

Citrus Under Protective Screen is a profitable solution for fresh market citrus

Arnold Schumann



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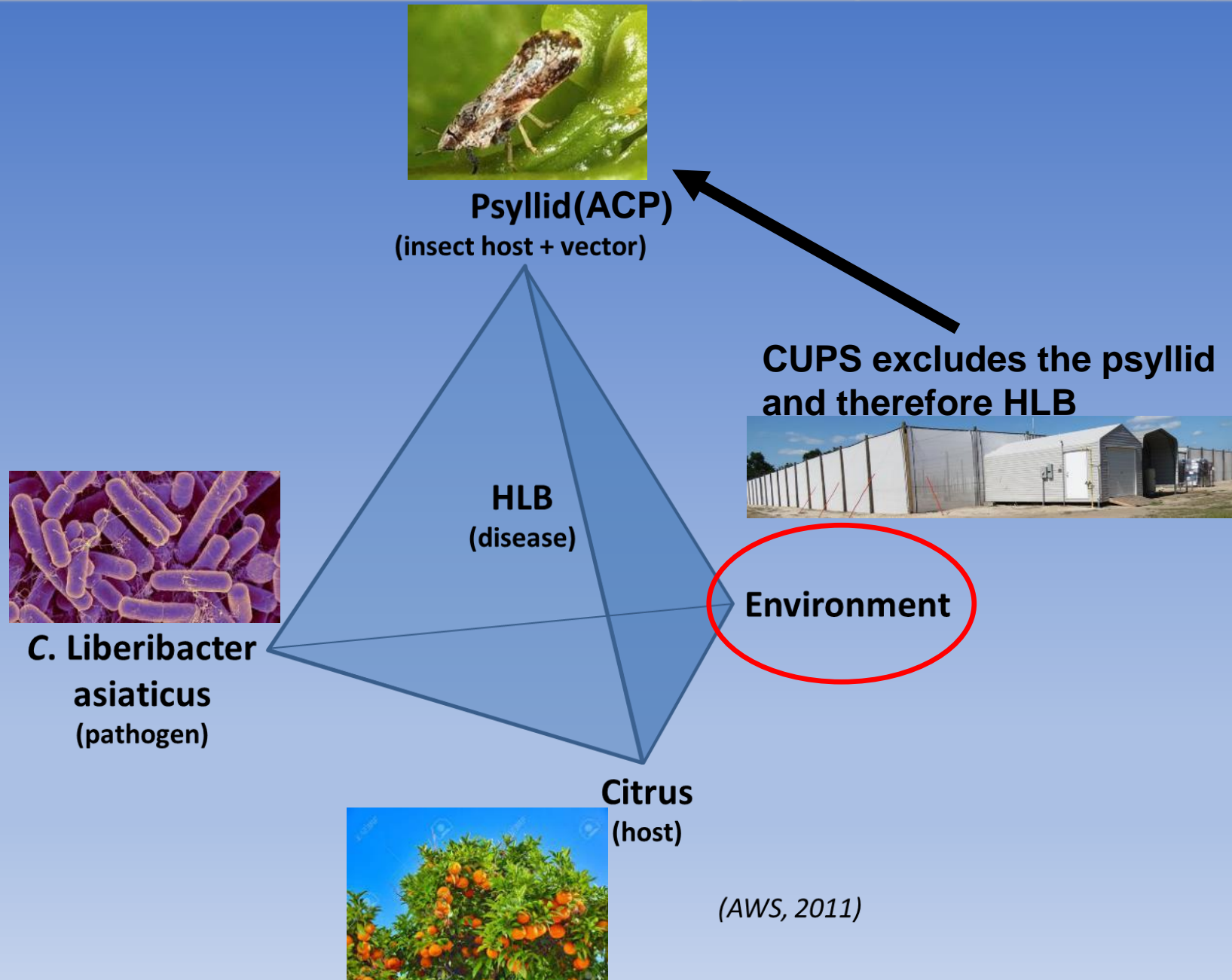


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Why CUPS? The citrus Huanglongbing (HLB) disease complex



CREC CUPS highlights at 9 years

- 99% of citrus trees in Citrus Under Protective Screen (CUPS) remain HLB-free after nine years
- Psyllids infested the trees during re-screening, but HLB spread was minimal & psyllids were readily eliminated most times, and with non-detectable CLas positivity
- Cumulative grapefruit yields of 7,300 boxes/acre* in 8 seasons
* ~\$175,200 net fruit revenue/acre at \$24/box
- Fruit quality is enhanced by fine-tuning fertilization & fruit flavors are untainted by HLB. No low Brix problems
- Biofungicides / PGPB improve IPM and sustainability

Highlights at 9 years

- No citrus canker present in the CUPS; doesn't survive
- Negligible citrus leaf miner (CLM) damage in CUPS
- CUPS suffered moderate damage from three hurricanes (2017 to 2022) but trees and fruit crops were undamaged
 - no post-hurricane recovery over multiple years



