University of California

Nitrogen Management Training

for Certified Crop Advisers

Nitrogen Management in Citrus and Avocado

UC Cooperative Extension | University of California Agriculture and Natural Resources

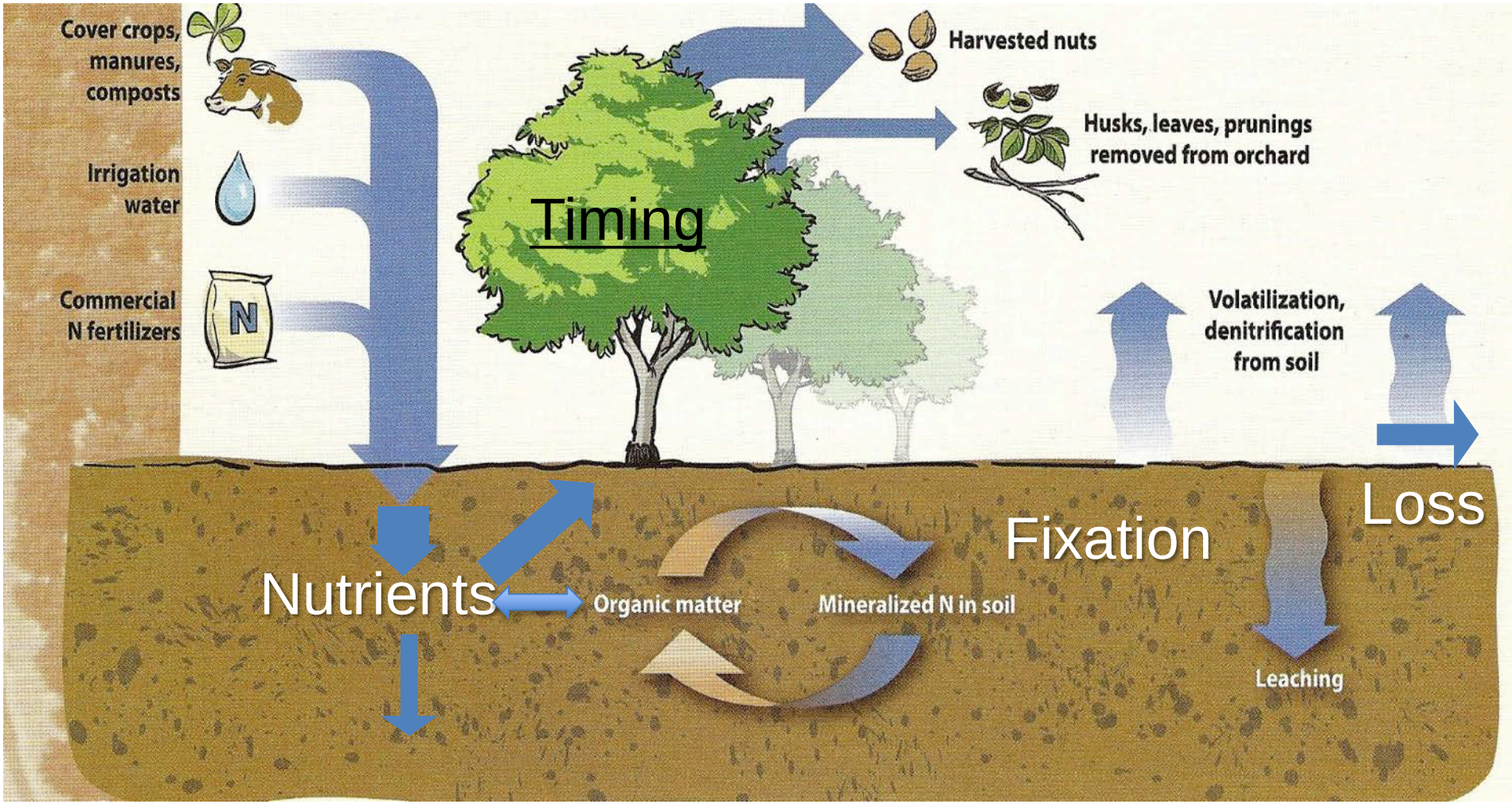
Efficient Nitrogen Management
-the 4 R's-

- Apply the Right Rate
  - Match supply with tree demand (all inputs- fertilizer, organic N, water, soil).
- Apply at the Right Time
  - Apply coincident with tree demand and root uptake.
- Apply in the Right Place
  - Ensure delivery to the active roots.
  - Minimize movement below root zone
- Using the Right Source and Monitoring
  - Maximize uptake, maximize response and minimize loss.

