

# Getting to the Root of the Tree

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PENNSTATE



# Talk Outline

- Why are roots important?
- Are all roots the same?
- Do roots grow when we think they do?
- Can we manage roots?

# Why Are Roots Important?

# Establishment and Anchoring



# Water Uptake



<http://www.omafr.gov.on.ca/neworchard/images/apples/15trickle/jpg>

# Nutrient Uptake



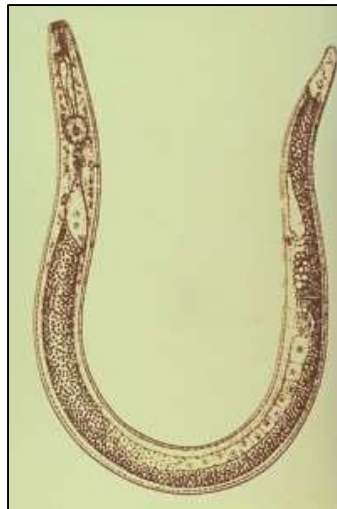
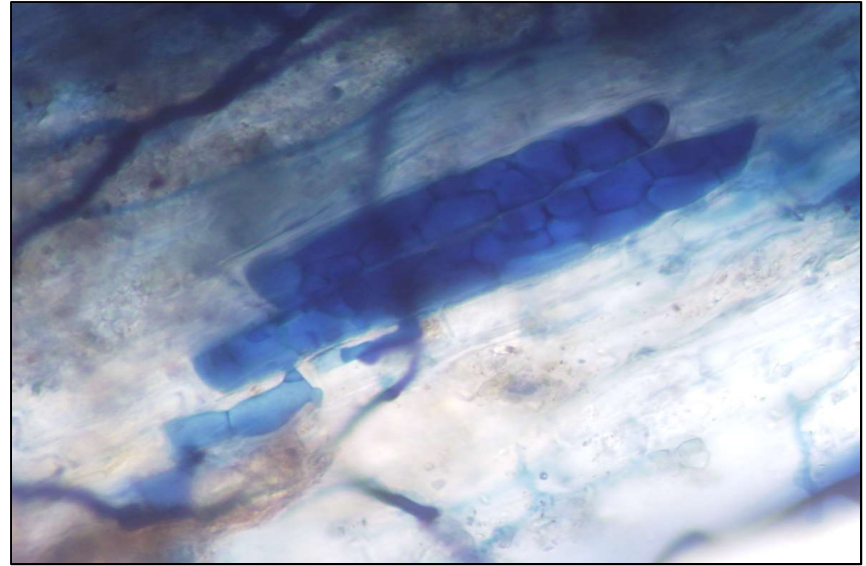
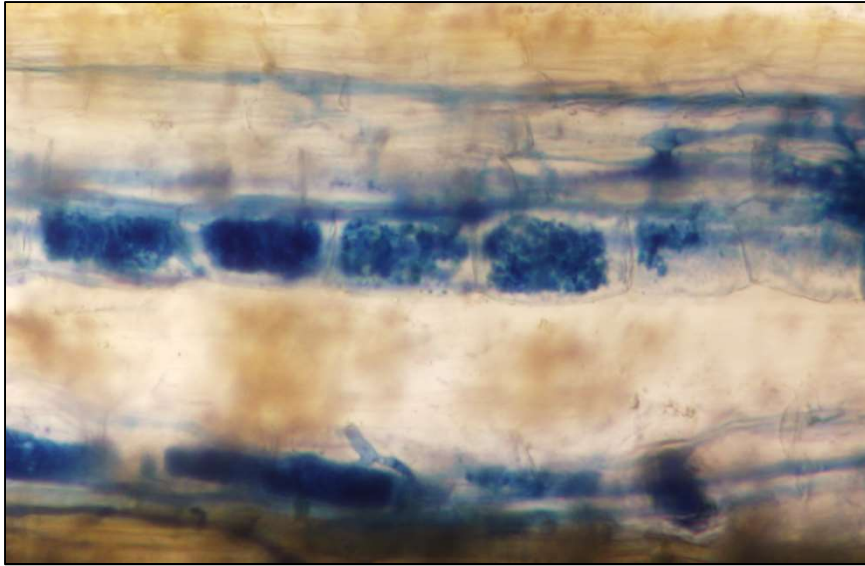
<http://www.samfg.com/wp/wpcontent/uploads/2014/10/HessACpotash1.jpg>

