Working to Provide Sustainable Yields of Higher Quality Fruit – New Scion and Rootstock Selections in the UF-CREC Pipeline

Jude Grosser & Fred Gmitter
Welcome: John Chater!

UF/CREC Lake Alfred

UF IFAS
UNIVERSITY of FLORIDA

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. **Current and future replanting should be only with varieties that put improved products into the marketplace!**

Left: juice from OLL-8:

Right: Florida NFC purchased at Publix

UF IFAS
UNIVERSITY of FLORIDA

UF Sweet Oranges Released

Where did they come from? Not from crosses!

CREC Released Sweet oranges	Source
• B9-65 Valencia	organogenesis, adventive shoot
• OLL-4	somatic embryogenesis from callus
• OLL-8	somatic embryogenesis from callus
• N7-3 ‘Valenfresh’	somatic embryogenesis from protoplasts
• SF14W-62 ‘Valquarius	somatic embryogenesis from protoplasts
• SF11-1-24 MidSweet	budwood irradiation
• N13-32 Hamlin	somatic embryogenesis from protoplasts
• EV-1 Early Valencia	organogenesis, adventive shoot
• EV-2 Early Valencia	somatic embryogenesis from protoplasts

2021 CREC Release	
• OLL-20	somatic embryogenesis from callus

Table 1. Pilot Plant juice data from mid-February (current 2021 season) showing the higher soluble solids and juice color of OLL-8 juice on rough lemon (RL) and Carrizo (CZO) rootstocks, as compared to standard Valencia (4th consecutive year). Fruit was harvested from Orie Lee Family Groves in St. Cloud, FL. At 400 boxes/acre, at $2.50/lb. solid this would translate to $1,000/acre additional profit; and OLL trees also grow off faster than standard Valencia!

Sample ID	Wt. Sample	Wt. Juice	Lbs. Juice Per Box	% Acid	Total Brix	Ratio	Lbs. Solids Per Box	Juice Color
OLL-8/RL	20.88	12.54	54.052	1.03	12.99	12.61	7.02	38.4
VAL / RL	22.06	12.99	52.996	0.82	11.41	13.91	6.05	36.9
OLL-8/CZO	18.27	10.77	53.054	1.09	14.18	13.01	7.52	36.9
VAL/CZ0	16.79	10.14	54.354	0.95	11.41	12.01	6.20	35.9

UF IFAS
UNIVERSITY of FLORIDA

Commercial release encouraged by Tropicana!

New Release OLL-20, exceptional juice flavor, made 7.7 lbs. solids on UFR-6 (Lee Family Groves, no psyllid control)

