

Citrus Scion Breeding at the UF-CREC: Looking Back and Looking Ahead



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September 2019
CRDF Select Committee

- **Overcome the devastation of HLB**
- **Develop new, or recapture old, markets**
 - **Sweet oranges for the juice business**
 - **Mandarin hybrids**
 - **Grapefruit and grapefruit like hybrids**
 - **Acid fruit, e.g. lemons**

Citrus breeding is a continuum, and requires a delicate and common sense balance between short/medium-term and long-term objectives

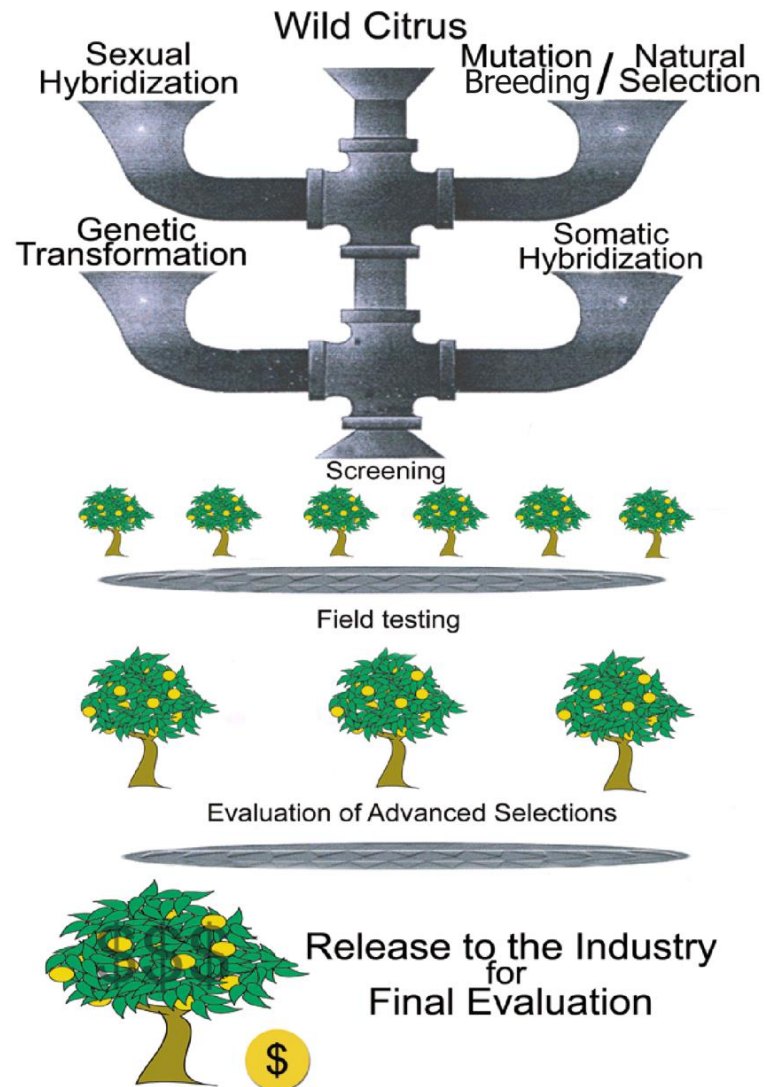
Our Priorities

- **ABOVE ALL, HLB TOLERANCE OR RESISTANCE!**
- **Sweet orange**
 - Extended season of cultivars with Valencia quality juice
 - Sweet orange-like hybrids with orange juice qualities
- **Grapefruit**
 - Improved fruit color
 - Canker resistance
 - Medically friendly
- **Mandarins**
 - Seedless and easy to peel
 - Attractive color and taste
- **Acid fruit**
 - High yielding lemons (fruit and oil)

