Resistance of *Pinus taeda* families against *Leptographium* root fungi and assessment of family morphological traits linked to *Leptographium* infection

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Pine Decline in Southeastern US

- First observed in 1959 in Talladega National Forest
- Sparse chlorotic crowns, excessive cone crop, fine and lateral root deterioration
- Misdiagnosed as little leaf disease

Pine Decline in Southeastern US

- Complex Interactions
- Abiotic and biotic factors
- Silvicultural disturbances
- Insect-fungal complex
- *Leptographium* spp.

***Leptographium* spp.**

- Anamorphs of genus *Grosmannia*
- *L. procerum*
- *L. terebrantis*
- *L. serpens*
- *L. huntii*

Pinus taeda L.

- Commercially grown pine species
- 13.4 million ha in the South (45% of all pine plantations)
- 7 million acres in Alabama
- 110,000 jobs and $30 billon to economy

Loblolly Pine Improvement

- 1.5 billion seedlings- genetically improved
- Growth rate, wood properties and disease resistance
- Many other diseases- genetically controlled (Schultz, 1997)
- Virulence of *Leptographium* spp. tested on pine species (Matusick G, 2010)

Photos-NC State Cooperative tree improvement Program

Objectives

Resistance screening study

- Determine the resistance of *Pinus taeda* families against *Leptographium* spp.
- Characterize the families based on their resistance levels

Nutrition Study

- Assess the family morphological traits linked to *Leptographium* root infection

Hypotheses

Resistance screening study

- *Pinus taeda* families have variable levels of resistance
- Families can be characterized according to their level of resistance

Nutrition Study

- The more carbon allocation to the root system, the higher the resistance
- Higher nitrogen levels decrease resistance against *Leptographium* spp.

Rayonier

10-5-RYN(L-5)
7-56-RYN(L-8)
11-1123-RYN(L-12)
7-1037-RYN(L-16)
5-1507-RYN(L-17)
**W-34-RYN(S-2)
**I-09-RYN(S-3)
**K-13-RYN(S-4)
**W-18-RYN(S-5)

Plum Creek
Growing Value from Exceptional Resources

7-1040-PC(L-6)
11-1095-PC(L-7)
08-103-PC(L-13)
11-1153-PC(L-14)
05-005-PC(L-18)
**A-05-PC(S-1)

Rayonier Regeneration Center Glennville, GA

ARBORGEN

10-83-AG(L-20)
5-1033-AG(L-21)
10-500-AG(L-22)
11-1066-AG(L-23)
*LB-A02-05 10-1027X(L-1)
*LB-G69-09 7-1505 M(L-2)
*LB-A13-09 1-656 M(L-3)
*LB-A12-07 5 204 M(L-4)

Weyerhaeuser

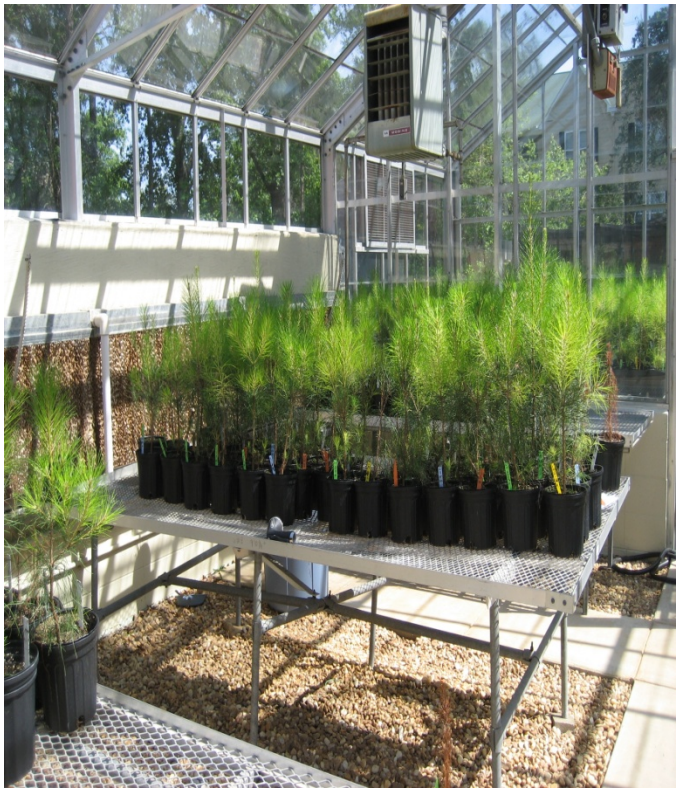
181210-WY(L-9)
41059-WY(L-10)
81516-WY(L-11)
211005-WY(L-15)
111060-WY(L-19)

