Development of Leaf Sampling Methods and Nutrient budget for Almond

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Development of Sampling Methods

Objectives

- **Predict July leaf N % using an April sampling.**
- **Develop a leaf sampling protocol representative of CA almond orchards.**

Methods

- **Four Representative CA almond orchards sampled from 2008 to 2010.**
- **Modeling prediction and spatial analysis during 2011.**
- **Validation of the results selecting six new orchards in 2012.**

Changes in leaf nutrient status with season and site. Development of new orchard sampling strategies.

2008 ***2009*** ***2010***

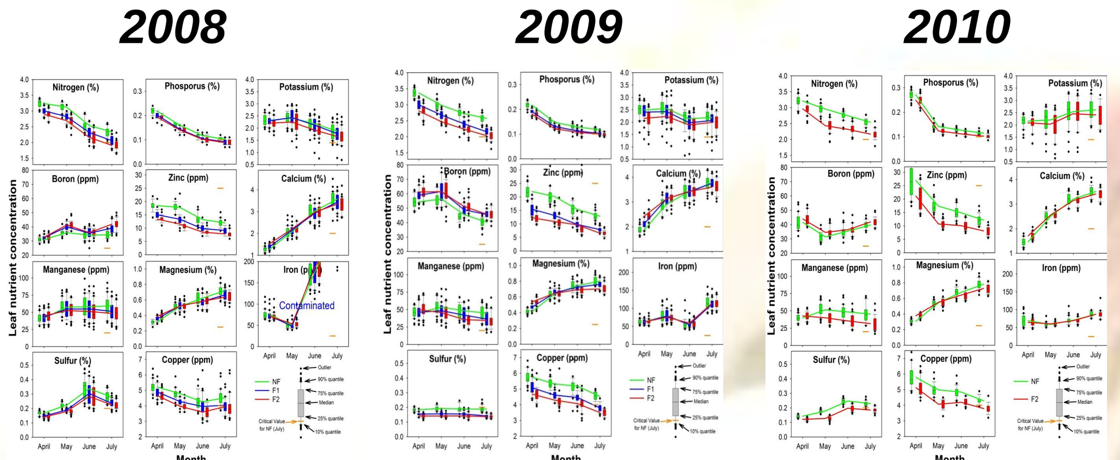

Figure 1. Typical nutrient behavior throughout 2008, 2009, and 2010 season in leaves from non-fruiting spurs (NF), spurs with 1 fruit (F1), and spurs with 2 fruits (F2). The graphs show data collected from the Arbuckle orchard.

New Orchard Sampling Criteria

For each orchard/block or sub-block that you wish individual information on, do the following:

- Sample all the leaves of 5-8 non-fruiting well-exposed spurs per tree at approximately 43+/-6 days after full bloom when the majority of leaves on non-fruiting spurs have reached full size. In the majority of Californian orchards this corresponds to mid-April.
- Collect leaves from 18-28 trees per orchard. Combine all leaves in a single bag for submission to reputable laboratory. EACH SAMPLED TREE MUST BE AT LEAST 30 YARDS APART. A minimum of 100 leaves per sample bag is required.
- Send the samples to the lab and ask for a FULL NUTRIENT ANALYSIS (N, P, K, B, Ca, Zn, Cu, Fe, Mg, Mn, S) and application of UCD-ESP program.

Predicting the % of trees in an orchard that will be above of a standard critical value.

Data collected form 2008-2012 was used to characterize 'typical' variability in leaf nutrient concentrations in April and in July. This was then used to help predict the relationship between mean nutrient status and the range.

This data can be used to optimize production and minimize the potential for overfertilization.

Table 1. Observed % of trees above 2.2 % of N in July against the predicted % of trees using a July sampling.

Site	Observed % above 2.2 in July	Predicted % above 2.2 in July using July N Sampling
1	32	41
2	32	31
3	90	81
4	80	88
5	82	93
6	92	85

Table 2. Observed % of trees above 2.2 % of N in July against the predicted % of trees using an April sampling.

