CITRUS UNDER PROTECTIVE SCREEN (CUPS) – YEAR 4 UPDATE

Arnold Schumann, Laura Waldo, Tim Ebert, Danny Holmes, Napoleon Mariner & Gary Test

CREC, UF/IFAS, Lake Alfred, FL
INTRODUCTION

- The CUPS idea was developed in ~2011/12 (with Tim Spann, Chris Oswalt + Barrett Gruber) after two productive visits to Fruit World in California (Craig Kaprielian)

High yielding, high quality production under cover

Murcotts: >1,000 boxes/acre

Tomatoes: 30x higher yield than outdoors
INTRODUCTION & OBJECTIVES

• Grow Citrus Under Protective Screen (CUPS) to exclude the Asian Citrus Psyllid and therefore Huaglongbing (HLB) disease

• Produce asymptomatic, low-seeded, premium grade fresh fruit in HLB-endemic Florida by using CUPS

• CUPS is a complex integrated system— not simply a screen cover- but a completely reworked modern production system

• The protective screen house is the single most costly item required for CUPS (up to one dollar per square foot): much less/ sq.ft than a greenhouse, and the price can be reduced 50% or more by using overseas suppliers, careful design, and economies of scale

• The higher cost of CUPS must be offset by high fruit revenue
CUPS facility at the CREC
1.3 acres (58,000 sq. feet)
Container hydroponics can accelerate and boost fresh citrus production in a CUPS environment to maximize early return on investment.
February 2017:
‘Honey Murcott’ @ 2.5 years, 7-gal pots, 1,361 trees /acre:
680 boxes/acre, 99% pack-out
‘Ray Ruby’ grapefruit @ 2.5 years, 10-gal pots, 871 trees /acre: 346 boxes/acre (total 496 boxes/acre in 2 years)
‘Honey Murcott’ commercial harvest @ 2.5 years
‘Honey Murcott’ after post-harvest hedging
June 2017: ‘Honey’ murcott @ 2.75 years
‘Early Pride’ early variety @ 2.0 years, 10-gal pots, 1,361 trees /acre
January 2018: ‘Ruby Red’ grapefruit @ 3.5 years
‘Ray Ruby’ grapefruit @ 3.5 years, 10-gal pots, 871 trees /acre
‘Honey’ murcott @ 3.5 years, 7-gal pots, 1,361 trees /acre
Outdoor ‘Ray Ruby’ @ 3.5 years
Outdoor ‘Honey’ murcott @ 3.5 years
Feb 2018: ‘Ray Ruby’ grapefruit hedging, 871 trees /acre
Mar 2018: ‘Honey’ murcott topping, 7-gal pots, 1,361 trees /acre
November 2017: ‘Early Pride’ = seedless
‘Persian’ lime = seedless

‘Meyer’ lemon = low seeded

‘Ray Ruby’ grapefruit = low seeded
‘Honey Murcott’ mandarin = seedy

‘W. Murcott Afourer’ mandarin = seedless

‘Page’ tangelo = seedless
July 2018 immature fruit samples – CREC CUPS
‘Bingo’ = seedless
‘Dancy’ = seedy
‘Kinnow’ mandarin = low seeded
‘Nules’ clementine = seedless
‘Sugar belle’ = seedless
CUPS yield results at 3.5 years

• ‘Ray Ruby’ grapefruit trees grown in CUPS or Outdoors:

<table>
<thead>
<tr>
<th>‘Ray Ruby’ grapefruit</th>
<th>Fruit yield boxes/ac</th>
<th>Fruit diameter (cm)</th>
<th>Acid (%)</th>
<th>Brix</th>
<th>Ratio</th>
<th>SS lb/box</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUPS</td>
<td>731</td>
<td>10.11</td>
<td>0.763</td>
<td>7.80</td>
<td>10.23</td>
<td>3.52</td>
</tr>
<tr>
<td>Outdoors</td>
<td>80</td>
<td>8.42</td>
<td>0.929</td>
<td>7.08</td>
<td>7.69</td>
<td>3.07</td>
</tr>
<tr>
<td>F-prob</td>
<td>&lt;0.001 ***</td>
<td>&lt;0.001 ***</td>
<td>&lt;0.001 ***</td>
<td>&lt;0.001 ***</td>
<td>&lt;0.001 ***</td>
<td>&lt;0.001 ***</td>
</tr>
</tbody>
</table>

juice yield: NS

All significant effects were due to HLB disease affecting the outdoor trees
CREC ‘Ray Ruby’ fruit size: 2018 plot harvest

CUPS: 75% in the desirable 40/36/32 classes
Outdoor: 11%

Packout was 100% in CUPS

Grapefruit size: fruit count per 4/5 bushel carton

- Frequency (%)

- CUPS: 75% in the desirable 40/36/32 classes
- Outdoor: 11%
- Packout was 100% in CUPS
Red grapefruit size: Florida 2004 versus 2017

(Florida Agricultural Statistics Service)

Grapefruit size: fruit count per 4/5 bushel carton

Desirable 40/36/32 classes

Jan-2017  Jan-2004
Economic indicators for CUPS
Price structure, ‘Ray Ruby’, excluding pick and haul:

