

Progress Report

Intraspecific Hydraulic Responses of Commercial Tree Seedlings to Nursery Drought Conditioning

CAFS.20.78

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- In 2019, the USA produced 1.3 billion tree seedlings planted across 2.5 million acres, a 9% increase since 2012 (Haase et al. 2020)
- Federal interest to increase reforestation efforts and seedling production for Federal, State, and private lands:
 - **REPLANT Act** (Sens. Stabenow (MI) & Portman (OH); Reps. Panetta (CA) & Simpson (ID))
 - **Solving Our Shortages for Seedlings Act (SOS)** (Rep. Bentz (OR))
 - **Trillion Tree Act** (Reps. Fulcher (ID) & Westerman (AR))



Haase, D.L. *et al.* Tree Planters' Notes 63(2): 26-31



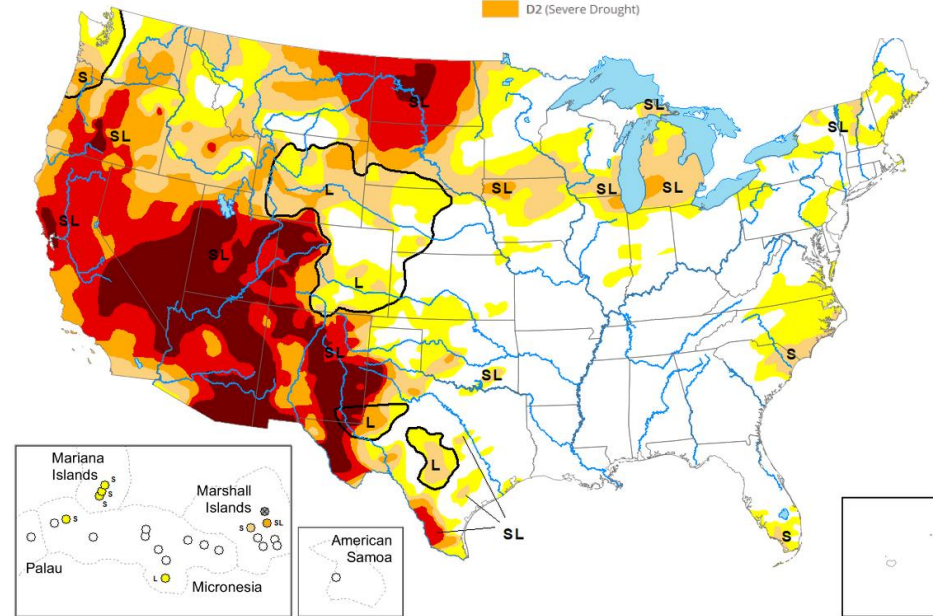
Justification

Current Drought Conditions

Map released: May 20, 2021

Data valid: May 18, 2021

Intensity and Impacts



<https://forest-atlas.fs.fed.us>

<https://droughtmonitor.unl.edu>



Center for Advanced Forestry Systems 2021 Meeting



Our **objective** is to examine seedling physiology and root system architecture in response to nursery-induced drought conditioning and subsequent drought of coastal Douglas-fir, western larch, and black walnut seed sources across a range of maternal tree environments

