Citrus Nutrition in North Florida

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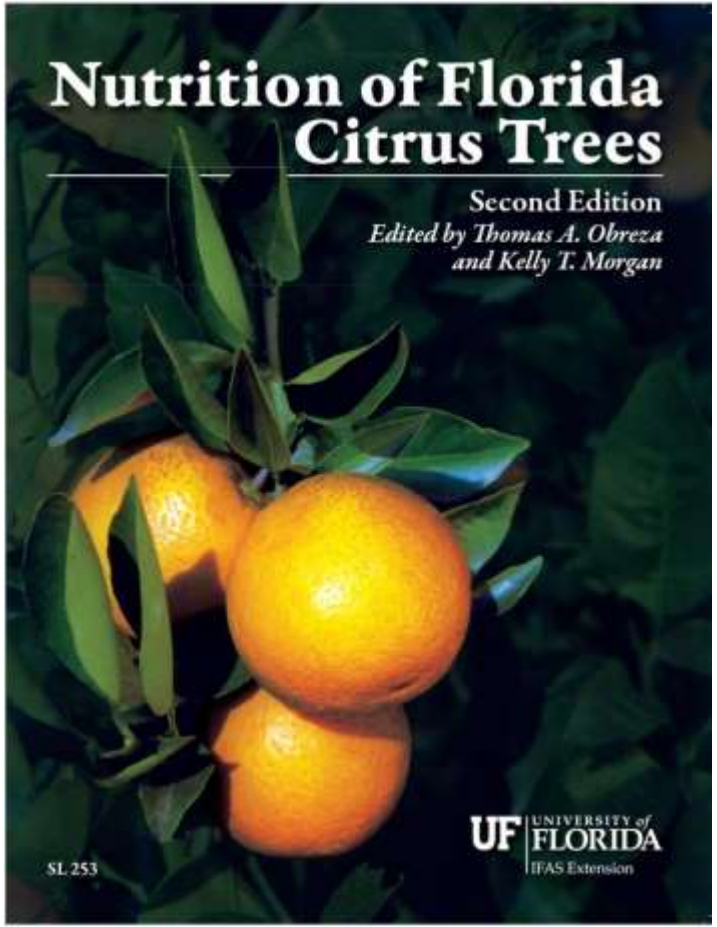

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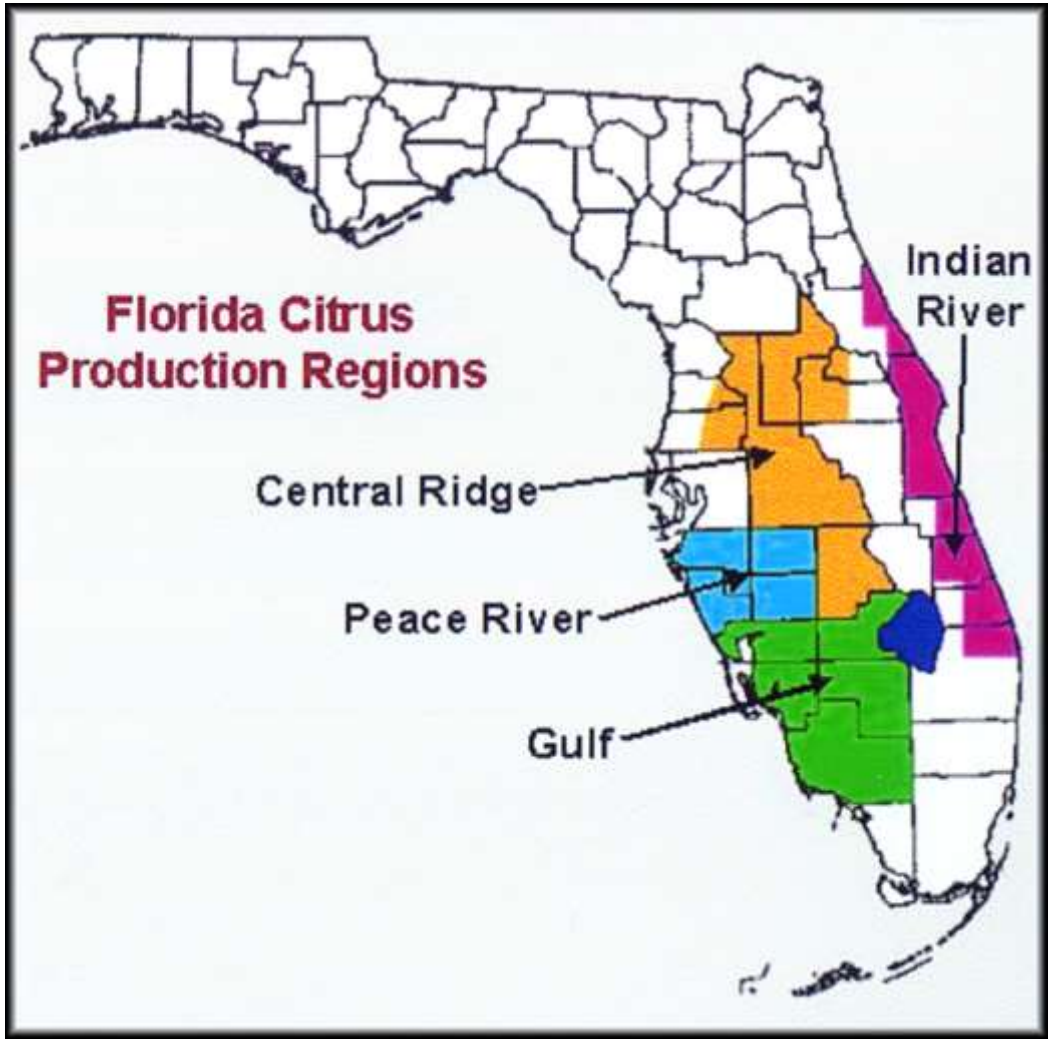
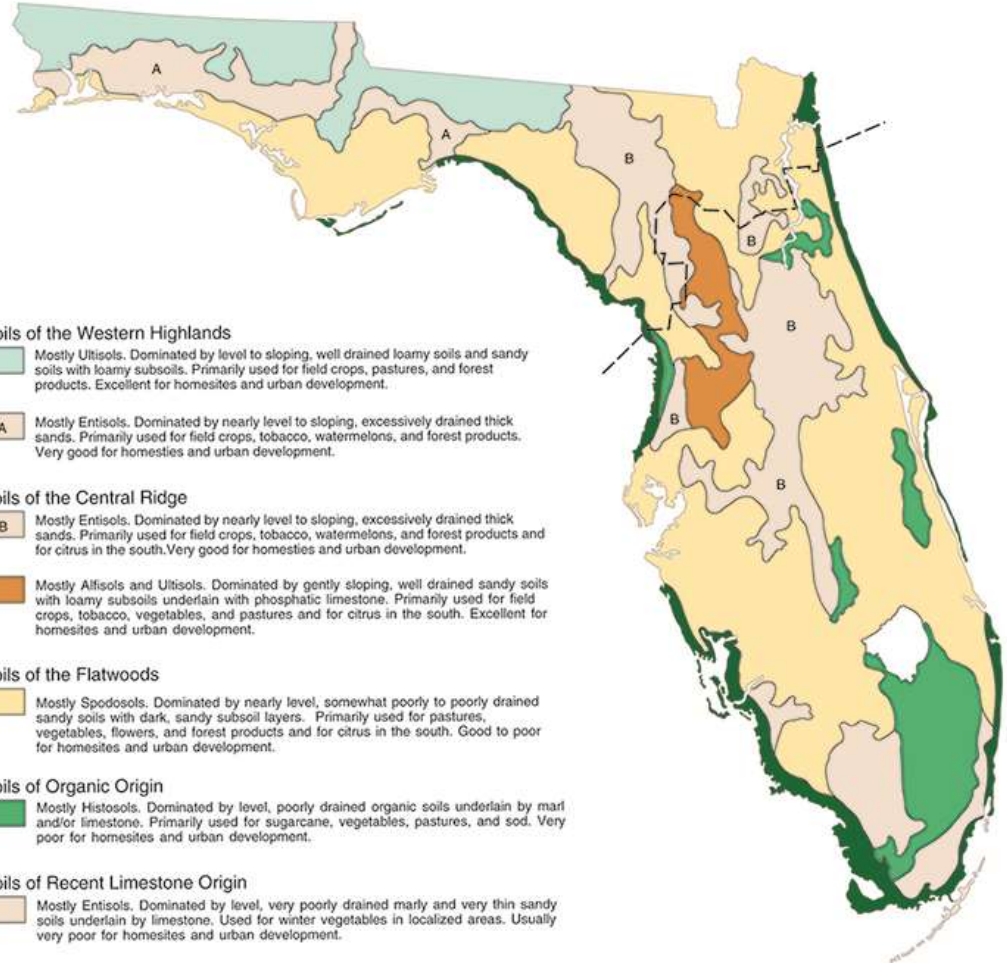