The 4 R's are specific to every orchard each year.

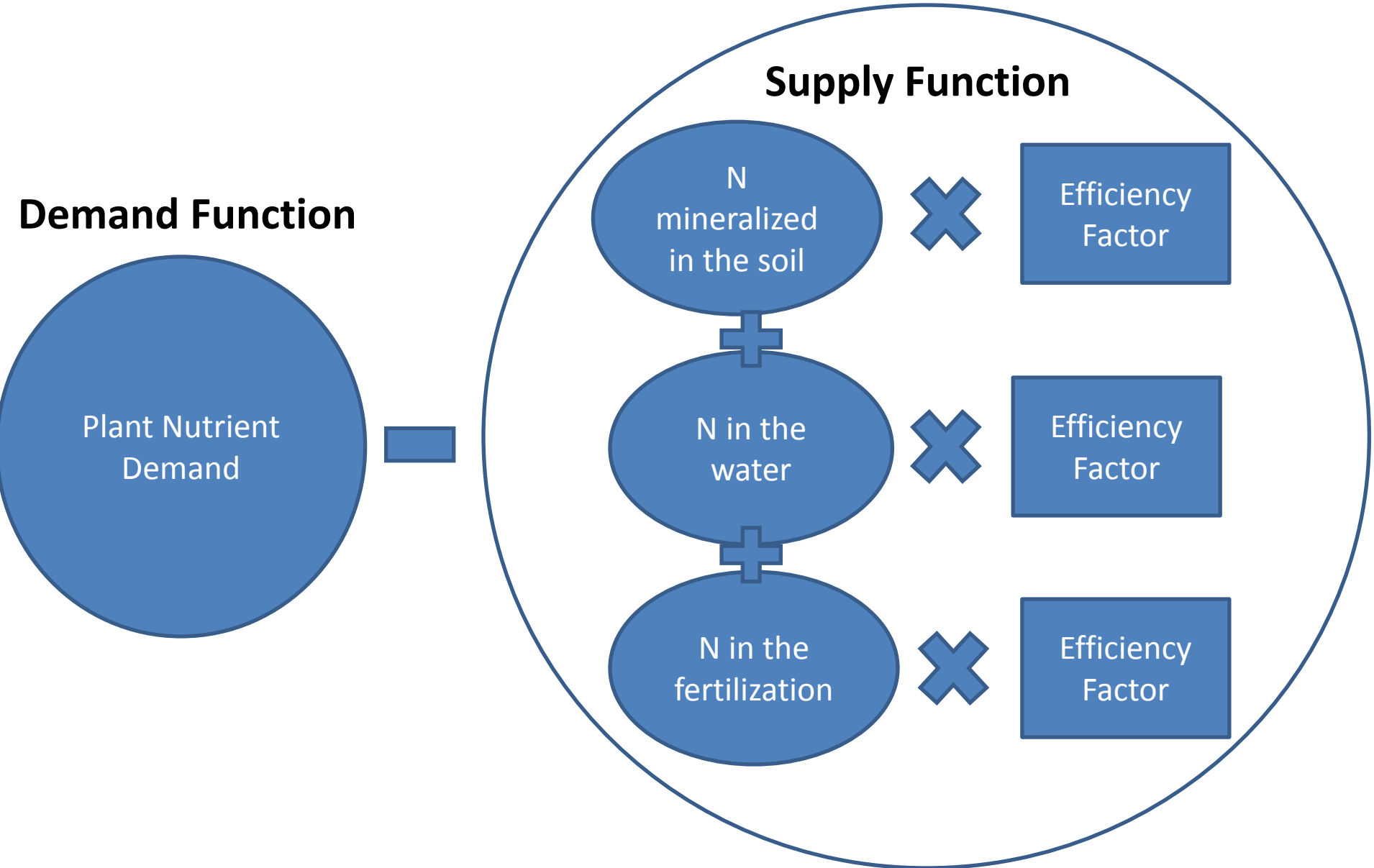
Optimizing N Use in Tree Crops

Supply (Rate) = Demand (Amount and Timing)



