Project Continuation Proposal

Interactions Among Silviculture, Spacing and Genetics in Loblolly Pine Plantations

CAFS.14.49
FPC RW20

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RW20: Study locations

Piedmont Site
Reynolds Homestead Center, VA
Wood NPP = 5 Mg ha^{-1} yr^{-1}

Coastal Plain Site
Bladen Lakes State Forest, NC
Wood NPP = 10 Mg ha^{-1} yr^{-1}

Santa Catarina Site
Renova Forest, Brazil
Wood NPP = 20 Mg ha^{-1} yr^{-1}

RW20 Treatments
Silviculture x Genetics x Spacing
Split-Split Plot Design

- Mail Plots - Silviculture

  Operational vs Intensive

- Split Plot - Genetics

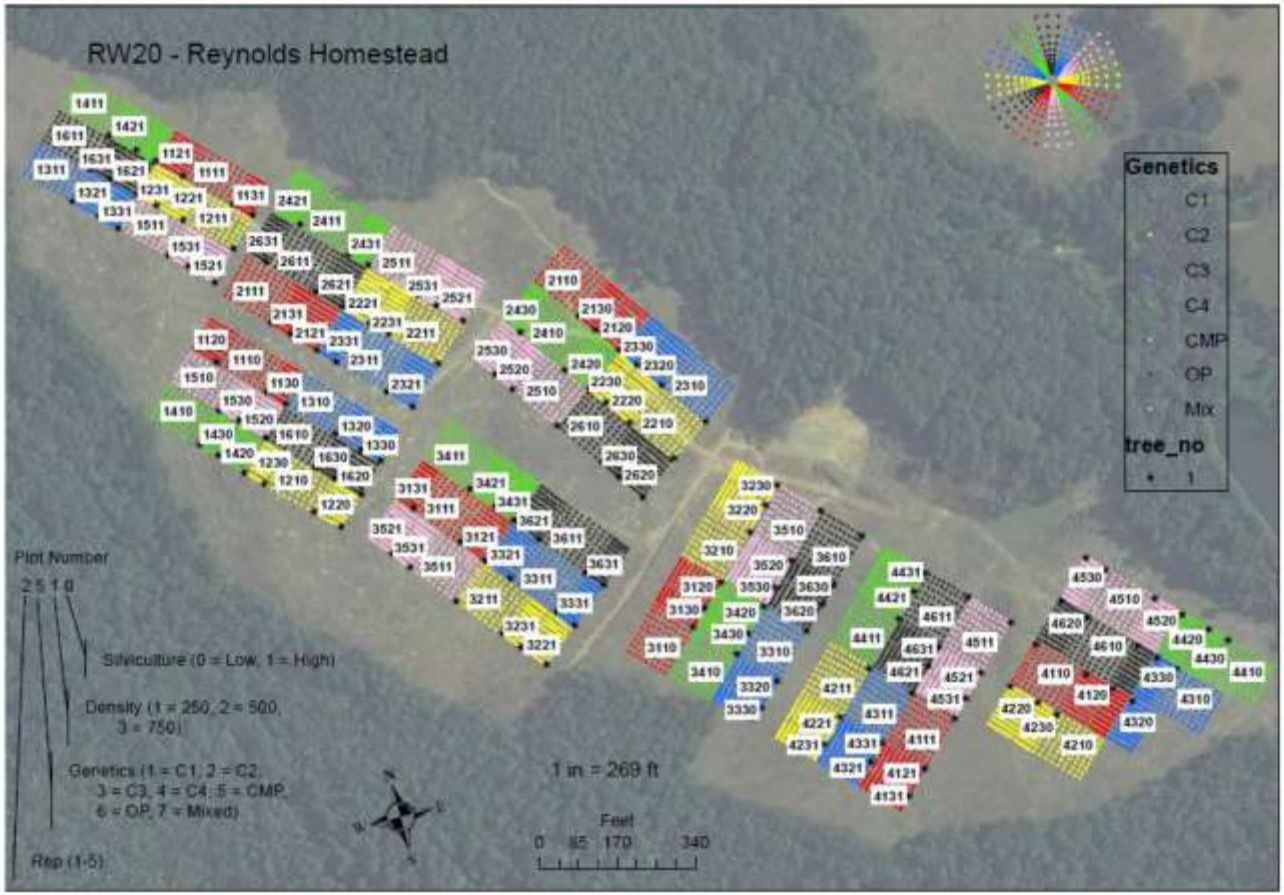
  OP, CMP, Variety 1 (N), Variety 2(B), Variety 3 (N), Variety 4 (B)

  (two narrow crown varieties; two broad crown varieties)