Florida Citrus
Production Regions
Indian
River
Central Ridge
Peace River
Gulf

Considerations using SL 253 in north Florida

Factor	Commercial FL citrus industry	North Florida
Soil	Sandy topsoil, lack of clay, low organic matter, varying drainage.	Similar soils, but will find clay in root zone and higher OM.
Fruit production	Production dominated by juice oranges, with some fresh fruit.	Fresh fruit production… mandarins, navels, etc.
Climate	Longer growing season, fewer freezes of shorter duration.	Shorter growing season, more frequent freezes of longer duration, lower temps.

Soil considerations

Soil Types



Soils of the Western Highlands

Mostly Ultisols. Dominated by level to sloping, well drained loamy soils and sandy soils with loamy subsoils. Primarily used for field crops, pastures, and forest products. Excellent for homesites and urban development.

A — Mostly Entisols. Dominated by nearly level to sloping, excessively drained thick sands. Primarily used for field crops, tobacco, watermelons, and forest products. Very good for homesties and urban development.

Soils of the Central Ridge

B — Mostly Entisols. Dominated by nearly level to sloping, excessively drained thick sands. Primarily used for field crops, tobacco, watermelons, and forest products and for citrus in the south.Very good for homesties and urban development.

Mostly Alfisols and Ultisols. Dominated by gently sloping, well drained sandy soils with loamy subsoils underlain with phosphatic limestone. Primarily used for field crops, tobacco, vegetables, and pastures and for citrus in the south. Excellent for homesites and urban development.

Soils of the Flatwoods

Mostly Spodosols. Dominated by nearly level, somewhat poorly to poorly drained sandy soils with dark, sandy subsoil layers. Primarily used for pastures, vegetables, flowers, and forest products and for citrus in the south. Good to poor for homesites and urban development.

Soils of Organic Origin

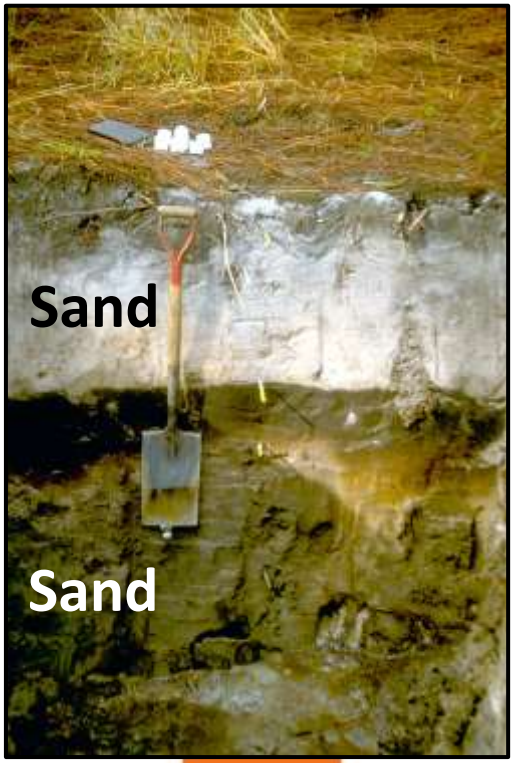
Mostly Histosols. Dominated by level, poorly drained organic soils underlain by marl and/or limestone. Primarily used for sugarcane, vegetables, pastures, and sod. Very poor for homesites and urban development.