CREC CUPS grapefruit: 0.75 years



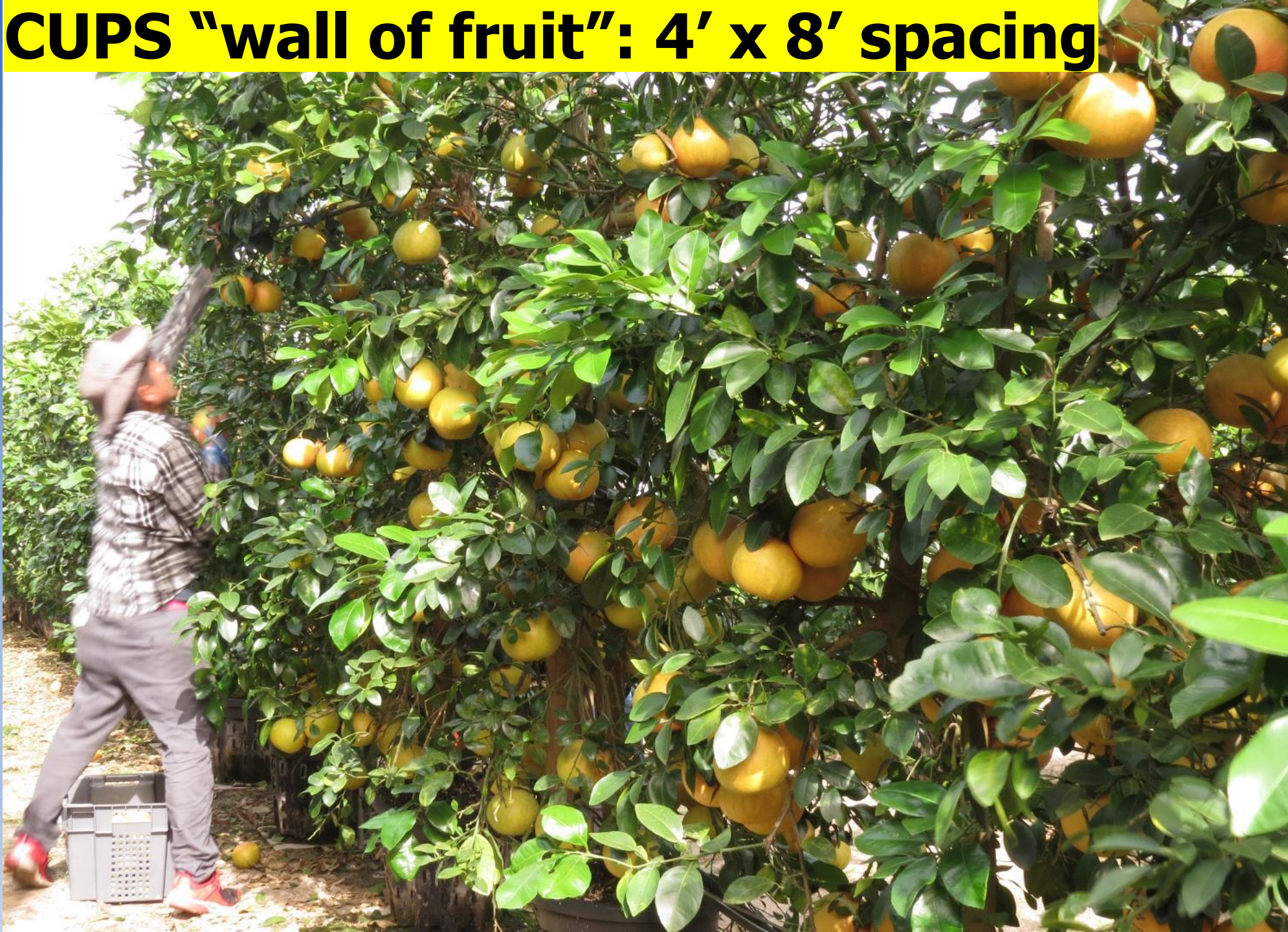
10-gal pots used for years 1-6

**CREC CUPS grapefruit: 7.5 years
\$20,000/acre/year (January 2022)**



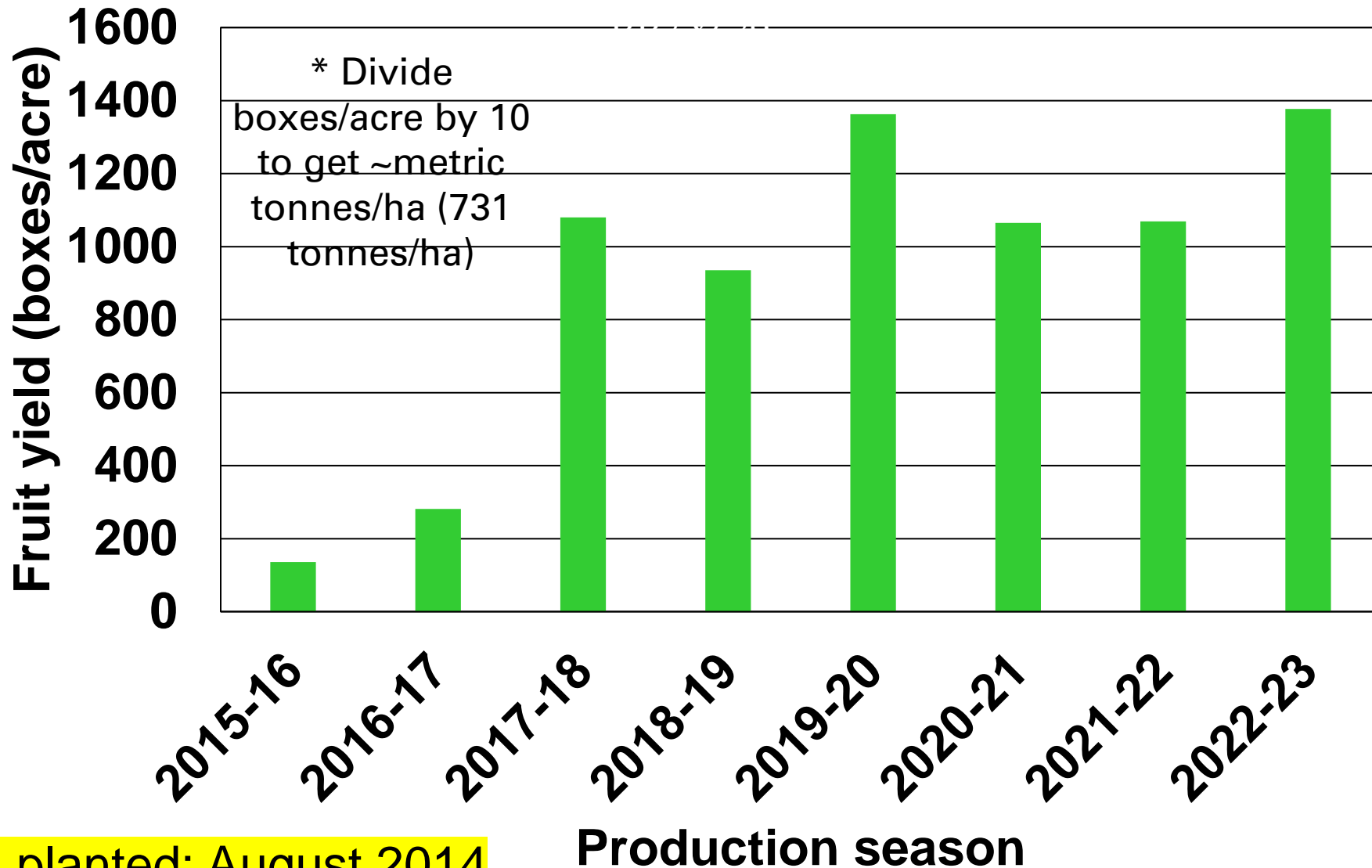
Trees were transplanted in year 6

CUPS "wall of fruit": 4' x 8' spacing



'Ray Ruby' / X639: 7,306 boxes/acre*

in eight years; 10 gal. pots; 4' x 8' spacing



Trees planted: August 2014

What is 'Ray Ruby' / X639: 7,306 boxes/acre in eight years" really worth? *

- 8 years = \$131,508 /acre at a grapefruit price of \$20 /box and 90% pack-out (*a conservative estimate for CUPS*)
- Equivalent to 49 years of conventional HLB-endemic grapefruit production at average 267 boxes /acre (*NASS, 2018-19*), \$20 /box and 50% pack-out
- 49 years of conventional caretaking costs, fertilizer, irrigation, insurance and environmental impacts versus 8 years with CUPS (also 8 CUPS acres ~ 49 conventional acres) ~6.2x difference