<table>
<thead>
<tr>
<th>SIZE</th>
<th>Field boxes</th>
<th>Sales</th>
<th>Container charge</th>
<th>Other charge</th>
<th>Net</th>
<th>Net/box</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>27</td>
<td>$1,266.43</td>
<td>$260.82</td>
<td>$13.50</td>
<td>$992.11</td>
<td>$36.74</td>
</tr>
<tr>
<td>40/36</td>
<td>64</td>
<td>$3,343.12</td>
<td>$950.40</td>
<td>$32.00</td>
<td>$2,360.72</td>
<td>$36.89</td>
</tr>
<tr>
<td>48</td>
<td>3.5</td>
<td>$135.34</td>
<td>$43.09</td>
<td>$1.75</td>
<td>$90.50</td>
<td>$25.86</td>
</tr>
<tr>
<td>Bulk</td>
<td>63</td>
<td>$902.01</td>
<td>$63.00</td>
<td>$31.50</td>
<td>$807.51</td>
<td>$12.82</td>
</tr>
</tbody>
</table>

**TOTALS** | **157.5** | **$5,646.89** | **$1,317.31** | **$78.75** | **$4,250.83** | **$26.99**

202 trees harvested: 157.5 boxes, 0.78 boxes/tree
871 trees/acre: 679 boxes/acre
@ $23.86/box incl. pick & haul: $16,204/acre net
(=average across all experiment treatments)
Highest = 824 boxes/acre: $19,661/acre net
*60% of fruit was premium grade
‘Ray Ruby’ CUPS grapefruit in 2018 (year 4)
‘Ray Ruby’ CUPS grapefruit in 2018 (year 4)
‘Ray Ruby’ CUPS grapefruit in 2018 (year 4)
‘Ray Ruby’ CUPS grapefruit in 2018 (year 4)

Estimated yield by fruit count = 860 boxes/acre
4-year cumulative = 2,135 boxes/acre
CREC ‘Ray Ruby’ grapefruit yields in CUPS: past, present and future (US897 rootstock, 871 trees/acre)

Potential net revenue for fruit: >$23,860/year @ 1,000 boxes/acre, $23.86 /box

This season

Fruit yield (boxes/acre)

2015/16 (year 1)
2016/17 (year 2)
2017/18 (year 3)
2018/19 (year 4)
2019/20 (year 5)
2020/21 (year 6)

CUPS actual
Estimated
Projected

(US897 rootstock, 871 trees/acre)
Hurricane Irma in Florida: 10-11 September 2017

Rainfall totals (inch):
Indian River 14.18
Lake Alfred 8.94
(FAWN)
September 2017: Hurricane Irma impacts to CREC CUPS
September 2017: Hurricane Irma impacts to CREC CUPS
September 2017: Hurricane Irma impacts to CREC CUPS
September 2017: Hurricane Irma impacts to CREC CUPS
September 2017: repairs to CREC CUPS
September 2017: repairs to CREC CUPS

Installed turnbuckles to all anchor cables

Other suggestions:
- Double cables at corners
- Longer ground anchors (8’)
- Double anchors on internal poles
Future plans and outlook

UF/IFAS is working with commercial CUPS growers in Florida

Commercial CUPS @ 1 year
Other varieties being tested in CREC CUPS

- Planted in 2017: Sugarbelle, Dancy, Clementine, Kinnow, Temple, Bingo
New varieties testing in CREC CUPS
‘Bingo’, @ 1.5 years
New varieties testing in CREC CUPS: Red grapefruit-like UF914, @ 4 years
New canopy management experiments in CUPS

- Branch bending
- Hand pruning
- Mechanical hedging/topping
- = manage alternate bearing
CONCLUSIONS

• CUPS is an attractive non-GMO fresh fruit solution to HLB

• Economic viability of CUPS technology can be maximized by early high yields of premium grade fruit & high pack-out, 100%

• Hydroponic cultivation of citrus in containers is an attractive option for boosting planting densities, early yields and quality of fresh fruit in CUPS, but is more complicated

• Questions remain, such as alternate bearing, longevity of the hydroponic citrus, and ultimate profitability, to be investigated with ongoing research and economic assessments

• Notable disadvantages of hydroponic citrus include higher establishment costs, more management, trellises required for support, and more difficult weed control. However robotic fruit harvesting is more feasible with trellised trees
SUMMARY – CREC CUPS

• The CREC screen house survived a category 2 hurricane in 2017

• Trees & fruit in the CUPS were protected from the hurricane

• After four years, there is no HLB in the CREC CUPS

• During four years of scouting, one psyllid adult found on a trap

• Two commercial harvests of ‘Ray Ruby’ grapefruit, and ‘Murcott’ sold fruit with 100% pack-out and up to 824 boxes/acre/year

• Estimated third harvest (fruit count) is on track >850 boxes/acre

• Other grapefruit- and tangerine-like varieties are being tested: seedless, early-season, attractive additions for CUPS
Thank you for your support
Grower stakeholders & cooperators
FDACS Specialty Crop Block Grant
UF/IFAS Citrus Initiative
UF/IFAS Extension Agents
Laboratory and Support Staff

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2018-70016-27387.

Contact: schumaw@ufl.edu