Measuring root growth and development in Indian River grapefruit

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Outline

- Introduction
- Experiment(s)
- Progress
- Questions?

Introduction

Lukas M. Hallman

Huanglongbing (HLB) background

- The disease has been around since the 19th century
- 1927: Psyllids are the known vector for HLB
- 1998: Asian citrus psyllid was discovered in Florida
- 2005: HLB was confirmed in Florida
- **2010: HLB confirmed in all citrus-producing counties in FL**

Where we are today

- **Current Mitigation Methods**
  - Aggressive Psyllid Control
  - Bactericides (*C*Las)
  - Tree removal & destruction

- **~200% increase in maintenance costs since 2003**

- **No Cure of HLB exists**
  - Challenges
    - Cannot be cultured
    - Limited mobility of compounds that kill Liberibacter

Correct management of the grove improve tree health

Flatwoods Soils

- Sandy
- Slowly-permeable subsurface layer
- Low fertility

Experiment(s)

Plan of Work

Objectives

1. Compare control release fertilization and soil drench fertilization to identify best application method for uptake of nutrients into both underground and aboveground components of HLB-affected grapefruits on flatwood soils.

2. Investigate the relationship between root growth/development and leaf nutrient contents by measuring tree health, yield, and fruit quality as well as bacteria titer of HLB-affected grapefruit.

Experimental Design

Treatment	Application
Control (100% Soluble Fertilizer)*	3 times per year
CRF 1x	3 times per year
CRF 2x	3 times per year
CRF 4x	3 times per year
Fertigation Simulation W	Weekly
Fertigation Simulation 1x	Bi- Weekly
Fertigation Simulation 2x	Bi- Weekly
Fertigation Simulation 3x	Bi- Weekly

*Control = current IFAS guidelines

- Randomized complete block design
- 8 Different treatments × 5 replications = 40 experimental plots
- Average 16 trees per plot, 8 designated sampling trees per plot

UF/IFAS IRREC Southwest Block

Ray Ruby grapefruits on Sour Orange rootstock

Picture by Lukas Hallman

Control Release Fertilizer

	Tree density	*Total amount applied (4-month CRF)*		
Treatment	(# trees/acre)	lb blend/application/tree	lb blend/year/tree	
CONTROL	194	3.731	11.194	10 - .5 - 10
Treatment		lb blend/application/tree	lb blend/year/tree	
CRF 1x	(# trees/acre)	2.870	8.611	13 - .65 - 13
CRF 1x	194	0.498	1.493	
CRF 2x	194	0.995	2.985	Micronutrients
CRF 4x	194	1.990	5.970	

- Premixed fertilizer is weighed and applied to the plants

Liquid Fertilizer

Source	Formula	Per tank (needed to prepare 80 gallons at time)				
		Amount (oz) 1X	Amount (oz) 2X	Amount (oz) 4X	Amount (oz) Weekly	
Urea	CO(NH2)2	28.718	28.718	28.718	14.359	
Phosphoric acid	H3PO4	8.622	8.622	8.622	4.311	LIQUID (in fl oz)
Potassium nitrate	KNO3	39.299	39.299	39.299	19.649	
Gypsum	CaSO4. 2H2O	23.317	23.317	23.317	11.659	
Magnesium sulfate (epsom salt)	MgSO4. 7H2O	37.474	37.474	37.474	18.737	
Boric acid	H3BO3	0.294	0.588	1.176	0.147	
Fe EDDHA	Fe EDDHA	1.837	3.674	7.348	0.918	
Manganese sulfate	MnSO4. 4H2O	2.682	5.364	10.728	1.341	
Zinc sulfate	ZnSO4. H2O	1.727	3.454	6.907	0.863	

Total per tank (column in the left divided by 3 tanks)

All pictures by Lukas Hallman

Data Collection

Underground components

- Root growth and development
- Soil nutrient composition
- Root nutrient composition
- Root *C*Las

Aboveground components

- Leaf nutrient composition
- Canopy volume
- Tree height
- Visual HLB disease rating
- Fruit yield and quality

Root growth and development

- Minirhizotron CID 602
- 80 minirhizotrons installed 2 per plot
- 1 window every month
- All windows every 3 months