Kathy Kelley-Anderson et al: ANR Pub # 21623

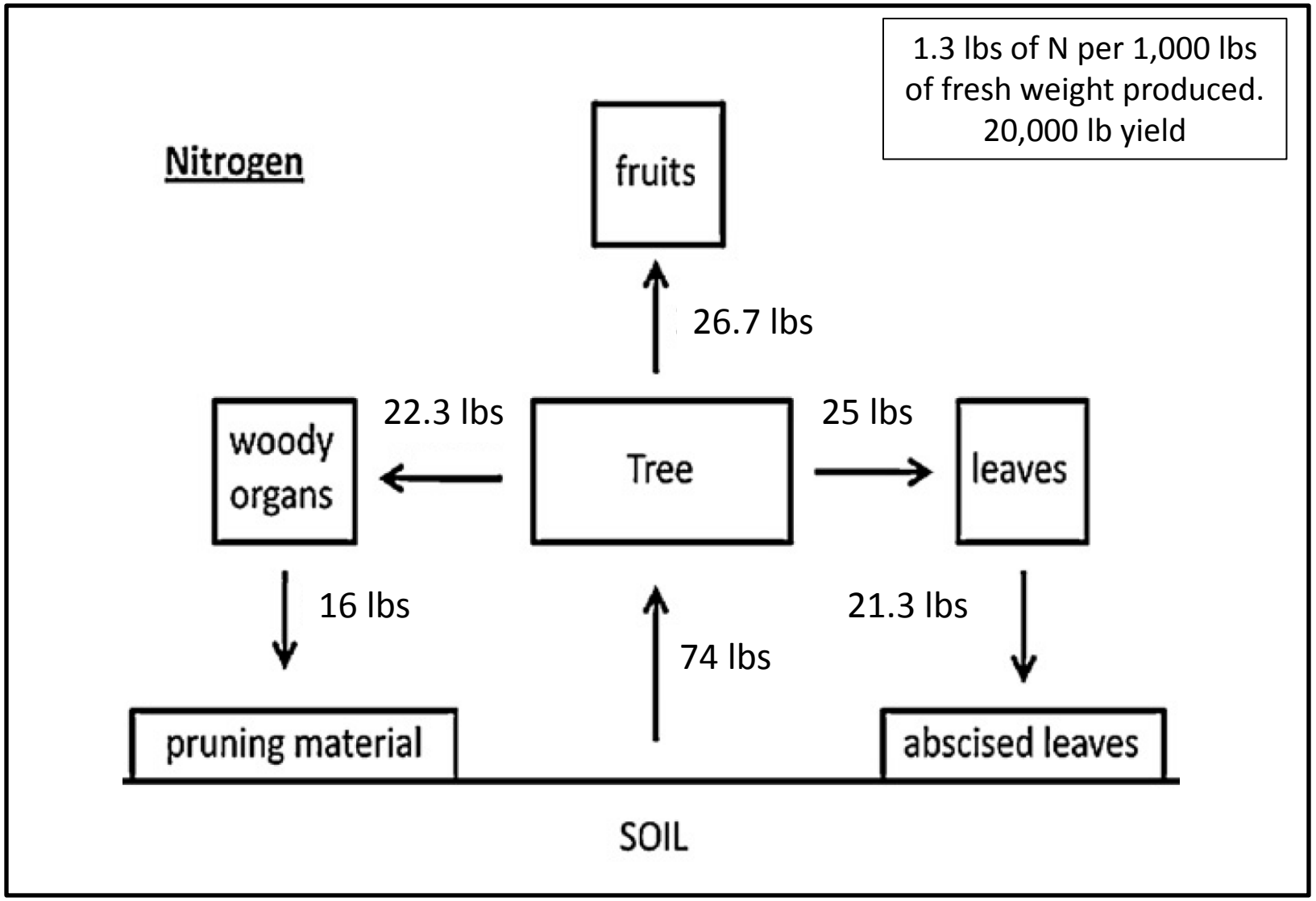
The Right Rate Equation



N Demand Rates

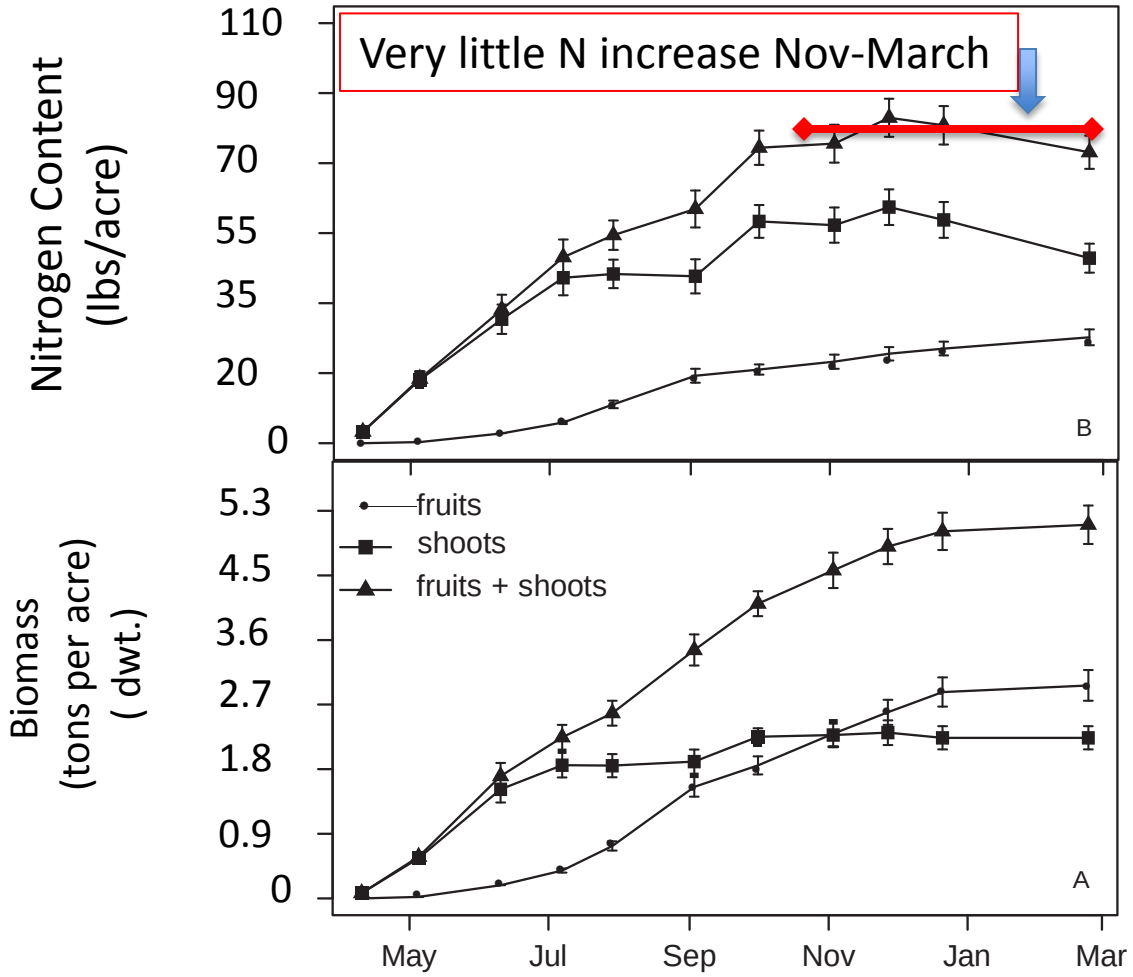
Citrus

N Demand and Partitioning: Orange



Modified from: Roccuzzo et al. 2012. Assessing nutrient uptake by field-grown orange trees. European Journal of Agronomy. 41:73-80.

N Demand Timing: Orange



- Fruit and shoots account for majority of N used in a mature orchard.
- 38% of N is used in the leaves.
- Nitrogen uptake occurs from April to November.
- No uptake December to February.

Modified from: Roccuzzo, 2012. Assessing nutrient uptake by field-grown orange trees. European Journal of Agronomy. 41:73-80.

N Demand in Relation to Tree Size: Citrus

Demand for growth – does not include the 1.3 lbs N per 1,000 lbs fresh weight that is required for fruit production.

- Young trees (1-5 years, canopy 0-250 ft^3):
  - More leaves than stems or wood
  - Leaves have higher N concentration than stems
  - Trees N accumulates at rate of 0.07 lbs/yr per 50 ft^3 increase in canopy volume
  - In most commercial orchards this represents 5-30 lbs N/acre/year

- Large trees (>8 years, canopy volume 1000-1500 ft^3)
  - Most growth is in woody tissue (not leaves)
  - Trees accumulate N at lower rate of 0.04 lbs/year per 50 ft^3 increase in canopy volume
  - About 5-20 lbs N N/acre/year

IFAS Fact Sheet SL-240, 2006

N Demand: Citrus Example

Example 1. Assume trees average 750 ft^3 in canopy volume (12 ft tall and 9 ft in diameter), 200 trees per acre and produce 300 boxes of fruit per acre. Assume a canopy increase of 100 ft^3 and a 50% N uptake efficiency.

