Citrus Production Basics

Brief History of Satsuma Production in AL

- In 1923, there were 12,000 bearing acres of satsumas in South Alabama. 6,000 acres non-bearing.
- Production in 1923 was 700 train carloads. Valued at $1.25 million. Growers got $1.50 for 3/4 bu. Box (~35 lbs).
  - At ~0.75$ per lb would be ~$21.9 million
- A freeze of 11 F on 1/7/24 destroyed the entire fruit crop for 1924.
- A freeze of 20 F on 11/20/40 destroyed the industry.

Alabama Citrus History

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What happened?

- 1923 harvest – peak for AL (700 carloads)
- Jan. 6, 1924 – sudden temp. drop to 12F
- 1928 – freeze damage
- 1930 – severe freeze
- 1933 – severe freeze
- 1935 – 2 freeze events
- Gradual dying out of trees as a result of freeze injury (1930, 33, 35)
- Nov. 20, 1940 – sudden change in temp. from 80F to 20F. Also, very cold January.

Satsuma industry is on the rise again

NY TIMES April 18, 1915
Cold Hardiness of Satsumas and other Citrus

<table>
<thead>
<tr>
<th>Citrus</th>
<th>Hardiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trifoliate Orange</td>
<td>***** superior</td>
</tr>
<tr>
<td>Kumquat</td>
<td>***** excellent</td>
</tr>
<tr>
<td>Changsha</td>
<td>****</td>
</tr>
<tr>
<td>Satsuma</td>
<td>***** excellent</td>
</tr>
<tr>
<td>Clementine</td>
<td>***good</td>
</tr>
<tr>
<td>Navel Orange</td>
<td>** fair</td>
</tr>
<tr>
<td>Valencia Orange</td>
<td>**</td>
</tr>
<tr>
<td>Lemons &amp; Limes</td>
<td>*poor</td>
</tr>
</tbody>
</table>

Hardiness a function of genotype, growth rate, and cold weather conditioning (acclimation).

World Fresh Citrus Market 2015-16
(1,000 metric tons)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total</th>
<th>Sweet Orange</th>
<th>Tangerine/Mandarin</th>
<th>Grapefruit</th>
<th>Lemon/Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>31,300</td>
<td>7,000</td>
<td>20,000</td>
<td>4,300</td>
<td>-</td>
</tr>
<tr>
<td>Brazil</td>
<td>14,350</td>
<td>14,350</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>EU</td>
<td>10,467</td>
<td>6,055</td>
<td>3,035</td>
<td>97</td>
<td>1,260</td>
</tr>
<tr>
<td>US</td>
<td>7,829</td>
<td>5,371</td>
<td>876</td>
<td>735</td>
<td>847</td>
</tr>
<tr>
<td>Mexico</td>
<td>6,235</td>
<td>3,535</td>
<td>-</td>
<td>430</td>
<td>2,270</td>
</tr>
</tbody>
</table>

Interesting Statistics

US Citrus Market 2015-16
(1,000 metric tons)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production</th>
<th>Consumption</th>
<th>Export</th>
<th>Import</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oranges</td>
<td>5,371</td>
<td>1,476</td>
<td>645</td>
<td>175</td>
</tr>
<tr>
<td>Tangerines</td>
<td>876</td>
<td>900</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>735</td>
<td>361</td>
<td>123</td>
<td>13</td>
</tr>
<tr>
<td>Lemon/Lime</td>
<td>875</td>
<td>1,036</td>
<td>111</td>
<td>605</td>
</tr>
</tbody>
</table>

Varieties and Variety Selection

- Loose-skinned
- Deeply colored
- Highly flavorful

- Types
  - Mandarins
  - Satsumas
  - Tangerines
  - Hybrids

- Classic Orange
- Comm. seedless
- Hamlin
- Amberseed

- Navel
- Valencia - juice

- Named for its clustering fruit habits
- Can be white, red, or pink
### Satsuma

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armstrong Early</td>
<td>Early Oct.</td>
<td></td>
</tr>
<tr>
<td>Early St. Ann</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LA Early</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Okitsu Wase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China S-9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown’s Select</td>
<td>Midseason (Late Oct.)</td>
<td></td>
</tr>
<tr>
<td>Kimbrough</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Neches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owari</td>
<td>Standard Mid Nov</td>
<td></td>
</tr>
<tr>
<td>Silverhill</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dobashi Beni</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Sweet Orange

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington (Navel)</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Cara Cara (Navel)</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Hamlin</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Ambersweet</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
</tbody>
</table>

### Tangerines and Hybrids

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clementine</td>
<td>Nov-Dec</td>
<td>Cross-Pollination</td>
</tr>
<tr>
<td>Ponkan</td>
<td>Nov-Jan</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Dancy</td>
<td>Dec-Jan</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Orlando</td>
<td>Oct-Dec</td>
<td>Cross-Pollination</td>
</tr>
<tr>
<td>Robinson</td>
<td>Very early</td>
<td>Cross-Pollination</td>
</tr>
<tr>
<td>Sunburst</td>
<td>Very early</td>
<td>Cross-Pollination</td>
</tr>
<tr>
<td>Lee</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Osceola</td>
<td>Dec-Jan</td>
<td>Cross-Pollination</td>
</tr>
</tbody>
</table>