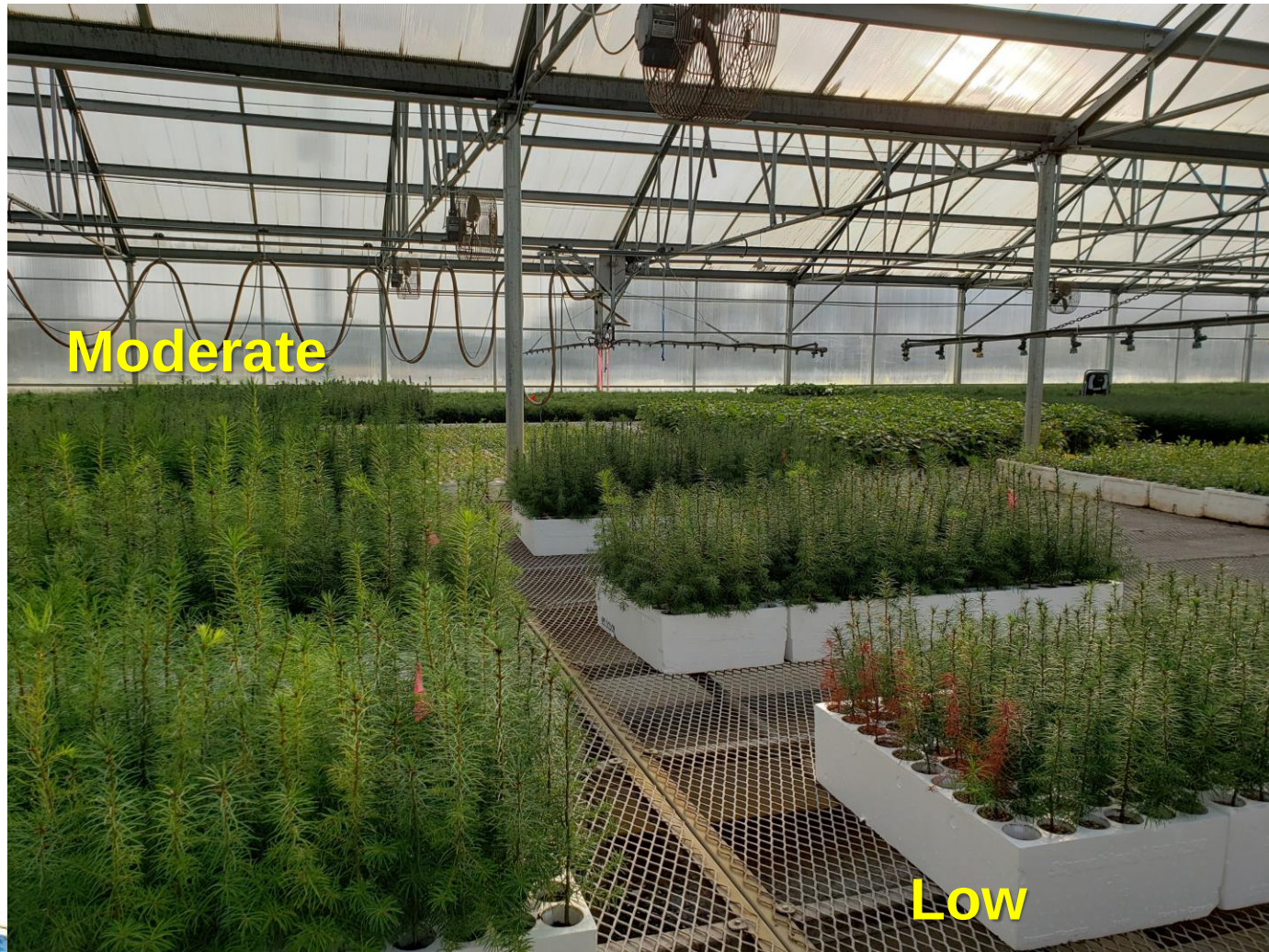


Nursery drought conditioning treatments (summer 2020)

- Douglas-fir, western larch, and black walnut seedlings from different seed sources were grown from various seed under three different watering regimes
- Douglas-fir:
 - 3 seed sources: Coast Range, Inland, and Cascade Foothills
 - 3 watering regimes: Control (75% moisture), Moderate (60% moisture), and Low (50% moisture)
- Western larch:
 - 8 seed sources (diverse seed source site climates in BC and INW)
 - 3 watering regimes: Control (75% moisture), Moderate (60%-75% moisture), and Low (45-60% moisture)
- Black walnut:
 - 3 seed sources (Kansas, Indiana, and Maryland)
 - 3 watering regimes: Control (85-95% moisture), Moderate (75-85% moisture), and Low (55-65% moisture)



