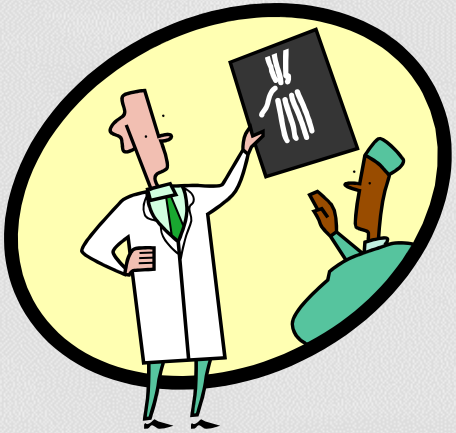
RGP vs RWR - Root Growth Potential vs Root Weight Ratio

What Do They Tell Us?

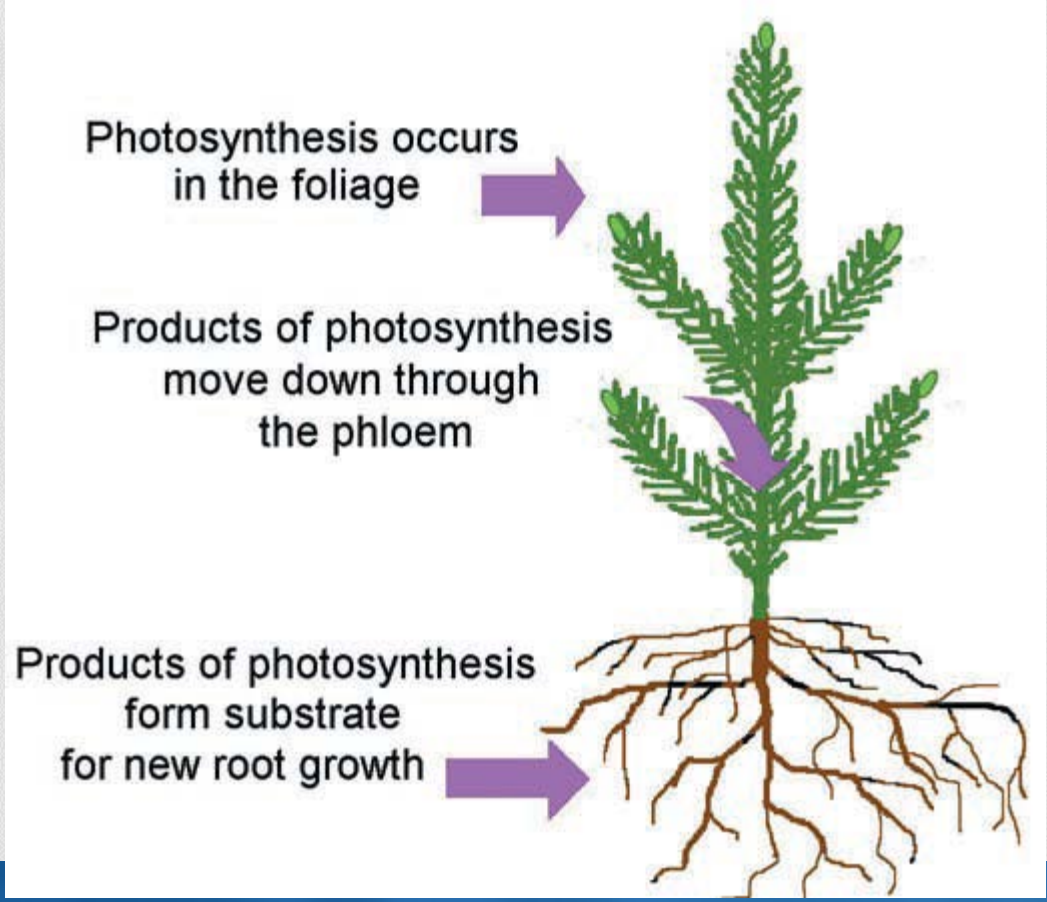


Tom Starkey

Philip Wakeley 1949

- First to speculate that inconsistent outplanting results could be associated with the root systems ability to resist water loss, absorb water and extend into the soil

- Outplanting success is dependent on new root growth which is dependent on current photosystates



- “The initial survival of transplanted seedlings depends largely on the ability of their root system to rapidly replace the roots lost during transplanting and handling and to regenerate new roots to re-establish contact with the soil”

Dewalt, et.al. Biennial Silviculture Research Conf. Atl, GA 1984

Definition

- **Root Growth Potential** – the ability of a seedling to initiate and elongate roots when placed in an environment favorable for root growth after transplanting.

RGP testing methods

- Soil Culture
- Hydroponics
- Aeroponics

Comparison of RGP Methods

Hydroponics

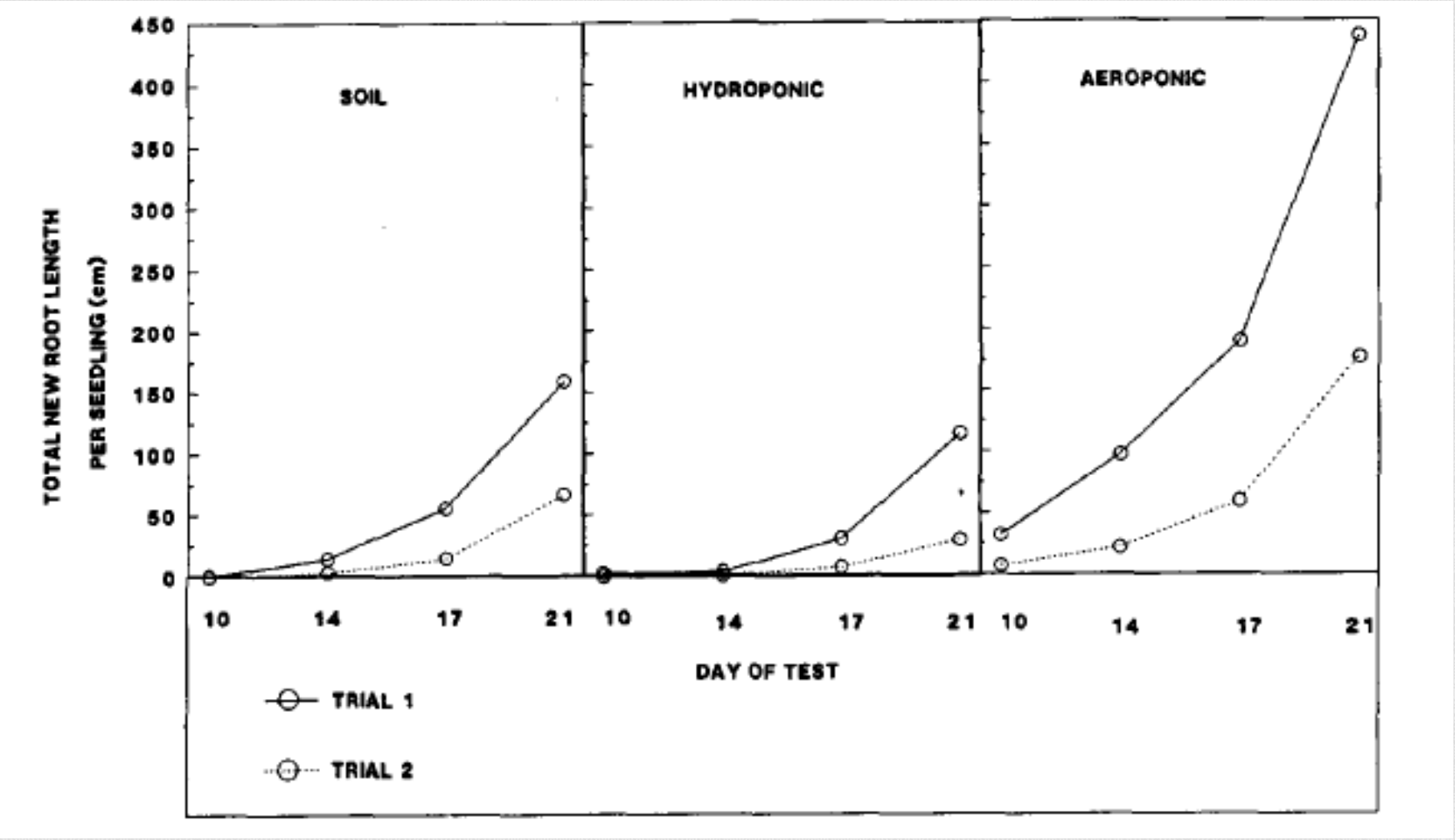
- Seedlings placed in aquarium with aerated water
- Similar # of new roots with soil
- Least costly
- ~ 30 days