* Not grown at Glennville
** Slash pine

Work done on Project

Resistance screening study

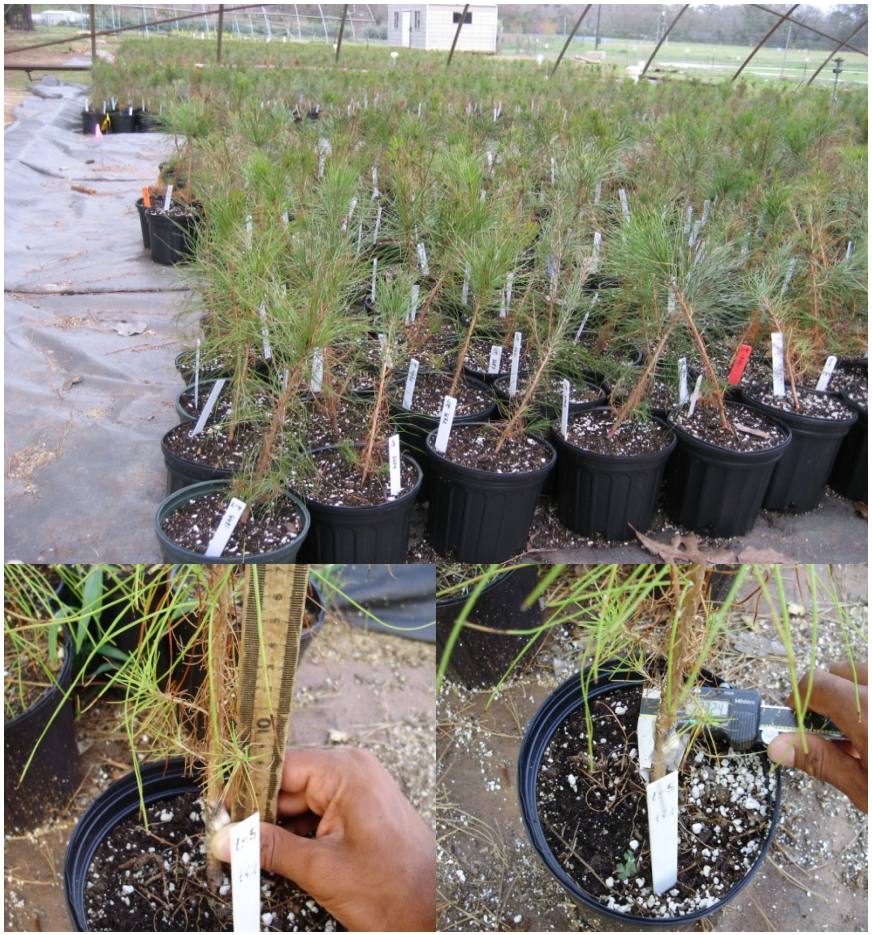
Nutrition Study



Work done on Project

Resistance screening study

- Twenty eight families-pot planted during first week of January
- Six blocks-840 seedlings per block
- Growth measurements-initial and final



Work done on Project

Resistance screening study

- Inoculations-12 weeks after planting
- Six treatments-*L. procerum, L. terebrantis, L. serpens, L. huntii,* wound+media control and wound control
- Five seedlings per treatment per family per block
- Wound inoculation method (Nevill et al. 1995)