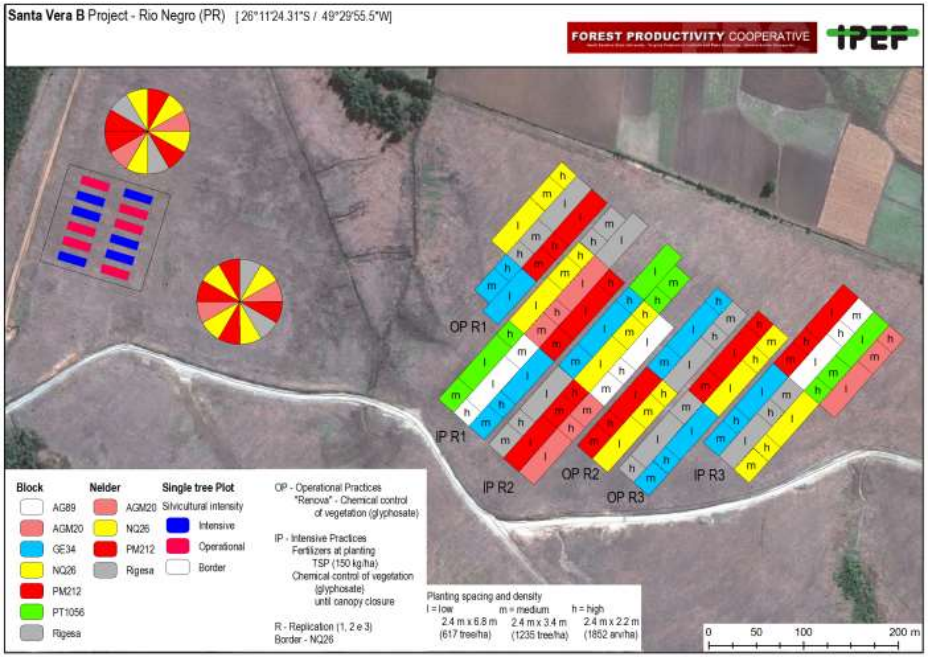
- Split-Split Plot - Spacing

  250 tpa, 500 tpa, 750 tpa

BIG studies up to 144 plots in single study



RW20: Silviculture x Density x Genetics



Sites in Virginia, North Carolina and Brazil

Genotype Differences in Crown Dimensions and Leaf Area

Variety #3
Narrow Crown

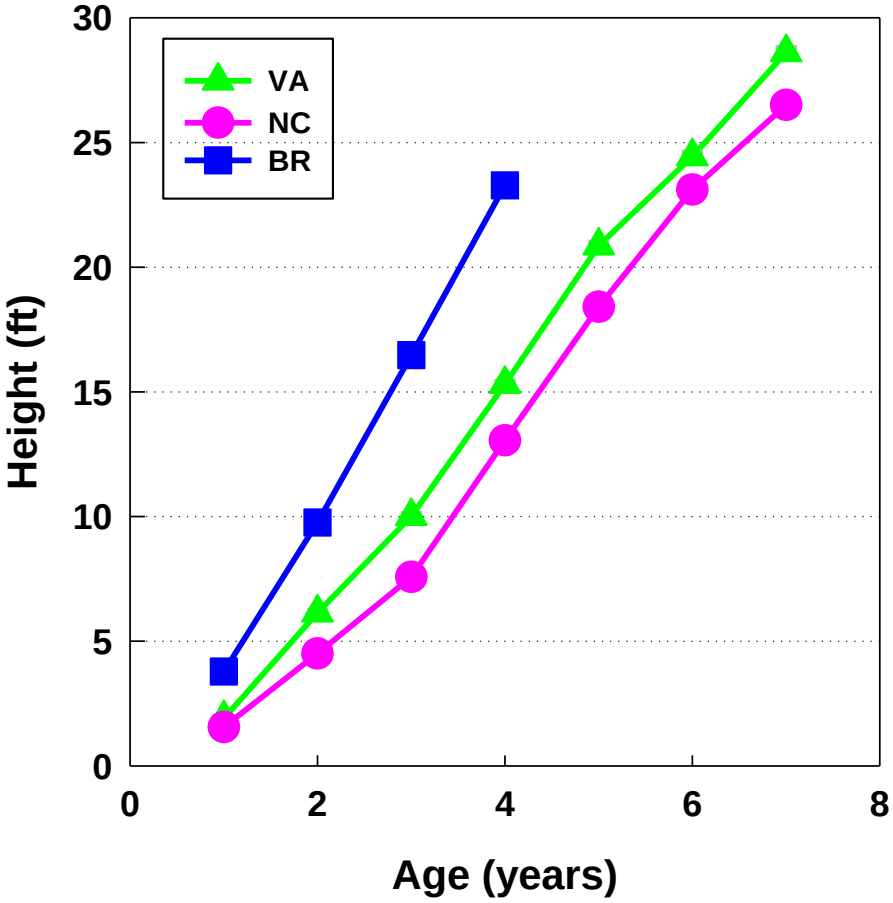
Variety #2
Broad Crown

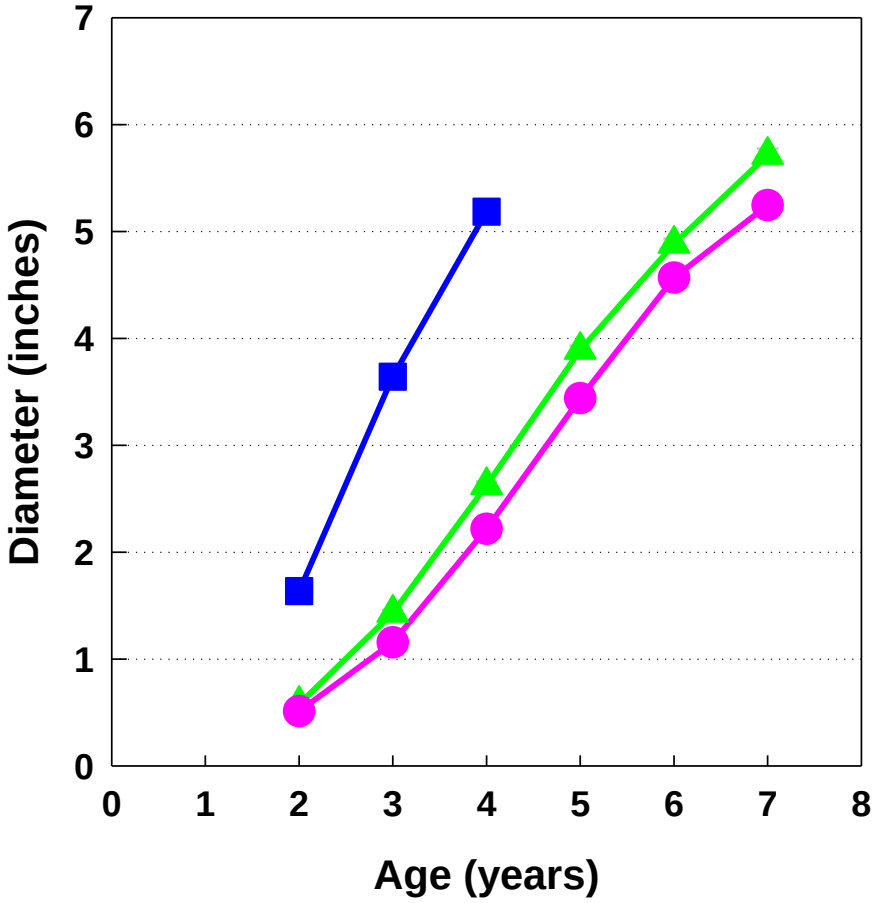
RW20 Reynolds at Age 5
Crown Ideotype

Narrow Crown

Broad Crown

Site effect

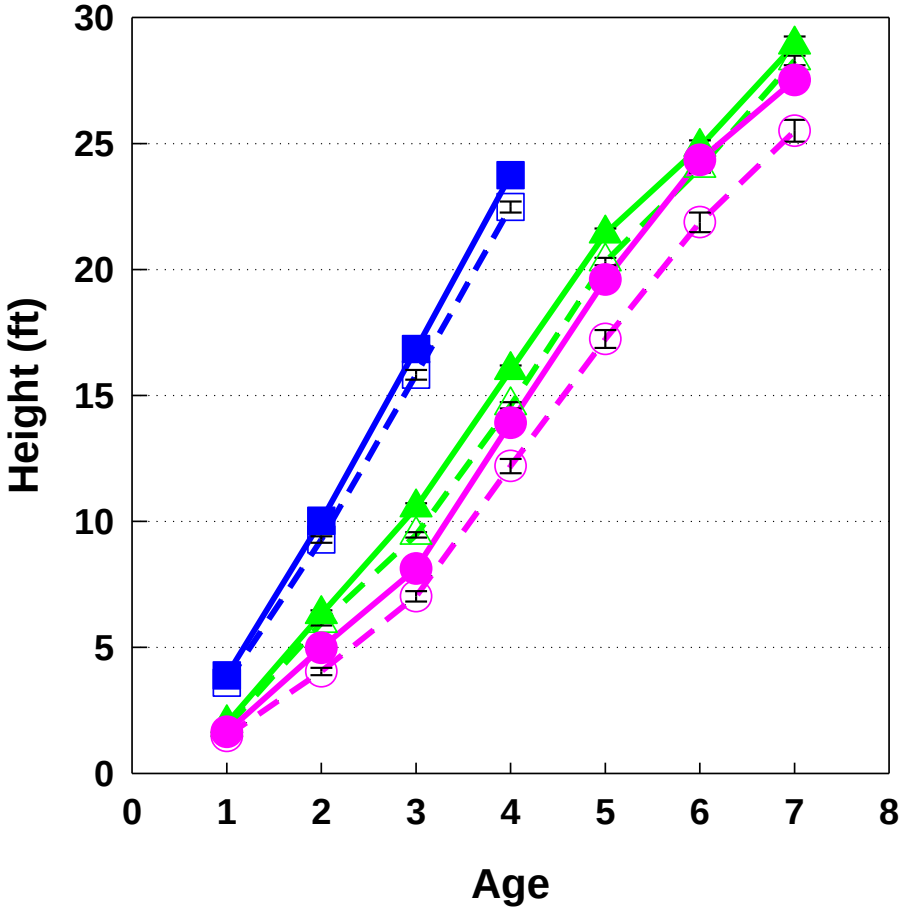

VA
NC
BR
Height (ft)
Age (years)
0
5
10
15
20
25
30
0
2
4
6
8

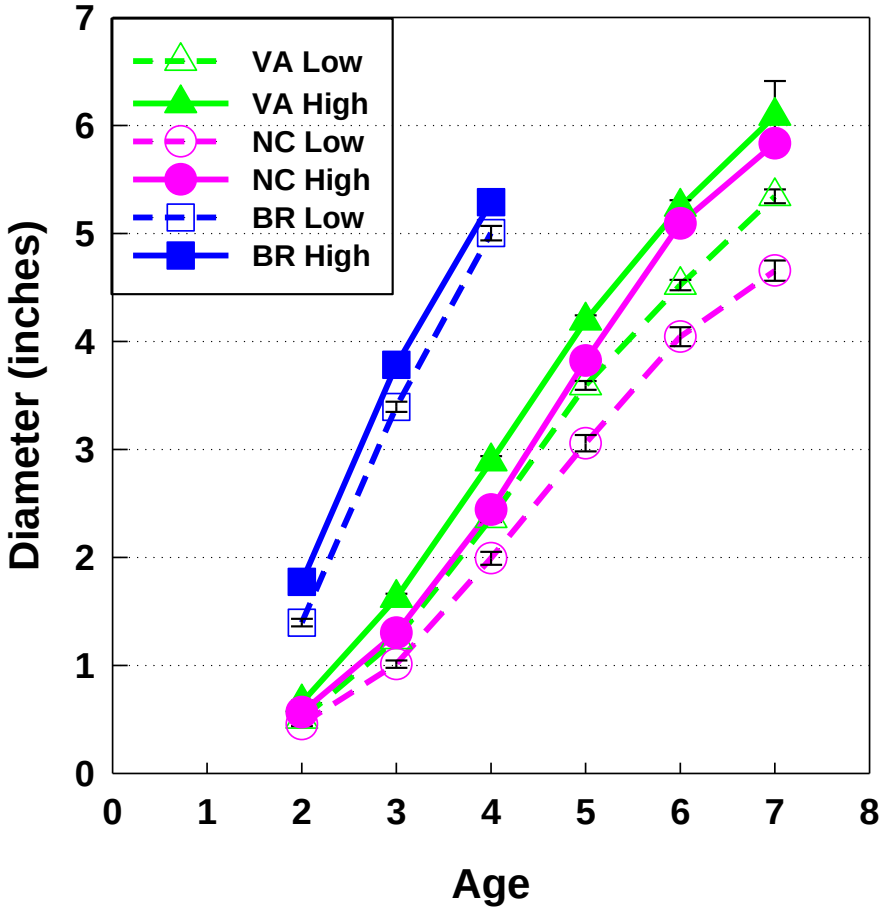

Diameter (inches)
Age (years)
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8

