Varieties and Rootstocks for an HLB-Endemic Florida

Jude Grosser
Fred Gmitter and Bill Castle

UF/CREC Lake Alfred

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Varieties

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BETTER ORANGES MAKE BETTER JUICE!

Improved Processing Sweet Oranges can significantly improve our NFC product! Better flavor and color makes the product more attractive in the store, and will certainly have purchasers coming back for more! This will facilitate marketing and build a larger consumer-base.

Left: juice from OLL-8:

Right: Florida NFC purchased at Publix

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New Release OLL-20, exceptional juice flavor, made 7.7 lbs. solids on UFR-6

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An orange-like hybrid **3-3-52** appears tolerant and was ranked highest in flavor at the CREC Fruit Display Day in February 2016 and 2017

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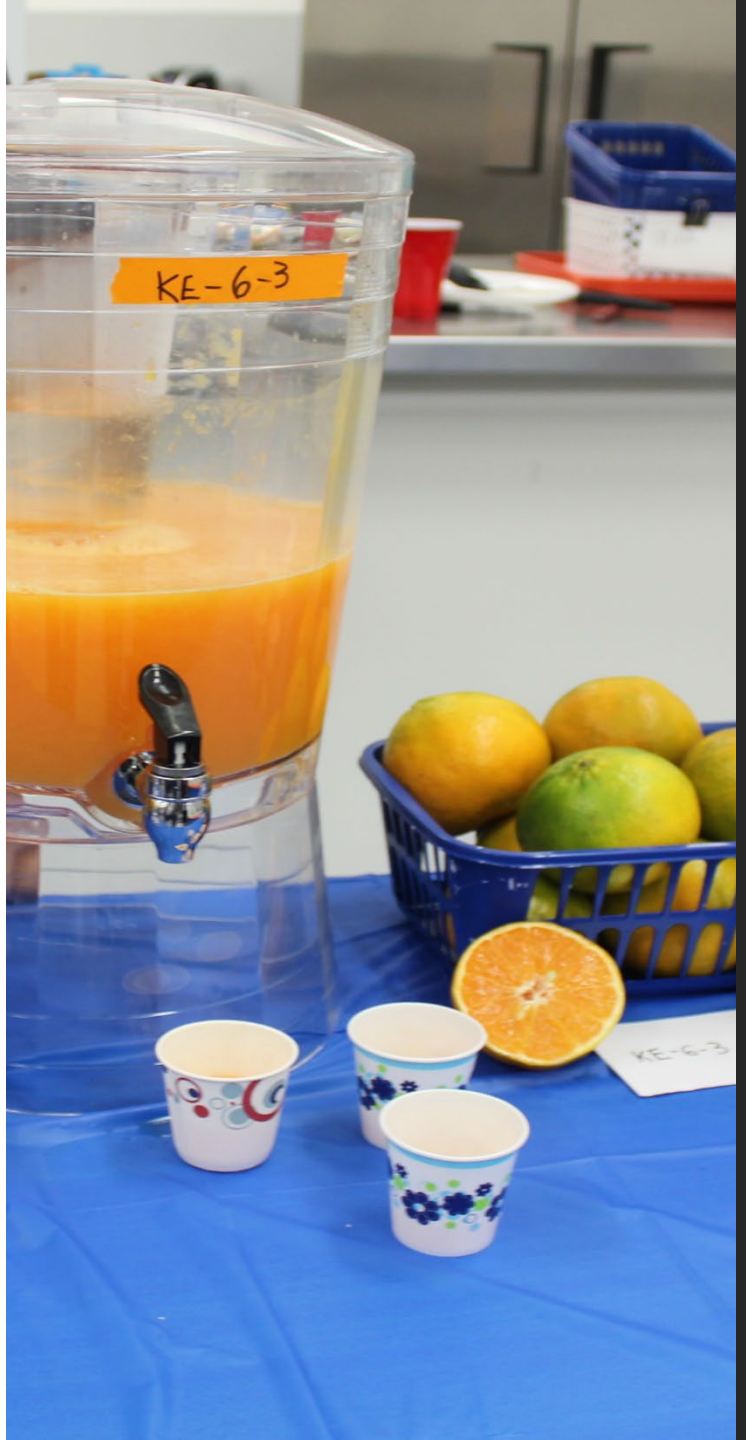
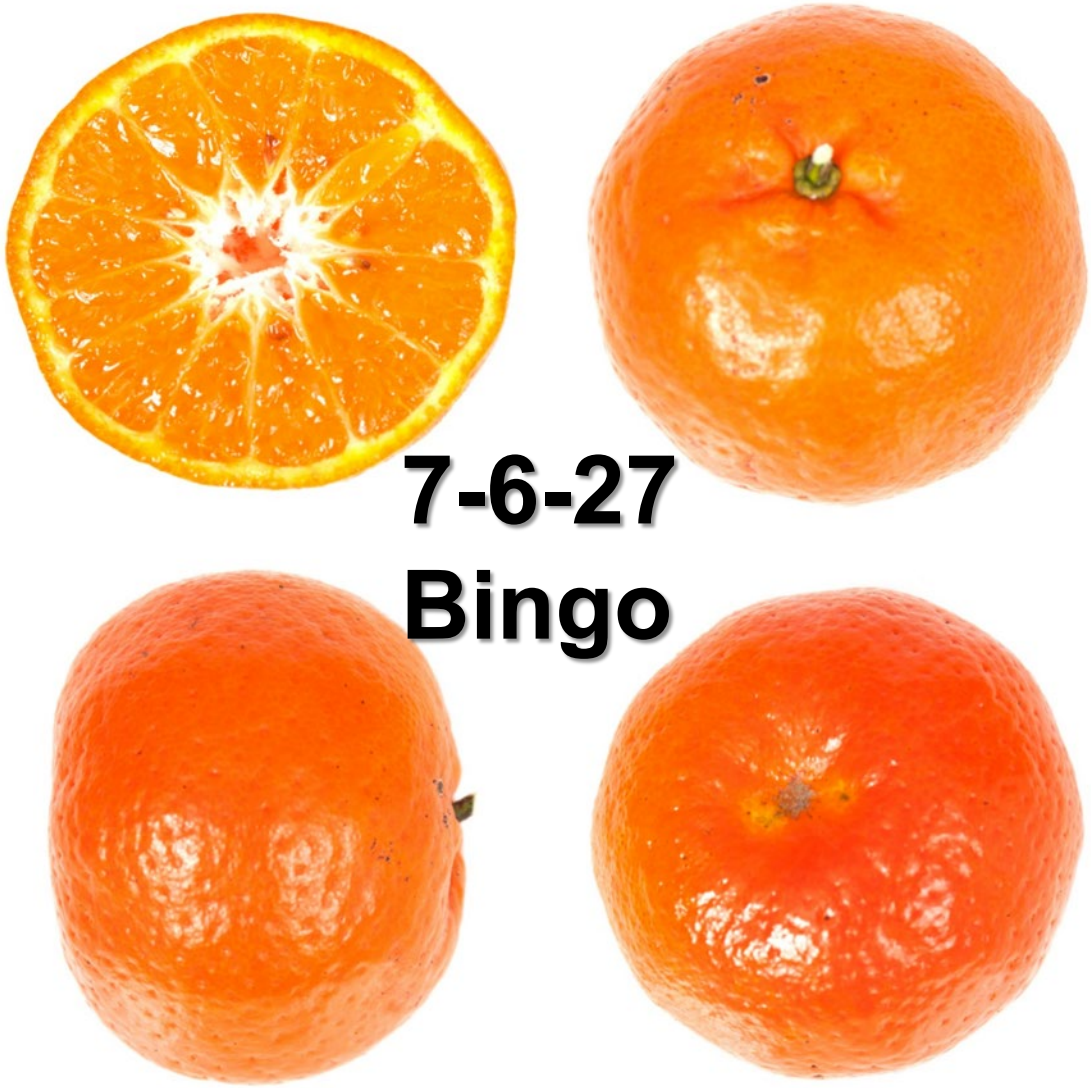


Good Hybrid Juice!

December color!



