

Promising Research Findings in Horticultural Practices for HLB Management

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2012 Florida Citrus Growers Institute

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Orange Hammock Grove

Orange Hammock Grove

McKinnon Corp, Maury Boyd

- 333 acres planted 1991
- Hamlin (125 ac) & Valencia (208 ac)
- Rootstocks Swingle & Carrizo
- Spacing: 22' x 12' (165 trees/acre)
- Flatwoods bedded grove
- Two row beds
- Maxijet emitters
- Psyllid control sprays by airplane
- Dry ground applied fertilizer
- Foliar applied nutritionals & SARs

Spring 2006



February 29, 2012







Production

Orange Hammock Grove (Hendry County)

Season		Hamlin			Valencia		
	Wt. Boxes	Lb. slds/bx	Bx/ac		Wt. Boxes	Lb. Slds/bx	Bx/ac
2011-12	72,697	5.62	599				
2010-11	70,996	5.67	586		74,223	6.36	436
2009-10	54,942	5.52	453		70,660	6.43	415
2008-09	87,938	5.67	725		75,580	6.63	444
2007-08	73,671	6.14	608		105,045	6.64	617
2006-07	65,495	5.73	540		68,791	7.10	404
2005-06	65,981	5.49	544		69,423	7.36	408
2004-05	73,381	6.00	605		86,104	7.22	506
2003-04	83,403	4.97	688		107,933	6.56	634
2002-03	65,004	5.17	536		76,911	6.15	452
2001-02	66,565	5.33	549		80,376	6.23	472
2000-01	67,425	5.39	556		57,659	5.89	339
1999-00	58,206	5.21	480		61,602	6.51	362

Mature Valencia Trees

Jan. 2008
PCR Results
40 % positive

		+							
				+	+		+		
				+			+		
blight		+		+	+		+		
blight		+					+	+	
blight			+		+		+	+	+
blight		+	+		+		+	+	+
+				+			+	+	
+			+			+	+	+	
	+		+		+	+	+	+	+

Jan. 2010
PCR Results
91 % Positive

+	+	+		+	+	+	+	+	
+		+	+	+	+	+	+	+	+
+		+		+	+	+	+	+	+
blight	+	+		+	+	+	+	+	+
blight	+	+		+	+	+	+	+	+
blight	+	+	+	+	+	+	+	+	+
blight	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	
+	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	blight	+

Evaluation of Boyd Cocktail

Trials and Objectives (Began 2008)

A. OBJECTIVES

1. Duplicate Orange Hammock Grove Results
2. Define components of nutrient/SAR that are contributing to maintaining tree health & production

B. TRIALS

<u>Three sites</u>	<u>Size</u>	<u>2008</u>	<u>2011</u>
1) SWFREC (Hamlin)	2 acres	infected 100%	100%
2) Commercial (Valencia)	6 acres	infected 60%	100%
3) Commercial (Valencia)	30 acres	infected 15%	98%

Per acre (250 gal/acre)	Product
2.25 lbs (2010 Serenade ASO)	Serenade Max WP
2 qts	Di-Oxy Solv organic
8 gal	*14-7-8 w/K-phite (1-pt/gal)
8 gal	or 3-18-20 w/K-phite (1-pt/gal)
8.5 lbs	Epsom Salts (MgSO ₄)
8.5 lbs	Techmangam (MnSO ₄)
2.8 lbs	Zinc Sulfate
0.85 oz	Sodium Molybdate
8.5 lbs	13-0-44 spray grade (KNO ₃)
1 qt	SAver w/ammonium sylicylate
5 gal	435 Oil
3.3 lbs (added fall 2009)	Beau-Ron (B)

* When using 14-7-8 (spring) eliminate the 3-18-20

1	2	3	4	5
SAR				SAR
K-Phite	K-Phite			
Micro	Micro	Micro	*	*
Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide
K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	K ₂ NO ₃ +oil
6	7	8	9	10
SAR	SAR		SAR	untreated
K-Phite		K-Phite	K-Phite	
*	Micro	*	Micro	*
Hydrogen Peroxide	Hydrogen Peroxide	Hydrogen Peroxide		
K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	K ₂ NO ₃ +oil	