### Grapefruit

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruby (Redblush)</td>
<td>Early</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Duncan</td>
<td>Oct-Dec</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Triumph</td>
<td>Oct-Dec</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Royal</td>
<td>Dec-Jan</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Rio Red</td>
<td>Dec-Jan</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Marsh</td>
<td>Feb-Jan</td>
<td>Self-fruiting</td>
</tr>
</tbody>
</table>

### Lemon and Lime and Lime Hybrids

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ripening</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meyer (lemon)</td>
<td>Sept-Nov</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Key(lime)</td>
<td>Oct-Dec</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Persian (lime)</td>
<td>Oct-Dec</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Eustis (lime hyb)</td>
<td>All Year</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Lakeland (lime hyb)</td>
<td>All Year</td>
<td>Self-fruiting</td>
</tr>
<tr>
<td>Tavares (lime hyb)</td>
<td>All Year</td>
<td>Self-fruiting</td>
</tr>
</tbody>
</table>
Citrus trees are grown (by grafting) on rootstocks

- Common rootstocks
  - Trifoliate Orange, Sour Orange, Rough Lemon, Swingle Citrumelo, Cleopatra Mandarin, etc.
- Size Control—Dwarfing (Flying Dragon)
- Nematode and Phytophthora resistance
- CTV Resistance
- Soil pH tolerance
- Cold tolerance (Trifoliate Orange is best)
Satsuma (*Citrus unshiu*)

- Satsuma on Trifoliate Orange rootstock is one of the most cold hardy commercial citrus plants.
  - Tolerates temperatures as low as 12-14°F when acclimated, but can be damaged at 20-23°F when not acclimated.

**Some Things to Remember**

- Plant varieties that can be harvested during the early season (September – November)
- Mandarin are the most cold-hardy.
- Satsuma Mandarin best suited
- Grapefruit requires cold protection
- If cross-pollination is required for a variety choose another variety that flowers at the same time.
- Trifoliate Orange rootstock – ‘Flying Dragon’
- High tunnel production opens the door.

**Rootstocks**

- ‘Rubidoux’ Trifoliate Orange
- ‘Flying Dragon’ Trifoliate Orange
- ‘Citrumelo’ Trifoliate Orange

**Site Selection and Plant Establishment**

- Full sun
- Interplanted Satsuma
- Well drained sandy loam soils
- Plant spacing 10 ft -15 ft within-row; 20 ft between rows; smaller plants can be spaced 8 ft – 10 ft within-row
- Dwarfing rootstock (‘Flying Dragon’) 10ft within rows in high tunnel
- Early varieties on Flying Dragon can be spaced closely

**Situation and Plant Establishment**

- Container or burlap
- Purchase healthy 1-year-old trees 3/8 – 5/8 in. caliper measured 1 in. above graft union
- 2-year-old trees 5/8 – 1 in. caliper
- Ideal time to plant: Early spring
- Individual tree planting sites: 4 ft – 5ft diameter with all grasses and weeds cleared
- Soil tests should be performed the fall prior to the season of planting
Site Selection and Plant Establishment

- Prepare a hole large enough for root ball.
- Place root ball in the hole keeping root ball level with the ground surface.
- Refill hole with half the required soil add water to settle the soil.
- Finish back-filling the hole
- Pack soil firmly against the trunk
- Using the soil, create a water basin 30 – 36 in. diameter and 4 in. high

Site Selection and Plant Establishment

- Water twice weekly 1 to 2 in. per week during first two weeks
- Reduce watering to once per week
- Water every 7 – 10 days once plants are established during the growing season
- Keep area around plant free of grass and weeds.

Pruning

- Citrus requires minimal pruning during the first year
- Should remove shoots below the scaffold limbs
- Scaffold branches should be 18 – 20 in. from the soil
- At planting: Cut branches back to 6 – 12-in. stubs
- No pruning is required to produce fruit
- Pruning should occur in the spring and summer

How much fertilizer?

<table>
<thead>
<tr>
<th>Tree Age</th>
<th>Lbs N per Tree per Year</th>
<th>Lbs 8-8-8 per Tree per Year</th>
<th>Lbs 13-13-13 per Tree per Year</th>
<th>Lbs 16-4-8 per Tree per Year</th>
<th>Lbs 34-0-0 per Tree per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planting Year</td>
<td>0.05 oz.</td>
<td>10 oz.</td>
<td>6 oz.</td>
<td>7 oz.</td>
<td>2.4 oz.</td>
</tr>
<tr>
<td>1-yr-old</td>
<td>0.2</td>
<td>2.5</td>
<td>1.5</td>
<td>1.25</td>
<td>0.6</td>
</tr>
<tr>
<td>2-yr-old</td>
<td>0.4</td>
<td>5</td>
<td>3</td>
<td>2.5</td>
<td>1.2</td>
</tr>
<tr>
<td>3-5-yr-old</td>
<td>0.75</td>
<td>9.4</td>
<td>5.8</td>
<td>4.7</td>
<td>2.2</td>
</tr>
<tr>
<td>7-8-yr-old</td>
<td>1</td>
<td>12.5</td>
<td>7.7</td>
<td>6.25</td>
<td>3</td>
</tr>
<tr>
<td>9-yr-old</td>
<td>1.5</td>
<td>18.75</td>
<td>11.5</td>
<td>9.4</td>
<td>4.4</td>
</tr>
<tr>
<td>10-yr-old</td>
<td>1.5</td>
<td>18.75</td>
<td>11.5</td>
<td>9.4</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Only one fertilizer source should be used at the rates indicated. If a combination of more than one fertilizer is desired in the same year, the rates of each should be reduced to meet the correct rates.