7-6-27
Bingo

Commercialization: Fast Track Suite III

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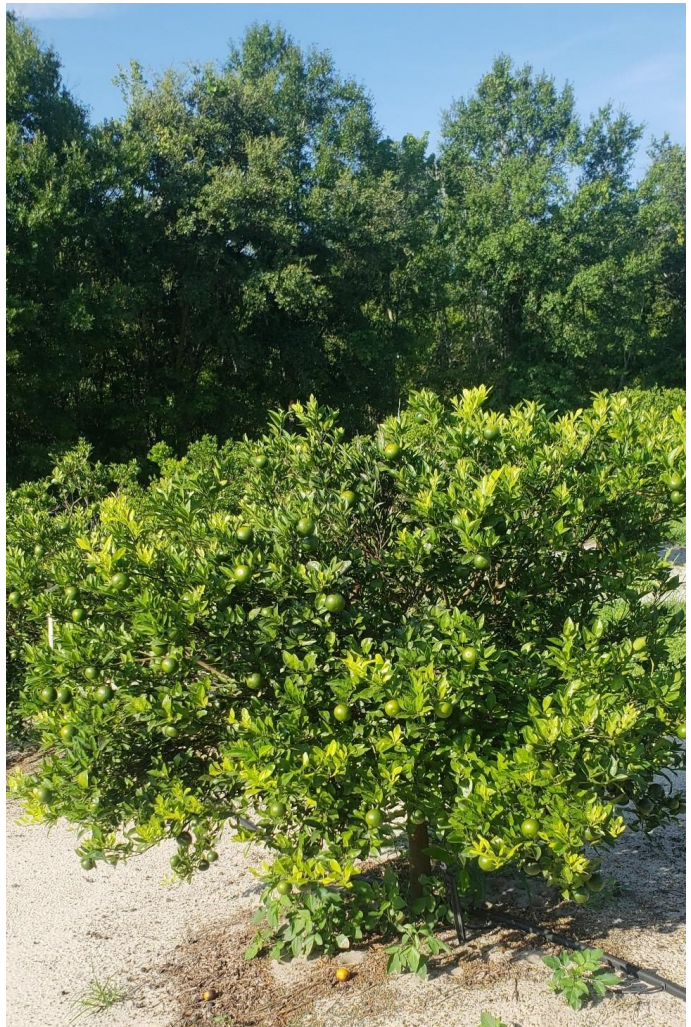
Bingo: problems with first year dieback, fruit set and fruit sizing being addressed.



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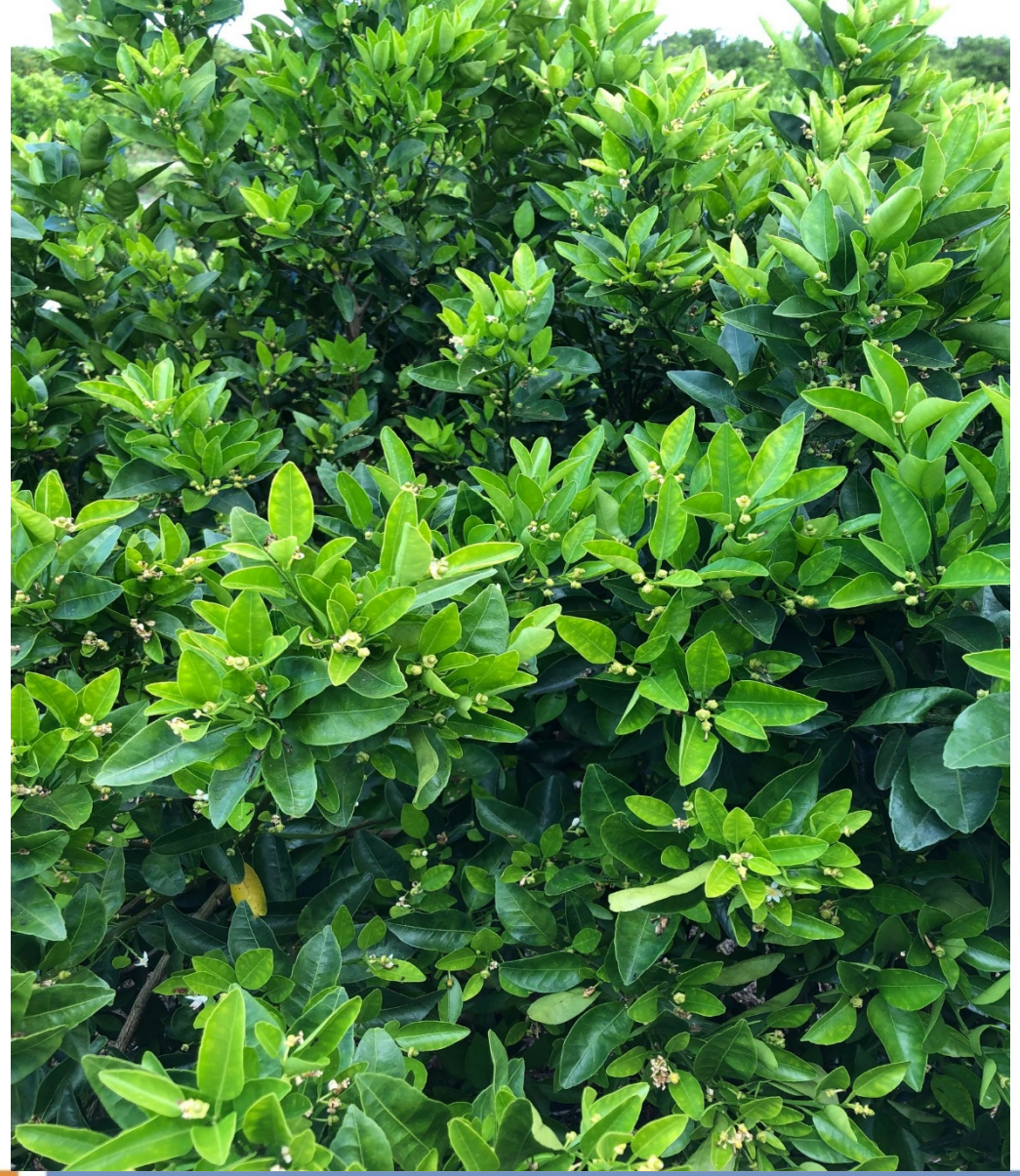

‘Bingo’ for market 2019?

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Marathon Fruit October 2019

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Marathon Fruit October 2019

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- Brix: 12.5 Acid: 0.89 Ratio: 14.04 19 August 2015
- Brix: 13.0 Acid: 0.59 Ratio: 22.03 25 September 2015
- Brix: 14.0 Acid: 0.69 Ratio: 20.28 29 October 2015
- Brix: 17.4 Acid: 0.62 Ratio: 28.06 17 December 2015
- Fruit remained in sound condition until early January
- No clipping required

Why Marathon?

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Marathon Fruit November 2015

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Marathon trees showing good vigor and HLB tolerance and setting good crop with fruit sizing up well in 2020!

Dark Red Cybrid Flame grapefruit showing recovery from HLB!

Cybrid Flame/Swingle tree showing good recovery from HLB when treated with CRF + extra polycoated manganese sulfate. Fruit had 11-12 brix this year. Now through PTP and being prepared for release.

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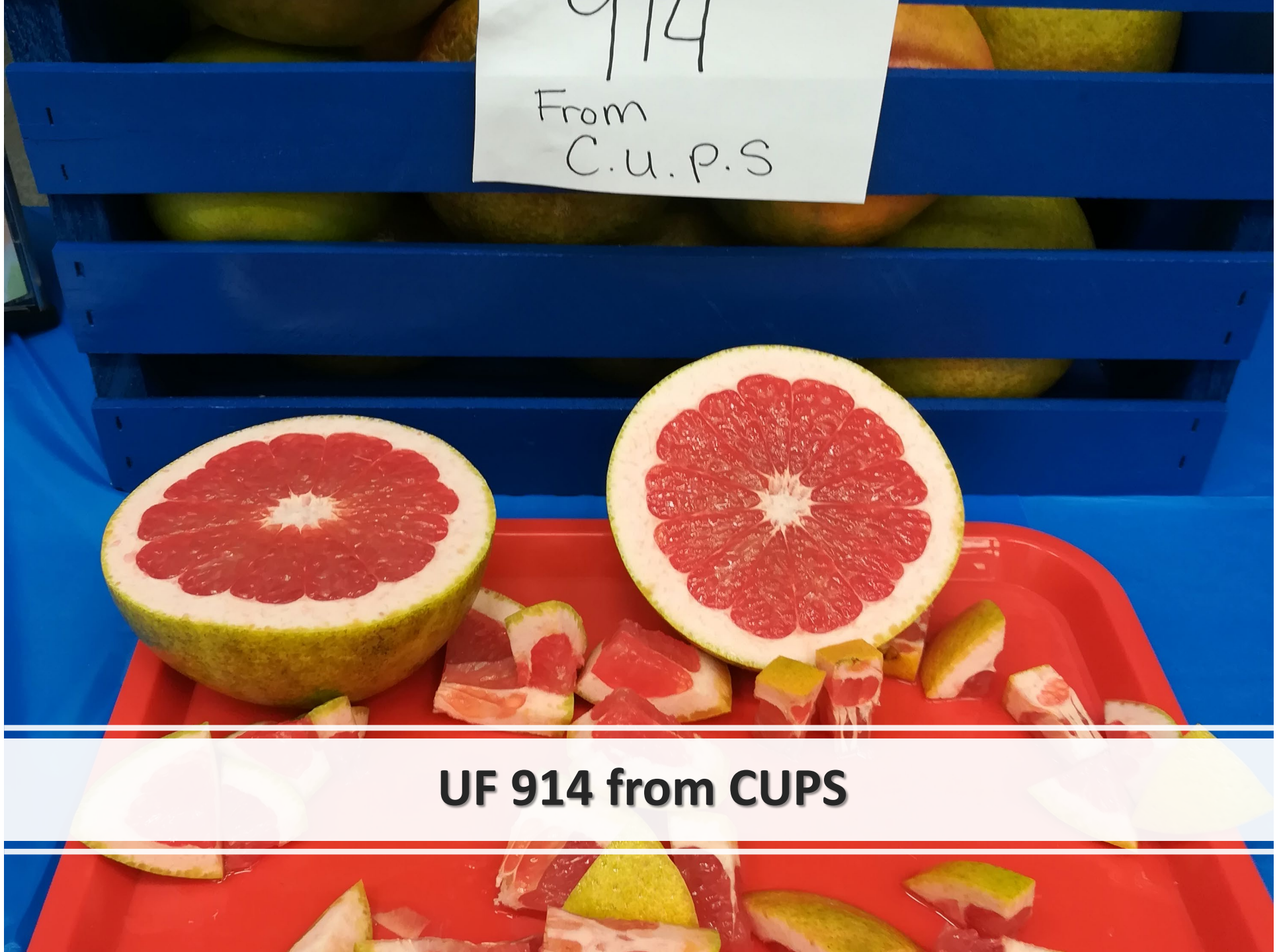
UF 914