Soils of Recent Limestone Origin

Mostly Entisols. Dominated by level, very poorly drained marly and very thin sandy soils underlain by limestone. Used for winter vegetables in localized areas. Usually very poor for homesites and urban development.

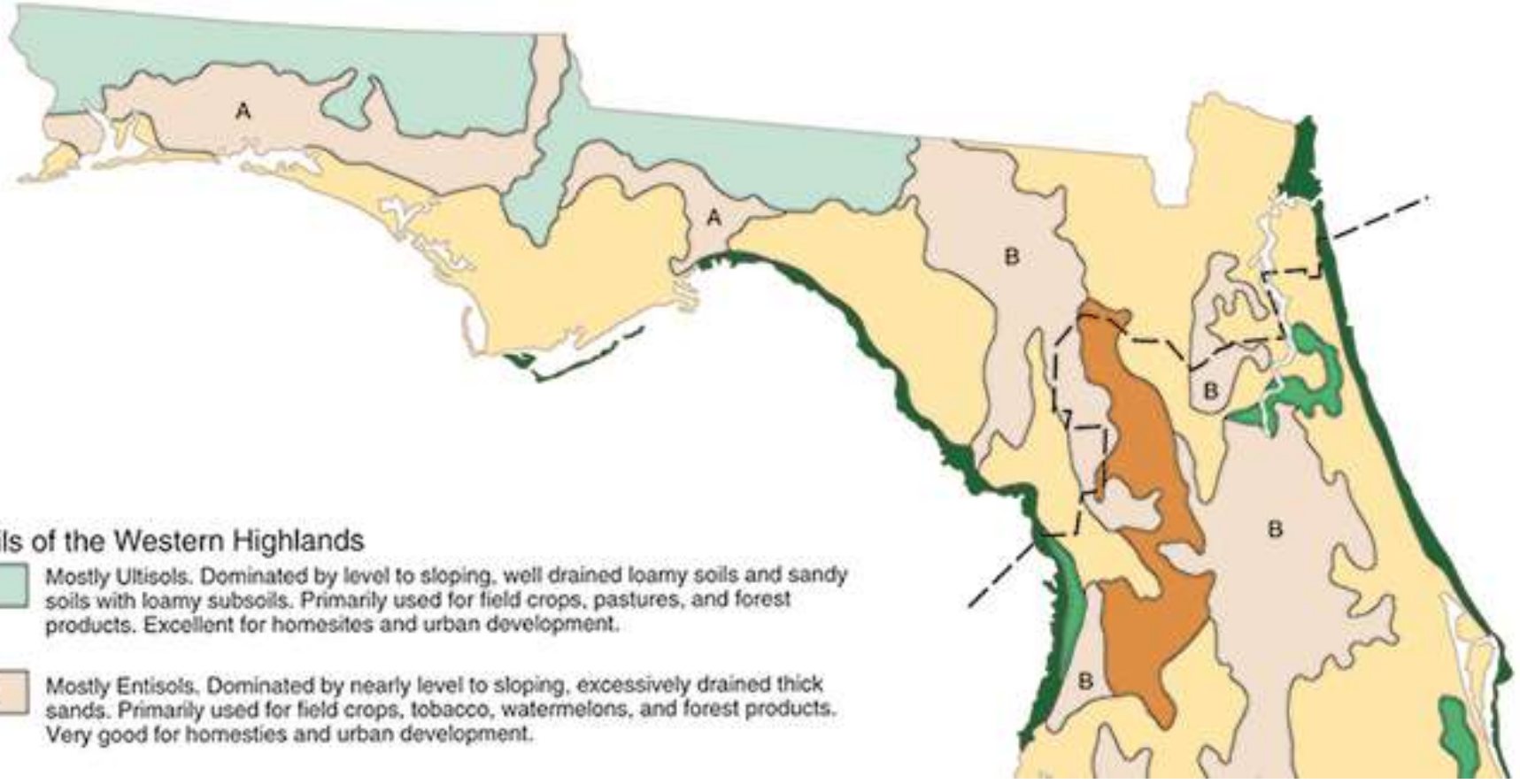
Candler
(Ridge)

Myakka
(Flatwoods)



Riviera
(Flatwoods)

Soil Types



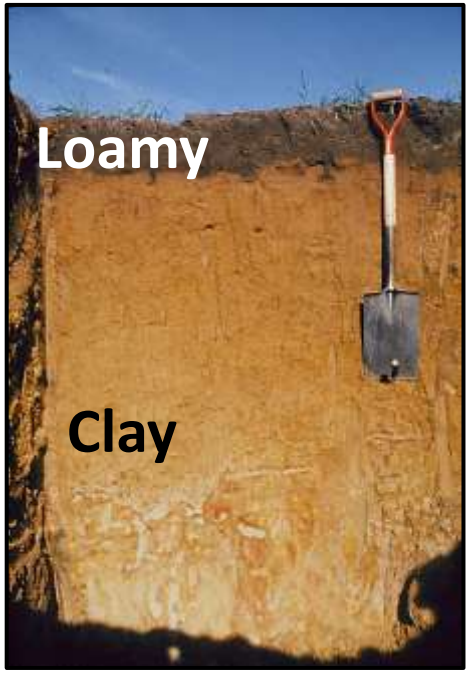
Soils of the Western Highlands

Mostly Ultisols. Dominated by level to sloping, well drained loamy soils and sandy soils with loamy subsoils. Primarily used for field crops, pastures, and forest products. Excellent for homesites and urban development.

A

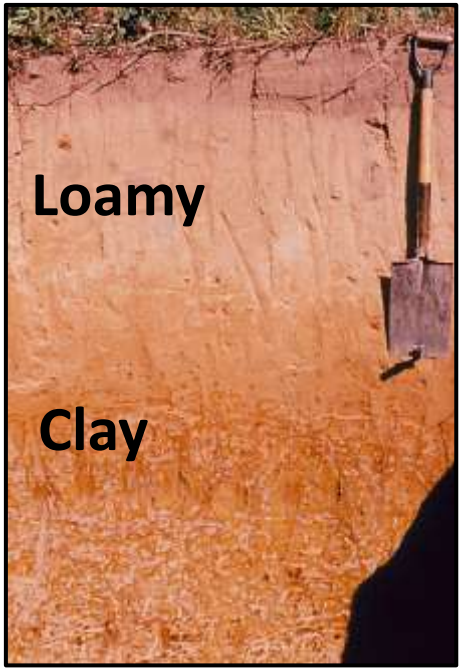
Mostly Entisols. Dominated by nearly level to sloping, excessively drained thick sands. Primarily used for field crops, tobacco, watermelons, and forest products. Very good for homesties and urban development.

