Tree Physiology: Nitrogen

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Watershed Coalition
Central Valley Coalitions

- Sacramento Valley Water Quality Coalition
  - Bruce Houdesheldt

- California Rice Commission
  - Tim Johnson

- San Joaquin County & Delta Water Quality Coalition
  - Michael Wackman

- Westside San Joaquin River Watershed Coalition
  - Joseph C. McGahan
  - David Cory

- East San Joaquin Water Quality Coalition
  - Parry Klassen
  - Wayne Zipser

- Westlands Water Quality Coalition
  - Charlotte Gallock

- Southern San Joaquin Valley Water Quality Coalition
  - 7 new coalitions
Status Quo May Change

- Current requirements still in place for all CV coalitions

- State Water Board petition process may force changes but no sooner than 2017-2018

- Basic message: *Complete required reports and stay in compliance!*
  - Still pursuing those who have not joined coalitions or filed for individual permits
  - Regional Water Board actively enforcing against non-reporters
    - Farm Evaluation, Nitrogen Summary Report, Sediment & Erosion Plan
State Water Resources Control Board

- ESJWQC Waste Discharge Requirements adopted Dec 2012; petitioned immediately
- Orders Regional Water Board to modify WDR extensively
  - Process
    - Written Testimony
    - Public Hearings
    - State Board Hearing in early 2017
- Petition to Superior Court (*if we or others don’t like it*)
  - Could further modify or order adoption as is
- Will apply to all Central Valley Coalition WDRs
- Go to [www.esjcoalition.org](http://www.esjcoalition.org) General Order for process documents
State Water Resources Control Board

• Draft State Board order includes mandates to
  – Monitor all domestic wells on member parcels
  – Eliminates low and high vulnerability areas: equal reporting
    • May be additional time for smaller farms
  – Requires all member information goes to Regional Water Board
    • Farm Evaluations
    • Nitrogen Management Plans
  – Creates “Irrigation and Nitrogen Management Plan”
What Is Now Required

**Member Responsibilities**

- Complete Farm Evaluation*
- Complete Nitrogen Management Plan
  - In high vulnerability groundwater area; submit Summary Report to ESJ annually
  - Certified by 3rd party or grower trained and self certified
  - Low vulnerability keep on site; no certification required
- Sediment and Erosion Control Plan
  - In areas identified as high vulnerability for erosion and sediment discharge
- Participate in annual outreach events

* Enforcement fines for non-reporting are exceeding $30,000!
NITROGEN MANAGEMENT PLAN WORKSHEET

NMP Management Unit: __________________________

1. Crop Year (Harvested): ___________________

2. Member ID# ________________________________

3. Name: ________________________________

<table>
<thead>
<tr>
<th>CROP NITROGEN MANAGEMENT PLANNING</th>
<th>N APPLICATIONS/CREDITS</th>
<th>15. Recommended/ Planned N</th>
<th>16. Actual N</th>
</tr>
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<tbody>
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<td>7. Production Unit</td>
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<td></td>
<td>27. Total N Applied &amp; Available</td>
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</tr>
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PLAN CERTIFICATION

28. CERTIFIED BY: __________________________

30. Low Vulnerability Area, No Certification Needed
31. Self-Certified, approved training program attended

DATE: __________________________

32. Self-Certified, UC or NRCS site recommendation
33. Nitrogen Management Plan Specialist
# NMP Summary Report – 2015 Crop Year

Refer to your Nitrogen Management Plan for information to complete this form

**Year Crop Harvested (Box 1):** ______________ 

**Submittal Date:** _________________

**Member ID (Box 2):** ________________ 

**Member Name (Box 3):** _______________

<table>
<thead>
<tr>
<th>Site Location Information¹</th>
<th>Crop</th>
<th>Total Acres</th>
<th>Total Available N Applied pounds per acre</th>
<th>A/Y Total Available N / Actual Yield²</th>
<th>Production Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Unit</strong></td>
<td>Box 6</td>
<td>Box 10</td>
<td>Box 22 + Box 25</td>
<td>(Box 22+25)/Box 11</td>
<td>Box 7</td>
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¹ Note: Site location information is required for accurate data collection. ² A/Y ratio is calculated to assess the efficiency of nitrogen management.
Reporting A/Y

*Total Applied Nitrogen divided by Total Yield*

- Summary template asks for A/Y to be calculated
- Divide “**Total Applied Nitrogen**” (commercial, compost, irrigation water N) by **Total Yield**
  - Total yield per management unit
  - Total N applied per management unit

