Nitrogen Management Training
for Certified Crop Advisers

Nitrogen Management in Nuts: Walnut, Almond, and Pistachio
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)

Nutrients

Fixation

Loss

Timing
The Right Rate Equation

Demand Function

Supply Function

- N mineralized in the soil
- N in the water
- N in the fertilization

Efficiency Factor

Plant Nutrient Demand
N Demand Rates
Right Rate: Almonds

Nutrient removal Per 1000 lb Kernels

Nonpareil
  • N removal 68 lb per 1000 lb Kernels

Monterey
  • N removal 65 lb per 1000 lb Kernels
Right Rate and Timing: Almonds

- Applying excess N does not result in greater uptake by fruit, but does increase leaching potential.
- There is less vegetative growth when yield is high, even when N is applied in excess.

![Graph showing nitrogen removal by 1000 kernel yield over days after full bloom.]

- Increasing N from 275 to 350 lbs did not increase fruit N removal at harvest.
- In plants receiving adequate N, 68 lbs of N is removed in 1000 lbs kernel yield.
- 80% of crop N is accumulated by 130 days after full bloom.
Right Rate and Timing: Almonds

Nitrogen uptake and remobilization timeline for Almonds, indicating key dates and nitrogen levels. The chart highlights the optimal timing for nutrient application to match the plant's developmental stages: Dormant, Bloom, Fruit Set, Fruit Enlargement, Kernel Fill, 10% Hull Split, Harvest, and Leaf Fall.
Right Rate: Yield vs. Vegetative Growth in Almonds

The proportion of the annual N budget that goes to vegetation declines as the yield increases above 2,000 lbs.
Right Rate: Walnuts

• 14-20 lbs N per 1000 (in-shell, including hull)

• UC-Davis, the Walnut Board of California, and FREP currently refining walnut data

• Additional Resources:
  - Detailed instructions for Walnut N demand and budget by Kathy Kelley and Joe Grant
  - A more in-depth version of the above worksheet is available for $10 here:
Right Rate: Walnuts

Walnuts: Monthly Nitrogen Accumulated in Fruit
(For every harvested ton. Lbs & Percent of Total)

Chandler (Fruit) - 2013

Tulare (Fruit) - 2013
Right Rate: Walnuts

• N demand to replace abscised leaves and prunings – 8 lbs N/acre/year
• N storage in woody trees parts – 15 lbs N/acre/year

• Recommendations for N in walnut can be found by running this online model

Right Rate and Time: Pistachios

Nutrient removal per 1000 lbs dry CPC yield

- Valuable for estimating demand or replacing nutrient export
- Provides insight into efficiencies
  - N removal 28 lbs per 1000
  - K removal 24 lbs per 1000
  - P removal 3 lbs per 1000
- 25 lb N and 22 lb K per acre, per year is required for tree growth (Rosecrance et al 1998)

(Brown and Siddiqui-unpublished)
Improving N Use Efficiency
Tree NUE = N removed in harvested fruit / applied N

- 42,000 lbs N applied for 6 years to 40 acres
- 26,880 lbs N exported in yield
- 6,000\text{est} lbs N pruning, leaves, and growth
- 9,120 lbs N ‘lost’
- 38 lbs N/acre/year

- 24 yo Pistachio, 5 inch rainfall zone, no deep percolation.
- Silt loam, pH 6.7-7.0, OM 0.6%, 2 ppm NO$_3$N (100cm).
- Fertigated with five in-seasons split apps.
- 10 yr ave yield = 4,000 lb/acre = 112 lb N acre in exported fruit
- Mean N application 175 lb/acre.

6 year Mean NUE = 0.72

- 2002 - 2007

- Outlier
- 90\% quantile
- 75\% quantile
- Median
- 25\% quantile
- 10\% quantile
Non-uniform Yield Within Field

Varying yields across 80 acres of Pistachio trees:

Managed as a single plot, large fields will always be non-uniform and less nutrient-efficient than smaller fields.
N Management Tools
Leaf Sampling:

- July/August leaf sampling is useful to monitor general performance or identify deficiencies but is inadequate as a management strategy because it:
  - Does not provide rate or timing information
  - Comes too late to adjust in-season fertilization.

- UCD has developed new Early Leaf Sampling (UCD-ESP for Almond and UCD-PPM for Pistachio) methods for Almond and Pistachio, and is in progress for Walnut
  - Early sampling is useful to determine if leaves have commenced the season with adequate N, and is a valuable supplement to yield based fertilizer management practices

- Several labs have adopted these methods
  - Ask your lab if they use the UCD-ESP or UCD-PPM program
Leaf Sampling:

- Collect leaves/leaflets from 18 - 28 trees in one bag per management zone.
- Each tree sampled should be at least 30 yards apart.
- In each tree collect leaves around canopy from 20+ exposed leaves/leaflets on non-fruiting spurs or shoots located 5-7 feet from the ground.
- Analyze leaf tissue for essential plant nutrients (N, P, K, S, Mg, Ca, B, Cu, Fe, Mn, Zn).
- For early leaf samples utilize UCD developed early sampling guidelines for interpretation.
- For July sampled leaves utilize standards provided in the Almond and Pistachio Production manuals.
Managing N in Almond, Pistachio and Walnut:

- Base preseason fertilizer plan on expected yield LESS N in irrigation and other inputs.
  - 1000 lbs almond kernel removes 68lb N
  - 1000 lbs pistachio (CPC yield) removes 28 lbs N
  - 1000 lbs in-shell walnuts removes 14-20 lbs N
  - Account for vegetative growth for each tree nut crop

- Conduct a leaf analysis following full leaf out.

- In April-May, review leaf analysis results and updated yield estimate, then adjust fertilization for remainder of season.
Online Tools:

• N Calculator developed by SureHarvest and the Almond Board of California available at www.sustainablealmondgrowing.org

• CDFA FREP website for all tree nuts
  Almond - http://apps.cdfa.ca.gov/frep/docs/Almonds.html
  Walnut - http://apps.cdfa.ca.gov/frep/docs/Walnut.html
  Pistachio - http://apps.cdfa.ca.gov/frep/docs/Pistachio.html

• UC Davis Fruits and Nuts website
  http://fruitsandnuts.ucdavis.edu/Weather_Services/Nitrogen_Prediction_Models_for_Almond_and_Pistachio/
Conclusions: N Management in Tree Nuts

- Efficient N management is determined by the 4Rs
- Determine N demand for each individual crop
- Time to match demand – 80% in-season 20% post maturity if needed and trees are healthy
- Target placement where roots are active
- Account for all potential N sources including fertilizer, cover crops, compost, manure, and irrigation water

Every field, every year, is a unique decision
University of California

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Contributing Authors:

Patrick Brown, Professor & Pomologist
Department of Plant Sciences, UC Davis

Allan Fulton, Extension Specialist
UC Cooperative Extension, Tehama County

Franz Niederholzer, Extension Specialist
UC Cooperative Extension, Sutter-Yuba Counties

Blake Sanden, Extension Specialist
UC Cooperative Extension, Kern County

Roger Duncan, Pomology & Viticulture Farm Advisor
UC Cooperative Extension

David Doll, Pomology Farm Advisor
UC Cooperative Extension, Merced County