



Phenotype Screening
CORPORATION
enabling discovery

Non-Destructive Digital Imaging of Poplar Root Systems

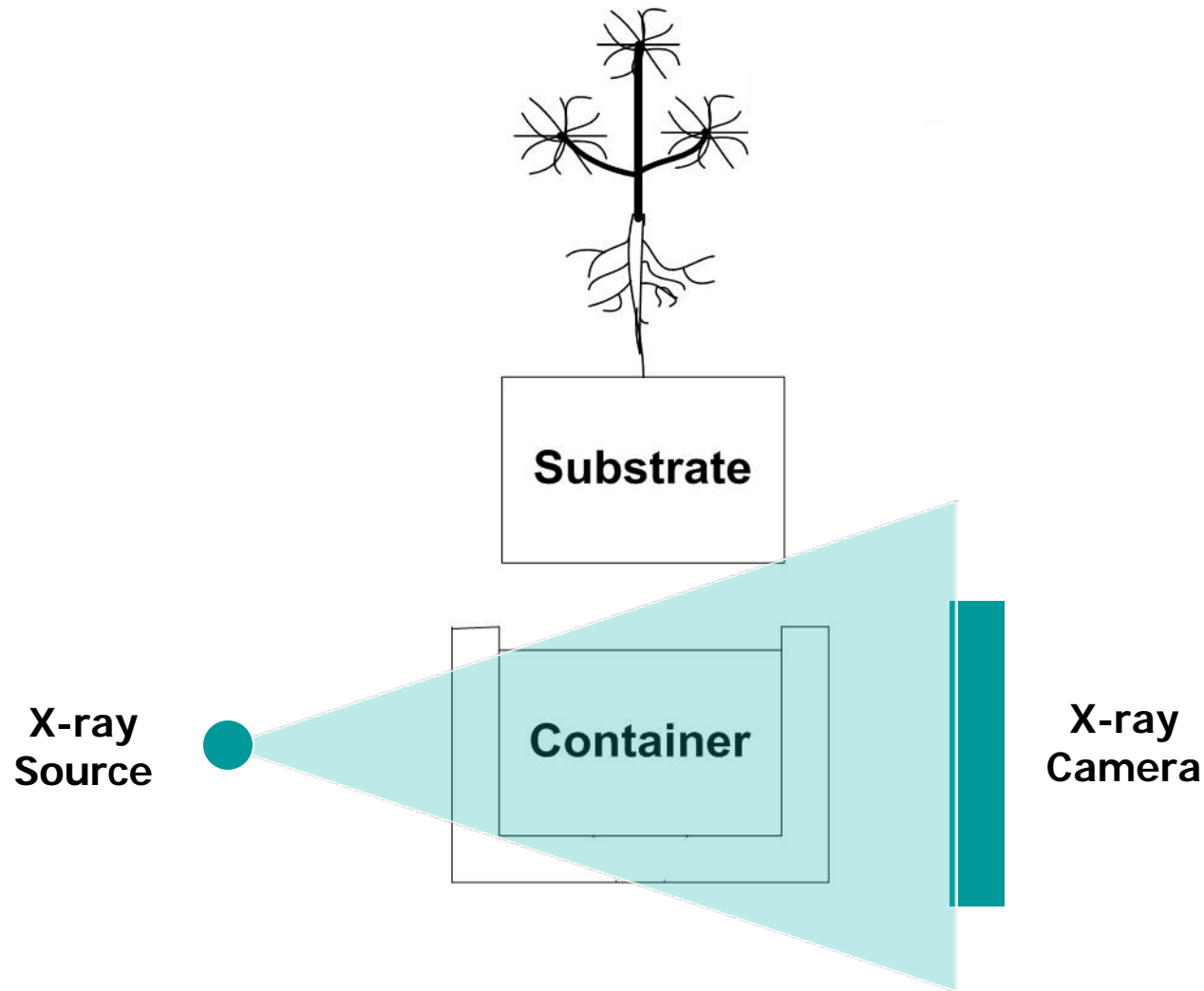
PAG XVII – Forest Trees Workshop
January 11, 2009

Phenotyping Roots is Hard

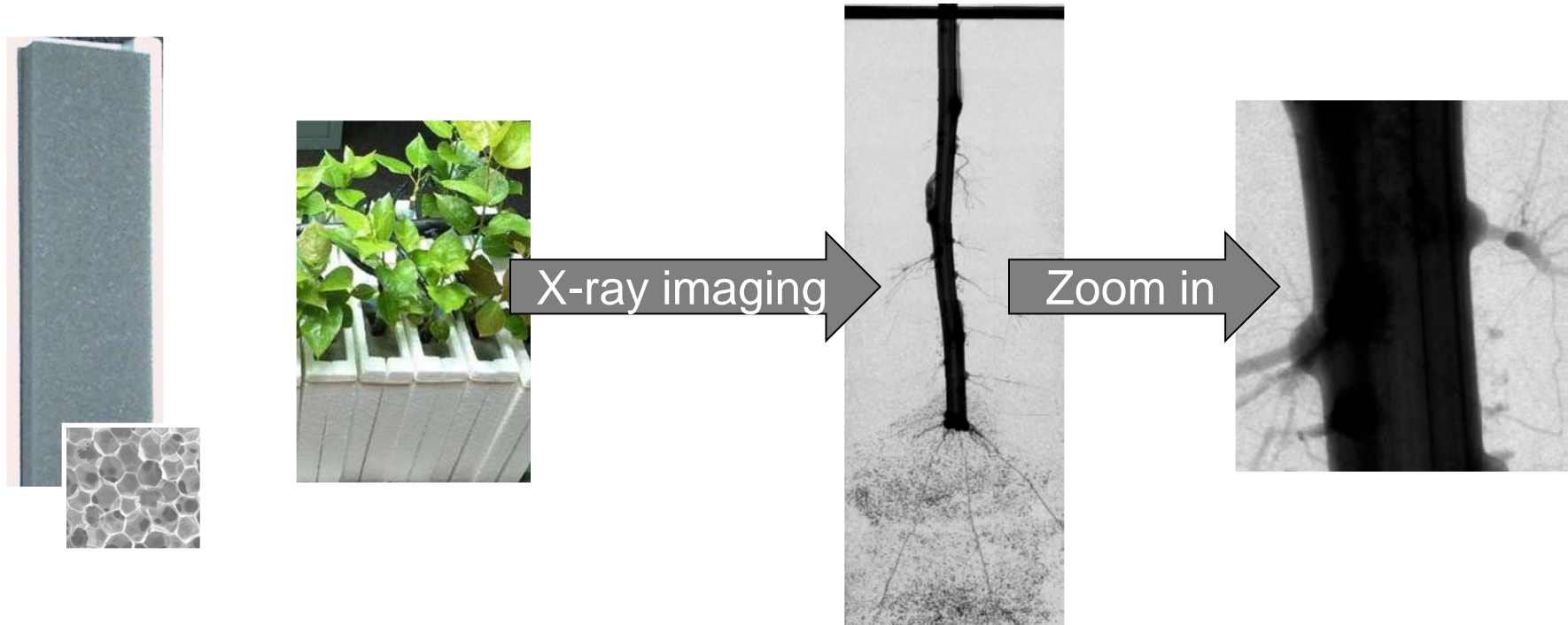
- Soil gets in the way
- Removing roots from soil kills the plants and ends the experiment
- Methods in use provide limited information