Aeroponics

- Suspended seedlings roots continuously sprayed with water
- More new roots
- Faster new root growth
- ~14-30 days

Soil Culture

- Seedlings planted in sand or peat/perlite soil
- Difficult to control soil temperature
- Difficult to control soil moisture
- ~30 days+



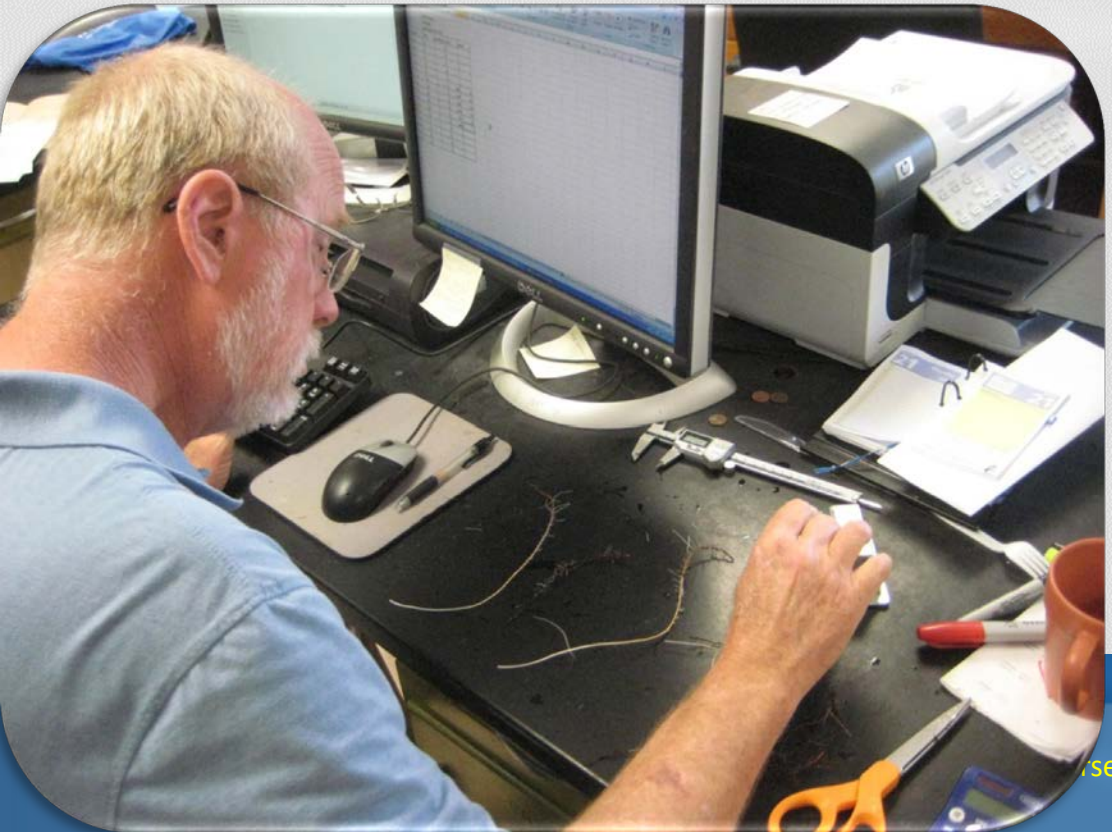
Rietveld WJ, 1989. New Forests

Testing Procedures

- Place in aerated water in black aquariums

Testing Procedures

- Count root rips >0.5 cm

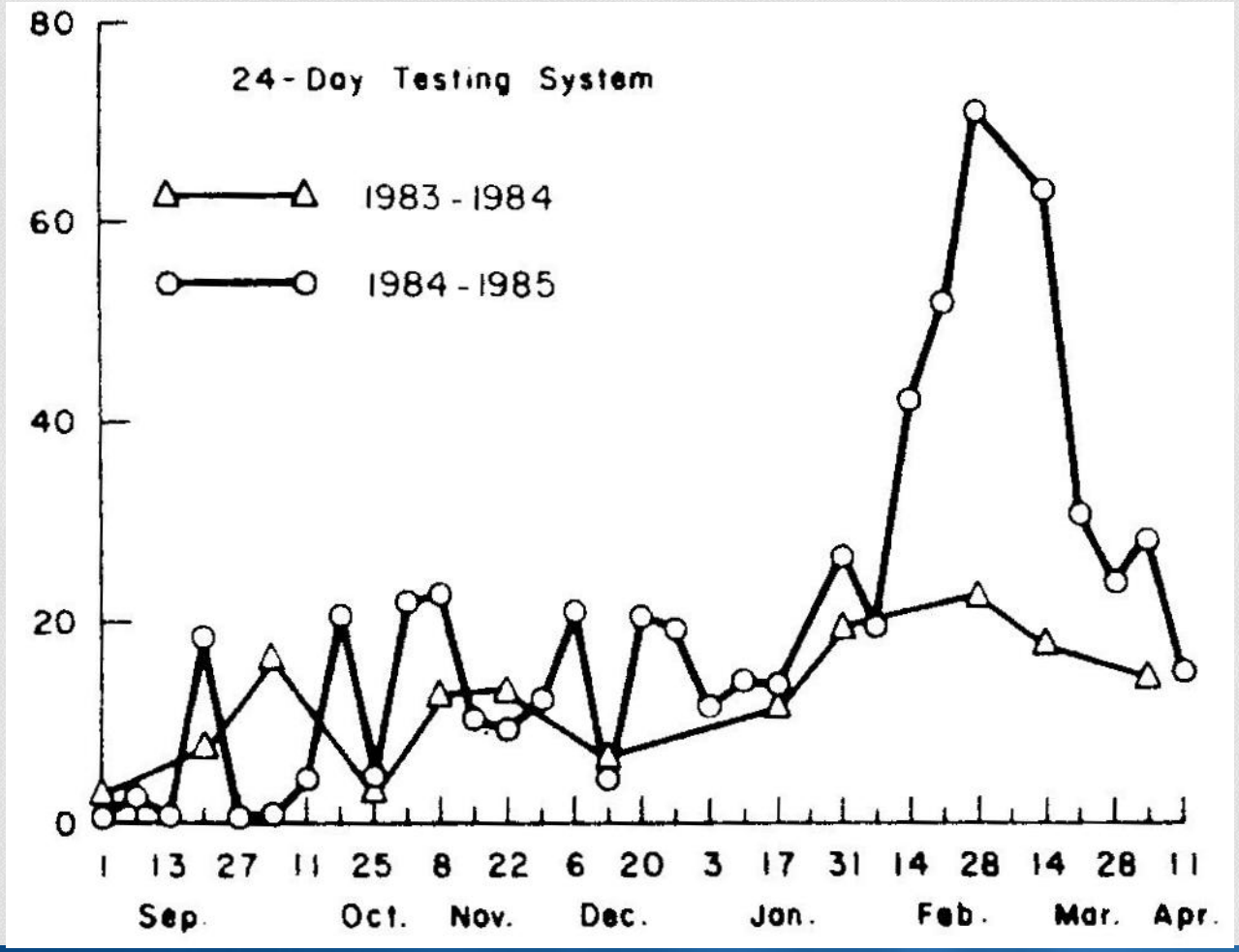