- Red flesh and peel color; seedless
- Grapefruit size (+), flavor and aroma
- Tender and juicy flesh
- Very low in FC's (GJE)
- Good brix, lower acid
- Excellent production and quality in CUPS



UF 914 from CUPS

HLB-tolerant red grapefruit hybrid 1862

HLB-tolerant red grapefruit hybrid 1924

LEMON FOR INDUSTRY and FRESH

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SEEDLESS LEMON FOR FRESH

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Rootstocks

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St. Helena Rootstock Survey Trial

- Location: Dundee, Polk county
- Scion: Vernia & Valquarius
- Rootstocks: large collection of new diploid and tetraploid rootstock candidates
- Date Planted: 2008 & 2010
- Design: Randomized complete-block.
    - Replications: variable per rootstock
    - Plot size: 4-tree rectangular plots
    - Spacing: 9 x 20; 12 x 20; 15 x 25 ft
- Data collected:
    - Yield and juice quality every year since 2011 [Yield data has been collected using a volumetric method. Data was collected from a minimum of one 4-tree plot for each scion/rootstock combination each season, and from two plots per combination when possible.
    - Tree size data has also been collected, and used to predict the optimum tree spacing for each combination, and this information has been combined with the actual yield and fruit quality data to project the total lbs. solids that could be produced for each scion/rootstock combination if trees were planted at the optimum spacing.

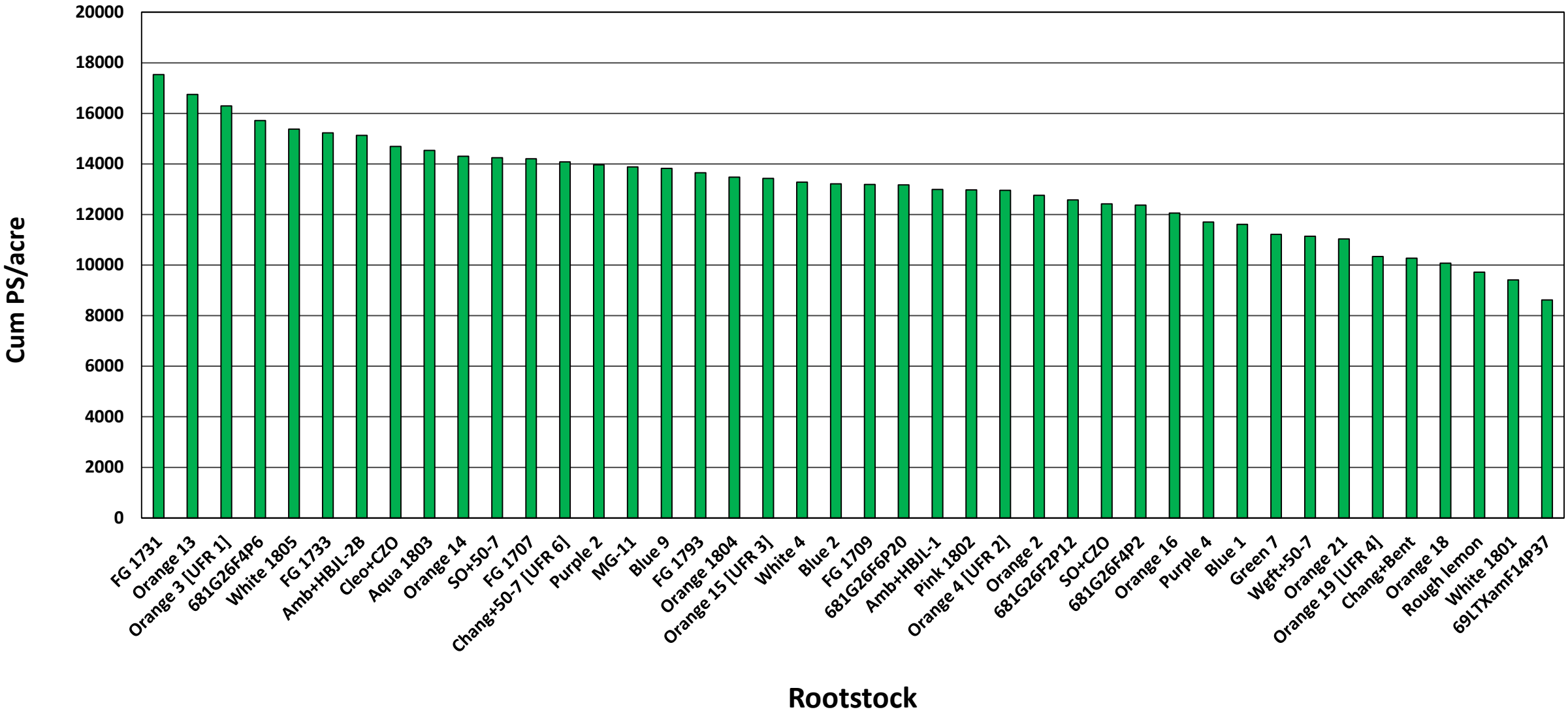
Table 1a. St. Helena Rootstock Survey Trial – 2019 **Valquarius** Yield and Fruit Quality for Trees planted in 2008