**based on assumptions of fruit price, pack-out*

Ray Ruby grapefruit in CUPS



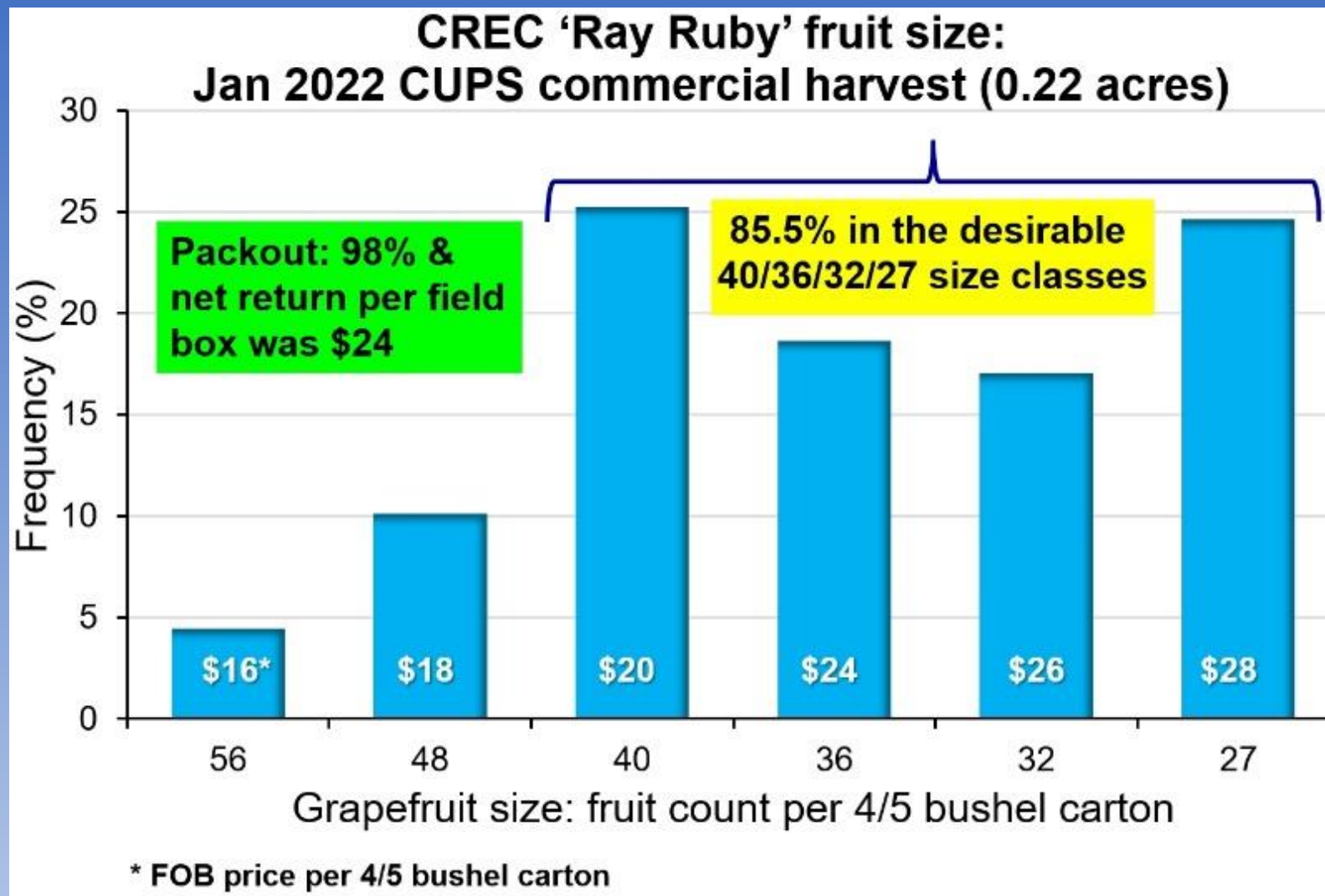


Figure 3. Histogram of percentage 'Ray Ruby' grapefruit in each size class from the CREC CUPS 2021/22 season, FOB fruit prices received per carton in each size class, average packout and net revenue return per field box.

USDA, NASS Citrus Forecast (March 2022)

Florida red grapefruit size:

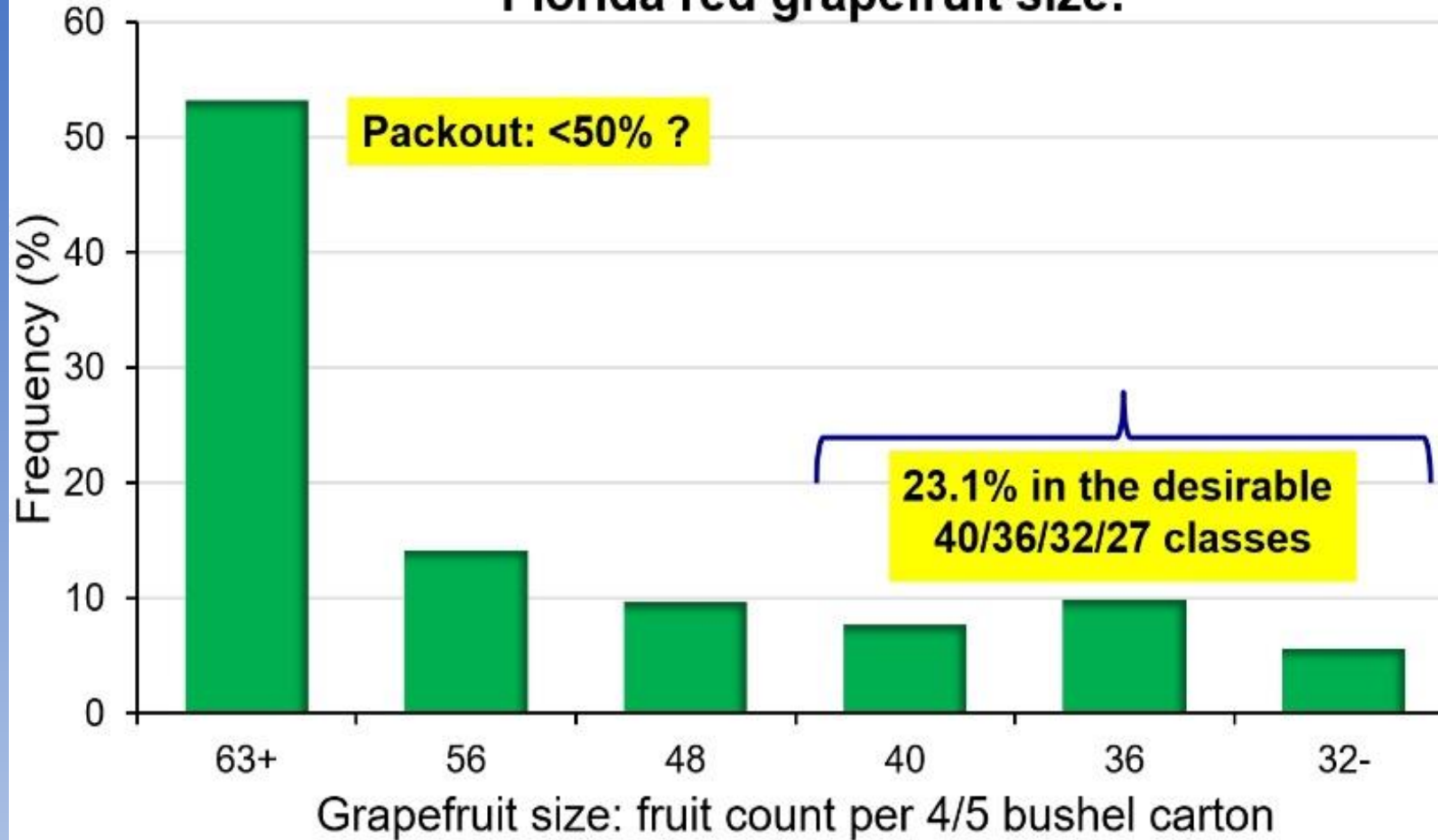


Figure 4. Histogram of percentage red grapefruit in each size class reported in the March 2022 USDA survey and forecast for Florida (HLB-affected trees, not in CUPS).