Observed % above 2.2 in July	Predicted % above 2.2 in July using April Sampling
32	49
32	90
90	85
80	98
82	95
92	91

Can we sample leaves in April and Predict July?

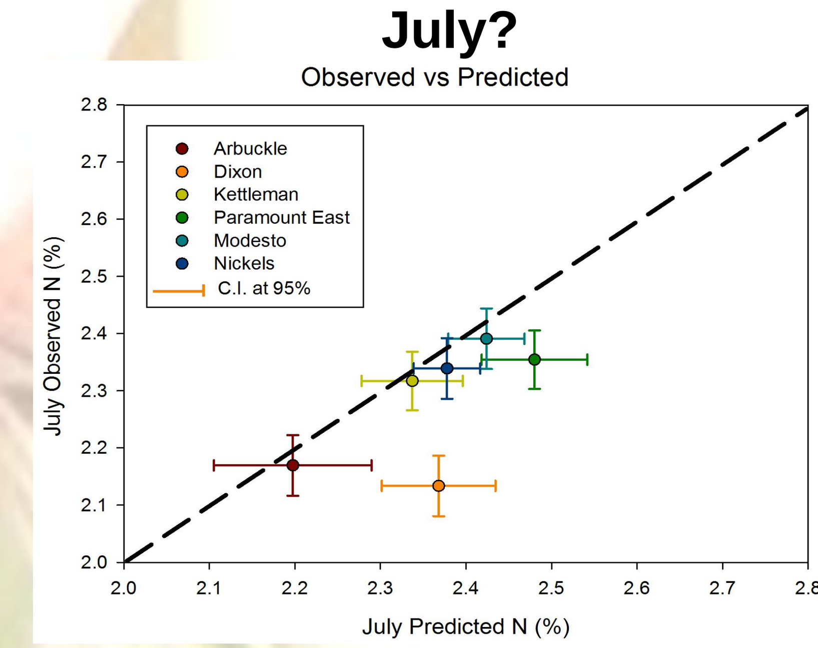

Figure 2. 2012 validation plot. Application of newly developed leaf nutrient prediction algorithm to 6 novel validation sites. Plot contrasts model predicted nutrient concentrations against measured concentrations.

Conclusions

- **A model to predict July nitrogen concentration and the percentage of trees above a certain July critical value have been generated, and effectively validated.**
- **A new sampling method has been generated and effectively validated.**
- **The model is available online at** http://ucanr.edu/sites/scri/Crop_Nutrient_Status_and_Demand__Patrick_Brown/ **and an Smartphone app will be lunched in 2013.**
- **Researchers invite growers, specialists, and laboratories to test the current model and send their feedback to phbrown@ucdavis.edu or sssaasilva@ucdavis.edu.**

Development of Nutrient Budget

Objectives

- **Develop Nutrient demand curves for almond**
- **Determine nutrient use efficiencies of N and K fertilizer sources**
- **Demonstrate yield response of almond to N and K fertilizer rates and sources**

Methods

- **Fertigation trail with four N and three K rates**
- **Two N and three K sources**
- **Two irrigation Systems: Fan Jet and Drip**
- **Leaf and nut samples collected five times during the season 2008-2012**