Rootstock	PS/Box [2019]	Boxes/Tree [2019]	PS/tree [2019]	Optimum Trees/Acre	Optimum Sq ft/tree [2019]	PS/Acre Projected [2019] (% increase 2019/2018)	Boxes/Acre Projected [2019] (% increase 2019/2018)	Cum PS/acre [projected] 2011-19	HLB Diagnosis c/o Southern Gardens Diagnostic Lab	Ct (4-tree composite sample)
FG 1731 [UF 13]	6.7	1.1	7.2	229	190	1655 (90)	247 (56)	17538	HLB positive	29.65
Orange 13	6.6	2.0	12.9	256	170	3312 (127)	502 (93)	16746	HLB positive	28.82
Orange 3 [UFR 1]	6.5	1.8	11.5	212	205	2445 (93)	377 (82)	16295	Questionable	30.06
681G26F4P6	6.2	2.5	15.1	198	220	2993 (70)	485 (53)	15716	HLB positive	29.63
White 1805	6.1	2.8	17.2	171	255	2942 (138)	484 (112)	15380	HLB positive	28.19
FG 1733 [FG 14]	6.3	1.8	11.4	229	190	2609 (172)	412 (110)	15233	HLB positive	26.55
Amb+HBJL-2B	6.4	2.3	14.8	207	210	3067 (223)	482 (177)	15128	Questionable	30.32
Cleo+CZO	5.8	1.1	6.2	229	190	1418 (62)	243 (57)	14693	No HLB found	32.26
Aqua 1803	6.2	2.3	14.4	207	210	2971 (145)	482 (112)	14538	HLB positive	27.00
Orange 14	6.9	0.8	5.7	242	180	1376 (106)	201 (79)	14303	HLB positive	29.45
SO+50-7	6.5	1.0	6.7	348	125	2316 (110)	358 (89)	14245	HLB positive	28.34
FG 1707	6.8	1.9	13.2	212	205	2790 (72)	409 (45)	14208	No HLB found	32.50
Chang+50-7 [UFR 6]	6.8	1.1	7.4	311	140	2291 (88)	336 (73)	14085	No HLB found	32.37
Purple 2	6.4	1.0	6.6	249	175	1655 (27)	259 (16)	13963	HLB positive	28.81
MG-11	6.0	2.1	12.4	229	190	2834 (109)	476 (69)	13885	HLB positive	28.72
Blue 9	6.4	1.1	7.1	256	170	1827 (64)	284 (54)	13829	HLB positive	28.17
FG 1793	6.1	3.0	18.1	185	235	3341 (150)	551 (139)	13651	No HLB found	33.02
Orange 1804	5.9	3.3	19.6	189	230	3713 (121)	629 (95)	13479	No HLB found	32.21
Orange 15 [UFR 3]	5.9	1.7	9.7	229	190	2218 (65)	378 (39)	13426	HLB positive	28.24
White 4 [UF-5]	6.6	1.4	8.9	212	205	1891 (46)	288 (25)	13276	HLB positive	27.96
Blue 2	6.7	0.8	5.2	235	185	1211 (-35)	181 (-43)	13213	HLB positive	27.40
FG 1709	6.5	1.1	7.1	249	175	1756 (31)	269 (22)	13189	HLB positive	27.18
681G26F6P20	6.3	1.6	10.2	223	195	2283 (92)	361 (66)	13169	HLB positive	27.33
Amb+HBJL-1	6.6	1.1	7.2	256	170	1853 (NA)	282 (88)	12995	No HLB found	32.09
Pink 1802	6.4	1.7	10.5	272	160	2868 (73)	449 (53)	12977	not sampled	
Orange 4 [UFR 2]	6.2	1.8	11.3	203	215	2285 (83)	371 (60)	12956	Questionable	30.07
Orange 2	6.9	0.9	6.2	198	220	1228 (-30)	178 (NA)	12762	not sampled	
681G26F2P12	6.6	1.3	8.4	264	165	2223 (60)	335 (37)	12578	Questionable	30.46
SO+CZO	6.7	0.9	6.3	242	180	1517 (36)	227 (13)	12421	HLB positive	29.07
681G26F4P2	6.1	1.7	10.4	223	195	2324 (164)	379 (120)	12375	Questionable	30.09
Orange 16	5.3	1.9	9.8	235	185	2308 (106)	437 (96)	12060	HLB positive	30.00
Purple 4	6.9	0.5	3.1	264	165	817 (-32)	119 (-41)	11706	HLB positive	29.04
Blue 1	6.7	1.1	7.7	272	160	2090 (132)	310 (78)	11611	HLB positive	28.61
Green 7	6.1	1.1	6.6	281	155	1851 (31)	303 (17)	11219	Questionable	31.92
Wgft+50-7	6.3	0.9	5.9	311	140	1848 (66)	292 (47)	11142	No HLB found	35.51
Orange 21	6.1	1.4	8.3	290	150	2410 (104)	394 (79)	11032	HLB positive	29.22
Orange 19 [UFR 4]	6.1	1.8	11.2	207	210	2315 (135)	379 (94)	10336	HLB positive	29.11
Chang+Bent	6.7	0.3	2.2	264	165	585 (-36)	87 (-42)	10274	HLB positive	29.09
Orange 18	6.3	1.1	7.0	290	150	2022 (37)	319 (24)	10073	HLB positive	28.45
Rough lemon	5.9	1.4	8.4	212	205	1777 (146)	303 (89)	9723	Questionable	30.79
White 1801	6.5	1.6	10.2	229	190	2345 (233)	362 (174)	9417	HLB positive	27.56
69LTXamF14P37	6.0	1.1	6.6	223	195	1469 (125)	245 (99)	8624	HLB positive	28.43

Table 1b. St. Helena Rootstock Survey Trial – 2019 **Vernia** Yield and Fruit Quality for Trees planted in 2008

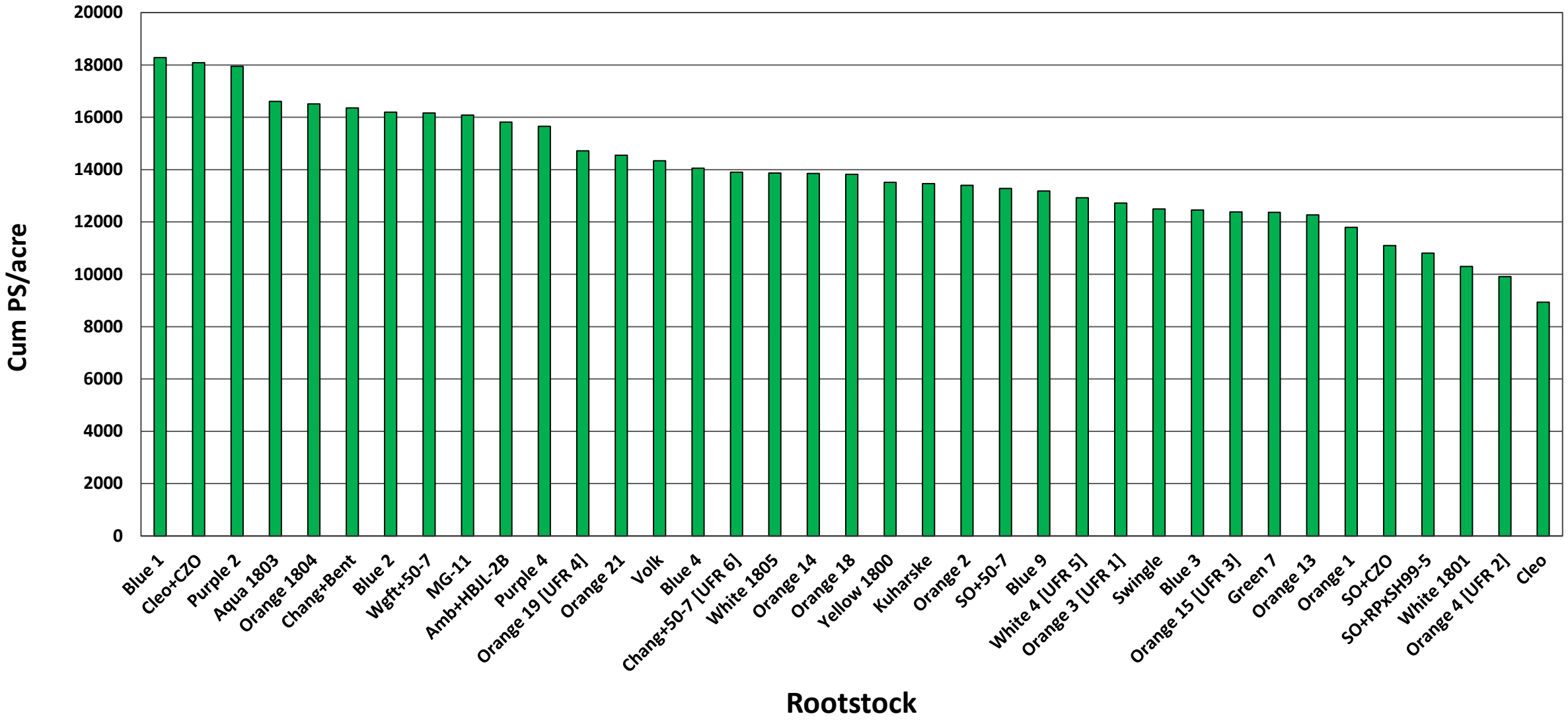
Rootstock	PS/Box [2019]	Boxes/Tree [2019]	PS/tree [2019]	Optimum Trees/Acre	Optimum Sq ft/tree [2019]	PS/Acre Projected [2019] (% increase 2019/2018)	Boxes/Acre Projected [2019] (% increase 2019/2018)	Cum PS/acre [projected] 2011-19	HLB Diagnosis c/o Southern Gardens Diagnostic Lab	Ct (4-tree composite sample)
Blue 1	6.5	2.5	16.0	223	195	3573 (NA)	546 (173)	18278	HLB positive	28.10
Cleo+CZO	6.9	1.8	12.4	249	175	3097 (NA)	448 (39)	18089	HLB positive	29.47
Purple 2	6.1	2.0	12.1	281	155	3411 (46)	556 (21)	17951	Questionable	30.36
Aqua 1803	6.6	2.3	15.4	203	215	3131 (114)	473 (73)	16612	No HLB found	32.24
Orange 1804	6.5	3.0	19.1	207	210	3951 (150)	611 (114)	16509	HLB positive	26.05
Chang+Bent	6.7	1.2	8.0	207	210	1664 (NA)	248 (-2)	16359	Questionable	31.60
Blue 2	7.0	1.2	8.4	281	155	2357 (NA)	337 (77)	16193	HLB positive	29.75
Wgft+50-7	6.7	1.9	12.3	235	185	2891 (NA)	435 (104)	16168	HLB positive	29.73
MG-11	6.8	2.3	15.6	229	190	3571 (113)	527 (72)	16081	Questionable	30.25
Amb+HBJL-2B	6.7	1.3	8.7	272.25	160	2364 (NA)	354 (NA)	15815	HLB positive	27.83
Purple 4	7.5	1.1	7.9	311	140	2466 (NA)	330 (42)	15659	Questionable	30.12
Orange 19 [UFR 4]	6.4	1.9	12.2	223	195	2730 (147)	426 (102)	14720	Questionable	30.03
Orange 21	6.6	1.9	12.5	281	155	3518 (129)	534 (83)	14550	Questionable	31.02
Volk	5.6	3.5	19.7	171	255	3362 (104)	604 (84)	14339	HLB positive	28.43
Blue 4	6.5	1.0	6.4	311	140	1992 (81)	308 (67)	14056	HLB positive	29.63
Chang+50-7 [UFR 6]	7.3	1.4	10.3	300	145	3079 (249)	420 (156)	13902	No HLB found	32.38
White 1805	6.9	1.4	9.9	290	150	2866 (101)	415 (69)	13868	No HLB found	32.77
Orange 14	6.8	1.1	7.5	207	210	1553 (48)	228 (14)	13854	No HLB found	34.48
Orange 18	6.7	1.5	10.1	256	170	2573 (NA)	384 (49)	13824	Questionable	31.12
Yellow 1800	6.5	2.4	15.4	235	185	3619 (136)	559 (122)	13516	HLB positive	27.22
Kuharske	6.9	2.6	17.7	212	205	3756 (119)	543 (87)	13466	Questionable	31.93
Orange 2	6.9	0.9	6.2	198	220	1228 (-2)	178 (-12)	13401	HLB positive	29.75
SO+50-7	7.1	0.8	5.9	311	140	1830 (NA)	258 (63)	13278	HLB positive	27.40
Blue 9	7.1	1.0	6.9	212	205	1166 (NA)	204 (11)	13186	Questionable	30.25
White 4 [UFR 5]	6.9	1.4	10.0	203	215	2026 (160)	292 (80)	12927	HLB positive	27.57
Orange 3 [UFR 1]	6.8	1.6	10.8	235	185	2542 (127)	376 (86)	12726	HLB positive	29.21
Swingle	6.7	1.8	12.1	207	210	2513 (114)	377 (88)	12500	HLB positive	29.98
Blue 3	6.7	0.9	6.3	300	145	2174 (NA)	282 (131)	12456	HLB positive	26.99
Orange 15 [UFR 3]	6.7	1.2	8.0	223	195	1790 (82)	268 (38)	12386	HLB positive	29.90
Green 7	7.1	1.2	8.5	235	185	1999 (76)	282 (51)	12366	HLB positive	28.31
Orange 13	6.9	1.3	9.1	264	165	2409 (104)	351 (75)	12274	HLB positive	29.81
Orange 1	7.0	1.5	10.1	218	200	2212 (136)	318 (101)	11794	HLB positive	27.11
SO+CZO	7.3	0.9	6.8	272	160	1859 (162)	256 (108)	11101	HLB positive	29.48
SO+RPxSH99-5	7.1	1.1	7.8	281	155	2185 (NA)	309 (61)	10806	HLB positive	27.55
White 1801	6.6	1.4	9.2	218	200	2014 (69)	305 (27)	10299	HLB positive	26.43
Orange 4 [UFR 2]	6.7	1.1	7.5	229	190	1713 (85)	254 (58)	9913	HLB positive	28.83
Cleo	5.6	1.6	8.9	203	215	1806 (75)	321 (87)	8937	HLB positive	29.92

