Understanding Citrus Root Mass Issues

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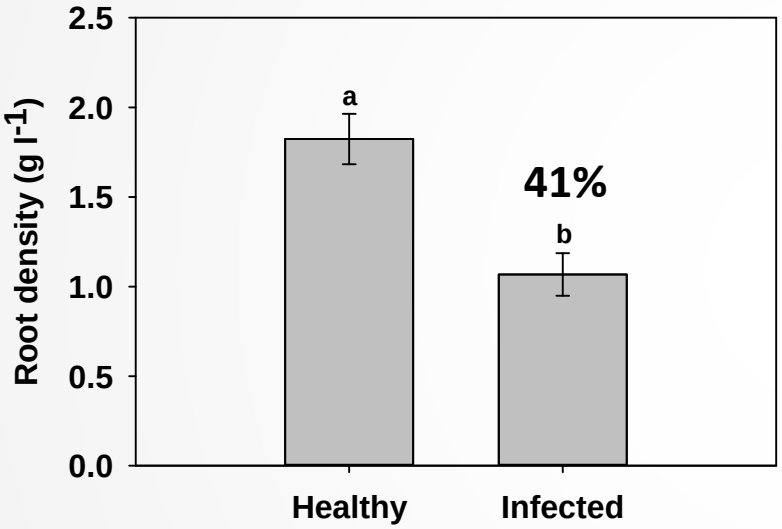
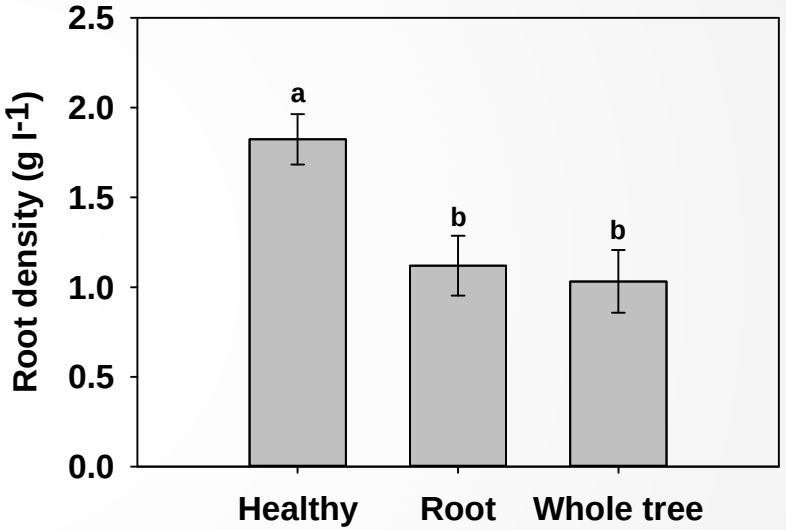
Outline

- Early root infection and root loss
  - Implications of root infection
- Early and late phases of HLB-associated root loss
  - When does it occur?
  - How much loss?
- What causes root loss?
  - Root growth or root turnover
- Implications for root health management