PCR Ct values for 3 test sites

Site	Year	Range	Mean	Incidence
SWFREC	2008	29.97 - 25.87	28.097 a	100%
	2009	27.32 - 24.43	26.065 b	100%
	2010	25.88 - 24.56	24.994 b	100%
	2011	30.57 - 28.13	29.179 a	100%
Meador	2008	32.58 - 27.21	29.884 a	41%
	2009	30.21 - 27.13	28.498 a	79%
	2010	26.22 - 24.82	25.643 b	99%
	2011	27.00 - 25.85	26.491 b	100%
B.Collier	2008			About 15%
	2009	34.27 - 30.22	32.234 a	40%
	2010	26.88 - 25.18	25.896 b	85%
	2011	27.04 - 23.99	25.226 b	98%

SWFREC Hamlin Juice Quality

	Trt.	% juice	Trt.	Acid	Trt.	Brix	Trt.	Ratio	Trt.	Slds/bx
2009	2	54.6 a	2	0.64 a	2	10.5 a	1	17.0 a	2	5.1 a
	7	53.5 ab	7	0.64 a	1	10.4 a	4	16.8 ab	1	5.0 ab
	3	52.9 ab	9	.062 a	7	10.2 ab	5	16.6 ab	7	4.9 ab
	1	52.7 ab	1	0.61 a	3	10.1 ab	8	16.5 ab	3	4.8 ab
	9	52.7 ab	3	0.61 a	4	9.9 ab	3	16.5 ab	9	4.7 ab
	4	50.5 b	4	0.59 a	6	9.7 b	7	16.0 b	5	1.5 b
2010	9	47.4 a	6	0.65 a	9	10.6 a	1	18.3 a	1	5.4 a
freeze	8	46.8 a	9	0.62 ab	4	10.4 a	4	18.0 a	9	5.0 ab
12/15/10	2	46.0 a	8	0.58 ab	8	9.8 ab	7	17.8 a	4	4.7 ab
	4	45.7 ab	4	.058 ab	1	9.7 ab	2	17.4 ab	8	4.6 ab
	5	45.4 ab	5	0.55 ab	7	9.6 ab	3	17.3 ab	2	4.4 ab
	6	39.7 b	1	0.53 b	6	8.1 b	6	14.0 b	6	3.4 b

2011 Hamlin Yield & Juice Quality

Trt	Lbs./tree
2	196.2 a
6	195.8 a
3	188.7 a
4	187.3 a
7	181.4 a
9	174.5 a
1	170.7 a
5	149.6 b
8	108.3 b
10	56.5 c

Trt	Juice (%)	Brix	Acid	Ratio	Lbs. solids Per box	Boxes lbs./tree
2	50.0	9.0	0.45	20.3	4.1	2.2 a
6	46.7	7.8	0.10	19.6	3.3	2.2 a
3	47.2	8.9	0.44	20.6	3.8	2.1 a
4	43.4	7.3	0.55	16.4	3.0	2.1 a
7	42.7	7.4	0.53	17.7	3.0	2.0 a
9	45.8	7.3	0.55	19.2	3.2	1.9 a
1	44.0	7.8	0.57	16.2	3.3	1.9 a
5	45.4	8.6	0.43	20.1	3.5	1.7 b
8	45.8	8.1	0.41	19.7	3.4	1.2 b
10	46.0	8.6	0.42	20.9	3.6	0.63 c
Signifi cance	NS	NS	NS	NS	NS	

PICTURE RESULTS

NUTRIENT TREATMENTS

2008, 2010 & 2011 HLB Trees
Before and After

Pictures (worth 1000 words) tell the story

2011 Canker Incidence in Hamlin

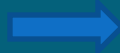
Treatment	Severity/time (tree condition)	Incidence (total amount)	Fruit drop (boxes)
9	535.2 a	4981.5 a	74.4 a (0.83)
2	491.1 ab	4758.8 ab	89.2 a (0.99)
4	426.7 bc	4304.1 abc	82.2 a (0.91)
7	417.8 bcd	4305.0 abc	68.3 ab (0.76)
1	412.3 bcd	3702.2 bcd	79.2 ab (0.88)
6	387.6 cd	3721.7 bcd	55.9 b (0.66)
8	384.5 cd	3637.9 bcd	45.9 b (0.51)
5	380.7 cd	3355.1 cd	55.8 ab (0.62)
3	323.8 cd	2865.3 d	49.9 b (0.55)
10	189.1 e	1031.6 e	16.6 c (0.18)

