New Approaches to Almond Nutrient Management

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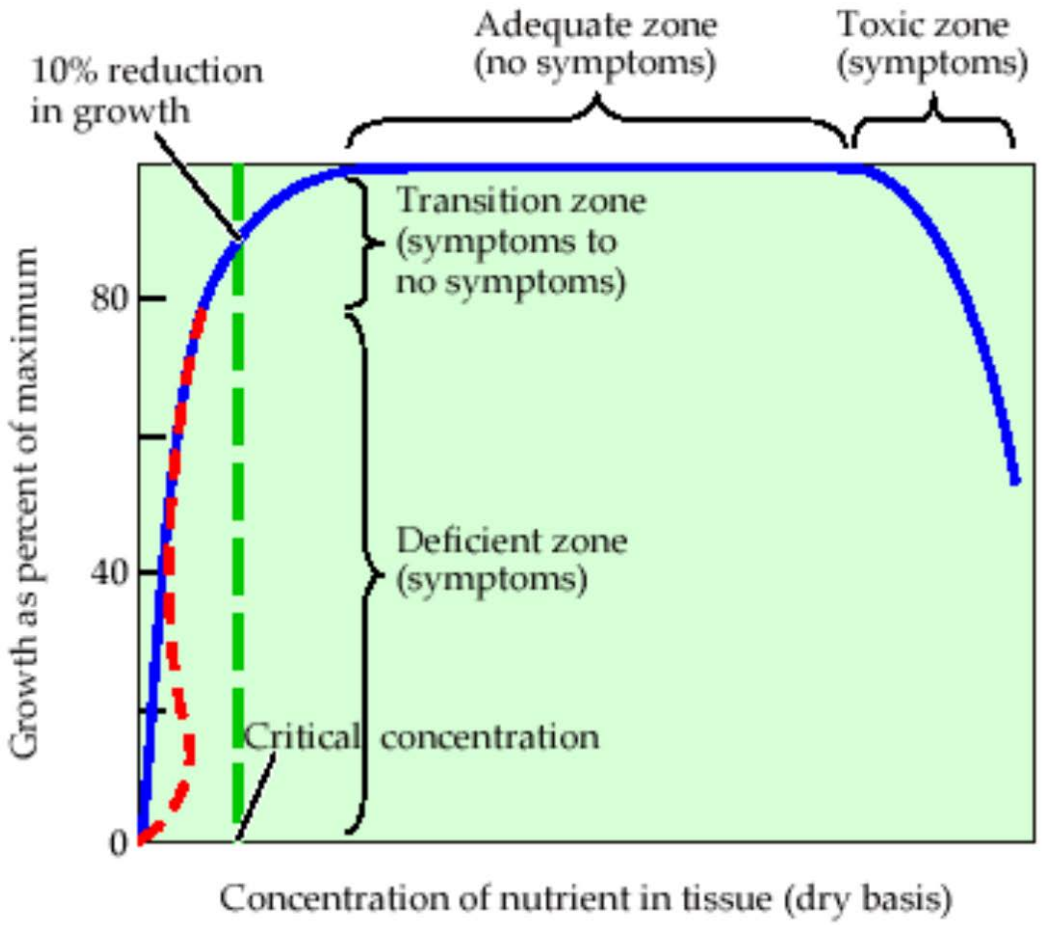
New Approaches to Almond Nutrient Management

Part 1: Leaf Sampling And Interpretation Methods.

What do we know and how do we manage? Leaf Sampling and Critical Value Analysis



*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.

:ols are well defined

spur leaves

quadrant at 6'.

