Millennium Block: A large-scale grapefruit scion and rootstock variety trial at the Indian River

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USDA-ARS
MB, a new beginning for the River

Citrus Industry News

Millennium Block Resurrected for HLB Research
November 20, 2017 / Grapefruit, HLB Management

https://citrusindustry.net/2017/11/20/millennium-block-resurrected-for-hlb-research

Massive Research Project in Millennium Block
July 10, 2020 / Research

https://citrusindustry.net/2020/07/10/massive-research-project-in-millennium-block

UF/IFAS Millennium Block citrus grove drive through event

Study rationale

There is an **urgent need** to test **newly released varieties and rootstocks** in the IR.

Scion and rootstock variety performance trials are cost-effective tools to:

- Evaluate **disease tolerance** of the scion
- Test **rootstock horticultural attributes** in a specific site
- Evaluate **plant growth and yield** to base planting decisions

DATA => PLANTING DECISIONS
OBJECTIVES

1. Assess the early performance of new grapefruit scion cultivars on three commercial rootstocks in the IR.

2. Compare grapefruit, navel, and mandarin growth and yield on University of Florida rootstocks, other recently released, and standard rootstocks in the IR.

HYPOTHESES

1. New grapefruit hybrids have better horticultural attributes and HLB-tolerance than the standard cultivars used in the IR.

2. The rootstock provides higher tolerance to tree decline due to HLB while maintaining high yield and fruit quality.
Study site

UF/IRREC Millennium Block at Fort Pierce, FL (27°25'49.7"N 80°24'19.5"W)

~20 acres planted (~4,500 trees) trees spaced 8’ × 25’ at 218 trees/acre

Pineda sandy soil / Flatwoods → Raised beds

Planting date: Sep 2019 and Aug 2020

All trials are independent
### Materials and methods: TRIAL 1
**Grapefruit scions and rootstocks**

<table>
<thead>
<tr>
<th>SCIONS (18)</th>
<th>ROOTSTOCKS (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>'US 6-16-172'</td>
<td>Sour orange</td>
</tr>
<tr>
<td>'US 6-17-48'</td>
<td>US-942</td>
</tr>
<tr>
<td>'US HoneyCoat'</td>
<td>X-639</td>
</tr>
<tr>
<td>'US Seedless Surprise'</td>
<td></td>
</tr>
<tr>
<td>'US 1-83-179'</td>
<td></td>
</tr>
<tr>
<td>'US 6-17-16'</td>
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<td>'US 4-4-1'</td>
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<tr>
<td>'UF N40-16-11-11'</td>
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</tr>
<tr>
<td>'Summer Gold'</td>
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<td>'UF N40-16-11-7'</td>
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<tr>
<td>'UF N11-29'</td>
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<tr>
<td>'UF 914'</td>
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<tr>
<td>'UF N40-16-11-3'</td>
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<tr>
<td>'UF 5-1-99-2'</td>
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<tr>
<td>'UF N40-16-11-15'</td>
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<tr>
<td>'Jackson'</td>
<td></td>
</tr>
<tr>
<td>'Star Ruby'</td>
<td></td>
</tr>
<tr>
<td>'Ray Ruby'</td>
<td></td>
</tr>
<tr>
<td>University of Florida</td>
<td>Commercial standard</td>
</tr>
<tr>
<td>Planted on 2020</td>
<td></td>
</tr>
</tbody>
</table>
**Materials and methods: TRIALS 2, 3, and 4 (independent)**

Grapefruit, navel orange, and mandarin scions on a wide range of rootstocks

<table>
<thead>
<tr>
<th>SCIONS</th>
<th>‘Ray Ruby’</th>
<th>‘Glenn F-56-11’</th>
<th>‘UF 950’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receipt date</td>
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<td>2247x6070-02-2</td>
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<tr>
<td>Rootstock</td>
<td>C-54</td>
<td>Cunningham</td>
<td>Kuharske citrange</td>
</tr>
<tr>
<td></td>
<td>WGFT+50-7</td>
<td>UFR-1</td>
<td>UFR-2</td>
</tr>
<tr>
<td></td>
<td>UFR-16</td>
<td>UFR-17</td>
<td></td>
</tr>
</tbody>
</table>