Douglas-fir



Western larch



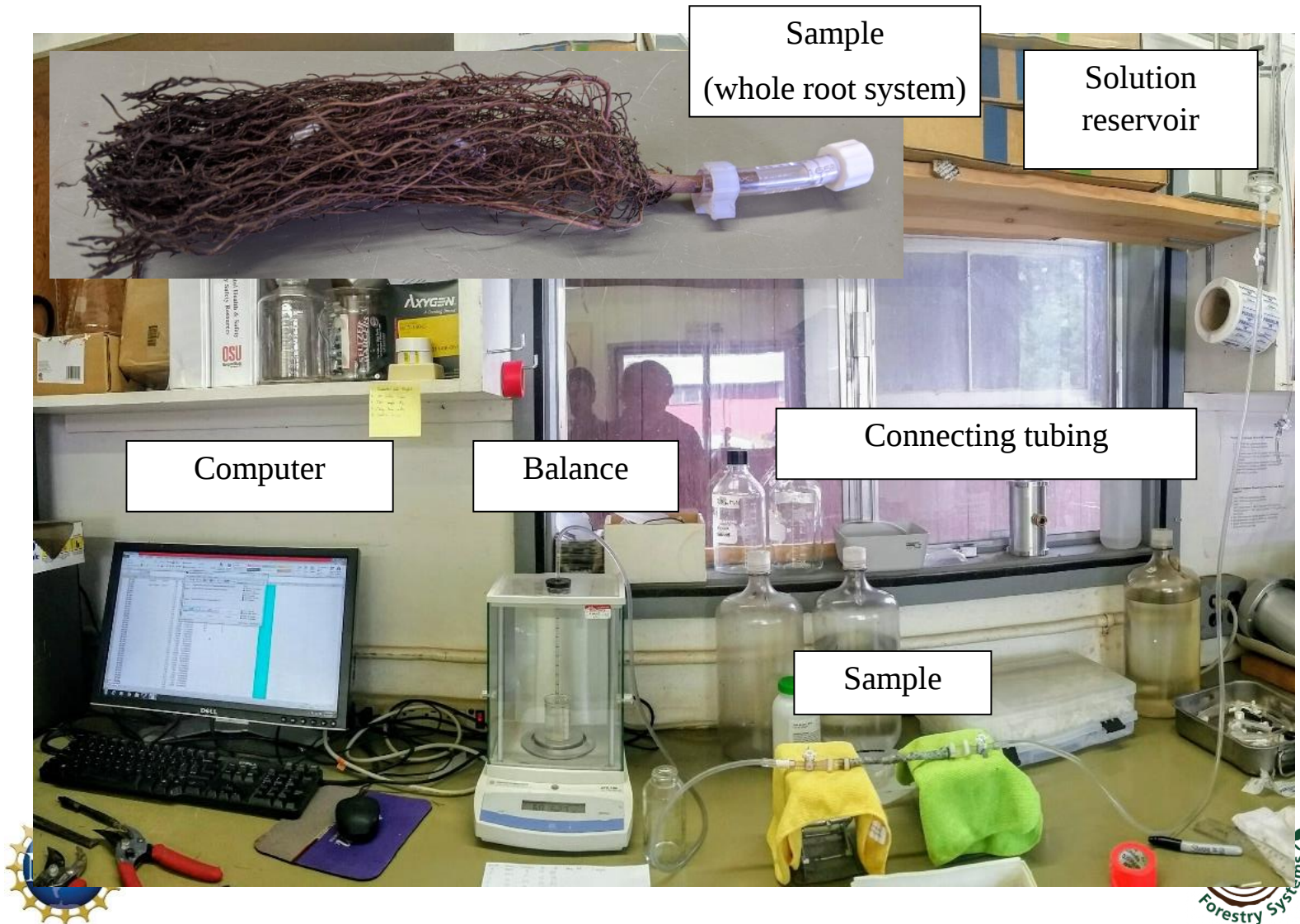
Black walnut



Hydraulic Conductivity Methods

July 2020 – Pre-treatment