RootViz FS X-Ray Analysis



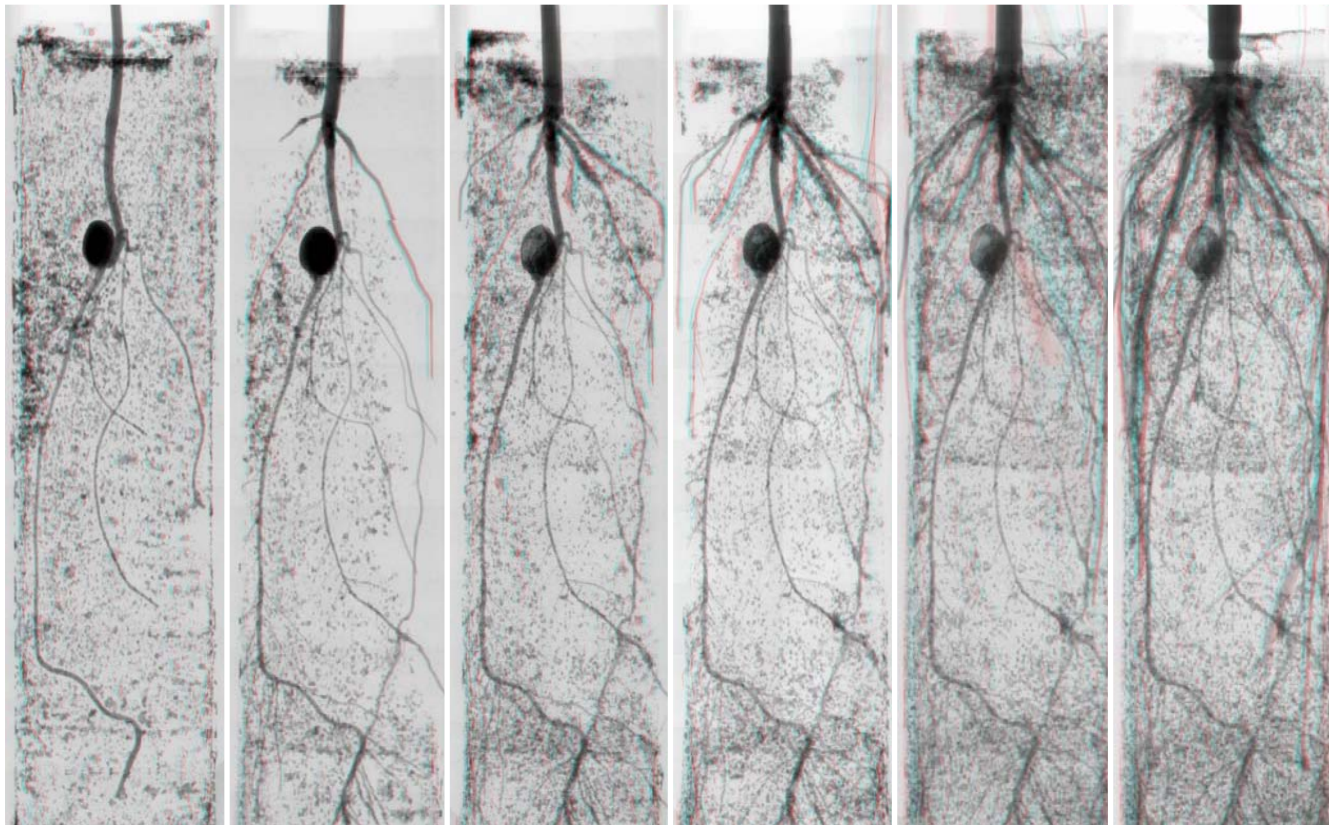
High Resolution Digital Images



Grow in low density
engineered rooting medium

High Resolution Digital Images

Developmental Studies are Possible



3 15 27 39 51 63
Days after Germination

Images are in Stereo providing some 3-D information
Viewable with red/cyan glasses

It works but it's not soil...

- How does growth in engineered substrate compare to soil?
- Are the results accurate?
- Are the results meaningful?

Collaboration with USDA Forest Service

- Compare growth of poplar clones between engineered substrates and soil.
- Compare traditional root analytical methods with x-ray analysis.
- Suggest modifications to foam substrates.
- Suggest improvements to x-ray characterization system.

