Nitrogen Management and Budgeting

Gabriele Ludwig
Almond Board of California
Workshop: Management of Nitrogen in Almonds

Patrick Brown, Professor, University of California, Davis

Blake Sanden, Farm Advisor UCCE

Sebastian Saa, Postdoctoral Scientist, University of California, Davis

Franklin Dlott, Product and Process Manager SureHarvest

Dr. Joe Browde, Sustainability Senior Associate, SureHarvest
Agenda

• Section 1: 25 minutes talk

• Section 2: 35 minutes hands-on work/discussion

• Section 3: 25 minutes CASP-SureHarvest model

• Section 4: 5 minutes evaluation form
Section one

New Nutrient Budgets and Leaf Sampling for Almond
Nitrogen is essential for productivity but when managed poorly N results in environmental problems.
Nitrogen and Phosphorus have ‘Escaped’ from Farms and Contaminated Water Resources

Environmental Legislation is Forcing a Change in Farming Practices.

94% due to Crop Agriculture

Application = >200% of Need

>55% of Wells in SJV and Salinas are Contaminated and 250,000 People do Not Have Access to Clean Drinking Water

Lakes, Streams and Estuaries Suffer When Nutrient and Sediment Load is too High.

(Ekdahl and others, 2009; Harter Report, 2012)
Legislative Response: Mandated Nitrogen Management Planning

• Application rates will be based upon field specific crop N budget estimations, accounting for all applied N x ‘efficiency factor’ (60-80%).
  • New techniques for N monitoring and budgeting
  • Adoption of ‘in-season’ decision making and N management

• Certified Crop Advisor sign off required.
  • Training and certification process under development
  • Post season verification and reporting.

• In the short term this will be a self-reporting industry driven activity.
  • However, if improvements in ground water resources are not realized then a tightening of these regulations can be expected.

• Will require enhanced efficiency of N use. Site (orchard) specific management. In season monitoring and adjustment.
  • New online tools for management
Whenever there is a challenge, there is also an opportunity…

...Improving the Efficiency of Nitrogen use will Reduce Production Costs and Reduce Environmental Impact
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 CA Tree Crops.

Supply (Rate) = Demand (Amount and Timing)

Loss

Nutrients

Fixation

Timing

Harvested nuts
Husks, leaves, prunings removed from orchard
Volatilization, denitrification from soil
Leaching

Loss

Organic matter
Mineralized N in soil

Cover crops, manures, composts
Irrigation water
Commercial N fertilizers
Right Rate and Right Timing

![Diagram showing nitrogen uptake at different stages of development](image-url)
Total and Annual Dynamics of N in Mature Almond Tree (data from 12 year old trees)

Annual accumulation (Yield: 4,700 lbs)

2011: (320 lb N total)
Nuts = 90%
Leaves = 2%
Bloom = 4%
Perennial = 5%

Around 20 lbs/acre of N were needed to support growth in this 12 year old 85% canopy cover orchard. In younger orchards and in low yield years the demand for N for growth may reach 40 lbs/acre.
Tree Nutrient Demand is Determined by Yield

### Nutrient removal Per 1000 lb Kernels

**Nonpareil**
- N removal: 68 lb per 1000
- K removal: 80 lb per 1000
- P removal: 8 lb per 1000

**Monterrey**
- N removal: 65 lb per 1000
- K removal: 76 lb per 1000
- P removal: 7 lb per 1000

### Growth Requirement

- Yield 2,000 to 4,000 = 0 lb N
- Yield 1,000 to 2,000 = 20 lb N
- Yield <1,000 = 30 lb N

**Right Rate:**

(Tree Nutrient Demand – N inputs)

N inputs = N in Fertilizers, N in water, N in soil
What is the shape of N demand through the season?

80% of total N in fruit is accumulated by 130 DAFB.
Nitrogen Use efficiency 2008 – 2010 under optimum treatment (N 275) was >80%.

\[ \text{NUE} = \frac{\text{N Export in Fruit}}{\text{N Applied}} \]
Tree Demand, When to Apply, How efficient.

Tree Demand? = 68lbs of N for 1000lbs of kernel produced plus growth requirement (0-30 lbs)

When to apply? = 80% during the first 4 months of growth, 20% post hull split – pre leaf senescence.