Data courtesy of Pam Roberts



February 2008

February 2010



Trt 1

Micronutrients, K-Phite, SARs
+ (13-0-44, Oil, H₂O₂)



Treatment average
Yield 171 lbs.
56% Canker loss



3-20W



← February 2008

February 2010 →

Trt 2

Micronutrients + K-Phite
+ (13-0-44, Oil, H₂O₂)



Treatment average
Yield 196 lbs.
60% Canker loss

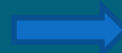


3-13W



February 2008

February 2010



Trt 8

K-Phite

+ (13-0-44, Oil, H₂O₂)



Treatment average
Yield 108 lbs.
75% Canker loss



4-11W



← February 2008

February 2010 →

Trt 9

Micronutrients, K-Phite, SARs
+ (13-0-44, Oil) no H₂O₂



Treatment average
Yield 175 lbs.
65% Canker loss





February 2008

February 2010



Trt 10

Untreated Control



Treatment average
Yield 57 lbs.
38% Canker loss



Treatment average
Yield 189 lbs.
40% Canker loss

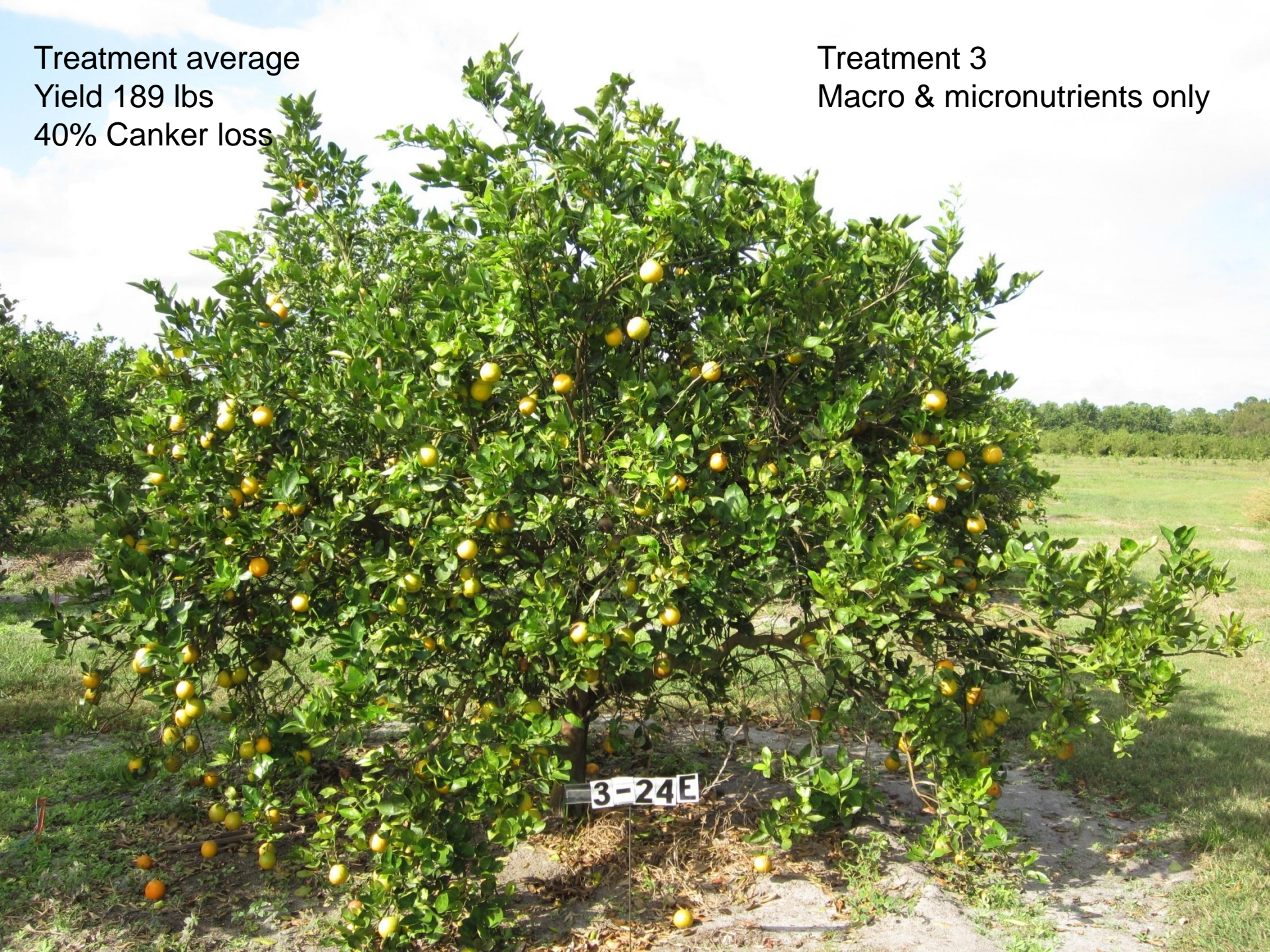
Treatment 3
Macro & micronutrients
only

3-22E



Treatment average
Yield 189 lbs
40% Canker loss

Treatment 3
Macro & micronutrients only



3-24E

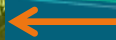
30 Acre Valencia Commercial Trial

Trt.	Yield (Lbs/tree)	Yield (Box/tree)	Spray Components
3	148.3 a	1.65 a	Micro + KNO ₃
2	148.2 a	1.65 a	Micro, Macro, H ₃ PO ₃ ,
1	144.8 a	1.61 a	Micro, Macro + H ₃ PO ₃ , SAR, H ₂ O ₂
7	144.7 a	1.61 a	Micro, KNO ₃ , SAR
9	139.8 a	1.55 a	Micro, Macro + H ₃ PO ₃ , SAR
5	129.3 ab	1.44 ab	SAR
4	121.2 ab	1.35 ab	KNO ₃
8	110.4 b	1.23 b	Macro + H ₃ PO ₃
6	108.9 b	1.21 b	Macro, H ₃ PO ₃ , SAR