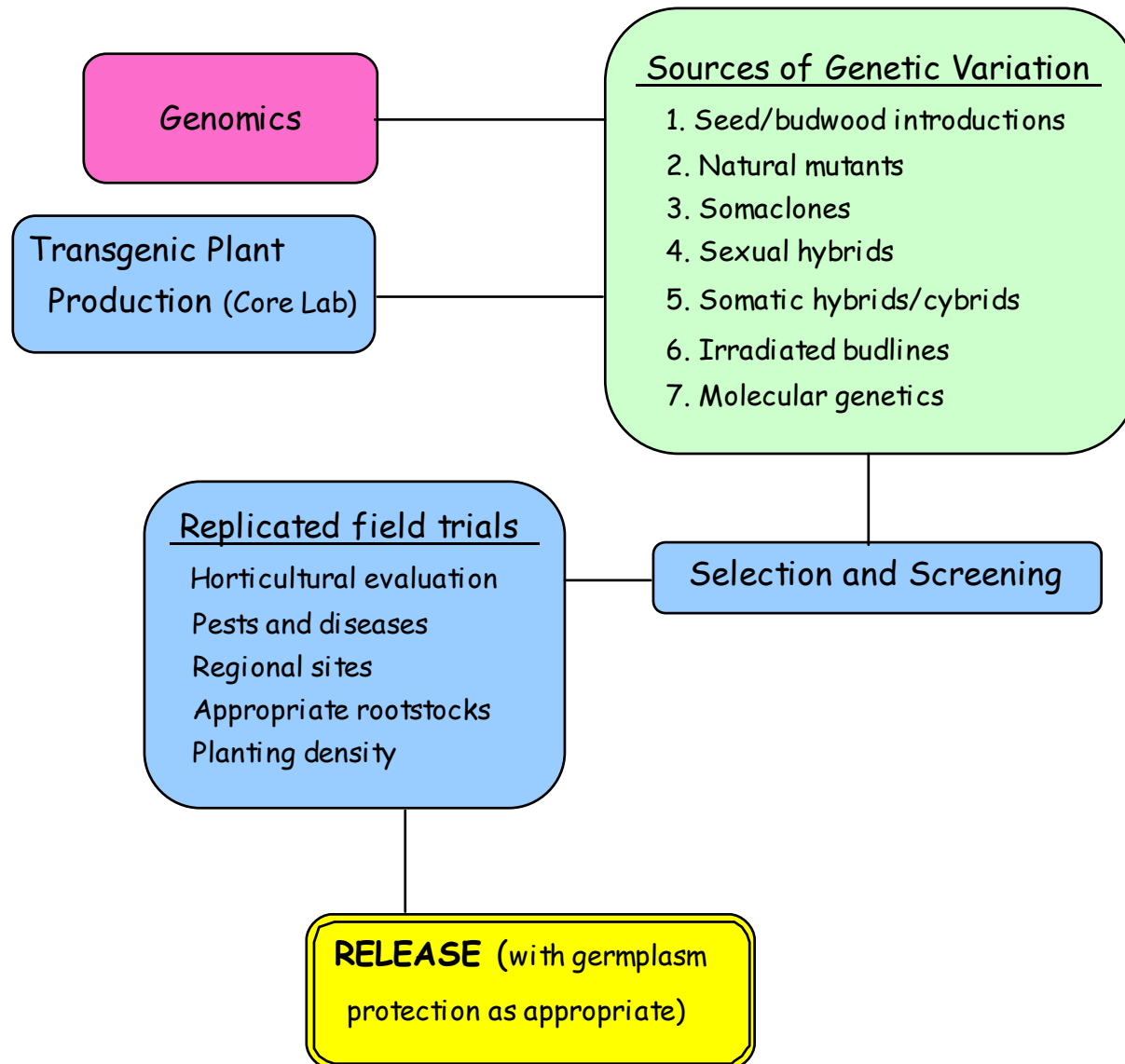
Our Scion Improvement Objectives

- **First somatic hybrids in citrus**
- **First to develop genetic engineering techniques for citrus**
- **First to exploit somaclonal variation for sweet orange**
- **First molecular marker systems for genetic mapping**
- **First publicly available citrus genome sequences**
- **First HLB-tolerant citrus cultivar 'LB8-9' Sugar Belle®**
- **OLL series, UF 914, EV1&2, Bingo, Vernia, 36+ Hamlin...**

Our Track Record



Basic Elements of UF/CREC Citrus Plant Improvement Protocol



- **Current portfolio of Hamlin, Midsweet, and Valencia; is that where we want the future OJ business to be?**
- **New midseason options include Valquarius, Vernia, and an earlier maturing LS Midsweet**
- **Later season, higher quality options include improved clones of Valencia and some of the OLL series**
- **Early season options, not only high colored Hamlin, but now the groundbreaking 'Florida EV 1' and 'Florida EV 2'**

New Sweet Oranges

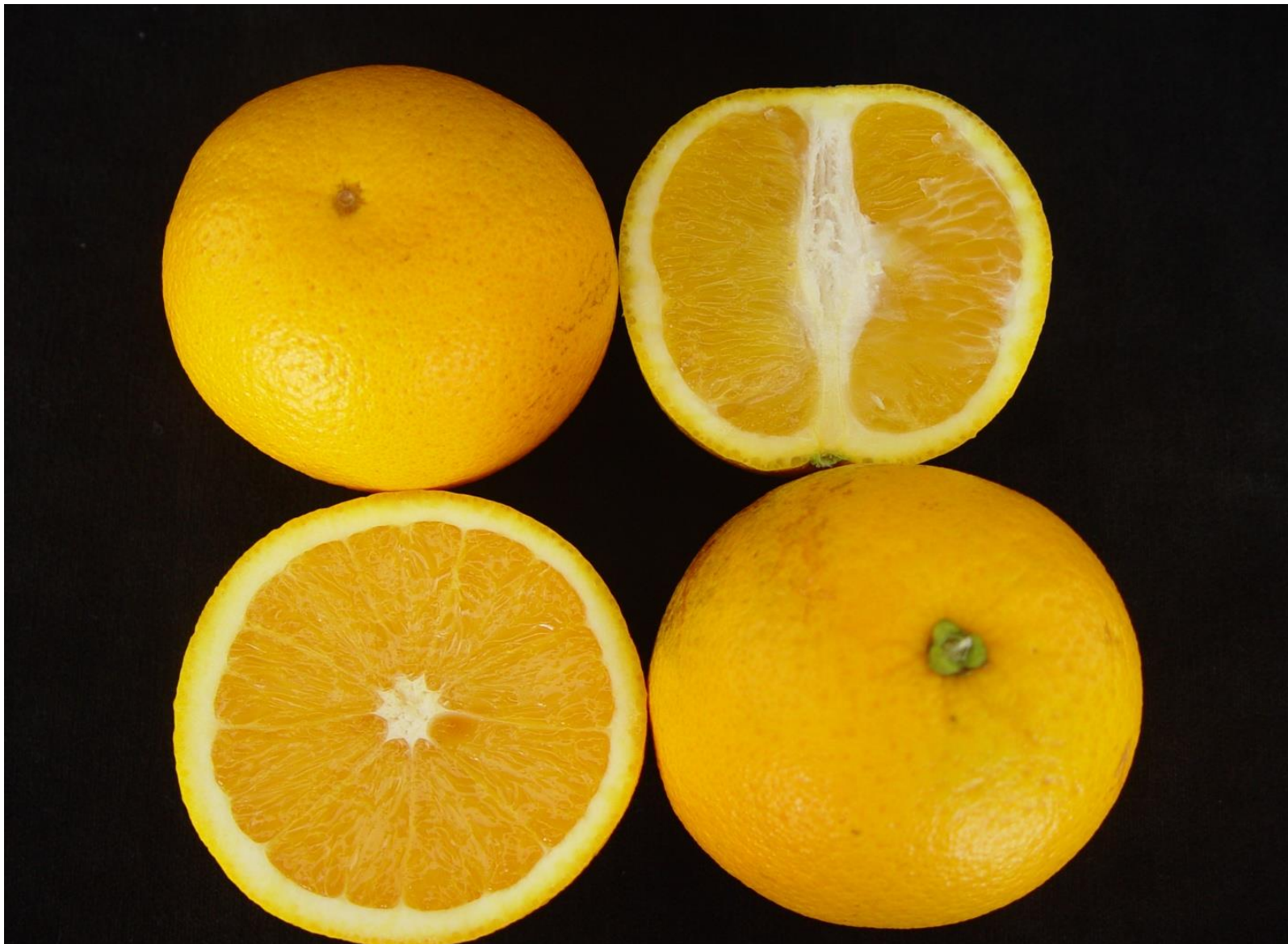
BETTER ORANGES MAKE BETTER JUICE!