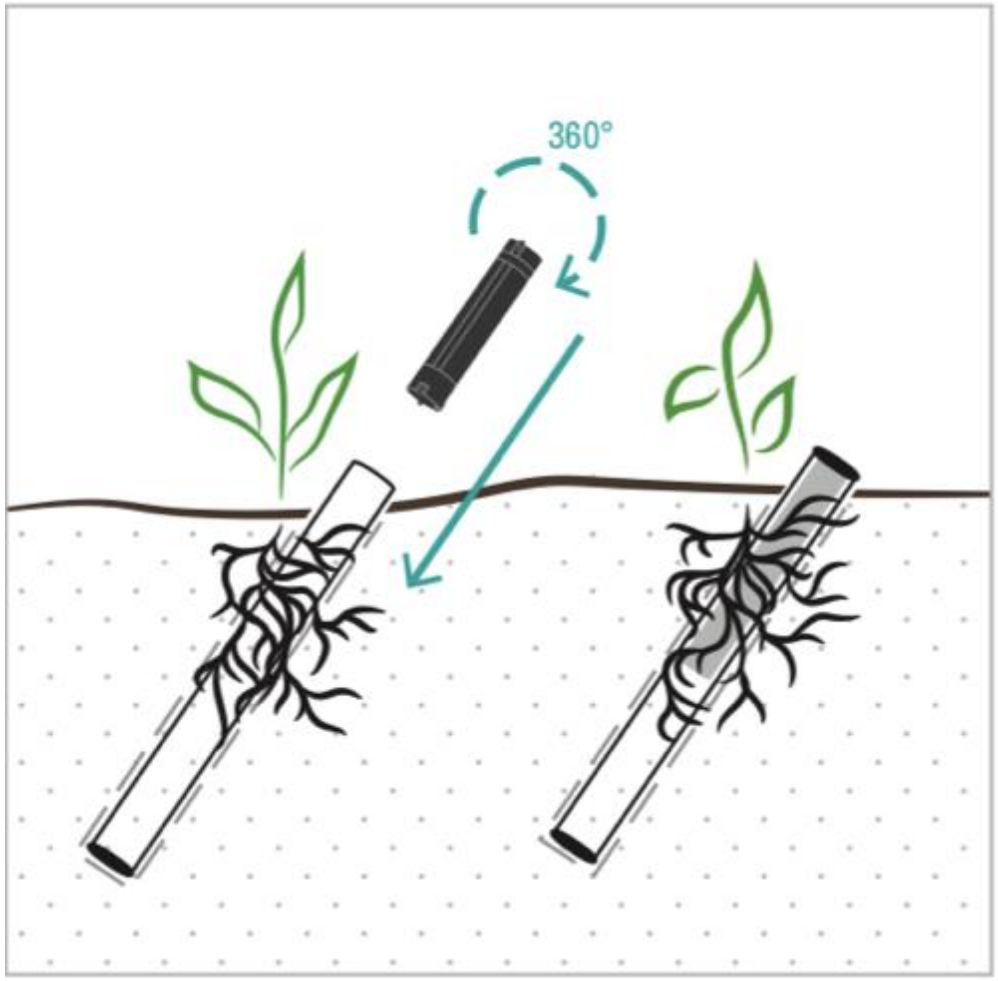
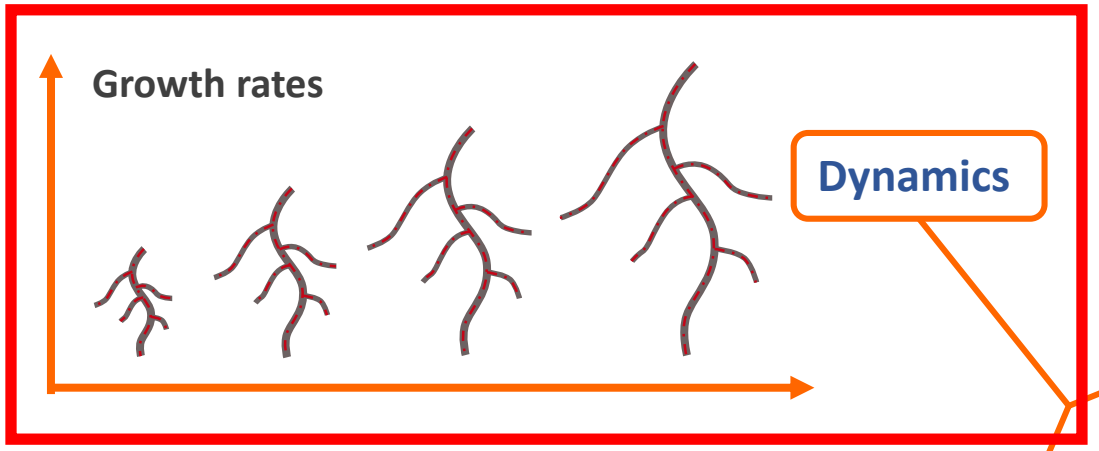
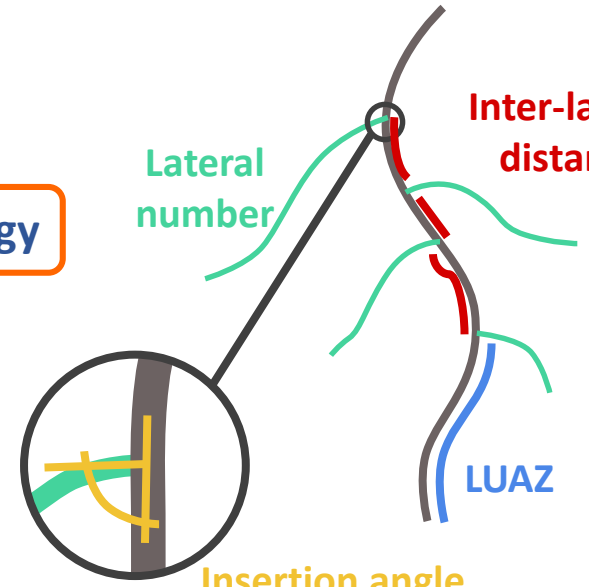