How efficient can we be if we do everything well? = 70% NUE
MANAGING MULTIPLE ORCHARDS:
Hypothetical Yield and Final Nutrient Use Efficiency: 275 Lbs N Applied
MAKING ONE FERTILIZATION DECISION FOR MULTIPLE ORCHARDS IS A RECIPE FOR LOST YIELD AND WASTED NITROGEN
Right Place: Field Variability Compromises Efficiency:

If managed as a single plot—larger fields will always be less nutrient efficient than smaller fields.

Opportunity: Controlled release fertilizers – Improved fertigation systems Precision Applications.

Yield Distribution in Almond
- Managing for the highest demand results in 40% over fertilization
- Managing for the lowest demand deprives 50% of trees of adequate N
- Managing to the average wastes 20% of applied N and deprives 30% of trees of adequate N
Right Place: Where does N uptake occur?

The majority of the roots are in the first 18 inches of soil.

The majority of the roots are in the first 18 inches of soil.
Right Place: Irrigation Rapidly Moves N into Soil Surface applied N Followed by Irrigation (90 minutes)

![Graphs showing the movement of ammonium sulfate, urea, and calcium nitrate in Salinas Clay, Yolo Loam, and Hanford Sandy Loam soils.](Courtesy www.IPNI.org)

Figure 2. The movement of ammonium, urea, or nitrate in the surface 9 in. of three soils. The urea and calcium nitrate were applied to the soil surface and irrigated with a uniform amount of water. The ammonium sulfate was added as a solution. The soils were sampled 90 minutes after fertilizer and water application. (Broadbent et al., 1958).
Tree Demand, When to Apply, How efficient.

Tree Demand? = 68lbs of N for 1000lbs of kernel produced plus growth requirement (0-30 lbs)

When to apply? = 80% during the first 4 months of growth, 20% post hull split – pre leaf senescence.

How to Apply: Manage application/irrigation to keep N in the root zone.

How efficient can we be if we do everything well? = 70% NUE
How do we monitor our trees?

How do we predict and adjust to ensure optimal efficiency?

Early Leaf Sampling
Can we sample in April and Predict July?

- To answer this question we collected data from different types of leaves, in multiple years and in multiple locations.

- Then, we developed 6 models in 2011.

- In 2012 we sampled 6 different orchards to check which one of the 6 models was the best one.
Results showed that one of the six models was very good at predicting July N concentration. Validation data confirms that July N can be predicted using an April Sample.

This model requires to collect NF leaves in April.
Sampling Criteria

- Collect leaves from 18 to 28 trees in one bag (depending of the confidence level and on the number of acres).

- Each tree sampled at least 30 yards apart.

- In each tree collect leaves around the canopy from at least 8 well exposed spurs located between 5-7 feet from the ground.

- In April, collect samples at 8121 GDH +/- 1403 (43 days after full bloom (DAFB) +/- 6 days).

- If you would like to collect samples in July, then collect samples at 143 DAFB +/- 4 days. SAME RULES!
Conclusions: Managing Nitrogen in Almond

*Base your fertilization rate on realistic, orchard specific yield, account for all N inputs and adjust in response to spring nutrient and yield estimates.*

- Make a preseason fertilizer plan based on expected yield LESS the N in irrigation and other inputs.
  - 1000lb kernel removes from 68lb N, 8lb P and 80lb K.
- Conduct (properly!) a leaf analysis following full leaf out.
- In May, review your leaf analysis results and your updated yield estimate, then adjust fertilization for remainder of season.
- At harvest review yields and adjust post harvest fertilization accordingly.
- Time application to match demand in as many split applications as feasible
  - 80% N uptake occurs from full leaf out to kernel fill.
  - Apply up to 20% hull split to immediately post harvest, corrected for actual yield - but only if trees are healthy. Use foliars if N loss is possible.
  - Optimize everything!

- Every field, every year, is a unique decision
Section two

35 minutes hands-on work/discussion
1. What do the 4Rs stand for? Circle four of the following options:

a) Right Rate  
b) Right Source  
c) Right Weather  
d) Right Place  
e) Right Cultivar  
f) Right Time
2. How do you calculate the right rate?