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



Valquarius™

ORANGES

'OLL-8'

- Key attributes: Excellent color and quality, extends harvest window of 'Valencia' quality juice
- Produces round oranges with internal and external color similar to 'Rhode Red Valencia'
- Holds on the tree exceptionally well, and maintains quality into the summer
- Trees appear to yield better than standard 'Valencia'
- High juice content and good pounds solids
- Peels easier than a standard 'Valencia'
- With its added color, could also be a valuable addition to the Florida fresh market portfolio
- Most precocious bearing clone among the OLL somaclones



'OLL-4'

- Key attributes: excellent color and quality, extends harvest window of 'Valencia' quality juice; also believed to be higher yielding than 'Valencia'
- Produces fruit with excellent internal and external quality with exceptional juice color scores, juice content and soluble solids
- Holds on the tree exceptionally well
- Maintains quality into the summer; however, it matured earlier, and with better ratios than 'Valencia' in 2014
- Has been the highest yielding tree among the OLL somaclones



OLL-8 on UFR-2 (4 years)



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EV 1 and EV 2

Table 3. Juice data from 6-year old trees on rough lemon rootstock – Alligator Grove, St. Cloud, FL. Pilot-Plant Data from samples run on December 10, 2014.

Variety	Wt. Sample	Wt. Juice	Lbs. Juice Per Box	Acid	Total Brix	Ratio	Fruit Ct	Lbs. Solids	Lbs. Solids Per Box	Juice Color
Vernia	26.83	16.07	53.906	0.87	11.04	12.69	78	5.9512	5.95	35.3
B7-70	26.94	15.24	50.913	0.71	11.30	15.92	61	5.7532	5.75	36
Hamlin	25.36	14.91	52.914	0.94	11.17	11.88	64	5.9105	5.91	34.5
Valuarius	25.69	14.48	50.728	0.84	9.87	11.75	55	5.0069	5.01	35.7
SF14W-65	26.75	14.95	50.299	0.67	11.06	16.51	63	5.5631	5.56	36
TI-19	28.14	16.71	53.443	0.98	9.53	9.72	58	5.0931	5.09	35.4

EV-1 and EV-2 Early Valencias generally reach 15 ratio by Thanksgiving!



New Release OLL-20

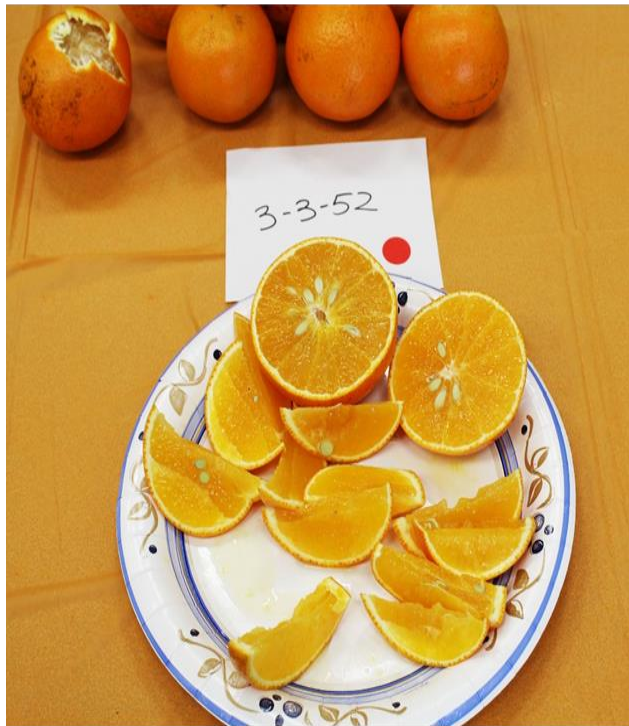


SERENDIPITY



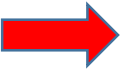

Valencia Mutant

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 2021

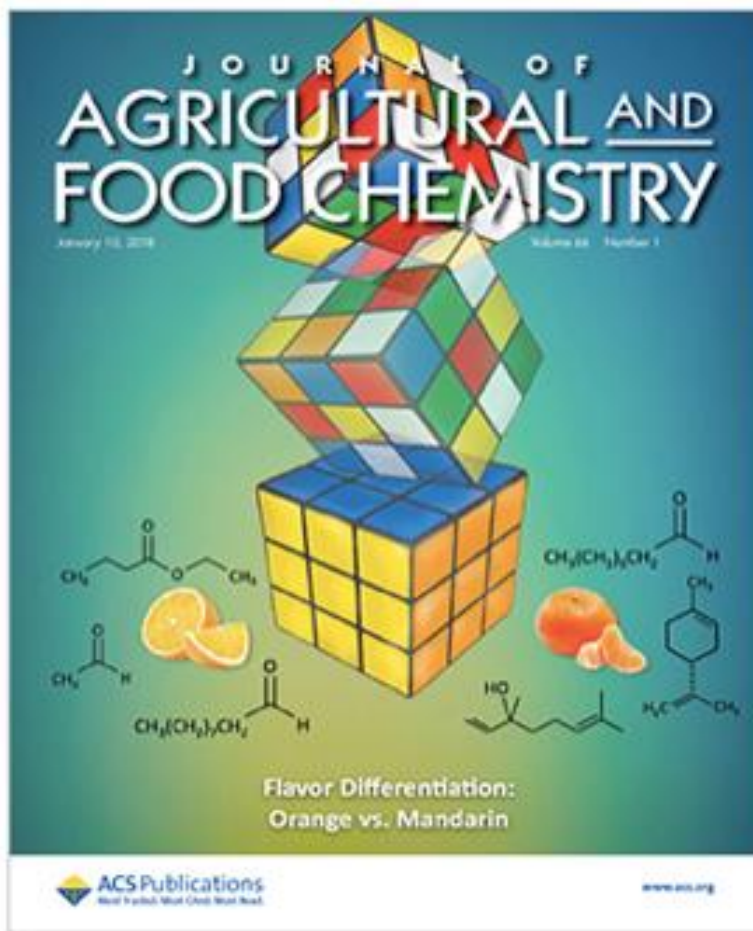


Mac Scion Trial

Nursery “dirty house” summary

	Scion	No HLB Found	Total	% of No HLB
	18A-2-43	86	98	87.76
	3-3-52	26	26	100.00
	6-2-55	55	63	87.30
	7-9-31	26	28	92.86
	C4-14-51	64	115	55.65
	C4-14-53	58	92	63.04
	C7-12-19	78	81	96.30
	18A-2-31	52	90	57.78
	LB9-4	56	75	74.67
	OLL-DCS-3-36	45	45	100.00
	OLL-DCS-3-40	99	101	98.02
	RBA-21-36	44	47	93.62
	RBA-22-29	68	68	100.00
	Total	757	929	

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About the Cover:

Sweet orange and mandarin fruits are consumed worldwide. In this study, we preliminarily decoded the characteristic flavor differences between them. Ethyl butanoate, ethyl 2-methylbutanoate, octanal, decanal, and acetaldehyde were revealed to be essential for orange-like aroma, whereas linalool, octanal, α -pinene, limonene, and (*E,E*)-2,4-decadienal were considered key components for mandarin-like aroma.