Nutrient Accumulation in Fruits and Tree

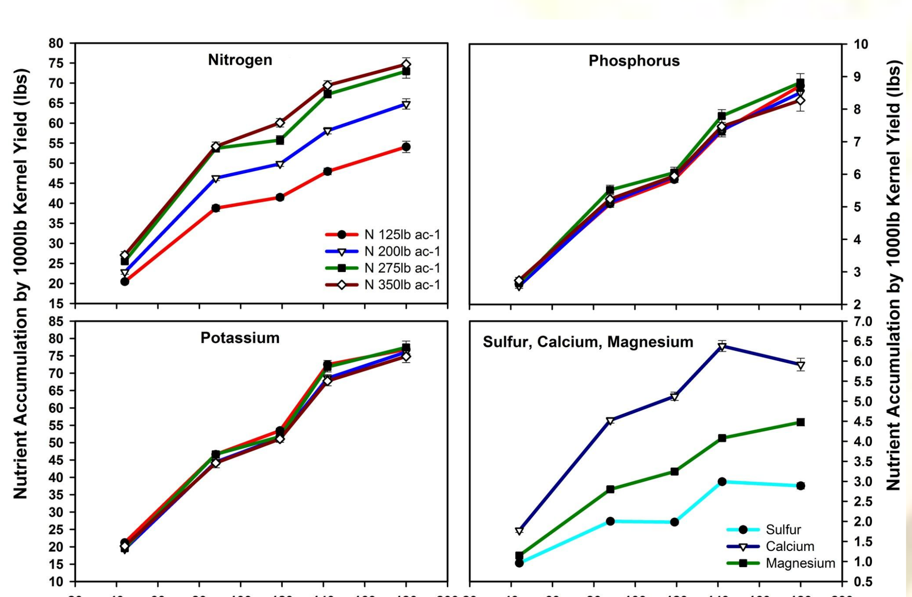

Figure 3. Accumulation of nitrogen, phosphorus and potassium with different N rates and Sulfur, Calcium and Magnesium with 275lb/ac N by 1000lb kernel yield in almond in 2011. Each point shows mean and std error

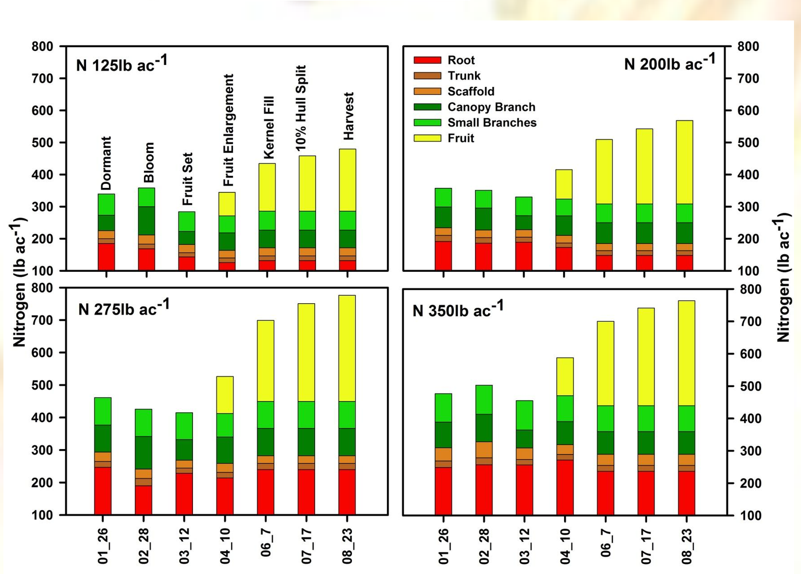

Figure 4. Changes in nitrogen accumulation in fruit and perennial organs of almond under differential nitrogen supply.

Yield Response to Nitrogen Application

Table 3. Mean kernel yield of Nonpareil almond in 2011. Means in same irrigation type not followed by the same letter are significantly different .

Irrigation	N UAN 32				N CAN 17			
	125	200	275	350	125	200	275	350
Drip	3,732	4,229	4,696	4,775	3,564	4,365	4,833	4,969
	c	b	a	a	c	b	a	a
Fan Jet	3,744	4,048	4,480	4,406	3,746	4,161	4,420	4,361
	c	b	a	a	c	b	a	a

Table 4. Mean kernel yield of Monterey almond in 2011. For N rates means not followed by the same letter within irrigation type are significantly different . For N source means with star (*) at the same rate of N are significantly different.