October 2020 – Post-treatment



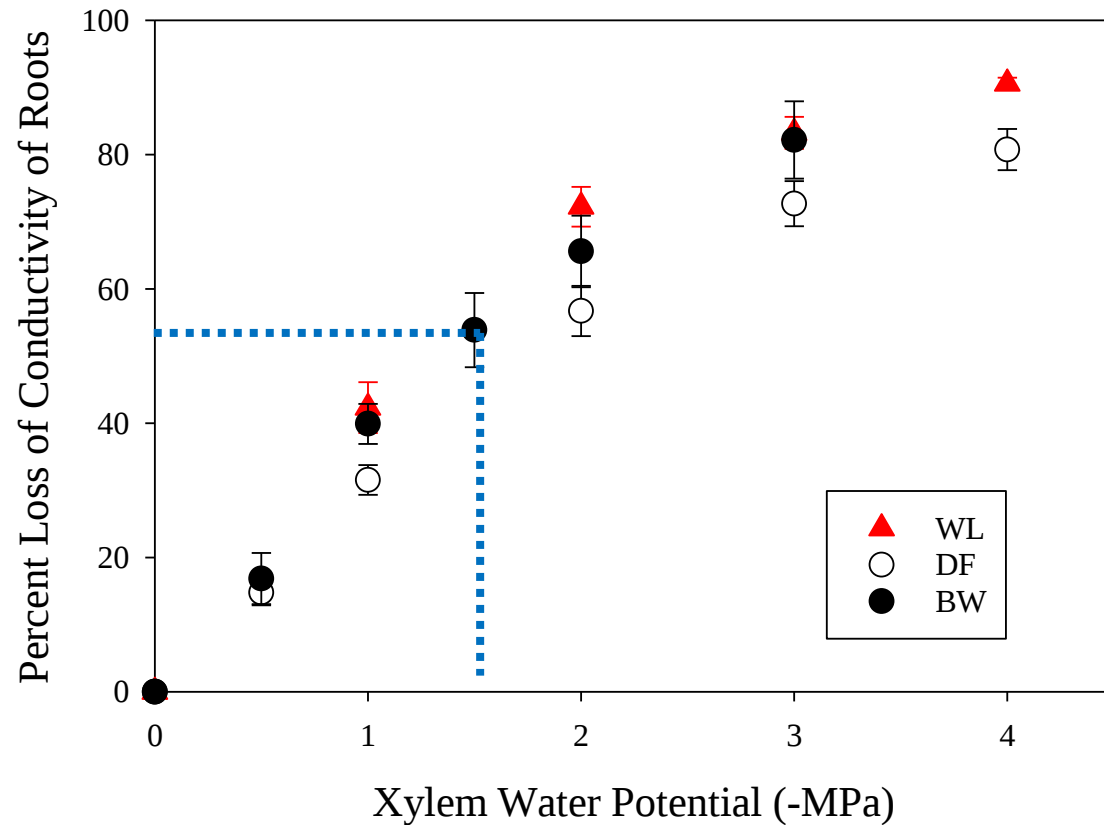
Purdue University Controlled Environment Phenotyping Facility