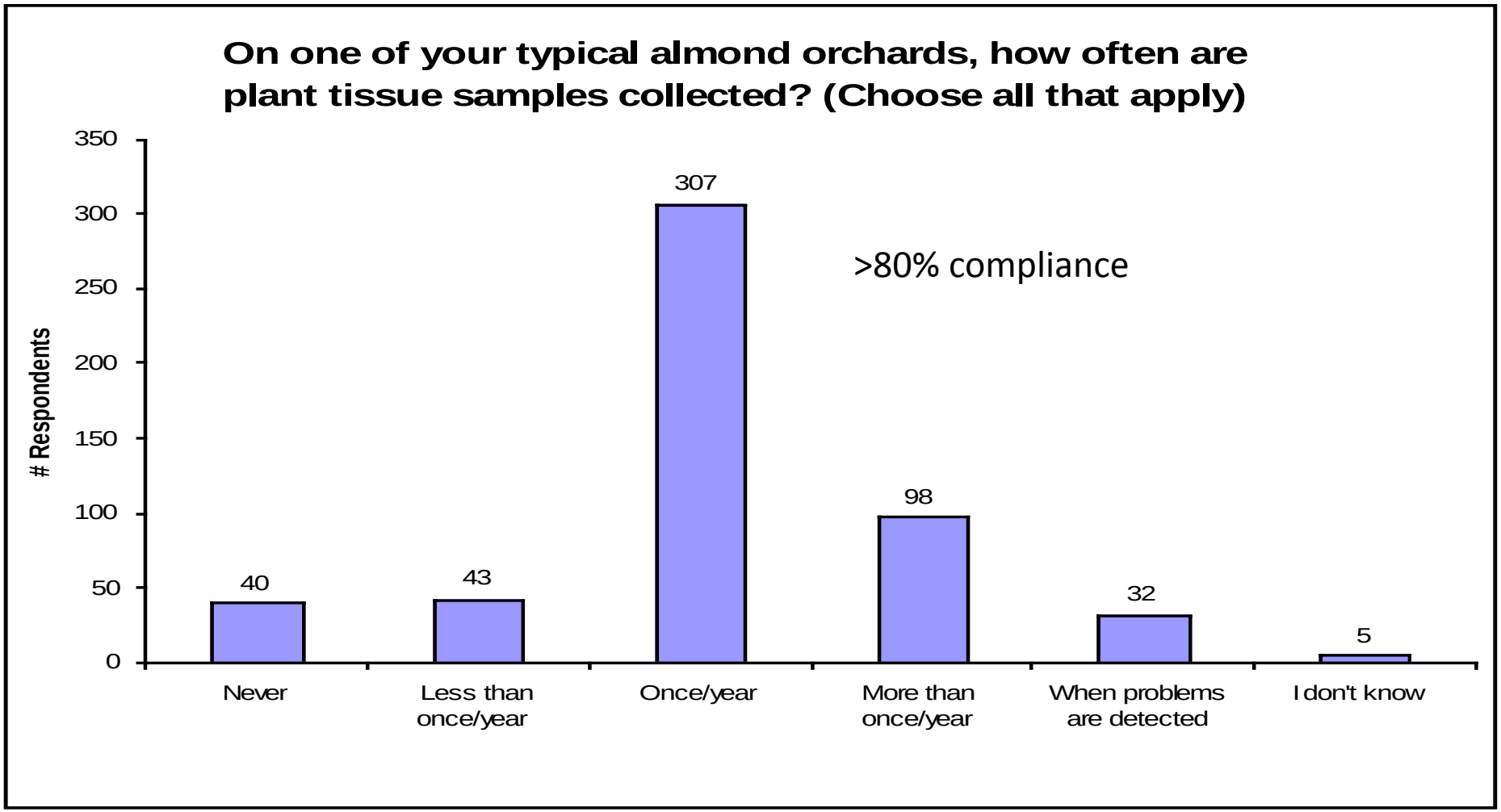
analysis with standard Critical
ed in Almond Production Manual

ials (N, K, B)