Photos-Yuan Zeng

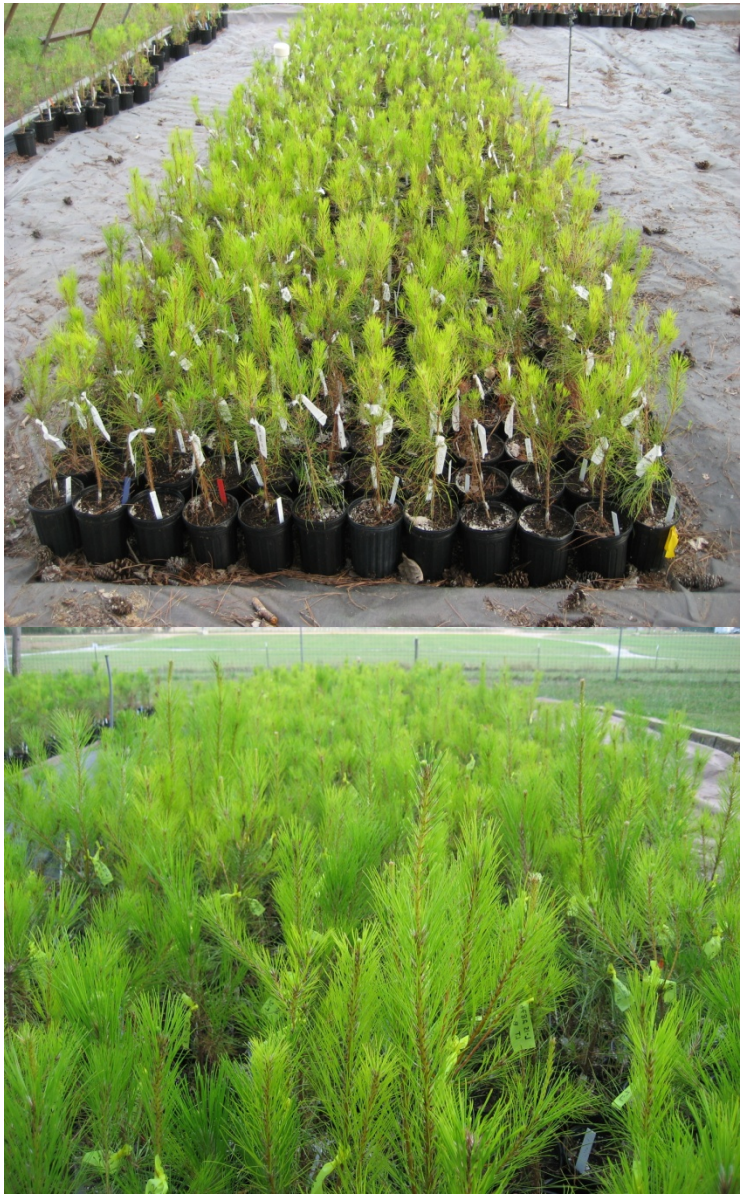
Hailstorm Damage

Resistance screening study

Work done on Project

Resistance screening study

- Harvesting-12 weeks after inoculations
- Four blocks harvested
- Data recording-final growth measurements
- Seedling alive/dead