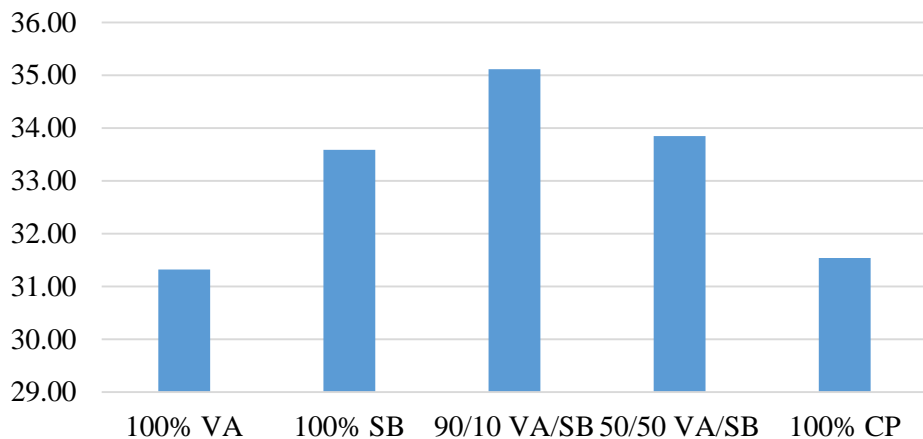
[View the article.](#)

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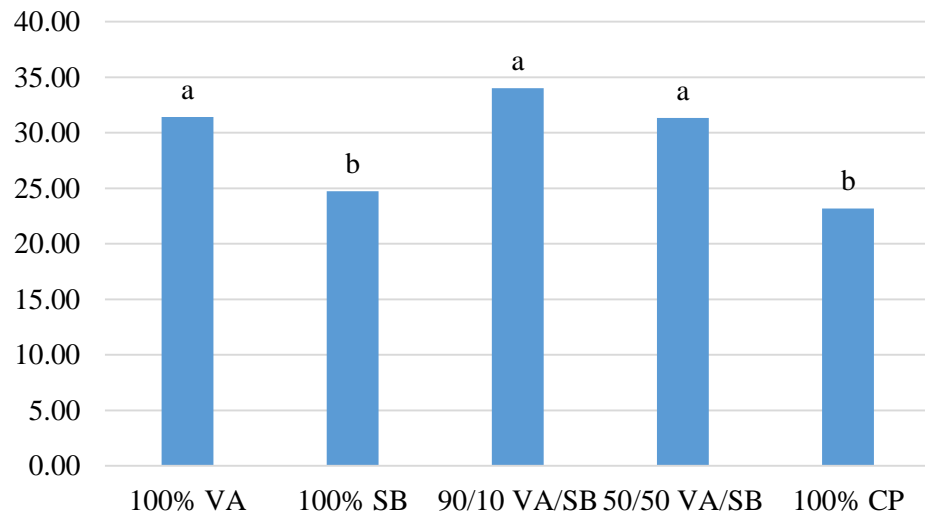
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From the lab of Dr. Yu Wang-CREC