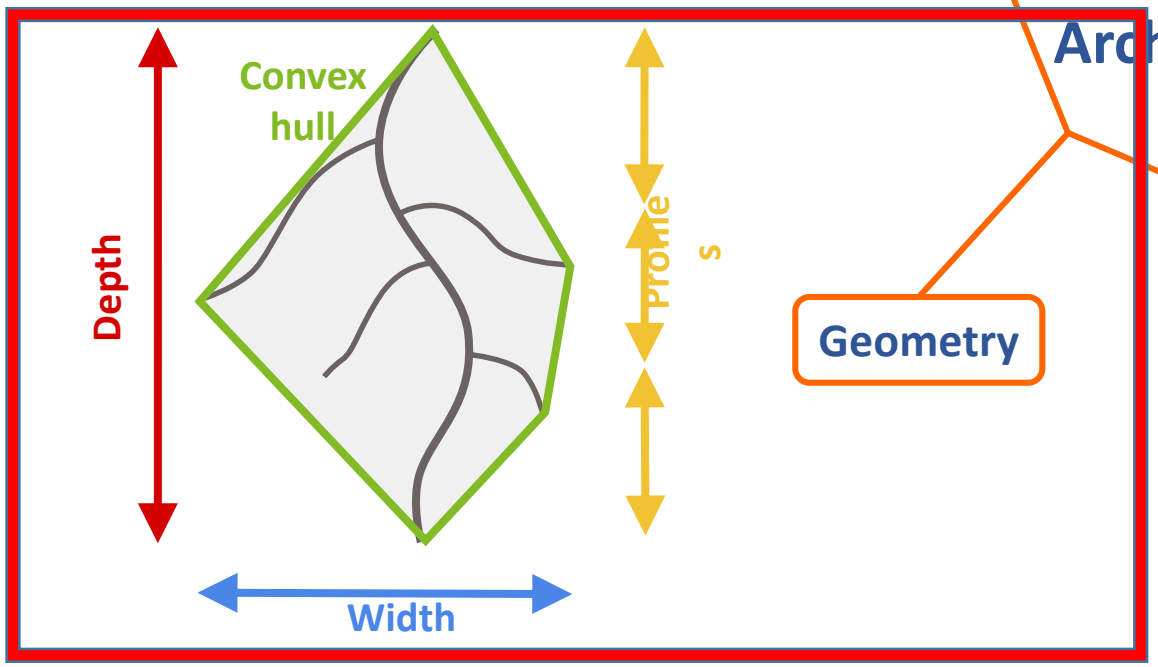
Diagram by CID Bioscience

Traits to measure