- Coalition will calculate amount of N removed from A/Y that you report
Member Outreach on A/R

\[(\text{Applied N divided by Removed N})\]

Goals

– Inform members of relative performance to other like growers (Applied and Yield)

– Inform members of performance relative to UCCE recommendations for Nitrogen Applied and Nitrogen Removed (CDFA guidelines)
Member Outreach on NMP Summary Report

Packet of information to be mailed/emailed to members by your coalition

Contents:

• Reporting Component
  – Summary of reported data (A/Y) and when possible, A/R
  – Comparison to other growers with same crop

• Education Component
  – Information on nitrogen crop consumption curves (where available)
  – Applications and yield - UCCE recommendations
Nitrogen Management Plan (NMP) Self Certification

Growers in High Vulnerability groundwater areas need either:

-- CCA (Certified Crop Advisor) sign-off of NMP or

-- Receive grower certification

Half-day course taught by CCA who has attend UC training on NMP

Your Coalition will announce training meetings this winter and spring
Read **Watershed Coalition News**
For more Information on ILRP

CURES publication sponsored by Almond Board of California

(Latest Issue in your registration packet)
Nitrogen Management in Almonds

Patrick H. Brown
Professor
Department of Plant Sciences
University of California, Davis
Ideal Nitrogen Management Approach
-the 3 R’s of Nitrogen-

• Apply the **Right Rate**
  – MATCH THE SUPPLY OF N TO THE DEMAND FOR N.

• Apply at **Right Time**
  – TIME APPLICATIONS TO COINCIDE WITH PLANT UPTAKE.

• In the **Right Place**
  – KEEP N IN THE ACTIVE ROOTZONE AND DELIVER N UNIFORMLY/PRECISELY ACROSS ORCHARD.

Supply
- Cover crops, manures, composts
- Irrigation water
- Commercial N fertilizers

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

Timing
- Foliars

Loss
- Nitrogen
- Nitrate
- Organic matter
- Mineralized N in soil
- Leaching

IRRIGATION MANAGEMENT

Kathy Kelley-Anderson et al: ANR Pub # 21623
The Right Rate Equation

Demand Function

Plant Nutrient Demand

Supply Function

N mineralized in the soil

N in the water

N in the fertilization and OMA

Efficiency Factor

Efficiency Factor

Efficiency Factor
Determining Nitrogen Demand in Trees

Collection, Separation and Analysis of Annual Tissues

Tree Excavation, Partitioning, and Analysis of Perennial Tissues
Total and Annual Dynamics of N in Mature Almond (data from 11-12 year old trees)

From dormancy to mid-March there is very little N uptake.

Uptake commences at mid-leaf out and is essentially complete by hull split.

Perennial Organ N:

In 11 year old tree - 420 lbs N/acre in total orchard biomass (5-45 lbs N/Yr/Acre in years 1-12)

30 lbs of N is remobilized in Feb-Mar to feed flowers, leaves and fruit set.

30 lbs N accumulated in new perennial growth (5-35 lbs N/Yr/Acre from year 8-20).
Nut yield is the primary N demand in Almond.
Nitrogen Export in Almond Fruit

68 lbs per 1000 lb yield
(includes N in fruit and kernels and trash).
Right Rate and Timing: Almonds

Applying excess N does not result in greater uptake by fruit, but does increase leaching potential.

68 lbs/1000
If Yields are >2000 lbs then Nitrogen for Tree Growth is Included in the 68 per 1000 Allocation.
Right Place: Impact of Fertigation Timing on Nitrate Uptake by the Tree
Bad Example: N injected in first 3 hours of 12 hour irrigation.

How you irrigate and fertigate determines where in the root zone N is deposited.

Nitrate accumulated below effective root zone following poorly timed fertigation event.
Irrigation Uniformity = Nitrogen Uniformity...

And has a big impact on water use, nitrogen efficiency, and yield.

Measure your distribution uniformity and improve it!

For more information visit: http://www.almonds.com/irrigation
Right Place: Fields vary in their productivity due to soils, poor irrigation design, other deficiencies or other production constraints.

How do you choose an N rate when fields are non-uniform and cultivars are yielding differently?