St. Helena Rootstock Survey Trial – Cumulative PS/acre [projected] for **Valquarius** planted in 2008



CREC Citrus Plant Improvement

St. Helena Rootstock Survey Trial – Cumulative PS/acre [projected] for **Vernia** planted in 2008



CREC Citrus Plant Improvement

Table 1. St. Helena Rootstock Survey Trial – 2018-19 vs. 2019-20 **Valquarius** - Yield [box/tree] and Estimated PS/acre. **Trees planted in 2008**

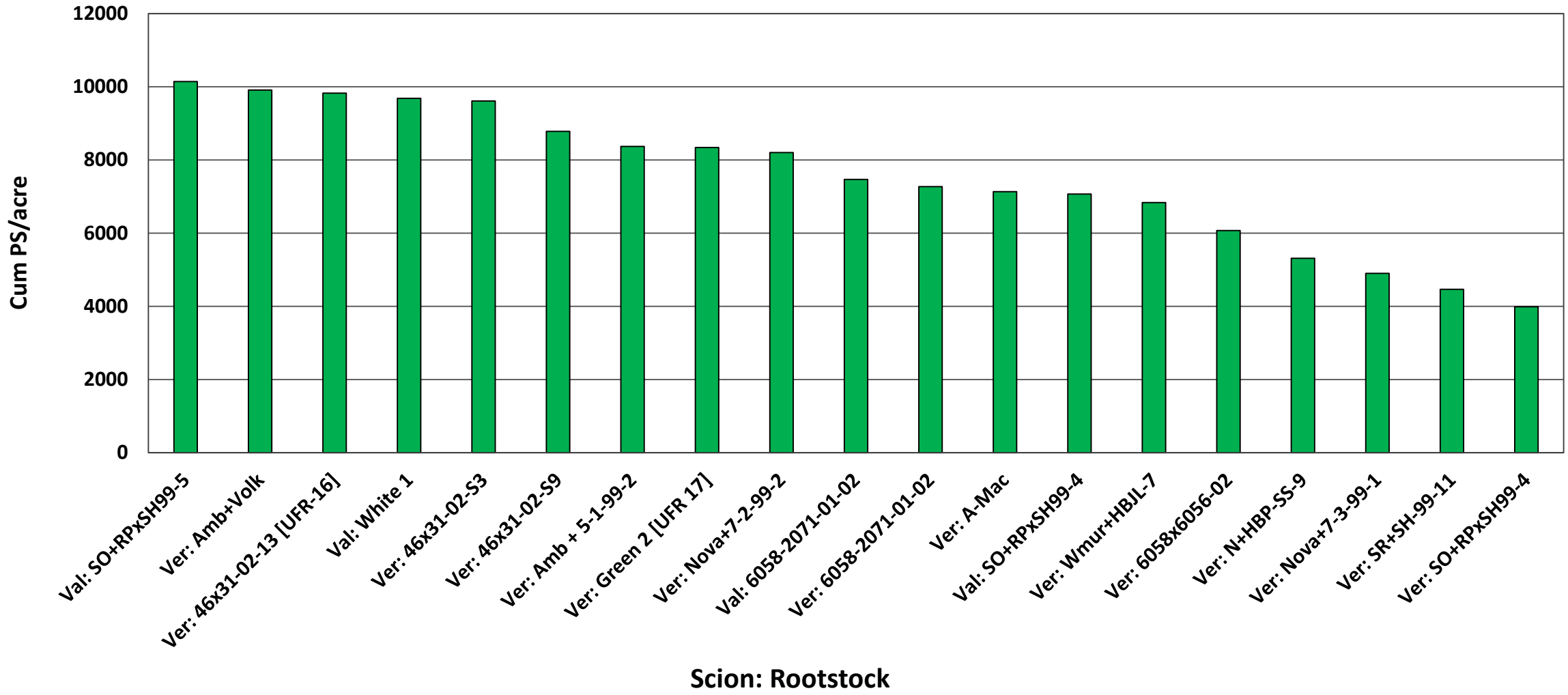
Scion	Rootstock	2018-19 Boxes/tree	2019-20 Boxes/tree	% of Yield Variation from 2018-19 to 2019-20	Estimated PS/acre [increase 2017-18 to 2018-19, %]	Estimated PS/acre [increase 2018-19 to 2019-20, %]
Valquarius	Chang+Bent	0.3	1.1	253%	557 [-39]	2448 (265)
	Blue 3	0.3	0.8	153%	677 [-50]	1329 (97)
	Purple 4	0.6	0.8	37%	1127 [-6]	1464 (30)
	Blue 2	0.9	1.2	33%	1479 [-21]	1864 (26)
	FG 1709	1.1	1.5	32%	1833 [37]	2430 (32)
	UFR-14 [FG 1733]	1.9	2.4	25%	2529 [163]	3038 (20)
	Rough lemon	1.5	1.9	23%	1902 [163]	2325 (22)
	Chang+50-7 [UFR 6]	1.2	1.5	23%	2390 [96]	2729 (14)
	Amb+HBJL-2B	2.3	2.7	18%	3074 [224]	3436 (12)
	Swingle	1.8	2.1	17%	2008 [34]	2340 (17)
	Green 7	1.2	1.4	13%	1835 [30]	2113 (15)
	FG 1707	1.9	2.1	11%	2808 [73]	2878 (3)
	UFR-13 [FG 1731]	1.1	1.2	9%	1652 [89]	1797 (9)
	Cleo+CZO	1.1	1.2	9%	1368 [56]	1569 (15)
	Cleo	1.5	1.6	5%	1621 [165]	1754 (8)
	681G26F6P20	1.6	1.7	5%	2265 [91]	2159 (-4)
	Orange 4 [UFR 2]	1.8	1.8	1%	2272 [82]	2161 (-5)
	Orange 1804	3.2	3.2	1%	3523 [109]	3346 (-5)
	69LTXamF14P37	1.1	1.1	0%	1475 [125]	1494 (1)
	SO+CZO	0.9	0.9	0%	1707 [53]	1503 (-12)
	Orange 21	1.4	1.4	-1%	2093 [77]	2032 (-3)
	Orange 19 [UFR 4]	1.8	1.7	-3%	2312 [134]	2092 (-9)
	FG 1702	1.2	1.2	-4%	1943 [46]	1936 (0)
	Orange 15 [UFR 3]	1.7	1.6	-5%	2225 [65]	2109 (-5)
	Blue 1	1.1	1.0	-5%	1856 [106]	1570 (-15)

(*) Calculated using measured width and hypothetical 20 ft. between all rows.