Presymptomatic root loss is linked to root infection



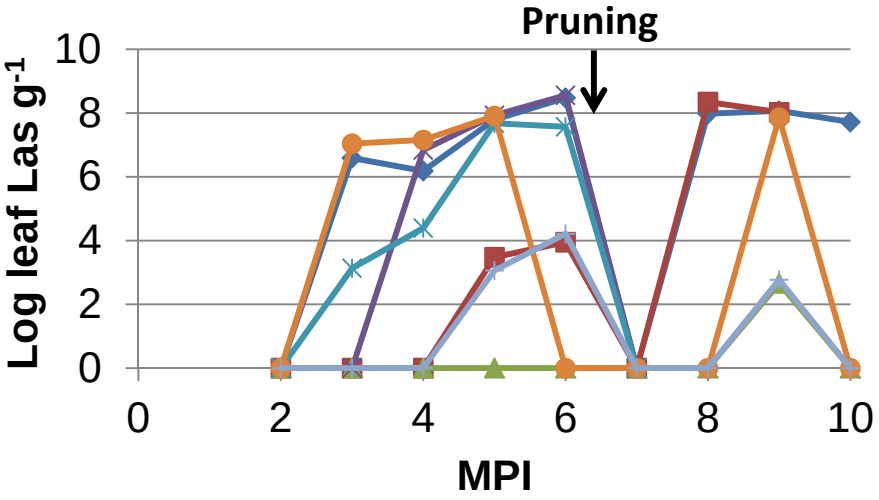


HLB root infection affects canopy

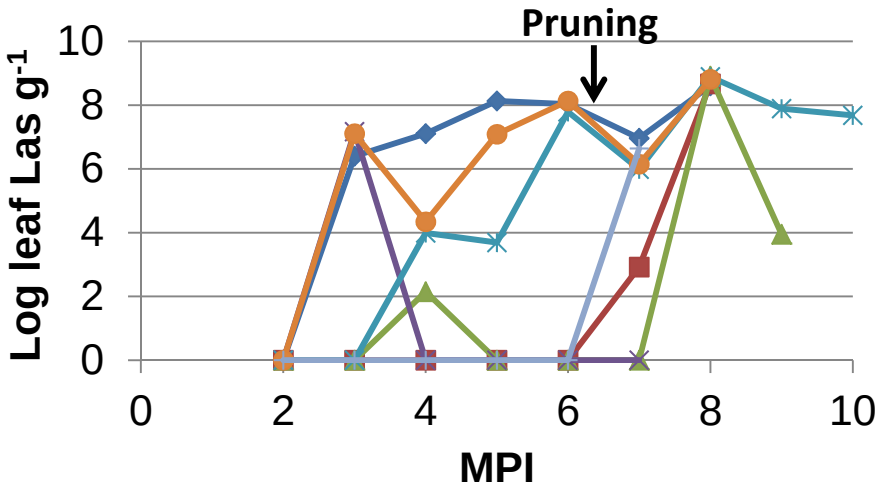
- Root infection
  - Can affect canopy health before canopy infection
  - Root health is compromised without visible symptoms
  - Root health is correlated to yield in phytophthora and diaprepes

- How does the root infection affect canopy infection?