Macro = 14-7-8 or 3-18-20

H₃PO₃ = Phosphite

SAR = Serenade + Salicylic acid

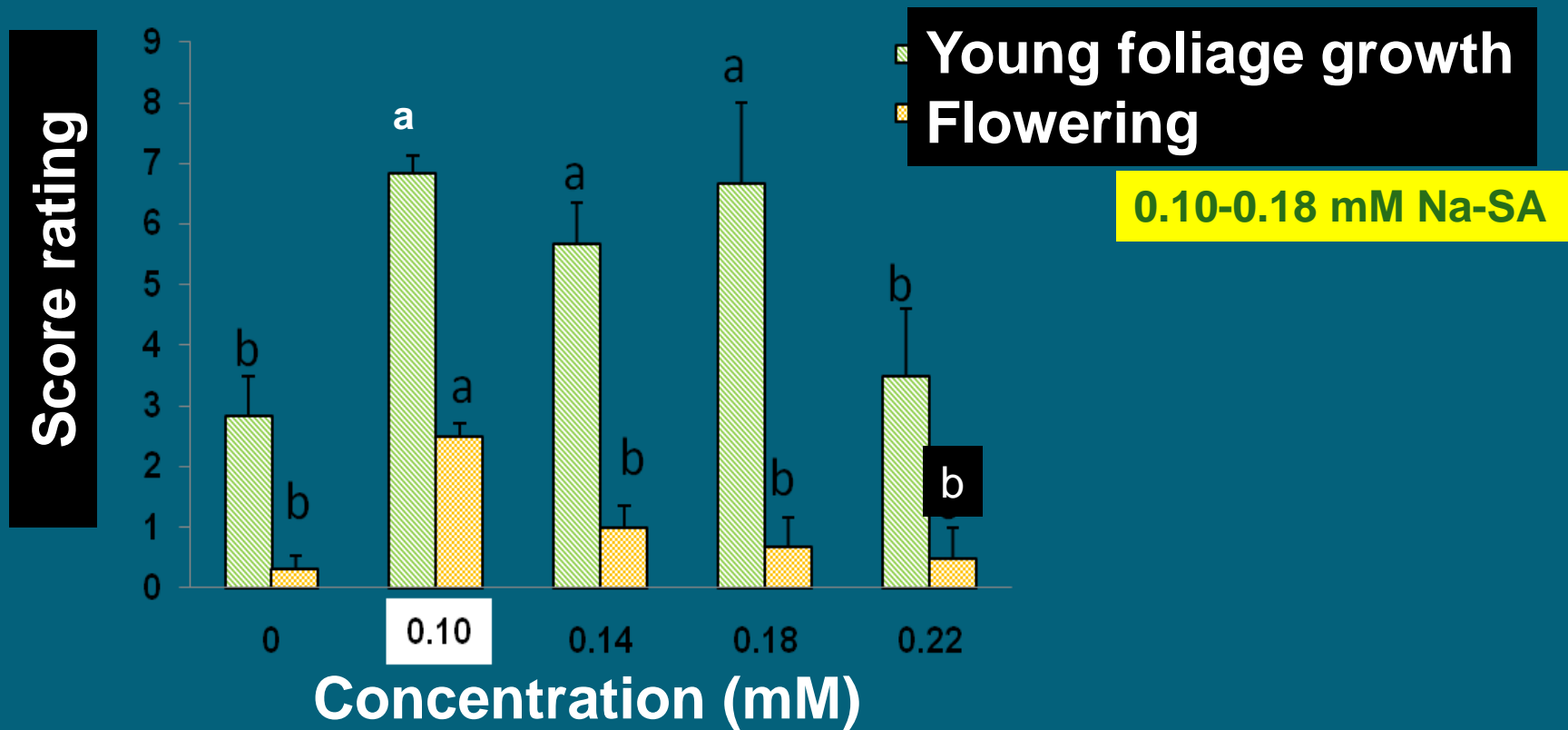


Control (Only water)

0.18 mM Na-SA



Leaf flush and flowering of HLB infected citrus trees sprayed with Na-SA



Case example



December 2008



June 3, 2009



February 2010

January 2012





Element (lb/ac/yr)		Boyd	Chemical Dynamics	Diamond R	Florida Phosphorus	Griffin	KeyPlex	Plant Food Systems
N		21	5	16	6	20	13	34
P		39	2	14	5	11	7	31
P ₂ O ₅		54	7	37	18	26	3	33
B			0.58	0.12	0.05	0.18	0.08	0.11
Ca			1.32		0.32		0.24	
Co					0.01			
Cu			0.02		0.05	0.17		
Fe			0.78	0.67		0.16	0.41	0.46
Mg		2.5	0.53	2.78	0.24	2.13	0.57	1.30
Mn		8.16	3.77	4.60	0.28	1.12	0.83	0.93
Mo		0.06	0.01	0.02	0.01			0.01
Ni					0.01			
S		9.63		4.5		1.30	0.65	0.50
Zn		2.98	3.78	5.04	0.48	1.15	0.81	1.72
SA		yes	no	yes	yes	no	no	yes
H ₃ PO ₃		yes	no	Yes	Yes	Yes	yes	Yes

Cost Comparison of Nutrient Spray Programs for HLB

Program Name	Spray rate (gpa)	Total materials (\$/acre)	Nutrient only (\$/acre)	Number sprays (year)	Spray cost (/spray)	Total cost (\$/acre)