Table 3. St. Helena Rootstock Survey Trial – Yield and Fruit Data for Trees planted in 2010

Scion	Rootstock	PS/Box [2019]	Boxes/Tree [2019]	PS/tree [2019]	Optimum Trees/Acre	Optimum Sq ft/tree [2019]	PS/Acre Projected [2019] (% increase 2019/2018)	Boxes/Acre Projected [2019] (% increase 2019/2018)	Cum PS/acre [projected]	HLB Diagnosis	Ct (4-tree composite sample)
Valquarius	SO+RPxSH99-5	6.9	1.1	7.5	323	135	2414 (70)	349 (50)	10139	Questionable	30.09
Vernia	Amb+Volk	6.5	1.4	9.1	293	180	2666 (136)	410 (75)	9909	Questionable	31.32
Vernia	46x31-02-13 [UFR-16]	6.4	2.1	13.4	280	155	3751 (109)	582 (89)	9823	HLB positive	27.39
Valquarius	White 1	6.2	3.1	19.1	189	230	3615 (238)	586 (212)	9682	N/A	N/A
Vernia	46x31-02-S3	6.3	1.8	11.5	264	165	3046 (129	486 (104)	9613	HLB positive	27.49
Vernia	46x31-02-S9	6.9	1.1	7.5	317	137	2366 (13)	342 (-2)	8783	HLB positive	28.31
Vernia	Amb + 5-1-99-2	6.5	1.0	6.2	300	145	1855 (69)	285 (48)	8372	HLB positive	28.50
Vernia	Green 2 [UFR-17]	6.3	1.8	11.4	203	215	2314 (173)	367 (125)	8341	Questionable	30.34
Vernia	Nova+7-2-99-2	6.6	1.4	9.4	272	160	2548 (139)	389 (108)	8203	Questionable	30.15
Valquarius	6058-2071-01-02	5.9	1.7	9.8	311	140	3048 (41)	513 (32)	7467	Questionable	30.92
Vernia	6058-2071-01-02	6.4	1.1	6.7	264	165	1771 (99)	277 (86)	7271	No HLB found	34.00
Vernia	A-Mac	6.2	1.1	6.9	242	180	1674 (-10)	269 (-23)	7135	Questionable	30.97
Valquarius	SO+RPxSH99-4	6.6	0.7	4.3	290	150	1259 (34)	191 (25)	7070	N/A	N/A
Vernia	Wmur+HBJL-7	6.7	1.0	6.4	235	185	1500 (13)	223 (10)	6837	HLB positive	28.33
Vernia	6058x6056-02	5.9	1.7	9.7	218	200	2104 (92)	360 (67)	6070	HLB positive	29.12
Vernia	N+HBP-SS-9	6.9	0.6	4.4	235	185	1036 (-9)	150 (-18)	5313	Questionable	30.04
Vernia	Nova+7-3-99-1	6.2	1.0	5.9	229	190	1340 (31)	218 (7)	4901	HLB positive	29.20
Vernia	SR+SH-99-11	6.6	0.2	1.3	335	130	445 (-18)	67 (-15)	4464	HLB positive	29.65
Vernia	SO+RPxSH99-4	6.1	1.0	5.9	281	155	1665 (88)	273 (91)	3989	HLB positive	27.09

St. Helena Rootstock Survey Trial – Cumulative PS/acre [projected] for Valquarius and Vernia planted in 2010



CREC Citrus Plant Improvement

St. Helena Trial: My opinion

- Best performing rootstock is **Orange 1804**; from Foguet/Argentina, produced about 3 boxes/tree last two seasons for both Valquarius and Vernia. Status: seed importation prohibited, requires TC (will be initiated this year).
- 2nd favorite rootstock is **UFR-14 (FG 1733)**; although first to be infected, excellent yield and fruit quality, yield increase this past season. Status: No seed trees, but through PTP, will become available via TC late 2020. Trees look thrifty.
- 3rd favorite rootstock is **Amb+HBJL-2**; good yields and fruit quality, yield increase this past season. Status: No seed trees, but through PTP, in TC, will be considered for commercial release.
- Overall, UFR rootstocks performing reasonably well. UFR-1 is being underutilized. UFR-6 is a good choice for high density plantings. Commercial rootstocks showing recovery with improved nutrition regime, especially Kuharske and Swingle.
- Other UF rootstocks showing promise: Cleo+Czo, Blue 1, White 1; all through PTP and being considered for commercial release.

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ST. CLOUD OLL CLONE/ROOTSTOCK TRIAL - DESCRIPTION

At the suggestion of long-time cooperator, Orie Lee, a demonstration was planted to compare the performance of 8 OLL [Orie Lee Late] sweet orange clones on 18 rootstocks. Pathogen-free budwood was not available for most of the OLL clones at the time of tree propagation, thus, a permit was obtained from FL Department of Agriculture, Division of Plant Industry [DPI] to propagate the trees using budwood from the original OLL somaclone trees, located on the Lee property. The DPI permit limited this project to 2 acres, so it was designed with one, 2-tree, plot per scion/rootstock combination. Trees were planted in June 2013 with rootstocks in rows running in one direction with OLL clones in perpendicular rows. Propagation took place on the Lee property with the assistance of Briteleaf Nursery. Trees received standard imidacloprid treatments the first two years, **but no psyllid control thereafter. Diaprepes weevils were observed in the trial block. By year 3, all trees in the trial showed HLB symptoms. Trees have received the Lee Groves standard 4 soluble dry fertilizer treatments per year, and since year 4 have received supplemental treatments of CRF (controlled release fertilizer) with an enhanced micronutrient package two times per year.**

This small trial is remarkable for multiple reasons. The soluble solids being produced in the fruit across most of the scion/rootstock combinations are exceptionally high, and would be considered high for young trees even for trees before the HLB endemic. Yields of some combinations are also quite good, even though psyllid control has not been employed, and the grove is under high psyllid/HLB pressure. Finally, it is quite interesting that so many of the trees are testing negative by PCR for an active *CLas* infection, suggesting a positive effect from the combination of good genetics and constant enhanced micronutrient availability.

Orie Lee OLL Clone/Rootstock Trial - Summary

- Location: St. Cloud Florida, Block 13-W
- Scions: 8 OLL (Orie Lee Late) somaclones
- Rootstocks: Swingle, Carrizo, x639 and 15 tetraploid rootstocks from the UF breeding program
- Date planted: June 2013
- Design:
  - One, 2-tree, plot per scion/rootstock combination; rootstocks planted in east/west rows; OLL clones in perpendicular north/south rows
  - Spacing: 12.5 x 25 ft. or 140 trees/acre
- Data:
  - 2018/19: Yield, juice quality, cumulative Yield, PS/tree, HLB PCR Ct values
  - 2019/20: Yield, juice quality, cumulative Yield, PS/tree, HLB PCR Ct values

- TRIAL STATUS: ACTIVE

Table 2. St. Cloud Demonstration Planting: Yield [box/tree] and cumulative yield for seasons 2018/19 and 2019/20.