Dothan
Walton Co.



Orangeburg
Walton Co.

Fuquay
Madison Co.



Faceville
Jefferson Co.

Soil considerations in nutrient management

- pH (5.5 to 6.5)
- Organic matter (nutrient-holding capacity)
- Sand/Silt/Clay texture (water-holding capacity)

Greater than 2% OM and/or loamy texture in root zone:

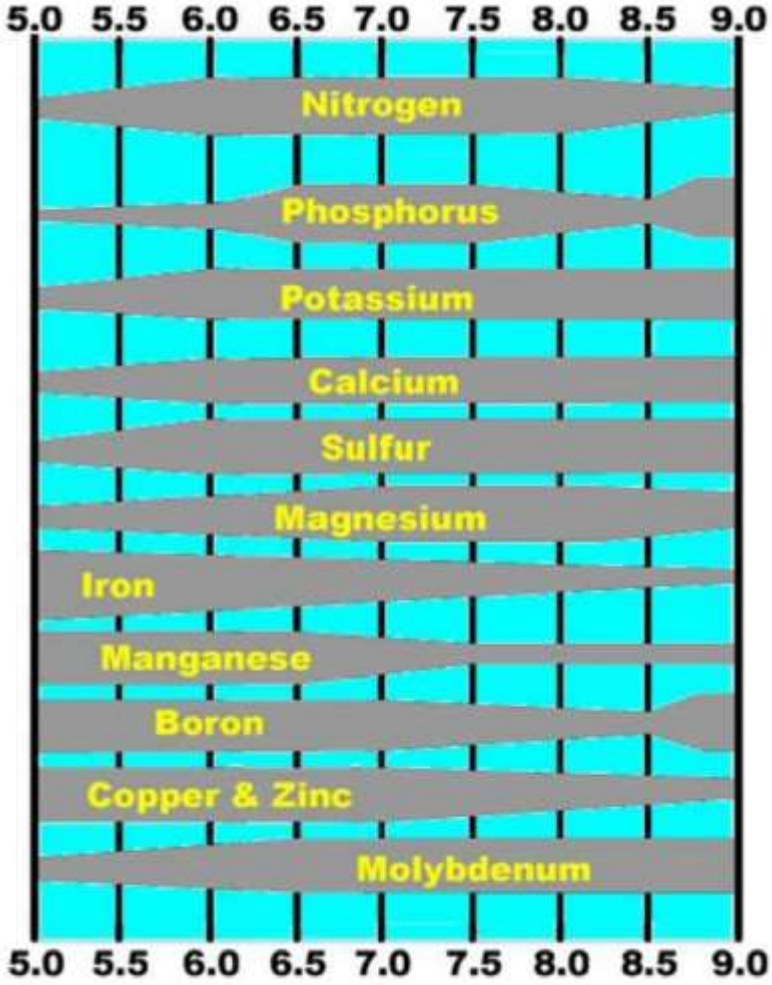
Use lower end of recommended nitrogen fertilization range.

Less than 1% OM with sandy texture:

Use higher end of recommended nitrogen fertilization range.

Plant nutrient considerations

Primary:	N, P, K
Secondary:	Ca, Mg, S
Micro:	Cu, Zn, Mn, Fe, B, Mo

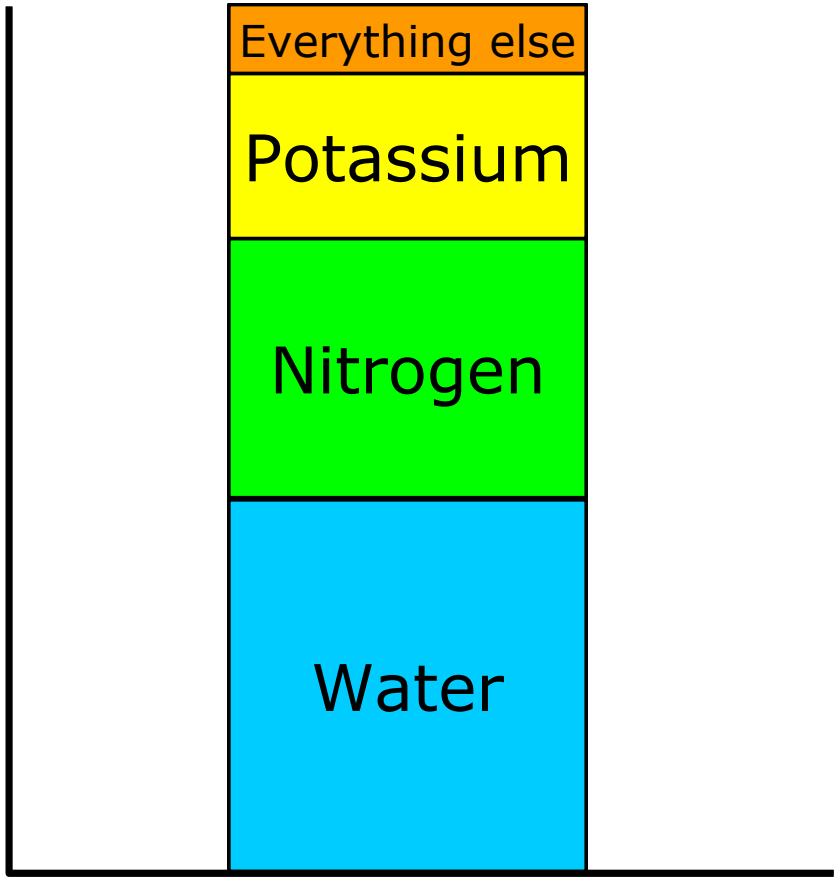

5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0
Nitrogen
Phosphorus
Potassium
Calcium
Sulfur
Magnesium
Iron
Manganese
Boron
Copper & Zinc
Molybdenum
5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0

Nutritionally, what takes you from here……to here?