UF IFAS UNIVERSITY of FLORIDA

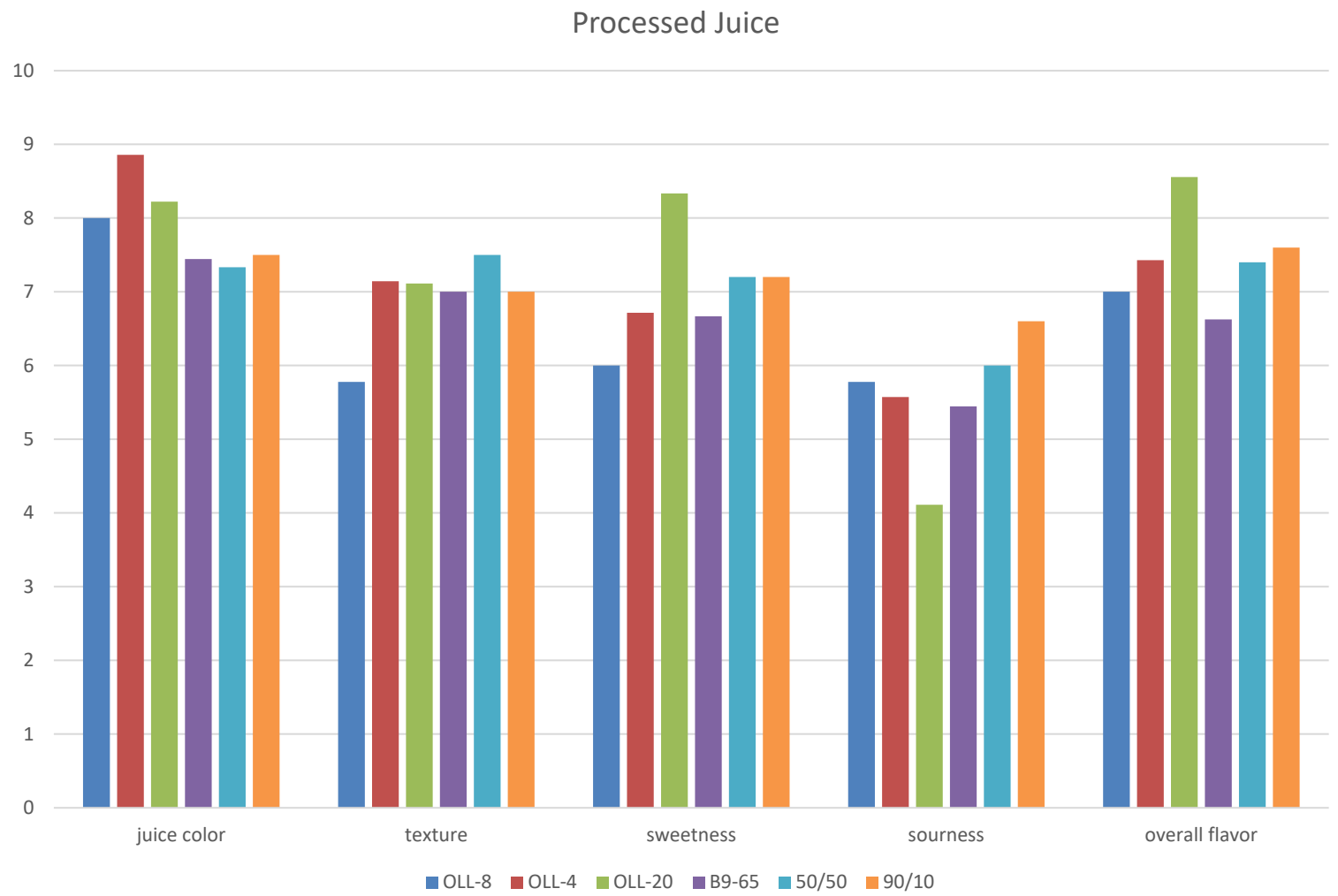


Figure 2. February 19 2019 Juice Display Results (subjective mean scores from display attendees; scale of 0-10 with 10=perfect score). 50/50 is a 1:1 blend of pasteurized Valquarius and LB8-9 Sugar Belle® juice; 90/10 a 9:1 blend of the same.

Fruit/Juice Displays, 4-5 per year; your chance to participate!

February 2022 Juice/Fruit Display; OLL-20 was the favorite; all juice was extracted from fruit harvested from field grown trees in Lake Alfred.

UF Sweet Oranges –Accelerated Entry into PTP for CRDF Scion Trials

Early Vernia Clones (candidates to replace Hamlin)

- MB-26-10 early December maturity Vernia
- MB-25-12 early December maturity Vernia
- MB-26-14 early December maturity Vernia
- MB-25-2 early December maturity Vernia
- MB-25-7 early December maturity Vernia (**higher brix**)

OLL Clones

- OLL-FB-7-35 early-January maturity, high soluble solids OLL
- OLL-FB-9-33 mid-January maturity, high soluble solids OLL
- OLL-FB-4-13 January maturity OLL
- OLL-FB-1-22 high brix, exceptional soluble solids
- OLL-5 highest cumulative yield in trial of original OLL somaclones