Nitrogen efficiency will require more fertigation technology: In-season spoon feeding; cultivar specific and site specific scheduling; fertigation systems that minimize N leaching.
Optimizing N use efficiency requires Optimal Management of all Inputs: e.g. Zinc deficiency can limit crop response to N.

Zinc deficient section or poor irrigation set up, or different soils, or different cultivars or…

Optimizing N use requires identifying and optimizing all production factors:

GNDVI 29 April 2009: SmartImage (B,G, NIR only) 1 m pixel (Britz Fert. Com.)
Right Place: Different Fields have Different Demands

Yield (lbs Kernel acre)
If all Fields Receive Same Fertilization: Nitrogen Use Efficiency will Differ Dramatically

- Fertilize to meet realistic yield expectations
- Apply from March to August to coincide with maximum uptake
- Manage fertigation to keep N in active root zone
- Manage in-field variability
Plant Tissue Testing:
A useful tool but NO LONGER your main tool.

| Nutrient (N) | Deficient below | Adequate | Phosphorus (P) | Adequate | Potassium (K) | Deficient below | Adequate | Calcium (Ca) | Adequate over | Magnesium (Mg) | Adequate over | Sodium (Na) | Excessive over | Chlorine (Cl) | Excessive over | Boron (B)* | Deficient below | Adequate | Excessive over | Copper (Cu) | Adequate over | Manganese (Mn) | Adequate over | Zinc (Zn) | Deficient below |
|--------------|----------------|----------|---------------|----------|---------------|----------------|----------|--------------|--------------|----------------|--------------|------------|----------------|------------|---------------|------------|----------------|-----------|----------------|----------|----------------|-------------|----------------|-------------|---------------|-------------|-------------|----------------|
|              |                |          |               |          |               |                |          |              |              |                |              |            |                |            |               |            |                |          |              |                |               |              |              |               |             |              |                |            |               |             |                |             |              |
|              |                |          |               |          |               |                |          |              |              |                |              |            |                |            |               |            |                |          |              |                |               |              |              |               |             |              |                |            |               |             |                |             |              |

*Critical values for boron deficiency and toxicity are currently being revised. Hull boron >300 ppm is excessive. Leaf sampling is not effective to determine excess boron.
Sampling Criteria: Almond
(repeated in every orchard or orchard zone that you wish to manage)

- Collect leaves/leaflets from non-fruiting shoots from 18 to 28 trees in one bag per management zone.
- Each tree sampled at least 30 yards apart.
- In each tree collect leaves around the canopy from at least 20 well exposed leaves/leaflets located between 5-7 feet from the ground.
- In April/May, collect samples at 35-45 days after full bloom.
  - Submit to a lab that uses UCD-ESP/ Almond board CASP program
- In July, collect samples using same method as April
  - Use crop production manuals to interpret July samples.
Managing N in Almond, Pistachio, and Walnut:

- Develop pre-season N fertilizer plan on expected yield LESS N in irrigation, soil residual N, and other inputs.
  - 1000 lbs almond kernel removes 68lb N
  - Add 15-40 lbs. N for developing orchards or vigorous trees with current season yield <2000 kernel lb.

- 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.

- Fertilize between March and Hull-Split in as many split applications as possible.
- Manage fertigation to keep N in root zone – Manage variability.
- Take leaf sample in July, reassess yield, adjust final fertilization.

*Every field, every year, is a unique decision*
California Almond Sustainability Program – Nitrogen Management Calculator

Cliff Ohmart – SureHarvest

http://www.sustainablealmondgrowing.org
Advantages for Using CASP Nitrogen Management Calculator

• Calculate fertilization rates based on UC nitrogen management research
  • 4 Rs of nutrient management (Right source, rate, timing & location)
  • Based on crop demand
  • Results in efficient fertilizer use
• Library of fertilizers in pull down menus for easy rate calculations
• Calculates nitrogen contributions from non-fertilizer sources
• Recalculates fertilizer rates as applications made during the season
• Can clone N budget from one orchard to another within and between years
• Generates ILRP nitrogen management report for your files at beginning and then end of season
• If user has account, data can be saved for calculations throughout the season and available for review in the future
Data Required for Nitrogen Management Calculator

• Beginning of season:
  • Crop year
  • Orchard name
  • Previous yield (last year, 2 years ago, 3 years ago – if possible)
  • Post bloom estimated kernel yield/acre
  • Estimated irrigation from ground water applied/acre
  • Lab results for nitrate concentration in ground water
  • If manure applied post harvest – type & tons/acre (same from 2 years ago if possible)
  • If compost applied – type, tons/acre & %N content
  • If legume cover crop – quality & method of incorporation
  • N carry over – Lbs of N per acre available from soil test
Data Required for Nitrogen Management Calculator – Fertilizer