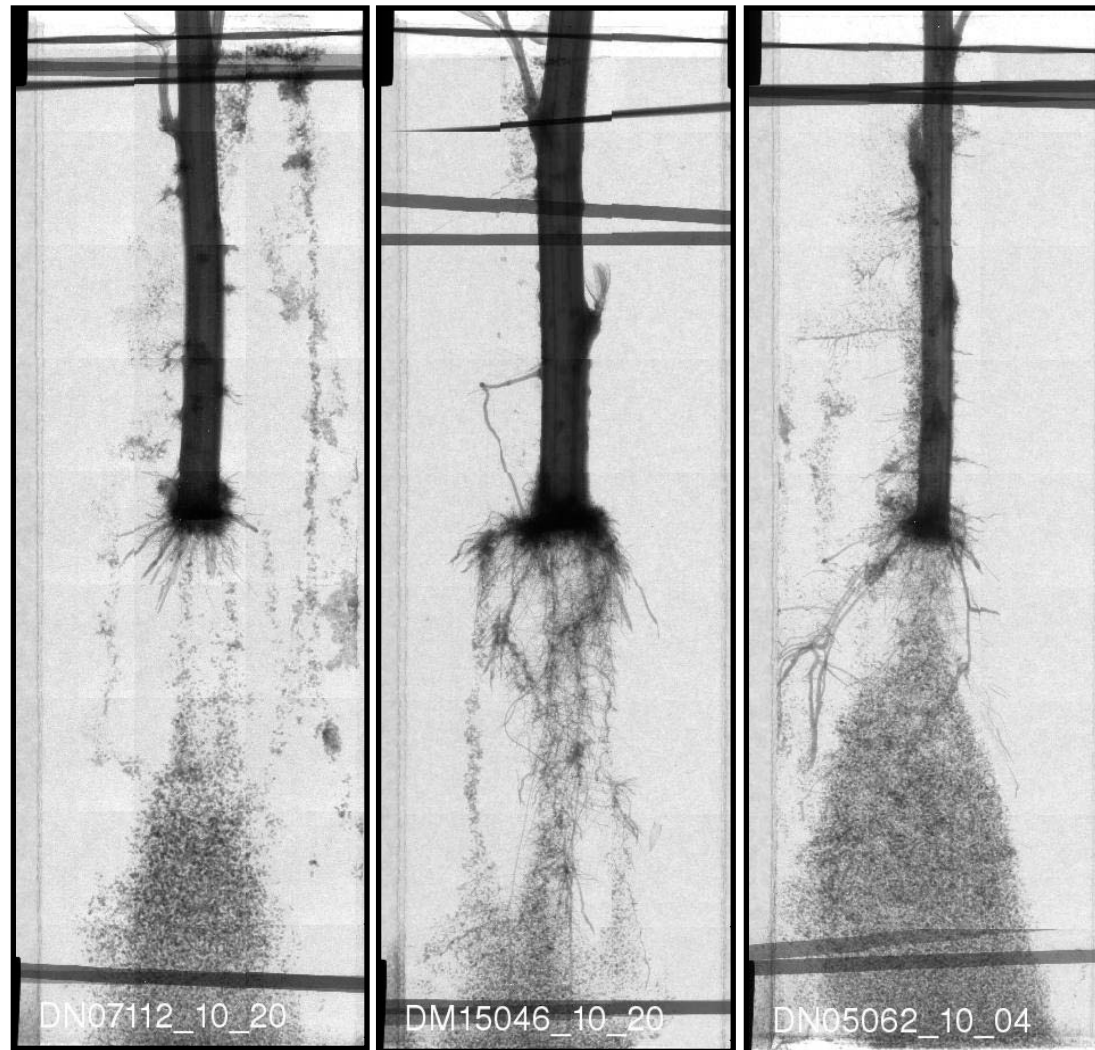
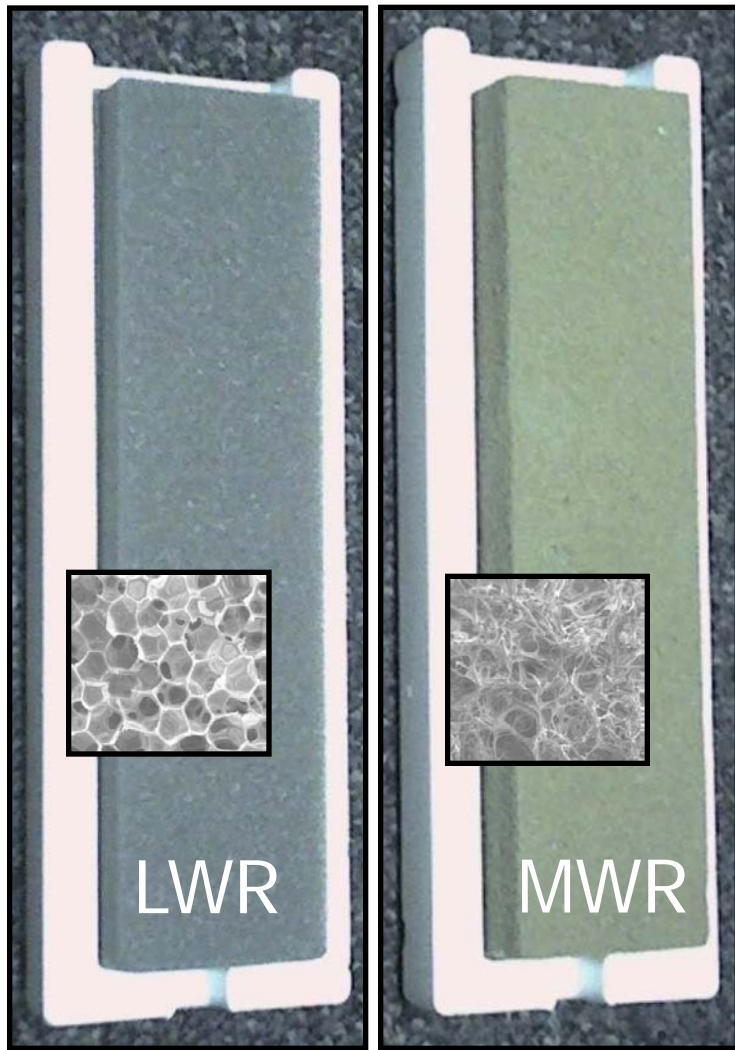


Poplar Rooting Study – Phase I

- 3 poplar clones: 4 replicates per clone
 - DN70 *P. deltoides* x *P. nigra*
 - NC14104 *P. deltoides* x *P. maximowiczii*
 - NM6 *P. nigra* x *P. maximowiczii*
- 4 Rooting Media
 - Sand
 - Peat/vermiculite mix
 - LWR engineered rooting matrix
 - MWR engineered rooting matrix