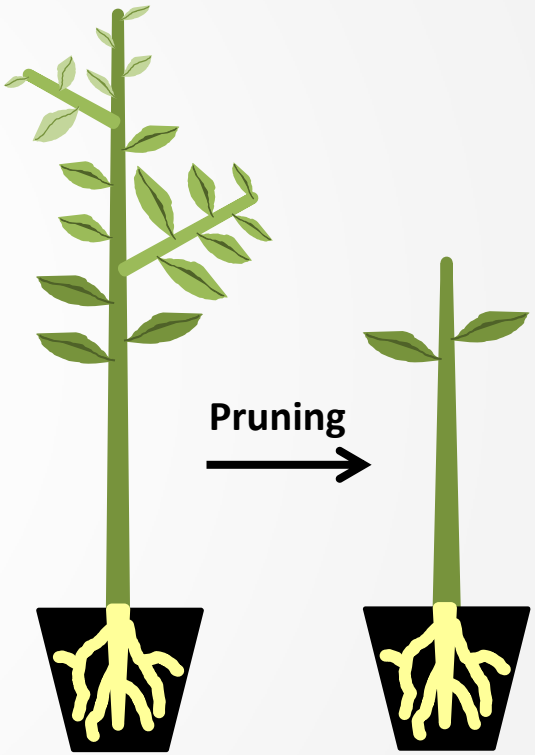
Roots are an HLB reservoir



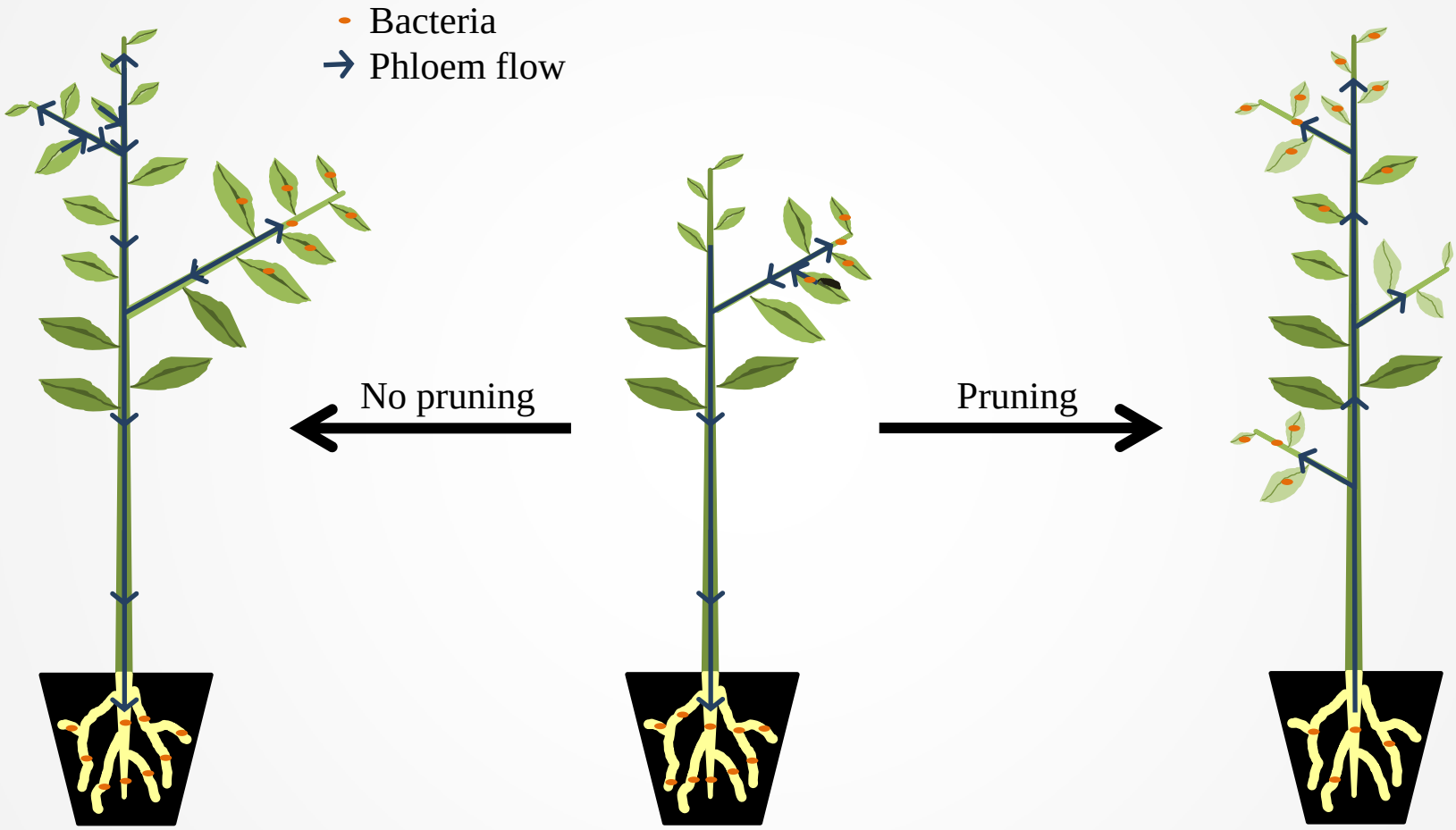
Low root bacteria



High root bacteria



Roots are an HLB reservoir

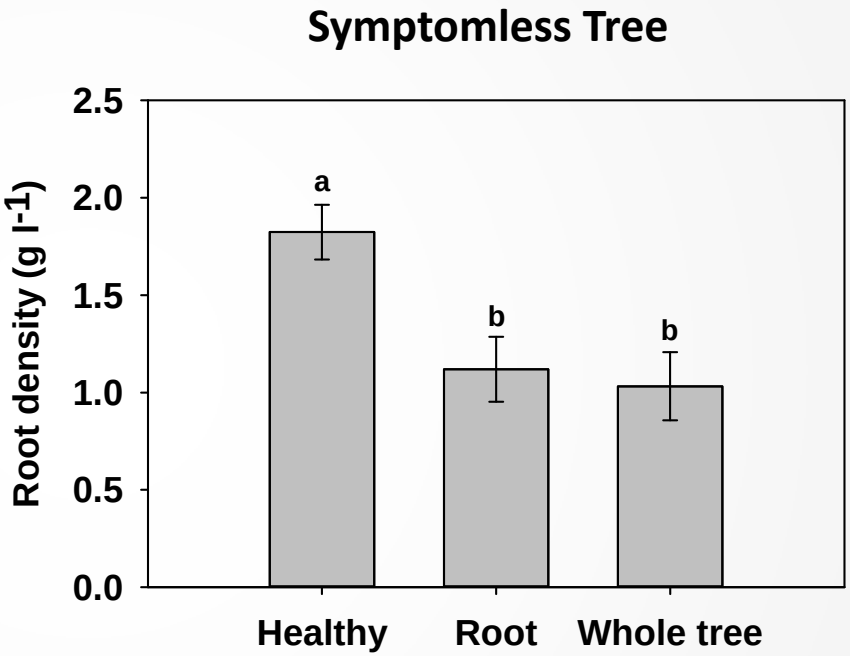


HLB root infection

- Root infection
  - Can't prune HLB out of trees
  - Root infection acts as reservoir for bacteria to infect new flush, especially after heavy pruning
  - Prevent rootstock suckers if tree is removed
- How does root infection affect root health?

Early and late phases of fibrous root loss

- Early root loss
  - Occurs before leaf symptoms
  - 30-50% root loss
  - Root infection
- Late root loss
  - 70-80% root loss
  - Canopy thinning



What does this mean?