Outplanting



Pre-treatment Root Hydraulic Conductivity

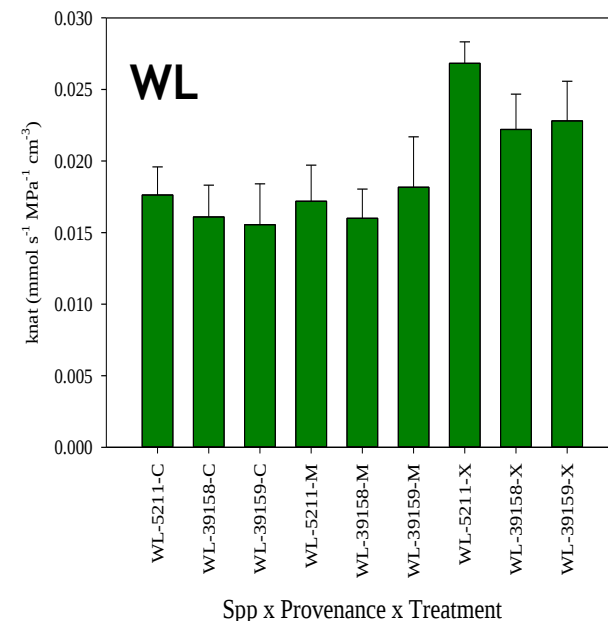
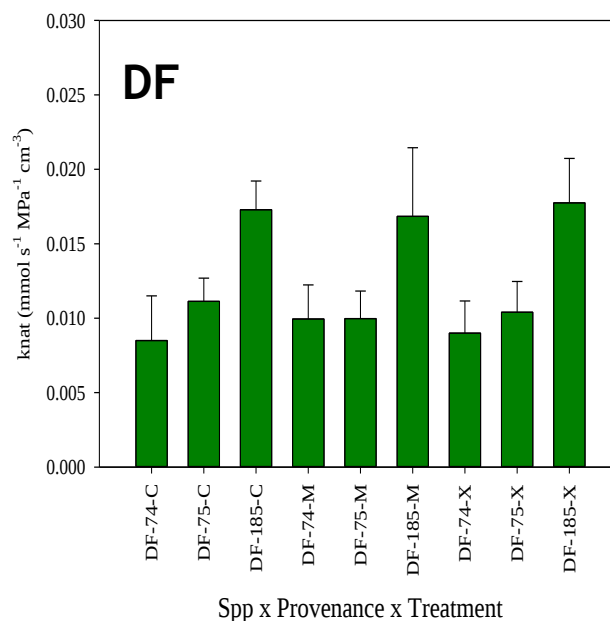
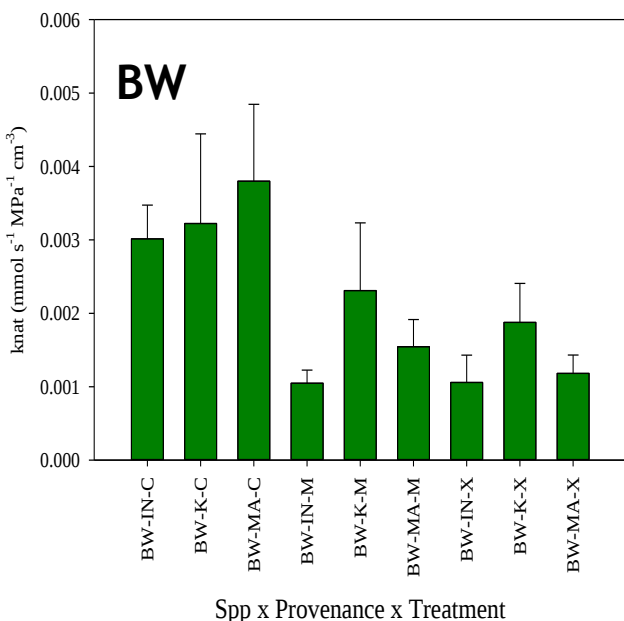


Root Vulnerability to Cavitation

Ψ_{50} (-Mpa)
 WL = 1.41
 DF = 1.99
 BW = 1.50



Root hydraulic conductivity at the end of the growing season



Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	0.00000613	0.00000307	0.77	0.4686
Trt	2	0.00005198	0.00002599	6.51	0.0028
Prov*Trt	4	0.00000500	0.00000125	0.31	0.8681

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	0.00056266	0.00028133	8.50	0.0009
Trt	2	0.00000013	0.00000007	0.00	0.9980
Prov*Trt	4	0.00001017	0.00000254	0.08	0.9889

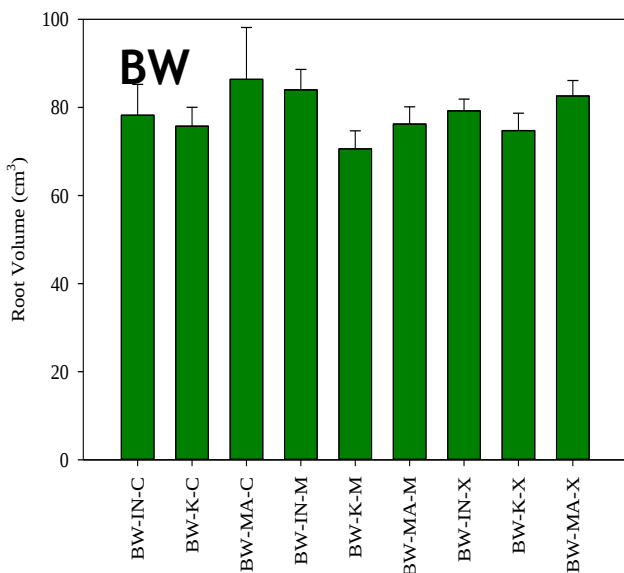
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	0.00003229	0.00001615	0.43	0.6534
Trt	2	0.00048566	0.00024283	6.47	0.0036
Prov*Trt	4	0.00002563	0.00000641	0.17	0.9522

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Spp	2	0.00837778	0.00418889	174.94	<.0001
Trt	2	0.00013184	0.00006592	2.75	0.0668
Spp*Trt	4	0.00041650	0.00010413	4.35	0.0023