Work done on Project

Resistance screening study

- Shoots separated from root system
- Shoots kept in Fast green solution

Work to be done on Project

Resistance screening study

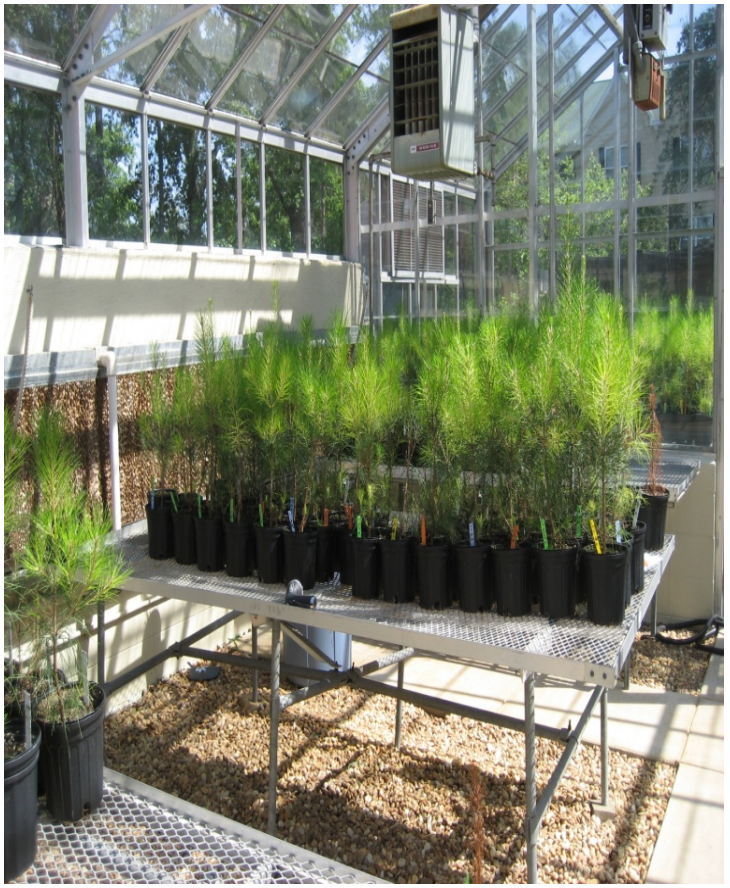
- Lesion length
- Occluded vascular tissue
- Biomass studies
- Re-isolation
- Data analysis

Photos-George Matusick

Nutrition Study

- Subset of *Pinus taeda* families used

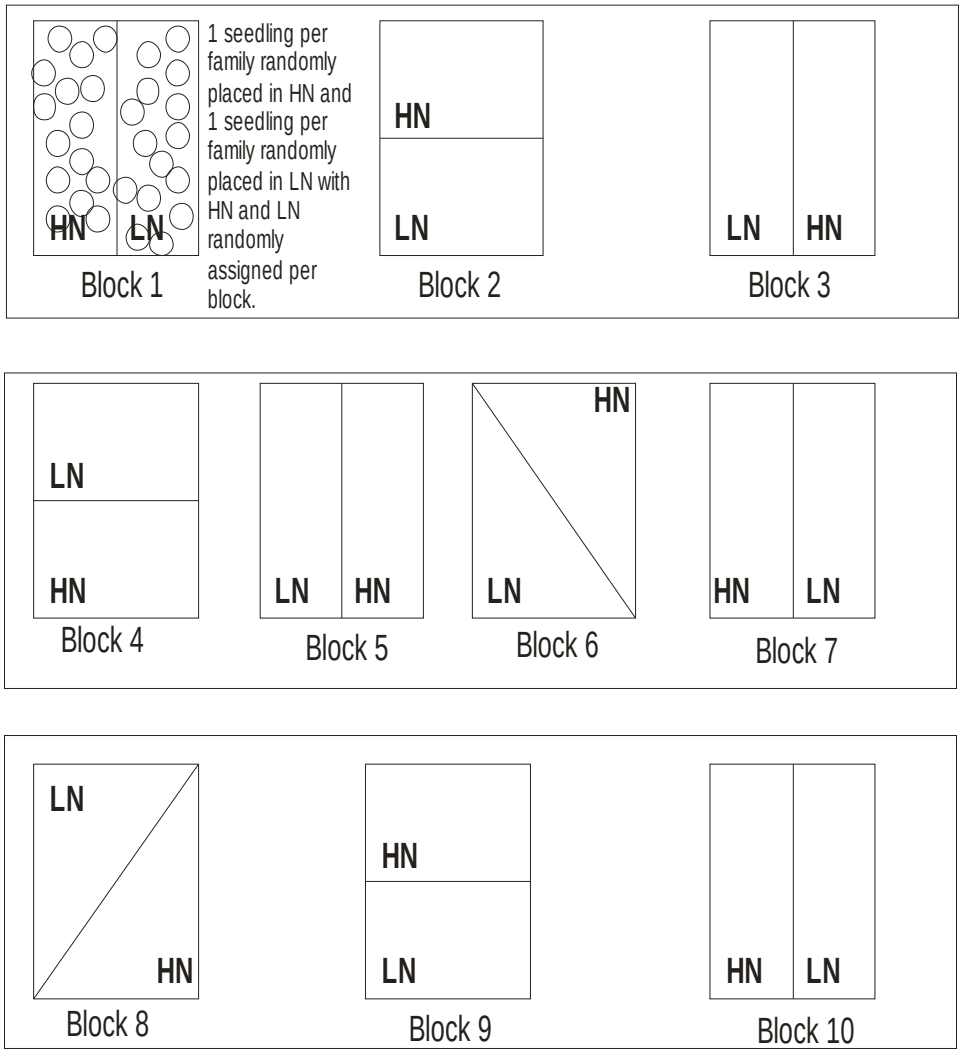
  7-1040-PC (L-6)
  7-56-RYN (L-8)
  05-005-PC (L-18)
  10-5-RYN (L-5)
  11-1123-RYN (L-12)
  08-103-PC (L-13)
  11-1095-PC (L-7)
  181210 –WY (L-9)
  10-500-AG (L-22)
  7-1037-RYN (L-16)
  11-1066-AG (L-23)
  41059-WY (L-10)
  81516-WY (L-11)
  LB-A02-05 10-1027X (L-1)
  LB-G69-09 7-1505M (L-2)