- Nursery managers in the south do not cull seedlings based upon RGP testing

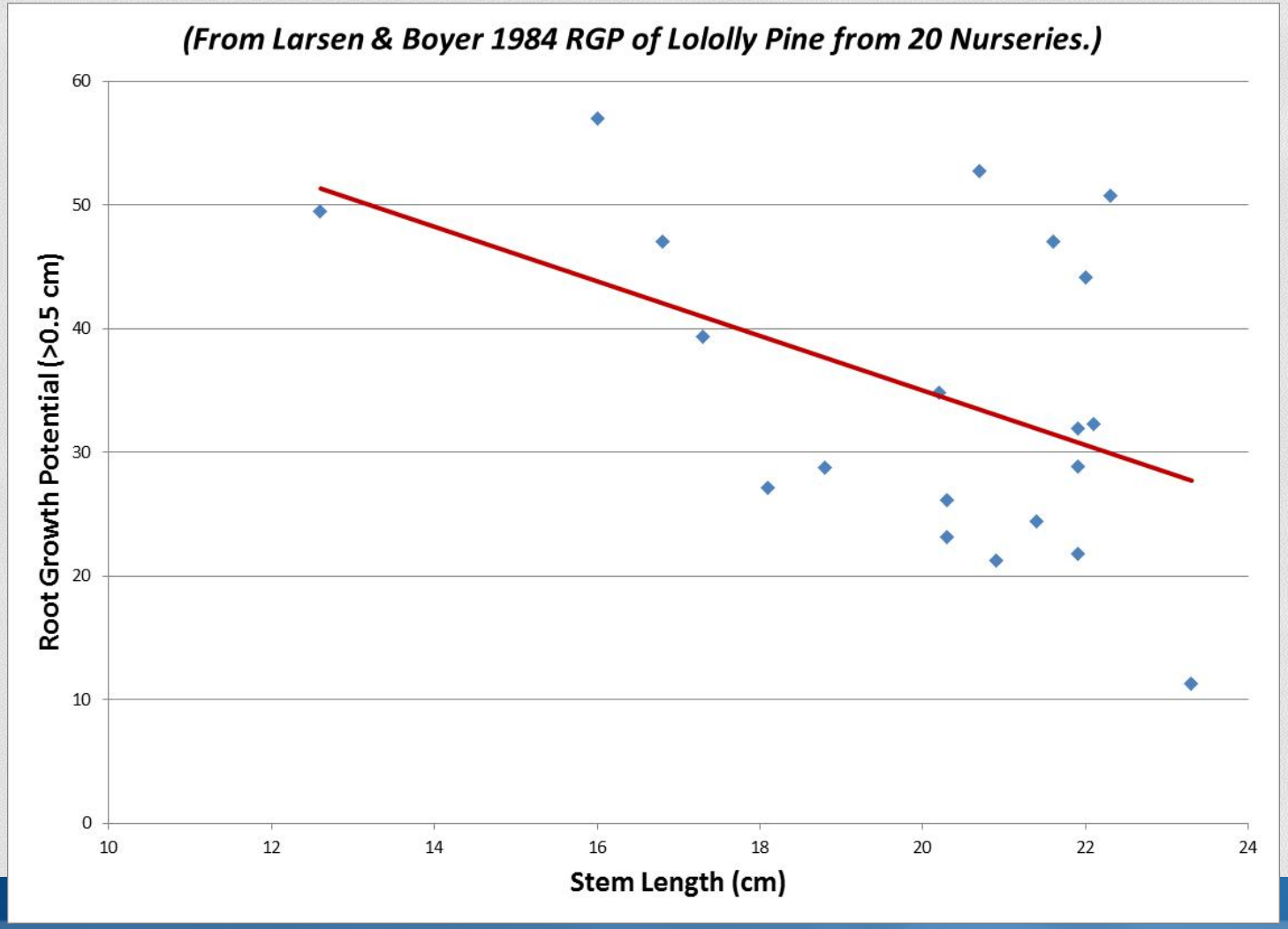
What Factors Effect Root Growth Potential?

- Time of lifting
- Growing density
- Irrigation
- Fertilization
- Genetics
- Root and top culture
- Time of sowing

Dewalt & Feret. 1987. Changes in loblolly pine root growth potential from September to April.
Can. J. For. Res. 17:635-643



- Taller seedlings have lower RGP

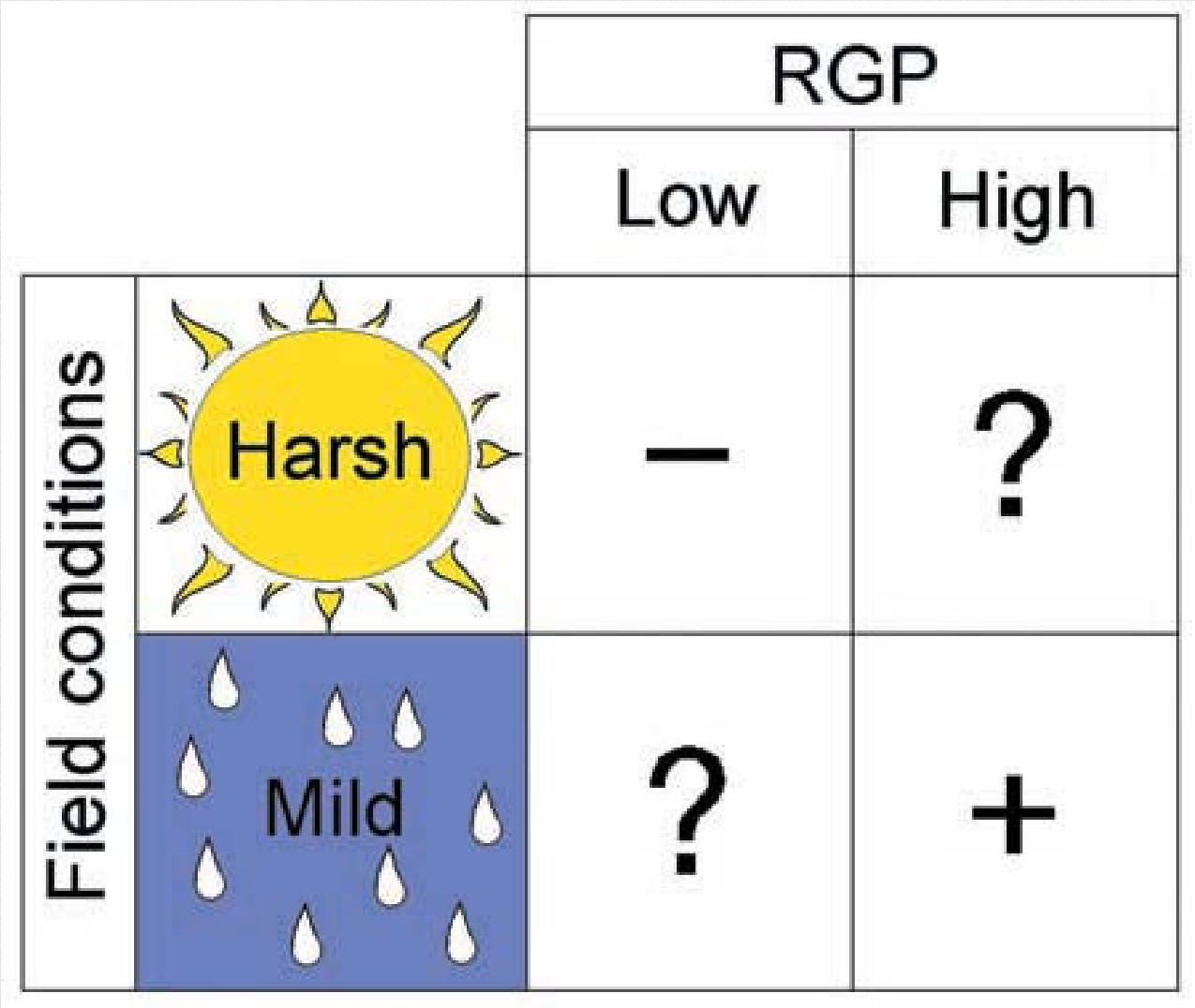


Myth Buster

- High RGP always ensures high survival, while low RGP always ensures low survival.