RW20 Reynolds Homestead
Age 4


Brazil Age 4
MAROON
MONSOON

Silviculture





Silviculture: Operational vs Intensive Piedmont VA

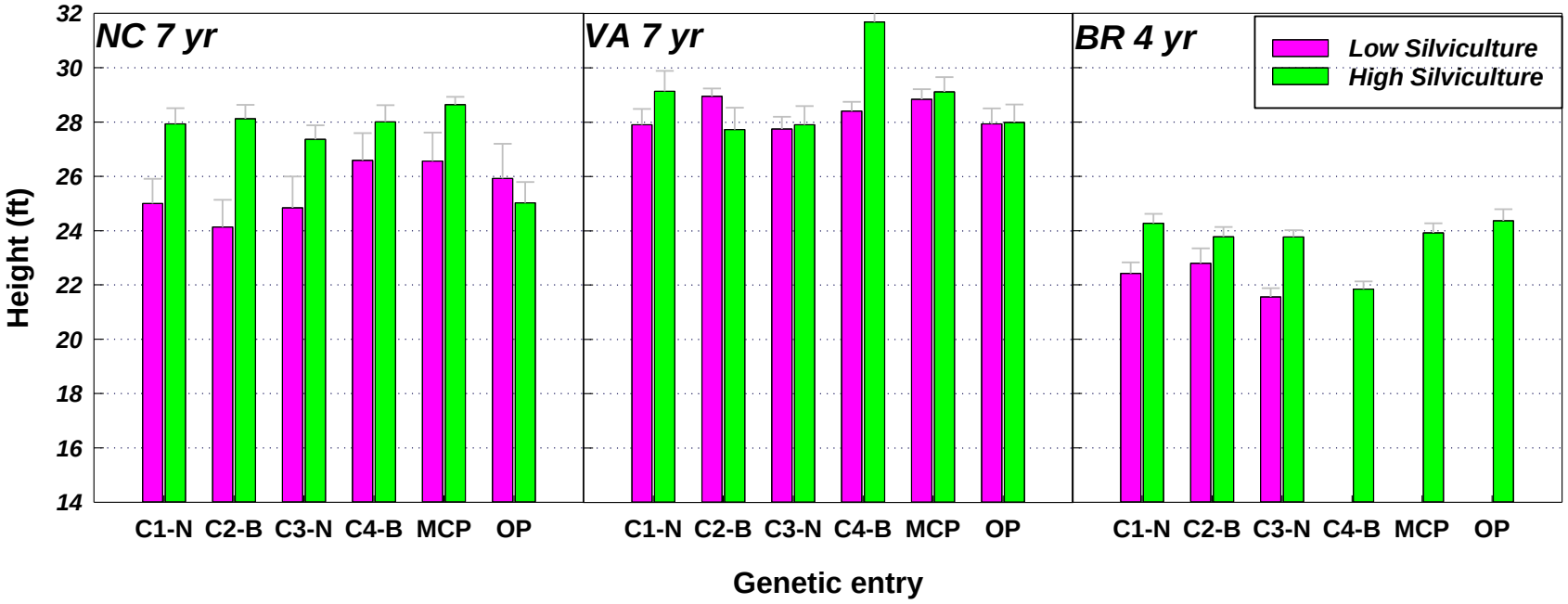



RW20 Reynolds at Age 5 Silviculture

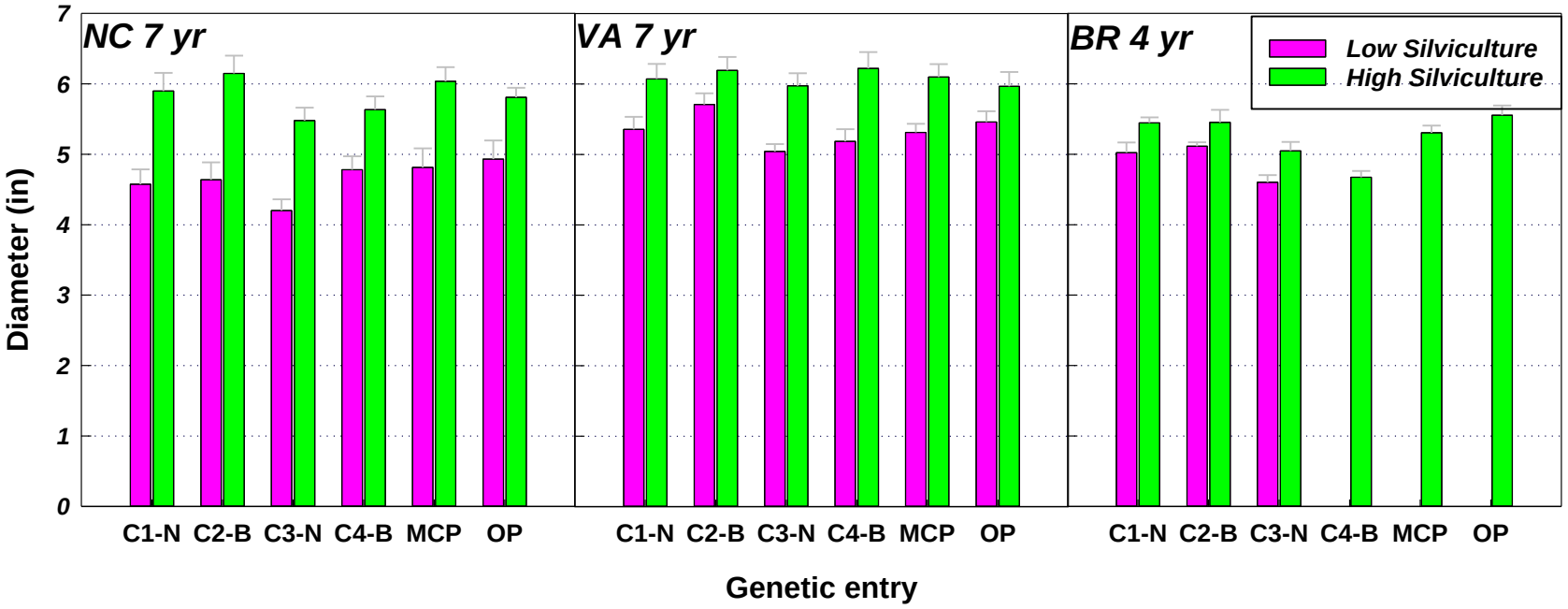
Low Silviculture

High Silviculture

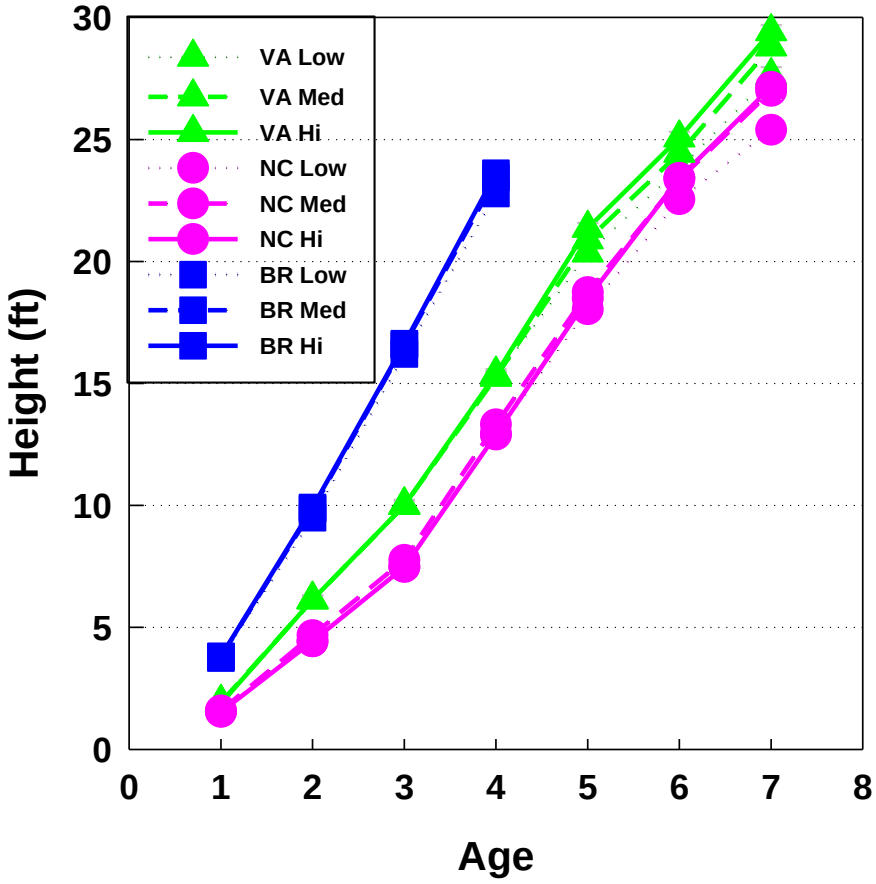
Clone x Silviculture

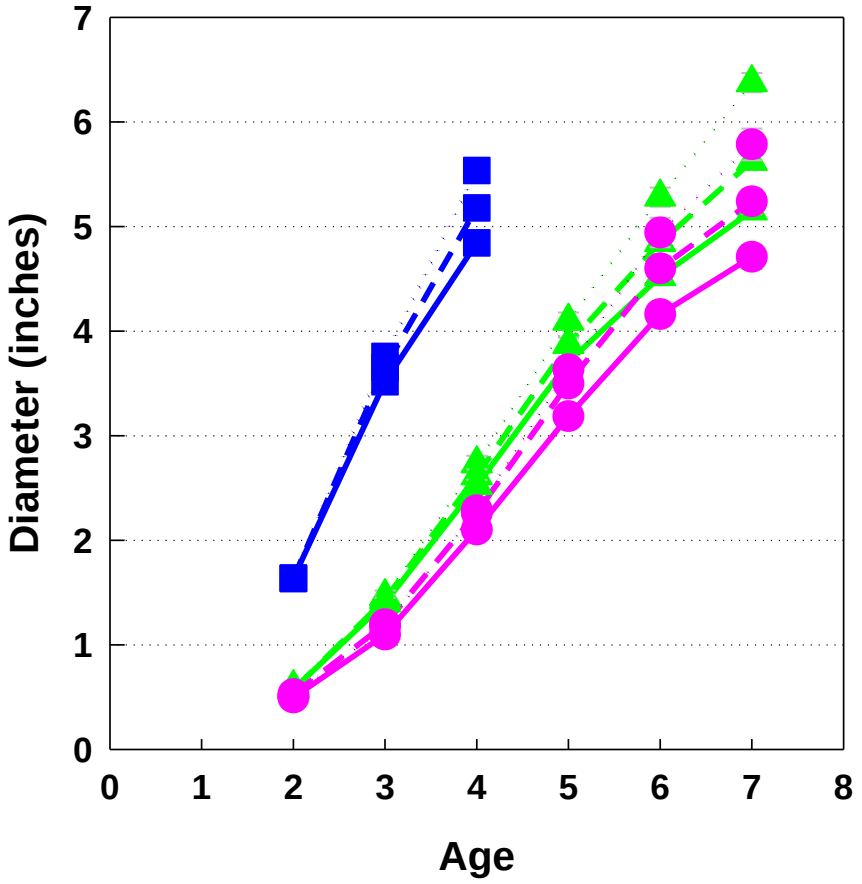


Clone x Silviculture

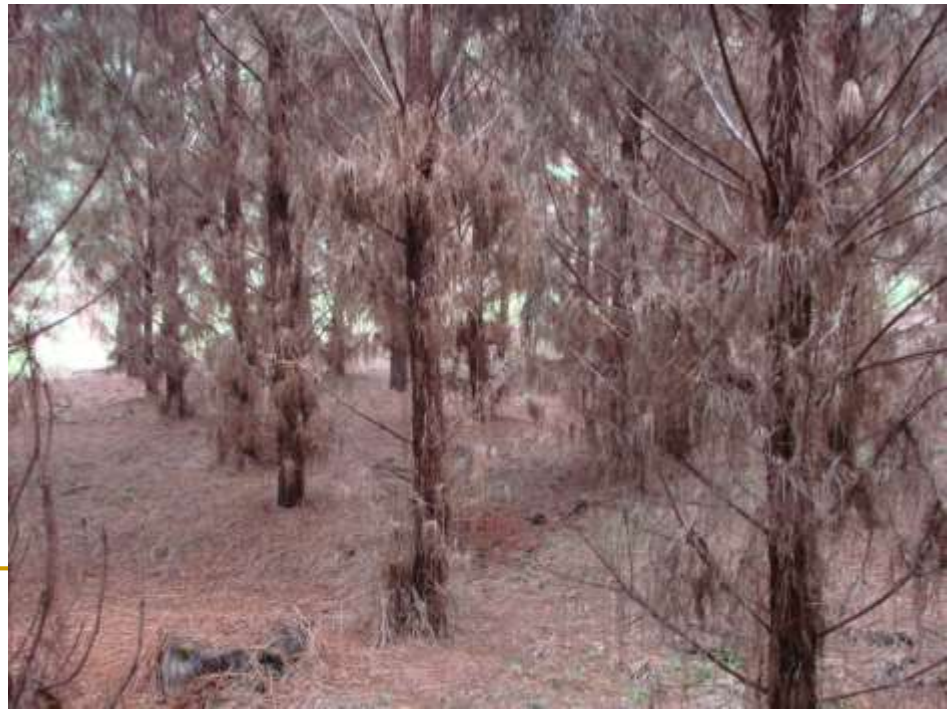


Stocking


VA Low
VA Med
VA Hi
NC Low
NC Med
NC Hi
BR Low
BR Med
BR Hi
Height (ft)
Age
0
5
10
15
20
25
30
0
1
2
3
4
5
6
7
8


Diameter (inches)
Age
0
1
2
3
4
5
6
7
0
1
2
3
4
5
6
7
8

Plot ID: 1531
Spacing: 2.4 x 2.2 m
750 TPA



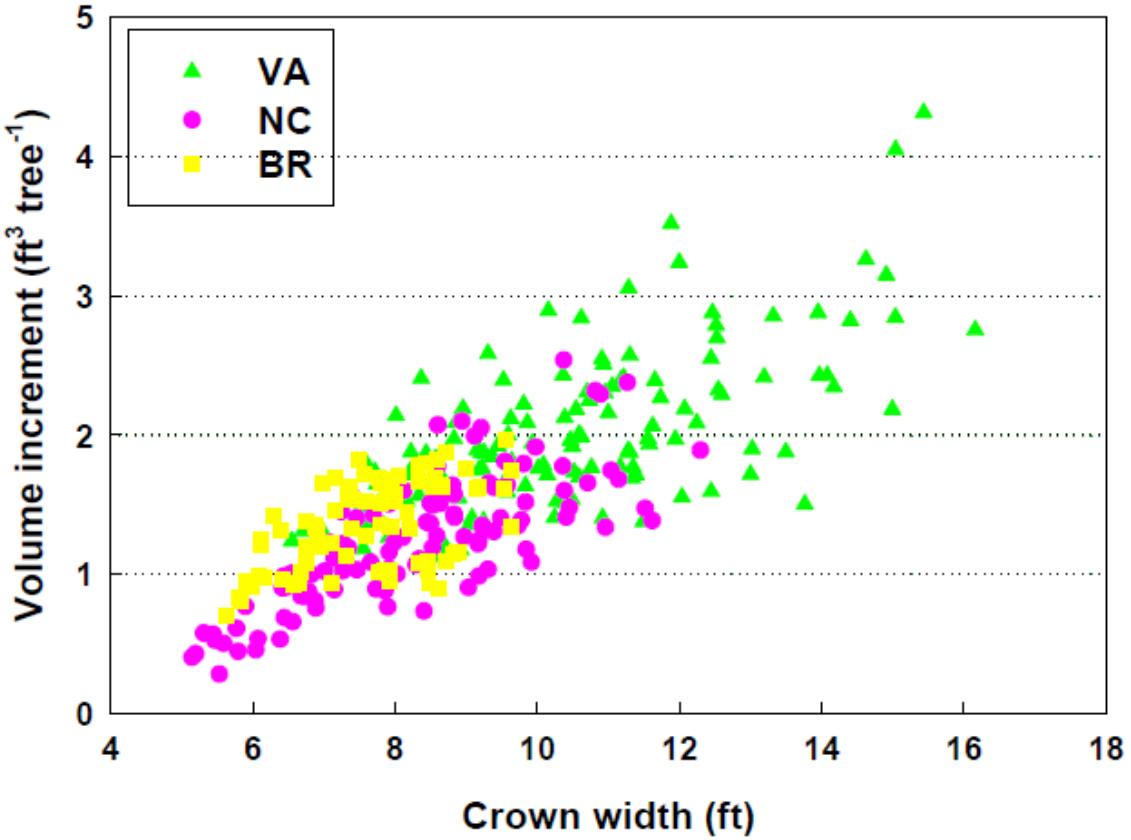
Plot ID: 1521
Spacing: 2.4 x 3.4 m
500 TPA