# Soil Health



David Eissenstat

# Soil Health



# Are All Roots the Same?



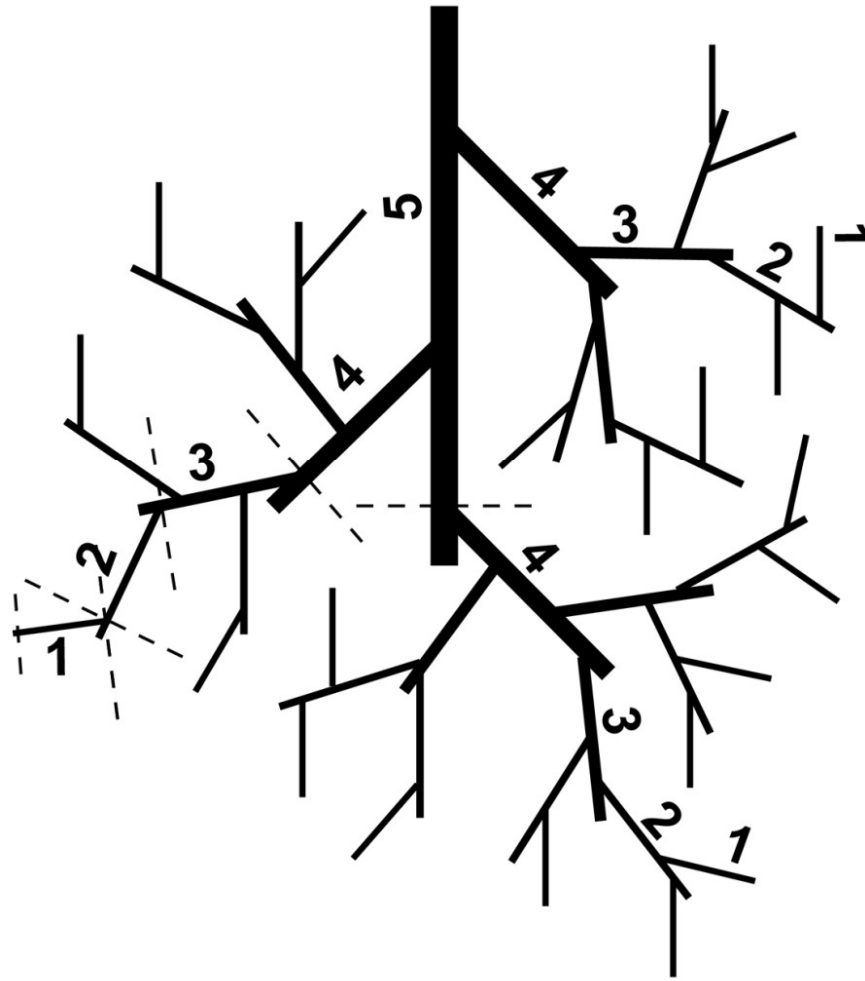
No

<https://www.plantvillage.com/en/topics/peach/infos>

# Different Roots Have Different Functions

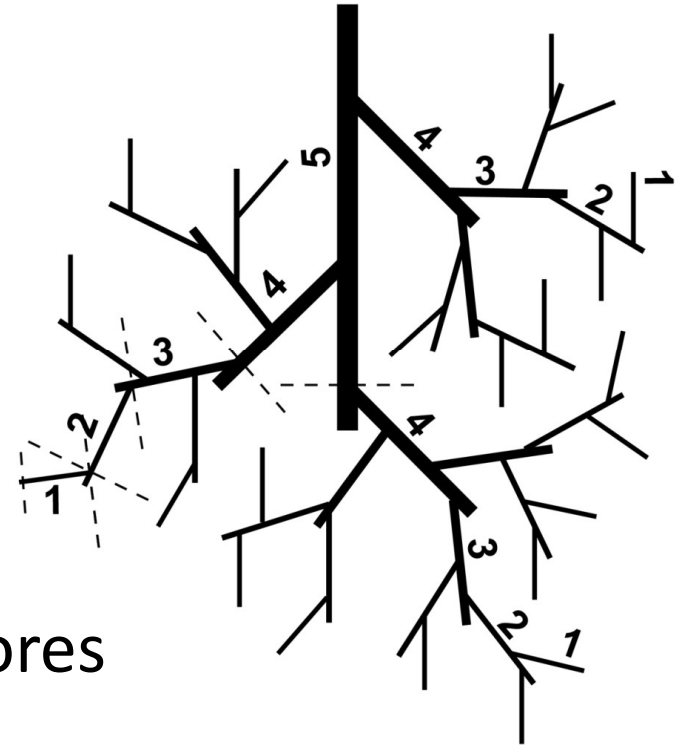
- Absorptive roots
- Transport roots
- Pioneer roots

# Root System Structure



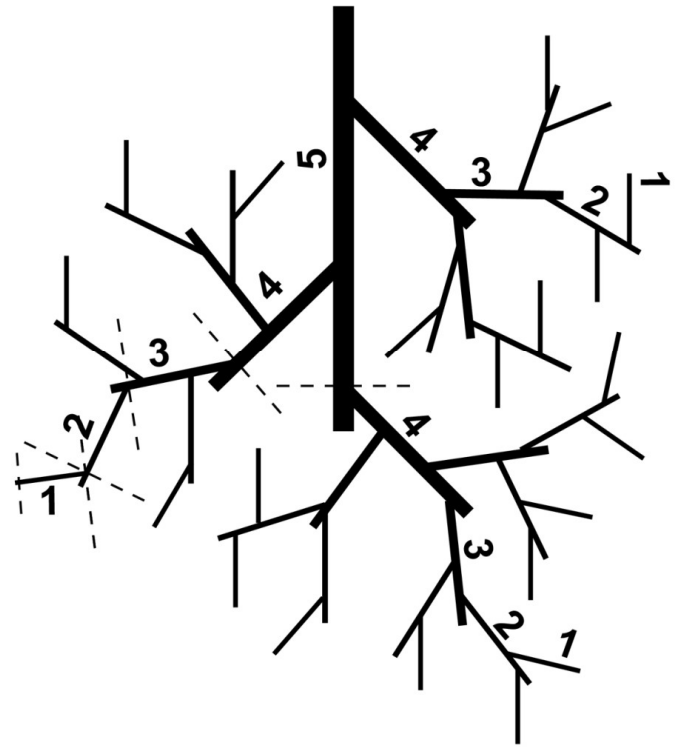
# Absorptive Roots

- Take up water and nutrients
  - 1<sup>st</sup> and 2<sup>nd</sup> order
  - Not woody
  - Short lifespan (30-60 days)
  - Mycorrhizal colonization
  - Metabolically active
  - White or lighter color
  - Target for microbes and herbivores



