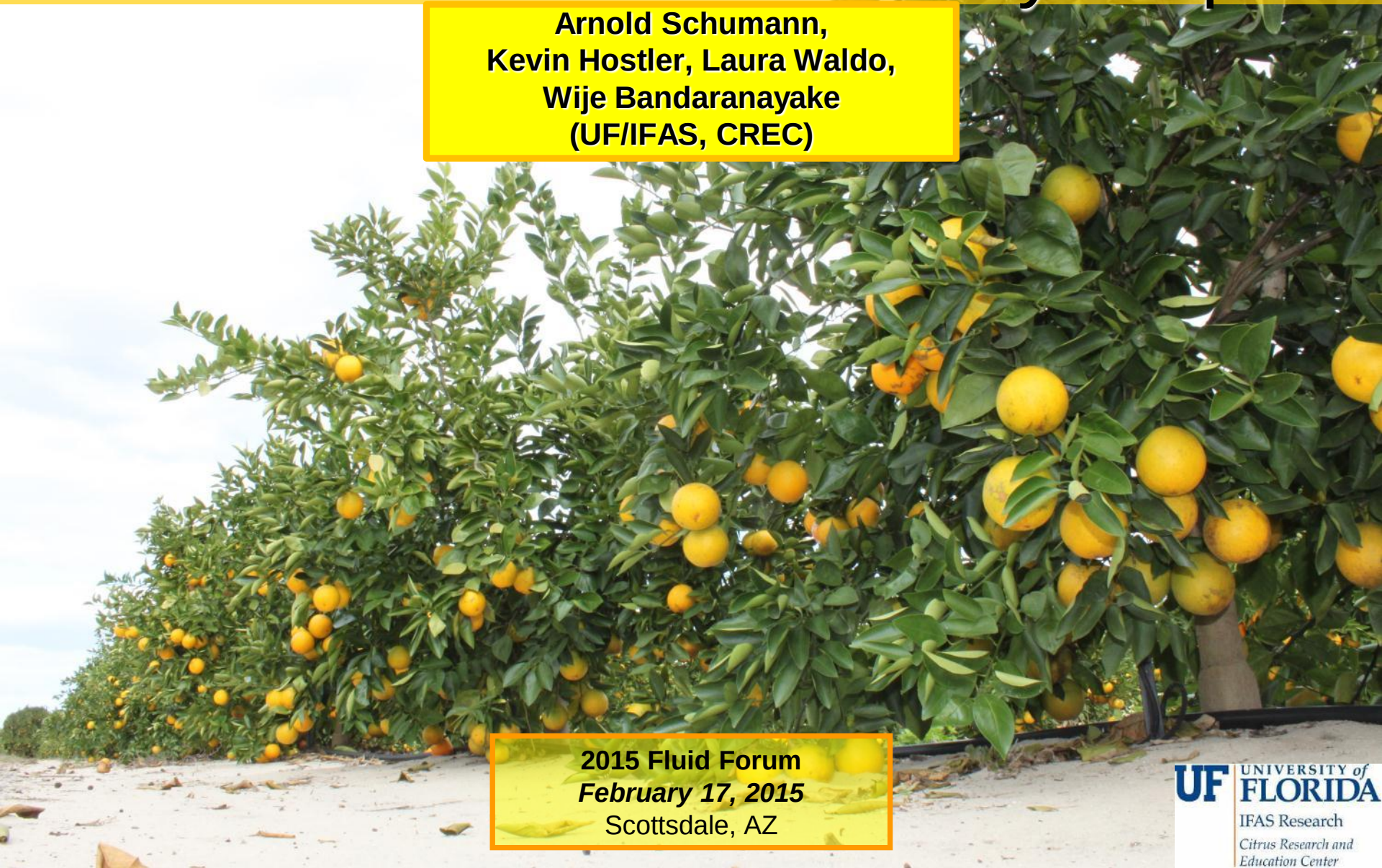
Advanced Production Systems for Florida Citrus and Blueberry Crops

Arnold Schumann,
Kevin Hostler, Laura Waldo,
Wije Bandaranayake
(UF/IFAS, CREC)



2015 Fluid Forum
February 17, 2015
Scottsdale, AZ

UF UNIVERSITY of FLORIDA
IFAS Research
Citrus Research and Education Center

Introduction

- During the past 5 years new citrus production systems in Florida were evaluated to develop strategies against endemic HLB disease
- Advanced fertigation (open hydroponics), rootstocks, and higher planting densities were key components used to improve grove performance
- Based on the initial successes with citrus, we expanded the research into a new citrus fertigation x rootstock x planting density experiment in 2012, and a pilot fertigation experiment with highbush blueberries in 2013
- Updates for both trials will be provided here