2nd year

8th year

Relative importance of nutritional factors affecting citrus tree growth, yield, and fruit quality.



Young trees (first 3 years)

Nitrogen

Table 8.1. Recommended N rates and minimum number of annual applications for non-bearing citrus trees.

Year in grove	lbs N/tree/year (range)	Lower limit of annual application frequency		
		Controlled-release fertilizer	Dry soluble fertilizer	Fertigation
1	0.15 – 0.30	1	6	10
2	0.30 – 0.60	1	5	10
3	0.45 – 0.90	1	4	10

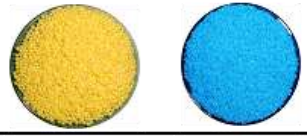
Phosphorus, Magnesium – Apply according to soil test.

Potassium – Apply K_2O equal to N rate.

Calcium – Check soil pH, Lime if needed.

Micronutrients – Apply only if soil was not previously cultivated.

Controlled-release fertilizer materials

<1960s	Manure and other "natural" materials
1960s	Sulfur-coated urea (SCU) Urea formaldehyde (UF) 
1970s	Isobutylidene diurea (IBDU) Methylene urea (MU) 
1980s	Plastic-coated urea (PCU) 
1990s	Plastic-coated, S-coated urea (PCSCU) Resin-coated N-P-K 
2000s	Refinement of earlier technologies 

Experiment: One application of CRF per year

Nitrogen is the most important mineral nutrient needed to build tree canopy

1st year

8th year

Effect of K fertilizer on tree growth

Without K fertilizer

With K fertilizer

Severe K deficiency

Effect of P fertilizer on tree growth

Without P fertilizer

With P fertilizer

Bearing trees – Nutrients removed in harvested crop

Table 3.3. Total amounts of various nutrients in 100 boxes[1] of orange fruits.

Nutrient	Hamlin[2]	Hamlin[3]	Hamlin[4]	Parson Brown[3]	Valencia[3]	Sunburst[3]	Average
	lbs nutrient/100 boxes of fruit						
N	12.5	10.6	10.8	11.3	13.5	13.6	12.1
P	1.4	1.5	1.7	1.5	2.0	1.8	1.7
K	17.6	13.6	13.9	13.3	14.4	14.0	14.5
Ca	4.5	4.0	5.2	4.9	4.3	3.4	4.4
Mg	1.9	1.1	1.0	1.2	1.2	1.0	1.2
S	1.1	---	0.8	---	---	---	1.0
Fe	0.024	0.020	0.036	0.030	0.072	0.036	0.036
B	0.020	---	0.025	---	---	---	0.023
Zn	0.020	0.032	0.008	0.032	0.029	0.041	0.027
Mn	0.011	0.020	0.004	0.023	0.023	0.023	0.017
Cu	0.006	0.005	0.006	0.006	0.007	0.007	0.006

[1]1 box of fruit = 90 lbs. [2]A. K. Alva, unpublished data. [3]Paramasivam et al. (2000). [4]Mattos et al. (2003).

Bearing trees - Nitrogen

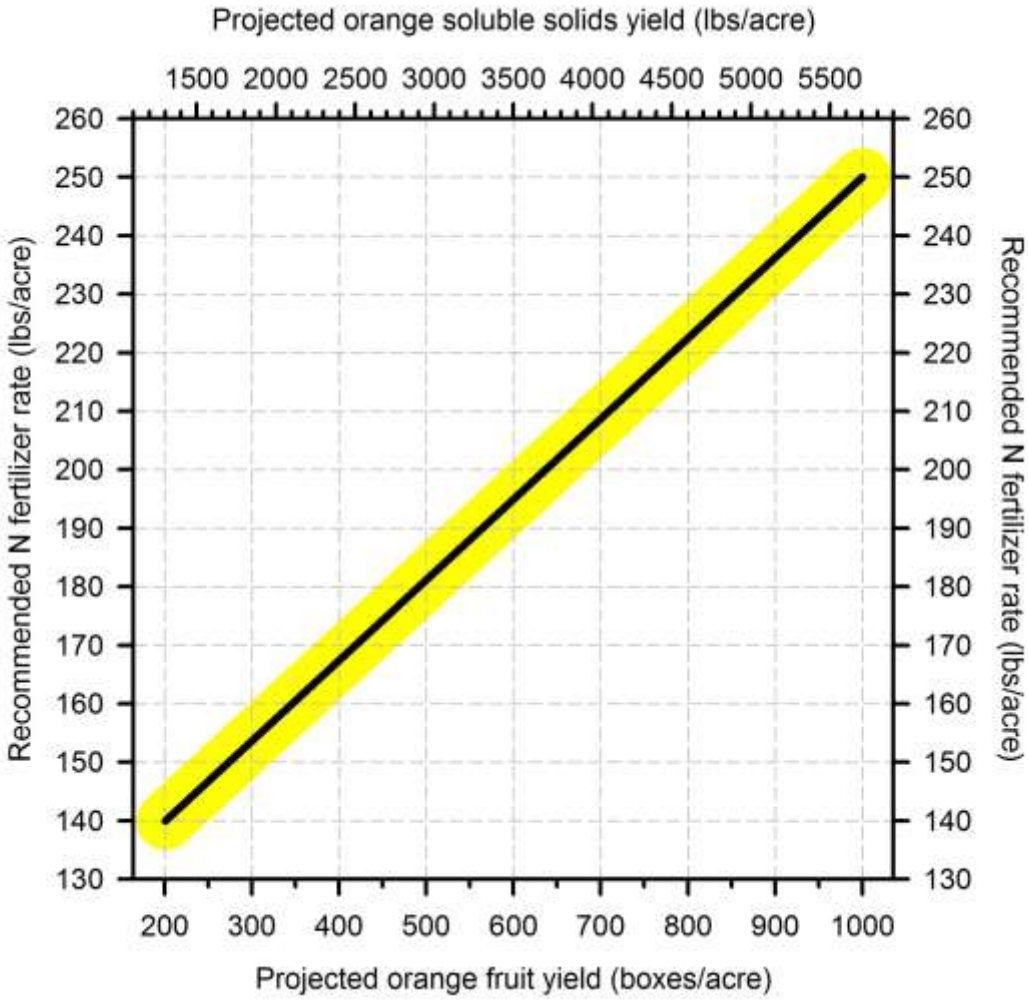
Table 8.2. Recommended N rates and minimum number of annual applications for bearing citrus trees.