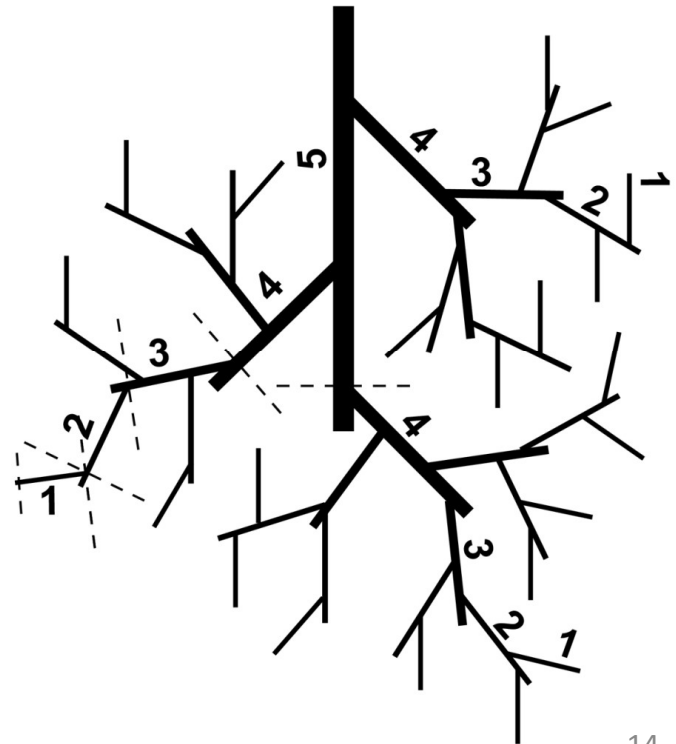
# Transport Roots

- Transport water and nutrients
  - 5<sup>th</sup> order and above
  - Woody
  - Longer lifespan (> 1 yr)
  - Tan or brown in color
  - Usually start as pioneer roots

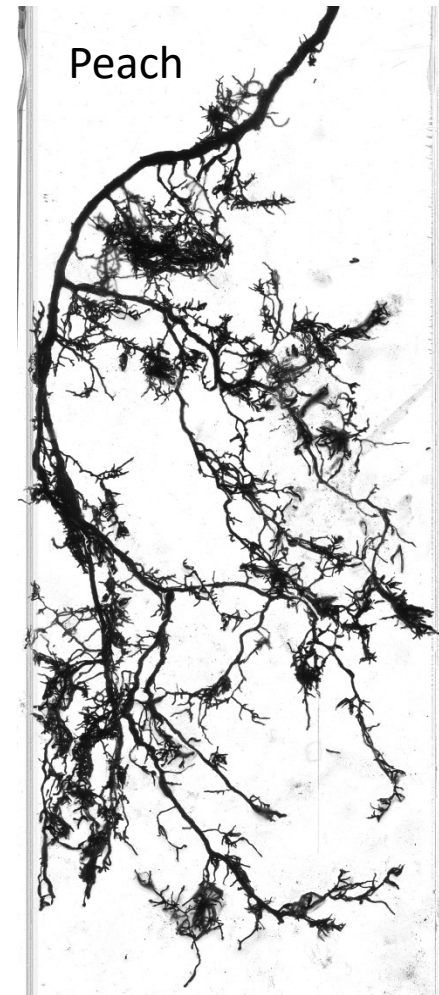
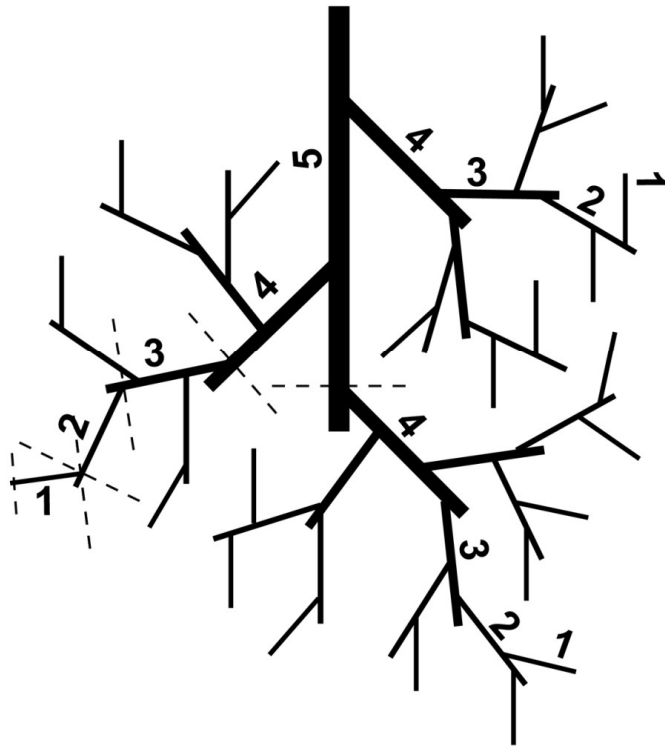


# Pioneer Roots

- Roots for support
  - Framework for absorptive and transport roots
    - Similar to scaffold branches
  - Grow quickly
  - Woody within a few weeks
  - Large diameter ( $>2\text{mm}$ )
  - Long lifespan
    - Usually the life of the tree