Root System Architecture



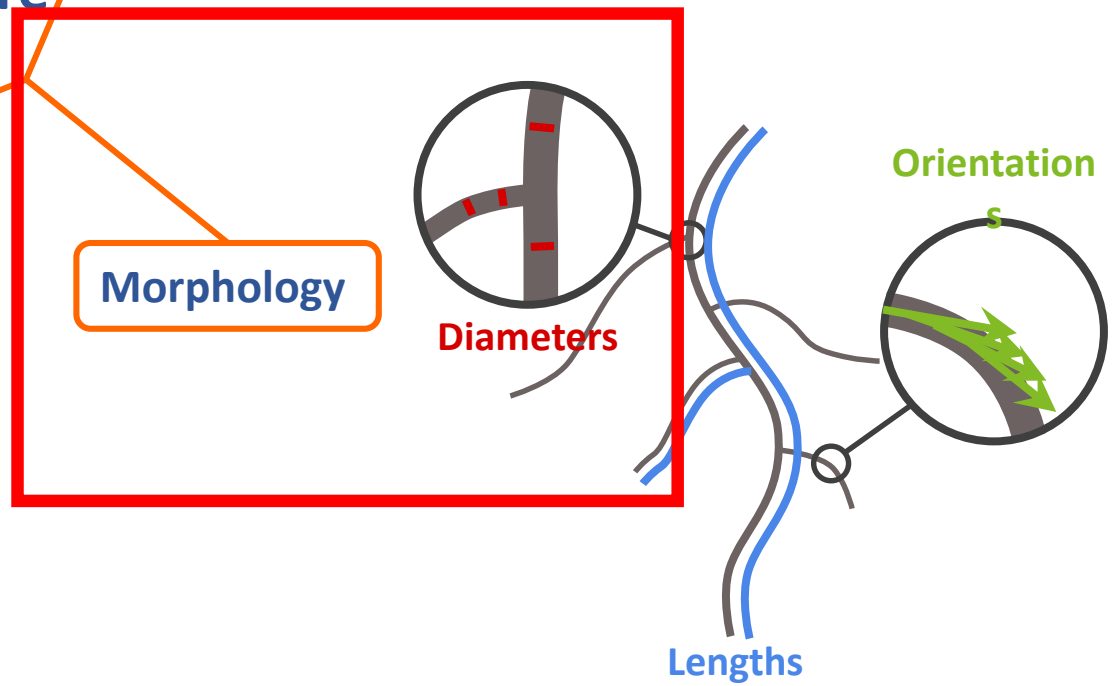
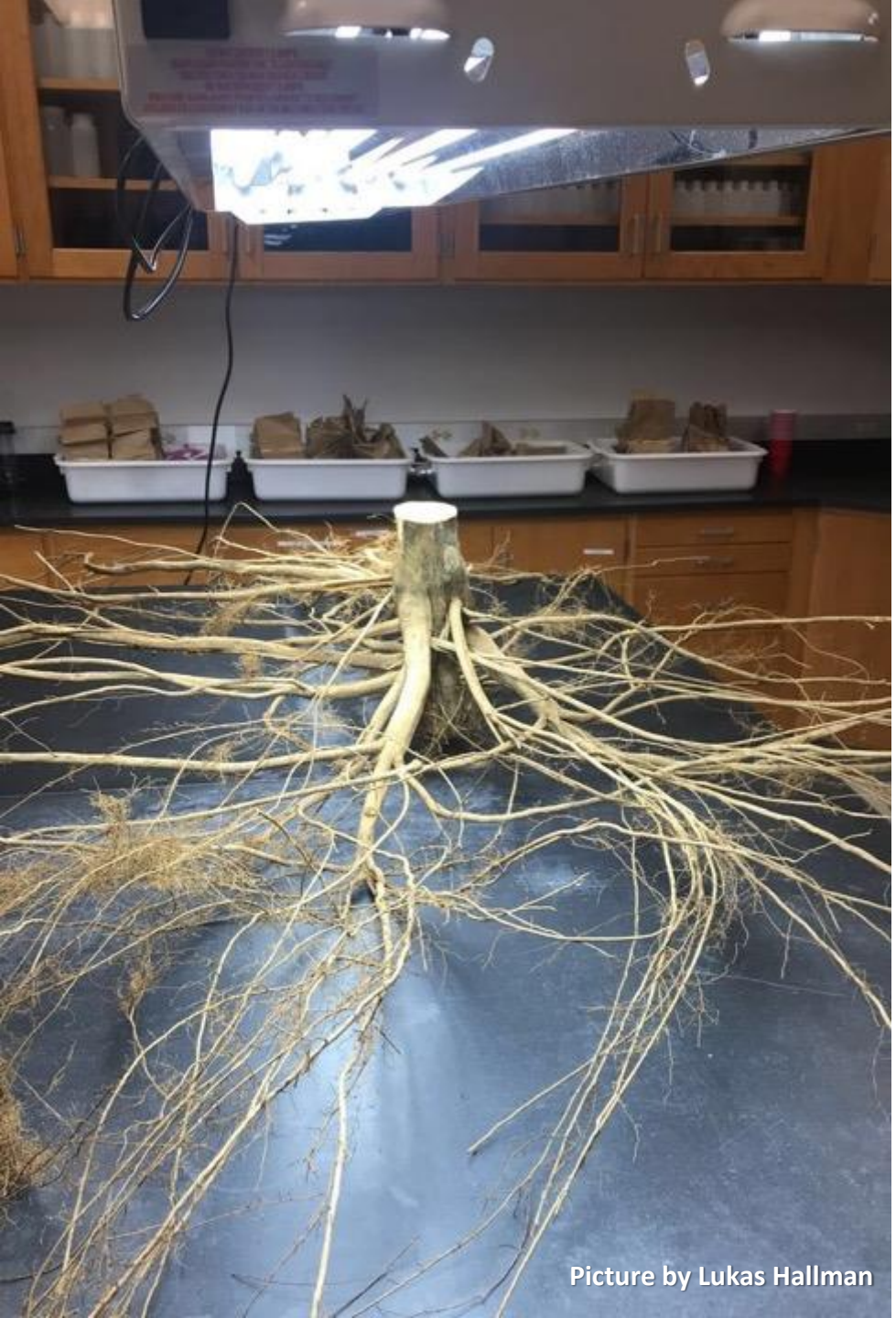