Year in grove	Oranges	Grapefruit	Other varieties	Lower limit of annual application frequency		
	lbs N/acre/year (range)			Controlled-release fertilizer	Dry soluble fertilizer	Fertigation
4 through 7	120 – 200	120 – 160	120 – 200	1	3	10
8 and up	140 – 250 Yield-based[1]	120 – 160[2]	120 – 300[3]	1	3	10

[1]See Fig. 8.3 for specific production-based N fertilizer rate recommendations.

[2]For grapefruit groves producing more than 800 boxes/acre, the maximum recommended N rate is 180 lbs/acre.

[3]For Orlando tangelos, the maximum recommended N rate is 250 lbs/acre. For Honey tangerines (Murcotts), the maximum recommended N rate is 300 lbs/acre.


Projected orange soluble solids yield (lbs/acre)
1500 2000 2500 3000 3500 4000 4500 5000 5500
Recommended N fertilizer rate (lbs/acre)
260 250 240 230 220 210 200 190 180 170 160 150 140 130
Recommended N fertilizer rate (lbs/acre)
200 300 400 500 600 700 800 900 1000
Projected orange fruit yield (boxes/acre)

Bearing trees

Phosphorus – Based on soil and leaf tissue tests

Table 8.3. Recommendations for P fertilization of bearing citrus trees based on leaf tissue and soil tests taken according to the guidelines described in Chapter 4 (leaf and soil samples taken in July or August of each year).[1]

If leaf tissue P is...	...and soil test P is...	...the recommendation for P fertilization is:
Excessive or High	Soil test P value is not applicable.	Do not apply P fertilizer to the soil for 12 months following leaf and soil sampling, then sample again and re-evaluate.
Optimum	Sufficient	
Optimum	Less than sufficient	Apply 8 lbs P_2O_5/acre to the soil for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.
Low	Less than sufficient	Apply 12 lbs P_2O_5/acre to the soil for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.
Deficient	Less than sufficient	Apply 16 lbs P_2O_5/acre to the soil for every 100 boxes/acre of fruit produced during the current year. Sample leaves and soil again in 12 months and re-evaluate.

[1]These recommendations do not pertain to foliar-applied P.

Potassium – Apply K_2O equal to N rate; monitor with leaf analysis.

Bearing trees

Calcium – Monitor pH

Magnesium – Monitor soil tests and leaf analysis.

Micronutrients –

Table 8.4. Recommended methods, timing, and rates for micronutrient application to citrus groves.

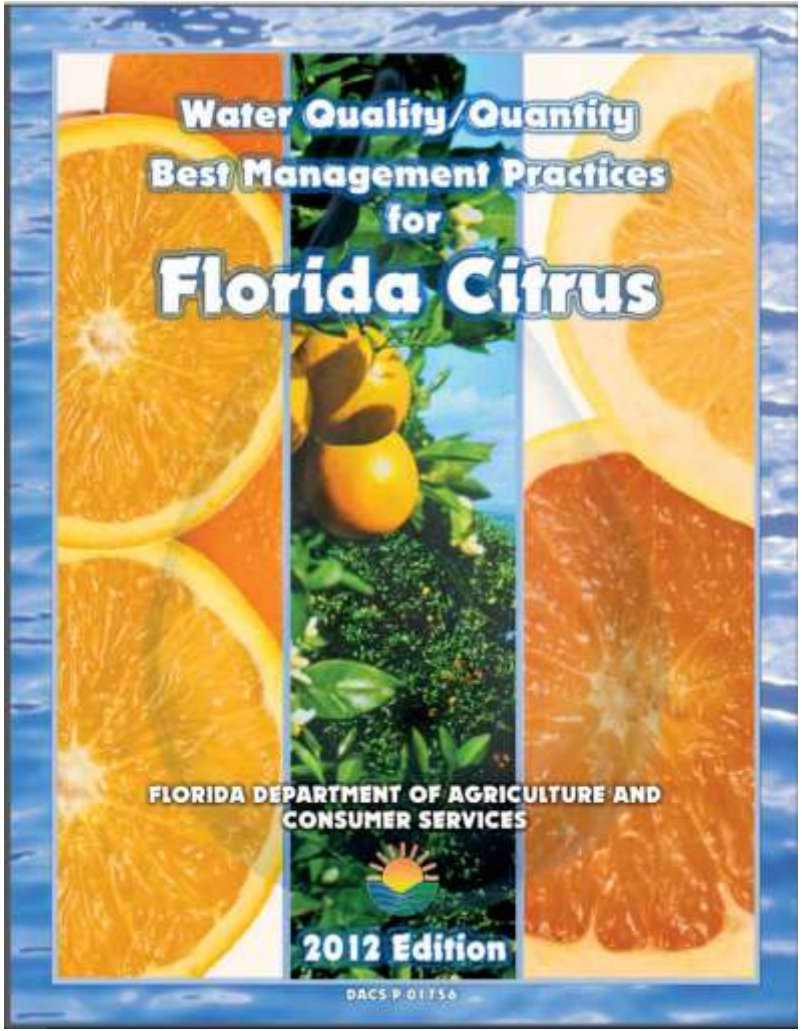
		Mn	Zn	Cu	B	Fe
Method	Foliar	Yes	Yes	Yes	Yes	No
	Soil	Yes[1]	No	Yes	Yes	Yes
Timing	Foliar	When spring flush leaves reach full expansion				
	Soil	Anytime as needed				
Rates		**lbs metallic equivalent/acre**				
	Foliar	3 to 5	5	3 to 5	¼	---
	Soil	7 to 10	---	5	1	See below[2]

[1]Soil applications of Mn are not recommended on calcareous soils.