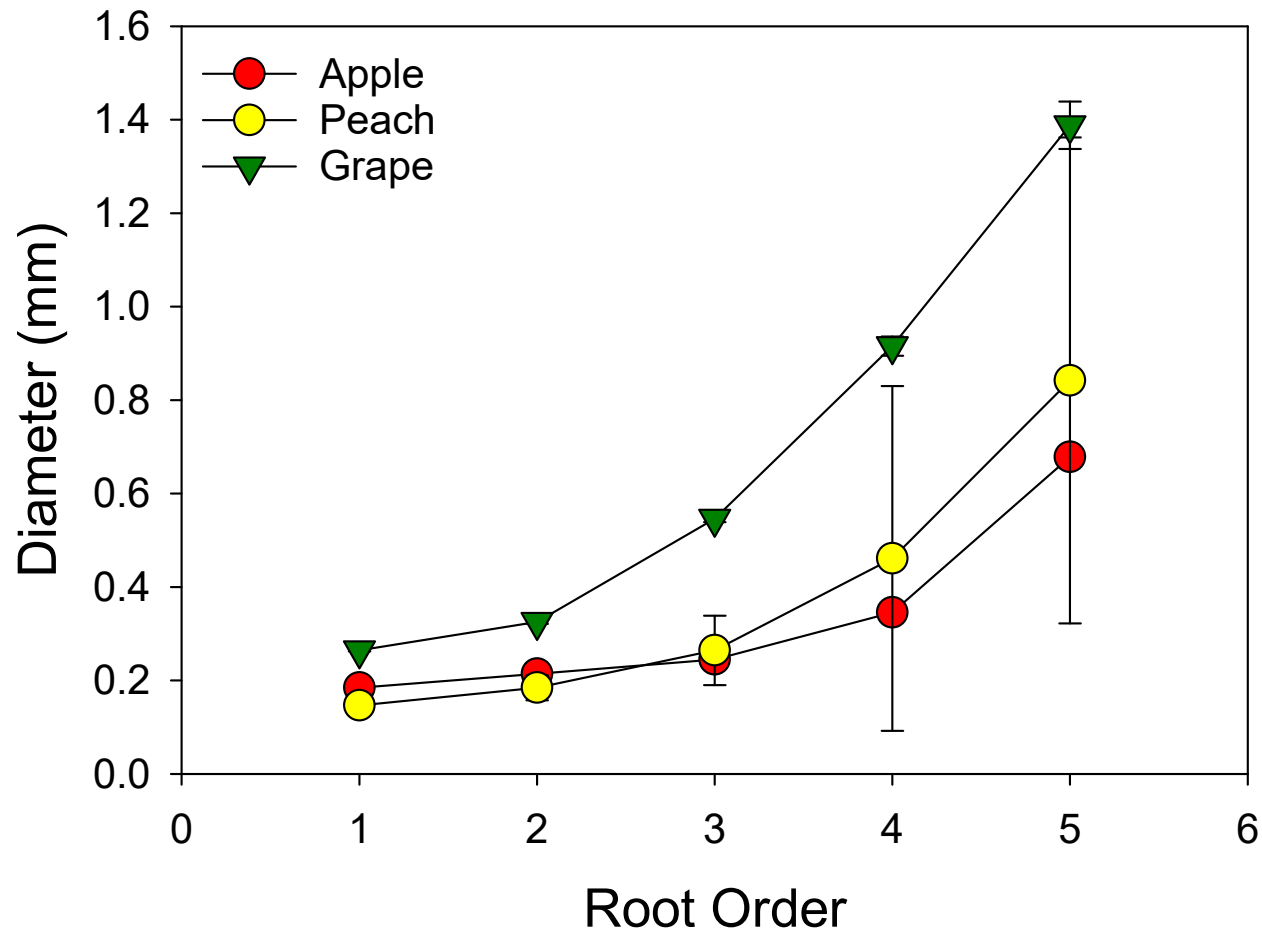


# In the Field

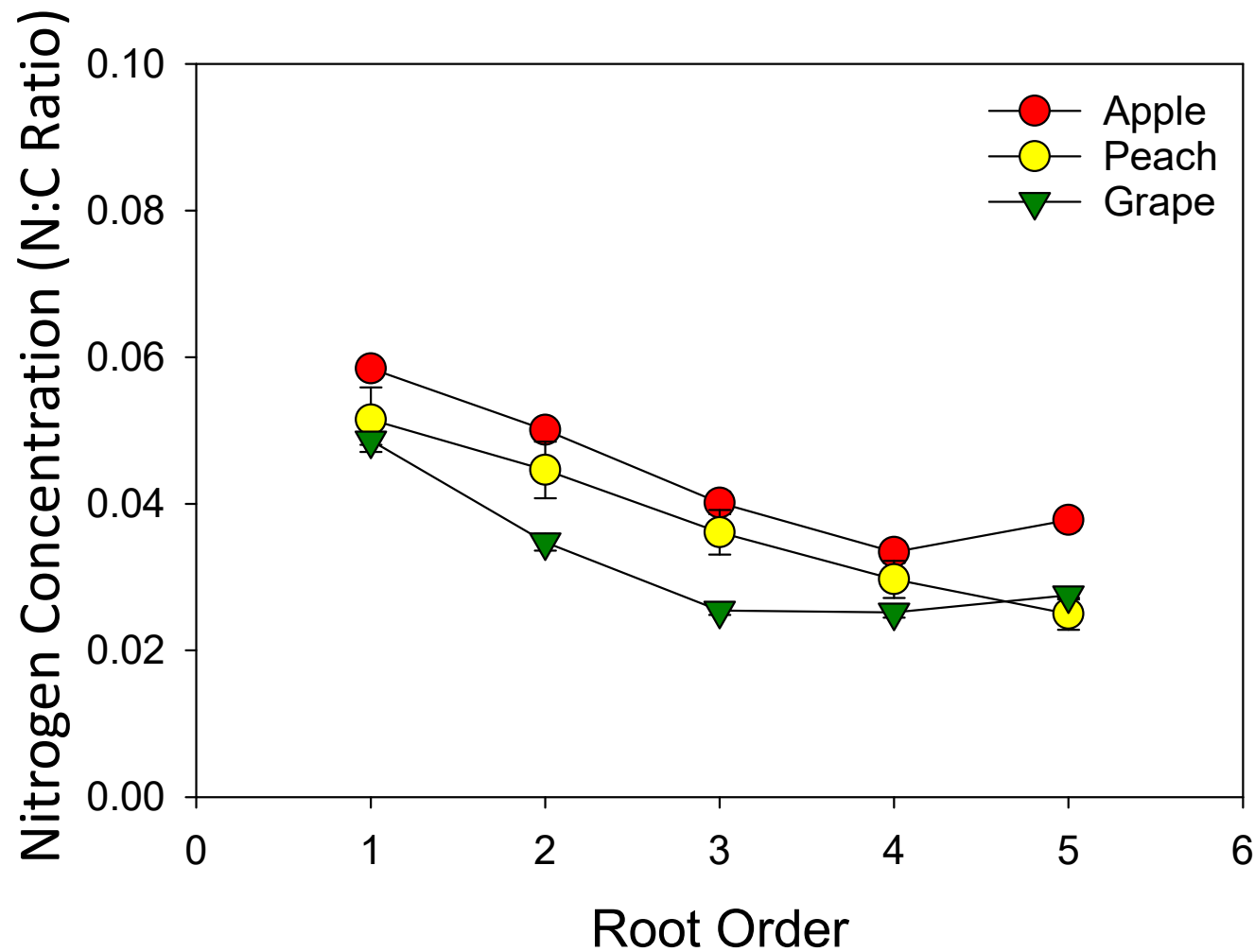


Traditional approach:  $<2\text{mm}$  ( $\sim 1/16^{\text{th}}$  in.)