Valencia HLB-tolerant Mutants

- Sweet Orange UF RBA-21-36
- Sweet Orange UF RBA-SF

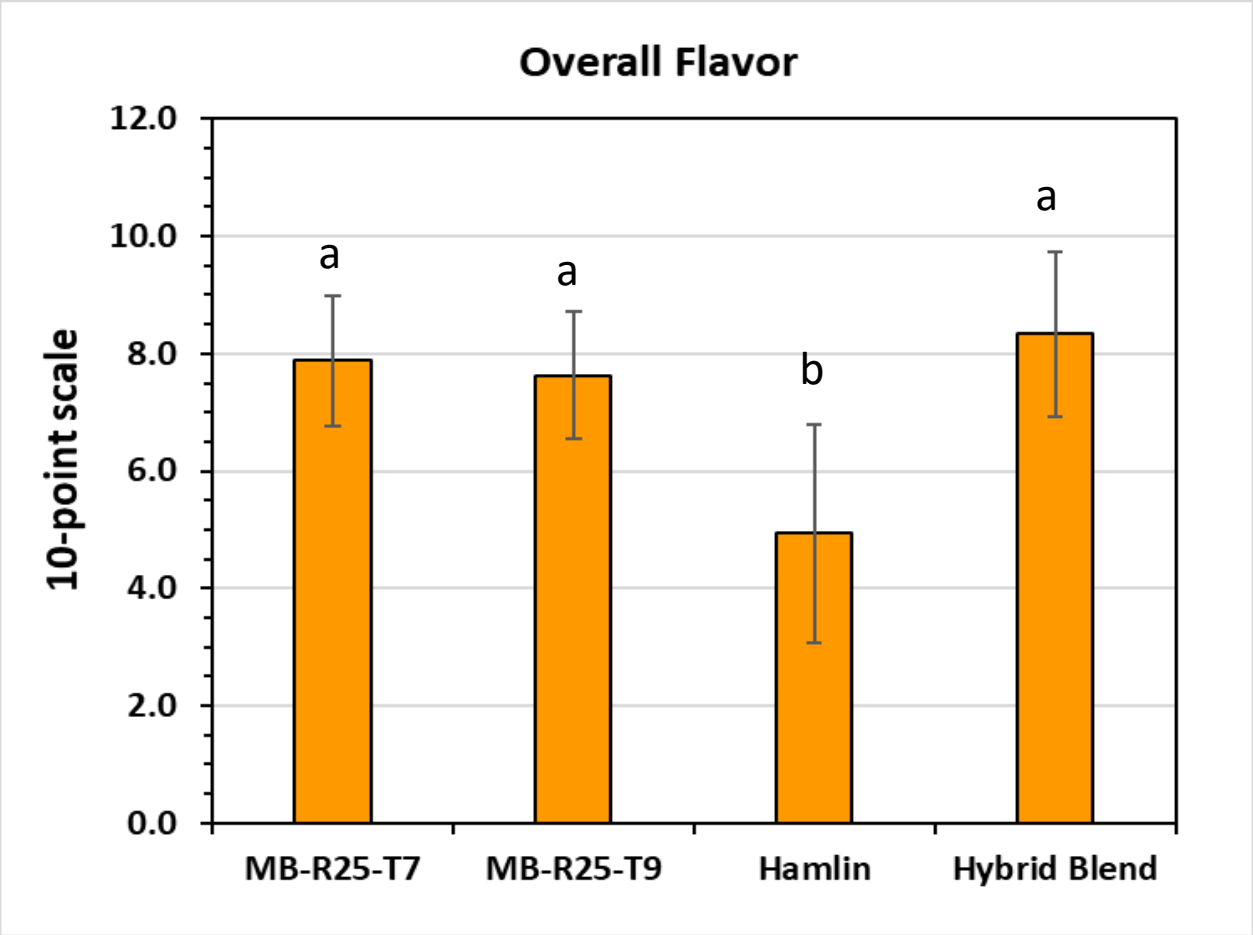
MB-25-7 at Lee Family Groves; no psyllid control

New Vernia Somaclone-Derived Clone MB-R25-T9 selected for December maturity; showing strongest HLB tolerance among 10 early-maturing clones. Trees 9 years old, grown with no psyllid control.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

12/16/2021 Fruit Display: Processed Oranges

Two new early-maturing Vernia clones and a blend out-perform Hamlin for flavor, soluble solids and color!