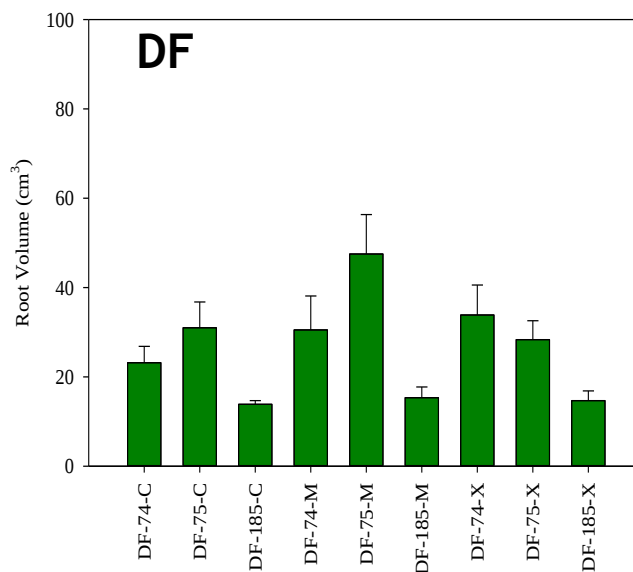
Major Findings

Root volume at the end of the growing season



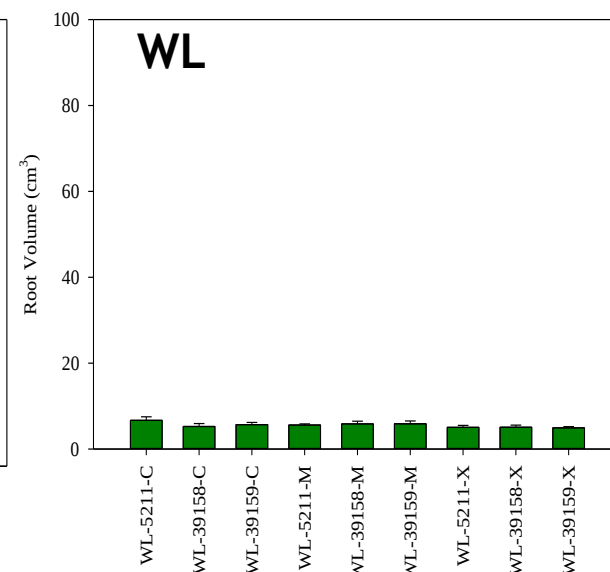
Provenance x Treatment

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	898.8611111	449.4305556	1.72	0.1874
Trt	2	122.1111111	61.0555556	0.23	0.7923
Prov*Trt	4	566.2222222	141.5555556	0.54	0.7057



Spp x Provenance x Treatment

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	4166.370370	2083.185185	12.18	<.0001
Trt	2	661.370370	330.685185	1.93	0.1564
Prov*Trt	4	996.185185	249.046296	1.46	0.2313



Spp x Provenance x Treatment

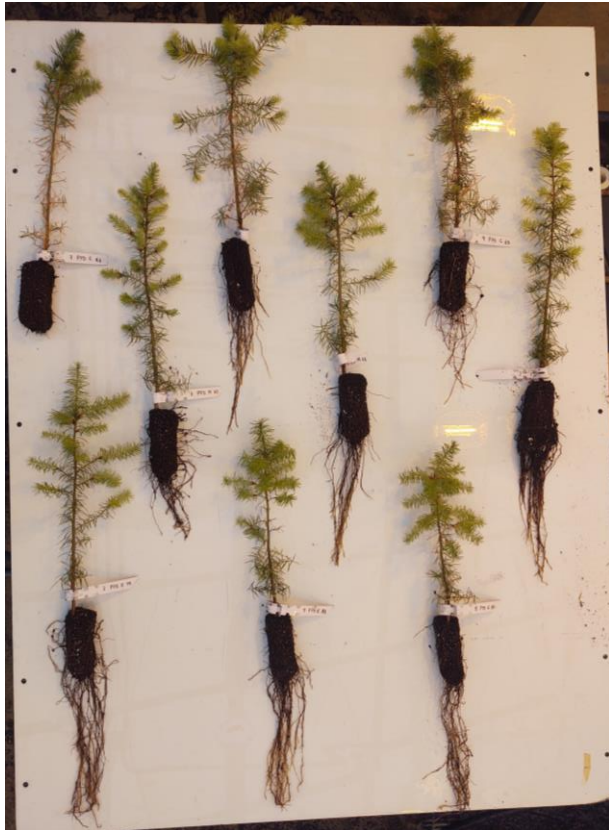
Source	DF	Type III SS	Mean Square	F Value	Pr > F
Prov	2	0.10037037	0.05018519	0.02	0.9764
Trt	2	7.20481481	3.60240741	1.72	0.1911
Prov*Trt	4	1.74074074	0.43518519	0.21	0.9329