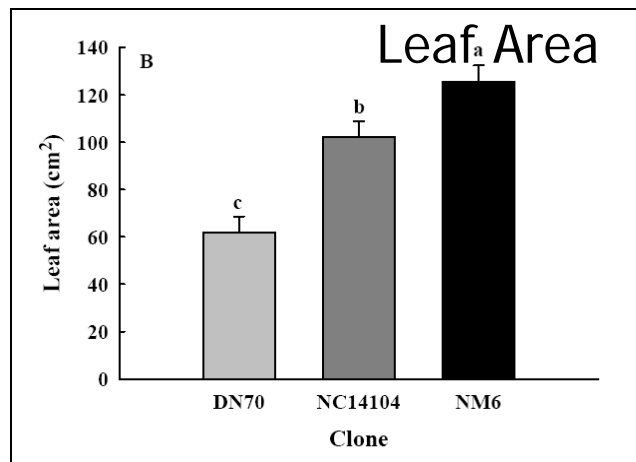
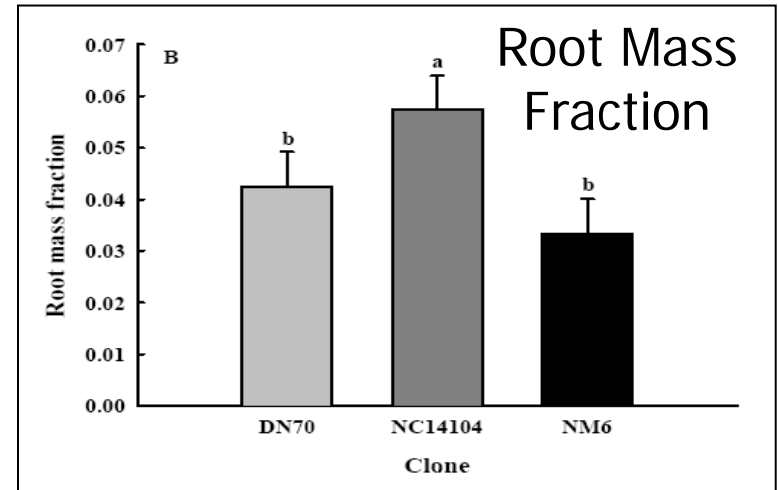
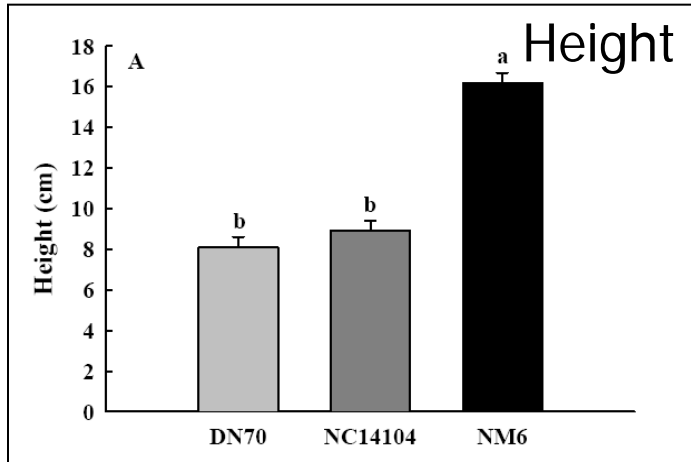
Root Development Analysis – X-ray



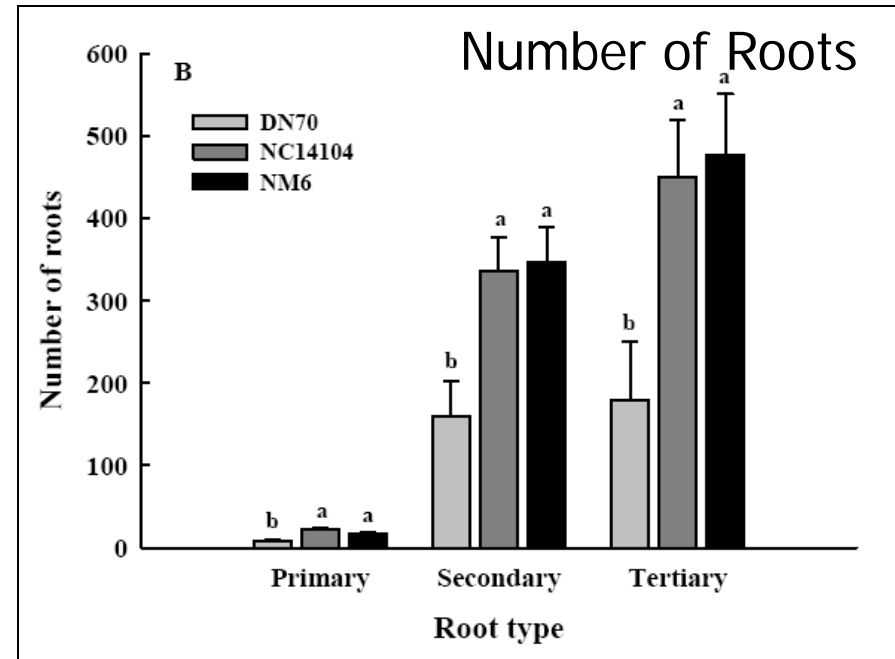
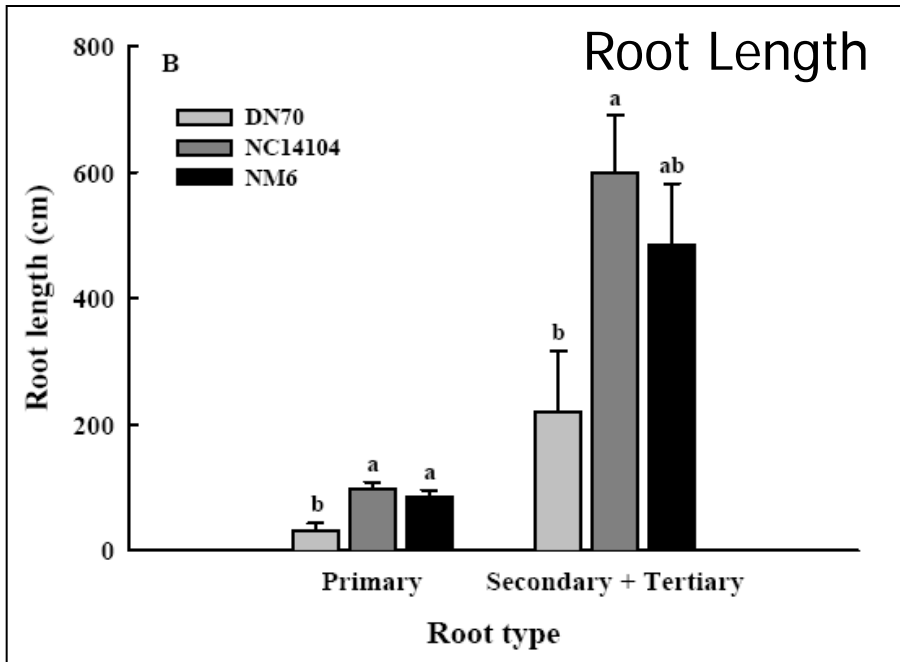
Root Development Analysis Soils and Excavation