UF UNIVERSITY of FLORIDA

The situation in HLB-endemic Florida

- By year 5 most young groves are already seriously compromised by HLB
- Economic break-even in conventionally spaced processed orange groves is about 10-12 years
- The risk of not reaching economic break-even is high
- Advanced fertigation (open hydroponics), rootstocks, and higher planting densities are tools that can accelerate growth and early fruit production, hastening the achievement of economic break-even

HLB-affected ‘Hamlin’ yield in year 5:

UF UNIVERSITY of FLORIDA

Advanced Citrus Production Systems (ACPS)

High density (363 trees/acre)
+ *precocious scion/rootstock ('Hamlin'/C35)*
+ *"open hydroponics" (N,P,K,…Mo)*
= 622 boxes/acre in year 4

UF UNIVERSITY of FLORIDA

New Research Project Objectives

- **1) To test innovative super-high density citrus grove replanting configurations with a drip fertigation open hydroponics (OH) system for maximizing early return on investment in a canker and HLB-endemic disease environment.**

- **2) To develop sustainable high yielding OH solutions for highbush blueberry cultivation in Florida which will eliminate the need for expensive mulching with pine bark.**

1) Citrus APS

- **Planted 08/2012**

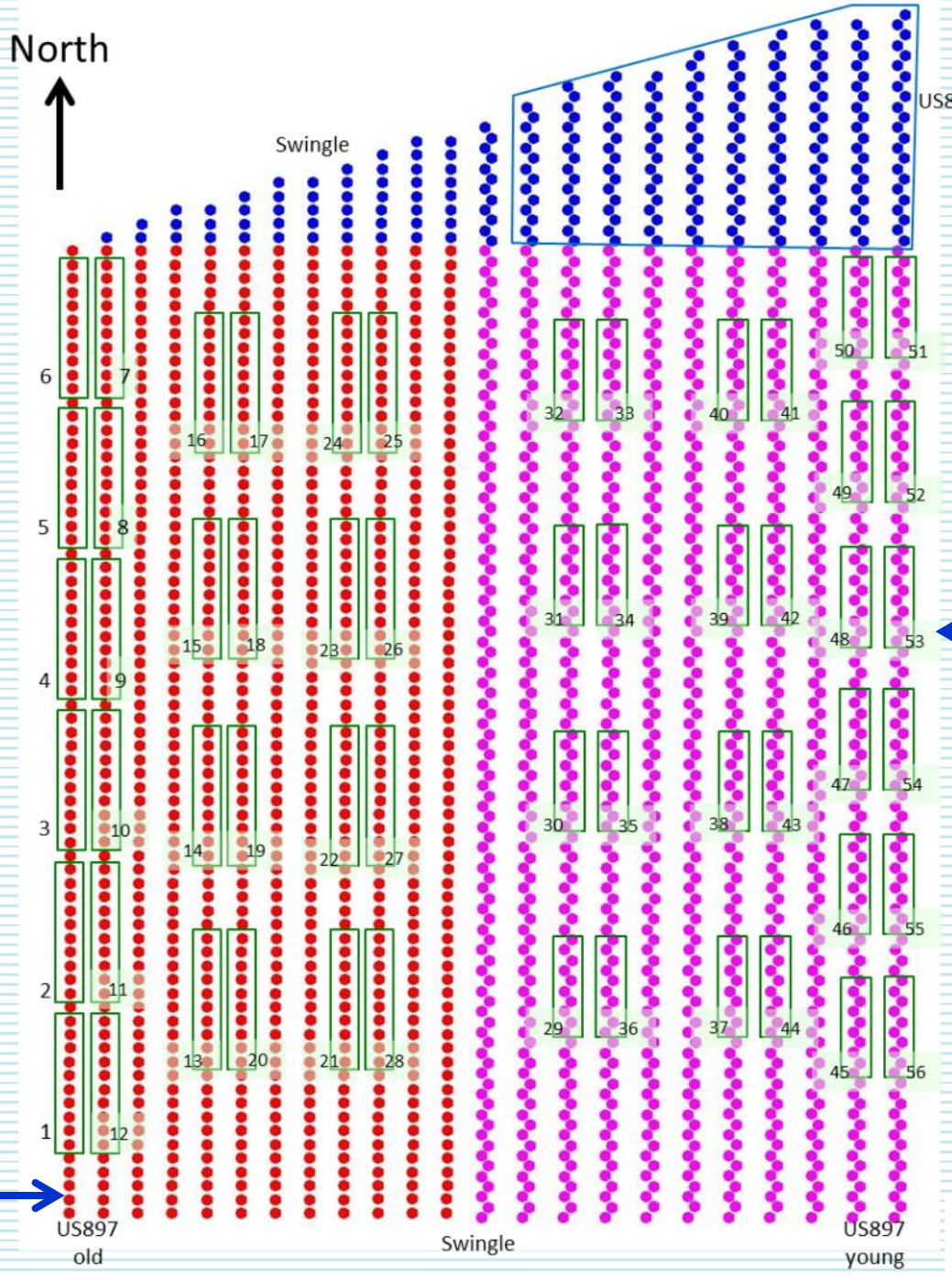
- **Main source of N:**

1) **calcium nitrate**
2) **ammonium nitrate**

- **Rootstocks:**

1) **Swingle**
2) **US897**

- **All drip fertigated**
- **(2x0.5 gph/tree)**



UF UNIVERSITY of FLORIDA

Tramline planting

538 trees/acre = 9 x ½(3+15) feet

Measurements:

Soil pH in the drip zone, and leaf and soil nutrients obtained from quarterly sampling

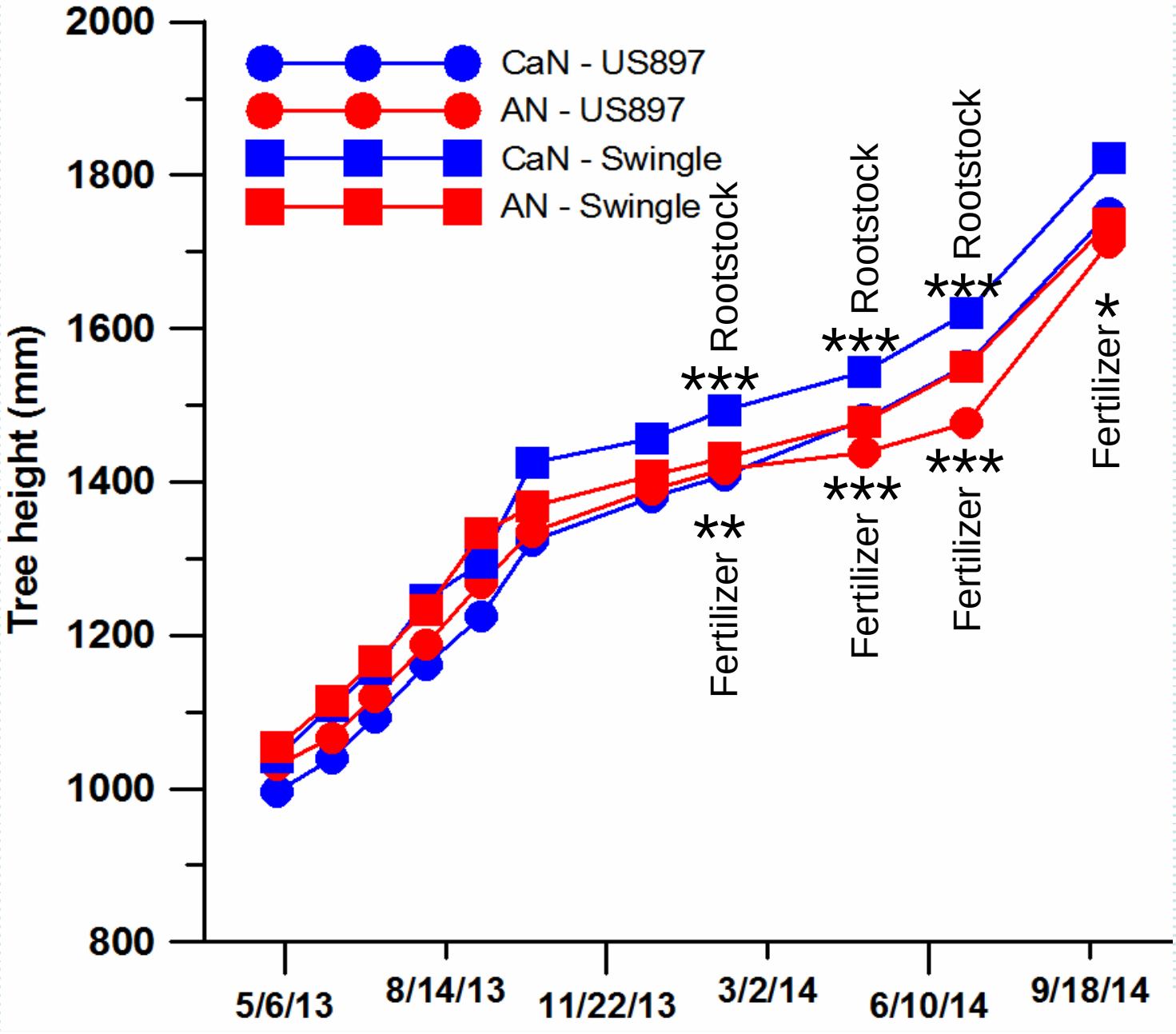
SPAD leaf color, tree height and canopy width measured quarterly