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Spp	2	181783.1945	90891.5972	503.28	<.0001
Trt	2	109.1519	54.5760	0.30	0.7396
Spp*Trt	4	729.8882	182.4720	1.01	0.4036



DF following Phenotyping Facility experiment

Provenance 75



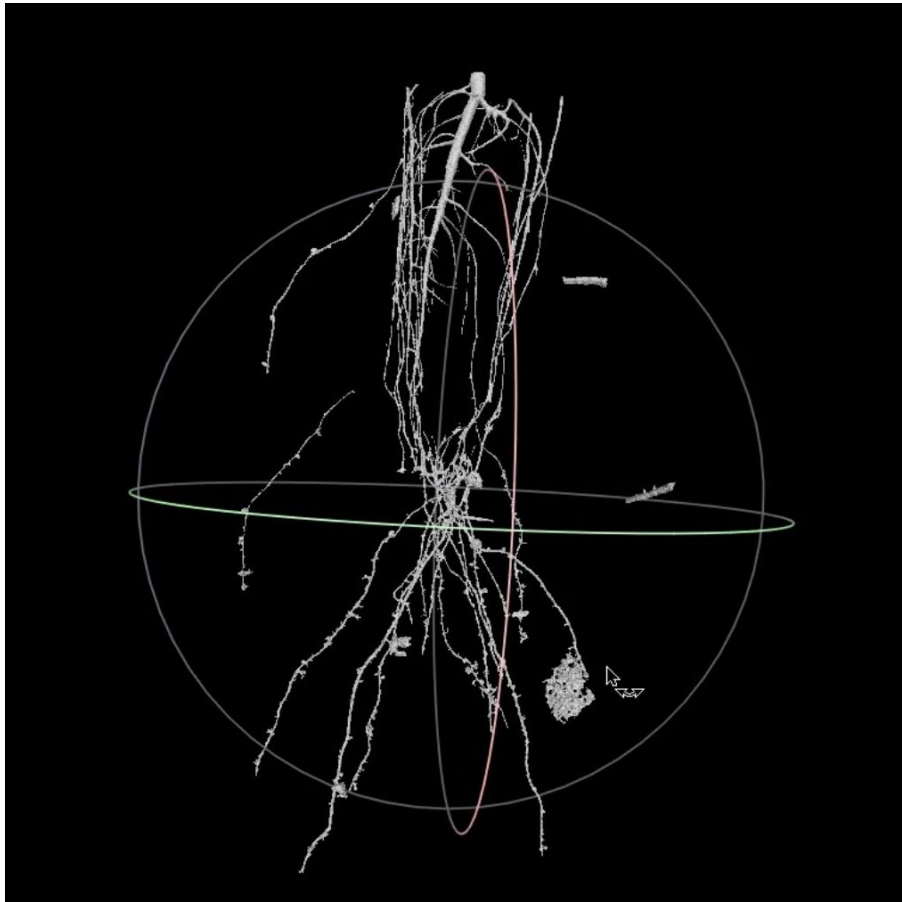
Provenance 185



Provenance 74



DF following Phenotyping Facility experiment



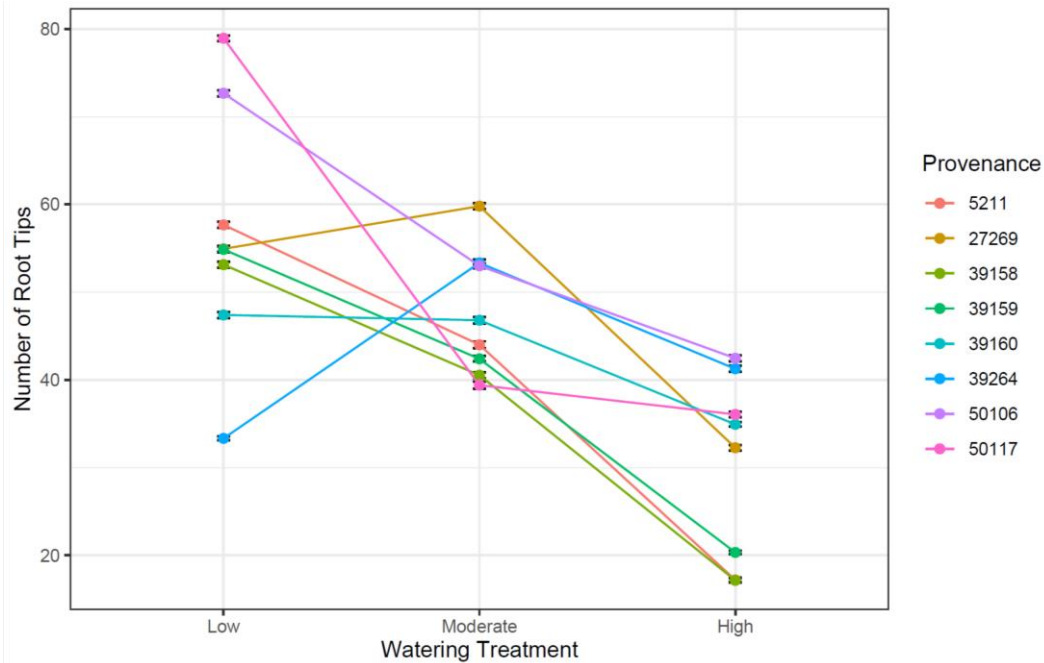
Major Findings

WL (family 50117) roots following aeroponic chamber growth

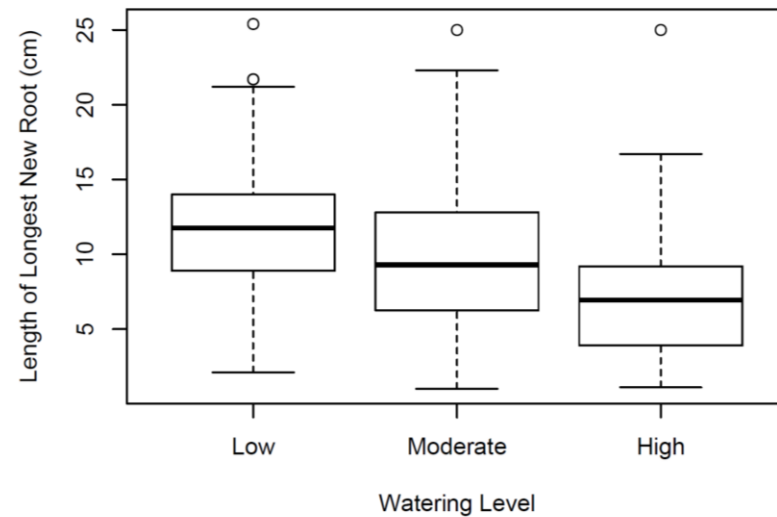


WL roots following aeroponic chamber growth

Count of new roots



Length of longest new root



- Species-specific drought conditioning protocols for western larch, Douglas-fir, and black walnut that may help produce seedlings that can better tolerate drought conditions in the field.
 - May help reduce reforestation costs associated with replanting failed plantations



- Concluded nursery phase of the project testing different drought conditioning regimes
 - Growth, biomass allocation, gas exchange, plant moisture stress, root hydraulic conductivity
 - **Black walnut:** greatest conductivity for control seedlings, minimal difference between Moderate and Low treatments
 - **Douglas-fir:** conductivity did not vary by treatment, but family 185 had much greater conductivity than other two families
 - **Western larch:** conductivity did not differ between families, but the low treatment had much greater conductivity than the Control and Moderate treatments. Low treatment also had significantly greater new root production under optimal lab conditions
- Phenotyping facility project currently underway. Douglas-fir seedling are complete. Western larch seedlings are currently in their experiment, followed by black walnut
- Seedlings have been outplanted in their respective regions and will be monitored for growth and physiology during this growing season