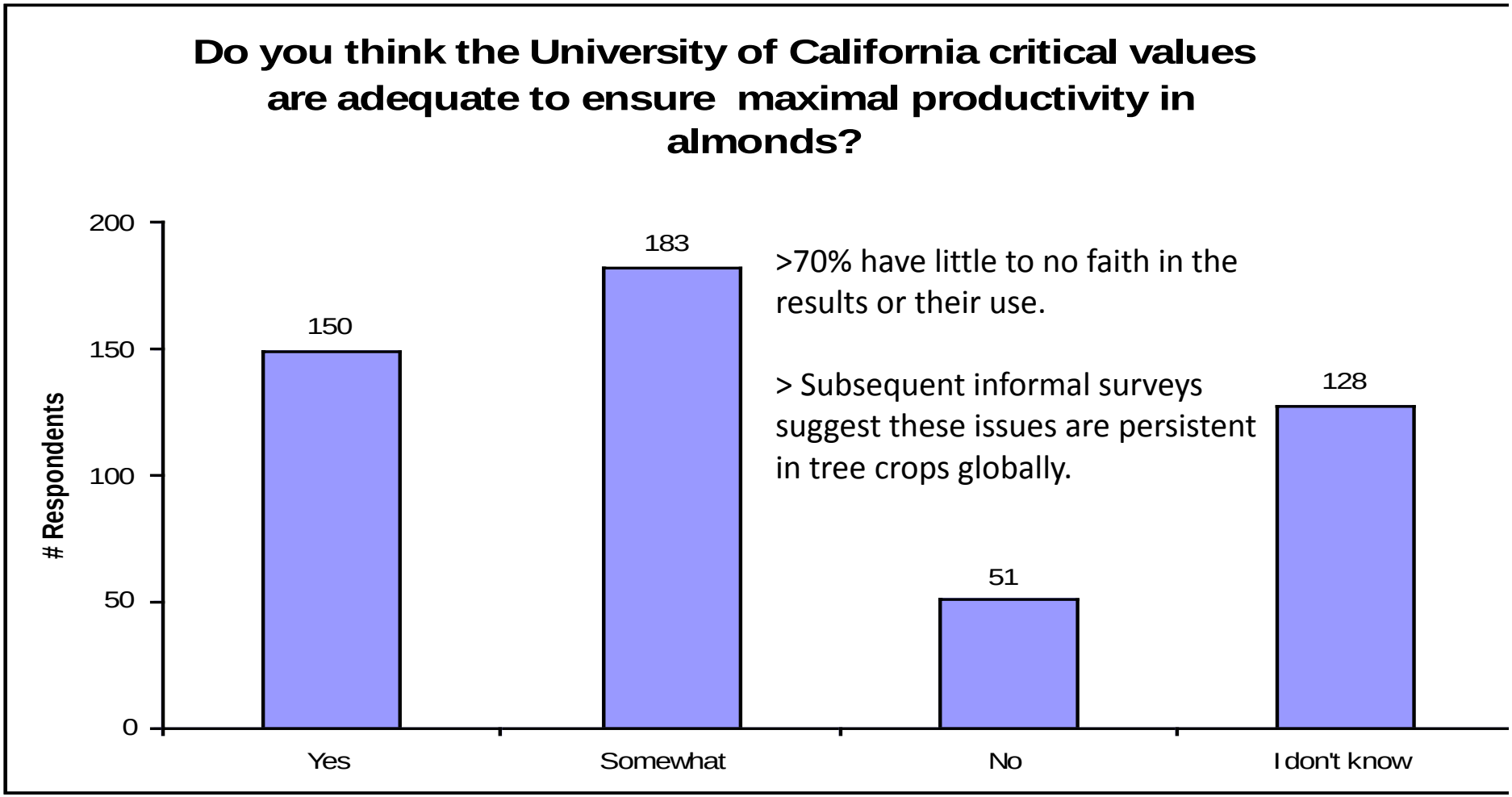
mptoms (P, S, Mg, Ca, Mn, Zn, Fe,

wn (Ni, Cl, Mo)

Are tissue samples collected and if so how often?



Are tissue samples being used to guide fertilizer management?



Apparently tissue sampling is not trusted- Why?

- It was designed to detect deficiency.
- It is not designed to determine how much fertilizer to apply.
- The complexity of tissue sampling was recognized, but not adequately optimized for trees.
- Samples collected do not always represent the true nutrient status of the orchard as a whole.
- Current Sampling Protocol is too late in year to make in season adjustments.
- Our current CV's may not apply in all cases or may be wrong.

Objectives:

- Develop methods to sample in April and relate that number to July critical value.
- Develop method for grower to sample his field (recognizing that typical practice is only 1 sample per field is generally collected).
- Reevaluate the current CV's.