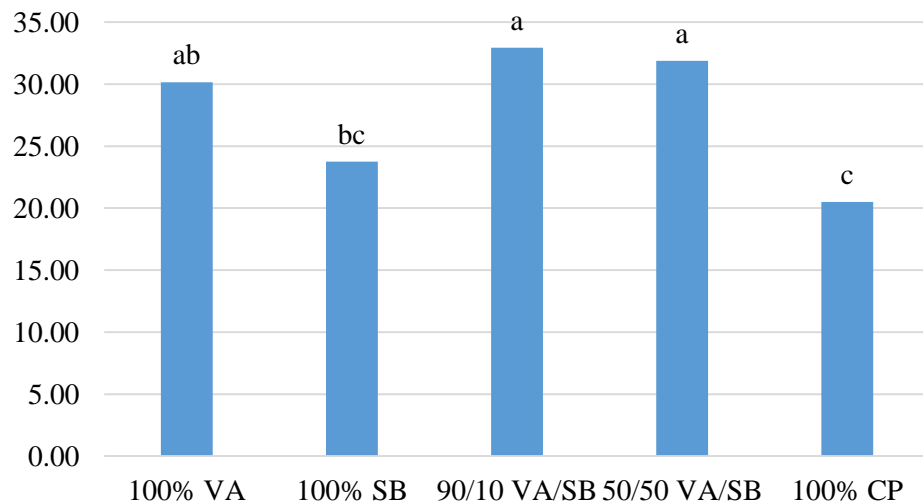
Overall Appearance



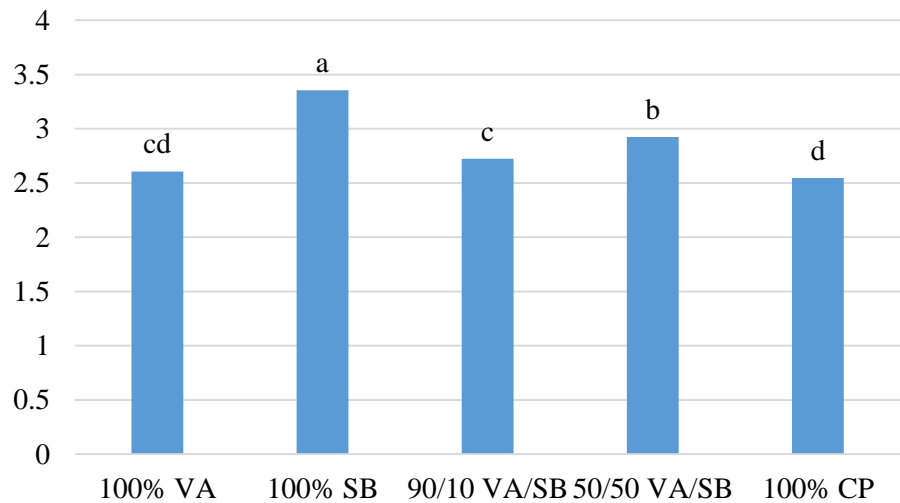
Overall Liking



Overall Flavor Liking

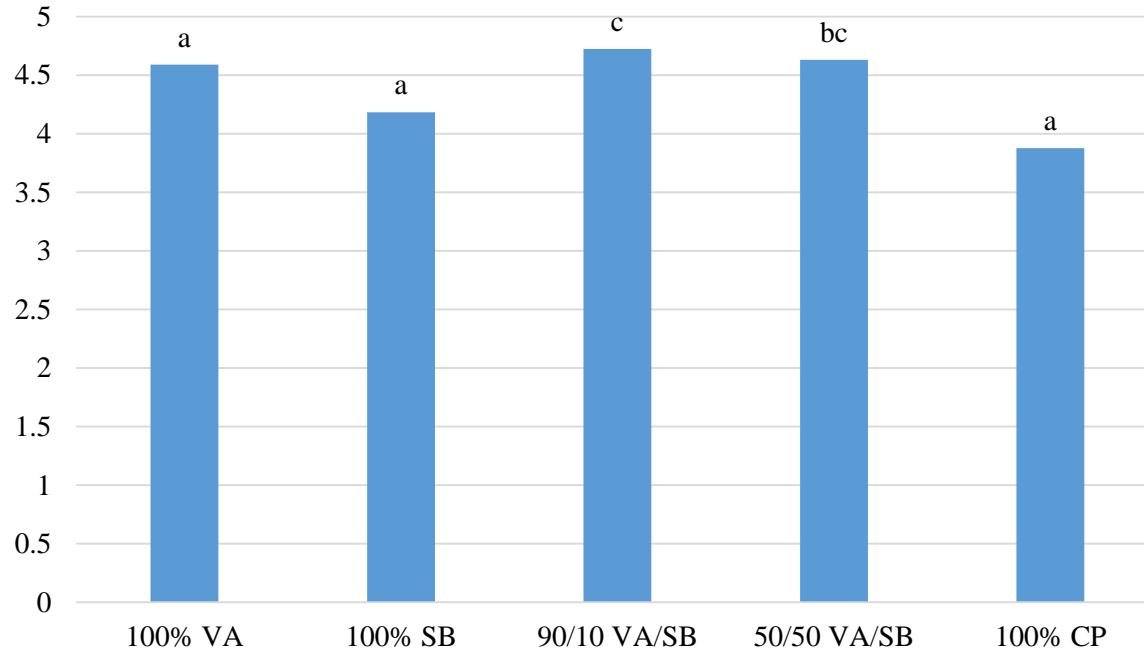


Color



100% VA: 100% Valquarius; 100% SB: 100% Sugar Belle; 90/10 VA/SB: 90% Valquarius & 10% Sugar Belle; 50/50 VA/SB: 50% Valquarius & 50% Sugar Belle; 100% CP: 100% commercial product.

Price willingness to pay



100% VA: 100% Valquarius; 100% SB: 100% Sugar Belle; 90/10 VA/SB: 90% Valquarius & 10% Sugar Belle; 50/50 VA/SB: 50% Valquarius & 50% Sugar Belle; 100% CP: 100% commercial product.

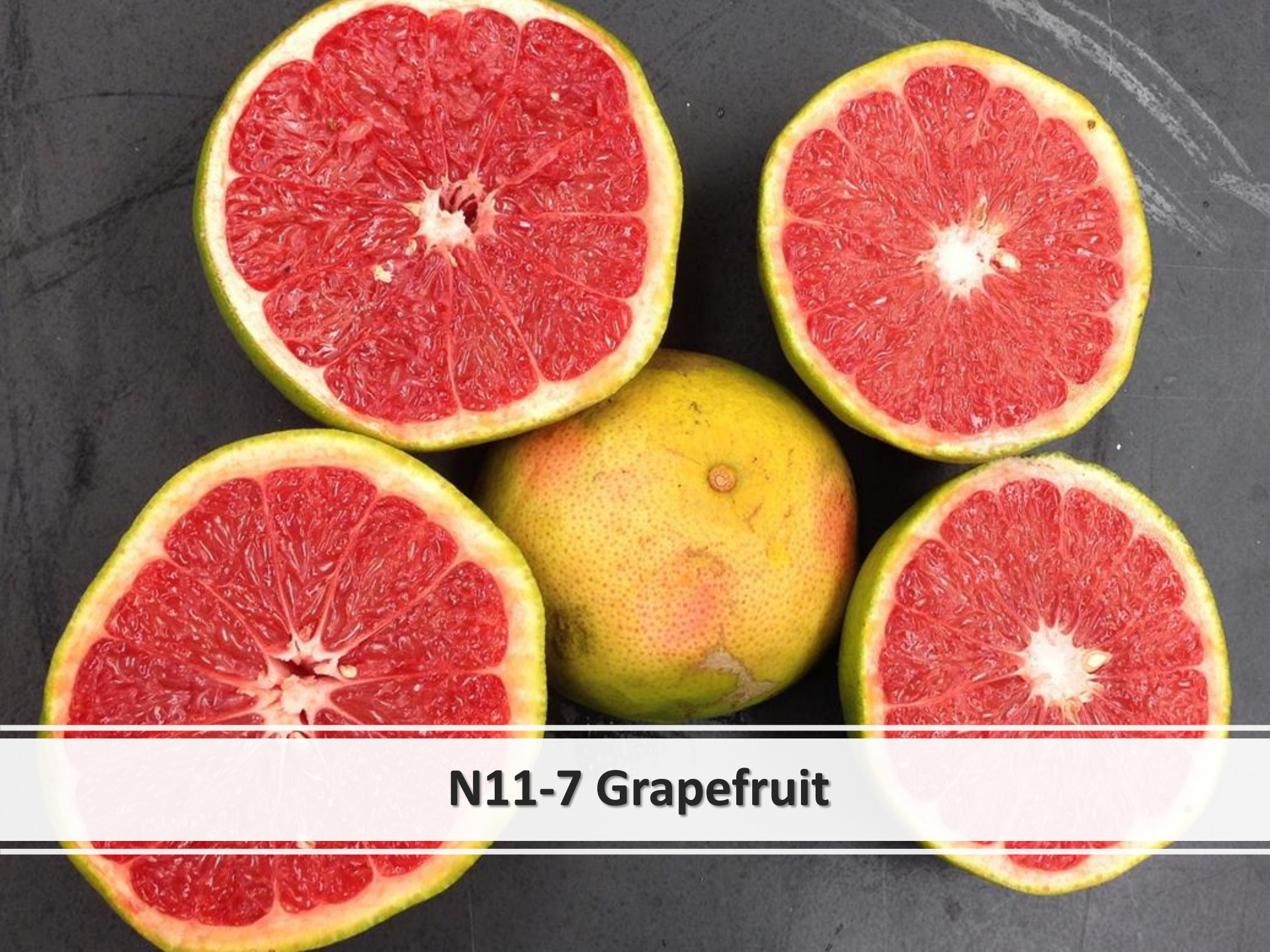
- **OLL seedling selections (17), PCR- & fruit quality**
- **Vernia (2), healthy 12 year old trees**
- **Irradiated Valencia (2), tolerant replicates**
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- **Mandarin hybrids for blending (19)**
- **Sweet orange-like (2) based on aroma profiles**
- **Many other selections for HLB genetic studies**
- **Collaboration with USDA and FCPA members**



Pummelo 5-1-99-1 Seedless Mutant

Canker and HLB-tolerant grapefruit hybrids?