Plot ID: 1511
Spacing: 2.4 x 6.4 m
250 TPA

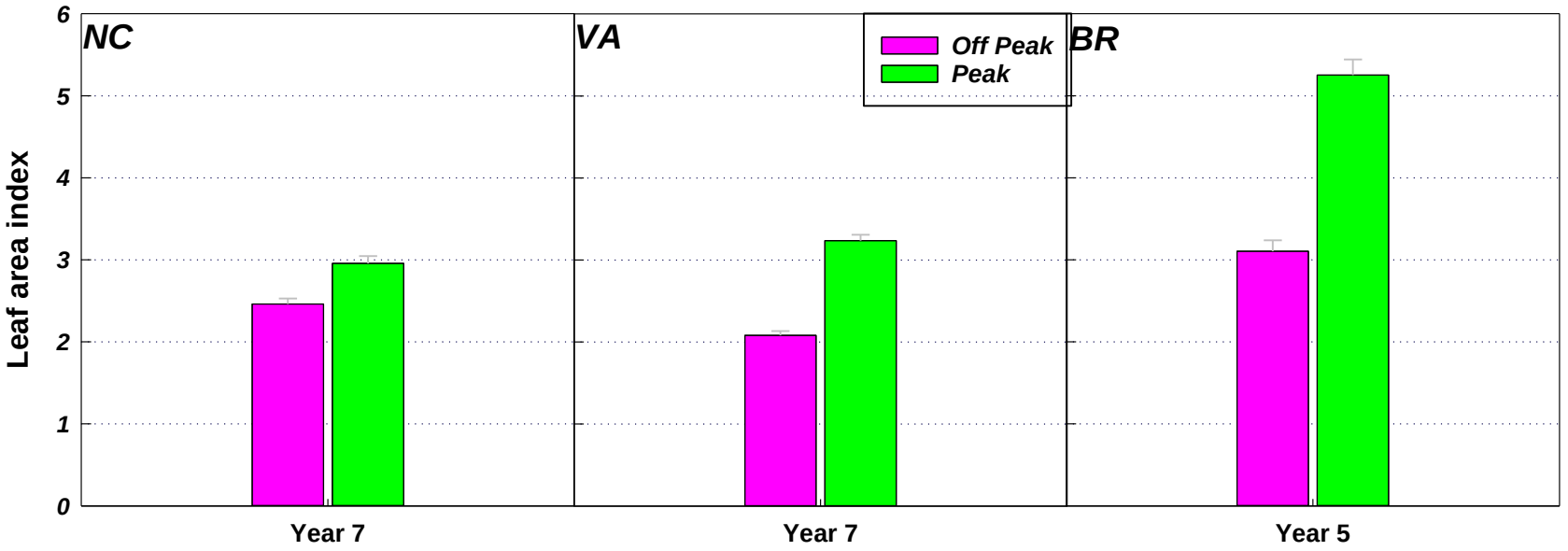
RW20 in Brazil
Nelder Spacing Study

Nelder SI
Genotype ID: 1141

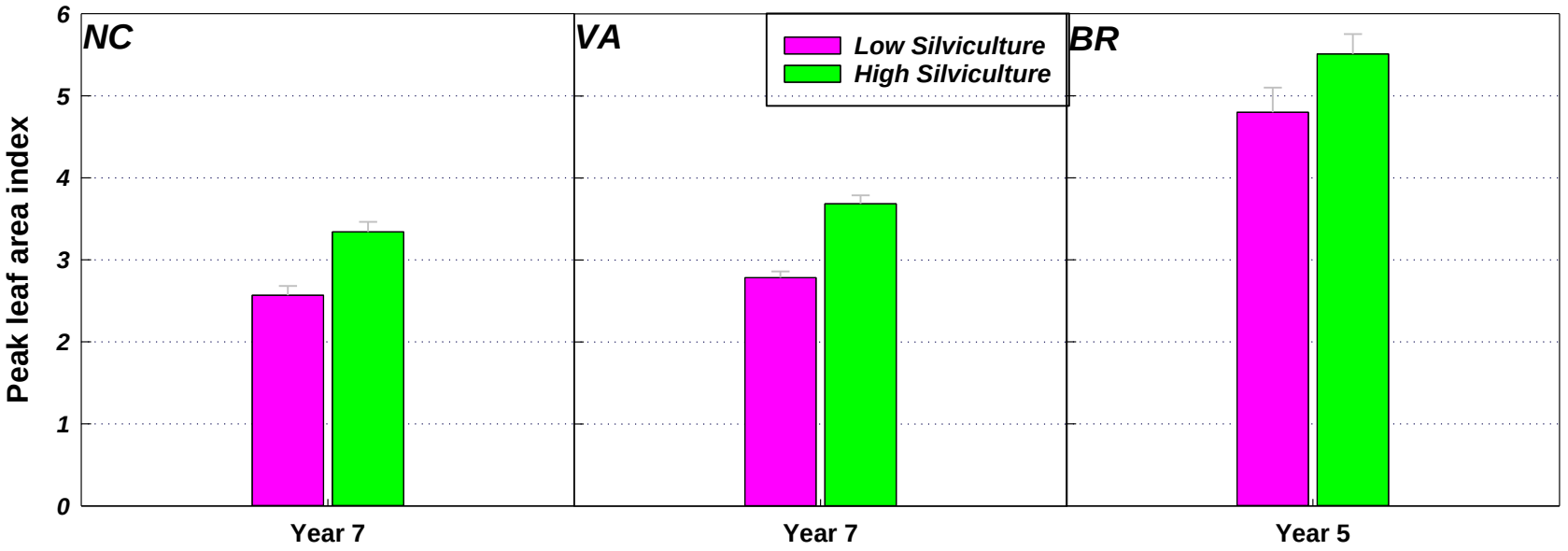
Volume growth related to crown width - for now



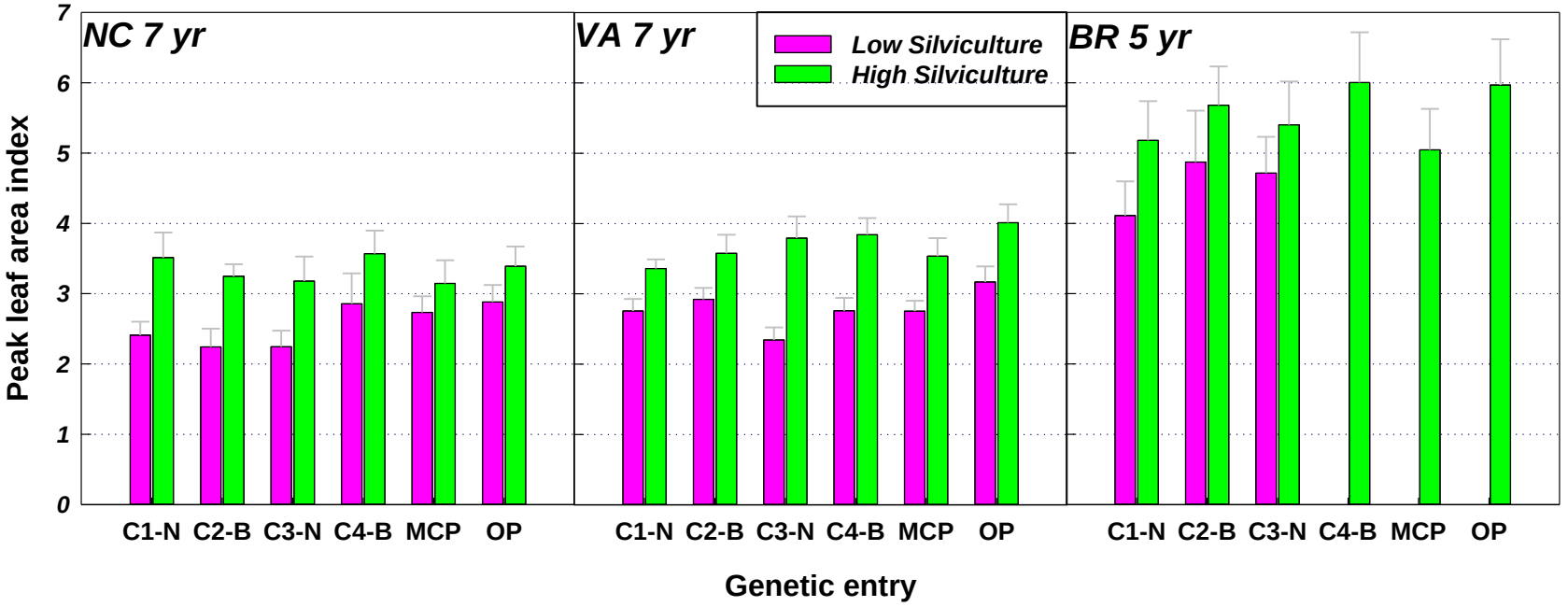
LAI site comparison on and off peak



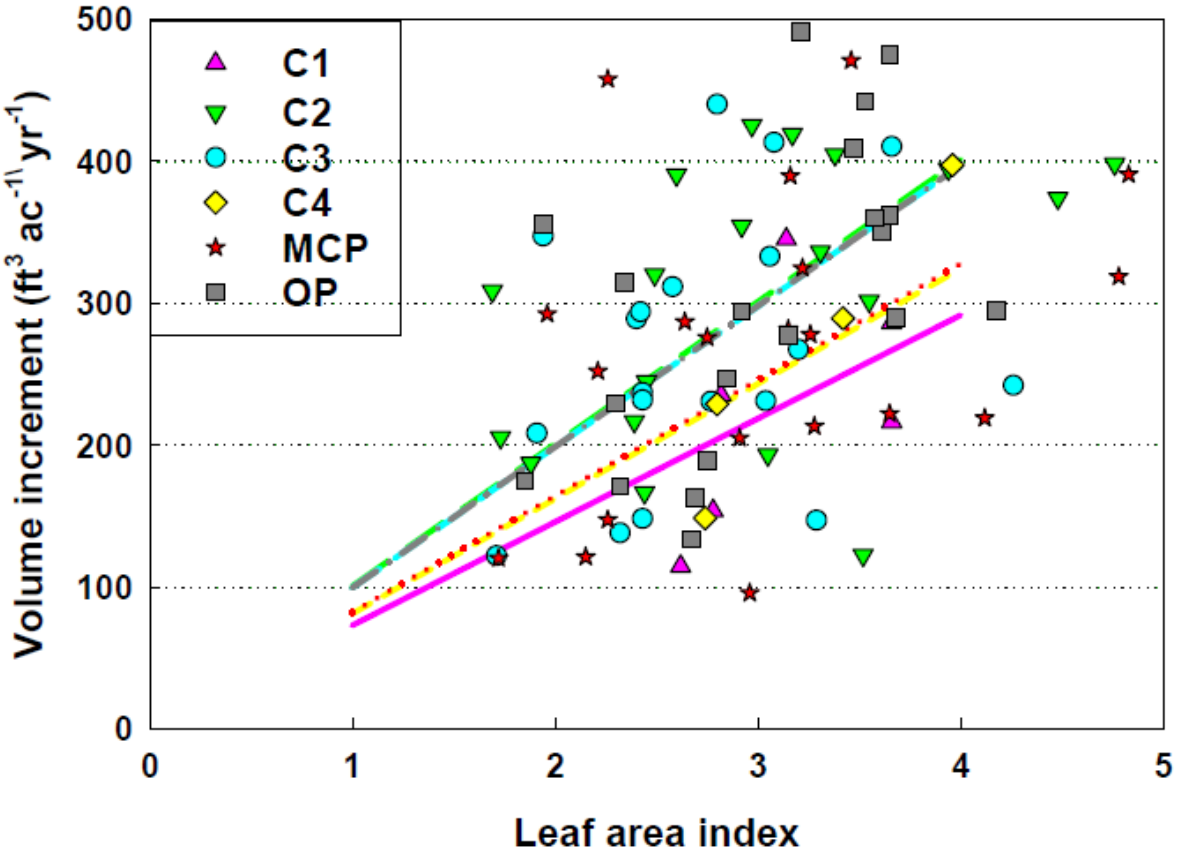
Silviculture (at peak LAI)