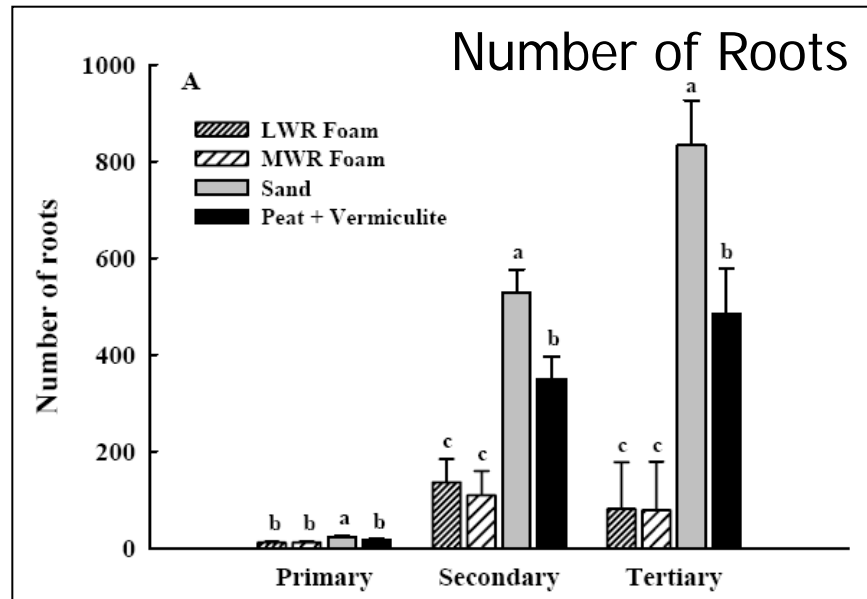
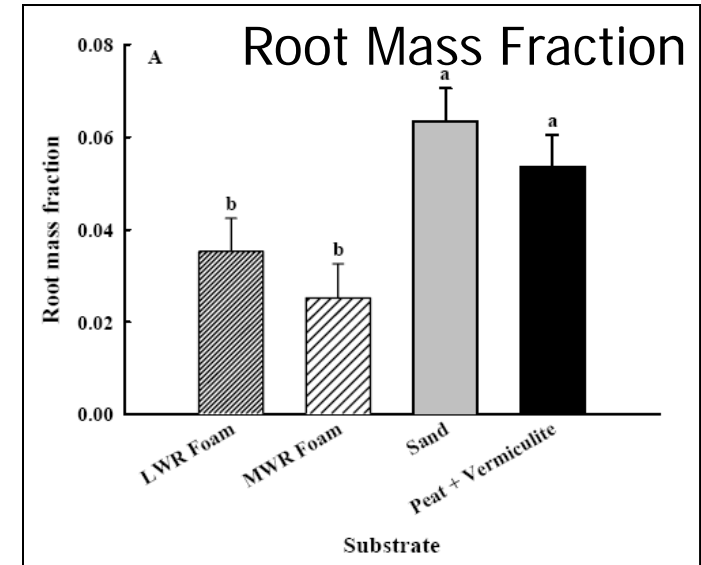
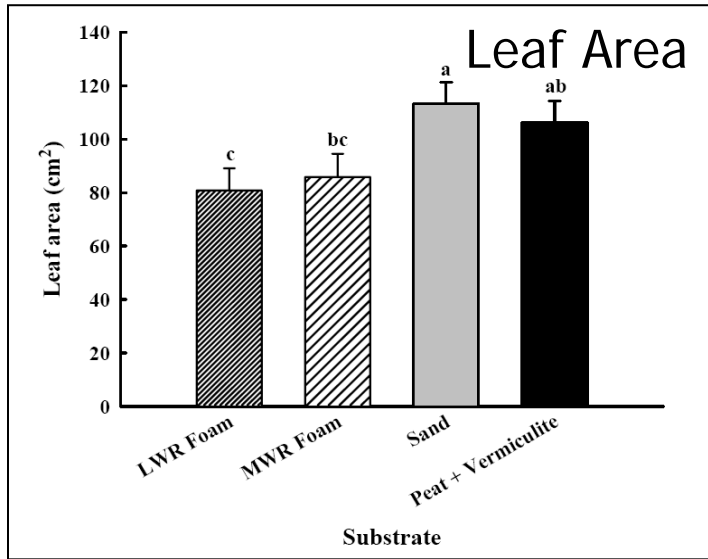
Clonal Differences



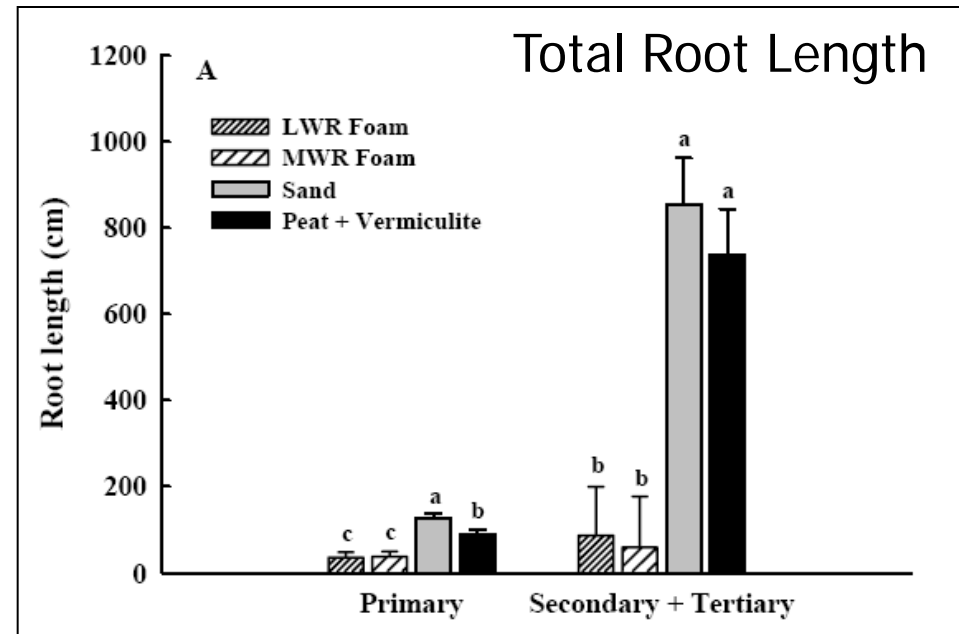
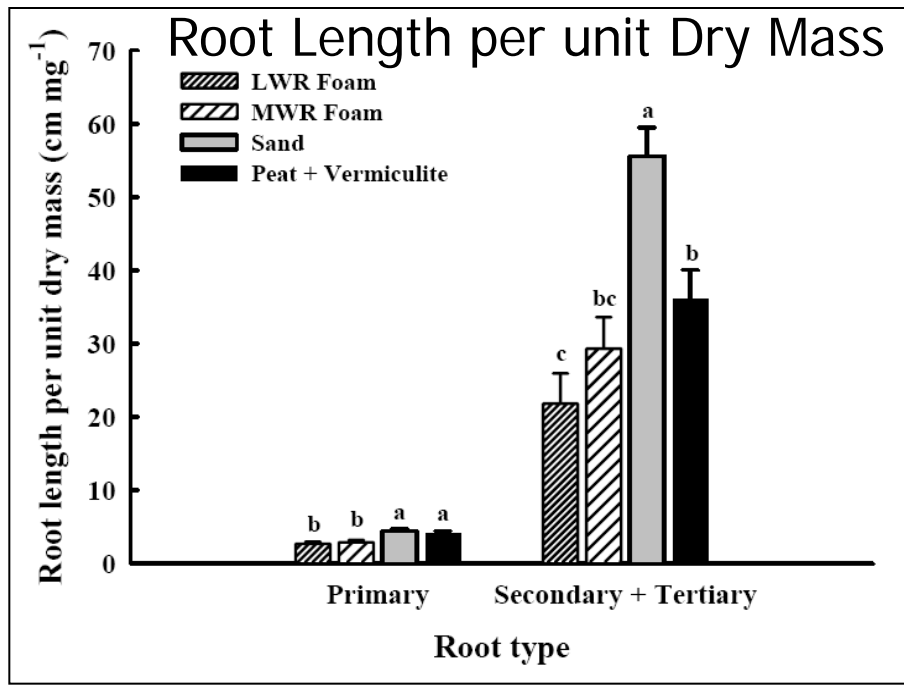
Clonal Differences