70%

Fruit N accumulation	30 lbs of N per acre
Biomass N accumulation	0.15 lb of N per tree
X 200 trees per acre	30 lbs per acre
Total Fruit and Biomass N requirement	60 lbs per acre
50% maximum efficiency = 60 lbs/0.5 = 120 lbs per acre N requirement	

60/0.7 = 86 lbs Fertilizer N

IFAS Fact Sheet SL-240, 2006

N Demand: Citrus Example

70%

Example 2. Assume trees average 1500 ft^3 in canopy volume (16 ft tall and 11 ft in diameter), 200 trees per acre and produce 700 boxes of fruit per acre. Assume a 70% N uptake efficiency.

Fruit N accumulation	70 lbs of N per acre
Biomass N accumulation (Figure 2)	0.10 lb of N per tree
X 200 trees per acre	20 lbs per acre
Total Fruit and Biomass N requirement	90 lbs per acre
50% maximum efficiency = 90 lbs/0.5 = 180 lbs per acre N requirement	

90/0.7 = 128 lbs Fertilizer N

IFAS Fact Sheet SL-240, 2006

N Management Tools

Citrus

Leaf Sampling: Citrus

Leaf analysis guide for diagnosing nutrient status of mature Valencia and navel orange trees

Interpretation	Nutrient (values in % dry weight)		
	Nitrogen	Phosphorus	Potassium
Deficient	< 2.2	< 0.09	< 0.40
Low	2.2 - 2.3	0.09 - 0.11	0.40 - 0.69
Optimum	2.4 - 2.6	0.12 - 0.16	0.70 - 1.09
High	2.7 - 2.8	0.17 - 0.29	1.10 - 2.00
Excess	> 2.8	> 0.30	> 2.30

Lovatt, C.J., 2014. Nutrient deficiency and correction. In: Ferguson, L., Grafton-Cardwell, E.E. (Eds.). Citrus Production Manual. pp. 161-182.

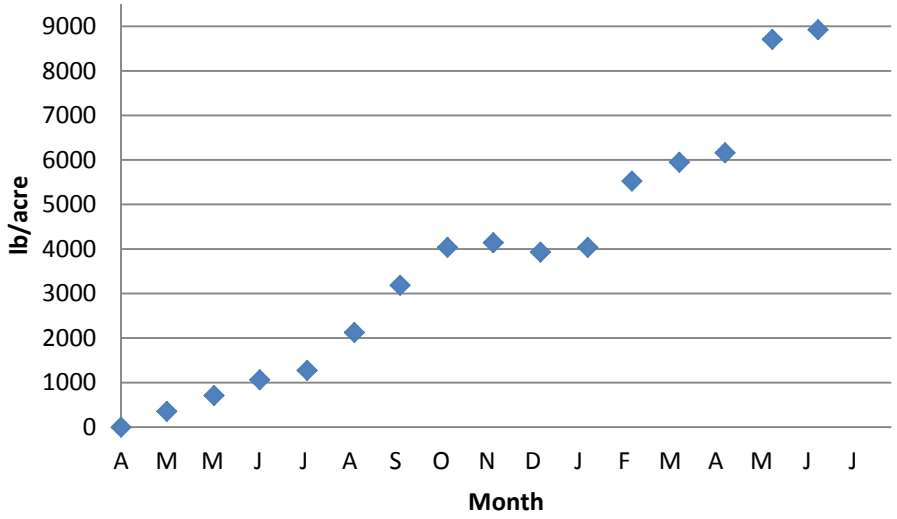
More information at http://apps.cdfa.ca.gov/frep/docs/Citrus.html