	SCION																							
Yield [Box/Tree]	**OLL4**			**OLL5**			**OLL7**			**OLL8**			**OLL9**			**OLL10**			**OLL6**			**OLL 20**		
ROOTSTOCK	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**	**2018/19**	**2019/20**	**cum**
Orange 14	1.8	1.6	3.4	1.3	2.3	3.5	2.0	2.3	4.3	2.2	2.6	4.8	1.0	1.5	2.5	1.8	1.5	3.3	1.8	2.1	3.9	0.9	1.5	2.4
UFR-2 [Orange 4]	0.5	1.8	2.3	1.0	2.1	3.1	1.5	1.5	3.0	1.8	2.1	3.9	0.4	0.5	0.9	1.3	1.5	2.8	1.6	2.4	4.0	1.8	2.3	4.1
UFR-5 [White 4]	1.5	1.6	3.1	1.8	2.4	4.1	1.5	1.3	2.8	2.5	1.9	4.4	0.8	1.3	2.0	2.1	1.4	3.5	1.3	1.5	2.8	0.6	0.6	1.3
Orange 16	2.3	2.0	4.3	1.6	1.9	3.5	1.4	1.4	2.8	2.0	1.6	3.6	0.5	0.8	1.3	1.5	1.8	3.3	1.8	1.3	3.0	0.6	0.8	1.4
White 1	2.0	1.8	3.8	1.5	2.1	3.6	1.5	2.0	3.5	1.8	1.6	3.4	0.4	0.9	1.3	1.0	1.5	2.5	1.1	1.3	2.4	1.1	1.4	2.5
UFR-4 [Orange 19]	1.9	1.8	3.6	1.3	2.4	3.6	2.0	2.0	4.0	1.3	1.6	2.9	0.1	0.3	0.4	0.6	1.6	2.3	0.9	1.5	2.4	1.9	1.0	2.9
UFR-1 [Orange 3]	1.8	1.9	3.6	1.0	2.4	3.4	1.8	1.9	3.7	2.0	1.8	3.8	0.5	0.9	1.4	1.5	0.9	2.4	1.0	1.3	2.3	0.5	0.9	1.4
UFR-6 [Chang+50-7]	1.3	1.6	2.9	1.3	1.4	2.6	1.8	1.5	3.3	1.3	1.1	2.4	0.9	1.3	2.1	1.0	1.0	2.0	0.6	0.8	1.4	0.9	1.0	1.9
x639	1.5	1.8	3.3	1.5	1.8	3.3	1.8	1.5	3.3	1.3	1.3	2.5	0.1	0.5	0.6	1.0	1.5	2.5	0.7	1.0	1.7	0.7	0.5	1.2
UFR-17 [Green 2]	1.3	1.3	2.5	1.8	0.8	2.5	2.9	1.6	4.5	1.0	0.9	1.9	0.1	0.8	0.9	0.8	1.6	2.4	0.6	1.3	1.9	0.6	0.8	1.4
Orange 13	0.8	1.1	1.9	0.8	1.9	2.6	1.0	1.4	2.4	1.0	0.9	1.9	0.8	0.4	1.1	1.5	1.3	2.8	0.6	0.8	1.4	0.7	1.0	1.7
UFR-3 [Orange 15]	0.9	1.5	2.4	0.5	1.6	2.1	0.9	1.3	2.1	0.9	1.0	1.9	0.9	1.0	1.9	1.4	0.3	1.6	0.8	0.8	1.5	0.6	1.3	1.9
Carrizo	1.3	1.0	2.3	0.6	1.1	1.8	1.8	1.8	3.6	1.3	0.9	2.1	0.3	0.5	0.8	0.6	0.8	1.4	0.3	0.5	0.8	0.6	0.8	1.4
Green 7	1.3	1.1	2.4	1.1	1.4	2.5	1.5	1.0	2.5	0.5	0.0	0.5	0.5	0.6	1.1	1.5	1.1	2.6	0.6	0.8	1.4	0.4	0.4	0.8
White 3	1.0	1.5	2.5	0.9	1.1	2.0	1.1	1.3	2.4	0.8	1.1	1.9	0.4	0.8	1.1	0.6	0.8	1.4	0.6	0.6	1.3	0.8	0.3	1.0
AMB+Carrizo	1.0	1.0	2.0	1.5	1.3	2.8	0.9	1.4	2.2	0.5	0.5	1.0	0.3	0.6	1.0	1.0	1.3	2.3	0.5	0.6	1.1	0.4	0.3	0.6
Swingle	1.0	1.3	2.3	0.5	1.3	1.8	1.0	1.0	2.0	1.0	1.3	2.3	0.0	1.3	1.3	0.0	0.8	0.8	0.5	1.0	1.5	0.5	0.5	1.0
Orange 2	0.8	0.8	1.5	1.4	0.0	1.4	0.9	0.0	0.9	1.3	1.0	2.3	0.8	1.0	1.8	0.1	0.0	0.1	0.6	0.0	0.6	0.8	0.3	1.0

*Note that the original OLL-20 tree was the first among the somaclones to become infected with *Clas*, showing strong symptoms before the other clones; thus the budwood used to propagate the trial trees probably had a higher titer of Clas to start with.

Table 6. Orie Lee trial – 2018/19 & 2019/20 and 2-year cumulative PS/box by scion and rootstock.

Scion	Rootstock	2018/19	2019/20	2-year cum	Scion	Rootstock	2018/19	2019/20	2-year cum	Scion	Rootstock	2018/19	2019/20	2-year cum
OLL8	AMB+Carrizo	6.4	7.0	13.4	OLL20	AMB+Carrizo		7.0		OLL4	x639	6.1		
	Carrizo	7.4	7.1	14.5		UFR-6 [Chang+50-7]		7.7			AMB+Carrizo	6.9		
	Green 2	6.5	6.3	12.8		Carrizo		6.6			Carrizo	6.9		
	Green 7	6.9	na	6.9		Green 2		5.8			Green 7	6.6		
	Orange 13	6.7	6.8	13.4		Green 7		7.0			Orange 13	6.4		
	Orange 14	6.1	6.5	12.5		UFR-5 [White 4]	6.6	5.8	12.4		Orange 14	6.1		
	Orange 16	6.7	6.9	13.5		Orange 13		6.1			Orange 16	6.2		
	Orange 2	6.8	6.8	13.6		Orange 14		5.6			Orange 2	7.3		
	Swingle	6.9	6.6	13.5		UFR-3 [Orange 15]		6.9			Swingle	7.1		
	UFR-1 [Orange 3]	6.6	7.1	13.7		Orange 16		7.0			UFR-1 [Orange 3]	6.8		
	UFR-2 [Orange 4]	6.5	6.5	13.1		UFR-4 [Orange 19]		6.4			Green 2	6.3		
	UFR-3 [Orange 15]	6.5	6.6	13.1		Orange 2		7.5			UFR-2 [Orange 4]	5.6		
	UFR-4 [Orange 19]	6.9	7.1	14.0		UFR-1 [Orange 3]		6.6			UFR-3 [Orange 15]	5.9		
	UFR-5 [White 4]	6.9	6.9	13.7		UFR-2 [Orange 4]		6.2			UFR-4 [Orange 19]	6.3		
	UFR-6 [Chang+50-7]	7.7	7.4	15.0		Swingle		6.5			UFR-5 [White 4]	7.1	7.2	14.3
	White 1	6.6	6.8	13.4		White 1		7.0			UFR-6 [Chang+50-7]	6.8		
	White 3	6.8	6.6	13.5		x639		5.6			White 1	6.9		
	x639	7.0	6.4	13.3		White 3		7.3			White 3	6.8		

Scion	Rootstock	2018/19	2019/20	2-year cum
OLL5	UFR-5 [White 4]	6.6	6.5	13.2
OLL6	UFR-5 [White 4]	7.2	6.9	14.1
OLL7	UFR-5 [White 4]	6.6	6.5	13.1
OLL9	UFR-5 [White 4]	6.7	6.8	13.5
OLL10	UFR-5 [White 4]	7.0	7.1	14.1

Table 7 . Orie Lee trial - 2018-19 & 2019-20 Ct Value** by scion for all rootstocks [table is color coded according to the Ct value diagnosis table].

Scion/RSTK	OLL 20		OLL 10		OLL 05		OLL 04		OLL 07		OLL 06		OLL 08		OLL 09		Overall			
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19		2019-20	
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	SD	Mean	SD
UFR-3 [Orange 15]	27	40	30	40	28	38	33	37	29	30	33	31	27	30	27	35	29	3	35	4
Orange 2	27	37	29	33	NA*	40	27	29	32	NA	26	NA	26	31	24	37	27	10	34	16
Orange 13	26	38	39	36	28	37	30	31	34	32	33	30	31	26	29	34	31	4	33	4
UFR-4 [Orange 19]	37	36	35	33	40	36	35	36	37	32	33	30	40	28	35	28	36	2	32	3
Orange 16	33	35	39	34	36	34	29	39	26	30	28	26	31	27	32	34	32	4	32	4
Orange 14	27	35	24	31	30	36	28	33	25	36	26	28	34	30	26	27	27	3	32	4
White 1	33	33	27	32	25	31	28	38	32	37	26	28	39	31	29	27	30	5	32	4
White 3	31	34	27	37	26	36	32	33	28	33	25	28	25	27	29	28	28	3	32	4
UFR-17 [Green 2]	27	30	24	37	27	32	31	28	25	33	29	37	31	29	29	27	28	3	32	4
UFR-2 [Orange 4]	33	37	32	32	24	30	40	31	33	30	40	30	33	30	40	32	34	5	32	3
Green 7	36	34	36	28	40	29	37	30	32	36	35	32	40	34	35	29	36	3	31	3
UFR-5 [White 4]	29	30	25	33	26	34	33	32	29	36	26	33	26	28	26	25	28	3	31	4
UFR-1 [Orange 3]	31	30	27	36	32	37	26	33	30	30	33	27	35	30	27	27	30	3	31	4
AMB+Carrizo	30	31	27	31	33	29	27	31	26	32	32	29	24	35	29	30	29	3	31	2
x639	40	32	39	31	38	36	40	35	40		35	25	40	27	35	27	38	2	30	4
Carrizo	31	37	28	35	30	30	39	30	28	27	26	27	28	28	33	28	30	4	30	4
UFR-6 [Chang+50-7]	29	30	32	34	32	30	33	32	39	29	31	28	40	30	28	27	33	4	30	2
Swingle	40	29	40	37	40	28	40	28	40		32	28	40	27	35	27	38	3	29	4
Mean	**31**	**34**	**31**	**34**	**32**	**33**	**33**	**33**	**31**	**32**	**31**	**29**	**33**	**29**	**30**	**29**	**31**	**4**	**32**	**4**

(*) NA: no data available

(**) Southern Gardens diagnostic lab, PCR analysis, mean of 2 trees, for each scion/rootstock combination.