Work done on Project

Nutrition Study

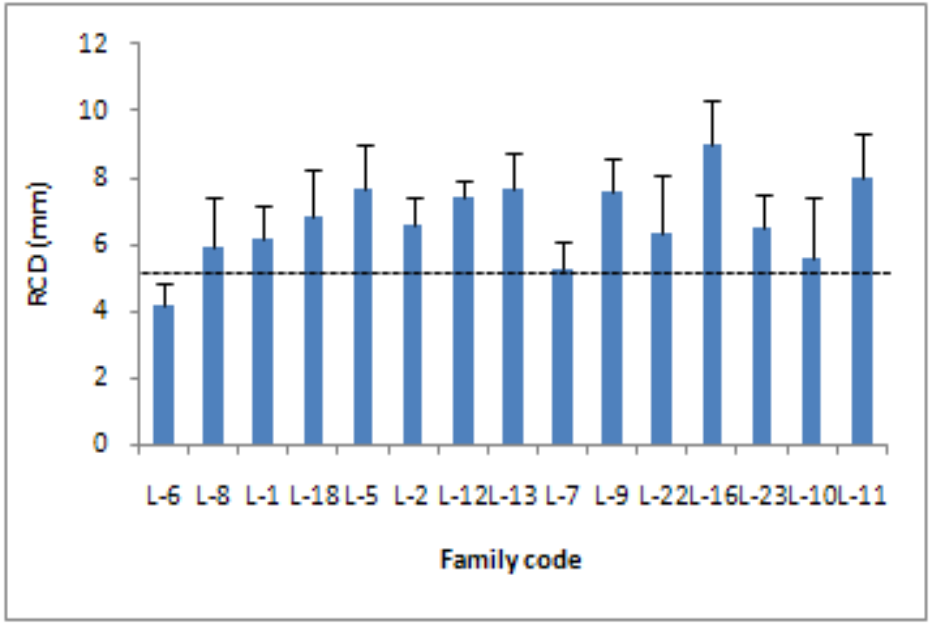
- Fifteen families-twenty seedlings each
- RCB split plot design-ten blocks, 30 seedlings/block
- Either high or low nitrogen (HN, LN) applied twice a week