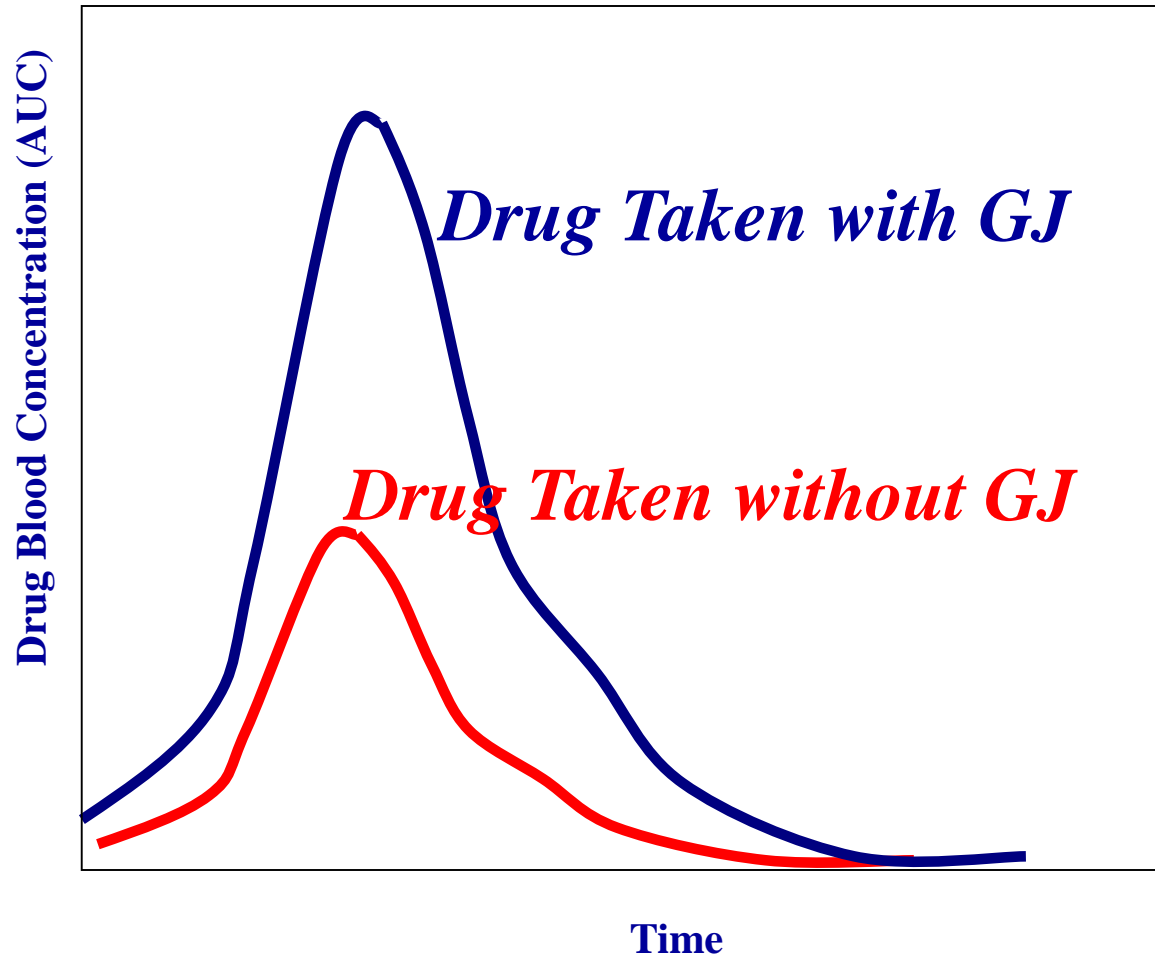




N11-7 Grapefruit

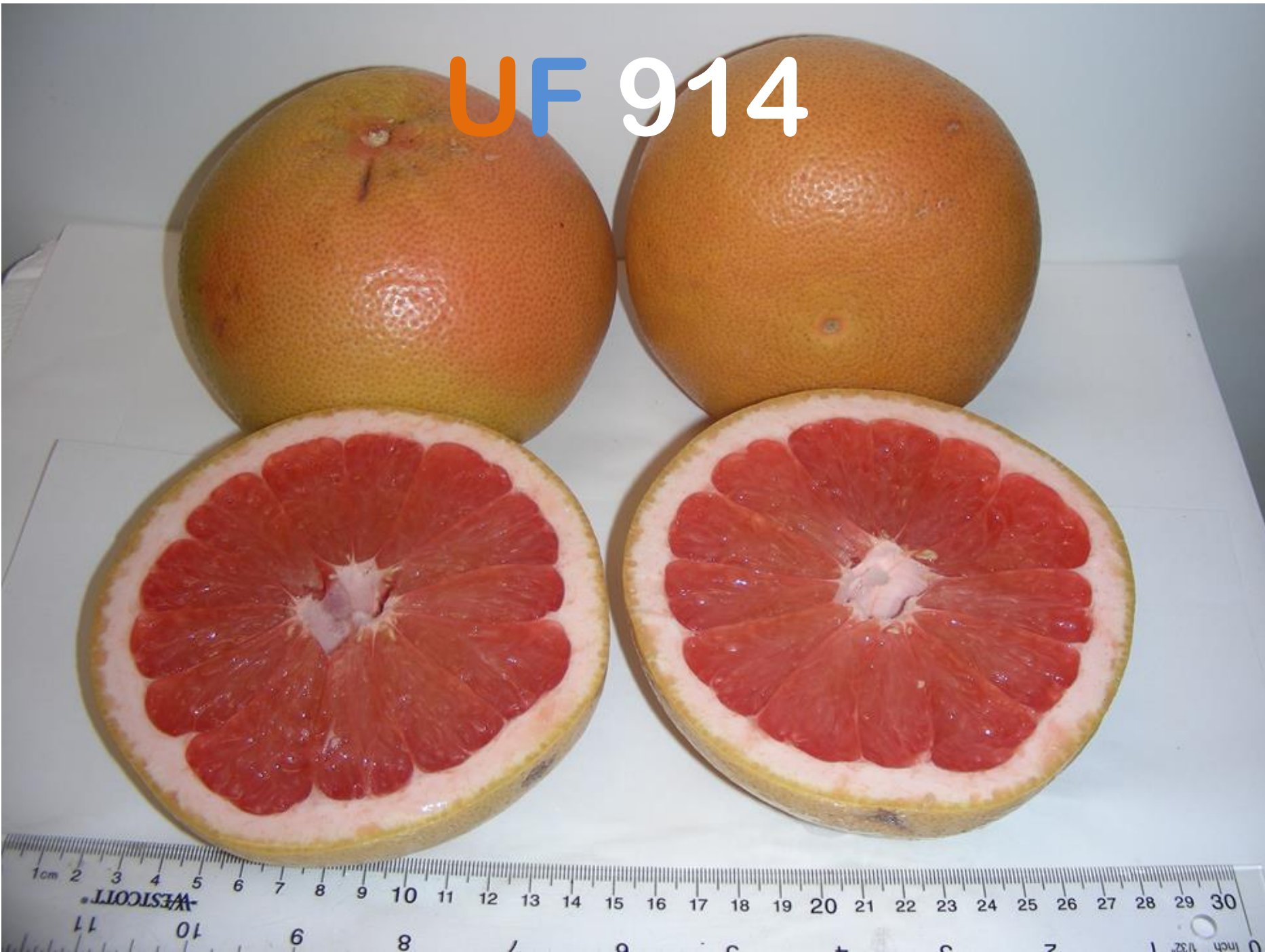


HLB-tolerant grapefruit hybrid 1862



AUC - Area under the plasma concentration versus time curve

UF 914



Fruit from 2 year old trees grown in pots in the CUPS Lake Alfred

Date	Variety	Brix	% Acid	Correction	Ratio
1/28/2016	UF 914	9.8	0.8	0.16	12.25
1/28/2016	Ray Ruby	7.1	0.9	0.18	7.89
2/17/2016	UF914	9.7	0.6	0.12	16.17
2/17/2016	Ray Ruby	6.6	0.6	0.12	11





LB8-9 (Sugar Belle®)