Rootstocks planted on 2020: **C-57, Cleopatra, Sun Chu Sha, US-1283**

Rootstocks to plant in 2021: **C-146, UFR 7 to 14**
EXPERIMENTAL DESIGN

✓ Arranged in a RCBD
✓ Treatment: scion/rootstock combination
✓ 5-tree replicated plots & 6 replications/treatment → 30 trees/treatment

Grove caretaking based on standard horticultural practices according to UF/IFAS recommendations

Data is collected from the 3-central trees/rep
Statistical analysis through ANOVA (Proc GLM), and Tukey mean comparison test using SAS v. 9.4
DATA COLLECTION

- Tree phenological stage monitoring
- Pest and disease incidence
- Tree size
- Fruit yield* and quality*
- Leaf and soil nutrient concentrations
- LAI (Leaf Area Index – Canopy thickness)
- HLB incidence + Canopy color + Leaf sampling for CLas titer

*As of 2nd year of growth
Preliminary results (2019-2021): Trial 1
Grapefruit scions and rootstocks

Factors | p-value
--- | ---
Scion | ≤0.0001
Rootstock | ≤0.0001
Scion x Rootstock | 0.0002

University of Florida Commercial standard Data collected on Oct-2020
Preliminary results (2019-2021): Trial 1
Grapefruit scions and rootstocks

‘UF-5-1-99-2’ Pummelette grapefruit on US-942 (A), Sour (B) and X-639 (C), and ‘Star Ruby’ on US-942 (D).
Preliminary results (2019-2021): Trial 2
‘Ray Ruby’ grapefruit and rootstocks

Data collected on Oct-2020
Preliminary results (2019-2021): Trial 2
‘Ray Ruby’ grapefruit and rootstocks

‘Ray Ruby’ grapefruit on A+VolkxOrange-19-11-8 (A) and Orange 16 (B).
Preliminary results (2019-2021): Trial 3
‘Glen F-56-11’ navel orange and rootstocks

Data collected on Oct-2020
Preliminary results (2019-2021): Trial 3
‘Glen F-56-11’ navel orange and rootstocks

‘Glen F-56-11’ navel orange on C-22 (A) and Willits (B).
Preliminary results (2019-2021): Trial 4
‘UF 950’ mandarin and rootstocks

Data collected on Oct-2020
Preliminary results (2019-2021): Trial 4
‘UF 950’ mandarin and rootstocks

‘UF 950’ mandarin on US-942 (A) and WGFT+50-7 (B).
<table>
<thead>
<tr>
<th>Trunk diameter (mm)</th>
<th>Canopy volume (m$^3$)</th>
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<td>4</td>
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<tr>
<td>4.5</td>
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</tbody>
</table>

- UFR-1, UFR-2, UFR-5, UFR-17
- C-54, Orange-16
- US-812, 46x20.04-6
- US-897, 46x20.04-6
- US-902, 46x20.04-6
- US-952
- US-959
- X-509
- X-518
- UFR-O5
- C-22
- X-915

Trunk diameter (mm) vs Canopy volume (m$^3$) for various cultivars and accessions.
Is HLB around?
Summary

- **Trial 1**
  ‘UF-5-1-99-2’ Pummelette had the highest canopy volume, and US-942 induced large-size trees

- **Trial 2**
  US-812 along with other rootstocks → largest ‘Ray Ruby’ grapefruit trees

- **Trial 3**
  C-22 along with other rootstocks → greatest ‘F-56-11 Glenn’ navel orange trees

- **Trial 4**
  US-942 along with other rootstocks → best ‘UF 950’ mandarin trees

- **Overall T2-T4**
  The cultivar performance is directly influenced by the rootstock used, with US-942, X-639 and UFR-15 producing the largest trees
INNOVATION: 2020 UF/IFAS IRREC “Millennium Block Drive-thru Field Day”

https://www.youtube.com/watch?v=ytnUNFy0PeM
Acknowledgments

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Funding provided by the UF/IFAS Dean of Research (Dr. Jackie Burns), UF/IFAS IRREC, and Citrus Research and Development Foundation (CRDF) project #18-037C.
Projects at the Ferrarezi Lab

- **Host**
  - Precision irrigation
  - Soil/Foliar enhanced fertilization and high planting density
  - Variety performance trial