Healthy

Full roots

Symptomless Infected

30-50% root loss

Thinning

70-80% root loss

A closer look at thinning

Woody branches visible

Symptomatic new flush

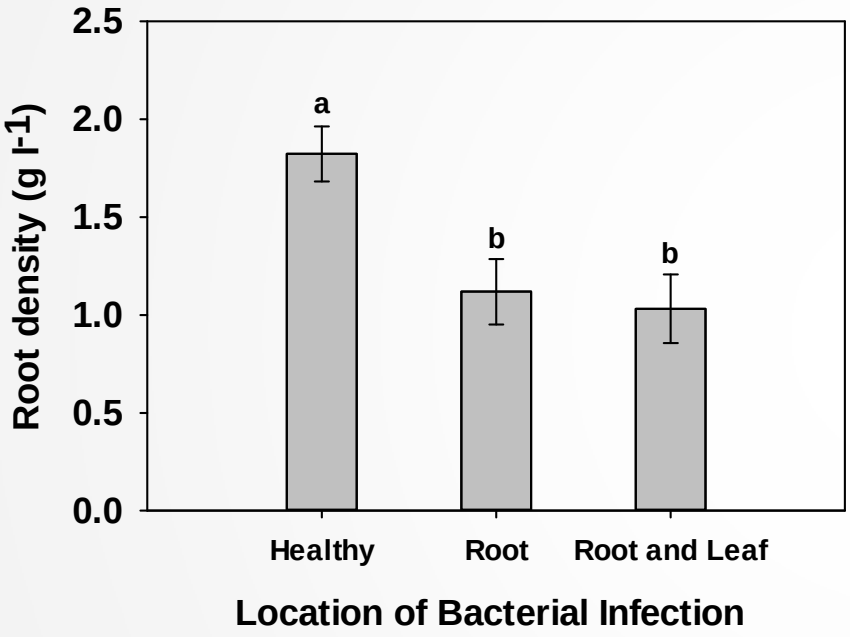
Leaf drop and dieback

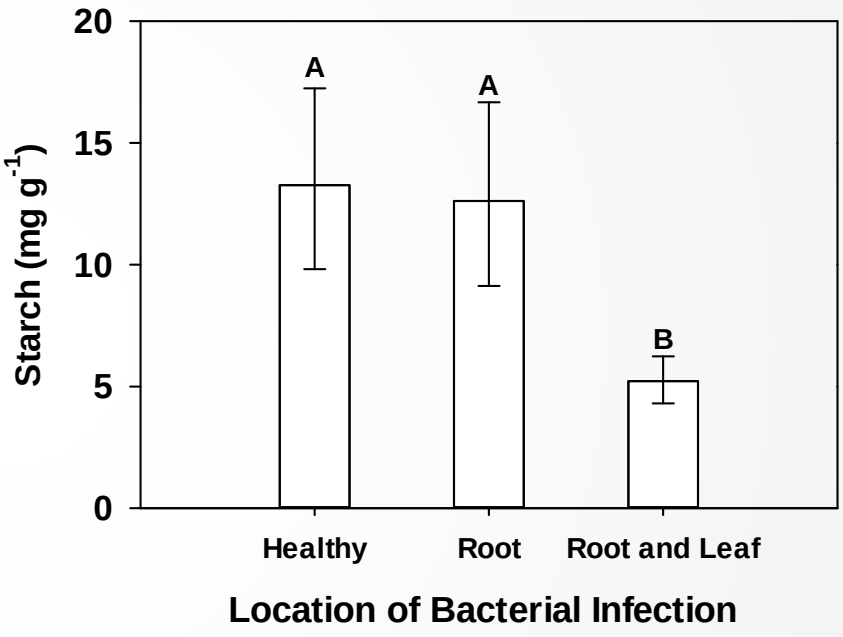
What is causing root loss

- Traditionally thought to be carbohydrate starvation
  - Phloem plugging in canopy and trunk blocks sugar transport