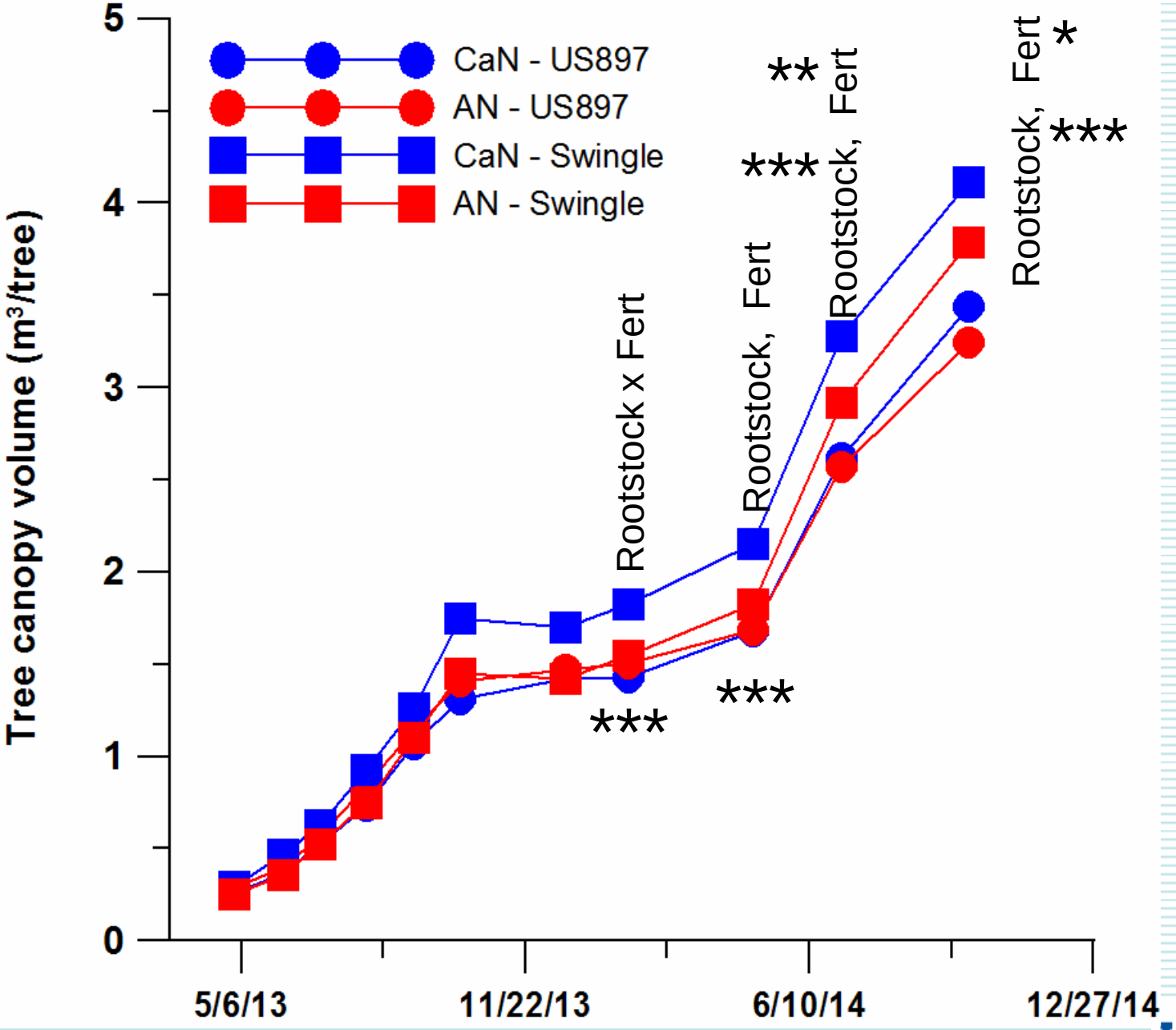
Electrical conductivity in the fertigated root zone