- **Vector**
  - Citrus Under Protective Screen (CUPS)
  - Mini-CUPS or IPC

- **Bacteria**
  - Antibiotics (Chemotherapy)
  - HLB-free nursery plant production
Citrus Under Protective Screen (CUPS)

This work is supported by the USDA National Institute of Food and Agriculture, USDA-NIFA-CDRE project 2018-70016-27387.
Irrigation management
Objectives

- Treatments:
  - Two production systems (¼-acre each):
    - Enclosure (100-ft wide × 120-ft long × 14-ft tall screen house)
    - Open-air
  - Two planting systems:
    - In-ground with typical Riviera sandy soil
    - Potted in 10-gal plastic containers (#10 Accelerator AP-10; Nursery Supplies, Chambersburg, PA) with substrate [50% Canadian sphagnum peat moss, 39% coarse expanded perlite & 11% medium expanded vermiculite (Fafard Citrus Mix Rsi; Sun Gro Horticulture, Agawah, MA)]
  - Three irrigation managements:
    - Weather-based
    - Soil-based with irrigation triggered when soil moisture drops below 33% Maximum Allowable Depletion (MAD)
    - Soil-based with irrigation triggered when soil moisture drops below 50% MAD
- Replications: 3
- Experimental design: Split-split plot
Experimental details

- **Plant material:** ‘Ray Ruby’ grapefruit on **US-897** rootstock planted Sept/2013
- **Treatments:**
  - Two production systems (¼-acre each):
    - Enclosure (100-ft wide × 120-ft long × 14-ft tall screen house)
    - Open-air
  - Two planting systems:
    - In-ground with typical Riviera sandy soil
    - Potted in 10-gal plastic containers (#10 Accelerator AP-10; Nursery Supplies, Chambersburg, PA) with substrate [50% Canadian sphagnum peat moss, 39% coarse expanded perlite & 11% medium expanded vermiculite (Fafard Citrus Mix Rsi; Sun Gro Horticulture, Agawam, MA)]
  - Three irrigation managements:
    - Weather-based
    - Soil-based with irrigation triggered when soil moisture drops below 33% Maximum Allowable Depletion (MAD)
    - Soil-based with irrigation triggered when soil moisture drops below 50% MAD
- **Replications:** 3
- **Experimental design:** Split-split plot
MATERIAL AND METHODS

Connection diagram

Solar panel

Battery

Data logger

Station Radio

Yagi Antenna

Transformer

Relay rivers

Irrigation trial

Soil Moisture Sensor

Fertilization trial

28VAC

12VDC

Transformer

Relay rivers

Irrigation trial

Soil Moisture Sensor

Fertilization trial

24VAC
- Volumetric Water Content (VWC) is recorded every 30 minutes.
- The graphs show how the soil moisture responds to irrigation and rain events.
‘Ray Ruby’ grapefruit on US-897

<table>
<thead>
<tr>
<th>Factor</th>
<th>P-value</th>
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<tbody>
<tr>
<td>C</td>
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Fertilization management
Objectives

To identify the best fertilization strategy for grapefruit cultivated under protective screen using granular and liquid fertilizer application.
Materials and Methods

Experimental details

- Plant material: ‘Ray Ruby’ grapefruit on Sour Orange rootstock planted Sept/2013
- Treatments:
  - Two production systems (¼-acre each)
    - Enclosure (100-ft wide × 120-ft long × 14-ft tall screen houses)
    - Open-air
  - Two planting systems
    - In-ground with typical Riviera sandy soil
    - Potted in 10-gal plastic containers (#10 Accelerator AP-10; Nursery Supplies, Chambersburg, PA) with substrate [50% Canadian sphagnum peat moss, 39% coarse expanded perlite & 11% medium expanded vermiculite (Fafard Citrus Mix Rsi; Sun Gro Horticulture, Agawam, MA)]
  - Fertilization methods
    - Fertigation (daily)
    - Fertigation (weekly)
    - Controlled-release fertilizer applied by soil 3x/year
- Replications: 3
- Experimental design: Split-split plot
`Ray Ruby` grapefruit on Sour Orange

<table>
<thead>
<tr>
<th>Factor</th>
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<td>C x P x F</td>
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QUESTIONS???