# All 5 Root Orders Have Diameter < 2mm

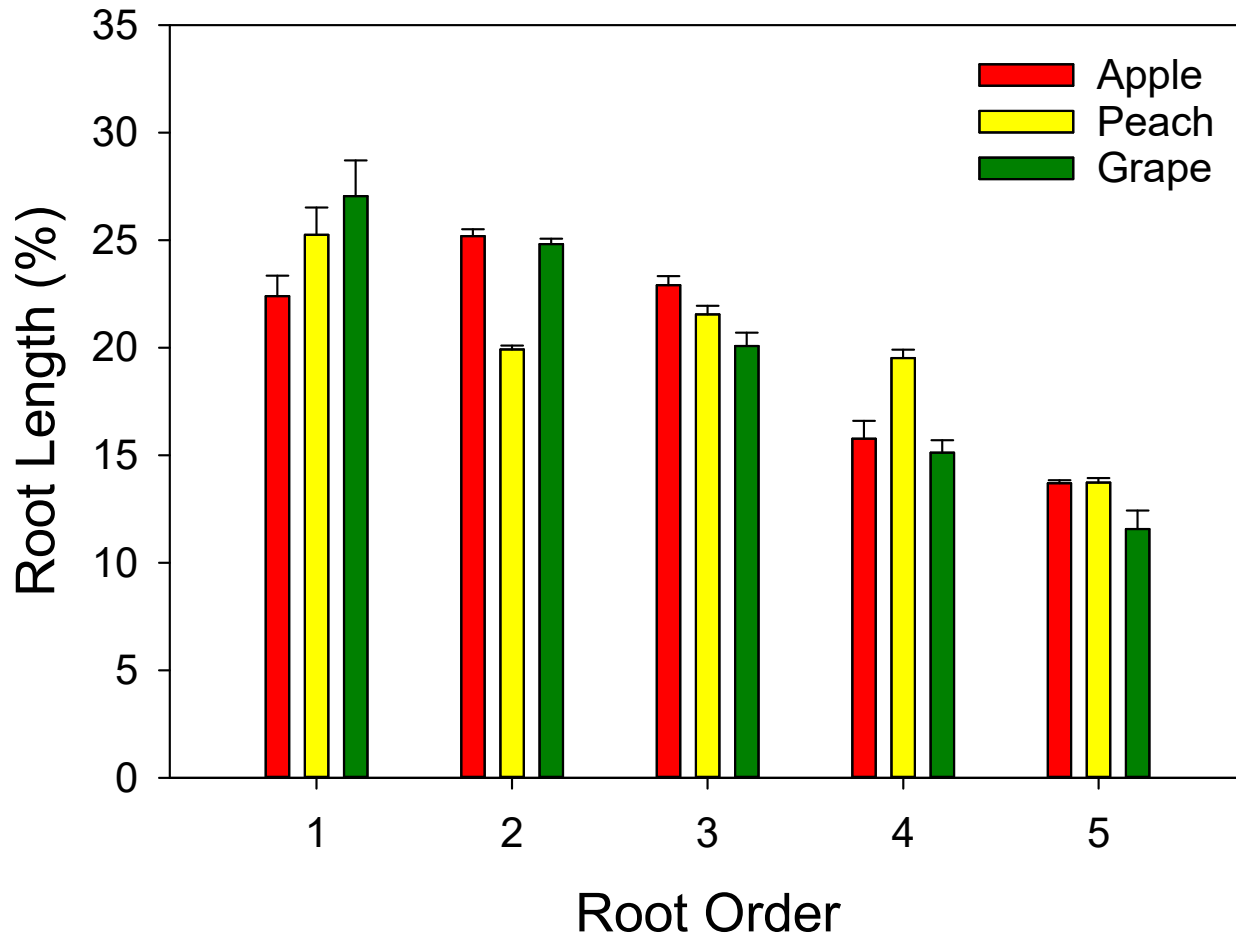


# Lower Order Roots Have High Nitrogen



- Important for metabolic function

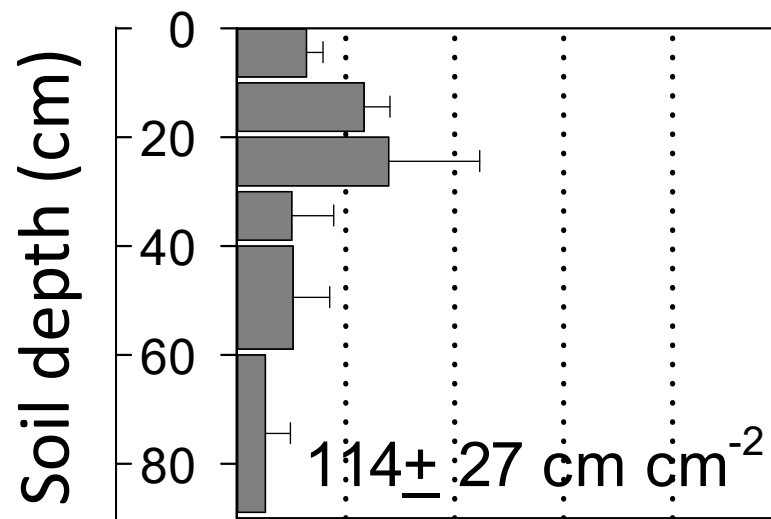