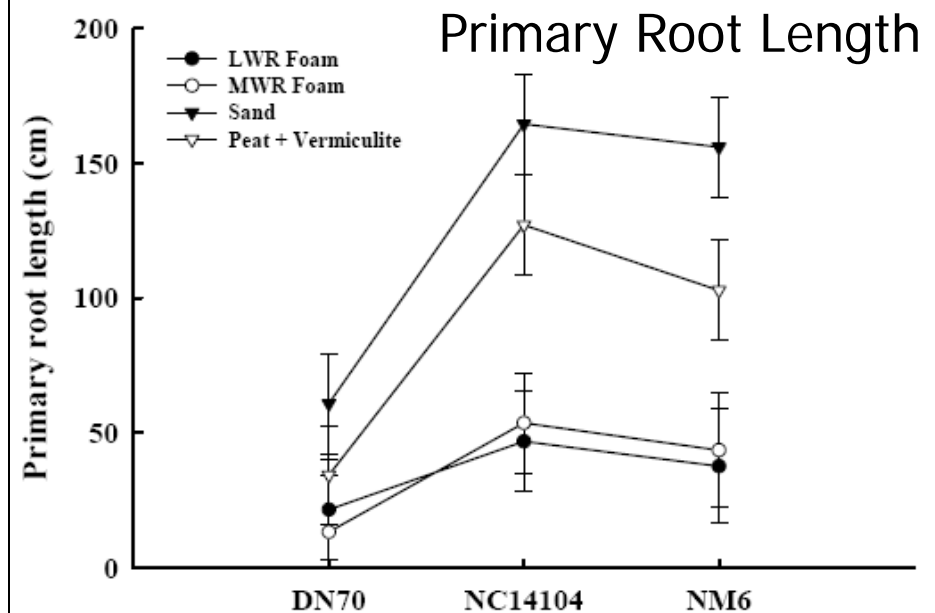
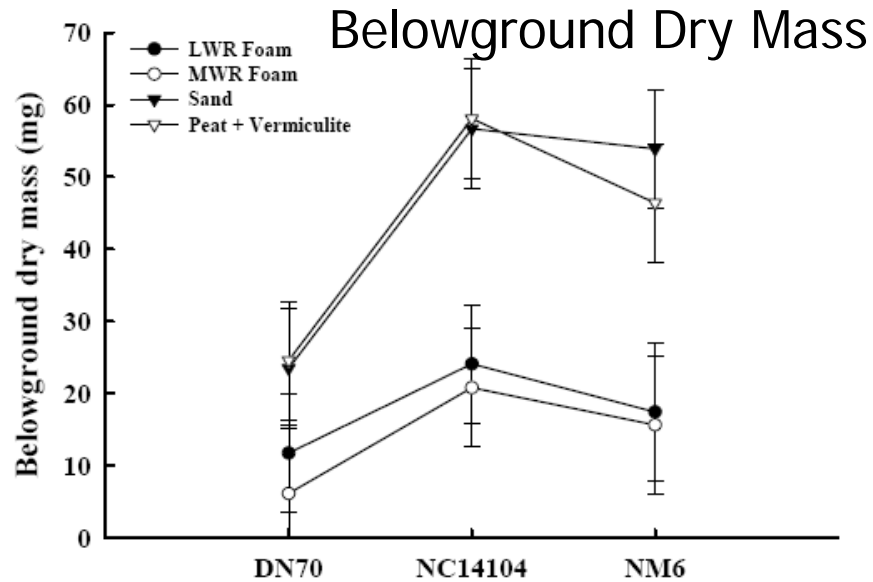
Substrate Effects



Substrate Effects



Clonal Ranking by Substrate



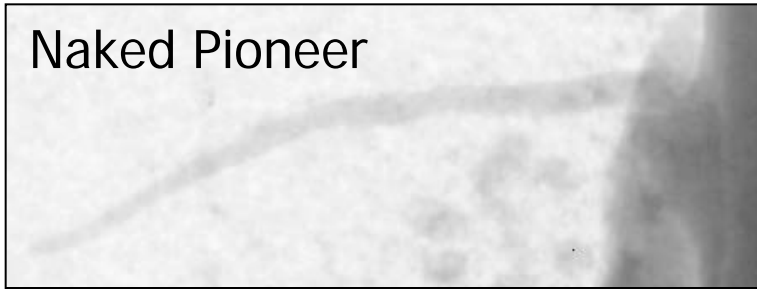
Clonal Rankings Between Engineered Substrates and Soils are Generally Consistent

Other Interesting Results...