- Outplanting environment ≠ RGP testing environment
- Analogy – Does your field seed germination always equal what the lab seed test predicts?

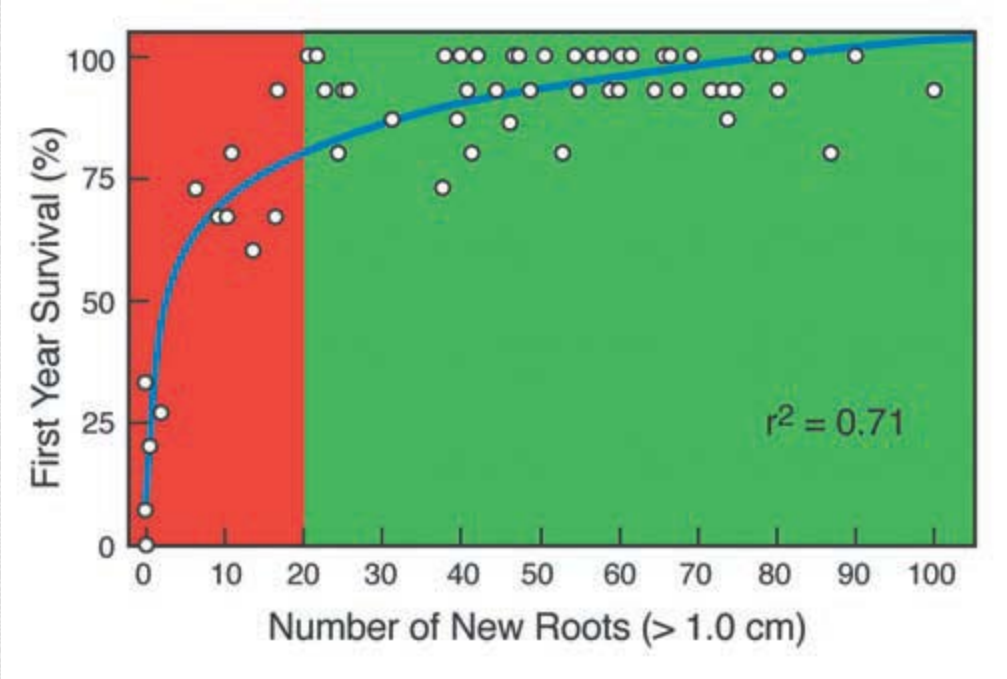
- A seedling can possess a high RGP, but if soil conditions are unfavorable, root elongation and seedling establishment can be hindered.
- For proper uptake of water and nutrients, 3 conditions must be met:
  1. Water & nutrients must be available in the soil
  2. Root growth must occur to reach water & nutrients
  3. Water & nutrients must respond to root surface gradient and move to the roots


RGP
Low
High
Field conditions
Harsh
Mild
–
?
?
+

- Some studies indicate RGP is poor indicator of field performance
- Other studies with Loblolly (Feret & Kreh 1985, Larsen et al 1986, Larsen et al 1989) and shortleaf (Hallgreen & Tauer 1989) have shown a positive link between RGP and survival and growth after outplanting

Factors that limit RGP after outplanting

- Soil Temperature
- Soil Moisture
- Soil Compaction
- Quality of planting


First Year Survival (%)
100
75
50
25
0
0
10
20
30
40
50
60
70
80
90
100
Number of New Roots (> 1.0 cm)
r2 = 0.71

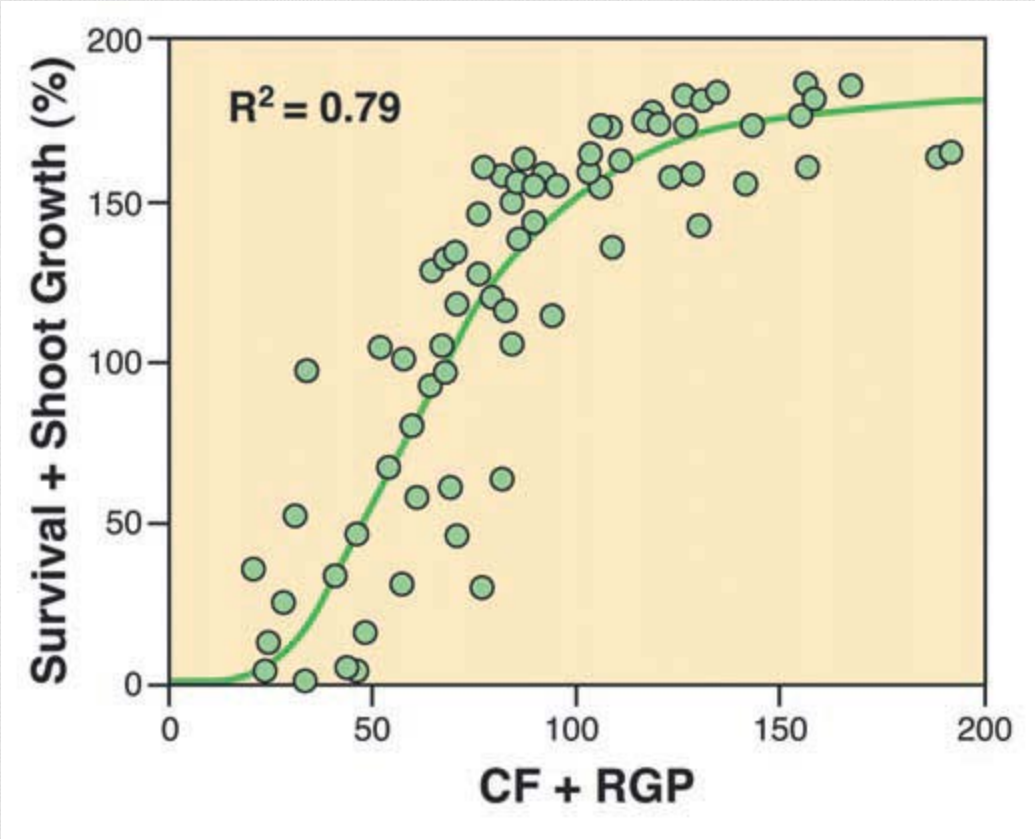
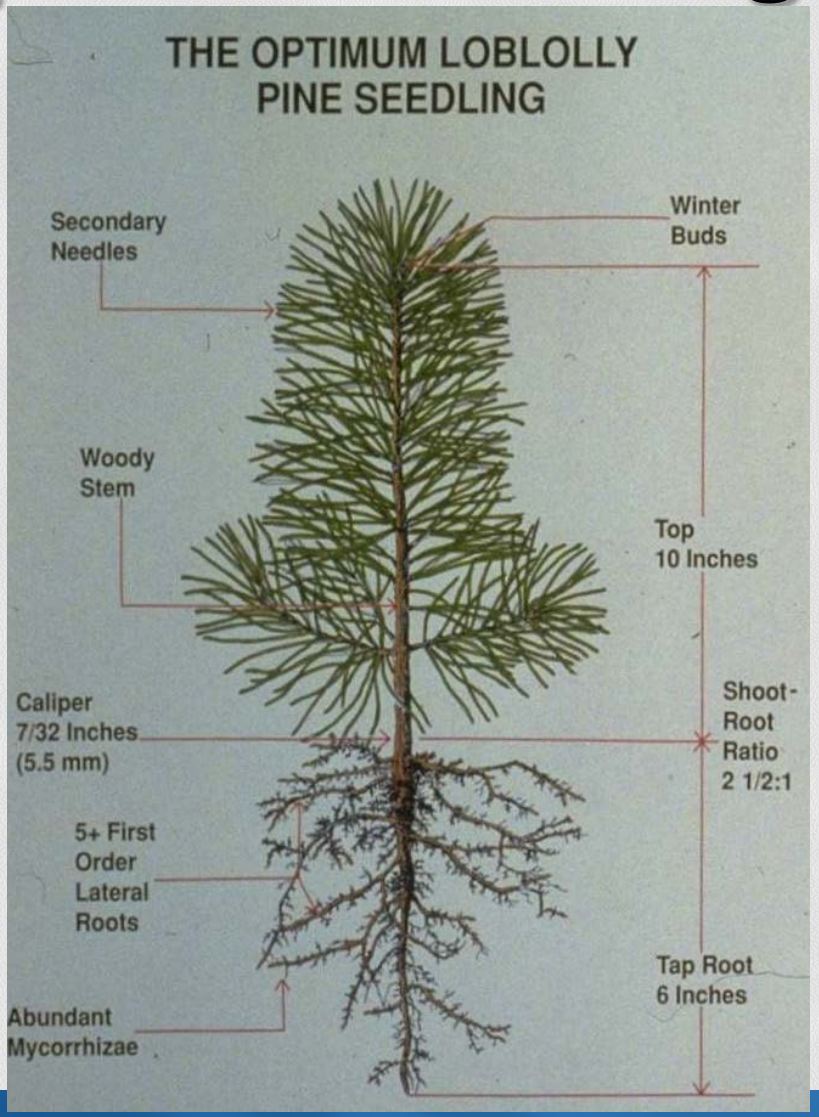