# Lower Orders Have Greatest Soil Contact



- Important for nutrient uptake

# Root Distribution

- Roots tend to be very shallow
- Gala/M.9
- Summerland, British Columbia



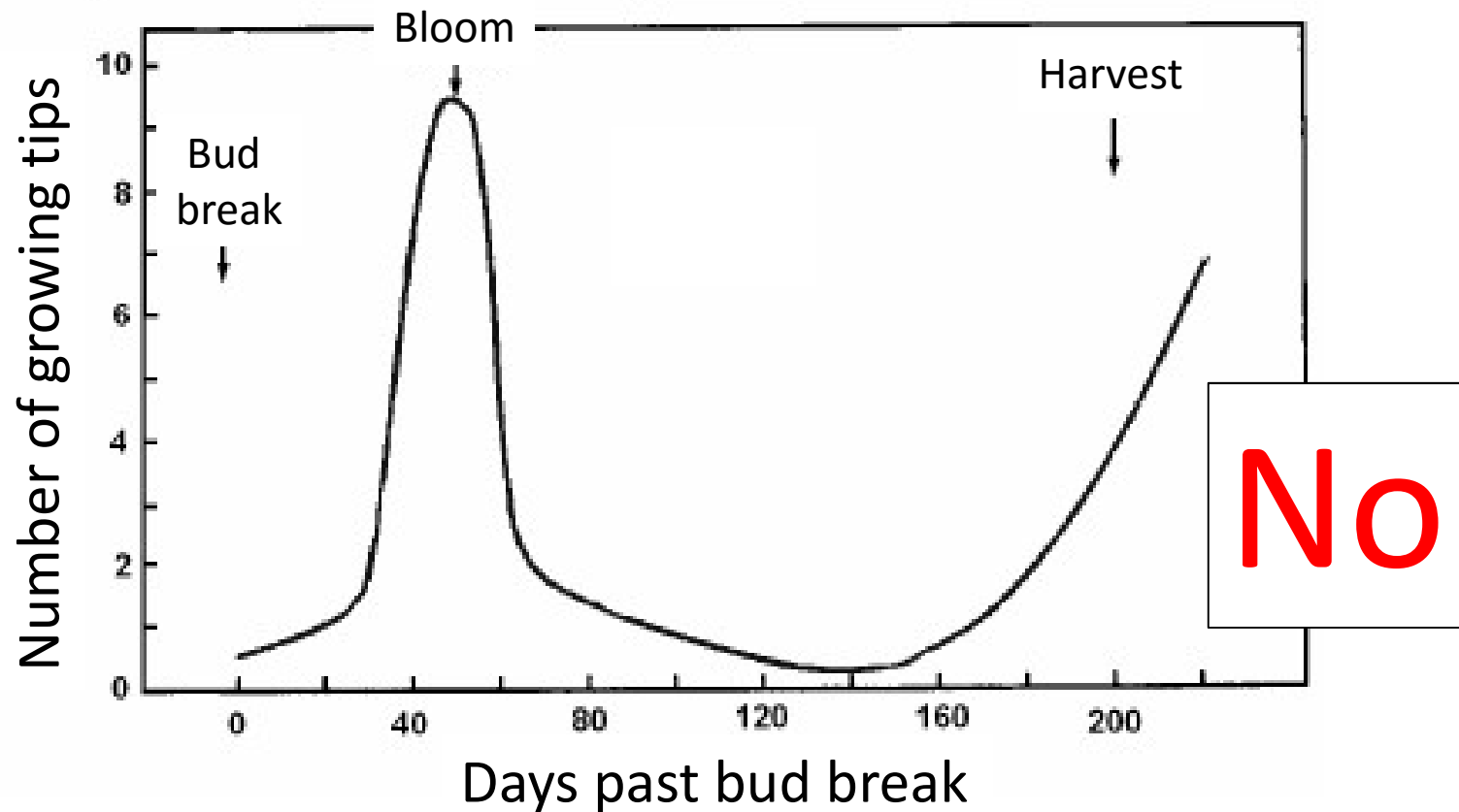
- Absorptive roots respond to soil amendments