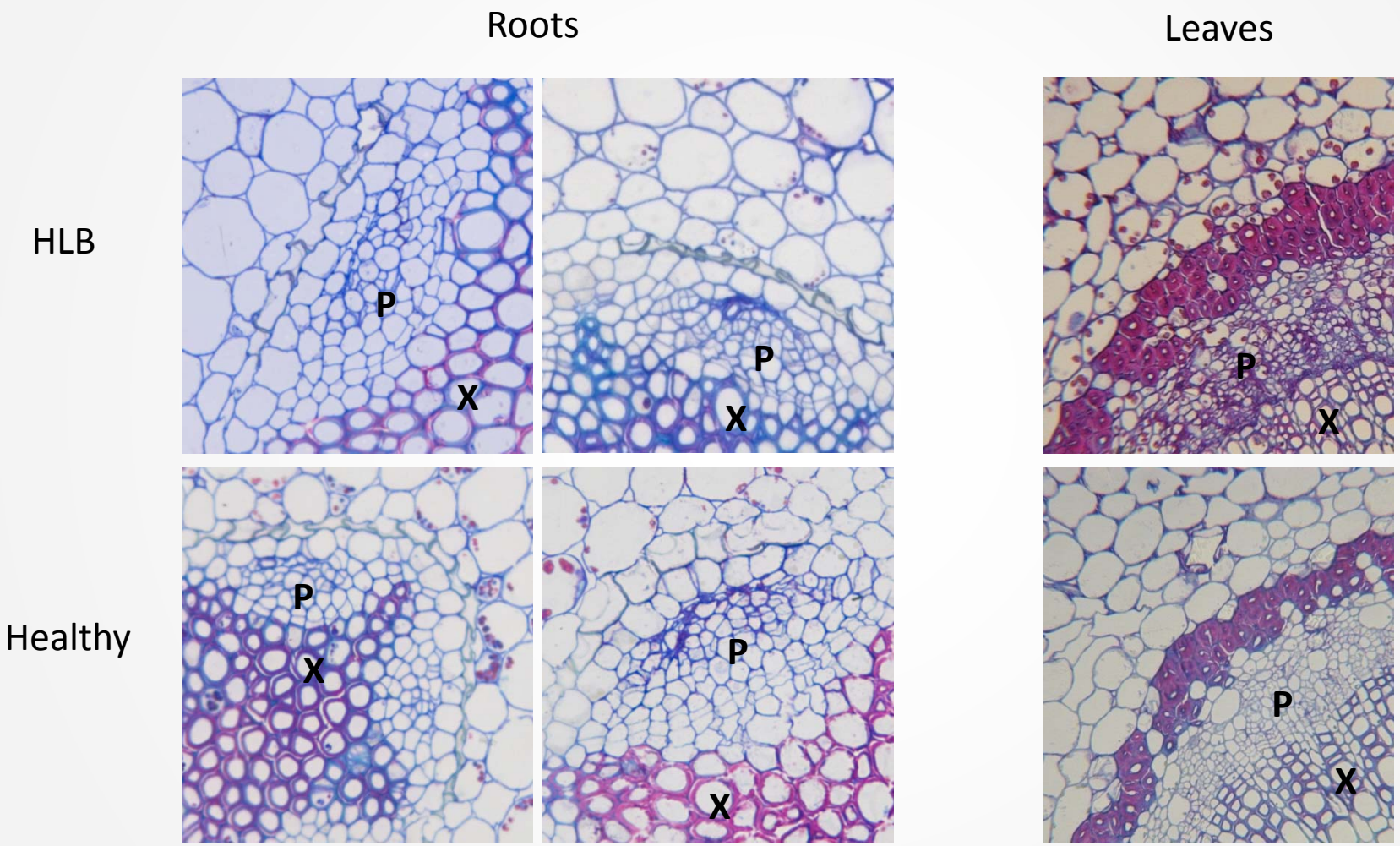
- Dependent on root infection
  - Phloem plugging in roots?