	Sample ID	No. Boxes	Wt. Sample Lbs.	Wt. Juice Lbs.	Lbs. Juice Per Box	% Acid	Total ° Brix	Ratio	Bin No.	Lbs. Solids Per Box	Juice Color
5	R4T4	1	16.81	10.35	55.413	0.93	13.03	14.01	38	7.2203	38.4
6	R4T5	1	20.32	12.21	54.080	0.71	12.03	16.94	41	6.5058	39.5
7	R4T6	1	15.78	9.70	55.323	0.69	12.52	18.14	33	6.9264	39.0
8	R4T7	1	16.38	9.65	53.022	0.65	10.62	16.34	29	5.6309	39.5
4	R4T12	1	16.02	9.79	55.000	0.88	10.79	12.26	37	5.9345	39.4
9	R5T2	1	18.11	10.71	53.225	0.94	11.97	12.73	49	6.3710	38.8
10	R5T3	1	16.92	10.39	55.266	1.13	12.86	11.38	43	7.1072	38.9
11	R5T33	1	17.94	10.44	52.375	0.85	12.40	14.59	45	6.4945	38.7
14	R6T8	1	17.59	10.75	55.003	0.85	12.14	14.28	47	6.6774	39.1
12	R6T11	1	9.77	5.87	54.074	0.94	11.18	11.89	24	6.0455	38.9
13	R6T32	1	7.15	4.64	58.406	1.06	12.16	11.47	18	7.1022	39.6
15	R7T26	1	16.47	10.11	55.246	0.74	9.11	12.31	36	5.0329	39.0
16	R7T29	1	16.45	9.77	53.453	0.66	11.07	16.77	33	5.9172	40.1
17	R7T35	1	12.92	7.50	52.245	0.60	11.19	18.65	28	5.8462	39.1
18	R9T10	1	18.36	11.03	54.069	1.06	12.27	11.58	60	6.6343	38.7
19	R9T15	1	16.14	9.84	54.870	0.79	11.56	14.63	35	6.3430	39.1
1	R10T19	1	16.03	9.39	52.720	0.85	11.92	14.02	40	6.2842	38.8
2	R10T24	1	15.95	9.37	52.871	0.95	12.14	12.78	43	6.4185	38.7
3	R10T30	1	17.55	10.72	54.974	0.85	11.73	13.80	40	6.4485	38.7

Mid-April harvest

New OLL Somaclone-Derived Clones selected for higher brix;
Trees 8.5 years old, grown with no psyllid control.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

New OLL Somaclone-Derived Clones selected for higher brix;
Trees 8.5 years old, grown with no psyllid control.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Good Hybrid Juice!

December color for blending

Several sweet orange-like hybrids have been selected for OJ improvement and entered into the PTP; some with better HLB tolerance

ie. 1859
3-3-52
KE-6-3
C4-15-50
C7-11-7

Juice analyses Test results

1 1

PAGE _____ OF _____ Customer: **Jude Grosser**

CREC Block **024**

UF/IFAS CITRUS **700 EXPERIMENT STATION ROAD** **Mandarin hyb (342)** **1/24/22**

ADDRESS TYPE FRUIT DATE

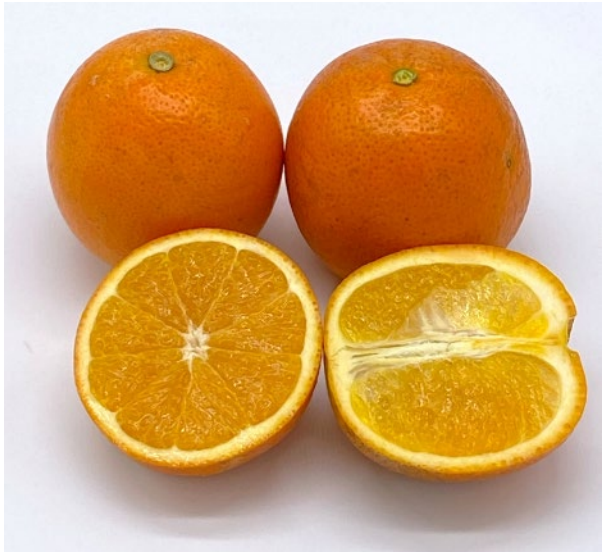
	Sample ID	Variety	No. Boxes	Wt. Sample	Wt. Juice	Lbs. Juice Per Box	Acid	Total Brix	Ratio	Bin No.	Lbs. Solids Per Box	Juice Color
1	**C4-11-50**	**TEMPT**	**1**	**23.12**	**10.41**	**42.775**	**0.76**	**11.68**	**15.37**	**43**	**5.00**	**41.9**
2	**C7-11-7**	**TEMPT**	**1**	**22.60**	**14.26**	**59.942**	**0.92**	**13.87**	**15.08**	**54**	**8.31**	**39.3**

Orange-like hybrid C7-11-7; productive, high solids, seedless hybrid with January maturity. Processing and fresh-fruit potential!