• First, you need to know the tree nitrogen demand based on predicted yield.
• Second, you need to calculate all the N credits.
• Third, you calculate the amount of fertilizer needed.
3. If you know that for every 1,000 lbs. of kernel produced the tree demands 68 lbs of N, then how much N does the tree demand if your predicted yield is 3,000 lbs? Circle one:

a) 68  b) 124  c) 204  d) 300  e) 400

Formula: Yield (lbs) x 0.068

A: 3000 x 0.068 = 204
4. Now, you need to account for all the N credits. Which of the following would be considered as N credit? Circle all that apply.

a) N in the Irrigation Water
b) N in Manure
c) N in the Compost
d) N in the Cover Crops
e) N in the soil below the rooting zone
5. Calculate your N credits for the following scenario in 2014:

a) Your Irrigation Water Contains Nitrate.

Lab reports 10 ppm Nitrate or 2.27 ppm Nitrate-N and you apply 48 inches of water

To convert Nitrate in water to lbs of N

- Formula for Nitrate: Nitrate concentration (ppm) x inches irrigation applied x 0.052
- Formula for Nitrate-N: Nitrate-N concentration (ppm) x inches irrigation applied x 0.23

Answer = _25_ lbs \((10 \times 48 \times 0.052)\)

An estimated 70% of the N in the irrigation water will be available.

\[ \text{N Credit from Irrigation} = 25 \times 0.7 = 17.5 \text{ lbs N Credit} \]
5. Calculate your N credits for the following scenario in 2014:

b) You use no manures

Answer = ___ lbs
5. Calculate your N credits for the following scenario in 2014:

d) You use no legume cover crop
Answer=____0____ lbs

Summarizing:

\[ a = \text{Calculated N in the water} \rightarrow 17.5 \text{ lbs} \]
\[ b = \text{Calculated N in the manures} \rightarrow 0 \text{ lbs} \]
\[ c = \text{Calculated N in the compost} \rightarrow 40 \text{ lbs} \]
\[ d = \text{Calculated N in the cover crop} \rightarrow 0 \text{ lbs} \]

Total N Credits = a + b + c + d = ____57.5____ lbs of N credits.
6. Let’s subtract “N credits” from the “N Tree Demand”, which will give us the remaining amount of N needed to support 3,000 lbs yield.

\[(204 \text{ N Tree Demand}) - (57.5 \text{ N credits}) = 147\]

147 lbs N/Acre are still needed.
7. If managed properly (correct timing and placement) then an efficiency of 70% can be achieved. To convert this crop N demand into units of fertilizer N required, divide by 0.70.

\[
\frac{147}{0.70} = 210
\]  

lbs of N is the recommended fertilizer application for a predicted production of 3,000lbs/acre and given the above N credits.
8. Right Time: When during the growing season should I apply the 210 lbs of N fertilizer? (Given 4 fertigation periods through year).

<table>
<thead>
<tr>
<th>Date</th>
<th>% of Total</th>
<th>lbs of N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Fruit Growth</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Kernel Fill</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Fruit Maturity or Early Post-Harvest</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

+ 210 lbs of N
8. Now let’s suppose the following scenarios:

a) It is May 1st and you have already applied half of your planned fertilizer (Early Spring and Fruit Growth). You collected leaves in April and the prediction for July was that your trees were going to have “adequate N”. You also re-estimate your yield and it is still 3,000 lbs.

Do you need to change your original fertigation plan?

Answer: __NO__
8. Now let’s suppose the following scenarios:

a) It is May 1st and you have already applied half of your planned fertilizer (Early Spring and Fruit Growth). You collected leaves in April and the prediction for July was that your trees were going to have “adequate N”. You also re-estimate your yield and it is still 3,000 lbs.

b) Same as case a), but your leaf N prediction says your trees are going to be “deficient in N”.

Answer: Increase remaining N fertilization by 20 lbs.
8. **Now let’s suppose the following scenarios:**

a) It is May 1st and you have already applied half of your planned fertilizer (Early Spring and Fruit Growth). You collected leaves in April and the prediction for July was that your trees were going to have “adequate N”. You also re-estimate your yield and it is still 3,000 lbs.

c) Same as case a, but now your expected yield is actually 2,000 lbs (1,000 lbs less than originally predicted). What do you do?
Because you have already applied Early Spring and Fruit Growth you can only reduce fertilization in Kernel Fill and Fruit Maturity/Post-Harvest period.