Diagram by Lorenzo Rossii



Soil nutrient composition

- Every 6 months
- Probe 2.5-3 cm diameter at 25-30 cm depth
- 4 samples per experimental block, samples are pooled together for each plot
- Samples go to Dr. Davie Kadyampakeni
- Mehlich III
- P, K, Mg, Ca, B, Zn, Mn, Fe, Cu, CEC, pH

Picture by Lukas Hallman

Root nutrient composition

- Every 6 months
- Probe 2.5-3 cm diameter at 25-30 cm depth
- 4 cores taken for each tree, mixed and pooled together for 1 sample per experimental block
- Taken with soil samples at the same time
- US sieve #6 to separate roots and soil
- Roots are washed and dried at 75 °C for 1 day
- Send to Waters Lab for N, P, K, Mg, Ca, S, B, Zn, Mn, Fe, Cu


Picture by Lukas Hallman

Leaf nutrient composition

- 4 trees per plot sampled every 6 months
- 4 leaves are taken from NW, SW, NE, and SE quadrants.
- Leaves are combined to make 1 sample per plot
- Leaves sent to Waters Lab
- N, P, K, Mg, Ca, S, B, Zn, Mn, Fe, Cu

Canopy volume and tree height

- 8 trees per plot every 6 months
- Tree Height is measured using marked meter pole
- Canopy width is measured perpendicular to and within-row at the farthest leaf
- Canopy height is measure at the top limb
- Canopy volume is calculated by the formula

$$CV = \frac{[(DPa \times DPe) \times Ch]}{4}$$

CV = Canopy volume

DPa = diameter parallel to row

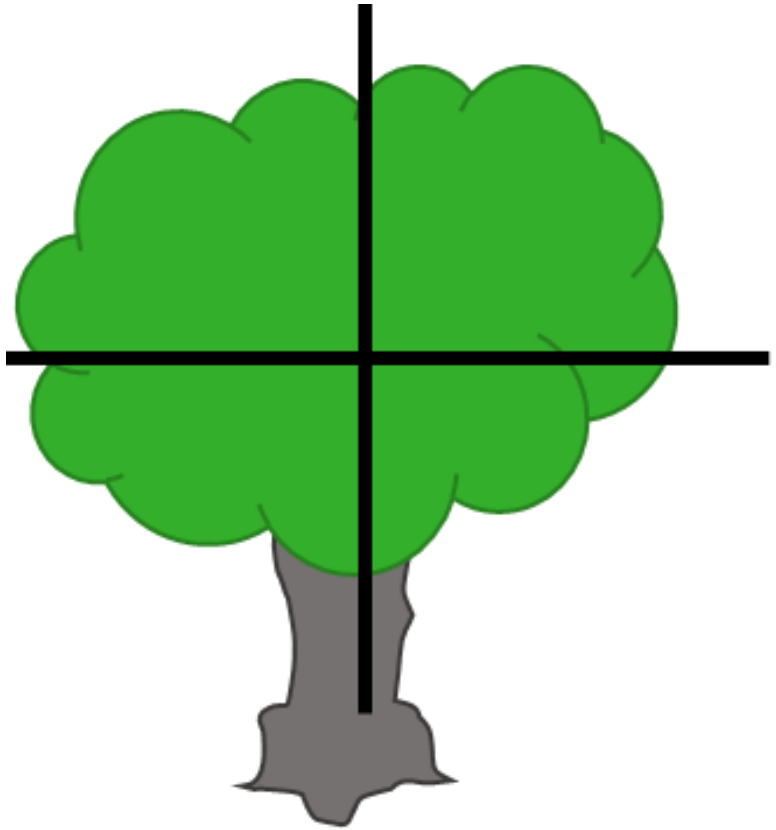
DPe = diameter perpendicular to row

Ch = Canopy height

Picture by Lukas Hallman

Root health

- Roots collected every 6 months along with soil samples using previously discussed protocol
- Send roots to Dr. Evan Johnson for bacteria titer



Rating	Description
1	No suspect symptoms
2	Symptoms- Blotchy mottle, sectored nutrient deficiencies, rabbit ear leaves
3	Mild Decline- Significant thinning
4	Moderate Decline- Leaf drop through canopy, stunting, some dieback
5	Dead- Significant dieback, will not recover

Visual HLB disease

- Every 6 months
- 8 trees per plot
- Requires 2 people

Leaf samples for Las titer

- Every 6 months
- 4 trees per experimental block
- 4 Leaves per tree
- Leaves are sent to Dr. Evan Johnson for titer