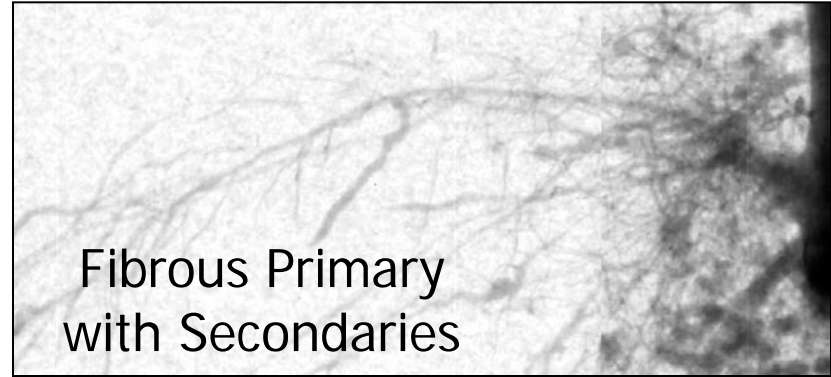
- Growth dynamics can be measured.
- Compare daytime vs. nighttime growth.
- Detailed morphology studies.

Distinct Morphotypes of Roots

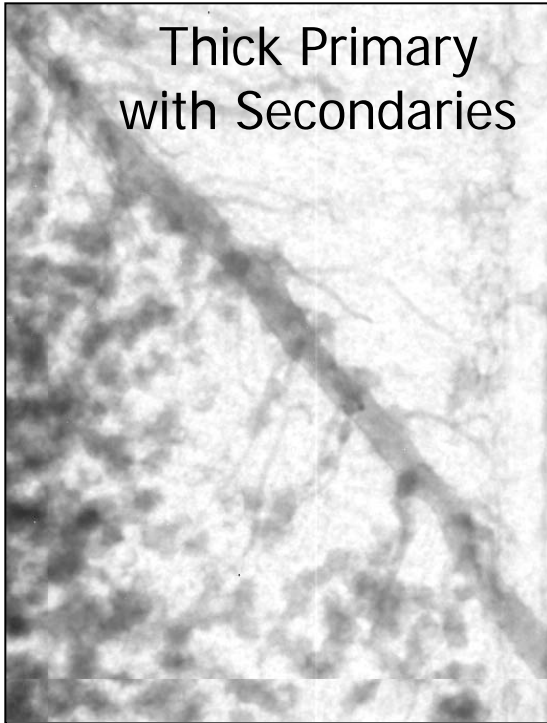
Naked Pioneer



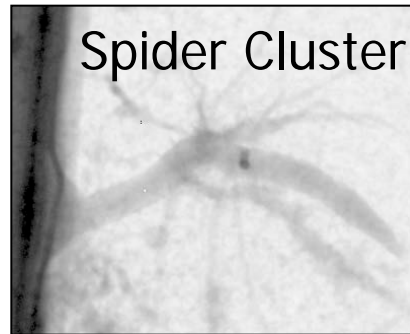
Fibrous Primary
with Secondaries



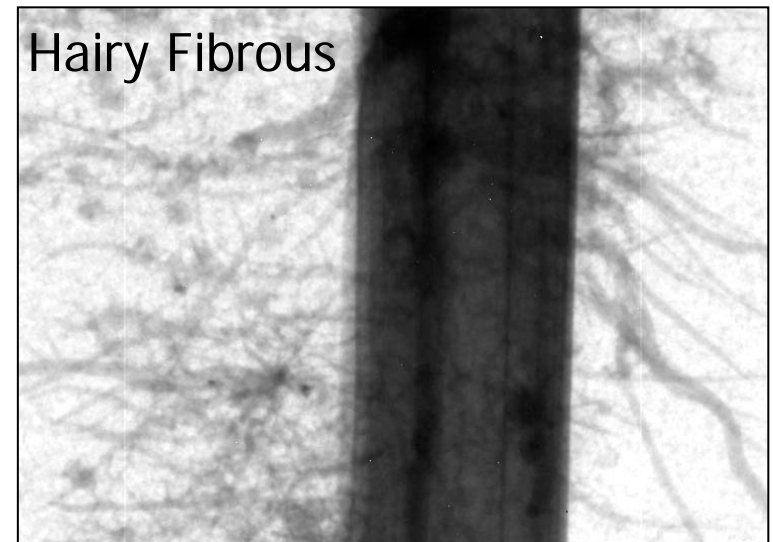
Thick Primary
with Secondaries



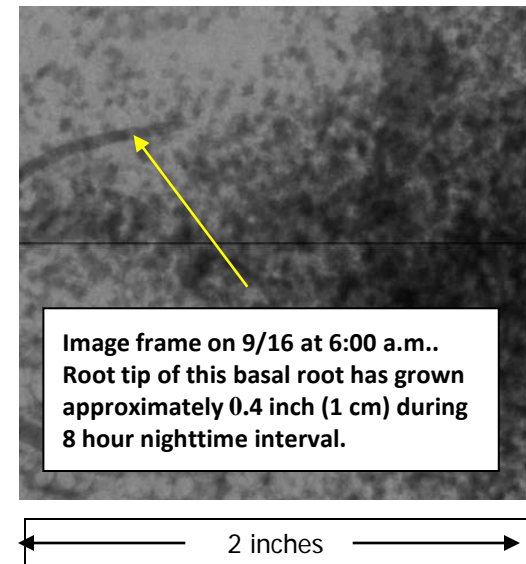
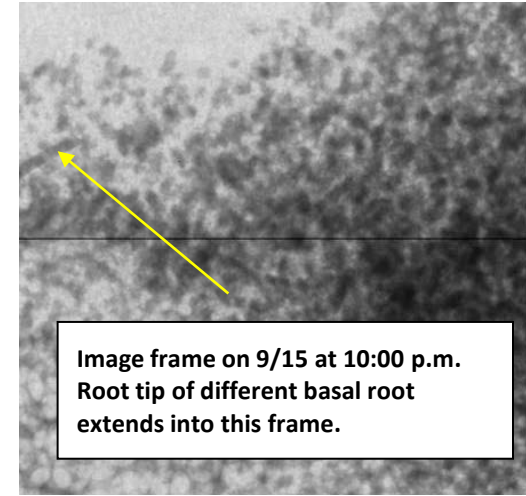
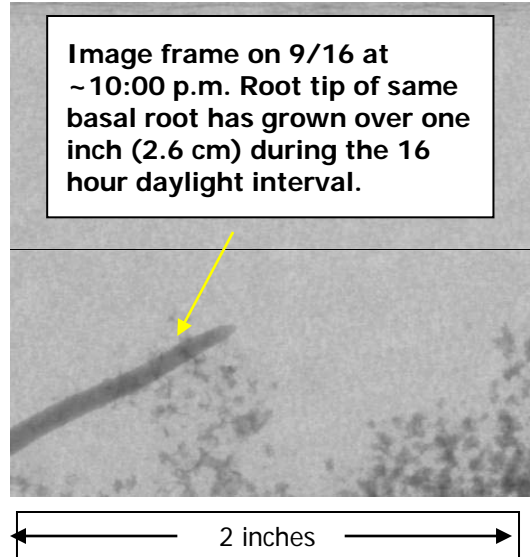
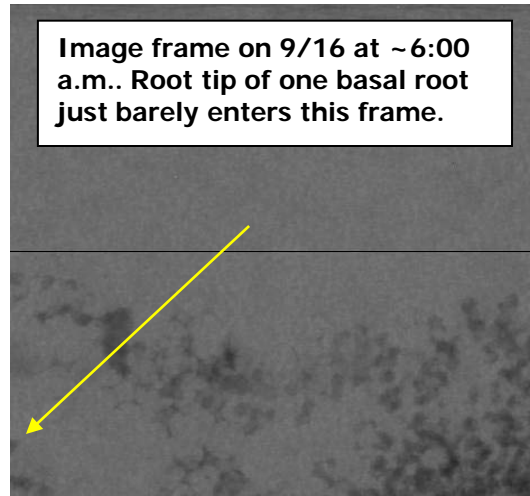
Spider Cluster