USDA, NASS Citrus Forecast (Jan 2003) Florida red grapefruit size:

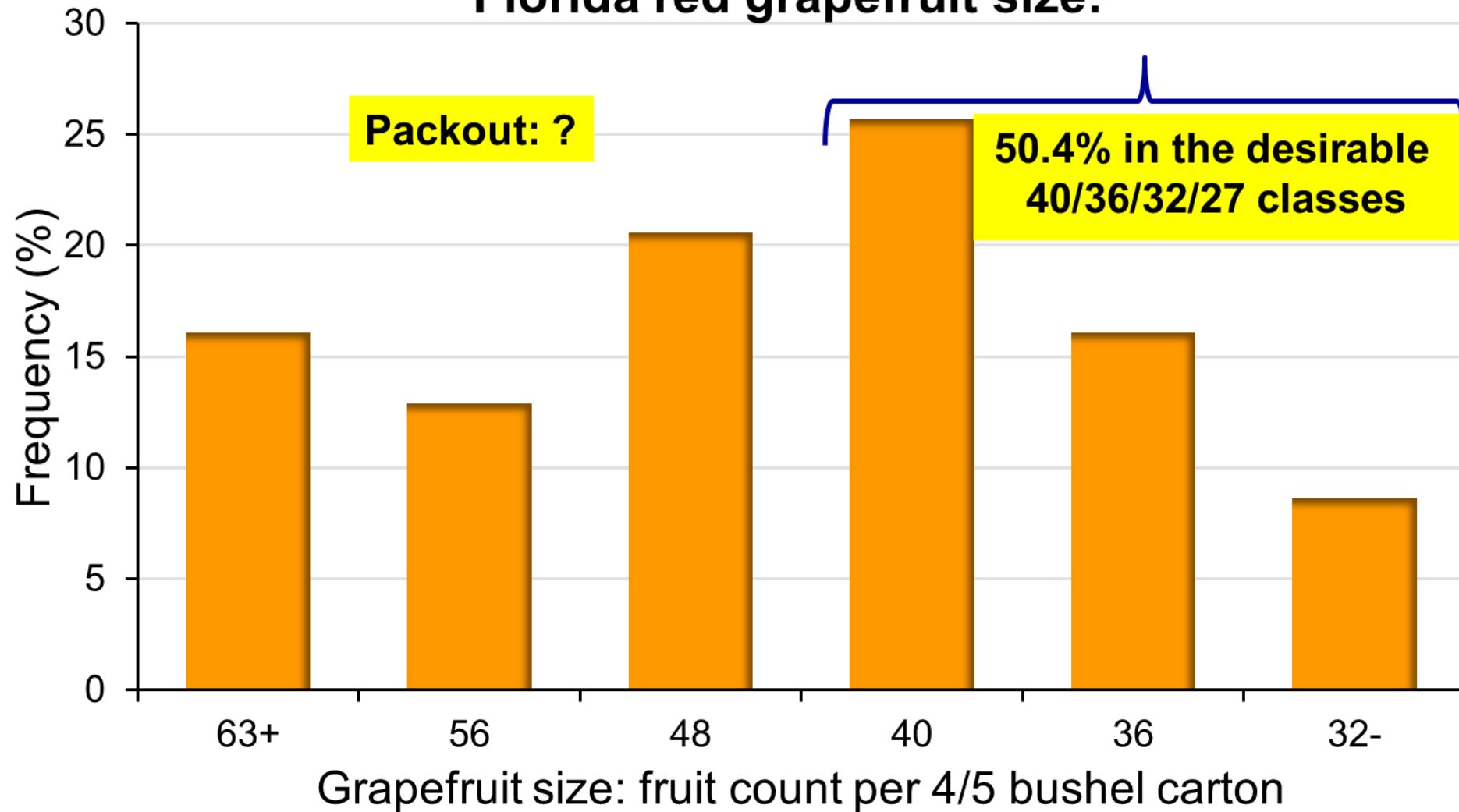


Figure 5. Histogram of percentage red grapefruit in each size class reported in the January 2003 USDA survey and forecast for Florida (pre-HLB, not in CUPS).

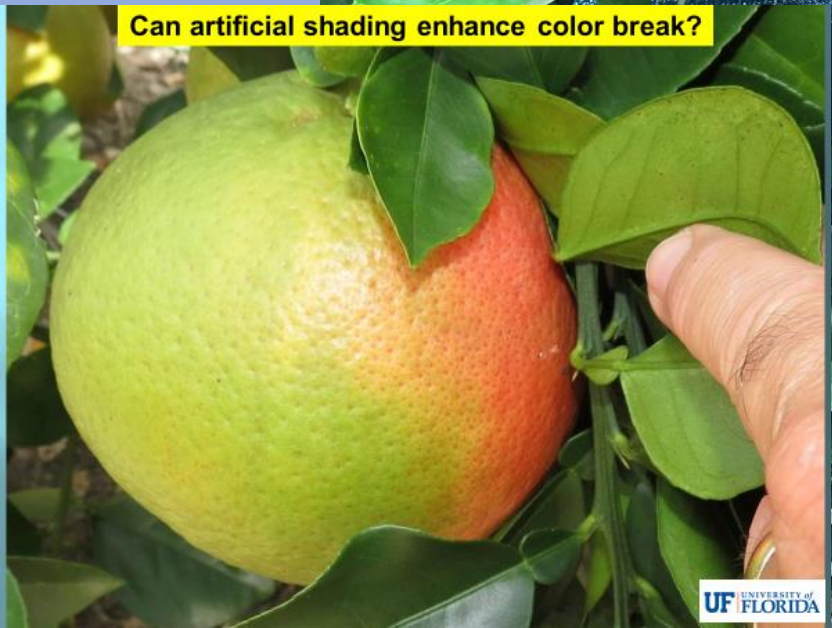
Table 1. Average yield and fruit quality measurements of ‘Ray Ruby’ grapefruit on three rootstocks in the CREC CUPS, January 12, 2022 (Year 7.5). The trees on X639 rootstock are growing in 9.3-gal pots and both US897 and Sour Orange trees are in the ground.