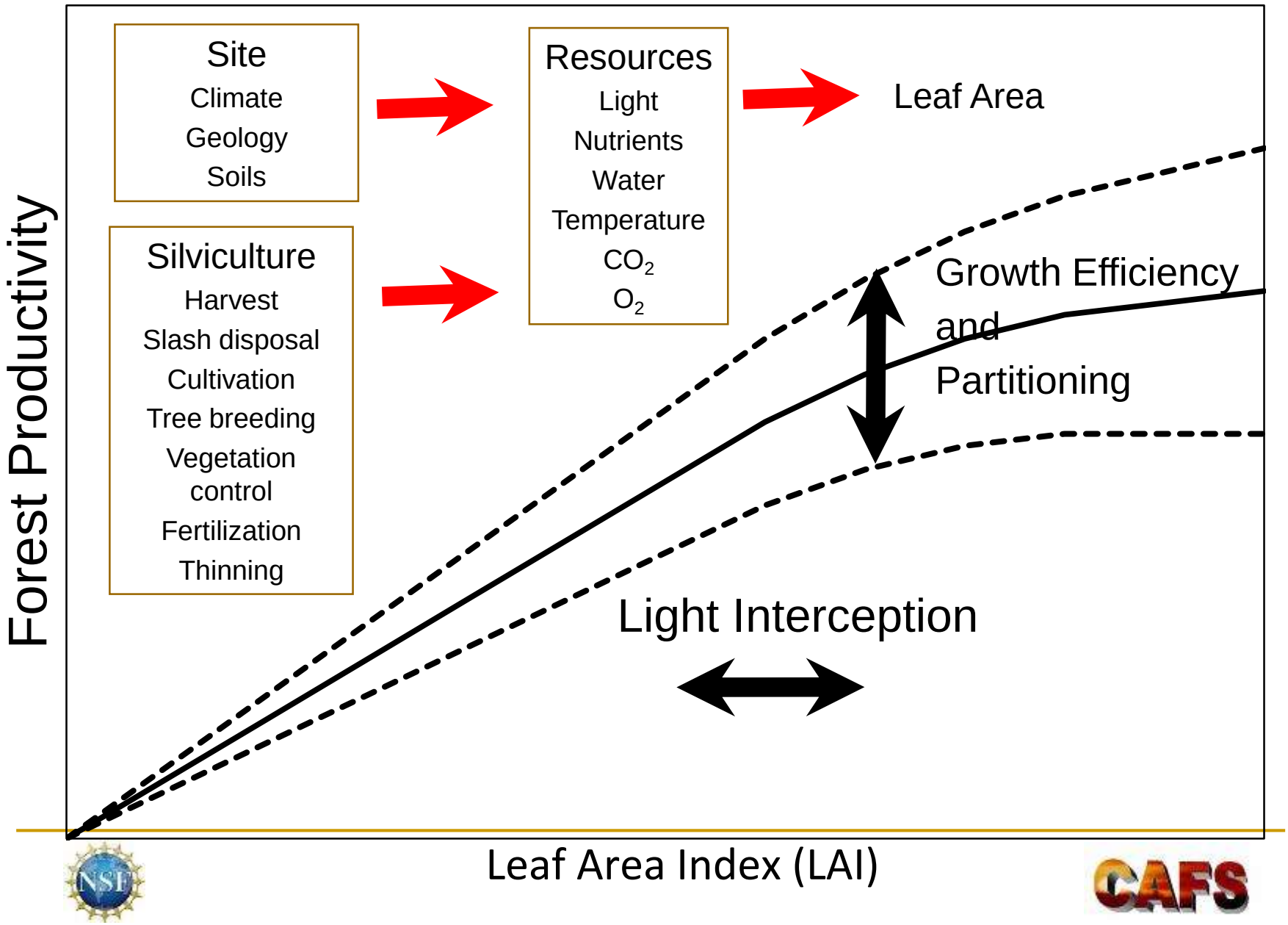
Peak LAI Clone x Silviculture



Apparent clonal differences in growth per unit LAI



Silviculture - Site Resources - Leaf Area

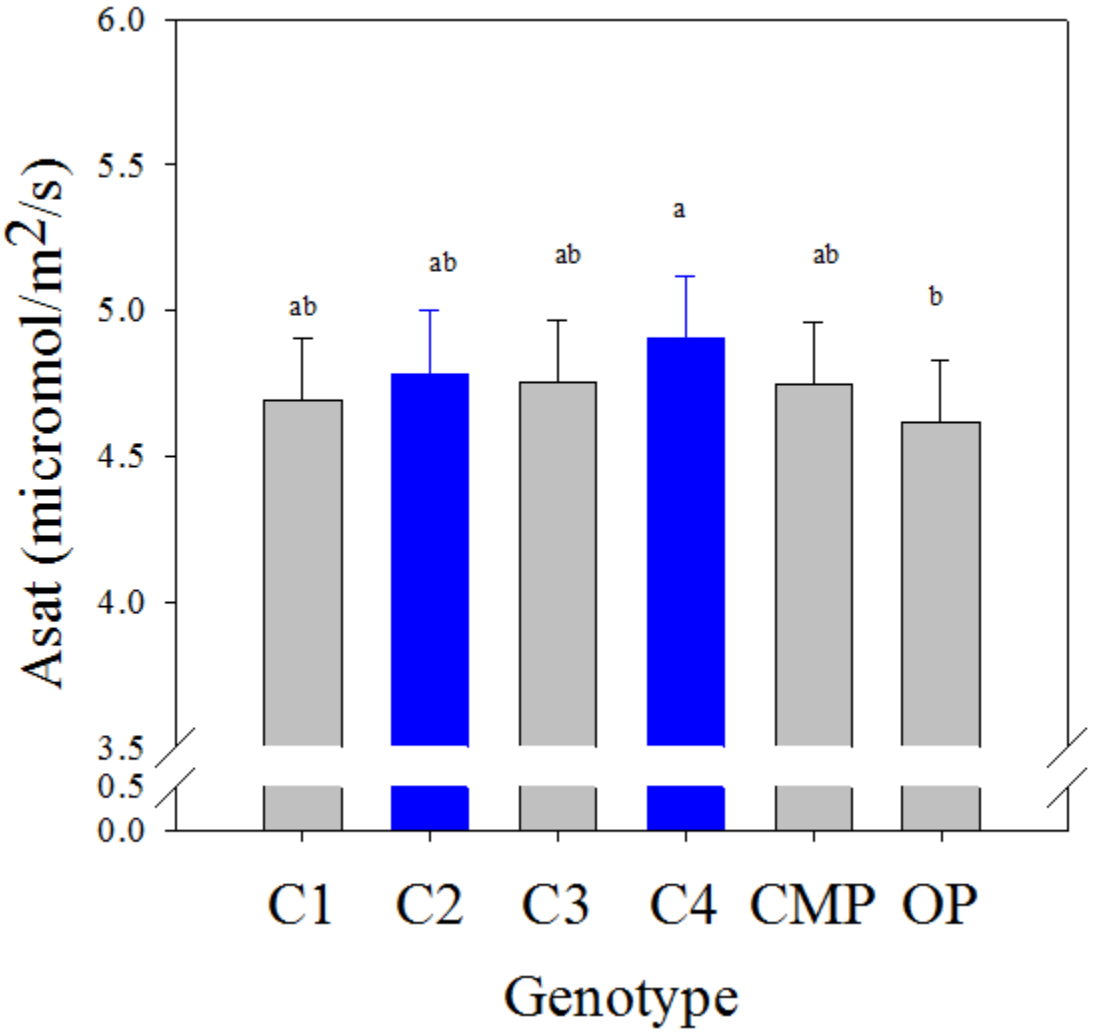


Differences in Ecophysiology
Photosynthesis, Water Use, Carbon Allocation

Clone with Low Silviculture

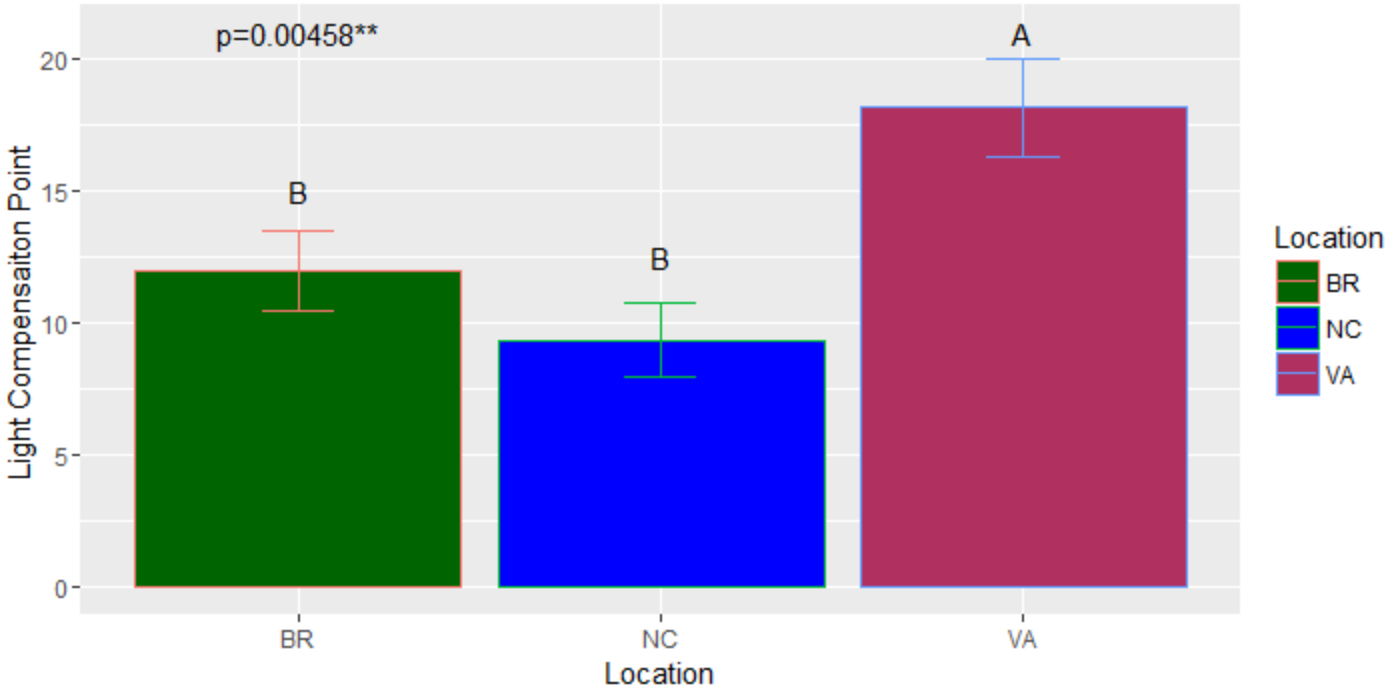
Clone with High Silviculture

No Large Differences in Maximum Rate of Photosynthesis



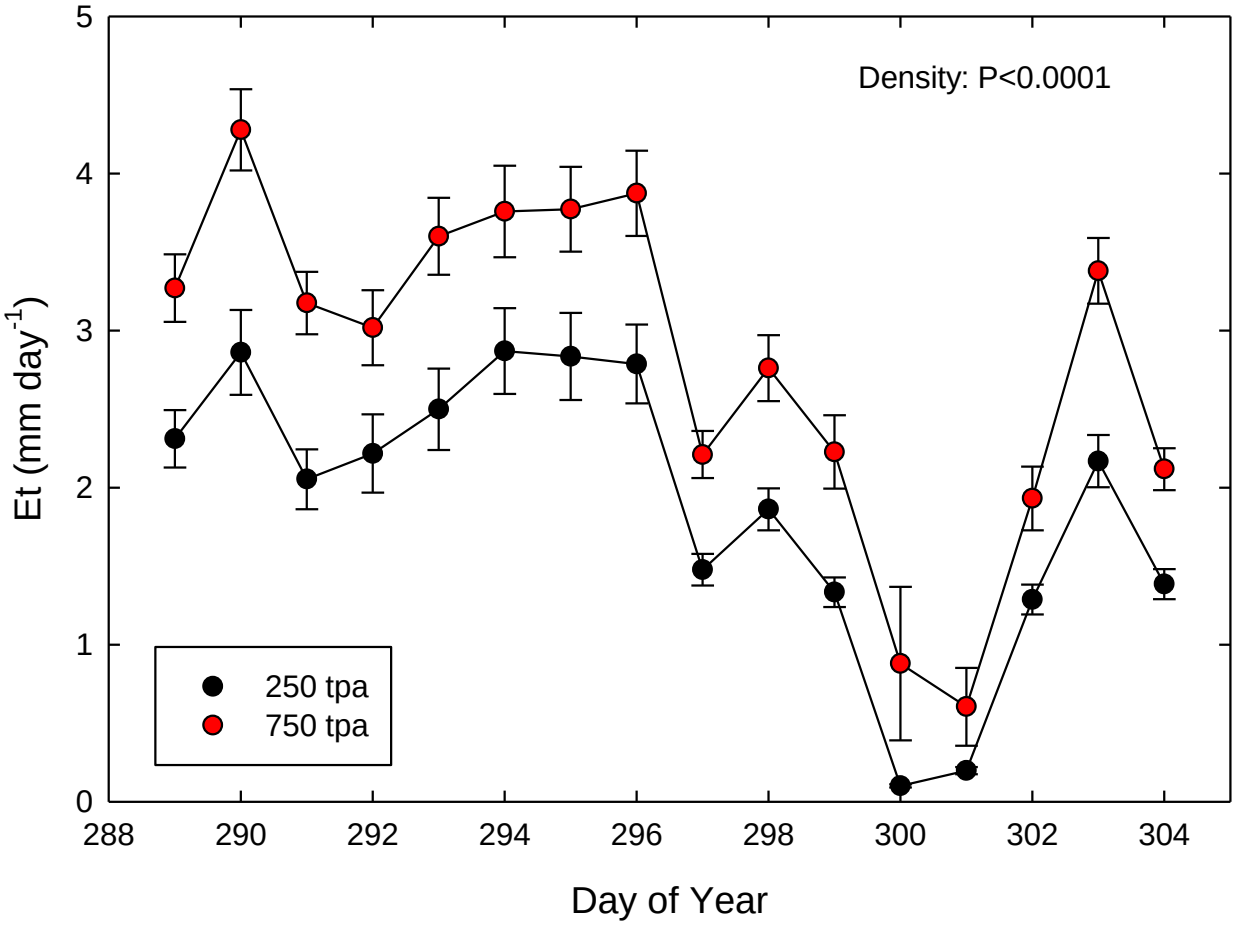
Light Levels in the Lower Crown

Light Compensation Point in the Lower Crown