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

UF 1859 Hybrid

- Original tree has good HLB tolerance
- High Brix, tropical flavor notes
- Attractive fruit for fresh market
- Juice processing characteristics TBD
- Included in MAC, topworking, and nursery trials



‘Marathon’

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

- Seedless under all circumstances, and easy to peel
- Good color, good flavor, and segment structure
- Very early maturity, with long on-tree storage capacity
- Firm fruit that may be harvested without clipping, saving labor costs at harvest
- Responds well to ethylene, and performs very well in long term cold storage
- ‘Daisy’ mandarin x ‘Mukaku Kishu’ parentage

Unique Characteristics

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Mandarin hybrid 18A-9-39: a new and distinct late-maturing, nearly seedless and easy-peel mandarin for the fresh market: 'Gator Bites'

'Gator Bites'

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Photos of 18A-9-39 tree with excellent cropping;
showing good HLB tolerance

‘Gator Bites’

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

HLB-tolerant mandarin 18A-8-40. Matures November/December.
Easy-peel and seedless, excellent flavor. Colors on tree, just entered into PTP.
Cutie/Halo-sized fruit, candidate for 'Gator Bites' sequence.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Grapefruit-like hybrid C2-5-3: a new and distinct early season fruit for the fresh market. Reaches 15 ratio late September. More tolerant of HLB than standard grapefruit and also canker tolerant!

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

New HLB-tolerant triploid grapefruit-like hybrids 1924 (left) and 1862 (right). Through PTP later this year.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

CE-D5-1-9-42: one of several seedless lemon selections that also are high oil producers!

LEMON FOR INDUSTRY and FRESH

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Rootstocks

UF IFAS
UNIVERSITY of FLORIDA

The **Ultimate Solution to HLB** is an HLB-resistant rootstock that can transfer it's resistance to any grafted scion!

Such a rootstock would bring the Early Valencias, Hamlin, all grapefruit, the 'Honey' Murcott (now nearly seedless selections available), etc, back into play HLB-risk free!

UF IFAS
UNIVERSITY of FLORIDA

ormal European lobster, and (right) a blue one caught in Scotland in 2011

IFAS
SITY of FLORIDA

The New Gauntlet in the HLB world
High Throughput Screening Method
>16,000 hybrids screened to date

1. Crosses of superior parents made at diploid and tetraploid levels
2. Seed harvested from crosses planted in bins of calcareous soil (pH=8), inoculated with *P. nicotianae* and *P. palmivora* (JH Graham)
3. Selection of robust seedlings based on growth rate, health and color (most don't make it!)
4. Transfer to 4x4 pots in commercial potting soil
5. Top of new tree goes for seed source tree production; remaining liner to the HLB screen
6. Hybrid liner is grafted with HLB-infected budstick of Valencia sweet orange; remaining rootstock top removed, forced flushing from HLB-infected sweet orange budstick
7. Trees monitored for HLB symptoms – healthy appearing trees entered into 'hot psyllid' house for 4 weeks, followed by field planting at Picos Farm (under DPI permit).

2016 Field Planting will include trees on left; featuring 3 superior crosses: C2-5-12 pummelo x papeda; A+HBP x White 1 and A+HBP x sour orange+rangpur. Candidates on left already passed through the 'hot psyllid' house.

Gauntlet Survivor at Picos Farm
–Valencia on Milam+HBP x Orange #14–09–14

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Possible tolerance from SugarBelle in rootstock hybrids?

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. This is one of several rootstocks with SugarBelle as a parent doing well in the ‘gauntlet’ screen.

1-year old ‘gauntlet’ tree of Valencia/SugarBelle x S10-15-9, infected with *Clas* before planting. Most vigorous of 150 ‘gauntlet’ trees planted at the same time, set lots of fruit!