Reduce original fertilization by 1000 lbs $ \times 0.068/0.70 = 97.2$

- You planned for 3000 lbs but only achieved 2000 lbs (June Drop)

Your Original Fertilization total for Kernel Fill and Fruit Maturity/Post-Harvest was = 105 lbs. N

This needs to be reduced by 97 due to reduced yield estimate:

105–97=8 lbs

8 lbs should be applied 60% and 40% in the remaining two fertigations. (Note: In a case such as this with very low application rates you may choose a foliar fertilization or to combine fertilizations.)

Kernel Fill = 0.60*8 = 4.8 (round to 5)
Fruit Maturity/Post-Harvest = 0.40 * 8 = 3.2 (round to 3)
<table>
<thead>
<tr>
<th>Date</th>
<th>% of Total</th>
<th>Lbs of N Original Estimation</th>
<th>Lbs of N New Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring</td>
<td>20</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Fruit Growth</td>
<td>30</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Kernel Fill</td>
<td>30</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>Fruit Maturity or Early Post-Harvest</td>
<td>20</td>
<td>42</td>
<td>3</td>
</tr>
</tbody>
</table>

If this adjustment is not made your final efficiency will be < 50%!!
Now let’s suppose the following scenarios:

d) It is September 15th (right after harvest) and you have already applied 80% of your fertilization plan (Early Spring and Fruit Growth and Kernel Fill). You collected leaves in April and the leaf N prediction for July was that your trees were going to have “adequate N”. You predicted 3,000 lbs, however yields were actually 3,500 lbs. You have already applied 168 lbs of N fertilizer. What do you do?

You need to provide additional N for 500 lbs*0.068/0.70=49 lbs in addition to the planned 42 lbs. 42+49=91 lbs N.
BEWARE: We do not recommend soil applications in excess of 75 lbs per acre Post Harvest. AND 75 lbs. fertigated N can ONLY be applied if trees are healthy. You may consider foliar application.

<table>
<thead>
<tr>
<th>Date</th>
<th>% of Total</th>
<th>Lbs of N Original Estimation</th>
<th>Lbs of N New Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring</td>
<td>20</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Fruit Growth</td>
<td>30</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Kernel Fill</td>
<td>30</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Fruit Maturity or Early Post-Harvest</td>
<td>20</td>
<td>42</td>
<td>75</td>
</tr>
</tbody>
</table>
e) It is September 15th (right after harvest) and you have already applied 80% of your fertilization plan (Early Spring and Fruit Growth and Kernel Fill). You collected leaves in April and the leaf N prediction for July was that your trees were going to have “adequate N”. However, your actual yields were 500 less than originally predicted (actual yield = 2,500). What do you do?

You need to reduce the final fertilization by – 500 lbs*0.068/0.70 = 49 lbs. The planned Post-Harvest fertilization was 42 lbs. Then, : 42-49= -7.

Thus, this application may be eliminated (Cost Savings!).
Your new fertilization plan...

<table>
<thead>
<tr>
<th>Date</th>
<th>% of Total</th>
<th>lbs of N Original Estimation</th>
<th>lbs of N New Estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring</td>
<td>20</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Fruit Growth</td>
<td>30</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Kernel Fill</td>
<td>30</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Fruit Maturity or Early Post-Harvest</td>
<td>20</td>
<td>42</td>
<td>0</td>
</tr>
</tbody>
</table>
10. Take Home Messages:

• Always consider your N credits since they can be an important source of N.

• Good yield estimates are essential.

• The more times you re-estimate your N budget during the season, the more chances you will have to apply what is needed.

• Postharvest applications are limited to tree uptake capacity. You should never apply more than 75 lbs, even if your calculations tell you to do so and ONLY if trees are healthy. Foliar N may be useful at this time.

• Your flexibility to correctly adjust your in-season fertilizer plan decreases as the season progresses.

• This type of exercise should be run in every individual orchard that you manage. Each orchard is unique with a unique history and nitrogen need.
Section three: 25 minutes
CASP-SureHarvest model

www.sustainablealmondgrowing.org
California Almond Sustainability Program

sustainablealmondgrowing.org
4Rs Framework

Yield-based crop demand, N-Credits & UC research
Yield-based crop demand

KERNEL YIELD | N-CREDIT IRRIGATION | N-CREDIT MANURE | N-CREDIT COMPOST

Enter pounds of kernel per acre

LAST YEAR’S ACTUAL YIELD (OR THIS YEAR’S PREDICTED YIELD): 3000

2 YEAR’S AGO YIELD:

3 YEAR’S AGO YIELD:

POST BLOOM ESTIMATED YIELD:

THIS YEAR’S ACTUAL YIELD:

CALCULATIONS

KERNEL YIELD

PREDICTED 3000 lbs/Acre
ESTIMATED lbs/Acre
ACTUAL lbs/Acre

CROP NITROGEN DEMAND BASED ON YIELD

PREDICTED YIELD 204 lbs N/Acre
ESTIMATED YIELD lbs N/Acre
ACTUAL YIELD lbs N/Acre
4Rs Framework

N-Credits

- N-Credit Irrigation
- N-Credit Manure
- N-Credit Compost
- N-Credit Cover Crop
- N-Credits Other
4Rs Framework

UC research

LEAF FACTOR

SPECIFY PREDICTION METHOD:
○ DIRECT ENTRY ○ UNPROCESSED LAB RESULTS

PREDICTED JULY N %:  

APRIL LEAF VALUES:

N %:  
K %:  
B (PPM):  
CA %:  
MG %:  
Does the math for you

**KERNEL YIELD**

**N-CREDIT IRRIGATION**

**N-CREDIT MANURE**

**N-CREDIT COMPOST**

**N-CREDIT COVER CROP**

**N-CREDITS OTHER**

**LEAF FACTOR**

**CALCULATIONS**

**KERNEL YIELD**

**PREDICTED** 3000 lbs/Acre

**ESTIMATED**

**ACTUAL**

**CROP NITROGEN DEMAND BASED ON YIELD**

**PREDICTED YIELD** 204 lbs N/Acre

**ESTIMATED YIELD**

**ACTUAL YIELD**

---

Enter pounds of kernel per acre

**LAST YEAR'S ACTUAL YIELD (OR THIS YEAR'S PREDICTED YIELD):**

3000

**2 YEAR'S AGO YIELD:**

**3 YEAR'S AGO YIELD:**

**POST BLOOM ESTIMATED YIELD:**

**THIS YEAR'S ACTUAL YIELD:**
Does the math for you

**ESTIMATE OF PREDICTED SEASON'S IRRIGATION WATER:**

48 Acre-in

**UNIT OF MEASURE USED BY LAB:**

- [ ] NO3
- [ ] NO3-N

**LAB MEASUREMENT:**

10 PPM

---

**N CREDITS**

- **IRRIGATION:** 25.0 lbs N/Acre
- **MANURE:** lbs N/Acre
- **COMPOST:** 40.0 lbs N/Acre
- **COVER CROP:** lbs N/Acre
- **OTHER N-CREDITS:** lbs N/Acre
- **SUM OF N-CREDITS:** 65.0 lbs N/Acre
Does the math for you

<table>
<thead>
<tr>
<th>KERNEL YIELD</th>
<th>N-CREDIT IRRIGATION</th>
<th>N-CREDIT MANURE</th>
<th>N-CREDIT COMPOST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPOST TYPE:</strong></td>
<td>Medium Composted</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMPOST TONS/ACRE:</strong></td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMPOST ANALYSIS (%N):</strong></td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N CREDITS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IRRIGATION</td>
<td>25.0 lbs N/Acre</td>
</tr>
<tr>
<td>MANURE</td>
<td>lbs N/Acre</td>
</tr>
<tr>
<td>COMPOST</td>
<td>40.0 lbs N/Acre</td>
</tr>
<tr>
<td>COVER CROP</td>
<td>lbs N/Acre</td>
</tr>
<tr>
<td>OTHER N-CREDITS</td>
<td>lbs N/Acre</td>
</tr>
<tr>
<td><strong>SUM OF N-CREDITS</strong></td>
<td><strong>65.0 lbs N/Acre</strong></td>
</tr>
</tbody>
</table>
Does the math for you

<table>
<thead>
<tr>
<th>RECOMMENDED APPLICATIONS</th>
<th>42 lbs N/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARLY SPRING (ES)</td>
<td>42 lbs N/Acre</td>
</tr>
<tr>
<td>FRUIT GROWTH (FG)</td>
<td>63 lbs N/Acre</td>
</tr>
<tr>
<td>KERNEL FILL (KF)</td>
<td>63 lbs N/Acre</td>
</tr>
<tr>
<td>FRUIT MATURITY OR EARLY POST-HARVEST (FM/PH)</td>
<td>42 lbs N/Acre</td>
</tr>
<tr>
<td>TOTAL RECOMMENDED N</td>
<td>210 lbs N/Acre</td>
</tr>
</tbody>
</table>