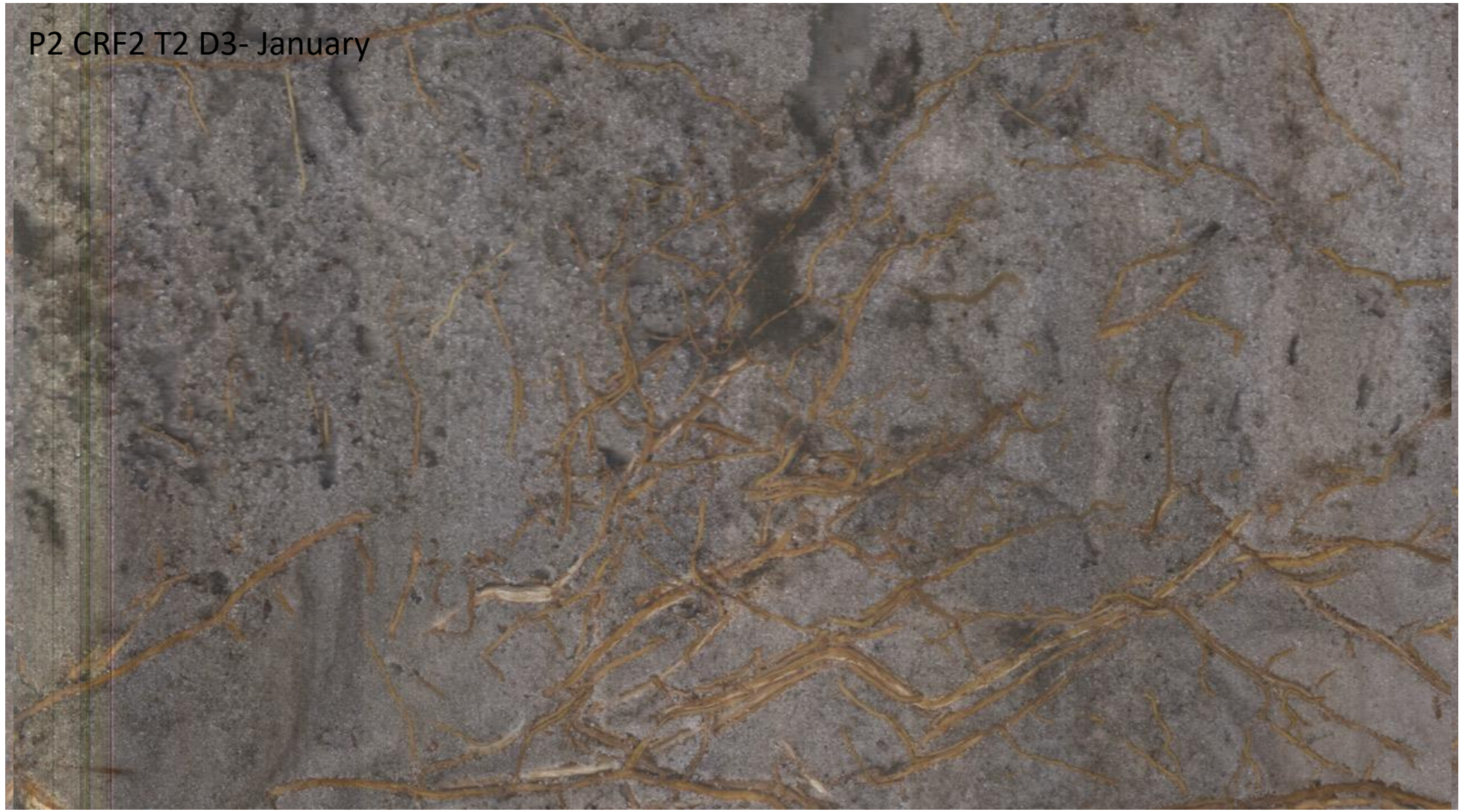
Yield, grapefruit pack out, and quality

- Collect fruit weight per tree annually
- If possible, collect 1 bushel bag of grapefruit per plot
- Juice quality testing and nutrient content
- Interested in learning quality testing process

Progress

Progress in 2019

Month	Activity
February - March	Initial sampling
April	Mini Rhizotron tubes installed
May- July	Pruning/ maintenance
August	Began treatments, first CRF treatment
September	Continued liquid treatments and second sampling
October	Continued liquid treatments
November	Root Imaging and liquid treatments
December	Continued liquid treatments and third sampling
January 2020	Root Imaging and liquid treatments


P2 CRF2 T2 D3- January


P10 F4 T1 D3- January

So Far…

- CRF treatments had slightly higher amounts of roots compared to fertigation treatments

- Only 3 scans have been taken out of 18

Does Oak Mulch help citrus root?

Experimental

- Project started in Sept. 2019
- Leaves collected every months for bacteria titer
- Soil samples collected every months for nutrients and pH

So far…

- pH changed at the beginning
- Nutrients availability in soil increased in oak mulched trees
- No differences in root growth and development
- No differences in CLas titer

To early to tell…

Acknowledgement

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Thank you!

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