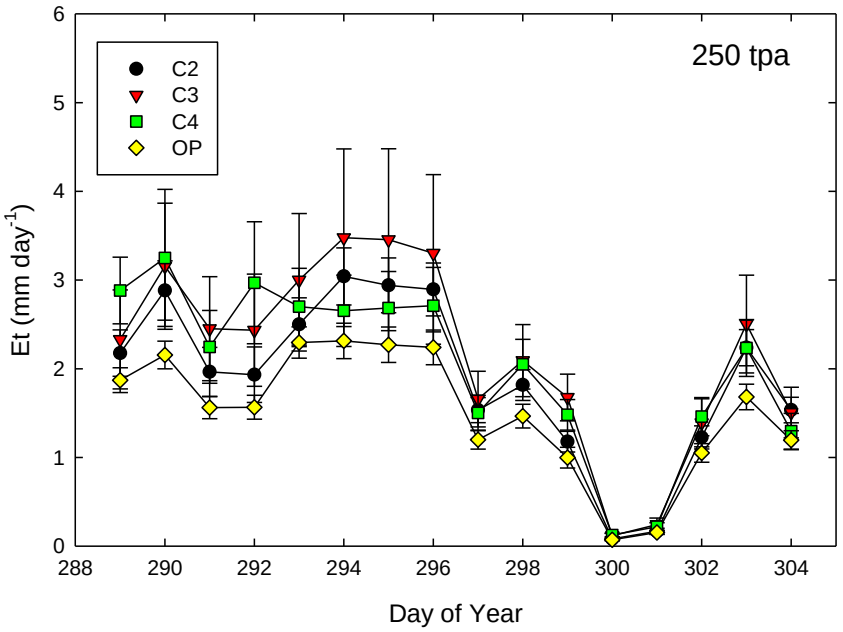


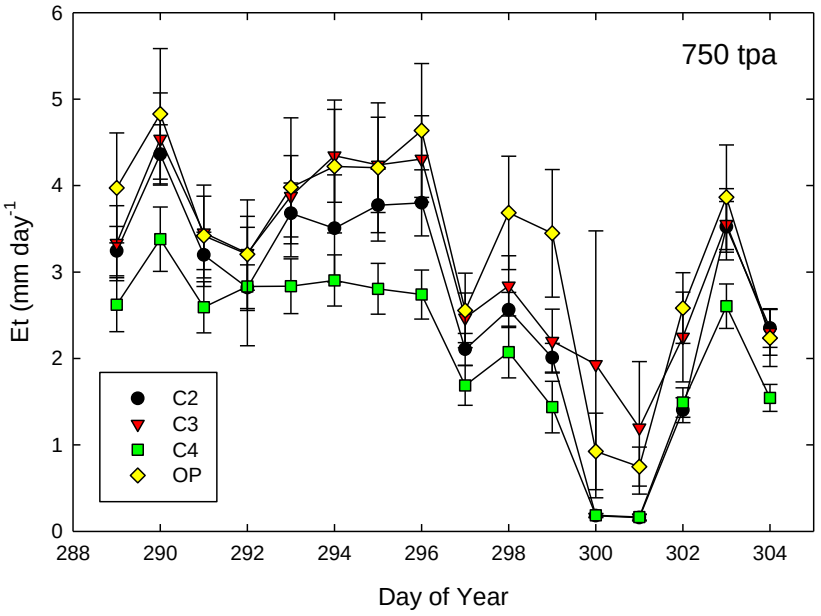
USF Cooperation

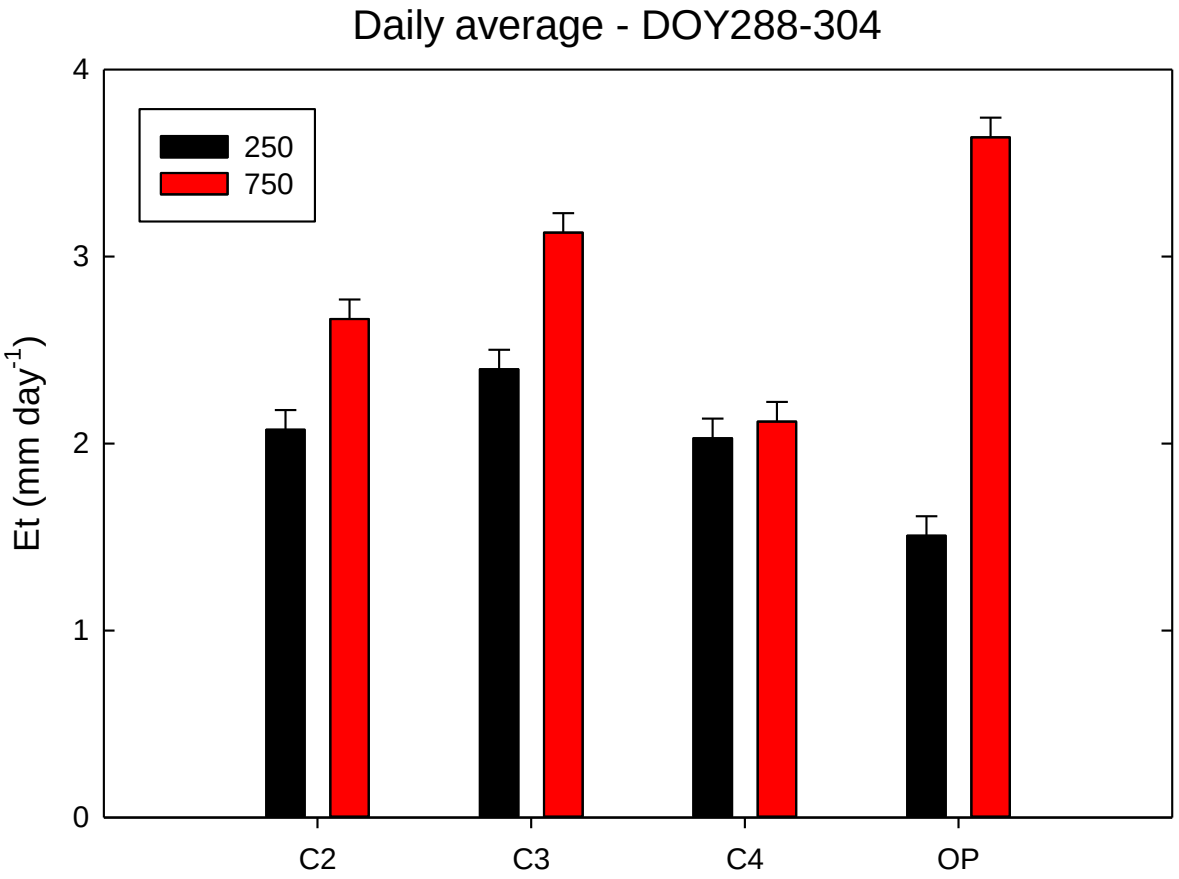
Sap Flow Measurement of Water Use



750 tpa plots are using about 32% more water than 250 tpa plots


250 tpa
C2
C3
C4
OP
Et (mm day-1)
Day of Year
0
1
2
3
4
5
6
288
290
292
294
296
298
300
302
304


750 tpa
C2
C3
C4
OP
Et (mm day-1)
Day of Year
0
1
2
3
4
5
6
288
290
292
294
296
298
300
302
304



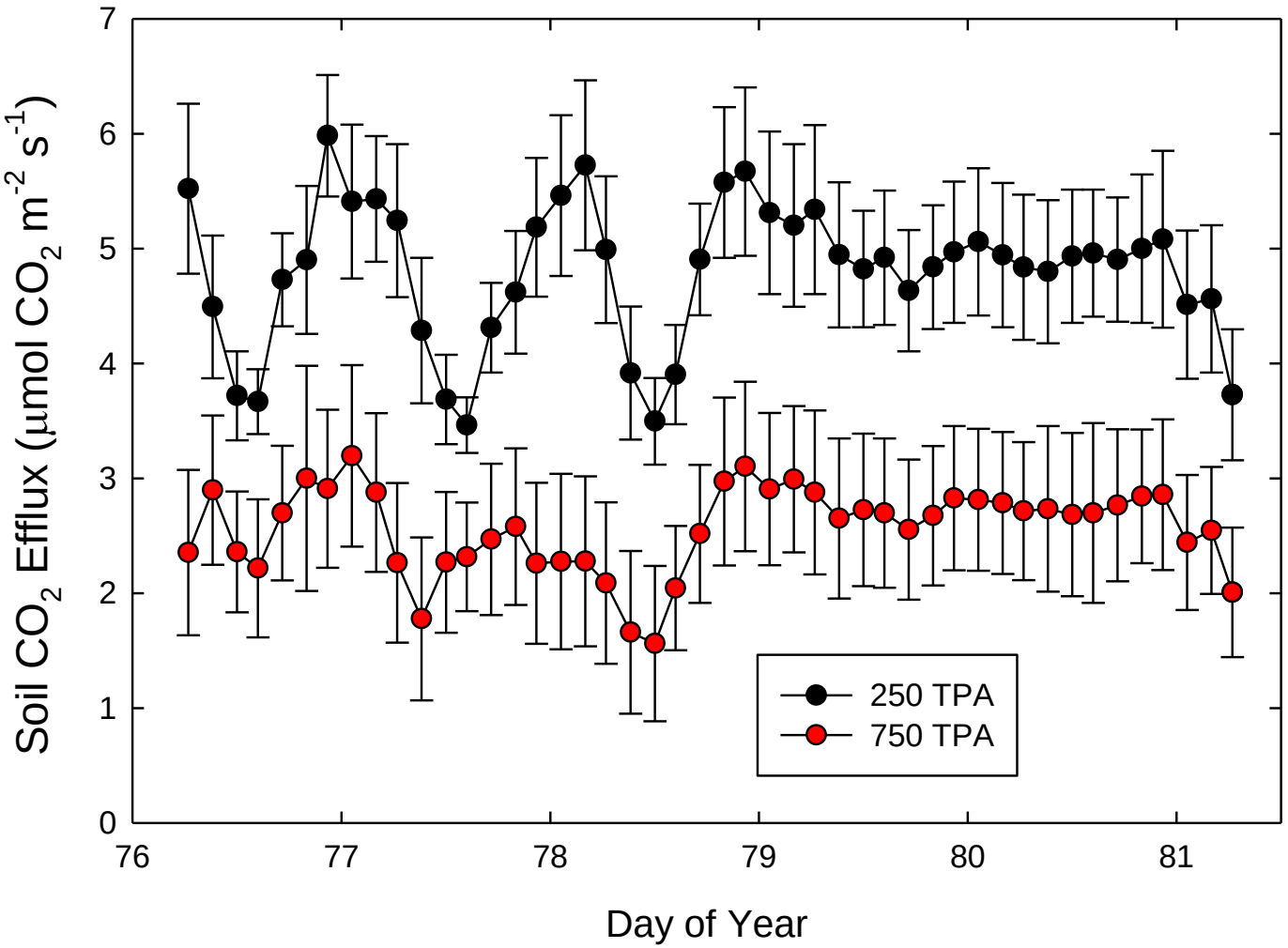
C2, C3, and OP have significantly greater Et than C4