Fruit yield and quality measured annually from year 2 (manual harvesting of a subsample of each plot). External (color) and internal (brix, juice %, acid %) quality will be measured

November 2012, Lake Alfred, FI

UF UNIVERSITY of FLORIDA





UF UNIVERSITY of FLORIDA

Leaf tissue analysis: Feb 2014
(N,P,K,Ca,Mg,S,Mn,Zn,Fe,B,Cu)

Rootstk***	US897	Swingle	Fert***	CaN	AN
N%	3.073	3.197		3.213	3.074

Rootstk***	US897	Swingle
K%	1.027	1.487

Rootstk*	US897	Swingle	Fert***	CaN	AN
Ca%	4.272	3.604		4.016	3.764

Rootstk***	US897	Swingle
B(ppm)	121.6	154.4

Rootstk***	US897	Swingle
Zn(ppm)	36.89	31.90

Rootstk***	US897	Swingle
Mn(ppm)	62.43	46.42

Rootstk***	US897	Swingle
Cu(ppm)	14.73	18.34

UF UNIVERSITY of FLORIDA

‘Valencia’/Sw tramlines after 1 year

UF UNIVERSITY of FLORIDA

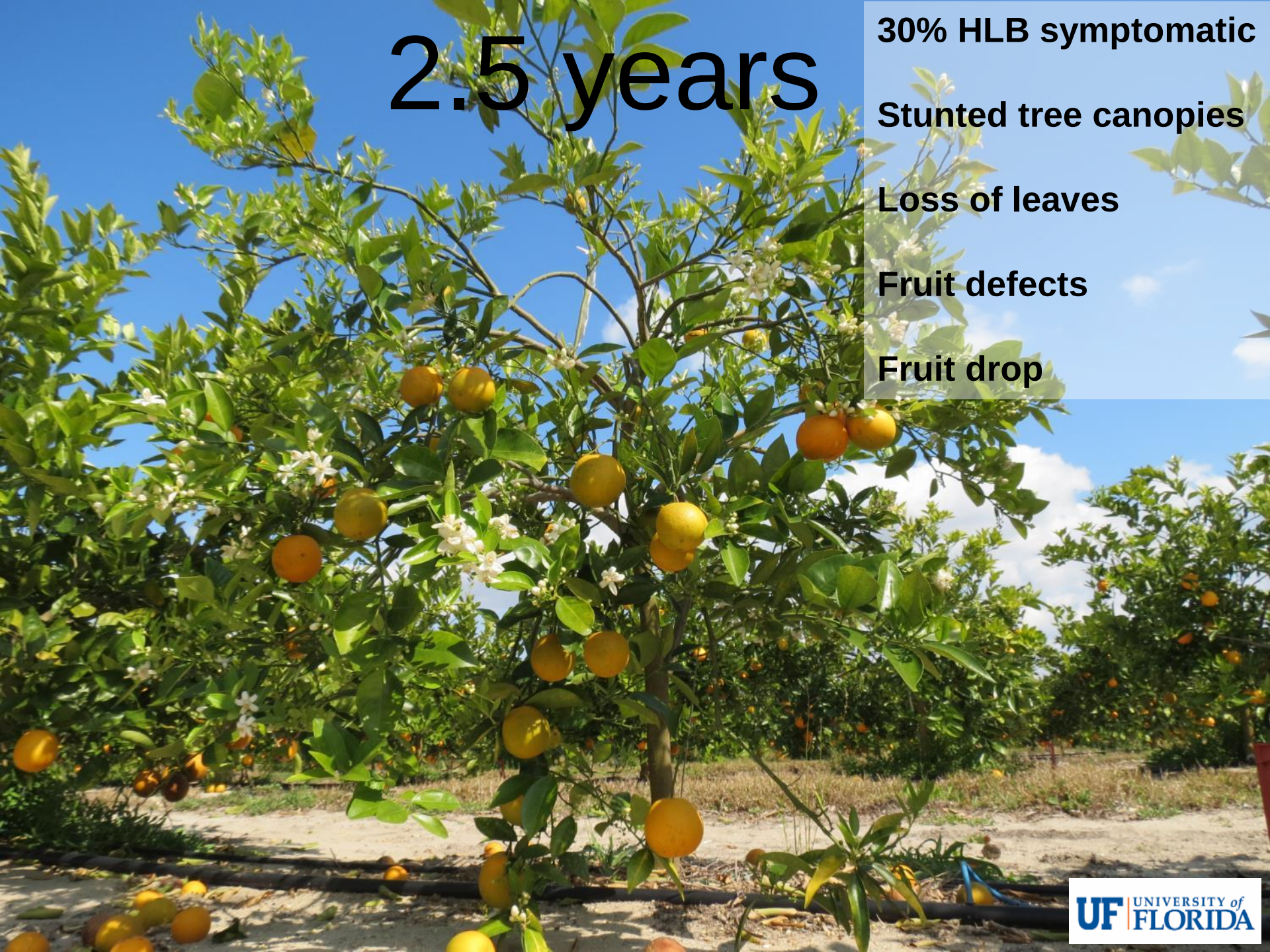

UF UNIVERSITY of FLORIDA


13 months
UF UNIVERSITY of FLORIDA


2.5 years
UF UNIVERSITY of FLORIDA


2.5 years
UF UNIVERSITY of FLORIDA

UF UNIVERSITY of FLORIDA


2.5 years
30% HLB symptomatic
Stunted tree canopies
Loss of leaves
Fruit defects
Fruit drop
UF UNIVERSITY of FLORIDA

Conclusions after 2.5 years

- ✓ Drip fertigation accelerated tree growth in years 1-2
- ✓ CaN fertilizer grew marginally larger canopies
- ✓ CaN fertilizer ensured better foliar Ca and N nutrition
- ✓ >30% HLB+ by end 2014, regardless of treatment
- ✓ At a doubling of infection every year, 100% infection expected by year 4-5 and economic breakeven not achievable