# Take Home Points

- Most active roots are the absorptive roots
  - 1<sup>st</sup> and 2<sup>nd</sup> order roots mostly
  - Greatest soil contact
  - Take up water and nutrients
  - Interact with microbes
  - Primarily in the top 12-15 inches of soil

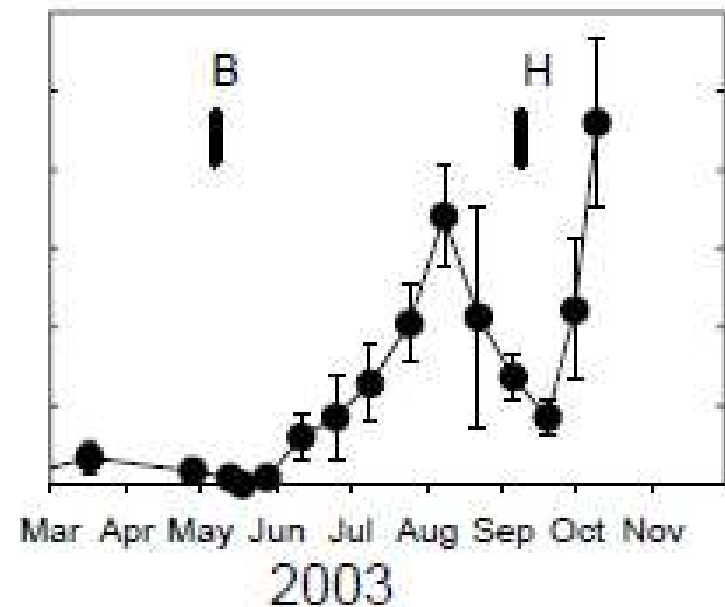
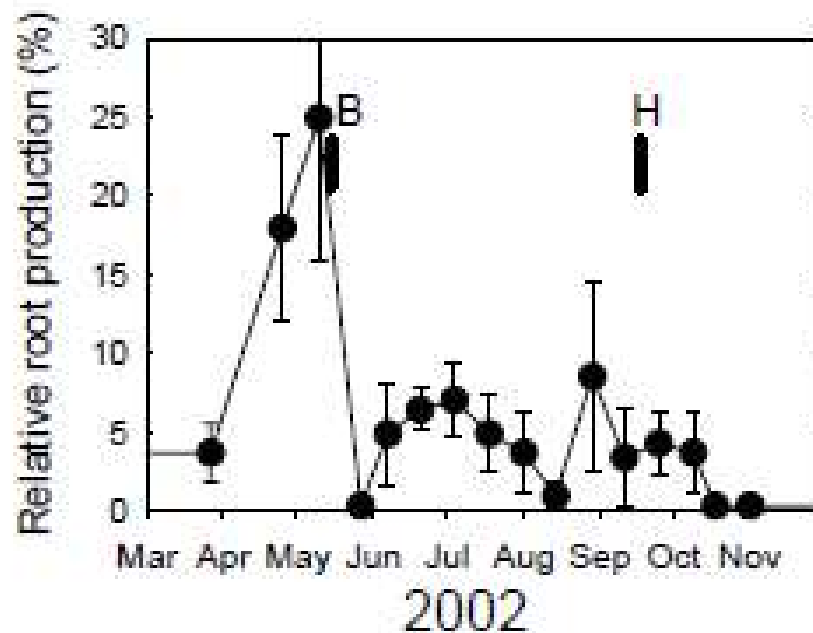
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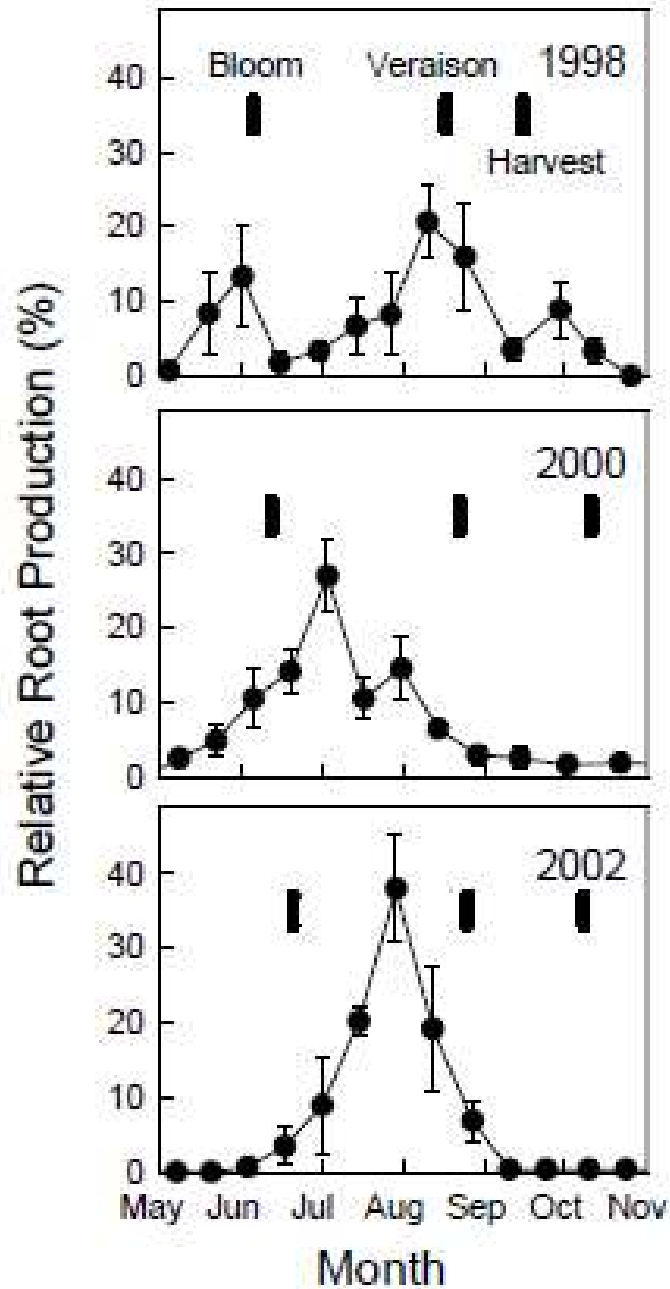
# Root Growth in Apple