Carbon Allocation – Soil Respiration

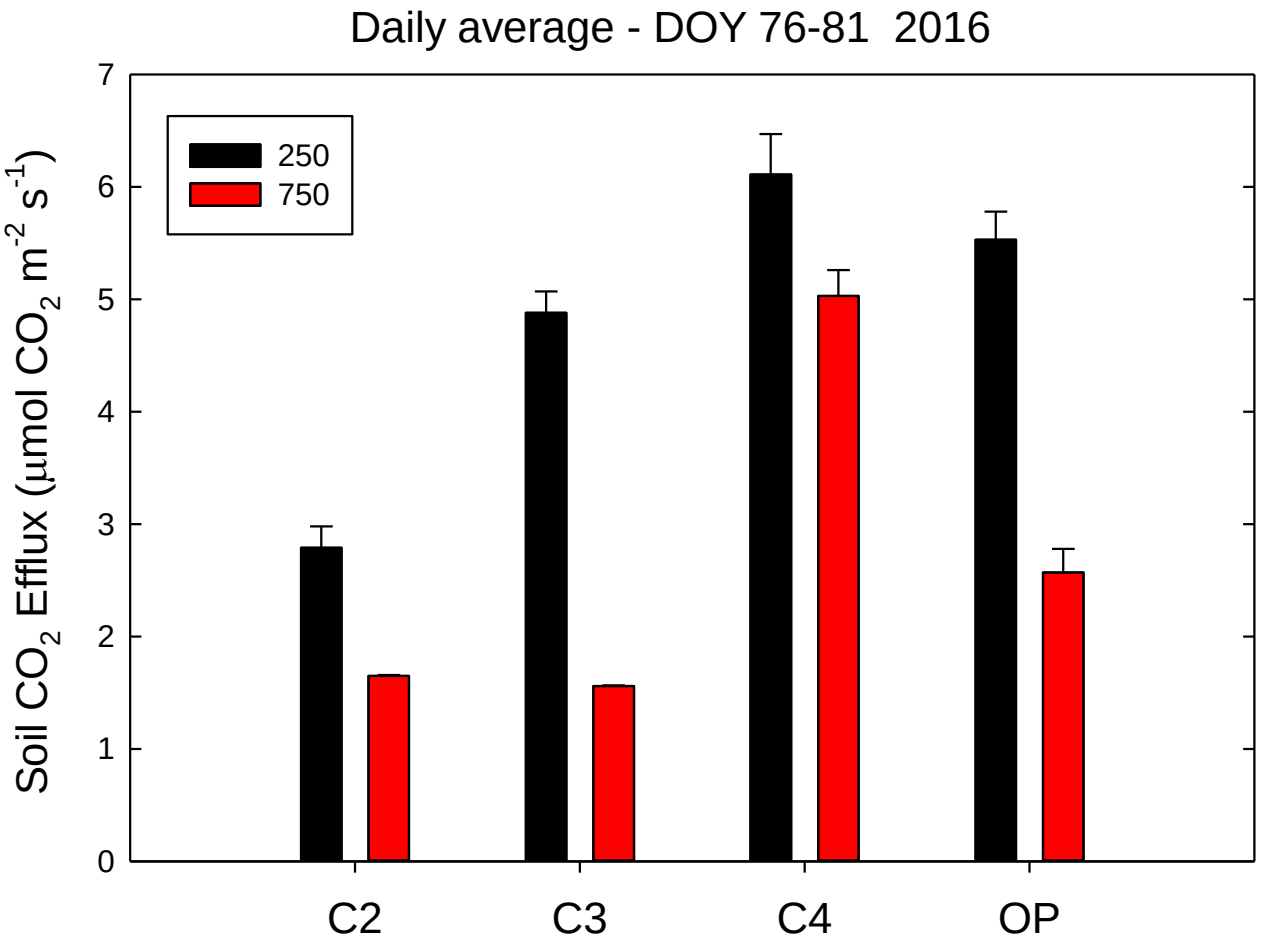
Measure of CO2 from the soil determines the amount of carbon allocated below ground.

Must Separate Heterotrophic Respiration (Rh) due to soil microbes and Autotrophic Respiraiton (Ra) due to roots.

RW20 Reynolds Homestead
Soil CO2 Efflux



RW20 Reynolds Homestead
Soil CO2 Efflux

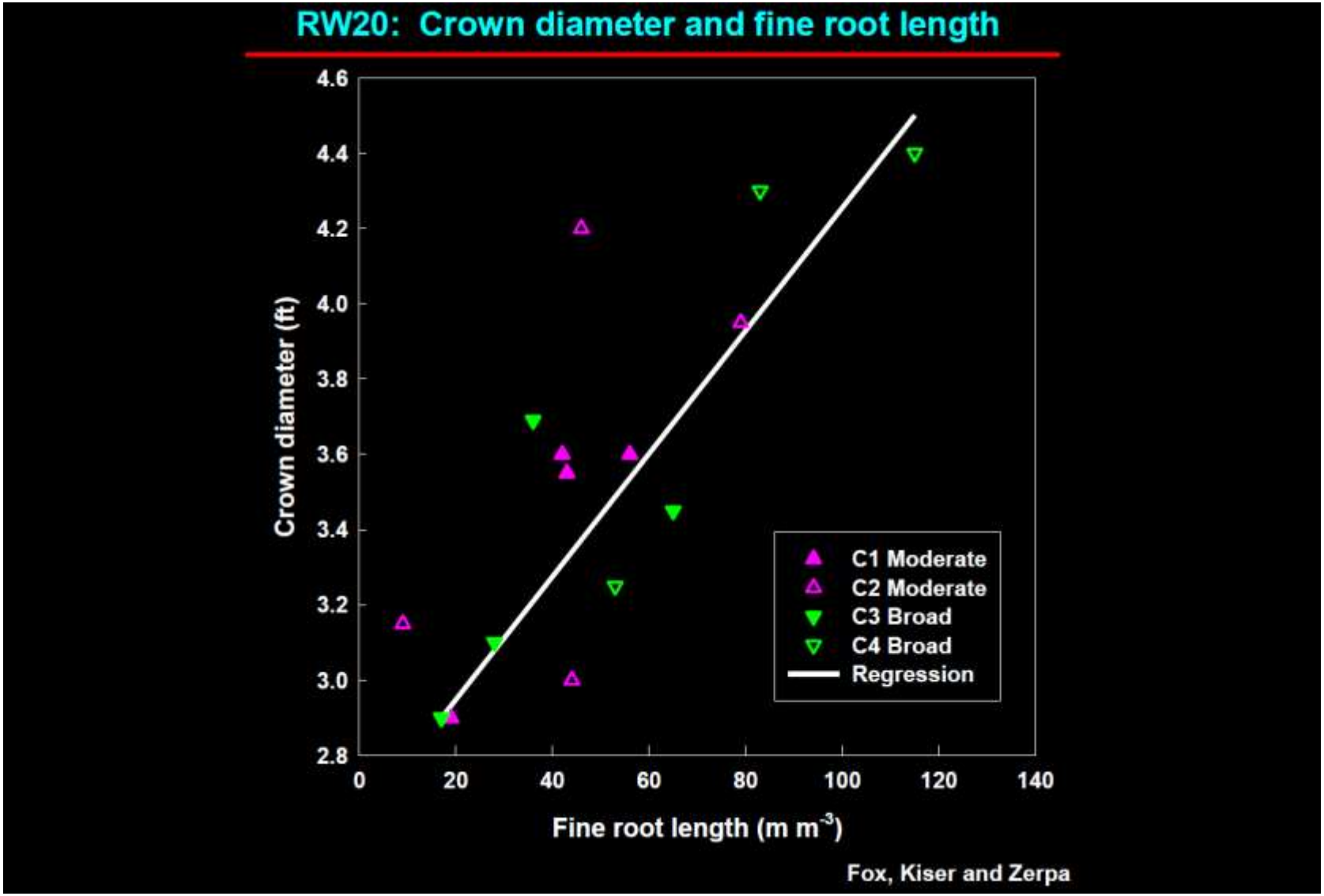


Proposed Research

- **Influence of Site, Silviculture and Genetics on:**
  - Carbon Allocation Patterns
    - Above Ground vs Below Ground
  - Nutrient Availability and Root Uptake
- **Remote Sensing with LiDAR**
- **Process Modeling of Forest Productivity (MAESTRA)**
- **Ultimately Will Lead to Understanding of Factors Determining Differences Productivity and Carrying Capacity in Forest Ecosystems in Different Regions**

Root Growth – Fine Roots

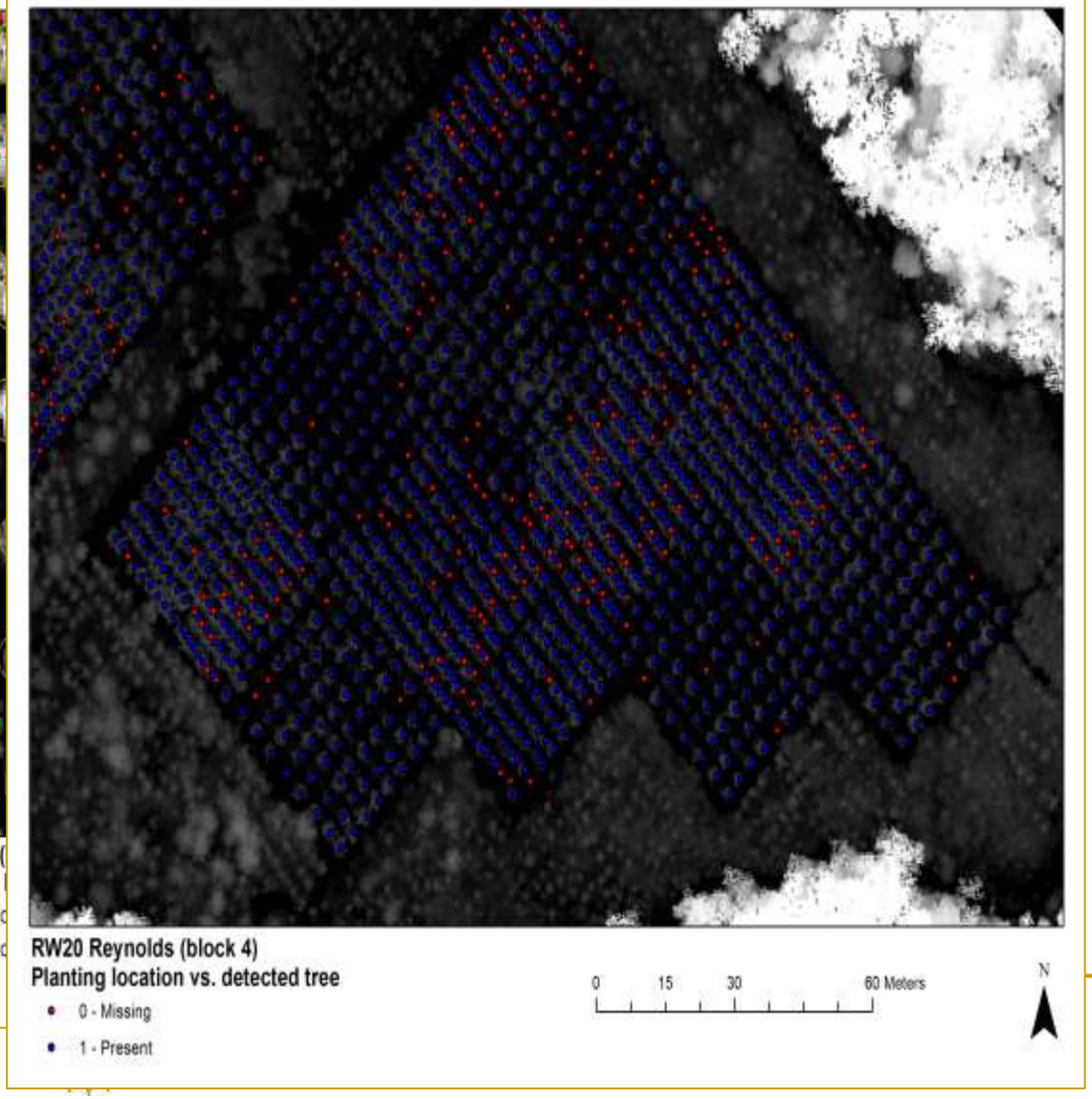
Fine Root Biomass and Production
Soil Cores and In-Growth