Other technologies like covered production are being tested in new fertigation trials to totally prevent HLB infection

UF UNIVERSITY of FLORIDA

2) Blueberry APS

Treatments:

- **Blueberry bushes grown in native mineral soil with standard NPK fertigation (ammonium nitrogen)**
- **Blueberry bushes grown in standard mulched pine bark beds and standard NPK fertigation (ammonium nitrogen)**
- **Blueberry bushes grown in native mineral soil with incorporated pine bark, and standard NPK fertigation (ammonium nitrogen)**
- **Blueberry bushes grown in native mineral soil with enhanced NPK fertigation (nitrate and ammonium) and comprehensive micronutrient supply, PLUS dissolved organic leached derivatives of pine bark delivered through fertigation**
- **Southern Highbush blueberry, 'Farthing' variety**

Pinebark amended layer

Roots prefer to grow in the pine bark only

Native soil layer

Saturated zone

Photo courtesy of Wije Baranayake

UF UNIVERSITY of FLORIDA

Using pine bark for highbush blueberry cultivation in Florida:

Photo courtesy of Wije Baranayake

Pine bark mulch is an essential component for production of highbush blueberries grown in FL

- **Low pH of pine bark**
- **High organic matter content**
- **Problems:**
  - **Needs replacement ~3-4 yrs**
  - **Restricted rooting zone**
  - **Irrigating pine bark is difficult**
  - **High cost**

Can customized liquid fertigation substitute for pine bark?

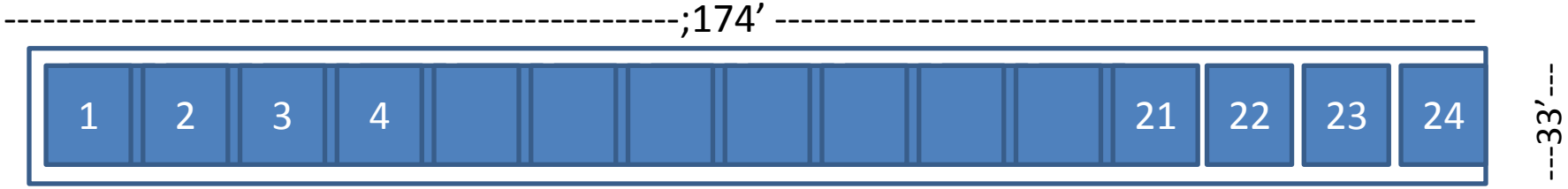
Soluble pine bark extract?