Hairy Fibrous



Root Growth Occurs Day & Night



Conclusions from Poplar Studies

- Poplars will root and grow, from cuttings, in engineered substrate materials.
- Root morphology differences were observed between plants grown in “soil” and those grown in engineered substrate.
- Clonal rankings in most root metrics were preserved across substrates.

Next Steps

- Is growth in engineering medium relevant to field performance?
- Can plantation traits be predicted by x-ray?
- Modifications of the rooting medium.



In collaboration with:
Dr Ronald Zalesny, Northern Research Station
US Forest Service, Rhinelander, WI

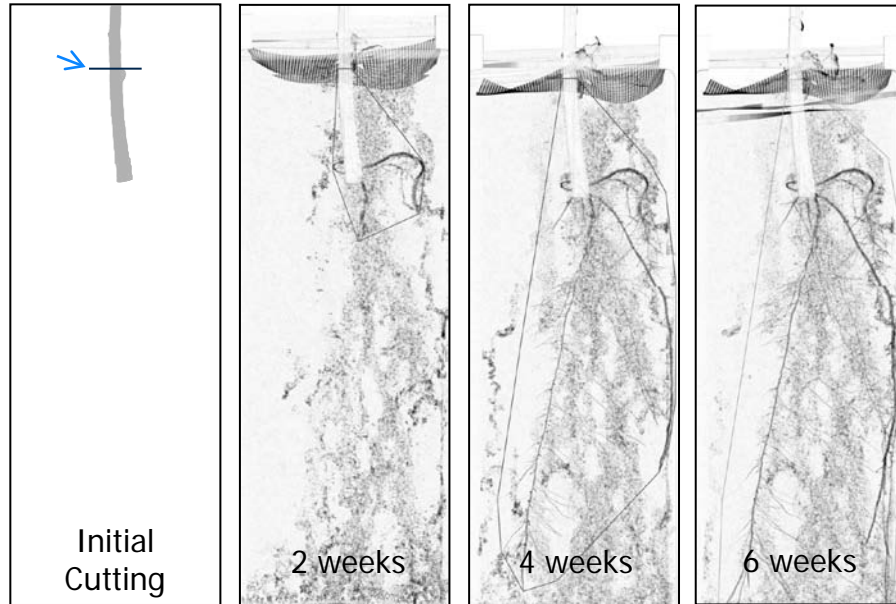


Poplar Rooting Study – Phase II

- 12 poplar clones: 3 genomic groups
 - *P. deltoides* x *P. nigra* (5 clones)
 - *P. deltoides* x *P. maximowiczii* (5 clones)
 - *P. nigra* x *P. maximowiczii* (2 clones)
- Field Growth
 - Destructive Harvest years 1 & 2
- Growth Chamber
 - LWR engineered rooting matrix

USDA Phase II – Data Collection

Engineered Rooting Medium



1 Growth Season Excavated Roots

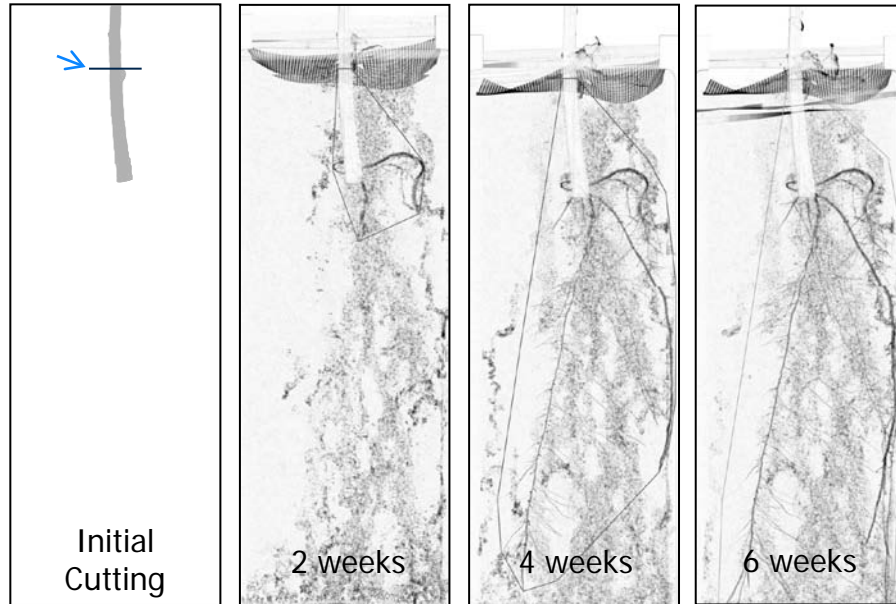


Common root data types

- Length
- Diameter
- Angle of descent
- Coarse vs fine
- Rooting space
- Distance from top

USDA II – Data Collection

Engineered Rooting Medium



1 Growth Season Excavated Roots



What about UN-common root data types?

We welcome input from the root research community.

Acknowledgements



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