RW20: Crown diameter and fine root length
Crown diameter (ft)
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
0
20
40
60
80
100
120
140
Fine root length (m m-3)
C1 Moderate
C2 Moderate
C3 Broad
C4 Broad
Regression
Fox, Kiser and Zerpa

Above Ground Biomass

Carbon Allocation – Below Ground

Identify Individual Trees



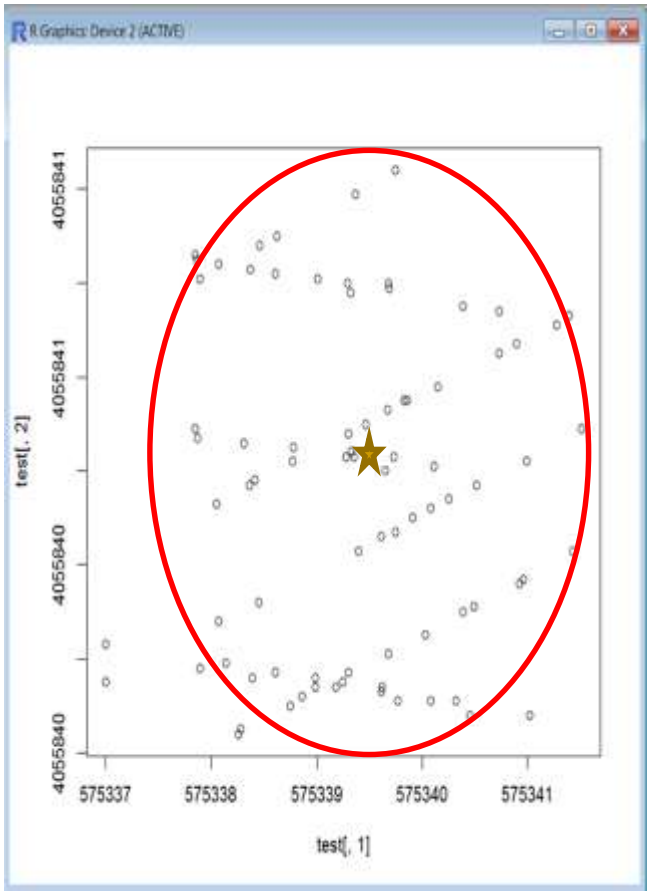
ITC locations were linked to original planting locations based upon:

1. Spatial proximity;
2. Average ITC characteristics within each plot extent, i.e. small ITC objects (height/crown radius) were excluded.

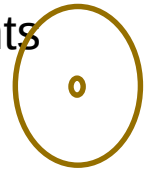
Tree crown horizontal extent

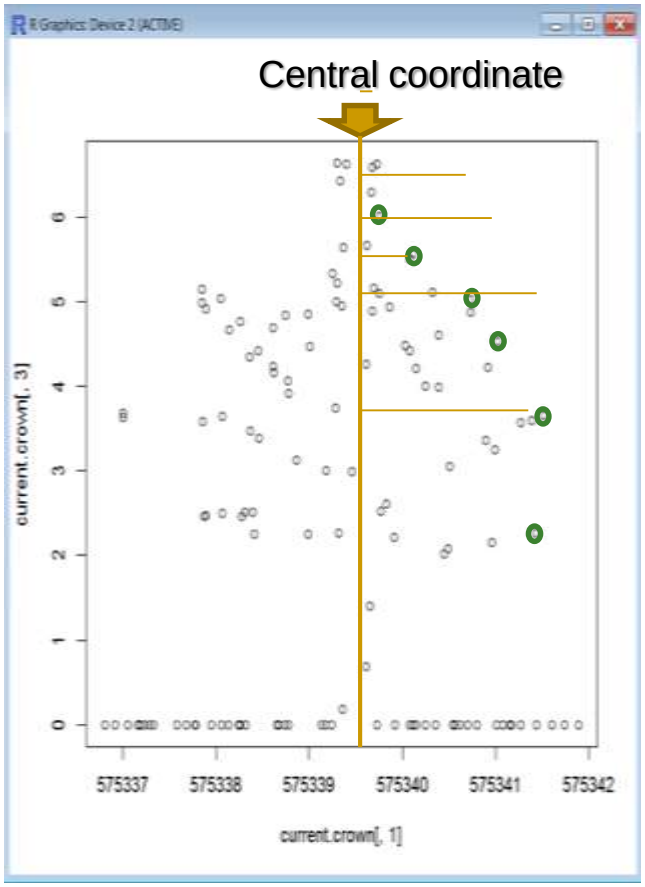
Workflow:

1. Subset lidar point within ITC extent;
2. Generate a ‘slice’ though the object;
3. Find local maxima (branch ends);
4. Calculate distance to tree centre;
5. Repeat for another direction.

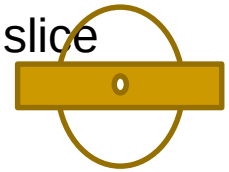


Top down view of points (>0.2m AGH)



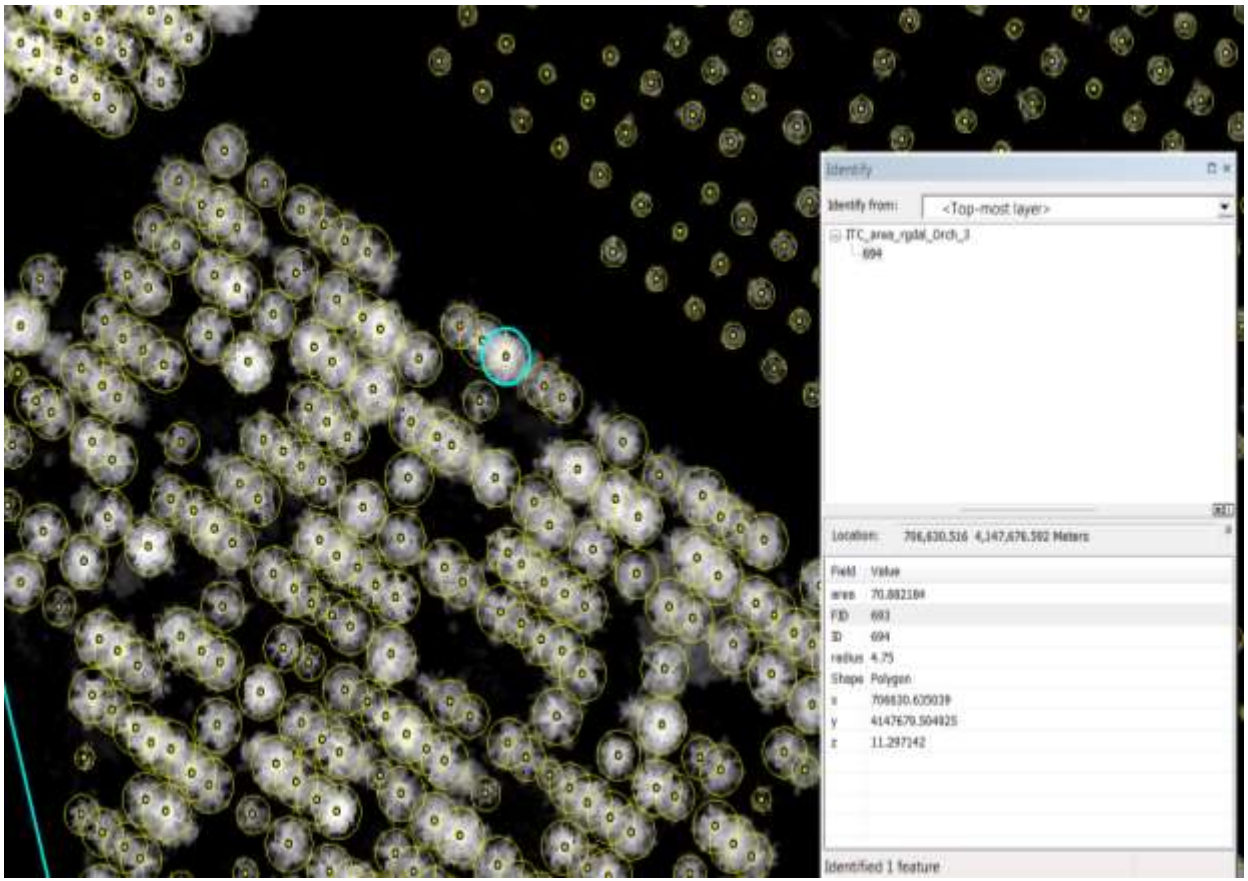


Side view of E-W slice

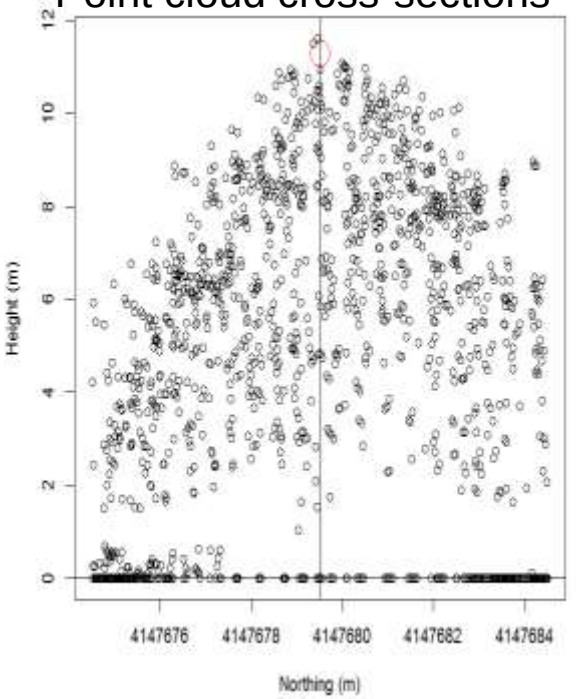


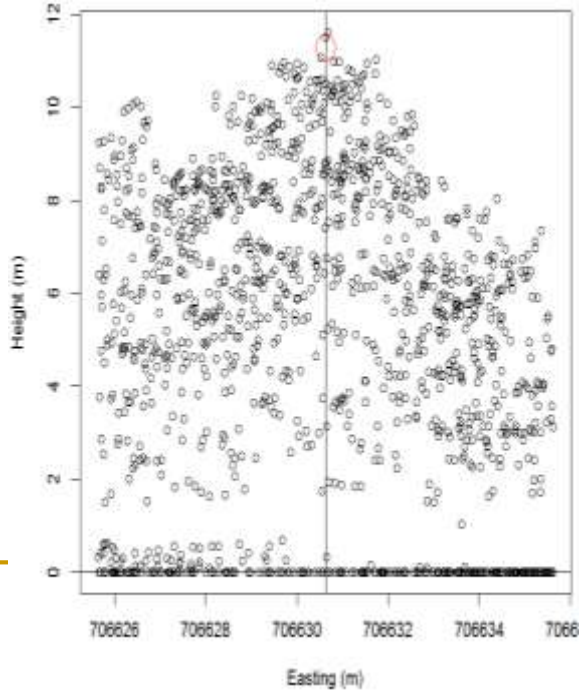
Tree Crown Analysis (ID 694)
VDOF Appomattox Seed Orchard

LAI = 4.01;
HT = 11.61 m;
Base = 1.0 m;
Radius = 4.75 m;



Point cloud cross-sections





Loblolly Pine in South America Increased Carrying Capacity

Argentina

Brazil

Why Does Carrying Capacity Change in Other Parts of the Word ?