Rootstock	Planting density	Fruit yield (boxes / acre)	Fruit diameter (inch)	Size (fruit count per 4/5 bushel carton)	Juice content (%)	Average Brix (%)	Acid (%)	Ratio
Sour orange	5' x 10'	855	4.0	35	50.6	9.6	0.77	12.4
US897	5' x 10'	723	3.9	38	52.3	9.1	0.77	11.9
X639	4' x 8'	1,069	4.1	33	49.3	8.7	0.75	11.6
Conventional groves: pre- and post-HLB								
Other	12' x 24'	561 (est)	Dec 2002	-	50.2	10.29	1.16	8.94
Indian River	-	-	Dec 2002	-	52.1	10.96	1.23	9.02
All FL	?	267 (est)	Dec 2022	-	61.8	9.73	1.15	8.5

Photosensitive shade cloth experiment



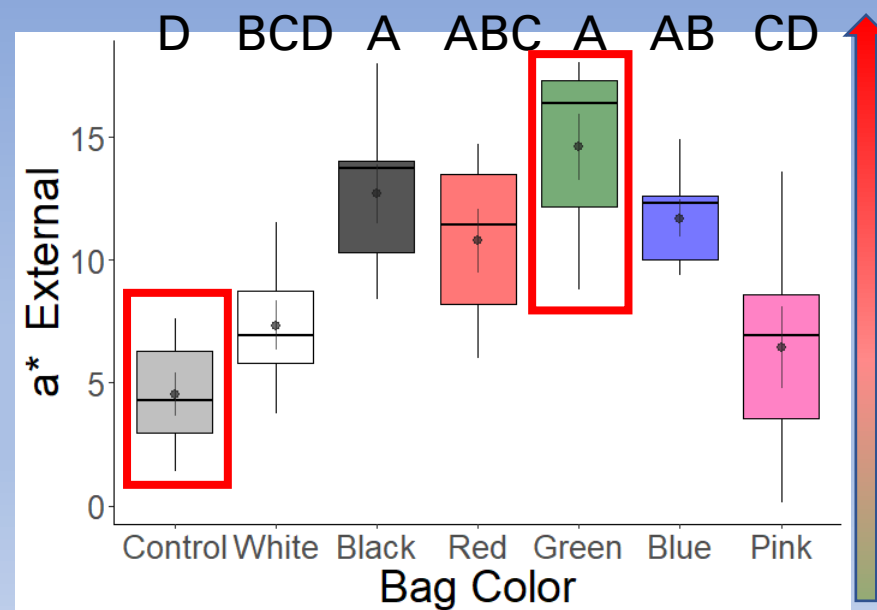
Can artificial shading enhance color break?



Ray Ruby Results External Color

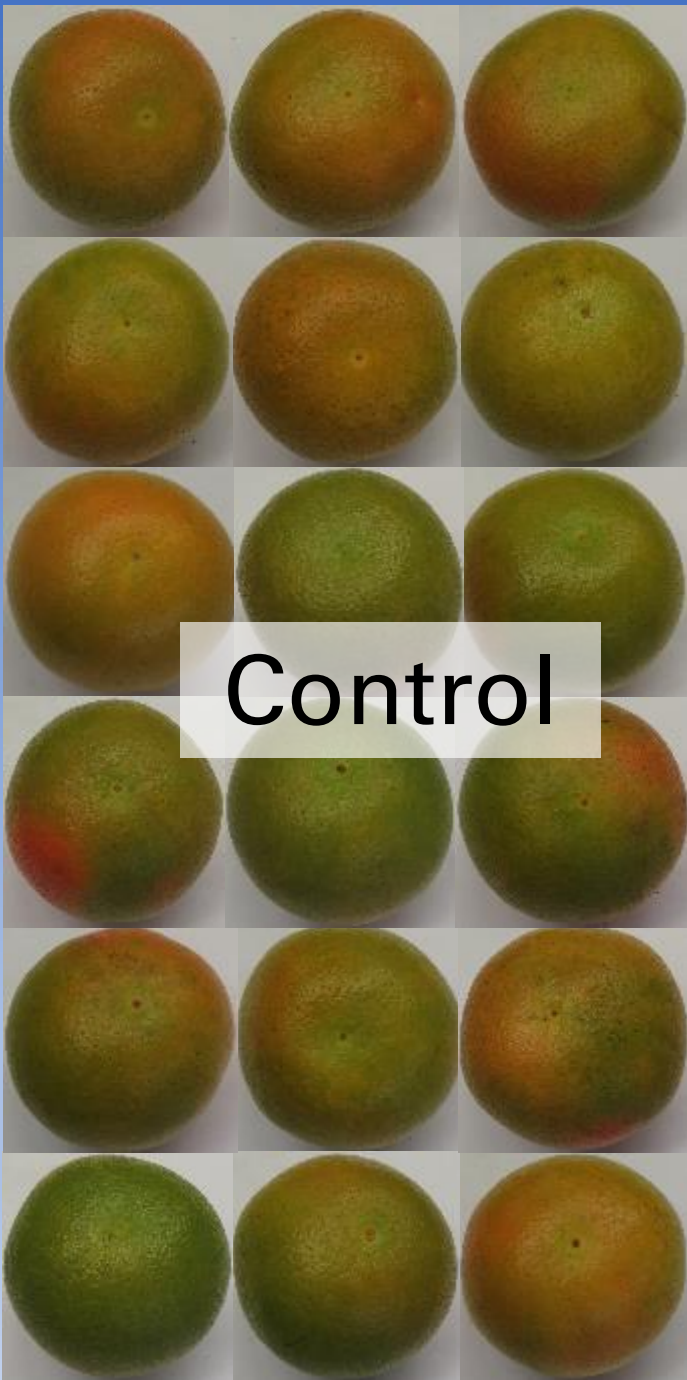
	L*	a*	b*
Control	35.32	4.55	35.27
White	36.2	7.34	36.69
Black	35.45	12.69	35.72
Red	35.8	10.79	36.49
Green	35.97	14.62	36.58
Blue	35.73	11.71	35.73
Pink	36.2	6.44	36.26