- Summerland, British Columbia
- Gala/M.9



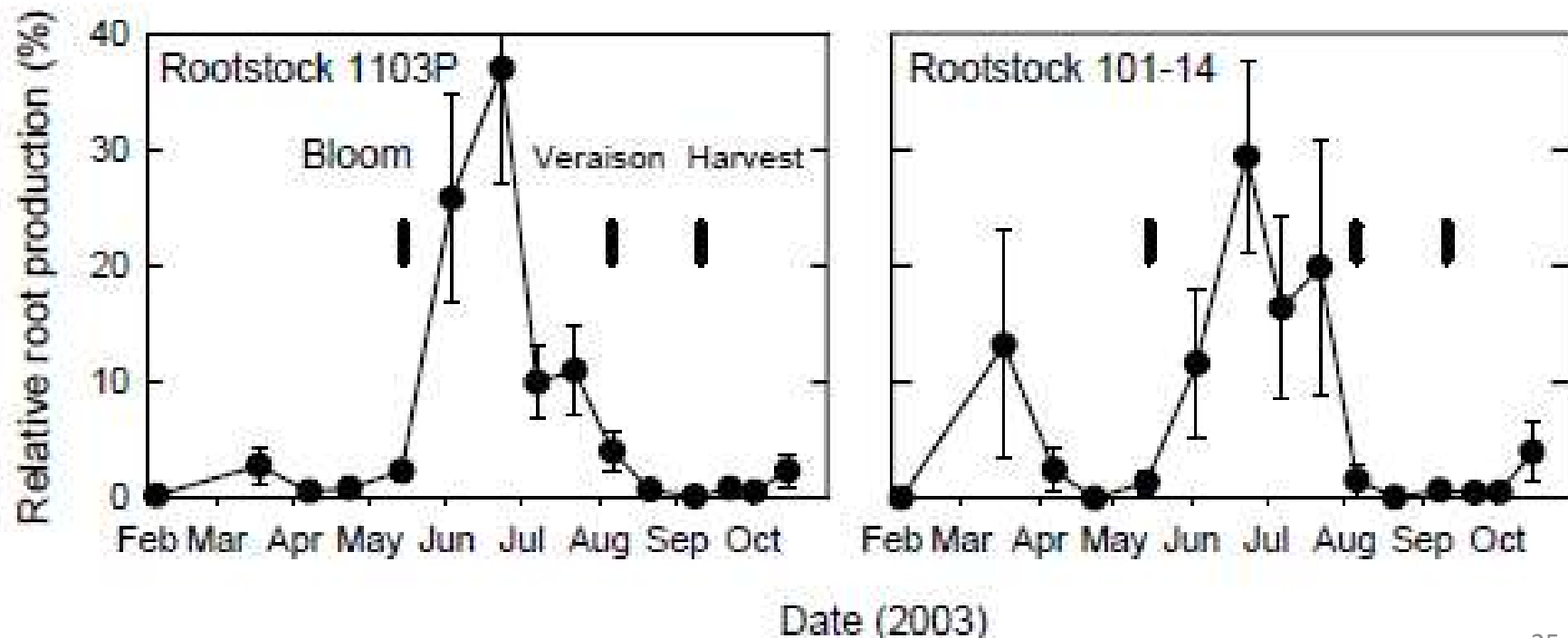
# Root Growth in Grape

- Fredonia, New York
- Concord



# Root Growth Differs by Rootstock

- 'Merlot' on two rootstocks
- Oakville, CA



# When Do Roots Grow?

- Difficult to predict
  - Seasonal differences
  - Variety/rootstock differences
- Biological mechanism is unknown

# Can We Manage Roots?

- Encourage growth of healthy absorptive roots
- Maintain healthy soils

# Developing a Healthy Root System

- Increase soil organic matter
  - Compost or green manure
  - Crop rotation
  - Pre-plant treatment
- Minimize plant stress
  - Crop load management
  - Irrigation
  - Fertilization
    - Enhance root growth
    - Encourage mycorrhizal fungal colonization
    - Minimize stress induced disease development
    - Overcome herbivory

# Future Research

- High density plantings
- Root competition
- Rootstock differences
- Apple replant disease
- Precision agriculture

# Thank You!