Figure 7.2.43—*Measuring root growth potential and chlorophyll fluorescence proved to be a good predictor of total outplanting performance (survival + shoot growth) of conifer seedlings (modified from L'Hirondelle and others 2007).*

Root Weight Ratio

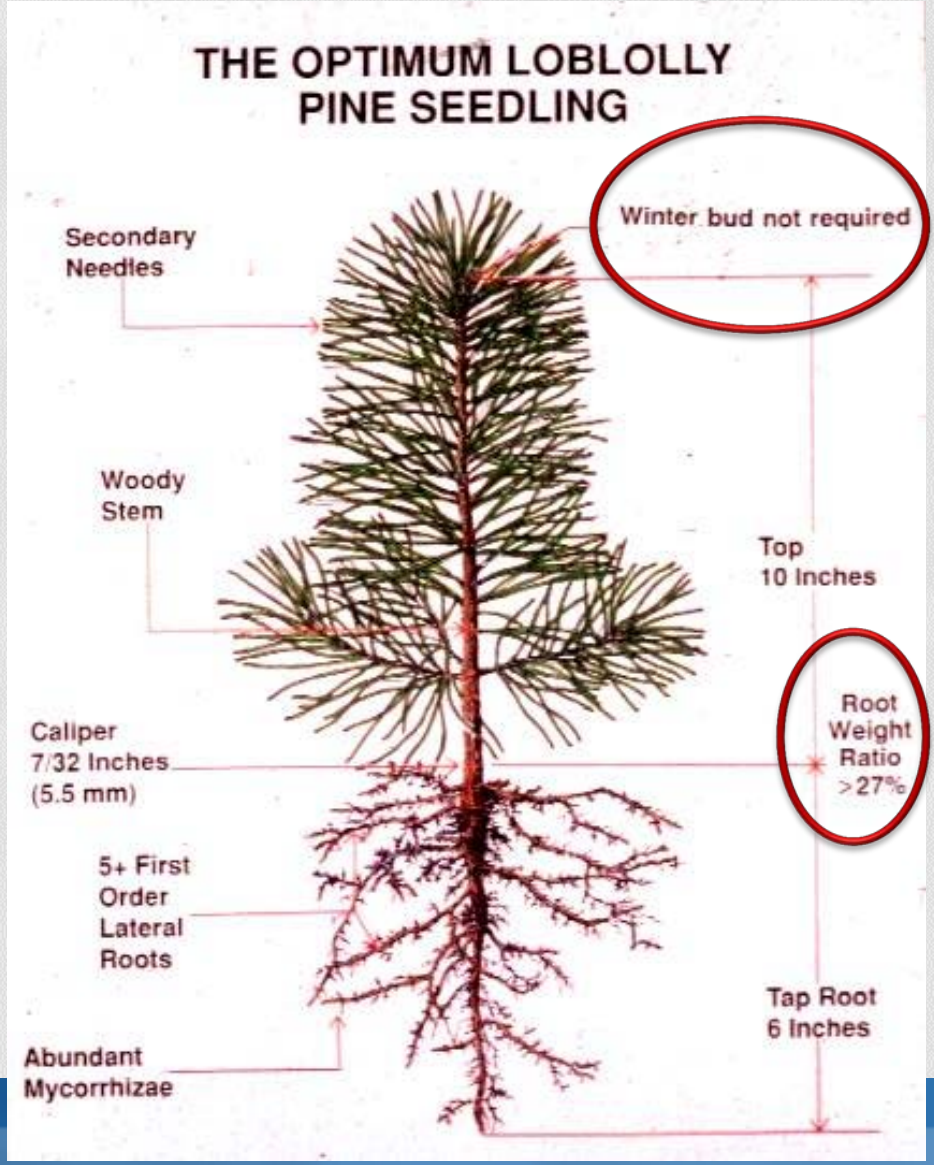
Target, Ideal or Optimum Seedling

- 1st attempt - Wakeley's three seedling grades
- More recently influenced by



Target, Ideal or Optimum Seedling

- And then modified by:



How do we get from a Shoot:Root Ratio of 2 ½ : 1 to Root Weight Ratio of >27%?

- Shoot:Root ratio based upon a weight basis or a volumetric basis.
- It was never intended to be expressed by dividing taproot length by shoot length.

How do we get from a Shoot:Root Ratio of 2 ½ : 1 to Root Weight Ratio of >27%?