NS $p > F < 0.001$ NS



Control

Green bags



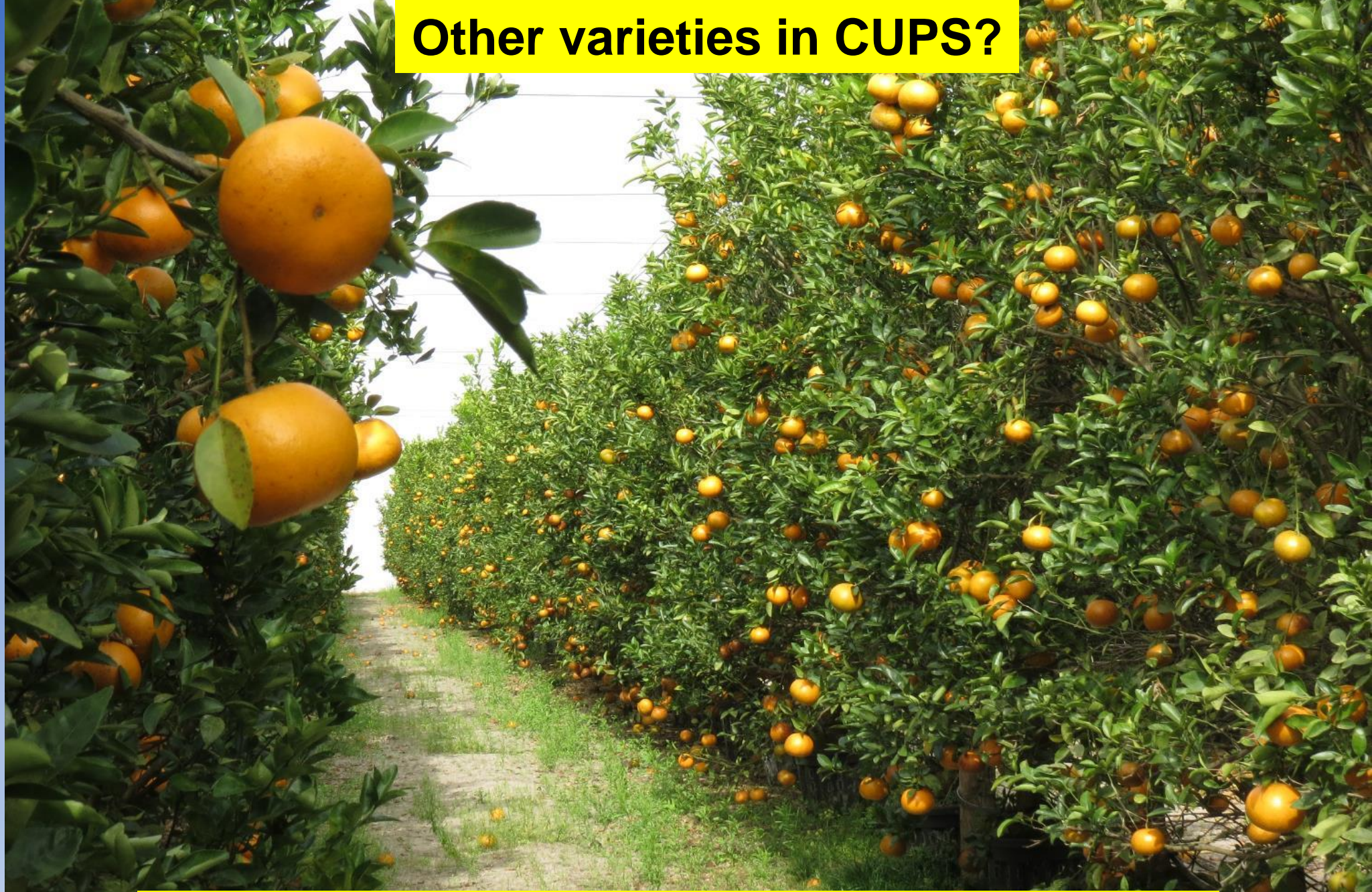
**Top varieties: Flame, Ruby Red
& Ray Ruby grapefruit**



'Ray Ruby' grapefruit, 12/12/2022 (8th harvest)



Other varieties in CUPS?