Boyd	250	518	313	3	40	433
Chemical Dynamics	125	90	90	4	25	190
Diamond R	125	266	210	5	25	335
Florida Phosphorus	125	157	157	4	25	257
Griffin	125	167	167	4	25	267
KeyPlex	125	193	193	5	25	318
Plant Food Systems	125	273	273	6	25	423

Citrus oil, SAver, Serenade, and hydrogen peroxide not considered nutrient products.
 Spray costs from R. Muraro, 2009-10.

Roots under HLB trees treated
with foliar nutrition look good



2009 & 2010 Root Study

Direction		Root density cm root/cm ³ soil	
2009	2010	2009	2010
N	NE	0.905 a	1.331 a
S	NW	0.901 a	1.331 a
E	SE	0.831 a	1.270 a
W	SW	0.871 a	1.375 a

Depth (inches)	Root density cm root/cm ³ soil	
	2009	2010
0 - 6	1.016 a	1.576 a
6 - 12	0.734 b	1.081 b

Treatment		Root density cm root/cm ³ soil	
2009	2010	2009	2010
9	8	1.09 a	1.57 a
3	9	0.99 ab	1.55 a
2	7	0.93 abc	1.52 ab
8	4	0.93 abc	1.48 abc
4	6	0.92 abc	1.47 abc
7	5	0.85 abc	1.42 abc
5	1	0.84 abc	1.25 bcd
10	2	0.83 abc	1.21 cd
6	3	0.74 bc	1.02 de
1	10	0.67 c	0.77 e