When do I fertilize?

Fertilize 3 times per year:

- Early budbreak, Fruit Swell, 1” diam. fruit
- Valentine’s Day, Mother’s Day, Father’s Day

Some Things to Remember

- Proper spacing
- Full sun
- Well drained soils
- Caliper is appropriate for plant age
- Plant at proper depth
- Water appropriately
- Very little pruning is required
- Fertilize at the appropriate times and at recommended amounts
What causes large, thick-skinned, rough fruit?

- Light Crop or High Leaf to Fruit Ratio
  - Common on young plants
- Freeze injury to Foliage
  - Heavy Fruit drop
- Inadequate Fertilizer in Heavy Crop Year, resulting in Alternate Bearing
- Late blooming

Spring Irrigation

- Water stress during bloom/set period can reduce number of fruit per tree.
  - Increased abortion, especially young trees.
- Fruit size can be reduced by water stress during the early swell period.
- Irrigate when soil moisture drops below 66% of available water

Fall Irrigation

- Heavy rains or irrigation in fall may reduce solids (sugar) and total acidity in fruit, by dilution effect; increasing juice content.
- Excessive dry spell when fruit is ripe will cause reduction of peel turgor.
- Irrigate when available water falls below 33%.

Summer Irrigation

- Irrigate when available water is below 66%
- 3/4 acre inch water per week=200 gallons per tree per week or 28 gallons per day.
- A 12 gph microjet operated twice per week would be run 8 hours each time.
  - Three times per week, 5 hours per run would be better.

Internal quality

- Brix=soluble solids=Sugar
  - Measured by light refractometer
- Titratable acidity=% Citric Acid
  - Measured by acid titration procedure

Brix: Acid Ratio (10:1 desired)
8.7 Brix: 0.87% Acid=10:1
6.8 Brix: 0.68% Acid=10:1
Not the same tasting fruit!!!

Factors that increase tree health and canopy sunlight reception increase accumulation of soluble solids!
In-ground citrus production is suited for the coastal region of Alabama. Cold is limiting factor, and container production is necessary for citrus in more northerly counties of Alabama. Many citrus plants can withstand 18-20°F. Leaf temps can fall 4° below ambient. Citrus fruit freezes at ~26°F.

**Varieties Recommended for Container Production**
- Owari Satsuma mandarin
- Brown's Select Satsuma mandarin
- Kimbrough Satsuma mandarin
- Nagambi Kumquat
- Meyer Kumquat

Citrus trees are usually sold in 2-3 gallon containers. Re-pot after the first year and every 3-5 years thereafter. A 15 gallon nursery container is recommended.

Pots should allow good drainage. Cut holes in the sides of the pot near the bottom. Do not use garden soil. Use a 4:1 mixture of pinebark and sand. Proper planting depth is crucial.
Production Areas Today

**Container Culture**

*Watering and Fertilizing*

- Requires more frequent watering than soil cultivated citrus
- Frequent watering leaches nutrient
- Use a slow-release fertilizer
- Micronutrients

**Diseases**

- Root rot
- Sooty mold fungus

**Insect Challenges**

- Spider Mites
- Citrus Rust Mites
- Scale
- Aphids
- Citrus Leaf Minor

**Alexander City, AL**

**Large Container**

- Well drained media
- 4:1 pine bark to sand
- Stable Moisture
- Slow Release Fertilizer (with minors)

**Pest Control**

- Mealybugs, mites, whitefly,

**Some Things to Remember**
What pests should you be concerned about?

- Rust Mites
- Red Spider Mites
- Birds (mockingbirds, thrushes, blackbirds)
- Melanose Disease
- Leaf-footed Bugs & Stinkbugs
- Scale
- Whiteflies
- Citrus Leafminers
- Citrus Scab

Ultra Fine Oil: (Paraffinic oil)
Use when temp. <90 °F and plants are well watered.
Invasive Diseases

- CTV (Citrus Tristeza Virus)
- Citrus Canker
- Citrus Greening Disease

Citrus Greening:
Serious threat to Alabama citrus

Symptoms:
- Vein yellowing
- Blotchy Mottle
- Leaves small and upright
- Poorly developed root system
- Fail to color properly
- Salty and bitter taste
- Productivity decline

AKA: Huanglongbing
Discovered in FL in 1998

http://nationalcleanplantnetwork.org/Citrus/
OrangeDog

Mothra

The End
Questions ?