N Demand Rates

Avocado

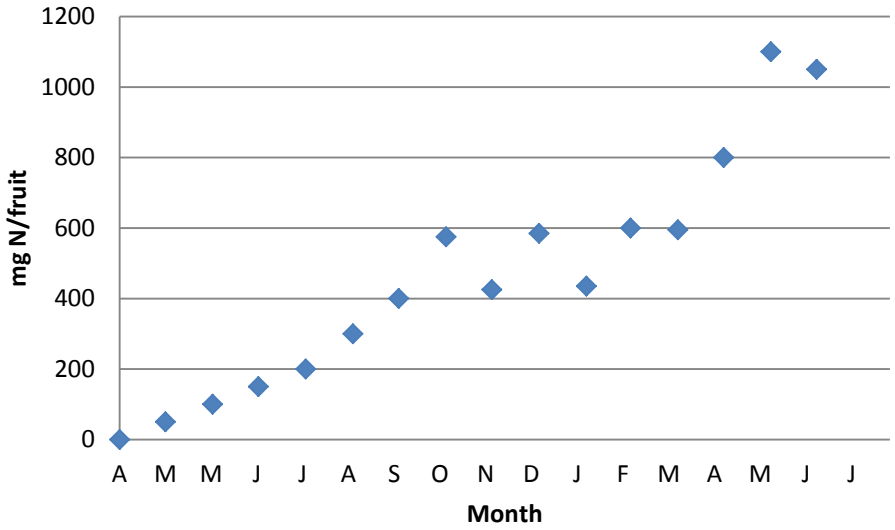
N Demand and Partitioning: Hass Avocado

- Fruit N removal = 2.2-4.3 lb N per 1000 lb fruit



←Fruit dry weight accumulation from a 4.5 ton/acre 'Hass' avocado crop

N accumulation in→ fruit from the same 4.5 ton/acre 'Hass' avocado crop



Roscrance, R., Faber, B. and C Lovatt 2012. Patterns of Nutrient Accumulation in 'Hass' Avocado Fruit. Better Crops 96(1) pp. 12-13.

N Demand and Partitioning: Hass Avocado

- 20-30% increase in vegetative growth occurs each year in a mature tree for a requirement of about 13-19 lbs N/acre/year
- Vegetative growth includes shoots, roots and build up for perennial wood for storage
- 3.5-6.8 lbs N/acre drop as leaves per year
- It's unclear what role leaf litter plays in the N budget for subsequent cropping years

Lovatt, C.J. 1998. Nitrogen nutrition of the 'Hass' avocado: Where does all the N go? Acta. Hort. 1:152-159.

N Demand Timing: Hass Avocado

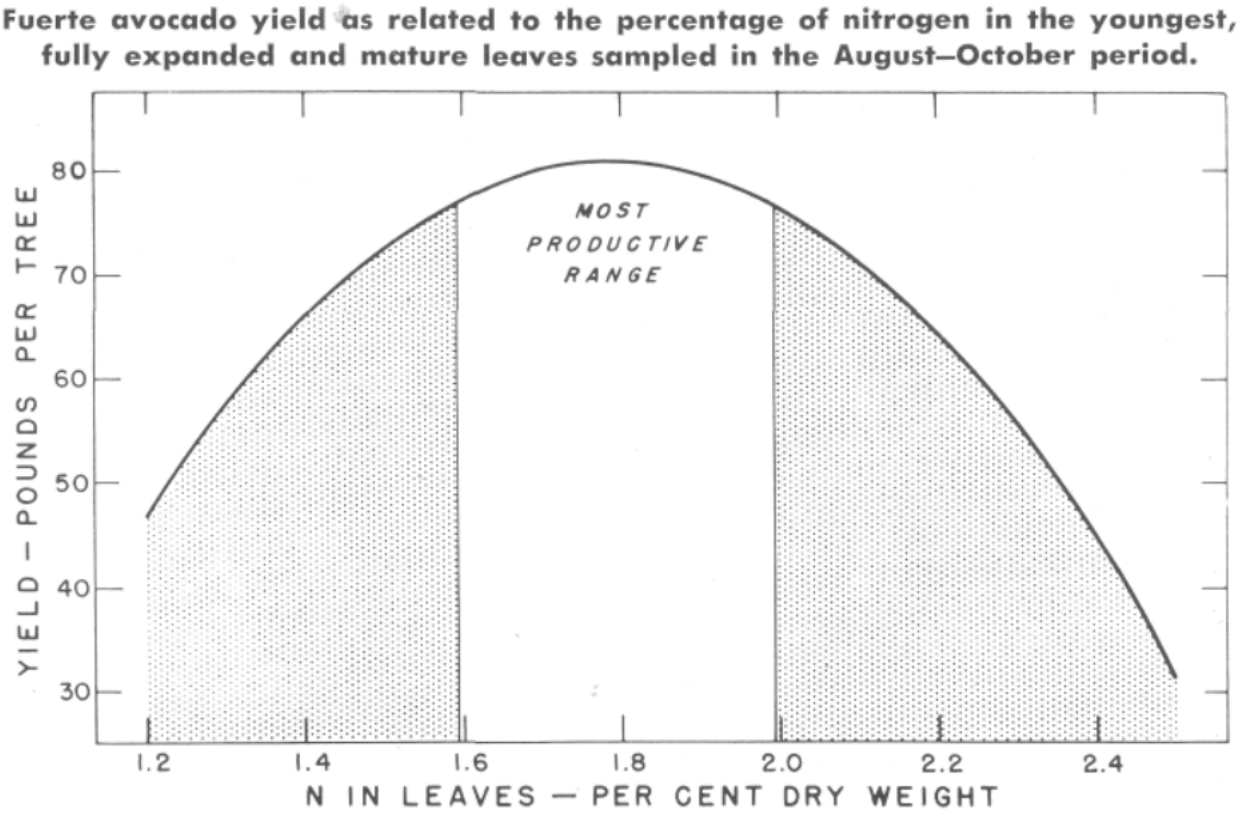
- Typical application timing: 6 split applications of about 25 lb/acre
- Jan, Feb, April, June, July, November
- Extra N in April (anthesis to early fruit set) and especially November (end of veg. shoot growth) improves yield, so these are likely the most critical periods of N uptake (Lovatt 2001)
- Extra N in Jan and Feb is most susceptible to leaching
- Extra N in June is allocated to leaves, not fruit
- Extra N in April reduced alternating bearing