[2]Acid soil: Fe-EDTA, ⅔ oz elemental Fe/tree; Calcareous soil: Fe-EDDHA, 1¾ oz elemental Fe/tree.

Monitoring citrus nutrition

- Once per year
  - Late summer leaf and soil samples
  - You want 6-month-old spring flush leaves
- Leaf/soil testing is a Best Management Practice (BMP)


Water Quality/Quantity
Best Management Practices
for
Florida Citrus
FLORIDA DEPARTMENT OF AGRICULTURE AND
CONSUMER SERVICES
2012 Edition
DACS P-01756

Soil and leaf testing

Table 4.1. Summary of the usefulness of soil testing and leaf tissue testing as citrus nutrient management tools.

Property or nutrient	Soil testing	Leaf testing
pH	√	
Organic matter	√	
N		√
P	√	√
K		√
Ca	√	√
Mg	√	√
Cu	√	√
Zn, Mn, Fe, B		√

Soil test interpretations

Table 4.4. Interpretation of soil analysis data for citrus using the Mehlich 1 (double-acid) extractant.

Element	Soil test interpretation				
	Very Low	Low	Medium	High	Very High
	mg/kg (ppm)[1]				
P	< 10	10 – 15	16 – 30	31 – 60	> 60
Mg[2]	---	< 15	15 – 30	> 30	---
Ca[2]			250[3]	> 250	
Cu			< 25[4]	25 – 50[5]	> 50[6]

[1]parts per million (ppm) x 2 = lbs/acre.
[2]A Ca-to-Mg ratio greater than 10 may induce Mg deficiency.
[3]The Univ. of Florida Extension Soil Testing Laboratory does not interpret extractable Ca.
Work with Florida citrus trees suggests that a Mehlich 1 soil test Ca of 250 mg/kg or greater is sufficient.
[4]Cu toxicity is unlikely even if soil pH is less than 5.5.
[5]Cu toxicity is possible if soil pH is less than 5.5.
[6]Cu toxicity is likely unless soil pH is raised to 6.5.

Leaf test interpretations

Table 4.2. Guidelines for interpretation of orange tree leaf analysis based on 4 to 6-month-old spring flush leaves from non-fruiting twigs (Koo et al., 1984).

Element	Unit of measure	Deficient	Low	Optimum	High	Excess
N	%	< 2.2	2.2 – 2.4	2.5 – 2.7	2.8 – 3.0	> 3.0
P	%	< 0.09	0.09 – 0.11	0.12 – 0.16	0.17 – 0.30	> 0.30
K	%	< 0.7	0.7 – 1.1	1.2 – 1.7	1.8 – 2.4	> 2.4
Ca	%	< 1.5	1.5 – 2.9	3.0 – 4.9	5.0 – 7.0	> 7.0
Mg	%	< 0.20	0.20 – 0.29	0.30 – 0.49	0.50 – 0.70	> 0.70
Cl	%	---	---	< 0.2	0.20 – 0.70	> 0.70[1]
Na	%	---	---	---	0.15 – 0.25	> 0.25
Mn	mg/kg or ppm[2]	< 18	18 – 24	25 – 100	101 – 300	> 300
Zn	mg/kg or ppm	< 18	18 – 24	25 – 100	101 – 300	> 300
Cu	mg/kg or ppm	< 3	3 – 4	5 – 16	17 – 20	> 20
Fe	mg/kg or ppm	< 35	35 – 59	60 – 120	121 – 200	> 200
B	mg/kg or ppm	< 20	20 – 35	36 – 100	101 – 200	> 200
Mo	mg/kg or ppm	< 0.05	0.06 – 0.09	0.10 – 2.0	2.0 – 5.0	> 5.0

[1]Leaf burn and defoliation can occur at Cl concentration >1.0%.

[2]ppm = parts per million.

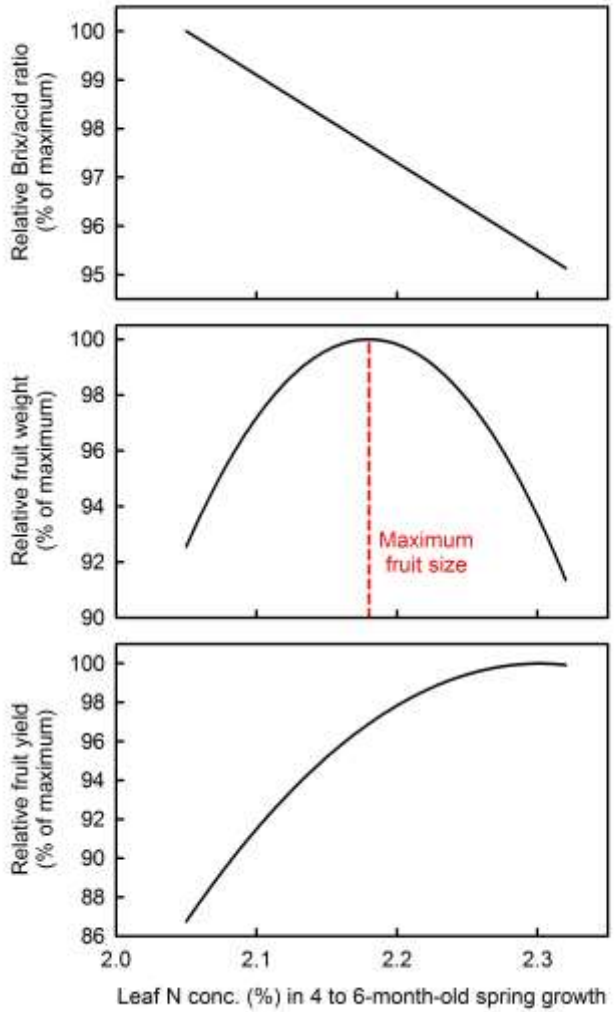
Fresh fruit production considerations

The most important nutrient mgt practices affecting fruit quality are irrigation and N-P-K.

Table 3.4. Increasing levels of nutrients within recommended ranges result in the responses shown, whereas excess nutrition can reduce fruit yield and quality (Koo, 1988). Key to symbols: Increase (+), Decrease (–), No change (o), No information (?).