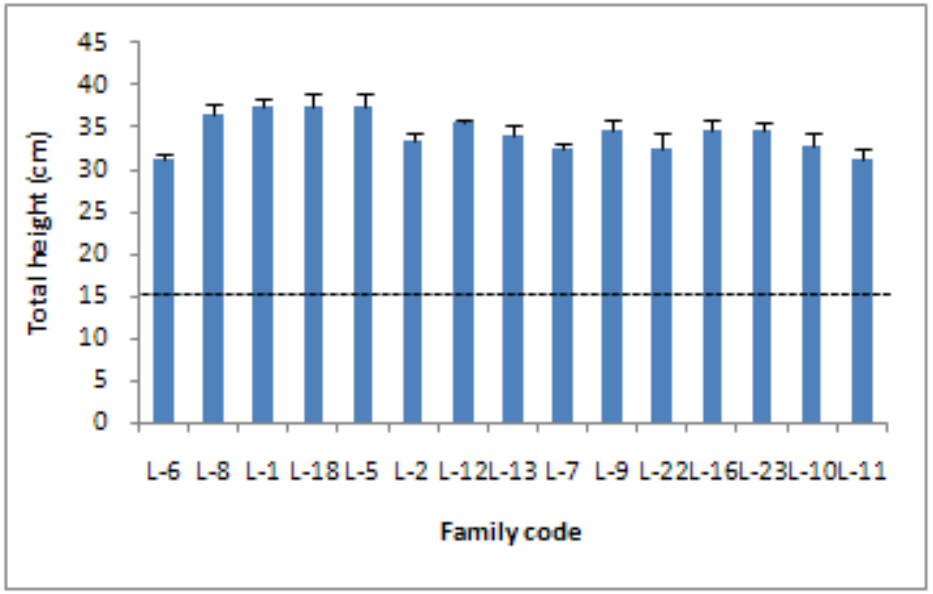


Work done on Project

Nutrition Study

- Ideal seedling quality for loblolly pine
- RCD>5 mm
- Height 15-25 cm
- RDW>0.8 g
- R:S>0.4 (Duryea and Dougherty 1991)