Murcott with full color break on 12/22/2020



Murcott trees: >8 years growing in pots

UF914 continues to perform well in CUPS

UF914 –
seedless,
sweet
“grapefruit”



Nov 2018

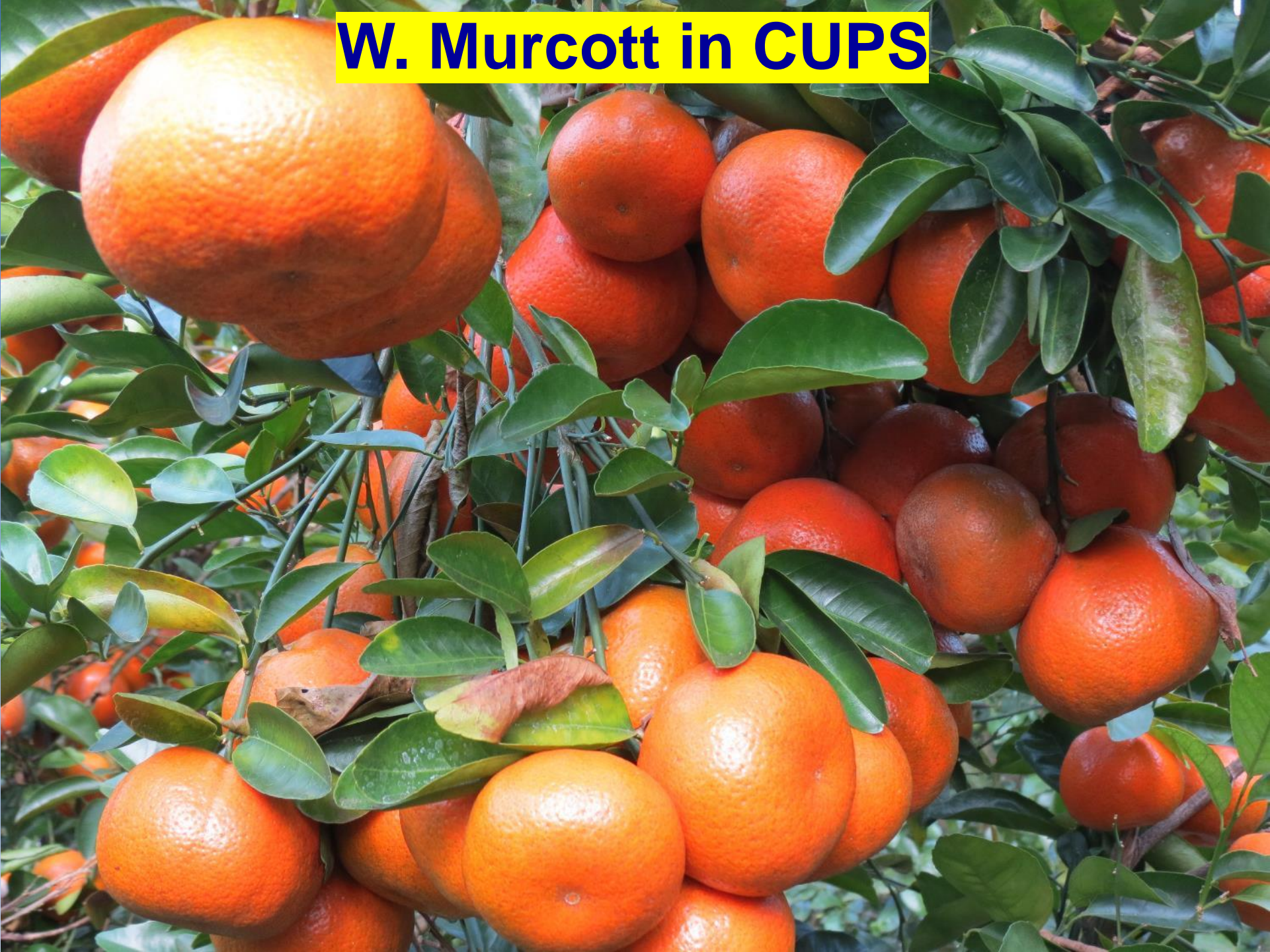


Feb 2019



UF914 yields:
>800 boxes/acre
in year 4

W. Murcott in CUPS



Dancy in CUPS



Early Pride in CUPS (October 2022)



Temple in CUPS (January 2023)



Minneola in CUPS (January 2022)



Sugarbelle in CUPS (December 2022)



Double-cropping papaya and citrus in years 1-2

*Harvest papaya fruit in years 1-2 while the citrus trees establish



Papaya seedlings

July 2022

July 2022



Double-cropping papaya and citrus in years 1-2

July 2023



July 2023

Potential to generate
fruit revenue from
papaya in years 1-2
while citrus is
unproductive. Then
remove papaya
plants



SUMMARY & CONCLUSIONS

- CUPS prevents HLB, canker, and hurricane damage to citrus
- CUPS = profitable* method for growing citrus for the fresh market
- CUPS fruit quality is similar to pre-HLB Florida fruit
- CUPS trees produce earlier yields than conventional groves
- CUPS saves input resources and costs by growing trees faster
- Internal Rate of Return for CREC CUPS estimated 9-16% (10y)*
- HLB incidence in the CREC CUPS is <1% after nine years
- Papaya double-cropping has potential for CUPS early returns
- <https://www.makecitrusgreatagain.com/CUPS.htm>
- *Singerman & Schumann, 2023: <https://tinyurl.com/CUPS-economics>

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