Early root loss precedes carbohydrate starvation





Fibrous roots lack phloem plugging



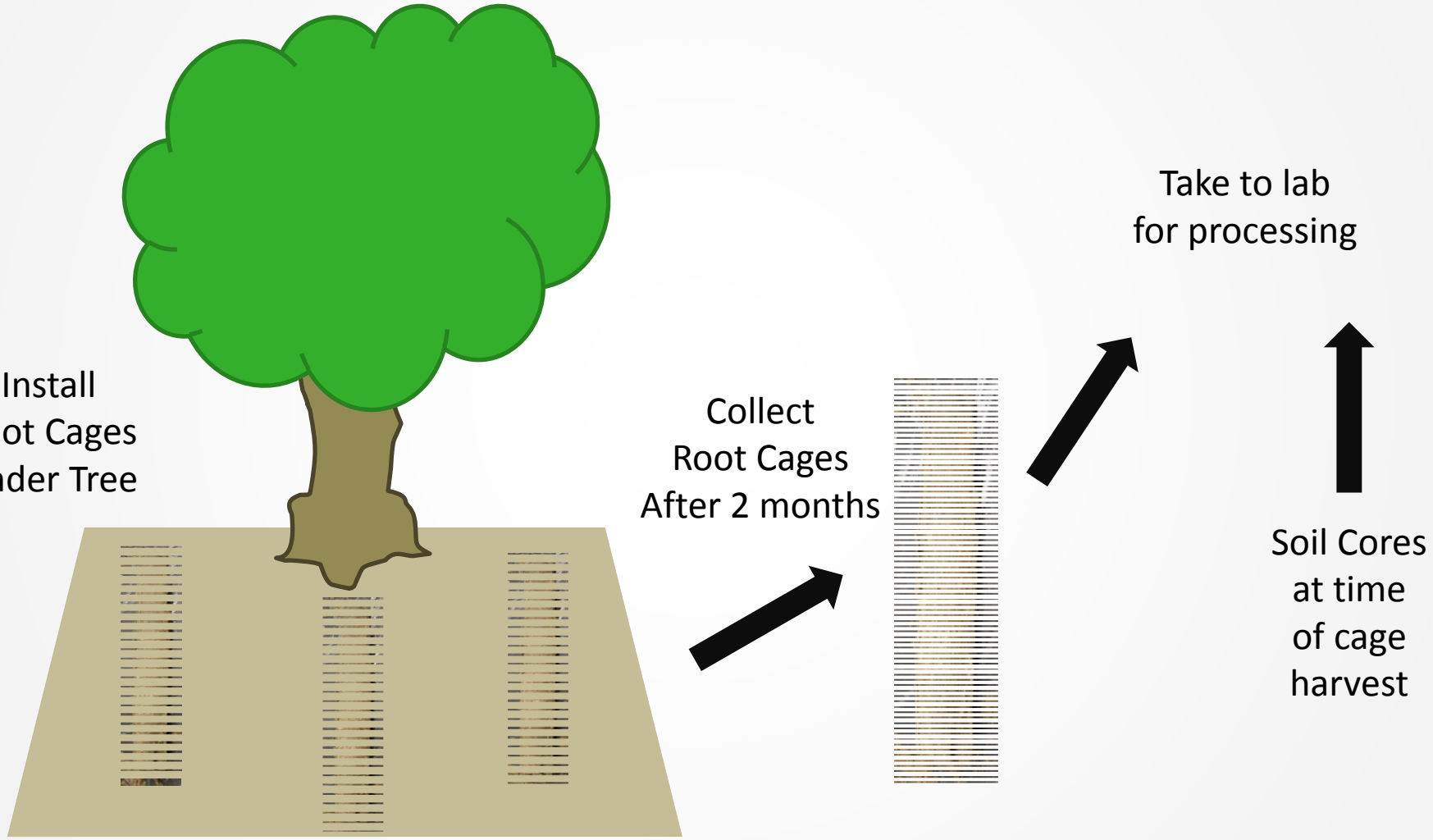
Root loss summary

- Early root loss
  - 30-50% root loss before leaf symptoms
  - Not sugar starvation
  - Not phloem plugging
  - Dependent on root infection
- Late root loss
  - 70-80% loss as canopy thins
  - Sugar starvation?
  - Not phloem plugging

What is causing early root loss?

- Healthy fibrous roots are replaced every 9-12 months
- Faster turnover of existing roots?
  - Not starvation or plugging?
- Reduced root growth?
  - Changes in hormone levels may inhibit replacement of old fibrous roots