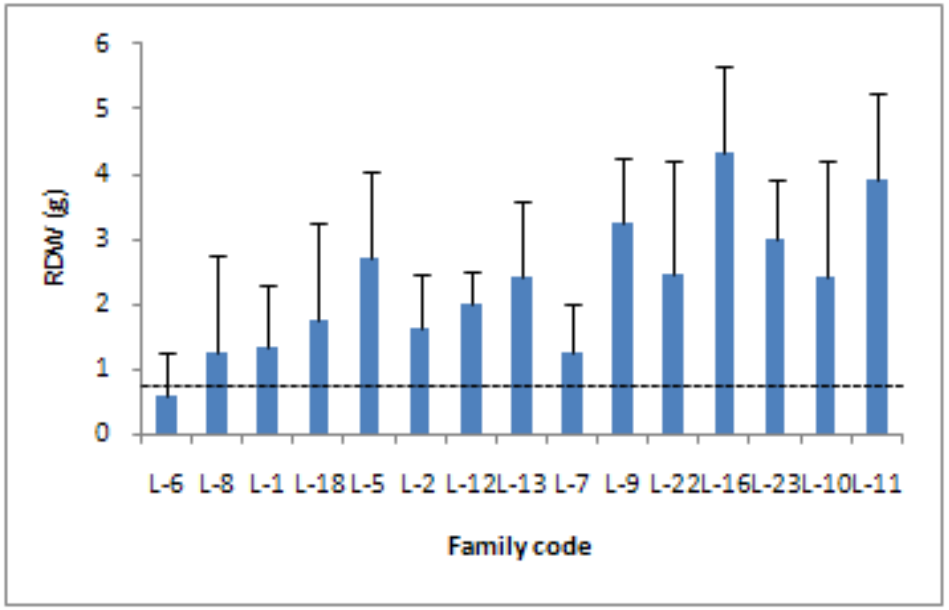


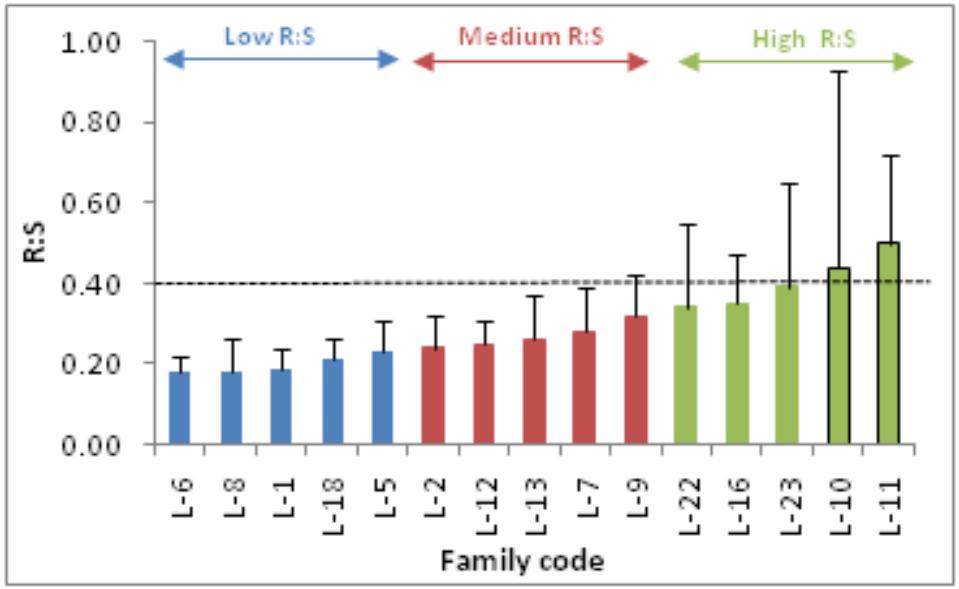


Work done on Project

Nutrition Study

- Families divided into three groups
- Low, medium and High R:S

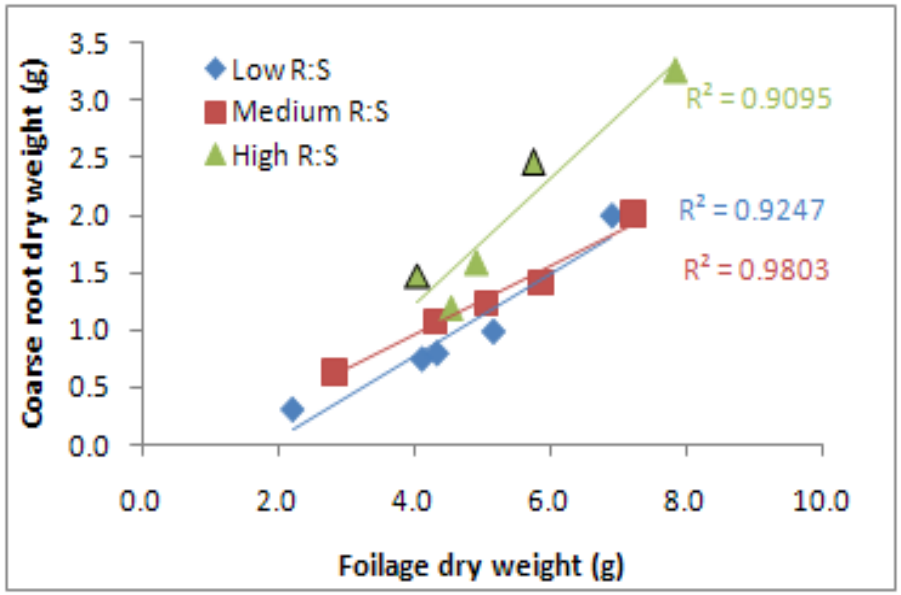


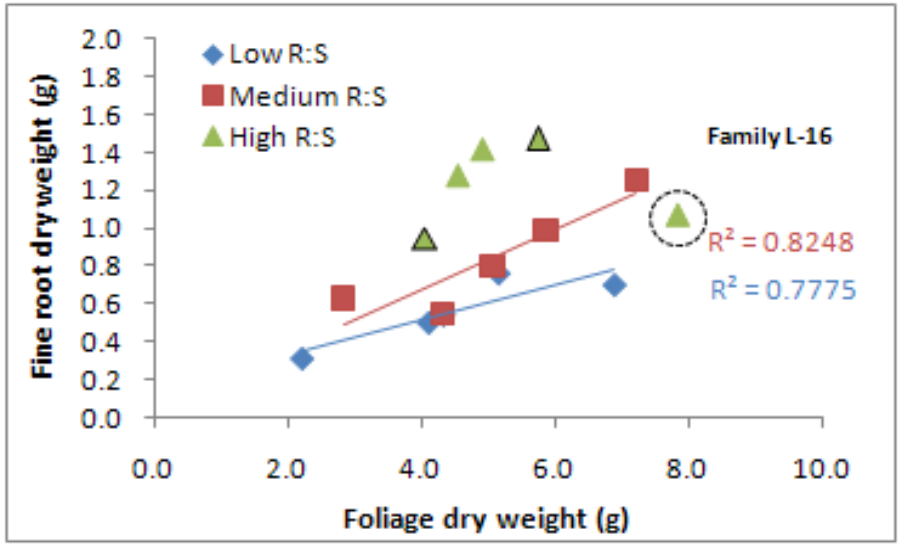


Work done on Project

Nutrition Study

- High R:S families are more variable
- As foliage dry weight increases, C allocation to coarse and fine roots increases
- Family L-16 has low fine dry root weight?





Work done on Project

Nutrition Study

- Growth measurements-three week intervals
- Inoculations-12 weeks after planting with *Leptographium huntii*

Work done on Project

Nutrition Study

- Foliar Nutrient analysis
- Target N concentration LN-1.0%, HN-1.5%
- Ideal foliar P-0.12
- K , Ca & Mg-high
- Micronutrients-adequate

Family	HN/LN	H/L R:S	N(%)	P(%)	K(%)	Mg(%)	Ca(%)
L-8	LN	L	1.05	0.21	1.87	0.22	0.98
L-18	LN	L	1.13	0.25	1.94	0.2	0.92
L-11	LN	H	1.22	0.21	1.61	0.21	0.88
L-23	LN	H	1.01	0.22	1.5	0.21	0.93
L-8	HN	L	1.34	0.2	1.59	0.19	0.79
L-18	HN	L	1.34	0.23	1.84	0.22	1.02
L-11	HN	H	1.25	0.19	1.46	0.19	0.83
L-23	HN	H	1.13	0.2	1.56	0.19	0.83
L-11	HN Chlorotic	H	1.47	0.2	1.71	0.19	1

Work done on Project

Nutrition Study

- Lower N in HN attributed to pot mix