Sugar Belle® near Vero Beach, HLB+ >8 years !



Sugar Belle® in SW Florida, 4 years old

The HLB Tolerance of LB8-9; Sugar Belle®



411 Mandarin Hybrid – Resurgence against HLB!

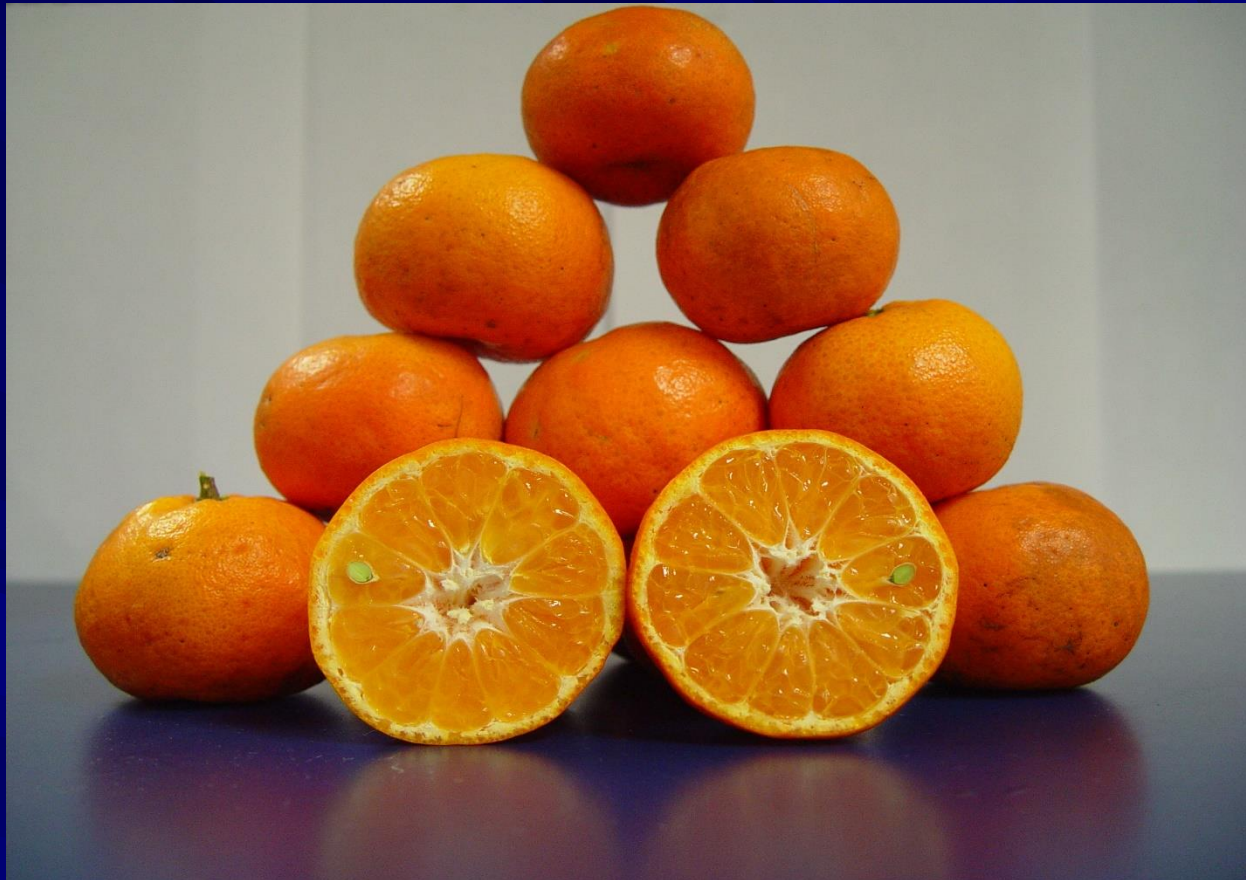


411 mandarin hybrid showing a resurgence against HLB on multiple rootstocks. HLB+ tree on WGFT+50-7 rootstock shown on right dug up from lost Haines City trial and moved to CREC 4 years ago, among several showing a remarkable recovery and productivity! An absolutely delicious piece of fruit!