Irrigation	N UAN 32				N CAN 17			
	125	200	275	350	125	200	275	350
Drip	3,096	3,492	4,343	4,047	2,580	2,973	3,425	3,885
	b *	b	a *	a	d *	c	b *	a
Fan Jet	2,838	3,539	3,674	3,709	2,941	3,290	3,631	3,494
	b	a	a	a	c	b	a	ab

Table 5. Mean kernel yield (lb/ac) of Nonpareil almond in 2011 for potassium rates and sources. No significant differences in kernel yield was found for K rates and sources

Irrigation	Potassium Rate (K lb/ac)			Potassium Source		
	100	200	300	SOP+KTS	SOP	KCl
Drip	4700	4643	4774	4723	4791	4804
Fan Jet	4382	4480	4498	4471	4362	4348

Nitrogen Use Efficiency

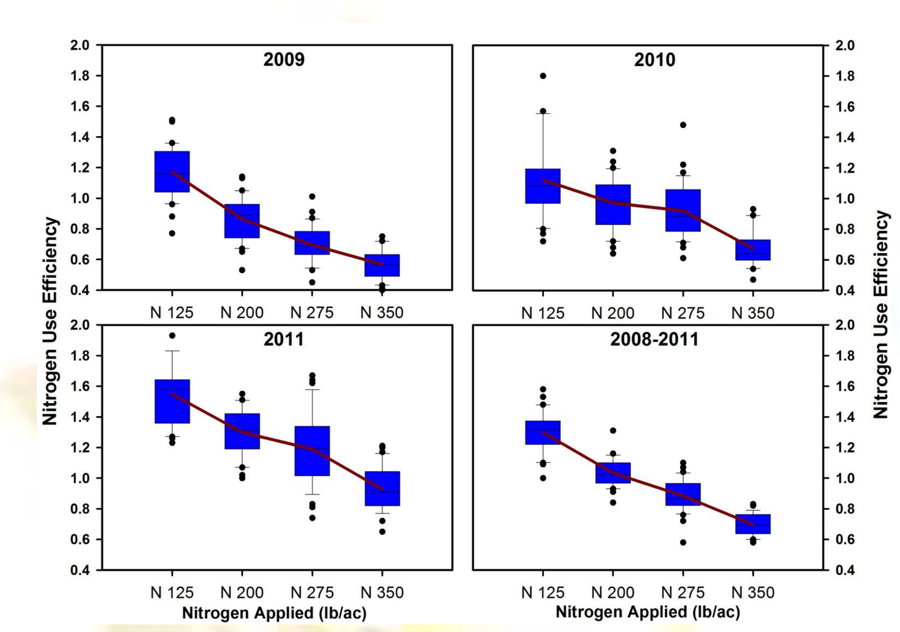

Figure 5. Nitrogen Use Efficiency (NUE) of various N rates. NUE calculated as N exported in fruits/N applied

Conclusions

- 1000lb kernel removes from 55 (at a leaf N of 2.0 in July)-74lb N (at a leaf N of 2.6 in July) with mean N 68lb at 2.4% leaf N concentration.
- P and K removal was 8.5lb and 75lb for 1000lb kernel yield
- 80% of N, 75% of P and K accumulates in the fruit before 119 DAFB (mid June in 2011).
- After tree is mature the greatest N removal from the orchard is in the harvested fruits
- In this trial a N rate of 275lb/ac maximized yield (4,700 lb acre) and there was no benefit from N application in excess of this value.
- Nonpareil's yield response to UAN 32 and CAN 17 was same while Monterey response was high with UAN 32 as N source
- A cumulative Nutrient Use Efficiency (N removed in harvest crop/N applied) of over 80% was observed for N rate 275lb/ac rate.

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USDA United States Department of Agriculture National Institute of Food and Agriculture Specialty Crop Research Initiative Project
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