Lovatt, C.J. 2001. Properly timed soil-applied N fertilizer increases yield and fruit size of 'Hass' avocado J. Amer. Soc. Hort. Sci. 126(5):555-559.

Nutrient Management Tools

Avocado

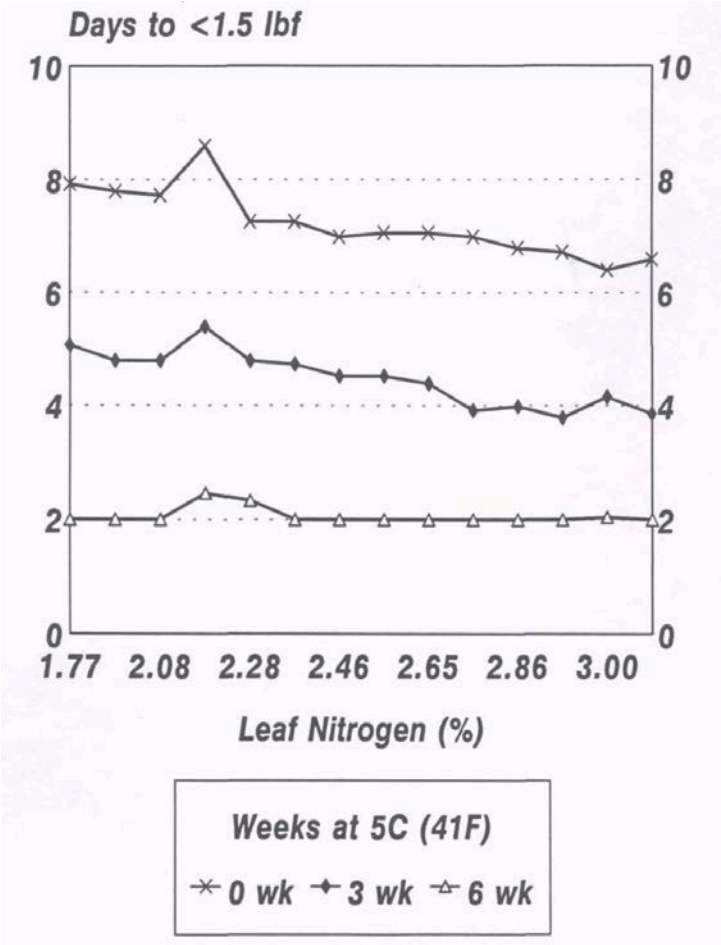
Leaf N Analysis Standards: 'Fuerte' Avocado