The fine print

This recommendation is not intended to be used as the sole source of information for making fertilization decisions. Local environmental conditions can have a profound effect on fertilizer demands. The Almond Board of California, the University of California, and the California State University are not responsible for the accuracy of this model.
Scenario – Harvested yield 500 lbs higher

Enter pounds of kernel per acre

**LAST YEAR'S ACTUAL YIELD (OR THIS YEAR'S PREDICTED YIELD):**

3000

**2 YEAR'S AGO YIELD:**


**3 YEAR'S AGO YIELD:**


**POST BLOOM ESTIMATED YIELD:**

3000

**THIS YEAR'S ACTUAL YIELD:**

3500

---

**CROP NITROGEN DEMAND BASED ON YIELD**

<table>
<thead>
<tr>
<th>Yield Phase</th>
<th>N/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted Yield</td>
<td>204</td>
</tr>
<tr>
<td>Estimated Yield</td>
<td>204</td>
</tr>
<tr>
<td>Actual Yield</td>
<td>238</td>
</tr>
</tbody>
</table>

---

**RECOMMENDED APPLICATIONS**

Assumes 70% nutrient use efficiency. Your results may vary.

<table>
<thead>
<tr>
<th>Application</th>
<th>N/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring (ES)</td>
<td>42</td>
</tr>
<tr>
<td>Fruit Growth (FG)</td>
<td>63</td>
</tr>
<tr>
<td>Kernel Fill (KF)</td>
<td>63</td>
</tr>
<tr>
<td>Fruit Maturity or Early Post-Harvest (FM/PH)</td>
<td><strong>85</strong></td>
</tr>
<tr>
<td>Total Recommended N</td>
<td>253</td>
</tr>
</tbody>
</table>
Scenario – Harvested yield 500 lbs lower

Enter pounds of kernel per acre

LAST YEAR'S ACTUAL YIELD (OR THIS YEAR'S PREDICTED YIELD): 3000

2 YEAR'S AGO YIELD: ?

3 YEAR'S AGO YIELD: ?

POST BLOOM ESTIMATED YIELD: ?

3000

THIS YEAR'S ACTUAL YIELD: ?

2500

CROP NITROGEN DEMAND BASED ON YIELD

<table>
<thead>
<tr>
<th></th>
<th>PREDICTED YIELD</th>
<th>ESTIMATED YIELD</th>
<th>ACTUAL YIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>204 lbs N/Acre</td>
<td>204 lbs N/Acre</td>
<td>170 lbs N/Acre</td>
</tr>
</tbody>
</table>

RECOMMENDED APPLICATIONS

ASSUMES 70% NUTRIENT USE EFFICIENCY. YOUR RESULTS MAY VARY.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EARLY SPRING (ES)</td>
<td>42 lbs N/Acre</td>
</tr>
<tr>
<td>FRUIT GROWTH (FG)</td>
<td>63 lbs N/Acre</td>
</tr>
<tr>
<td>KERNEL FILL (KF)</td>
<td>63 lbs N/Acre</td>
</tr>
<tr>
<td>FRUIT MATURITY OR EARLY</td>
<td>-10 lbs N/Acre</td>
</tr>
<tr>
<td>POST-HARVEST (FM/PH)</td>
<td></td>
</tr>
<tr>
<td>TOTAL RECOMMENDED N</td>
<td>158 lbs N/Acre</td>
</tr>
</tbody>
</table>
### California Almond Sustainability Program

#### NModeling

<table>
<thead>
<tr>
<th>Year</th>
<th>Organization</th>
<th>Enterprise</th>
<th>Facility</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>ABC Orchards</td>
<td>ABC Orchards</td>
<td>UC DAVIS TEST block</td>
<td>Pre-Application</td>
</tr>
<tr>
<td>2014</td>
<td>ABC Orchards</td>
<td>ABC Orchards</td>
<td>UC DAVIS TEST block</td>
<td>Pre-Harvest</td>
</tr>
<tr>
<td>2014</td>
<td>ABC Orchards</td>
<td>ABC Orchards</td>
<td>UC DAVIS TEST block</td>
<td>Post-Harvest</td>
</tr>
</tbody>
</table>

*Edit and Clone*
California Almond Sustainability Program

Display PDF or export data
### Recommended Applications

Assumes 70% nutrient use efficiency. Your results may vary.