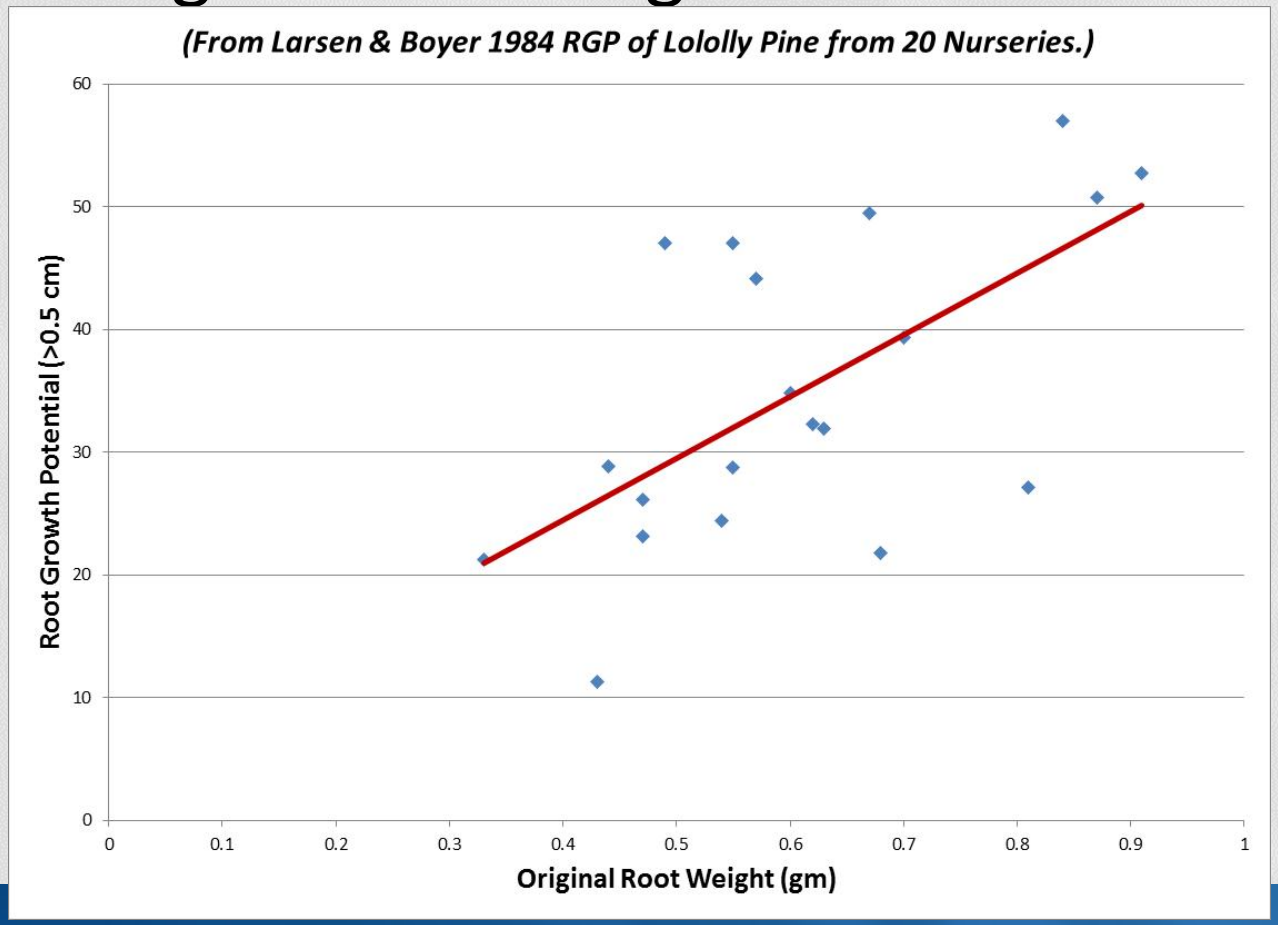
- Shoot:root ratio - in grams of biomass - 2 ½ gm for the shoot and 1 gm for the roots. Total seedling weight = 2 ½ + 1 = 3 ½ gm.
- Root weight ratio defined as: the weight of the roots divided by the total seedling weight or 1 ÷ 3 ½ = 28%
- The optimum seedling should have a root weight ratio of >27%

How is RWR determined?

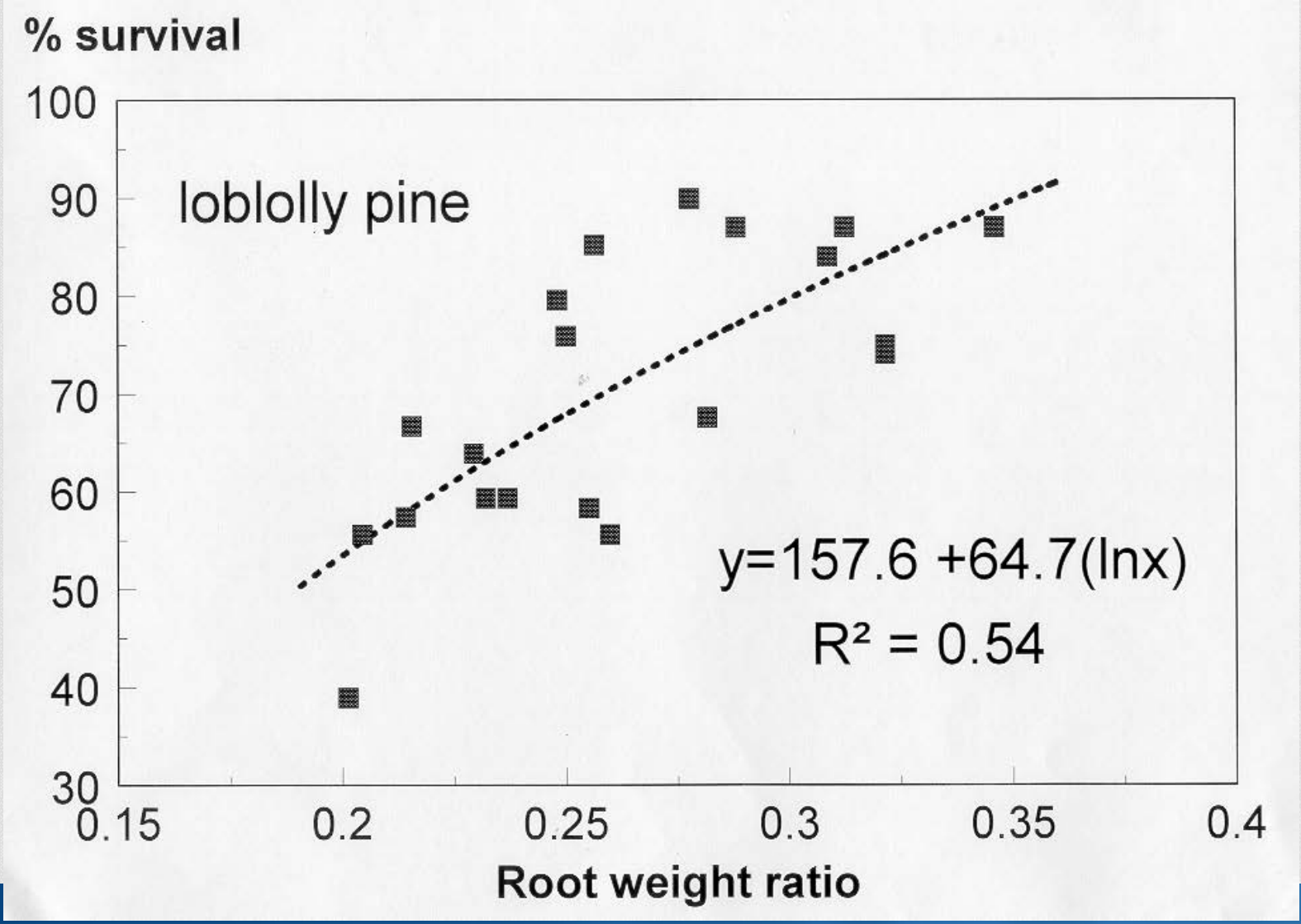
- Collect seedlings
- Separate roots from top
- Dry both in oven
- Weight both
- Calculate ratio of roots to total seedling weight

Root weight ratio = (root weight)/(shoot weight + root weight)