Measuring Root Growth

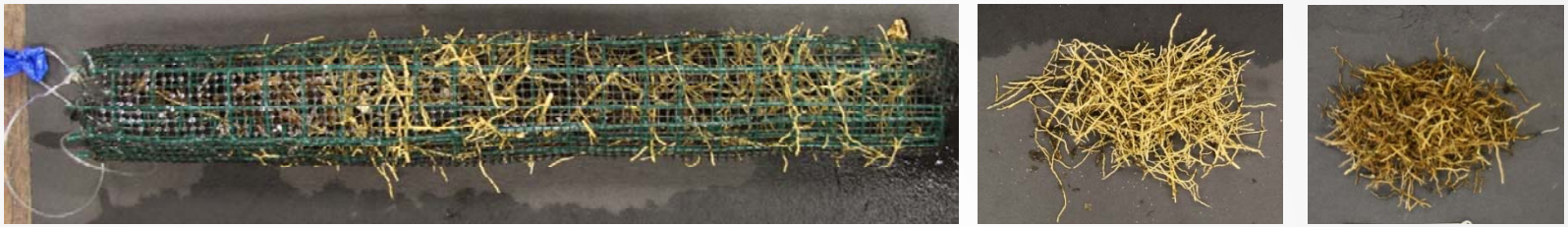


Measuring Root Growth

Root Cage

New Growth

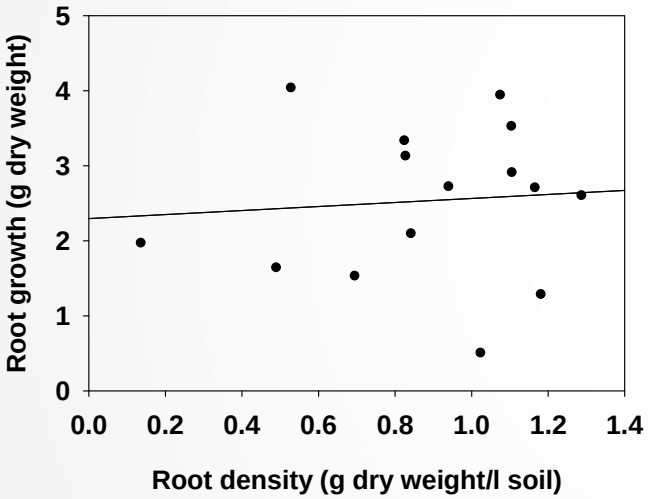
Root Density



Soil Cores

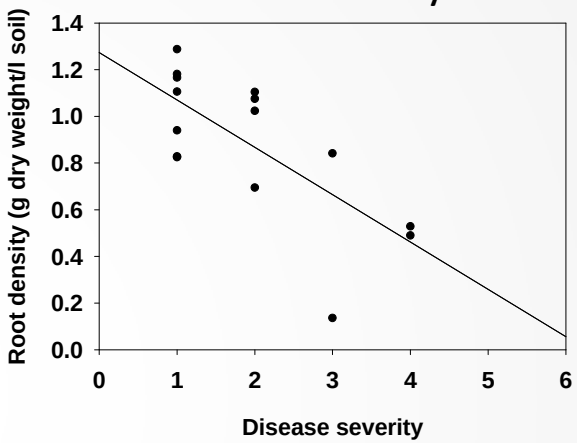
Root Growth is not inhibited

Fall Root Flush
From
Sept to Nov 2013

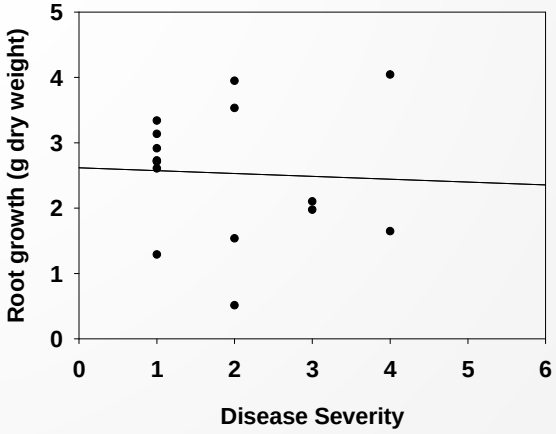


*Similar pattern
Less root growth
Nov 2013 to Jan 2014

Root Density



Root Growth



Root Growth is not inhibited

Presumed Healthy

New Growth

Root Density




Declining trees








Conclusions

What we know

- 30-50% root loss before leaf symptoms
- 70-80% loss as canopy thins
- Root growth is maintained in HLB-affected trees
  - Even declining trees
  - Faster root turnover

Management considerations

- Increasing root growth is not likely to help
- Need to encourage root longevity
  - Minimize stress on roots
  - Encourage optimal environment for roots

Search for solutions

- Rootstocks
  - Do new rootstocks maintain larger root systems?
  - Can they delay early or late phase root loss?
- Seasonality
  - When is root health management most important for HLB-affected trees?

Acknowledgments

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Peace River Packing

CRDF