Ct Value	Diagnosis
< 30	HLB Positive
30-32	Questionable
> 32	HLB Negative

Take Home Messages from OLL/Rootstock Trial:

- The combination of good scion/rootstock genetics and optimal nutrition can result in good yields with excellent fruit quality, with no psyllid control on producing trees.

- OLL's do well on UFR-1, UFR-2, UFR-4, UFR-5 and UFR-6; OLL-20 yields best on UFR-2. OLL-20 produced 7.7 lbs. solids on UFR-6!

- Orange 14 and Orange 16 merit consideration for commercial release.

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Can new rootstocks in the citrus breeding pipeline confer resistance to susceptible scions?

MAYBE!

Especially if trees are grown with optimized nutrition. Stay tuned!

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Table 1. Roostock candidates testing qPCR negative at least 3/5 times, trees 3.5-7 years in field at USDA Picos Farm with high psyllid pressure, planted with *CLas*-infected Valencia sweet orange scion. All trees but the first rootstock listed tested *CLas* positive during the 2018-2019 season. Results from NIFA-SCRI supported rootstock breeding project, PCR run by Southern Gardens Diagnostic Laboratory; root samples run by Cano laboratory, IRREC.

Row	Tree	Rootstock	leight	alth Inc	l_ct_D	Diagnosis_Dec	al_ct_Ja	Diagnosis_Jan	al_ct_Fe	Diagnosis_Feb	al_ct_Ma	Diagnosis_Mar	al_ct_Ap	Diagnosis_Apr	**Ct_Roots**	**Diagnosis_Roo**
13	57	MILAM-HBP x Orange 4	6	4	30.61	Questionable	33.36	No HLB Found	31.79	Questionable	33.66	No HLB Found	31.95	Questionable	Undetermined	No HLB found
13	58	C-2-5-12 x C. Latipes-13-75	5.5	4	27.71	HLB Positive	33.02	No HLB Found	32.12	No HLB Found	29.08	HLB Positive	30.58	Questionable	Undetermined	No HLB found
13	62	A-HBP x SORP-13- 72	5	4	31.68	Questionable	40.00	No HLB Found	30.71	Questionable	28.38	HLB Positive	26.44	HLB Positive	Undetermined	No HLB found
13	68	C-2-5-12 x C. Latipes-13- 44	6	4	30.10	Questionable	34.16	No HLB Found	30.23	Questionable	29.34	HLB Positive	29.33	HLB Positive	Undetermined	No HLB found
13	72	A-HBP x White 1-13- 13	6.5	4	33.17	No HLB Found	35.60	No HLB Found	26.97	HLB Positive	28.03	HLB Positive	32.56	No HLB Found	Undetermined	No HLB found
13	76	C-2-5-12 x C. Latipes-13- 5	7	4	30.22	Questionable	34.42	No HLB Found	29.70	HLB Positive	29.29	HLB Positive	31.22	Questionable	Undetermined	No HLB found
13	109	C-2-5-12 x C. Latipes-13-1	5.5	3	27.52	HLB Positive	31.80	Questionable	29.61	HLB Positive	30.03	Questionable	30.42	Questionable	Undetermined	No HLB found
13	116	A-HBP x SORP-13- 79	6	4	37.28	No HLB Found	40.00	No HLB Found	37.21	No HLB Found	33.34	No HLB Found	27.34	HLB Positive	Undetermined	No HLB found
13	129	A-HBP x White 1-13- 20	6	4	33.67	No HLB Found	34.98	No HLB Found	30.28	Questionable	34.53	No HLB Found	30.48	Questionable	Undetermined	No HLB found
13	167	Orange 15 mutation 34-4X	7	4	40.00	No HLB Found	35.00	No HLB Found	27.66	HLB Positive	31.89	Questionable	32.05	No HLB Found	Undetermined	No HLB found
13	172	C-2-5-12 x C. Latipes-13- 74	3.5	4	30.95	Questionable	33.45	No HLB Found	33.42	No HLB Found	32.94	No HLB Found	28.65	HLB Positive	Undetermined	No HLB found
13	173	A-HBP x SORP-13- 48	4.5	3	33.30	No HLB Found	29.03	HLB Positive	26.35	HLB Positive	33.10	No HLB Found	30.54	Questionable	Undetermined	No HLB found
13	180	C-2-5-12 x C. Latipes-13- 11	7	4	31.85	Questionable	27.84	HLB Positive	30.51	Questionable	28.93	HLB Positive	32.82	No HLB Found	Undetermined	No HLB found
13	183	A-HBP x SORP-13- 10	6.5	4	40.00	No HLB Found	31.78	Questionable	32.36	No HLB Found	28.11	HLB Positive	31.13	Questionable	Undetermined	No HLB found
13	193	A-HBP x SORP-13- 60	4	3	40.00	No HLB Found	34.83	No HLB Found	27.27	HLB Positive	32.15	No HLB Found	31.76	Questionable	Undetermined	No HLB found
19	91	MILAM+HBP X ORANGE 14-09-4	5.5	4	34.11	No HLB Found	30.82	Questionable	30.75	Questionable	30.03	Questionable	26.47	HLB Positive	Undetermined	No HLB found
19	86	46 X 31-00-S10 X US812-11-2	5	3	37.39	No HLB Found	33.93	No HLB Found	36.16	No HLB Found	30.43	Questionable	26.58	HLB Positive	Undetermined	No HLB found
19	74	A+HBJL-2B X ORANGE 19 -09-18	3	3	36.42	No HLB Found	26.95	HLB Positive	26.39	HLB Positive	32.48	No HLB Found	30.03	Questionable	Undetermined	No HLB found
19	113	A+VOLK-ORANGE19-11-21	6	4	38.16	No HLB Found	31.43	Questionable	29.25	HLB Positive	25.11	HLB Positive	34.53	No HLB Found	Undetermined	No HLB found
19	122	S10 x S11-11-S19	5	4	29.96	HLB Positive	31.09	Questionable	32.76	No HLB Found	29.84	HLB Positive	30.53	Questionable	Undetermined	No HLB found
19	127	A+VOLK X ORANGE19-11-5	4	4	29.10	HLB Positive	32.85	No HLB Found	28.32	HLB Positive	31.73	Questionable	30.04	Questionable	12.98582649	HLB Positive
19	132	A+VOLK-19-11-8	7	3	30.17	Questionable	32.16	No HLB Found	34.66	No HLB Found	29.35	HLB Positive	30.00	HLB Positive	31.84209633	No HLB found
19	181	A+HBP X CH-50-7-12-11	5.5	3	33.25	No HLB Found	28.45	HLB Positive	32.51	No HLB Found	30.28	Questionable	33.32	No HLB Found	33.76468002	No HLB found
19	182	A+HBP X CH-50-7-12-8	3	4	39.10	No HLB Found	32.95	No HLB Found	32.34	No HLB Found	25.77	HLB Positive	29.55	HLB Positive	Undetermined	No HLB found
29	132	S10 X x639-12-31	5	4	27.04	HLB Positive	30.56	Questionable	33.38	No HLB Found	31.15	Questionable	28.72	HLB Positive	Undetermined	No HLB found
29	138	S10 X S15-12-51	5	4	30.54	Questionable	33.17	No HLB Found	28.74	HLB Positive	29.41	HLB Positive	32.27	No HLB Found	Undetermined	No HLB found
29	148	Orange 10 X Orange 4-12-2	3.5	3	27.18	HLB Positive	31.04	Questionable	31.40	Questionable	29.78	HLB Positive	30.90	Questionable	Undetermined	No HLB found
29	152	A-HBP X CH-50-7-12-40	4.5	4	26.30	HLB Positive	35.00	No HLB Found	30.52	Questionable	32.76	No HLB Found	28.92	HLB Positive	Undetermined	No HLB found
29	157	A-8-1-99-4A X Orange 15-12-35	4.5	4	26.25	HLB Positive	33.72	No HLB Found	39.19	No HLB Found	33.21	No HLB Found	30.95	Questionable	Undetermined	No HLB found
29	175	N-HBP X Orange 19-12-3	4.5	3	31.57	Questionable	33.04	No HLB Found	31.53	Questionable	25.56	HLB Positive	29.93	HLB Positive	Undetermined	No HLB found
29	184	S10 X x639-12-13	5	3	33.60	No HLB Found	31.55	Questionable	28.15	HLB Positive	31.76	Questionable	32.01	No HLB Found	Undetermined	No HLB found

Possible Resistance via the rootstock?

Figure 2. 2-year old ‘gauntlet’ tree of Valencia/Sugar Belle x S13-15-16, infected with *CLas* before planting – note massive healthy new flush, typical of pre-HLB tree. Psyllids have also been observed on every new flush since planting.

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To the late HALL OF FAME CITRUS GROWER-RESEARCHER
And Outstanding Industry Collaborator Mr. Orie Lee

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