UF UNIVERSITY of FLORIDA

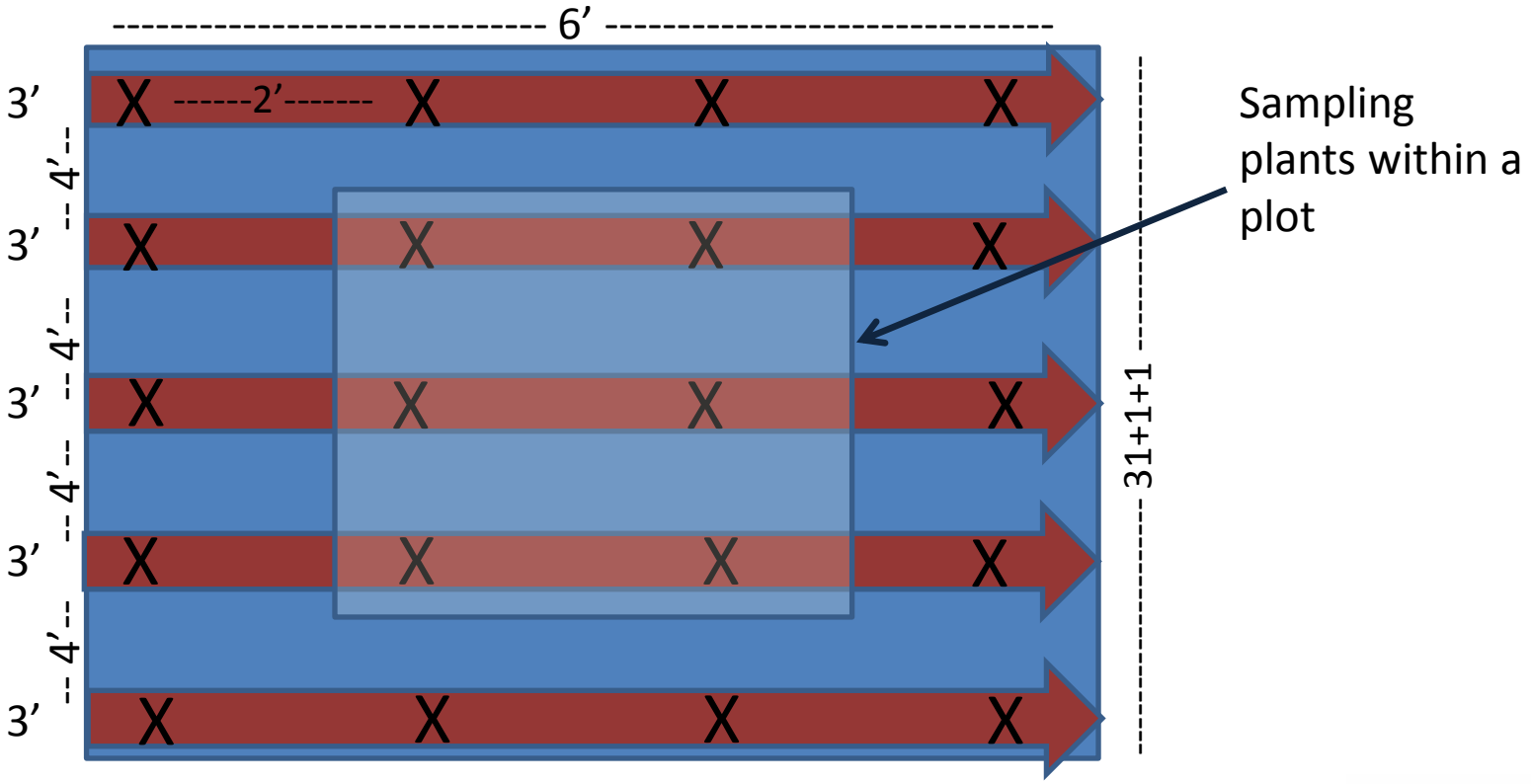
N

Main Plot

24 experimental units



Structure of one plot (Experimental Unit)



5 rows of blueberry in each plot with between row spacing = 4’ (sampling from middle 3 rows)

UF UNIVERSITY of FLORIDA


12” pine bark treatment

Tank containing pine bark-filled mesh bags prior to filling up with water

Soluble leachate from the bark was fertigated as part of treatment 4

UF UNIVERSITY of FLORIDA

Results: measurements from 2014 season

Soil pH measurements after 5 months

		Soil pH	
Treatment	Description	Treatment Plot	Initial
1	Native soil	5.77 (0.05)	5.76 (0.07)
2	Pine bark	5.70 (0.27)	5.65 (0.03)
3	Pinebark mixed with soil	5.84 (0.18)	5.66 (0.06)
4	Native soil + Pinebark extract	5.78 (0.13)	5.61 (0.07)

- Blueberry needs a soil pH below 5 for optimum performance.

