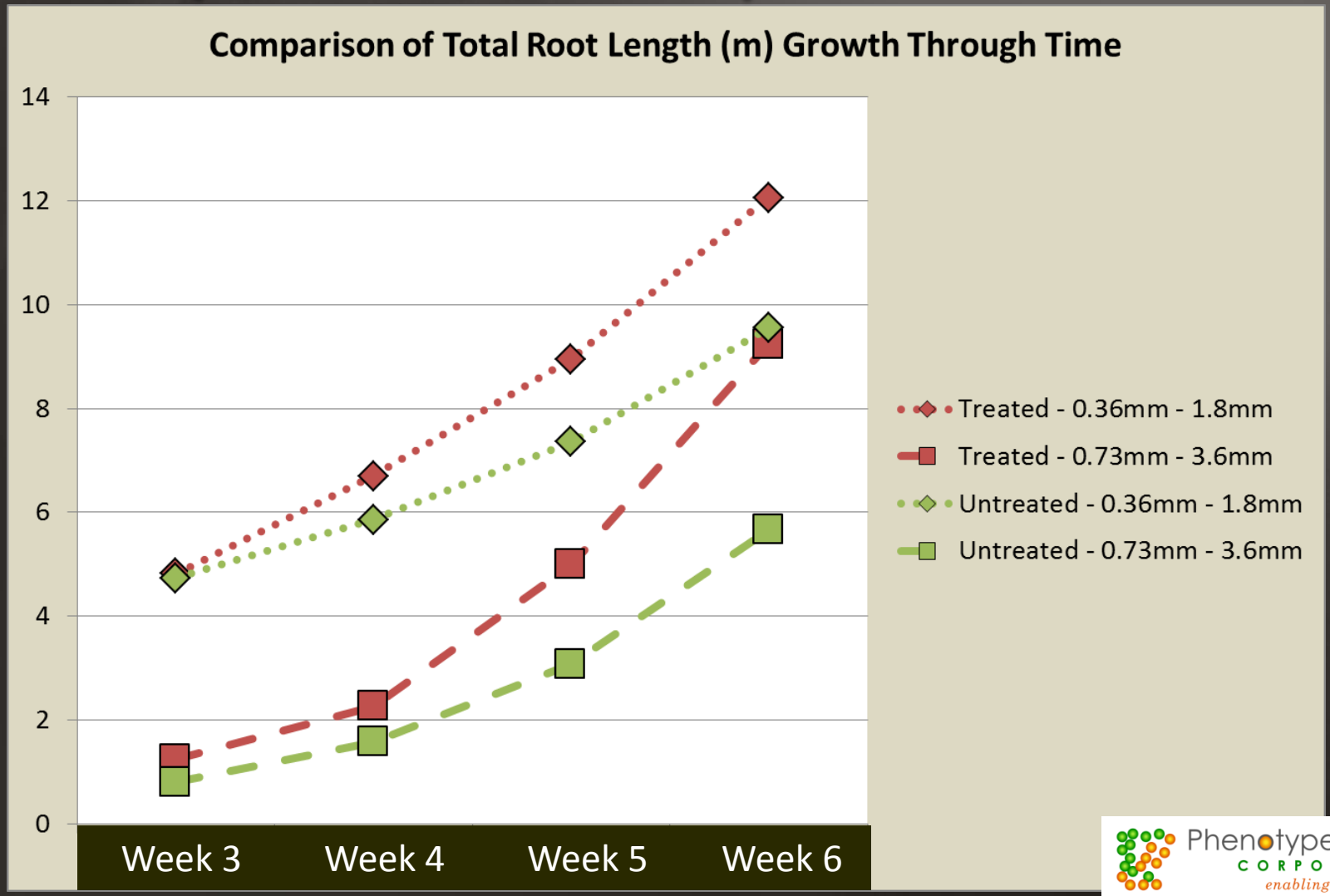
Quantification From X-ray Images to Study Root Development Over Time



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Our Growth Media Is Inert And Falls Away Nicely From Roots

- Preserves more fine roots for sampling
- Preserves access to clean root tissue for gene expression analysis.
- Access to root exudate sampling.

Video

Soft-tissue X-ray Imaging is a Versatile Tool for Plant Root Studies

- It is being used to compare:
  - High performance germplasm
  - Seed treatments
  - Effects of microbial communities
  - Tillage impacts
  - Nematode resistance
  - Insect resistance
  - Genetic transformations
- Let’s put it to use in your research!