UF IFAS UNIVERSITY of FLORIDA

Is HLB Resistance possible from the rootstock? Selected Gauntlet Trees (all with Valencia scion, planted HLB+) – From best trees

Row/Tree	Rootstock	Root ct	Leaf ct	Ploidy
24-27	C2-4-1x3246x2071-05-16-40	40	**34.7**	2x
24-59	S11x50-7-6-12	40	**37.3**	2x
19-175	N+HBPxOrange19-12-3*	40	30.1	4x
19-6	Green 6xOrange 14-09-24	40	29.8	4x
19-9	Green 6xOrange 14-09-21	40	29.6	4x
19-17	S10xS11-11-S16	40	28	2x
19-127	A+VolkxOrange19-11-5	40	30.9	4x
19-135	B21-R1-T25-11-2	40	30.5	2x
19-137	A+VolkxOrange19-11-1	40	28.4	4x
19-173	8-1-99-2xC-22-12-15	40	29.2	2x
19-187	A+HBPxCH+50-7-12-4	40	31.1	4x
19-92	A+HBJL2BxOrange19-9-7	40	29.5	4x
19-113	A+VolkxOrange19-11-21	40	29.5	4x

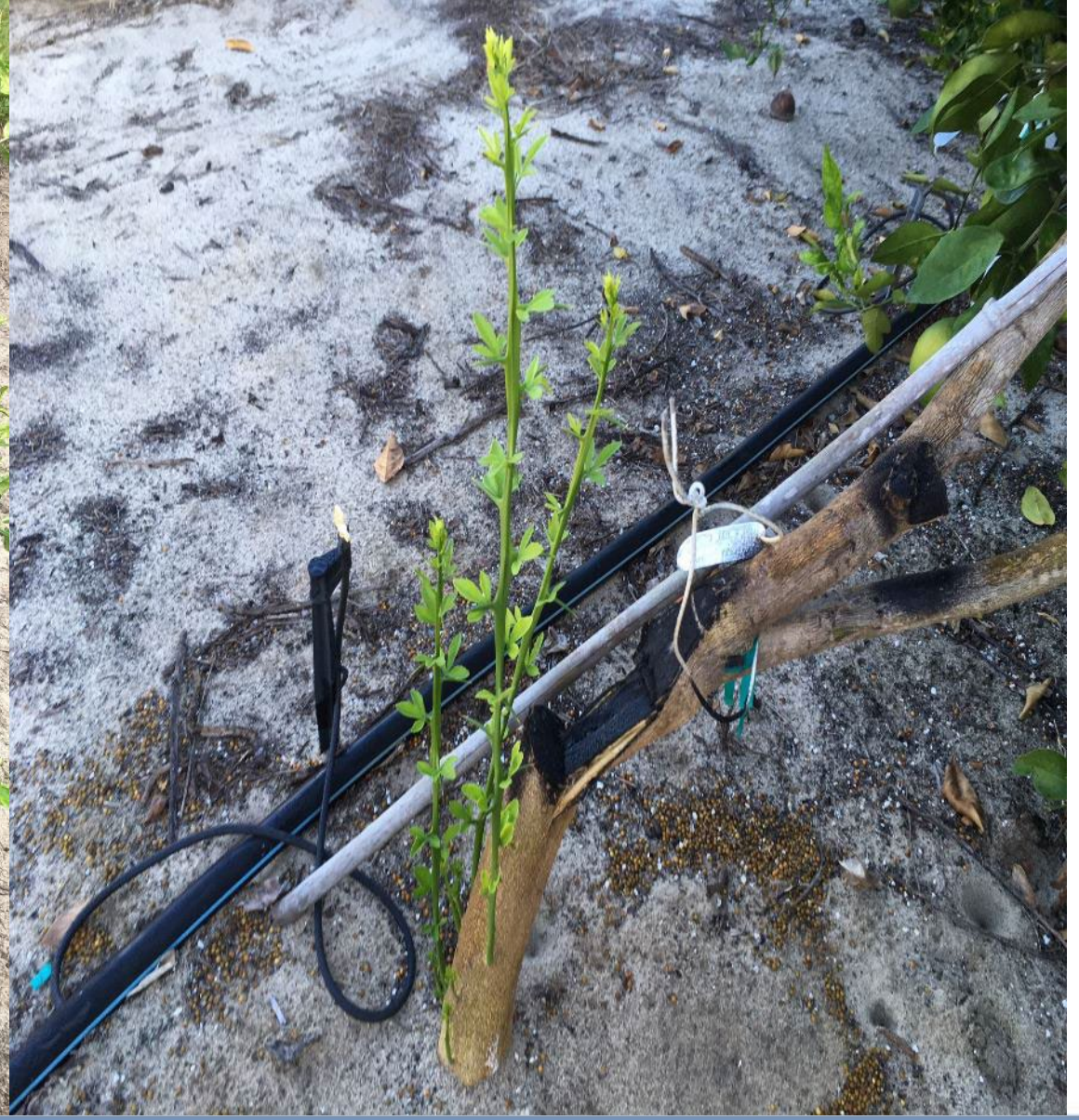
* high brix fruit

Root PCR - Dr. Lili Cano, IRREC;

Leaf PCR – Southern Gardens Diagnostic Laboratory – Mike Irey

1.5 year old Valencia on x639 planted HLB+ under DPI permit.
Putative deletion mutant of x639 (flow cytometry shows DNA missing).