<table>
<thead>
<tr>
<th>Application</th>
<th>N/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Spring (ES)</td>
<td>42 lbs</td>
</tr>
<tr>
<td>Fruit Growth (FG)</td>
<td>63 lbs</td>
</tr>
<tr>
<td>Kernel Fill (KF)</td>
<td>63 lbs</td>
</tr>
<tr>
<td>Fruit Maturation or Early Post-Harvest (FM/PH)</td>
<td>42 lbs</td>
</tr>
</tbody>
</table>

**Total Recommended N**

210 lbs N/Acre

---

**This recommendation is not intended to be used as the sole source of information for making fertilization decisions. Local environmental conditions can have a profound effect on fertilizer demands. The Almond Board of California, the University of California, and the California State University are not responsible for the accuracy of this model.**
Section four

Evaluation
A) Are You (Circle all that apply):

1) A grower who makes his or her own fertilization recommendations
2) A grower who works collaboratively with a CCA/PCA or Agronomist to make fertilization recommendations
3) A grower who predominantly relies (>80%) on the fertilization recommendations made by a CCA/PCA or Agronomist
4) A PCA/CCA or Agronomist who makes recommendations for growers

A) In January (pre-bloom) can you estimate your MAXIMUM potential yield within:

1) 2,000
2) 1,000
3) 500
4) No idea
C) In late-April, early May (after full leaf out and after fruit set), I can estimate my yield within:

1) 2,000 lbs.
2) 1,000 lbs.
3) 500 lbs.
4) No idea

D) At what date are you confident within 750 lbs. of your final yield?

1) After it is harvested
2) In June
3) In July
4) At Hull Split

E) I currently manage each individual orchard block according to its yield potential:

1) Yes
2) No
3) I have not in the past but I will now.
F) Will you, or the person who manages your fertilizer program, use the new N Model that was shown today?

1) Yes
2) No

If not, why not.................................................................................................................................
.........................................................................................................................................................
.........................................................................................................................................................
.........................................................................................................................................................

G) What is the minimum amount of N that you would apply to an orchard (>7 years old)?

1) Whatever the program tells me is needed even if it is zero lbs. N (This can happen in a low yield year if you have N in your irrigation water.)
2) Never less than 100 lbs. N
3) Never less than 200 lbs. N
H) Would you like to have a smartphone/tablet version of this online model?
1. Yes Smart-Phone
2. Yes Tablet
3. No

H) Please comment:
How can this program be improved, what additional information or training would you like, what aspects did not make sense, anything else we should be aware of.
**Fertilizer Management and Nutrient Budgeting**

Sebastian Saa, Saiful Muhammad, Blake Sanden, Patrick Brown

UC Davis, Department of Plant Sciences, One Shields Ave, Davis, CA 95616; *pbrown@ucdavis.edu*

### Objectives

1. Predict July leaf N% using an April sampling.
2. Develop a leaf sampling protocol representative of CA almond orchards.
3. Develop fertilizer response curves to relate nutrient demand with fertilizer rate and nutrient use efficiency.
4. Develop a phenology and yield based nutrient model for almond.
5. Deploy model in online system

### Results

#### Nitrogen Use Efficiency

- **Figure 1:** Nitrogen use efficiency 2005 - 2009 under optimum treatment (27 lbs of N/acre) was >80%

- **Figure 2:** Nitrogen use efficiency 2010 season with optimum treatment and nutrient applications.

- **Figure 3:** Nitrogen use efficiency 2011 season with optimum treatment and nutrient applications.

#### Timing of the Fertilization and Nitrogen Use Efficiency

- **Figure 4:** Nitrogen use efficiency trials of almonds in 2011, 2013 and 2014. Almond growers have the ability to adjust the timing of the nitrogen to achieve the maximum nitrogen efficiency.

#### Putting it all together

- **Figure 5:** Summary of the nitrogen management strategy for almond growers.
Thank you!

- Historical Contributions: Weinbaum, Rosecrance, Uriu, Farm Advisors.
- Andres Olivos
- Saiful Muhammad
- Blake Sanden
- Roger Duncan
- John Edstrom
- David Doll
- Bruce Lampinen
- Ken Shackel
- Emilio Laca
- Grower Cooperators
- Paramount Farming
- Almond Board of California
- USDA, CDFA
- SureHarvest