Beginning of season:

- Timing of application (4 seasonal stages of growth from UC model)
- Name of product (from pull down list)
- Rate per acre
- Application method

End of season:

- Actual kernel yield/acre
- Actual ground water irrigation applied per acre
Accessing N Management Calculator via CASP Home Page

• http://www.sustainablealmondgrowing.org
Opens to User Homepage with Important Links

Nitrogen Management Calculator Links
Click on N Calculator Link to Start
Model Based on UC Davis Research

• 4 growth stages when fertilizers are best applied
Fertilizer Recommended & Applied Tracked Graphically

Crop Year: 2015  Orchard: Block 1  Organization: AAATEST production  Business: AAATEST production

Timing:
- Early Spring
- Fruit Growth
- Kernel Fill
- Fruit Maturity or Early Post-Harvest

Recommended vs. Applied:
- Lbs N/Acre

Cumulative:
- Total Lbs N/Acre
Tabs for Working with Each Type of Nitrogen Source
Tabs for Working with Each Type of Nitrogen Source
Nitrogen Management Calculator Reporting for ILRP

### Nitrogen Management Plan Worksheet

<table>
<thead>
<tr>
<th>Crop Year (Harvested):</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member ID #: MEMB ID: ABC-123-def</td>
<td></td>
</tr>
<tr>
<td>Name: Jessie A. Moreno</td>
<td></td>
</tr>
<tr>
<td>APN(s): 123-45-678 123-45-679</td>
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<tr>
<td>Field(s) ID: Gratton Ranch</td>
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</table>

### Crop Nitrogen Management Planning

<table>
<thead>
<tr>
<th>N Application/Credits</th>
<th>15. Recommended / Planned N</th>
<th>16. Actual N</th>
</tr>
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<tbody>
<tr>
<td>Almonds</td>
<td>17. Nitrogen Fertilizers</td>
<td>290</td>
</tr>
<tr>
<td>Pounds (kernel)</td>
<td>18. Dry/Liquid (lbs/acre)</td>
<td>290</td>
</tr>
<tr>
<td>Projected Yield (Units/Acre)</td>
<td>19. Foliar N (lbs/acre)</td>
<td>0</td>
</tr>
<tr>
<td>N Recommended (lbs/acre)</td>
<td>20. Organic Material N</td>
<td>340</td>
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<tr>
<td>Acres</td>
<td>21. Available N in Manure/Compost (lbs/acre estimate)</td>
<td>20</td>
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<tr>
<td>Post Production Actuals</td>
<td>22. Total N Applied (lbs per acre)</td>
<td>310</td>
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<tr>
<td>Actual Yield (Units/Acre)</td>
<td>23. Nitrogen Credits (est)</td>
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<td>Total N Applied (lbs/acre)</td>
<td>24. Available N carryover in soil (annualized lbs/acre)</td>
<td>322</td>
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<tr>
<td>N Removed (lbs N/acre)</td>
<td>25. N in irrigation water (annualized, lbs/acre)</td>
<td>7</td>
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<tr>
<td>Notes:</td>
<td>26. Total N Credits (lbs per acre)</td>
<td>267</td>
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<tr>
<td>27. Total N Applied &amp; Available (lbs per acre)</td>
<td>327</td>
<td>268</td>
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### Plan Certification

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<td>32. Self-Certified, UC or NRCS site recommendation</td>
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<td>33. Nitrogen Management Plan Specialist</td>
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**Your Coalition will provide the method to be used to estimate N Removed.**
## Nitrogen Management Calculator Reporting: Details

### CROP NITROGEN MANAGEMENT PLANNING

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<tr>
<th>6. Crop</th>
<th>Almonds</th>
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<tr>
<td>7. Production Unit</td>
<td>Pounds (kernel)</td>
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<td>8. Projected Yield (Units/Acre)</td>
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<td>9. N Recommended (lbs/ac)</td>
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<td>10. Acres</td>
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### Post Production Actuals

<table>
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<th>14. Notes:</th>
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CASP is Accessible using Mobile Devices
Mobile login, navigation, assessment, reporting, and calculators
Questions?