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center



Putative x639 deletion mutant tree cut below graft, sprouts now recovered – no HLB (ct value = 40)!

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Putative x639 deletion mutant tree rescued; grafted tree and 35+ rooted cuttings also produced.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Another exciting source of **Genetic Diversity** being investigated is probable zygotic rootstocks coming from seed sources that produce some zygotic progeny (most commercial rootstocks do this to some degree, some more than others).

SSR Marker Analysis – Paige Holden and Qibin Yu in the Fred Gmitter Lab

Two stellar ‘escape’ trees recently identified in a Hamlin block at Orie Lee Groves, grown with no psyllid control and under very high blight pressure. SSR marker analysis conducted on the roots suggests that both of these are on different unique zygotic rootstocks!

UF IFAS UNIVERSITY of FLORIDA

The Ticket For the Immediate Future

Improved Scion Genetics for HLB Tolerance

Plus

Improved Rootstock Genetics for HLB Tolerance

Plus

Improved Affordable Production Systems w/ Enhanced Root Nutrition

$$ Success $$

Processing Oranges:
Valquarius (mid-season)
Valencia B9-65
OLL-4, 8 & 20

Rootstocks:
UFR-1
UFR-2
UFR-4
UFR-5
UFR-6 (high density plantings)
UFR-7 to 12 (citranges in TC)
UFR-15
UFR-17
USDA selections (Kim Bowman)

What can I plant now?

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

DeLuca Preserve Project – UF/IFAS – Propagations Underway

	Scion	OLL-20	1859	N11-7	Gator Bites	914		Totals
Rootstock								
S10xS15-12-25		218	218	218	218	109		981
LB8-9xS13-15-16		218	109	109	109	109		654
Amb+HBJL2		55		55		54		164
S10xS15-12-34		54						54
S11x60-7-16-6		55						55
LB8-9x50-7-16-4		54						54
A+HBPxCH+50-7-12-11		55						55
UFR-4 (Control)		54						54
STR-4-1 (XXX639)		55						55
A+HBPxWhite 1-13-39		54						54
Totals		872	327	382	327	272		**2180**

Jude Grosser
Fred Gmitter
John Chater

DeLuca Preserve Project – Combines superior new HLB-tolerant rootstock selections with improved processing and fresh-market scions; to be grown with optimized nutrition. Propagations – Agromillora Florida Inc.

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

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

Funding: Lee Family Groves, Hammond Groves, Grants from CRDF, NVDMC and NIFA/SCRI; the late Mr. Jim Hughes; and the Citrus Research and Education Foundation (CREF) for grove support.

Thanks also to: Misty Holt, Dr. Manjul Dutt, Dr. Ahmad Omar, Dr. Lili Cano, Dr. Ute Albrecht, Dr. Anas Fadli, Gary Barthe, JL Chandler, Jim Baldwin, Mauricio Rubio, JoLisa Thompson, Emory McTeer, Maria Quirico, Maria Brenelli, Elaine Moreira, Darien Holt, Derrick Pope, Karen, Plant, Ian DeBarry, Frank Rogers, Dr. Filomena Valim, Dr. Davie Kadyampakeni, Dr. Flavia Zambon, Dr. Arnold Schumann, Dr. Tripti Vashisth, Dr. Evan Johnson, & Dr. Jim Graham and many more. Thanks also to: Cecile Robertson (Dawson lab), Mike Irey and the SG Diagnostic Lab, Roy Sweeb and the CREC Packing House Crew, Diane Bright (Graham lab), Ed Stover and Steve Mayo & the USDA Picos Farm Crew, many others, and especially Troy Gainey and the CREC Grove Crew!

UF UNIVERSITY of FLORIDA
IFAS
Citrus Research and Education Center

Thank You!

UF-CREC Citrus Genetic Improvement Team
2022