- Most important morphological indicator of high RGP is original root weight



Relationship of RWR to survival



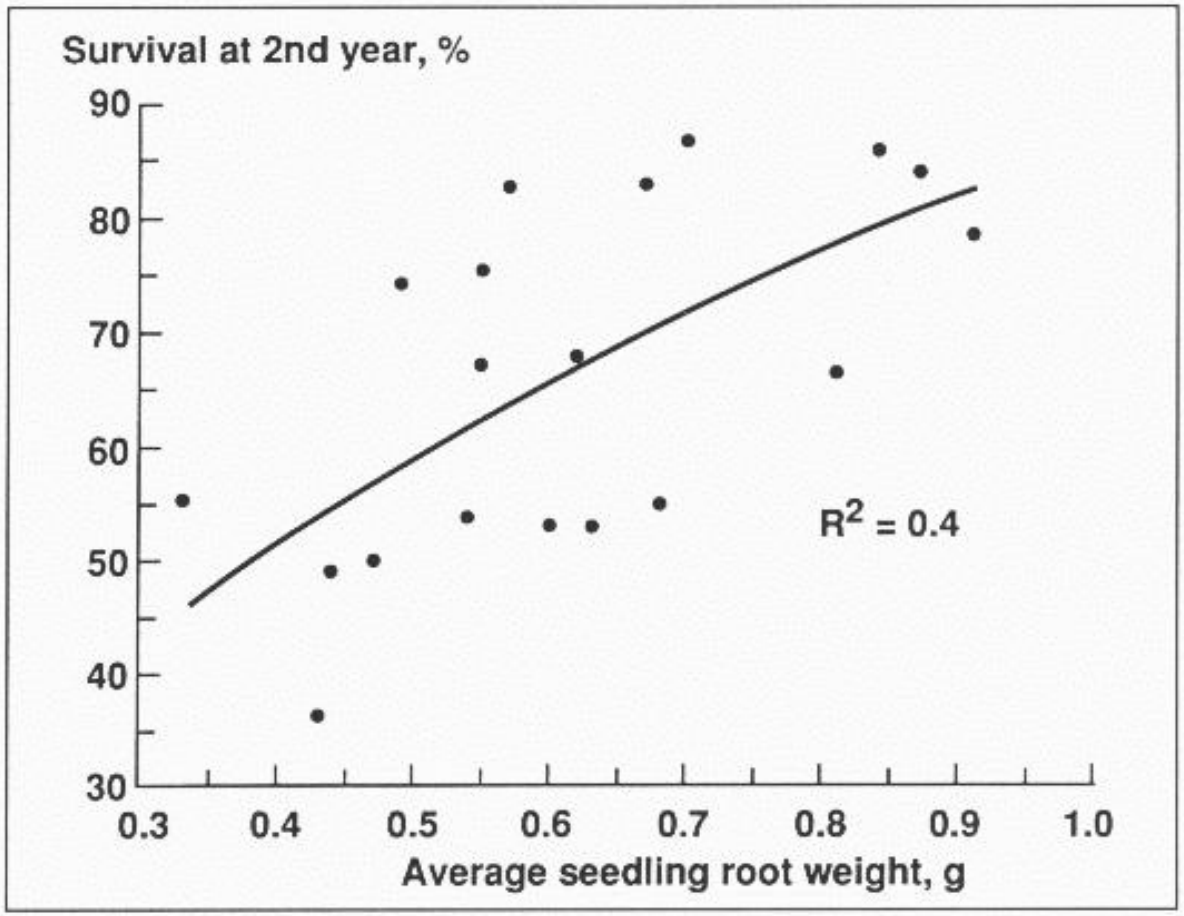
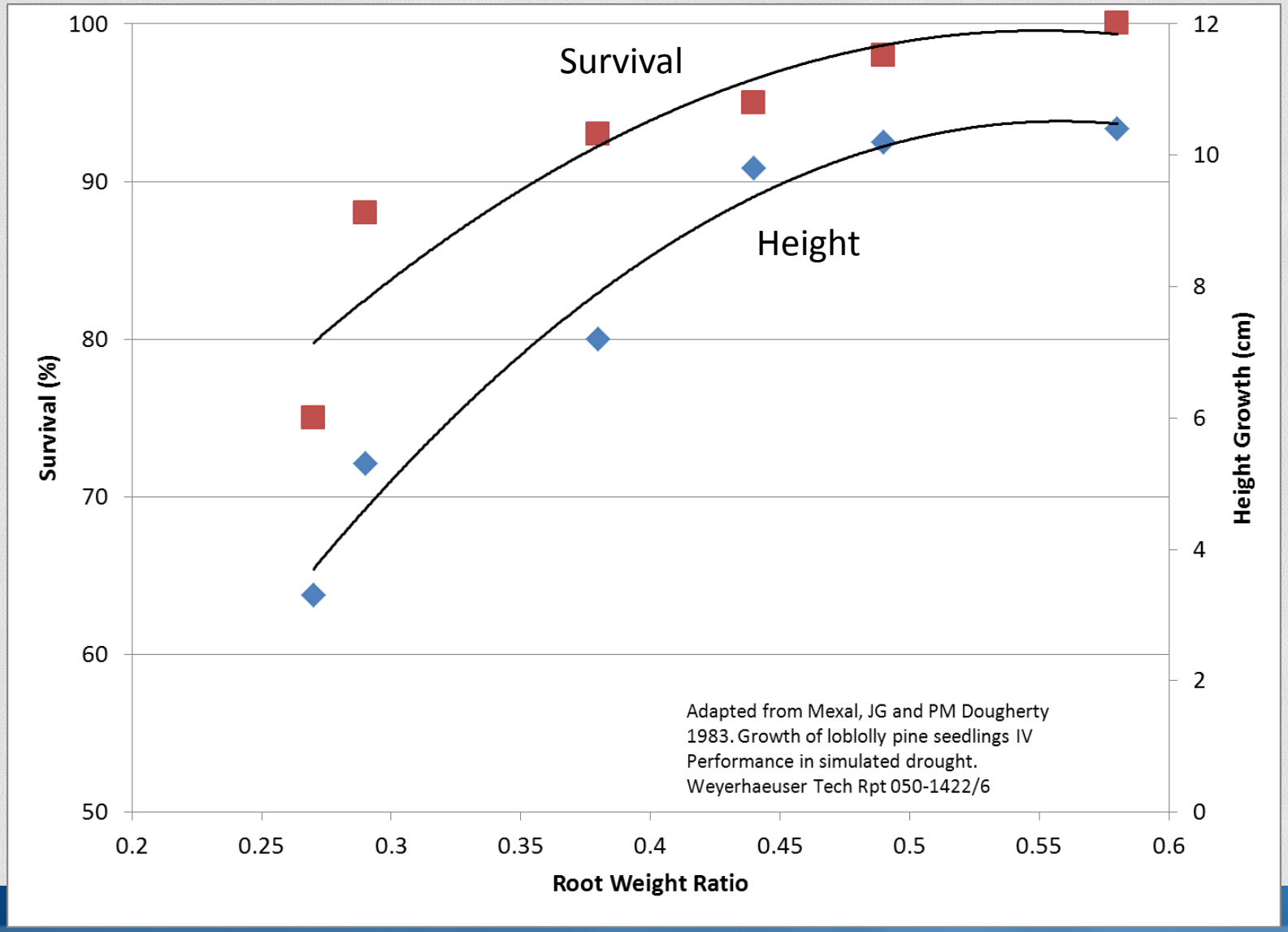
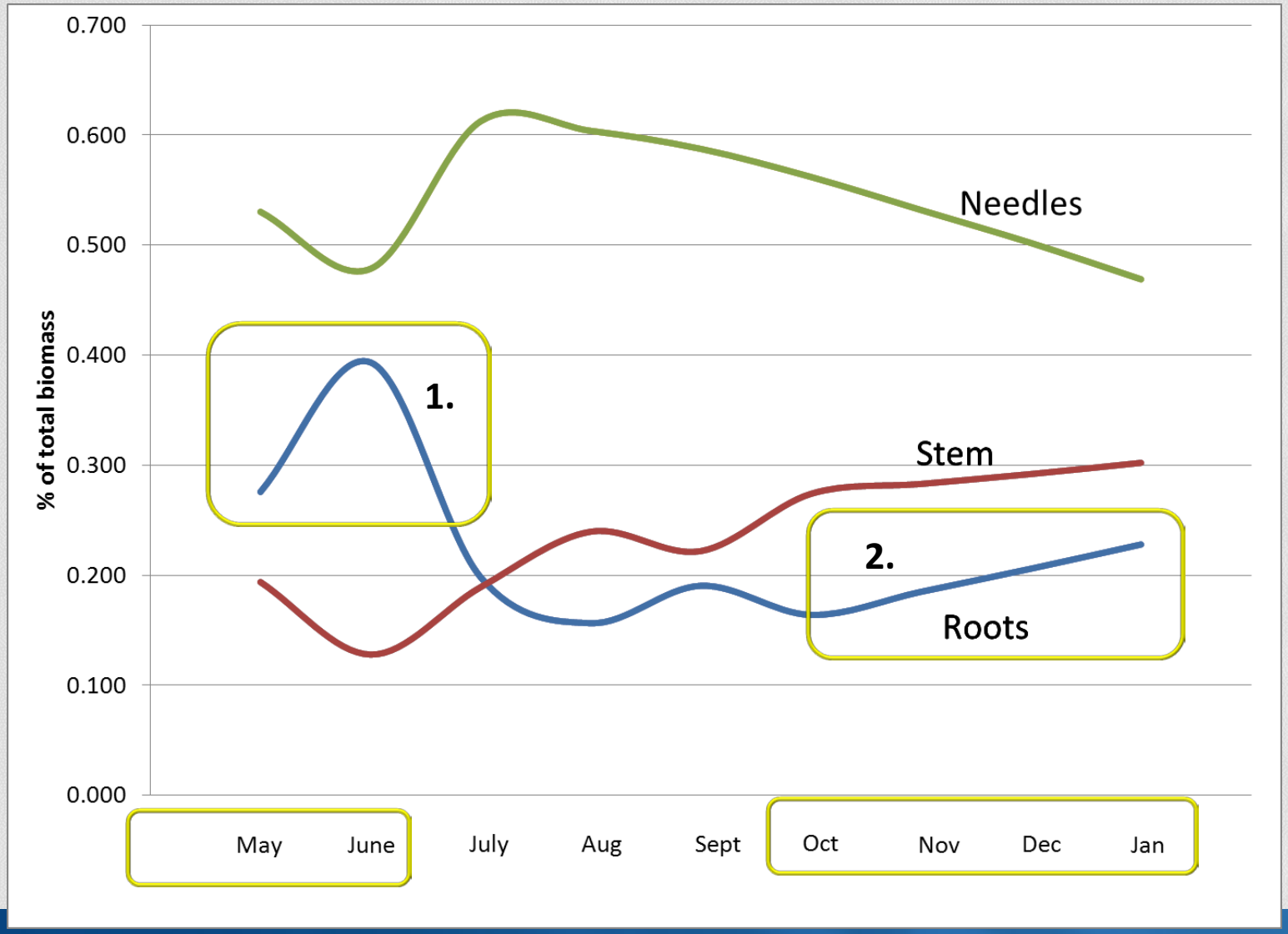