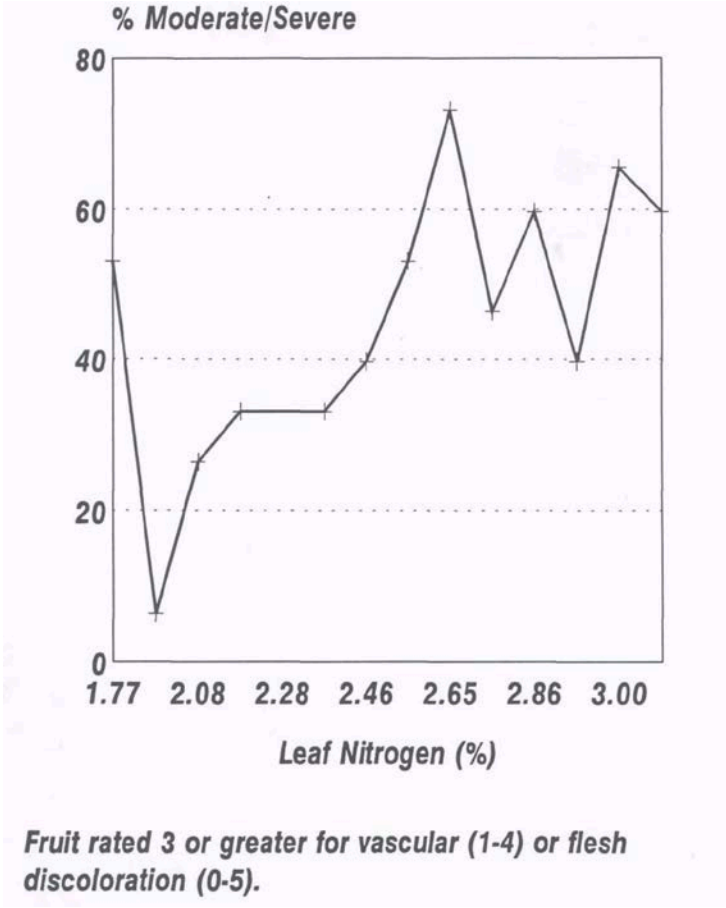
N tissue values for 'Hass' should be slightly higher than 'Fuerte'. Optimum leaf N for 'Fuerte' is 1.6 to 2%. Above this value there is a yield decline. 'Hass' value is set at a minimum of 2% with an unestablished upper range (probably around 2.3%).

Embleton, T, Jones, W, Gaber, M (1960) Fertilization of the Avocado: Leaf Analysis as a Guide to Nitrogen. California Agriculture 14(1), 12.

Post-Harvest Response to N: Hass Avocado



Influence of N on the time to eating ripeness



Influence of N on the incidence of mederate/severe chilling injury after 6 weeks at 5°C.

Arpaia, M, Mever, J, Stottlemyer, D, Bender, G, Witney, G (1993) The postharvest response of 'Hass' avocado to differential preharvest nitrogen treatments. *California Avocado Research Symposium* **1993**, 80-83.

N Management Tools: Hass Avocado

Total Fruit Nutrient Removal Calculator for Hass Avocado in California

Calculate the amount of nutrients that are removed when you harvest your crop. Enter your production below. **No commas or periods please!**

Production Volume: 1000 lbs.

Calculate

Nitrogen:	2.8045 lb.	Arsenic:	0.0016 oz.
Phosphorus:	1.0598 lb.	Barium:	0.0288 oz.
P_2O_5:	2.4269 lb.	Cadmium:	0.0064 oz.
Potassium:	6.7151 lb.	Chromium:	0.0112 oz.
K_2O:	8.1253 lb.	Cobalt:	0.0016 oz.
Iron:	0.1872 oz.	Lead:	0.0208 oz.
Manganese:	0.0352 oz.	Lithium:	0.0256 oz.
Zinc:	0.6176 oz.	Mercury:	0 oz.
Copper:	0.2304 oz.	Nickel:	0.0576 oz.
Boron:	1.5888 oz.	Selenium:	0.008 oz.
Calcium:	0.5586 lb.	Silicon:	0.3792 oz.
Magnesium:	1.1268 lb.	Silver:	0.0016 oz.
Sodium:	1.0288 lb.	Strontium:	0.0704 oz.
Sulfur:	2.0311 lb.	Tin:	0.0144 oz.
Molybdenum:	0 oz.	Titanium:	0 oz.
Aluminum:	0.3744 oz.	Vanadium:	0 oz.
		Chloride:	1.1219 lb.

Created by Reuben Hofshi and Shanti Hofshi

Copyright © The Hofshi Foundation 2003 - 2012 - All Rights Reserved

Data used in this calculator provided by M. L. Arpaia, University of California, Riverside (arpaia@uckac.edu). Fruit nutrient removal values are the averages of 4 grower lots (3 fruit per grower lot) harvested in June 1999. The peel, flesh and seed of individual fruit were analyzed.

University of California

Nitrogen Management Training

for Certified Crop Advisers

Contributing Authors:

Patrick Brown, Professor & Pomologist

Department of Plant Sciences, UC Davis

Ben Faber, Extension Specialist

UC Cooperative Extension, Ventura County