Therefore, elemental sulfur at a rate of 250 kg ha^{-1} was broadcast during mid March in an attempt to adequately acidify the soil

The weed fabric covering the blueberry plots prevented proper efficacy of the sulfur

Therefore an acidifying ammonium-*based blueberry fertilizer ("21:7:7 acidifier") was* used thereafter in all the treatments

Leaf nutrient concentrations: major & secondary

	N	P	K	Mg	Ca	S
	g kg^{-1}					
T1	15.9 b	1.20 b	9.18 a	2.25 a	8.00 a	1.42 a
T2	21.8 a	1.52 a	6.38 c	1.42 c	4.18 c	1.42 a
T3	21.4 a	1.47 a	6.02 c	1.43 c	4.48 c	1.45 a
T4	19.8 ab	1.32 b	8.18 b	1.82 b	6.27 b	1.50 a
Sufficient Range	**17 - 21**	**0.8 - 4.0**	**4 - 6.5**	**1.5 - 3.0**	**3.0 - 8.0**	**1.2 - 2.0**

Leaf nutrient concentrations: micro

	B	Zn	Mn	Fe	Cu
	mg kg^{-1}				
T1	42.7 a	74.5 a	106 a	118 a	120 a
T2	24.2 c	40.3 b	79 a	63 b	81 b
T3	26.0 c	39.3 b	94 a	65 b	92 b
T4	34.5 b	78.8 a	98 a	110 a	127 a
	25 - 70	**8 - 30**	**50 - 350**	**60 - 200**	**5 - 30**

Leaf gas exchange measurements

	Photosynthesis		Conductance		Transpiration		Water Use Efficiency		Chlorophyll Index (SPAD)
Treatment	Aug. 29	Oct. 1	Aug. 29	Oct. 1	Aug. 29	Oct. 1	Aug. 29	Oct. 1	Oct. 1
	mmol m^{-2} s^{-1}		mol m^{-2} s^{-1}		mmol m^{-2} s^{-1}		ratio		index
1	9.9 b	13.2	0.14 b	0.21	4.5	6	2.2	2.21	53.2 b
2	12.5 a	14.1	0.17 a	0.36	5.4	7.4	2.3	2.17	57.3 a
3	12.3 a	14.6	0.17 a	0.25	5.4	7.1	2.3	2.15	57.3 a
4	9.9 b	12.4	0.15 ab	0.41	5	8.3	2	1.73	56.5 a
		NS		NS	NS	NS	NS	NS	

Plant canopy measurements

	Plant Height (cm)				
Treatment	5/13/2014	6/13/2014	7/21/2014	9/5/2014	10/1/2014
T1	58.8 a	57.39 a	58.3 c	58.4 b	60.6 c
T2	62.3 a	64.44 a	71.2 a	80.0 a	82.0 b
T3	60.5 a	65.72 a	72.8 a	84.7 a	89.7 a
T4	62.9 a	62.03 ab	62.0 bc	61.0 b	61.5 c

	Number of Branches				
Treatment	5/13/2014	6/13/2014	7/21/2014	9/5/2014	10/1/2014
T1	2.9 a	3.69 d	7.4 d	17.4 b	26.5 b
T2	3.4 a	**6.89 ab**	15.8 b	38.7 a	51.1 a
T3	3.2 a	**8.06 a**	18.3 a	38.3 a	55.4 a
T4	3.2 a	4.11 cd	7.6 d	19.1 b	24.9 b

UF UNIVERSITY of FLORIDA

Conclusions after 1.5 years & future work

- ✓ Blueberries grew best in pine bark treatments
- ✓ Weak growth in mineral soil related to low leaf N?
- ✓ The pine bark extract had a non-significant impact
- ✓ Follow-up work will investigate rhizosphere differences in the treatments; mineralizable N
- ✓ Aerobic extracts of pine bark will be tested – versus previous anaerobic extracts

UF UNIVERSITY of FLORIDA

Acknowledgements