- NH_4^+ adsorbed on exchange sites
- Ca and Mg-cause of Fe chlorosis
- Preventing Fe from being in Fe^{++} (Ferrous)

Work done on Project

Nutrition Study

- Amendments
- N-increased in HN
- Ca and Mg dropped
- P and K decreased
- Micronutrients-adequate

Nutrient concentration(ppm)					
Initial	N	P	K	Ca	Mg
LN	100	30	75	36	18
HN	275	30	75	36	18
Amended	N	P	K		
LN	100	18	23		
HN	350	18	23		

Work to be done

Nutrition Study

- Nutrient water applications-45/54
- Growth measurements-8/10
- Foliage nutrient analysis-six weeks after amendments
- Harvesting-28 weeks after planting
- Total phenolic analysis

Work to be done

Nutrition Study

- Biomass
- Regression analysis-among the families and within each family
- Relationship between lesion area and variables:
  - Nitrogen
  - Phenolic concentration
  - Morphological traits
  - Growth rate
- Re-isolation

Expected Outcomes

Resistance screening study

- Resistant families
- Categorize families according to level of resistance

Nutrition Study

- High nitrogen-decreased resistance
- More carbon allocation-higher resistance

Impacts of research

- Family x site planting decisions for land managers
- Tree breeding programs
- Gene tagging and deployment

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Questions