FIG. 4. The relationship between root weight and seedling survival for loblolly pine (*17*).

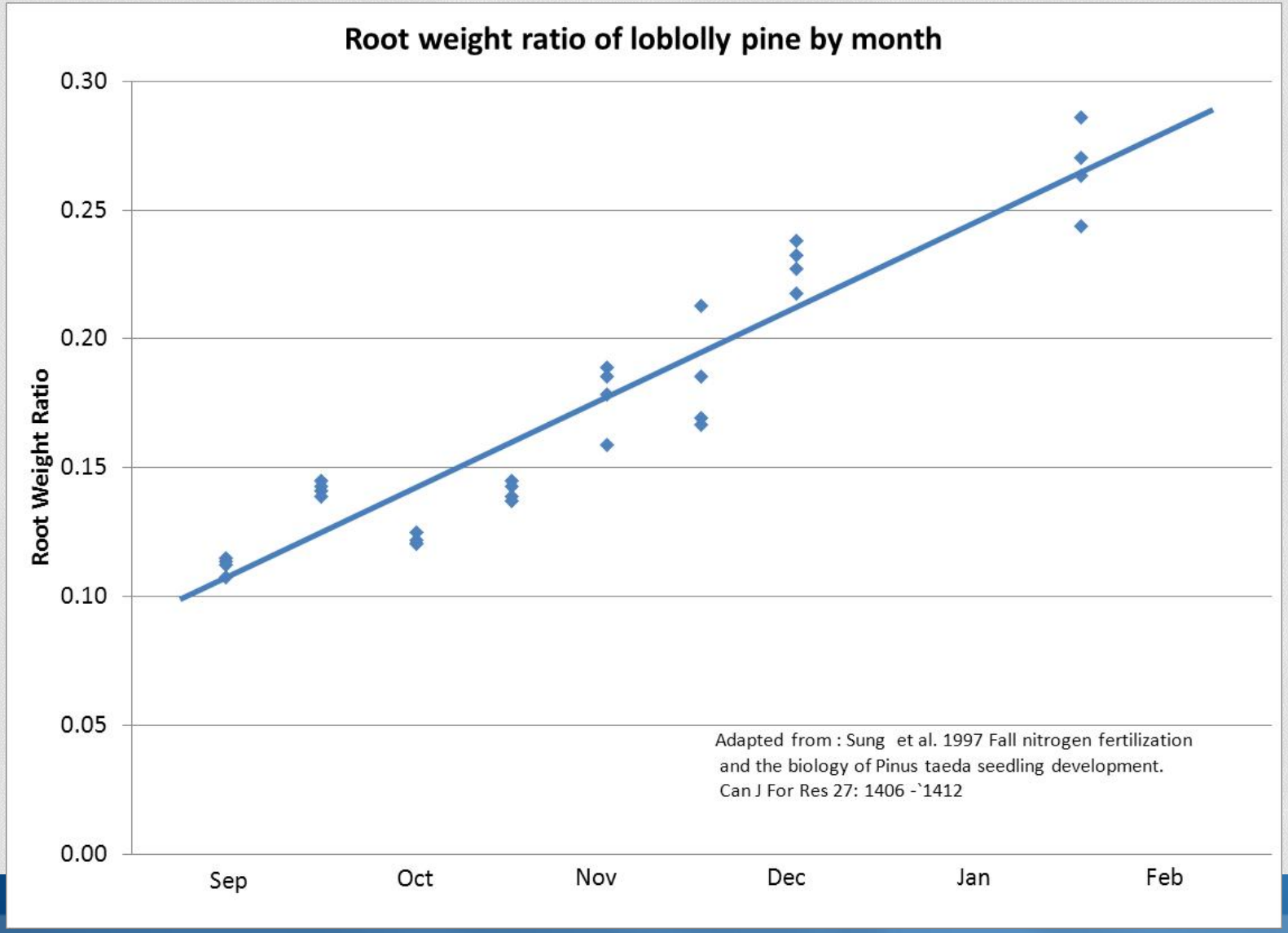
Relationship of RWR to survival & height



Time of Root Growth



Relationship of RWR and time of lifting



What Factors Effect Root Weight Ratio?

- Time of lifting
- Growing density
- Irrigation
- Fertilization
- Genetics
- Root and top culture
- Time of sowing

Summary

- Both give us a picture of root “health”
  - RWR – more roots – better chance of outplanting performance
  - RGP – high RGP – better chance of outplanting performance
- RWR – quick test (<5 days)
- RGP – slow test (~30 days)
- RGP – limited predictive ability
- RGP – better indication of root injury
- RWR – indication of quality of seedling lifting

Summary

- When the Coop wants to evaluate:
  Root injury,
  Survival potential under good conditions (short –term)
  we will use Root Growth Potential

- When we want to compare:
  Treatment effects
  Lifting efficiency
  Compare seedlots
  we will use Root Weight Ratio