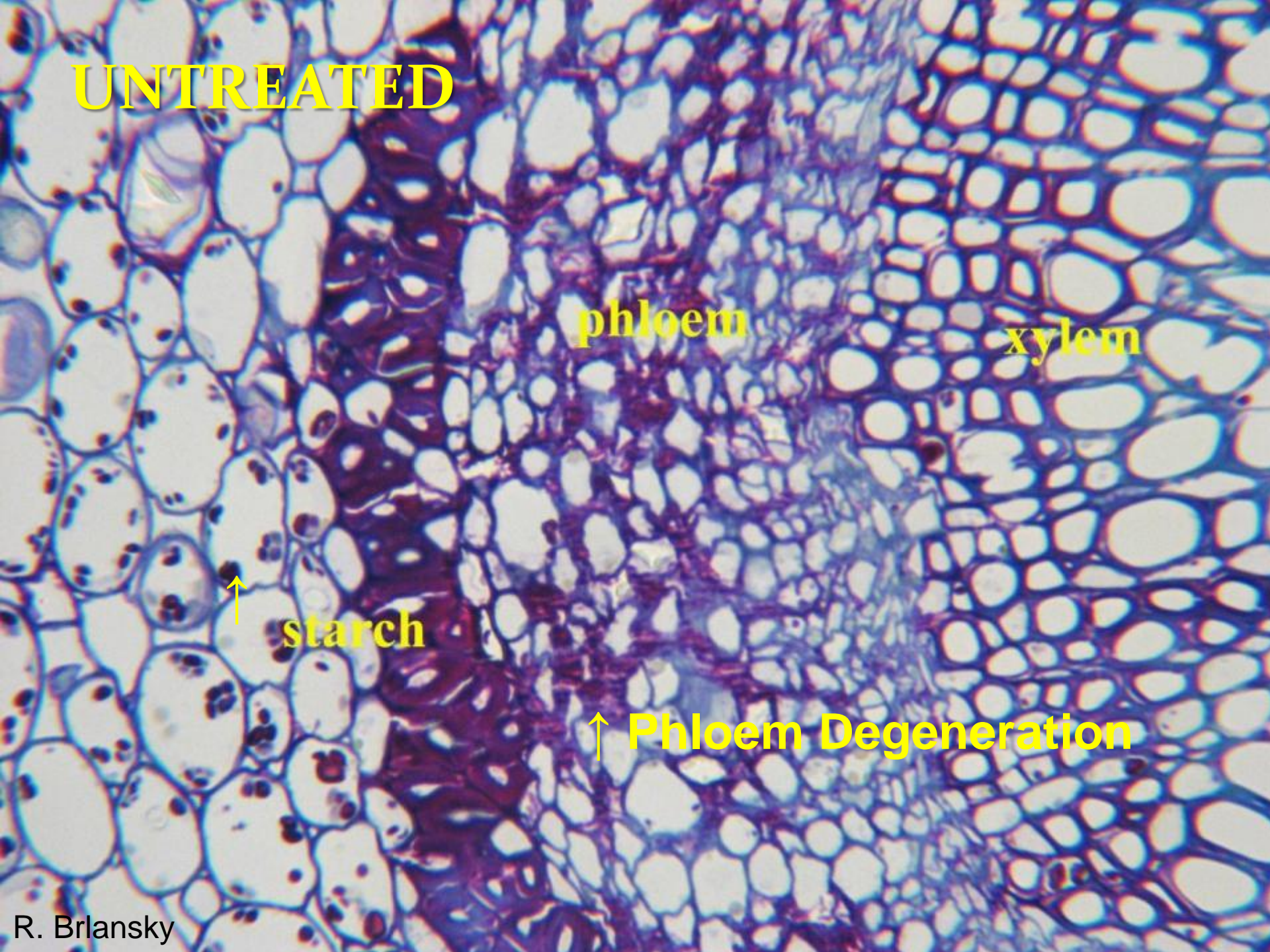
UNTREATED

phloem

xylem

starch

↑ Phloem Degeneration

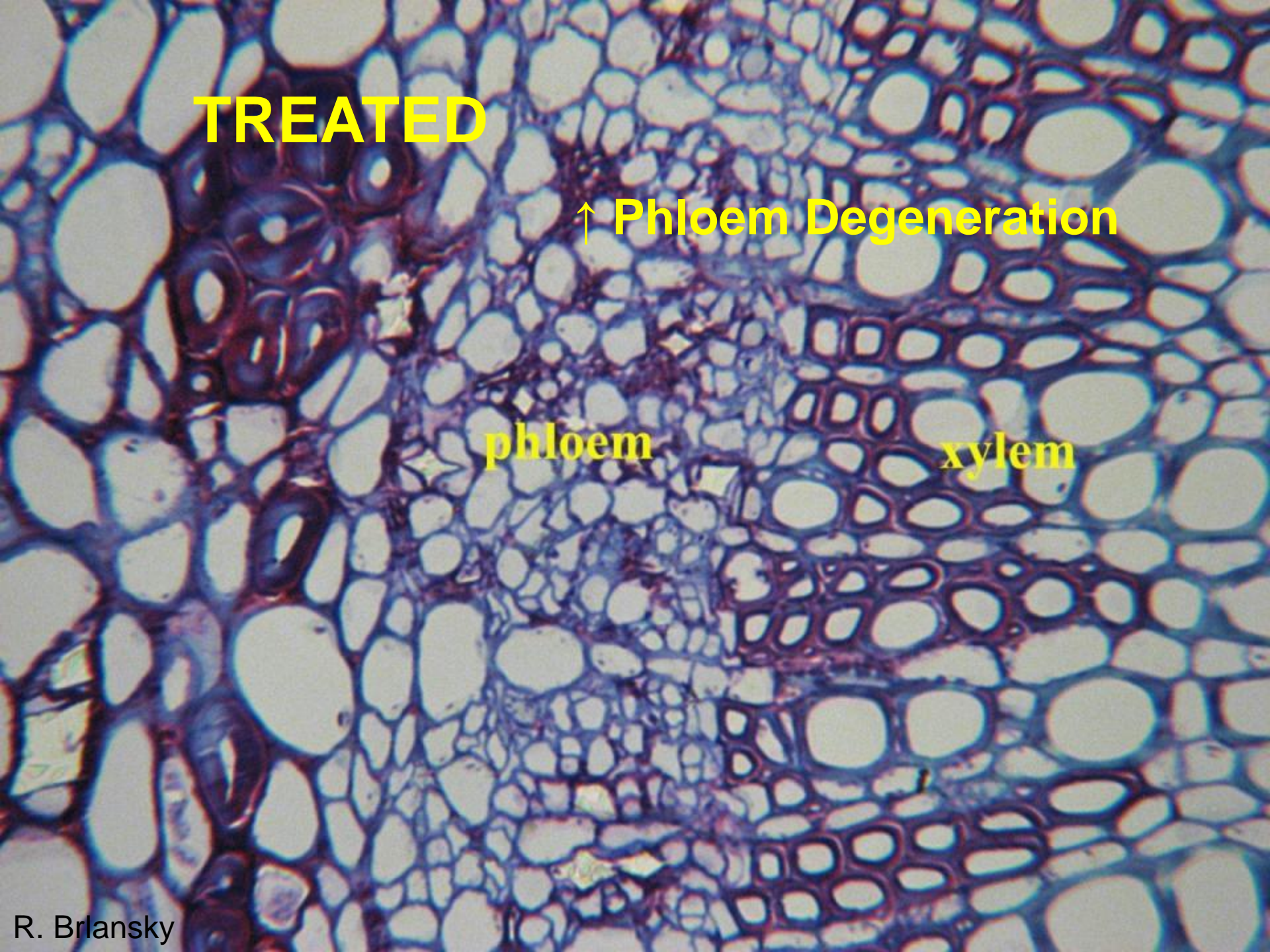


TREATED

↑ **Phloem Degeneration**

phloem

xylem



Current Conclusions

1. Nutrition works , macro and micronutrients core
2. Addition of Phosphite enhances yield response
3. Juice quality not affected
4. SARs stimulate growth, but HLB uncertain
5. Hydrogen peroxide as applied no HLB effect
6. Trees with HLB less tolerant to stress (drought, freeze, canker, other diseases, etc.)
7. Preliminary data suggests phloem is functional where nutrients are applied

Appreciation to:

- CRDF (Citrus Research & Development Foundation)
- The citrus growers in Florida
- Diamond R Fertilizer
- Plant Food Systems
- The Scotts Company
- AgraQuest
- Flo-Tec, Inc.
- Bayer CropScience
- Valent USA
- Yara