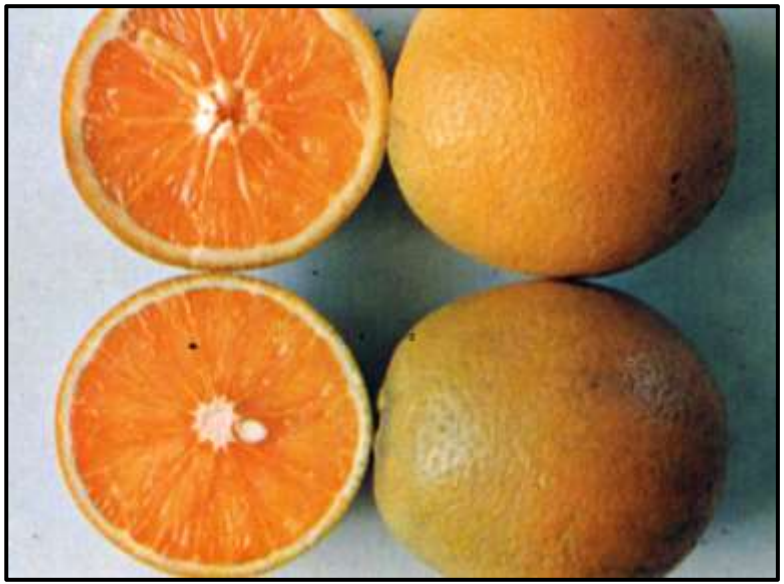
Measurement	Macronutrient element					Micronutrient element					Irrigation
	N	P	K	Ca	Mg	Mn	Zn	Cu	Fe	B	
Juice quality											
Juice content	+	+	o	o	o	o	o	o	o	o	+
Soluble solids (SS)	+	o	–	o	+	o	o	o	+	o	–
Acid (A)	+	–	+	o	o	o	o	o	o	o	–
SS/A ratio	–	+	–	o	+	o	o	o	o	o	–
Juice color (red)	+	o	–	?	?	?	?	?	?	?	o
Juice color (yellow)	+	o	–	?	?	?	?	?	?	?	+
Solids/box	+	o	–	o	+	o	o	o	+	o	–
Solids/acre	+	+	+	o	+	o	o	o	o	o	+
External fruit quality											
Size	–	o	+	o	+	o	o	o	o	o	+
Weight	–	o	+	o	+	o	o	o	o	o	+
Green fruit	+	+	+	o	o	o	o	o		o	+
Peel thickness	+	–	+	o	–	o	o	o	o	o	–
Peel blemishes											
Wind scar	–	+	o	?	?	?	?	?	?	?	+
Russet	–	–	o	?	o	o	o	o	o	o	o
Creasing	+	+	–	?	?	?	?	?	?	?	o
Plugging	–	o	–	?	?	?	?	?	?	?	–
Scab	+	o	o	?	?	?	?	?	?	?	+
Storage decay											
Stem-end rot	–	o	–	?	?	?	?	?	?	?	–
Green mold	–	o	o	?	?	?	?	?	?	?	+
Sour rot	o	o	o	?	?	?	?	?	?	?	o

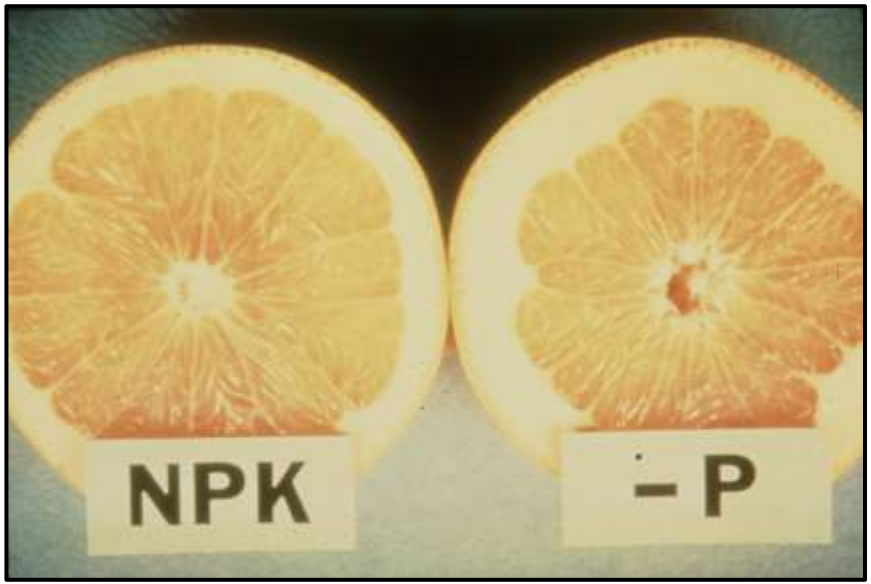
Nitrogen effects (grapefruit)



Potassium deficiency

Phosphorus deficiency





Fertilization for fresh fruit quality

- Use minimum N rate required to achieve desired yield.
- Fertilize for optimum K nutrition.
  - Soil applications can be supplemented with foliar applications to increase fruit size.
- Monitor P nutrition with leaf and soil analysis.

Climate considerations

Climate affects fertilization timing

- Good tree health and nutrition will help trees withstand freezing temperatures.
- “Pushing” trees (south FL) vs. inducing dormancy (north FL).
  - What causes a tree to grow?
    - Fertilization??... NO!
    - Warm days and rainfall/irrigation… YES!

Climate affects fertilization timing

- Heat and moisture trigger tree growth… but availability of nutrients influences the extent of that growth.
- Cutting off fertilizer in the fall will…
  - Allow summer growth to harden off.
  - Minimize fall growth that could be hurt by a freeze.
  - Induce dormancy.
- **No fertilizer in north FL after September 15th** (some say Aug 30).

Final thoughts

- SL 253 recommendations developed before HLB disease appeared.
- Follow citrus nutrient BMPs.
  - Right source, rate, time, and place.
- Water (rainfall, irrigation) has more influence on tree growth and fruit yield/quality than nutrition.

Thank you!

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