The Search for Seedlessness





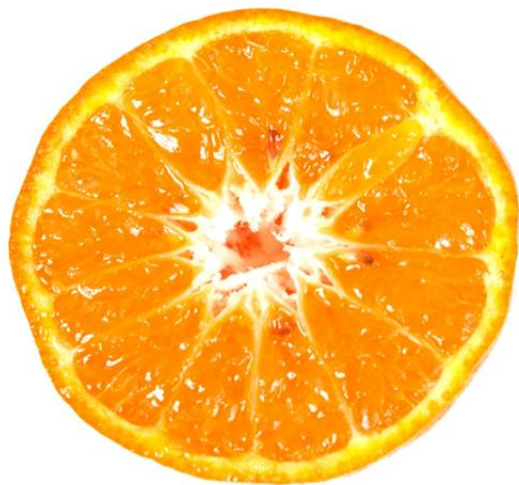


Nova + Osceola
December 6, 2005
brix= 14.8, acid=1.15,
ratio= 12.9

UF 950

- EZ to peel, seedless
- Clementine size
- Convenient to eat
- Crisp texture
- Better color and flavor than Clementine
- December maturity
- Alternaria resistant
- HLB tolerant
- Moved into commercial plantings

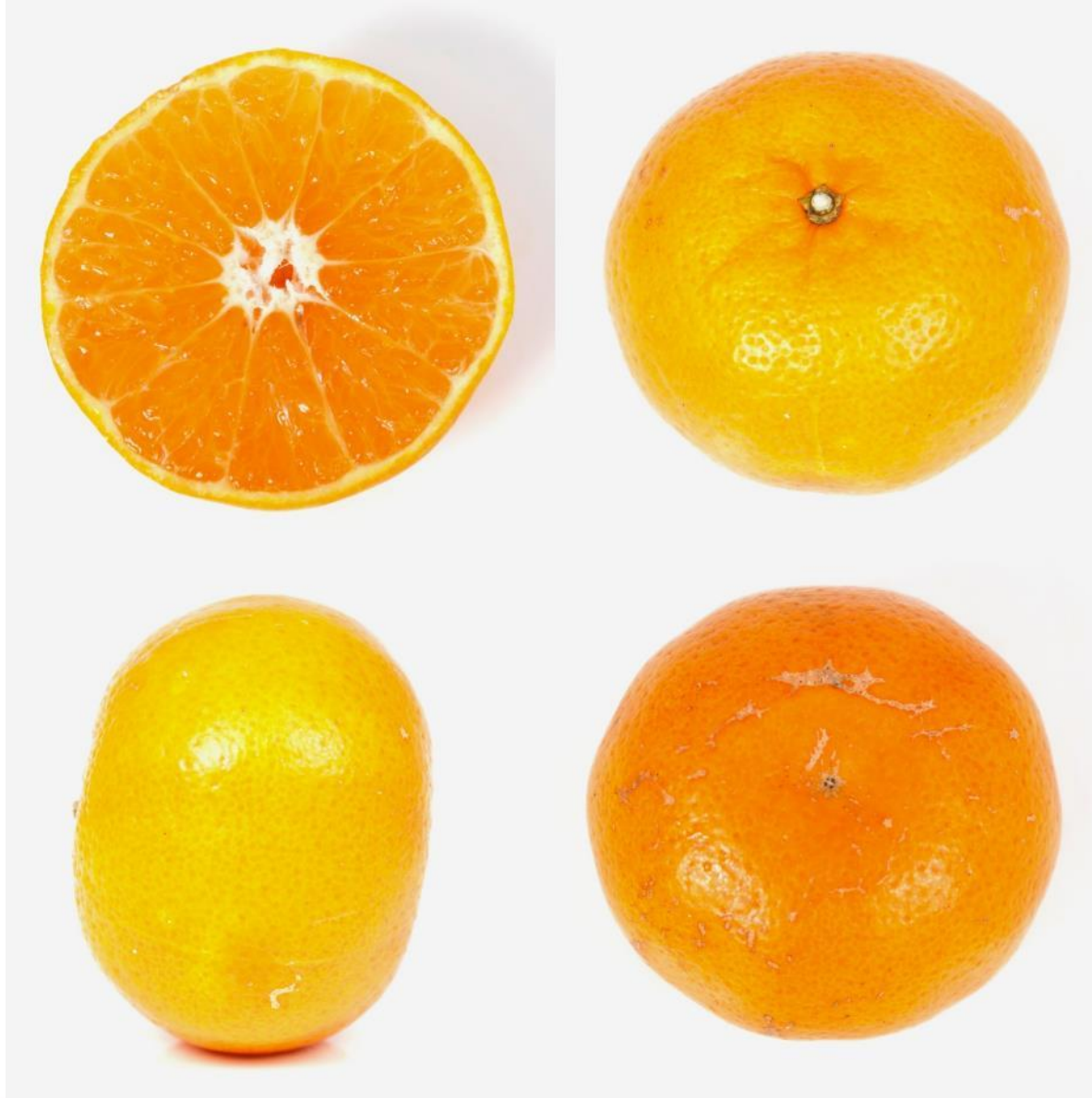




'BINGO'



'Bingo' on 4/4/16



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'Marathon'



Typical Fruiting Habit and Foliage

- **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**

1420: Long Maturity Window

Selection	Degreening	6 weeks of storage	8 weeks of storage		
		Healthy Fruit (%)	Healthy Fruit (%)	Total Decay (%)	Total Peel Breakdown (%)
BB-4-8-20	yes	100.00	62.50	25.00	12.50
	No	100.00	75.00	12.50	12.50
Bingo	yes	100.00	92.30	7.70	0.00
	No	100.00	92.85	0.00	7.15
1420	Yes	100.00	100.00	0.00	0.00
	No	100.00	100.00	0.00	0.00
Fallglo	Yes	100.00	66.66	33.33	0.00
	No	100.00	83.33	16.66	0.00


Post-harvest behavior

• Valquarius:	77,000
• OLL #8:	392,000
• OLL #4:	128,000
• LB8-9 (SB):	105,000
• Bingo:	74,000
• TOTAL	>776,000

FDACS-DPI 2015-2016; 2018

Growers are **MOVING AHEAD!**

What's Coming Soon?

- New and improved sweet oranges, with greater quality and improved tolerance of HLB
 - New HLB-tolerant orange-like hybrids that produce high quality juice amenable to processing (many that will also be seedless)
 - Numerous HLB-tolerant, easy-peel, seedless and delicious mandarins in the pipeline
 - New improved, seedless pigmented grapefruit/pummelo hybrids with better HLB and canker tolerance.
 - High-quality HLB-tolerant parents are being identified and utilized (for both scion and rootstock improvement)
 - Advances in root nutrition have led to a resurgence in the UF/CREC Citrus Breeding Program, increasing the numbers of scion hybrids fruiting every year
- 



Time is the Enemy



THANK YOU!