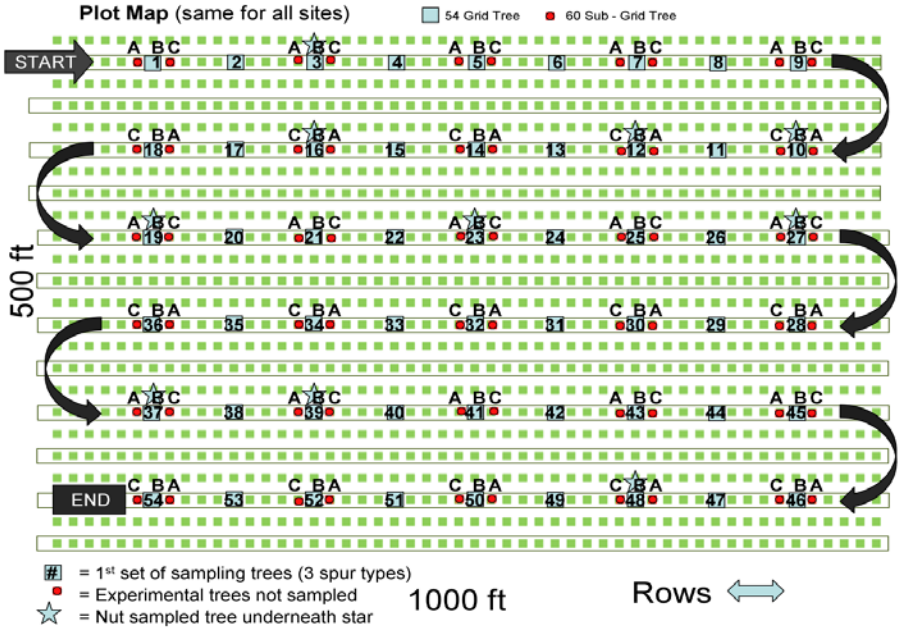
Solve Late Season Sampling And True Nutrient Status Problem

Orchard Selection

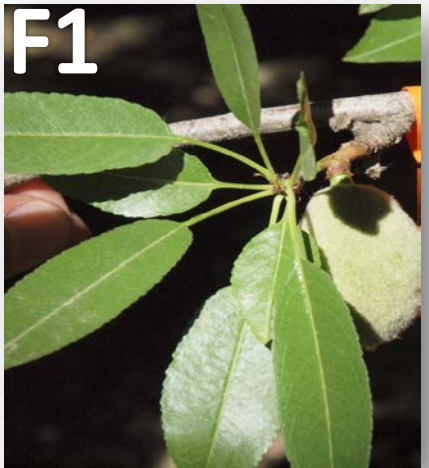
- Four sites from California's major almond producing regions
  - Arbuckle
  - Modesto
  - Madera
  - Belridge

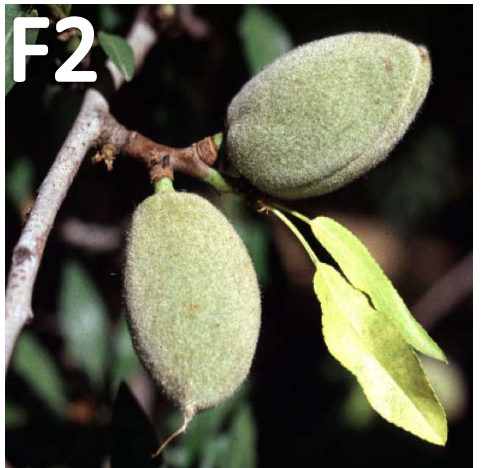
Location	Arbuckle	Salida	Madera	Belridge
Tree Age	1998	1998	2000	1999
Varieties	NP – 50% B – 25% A – 12.5% C – 12.5%	NP – 50% A – 25% WC – 25%	NP - 50% C – 25% M – 25%	NP – 50% M – 50%
Spacing	22' x 18' (110 trees/ac)	21' x 21' (99 trees/ac)	21' x 17' (122 trees/ac)	24' x 21' (86 trees/ac)
Irrigation	Drip	Microsprinkler	Microsprinkler	Microsprinkler

Design and Sampling



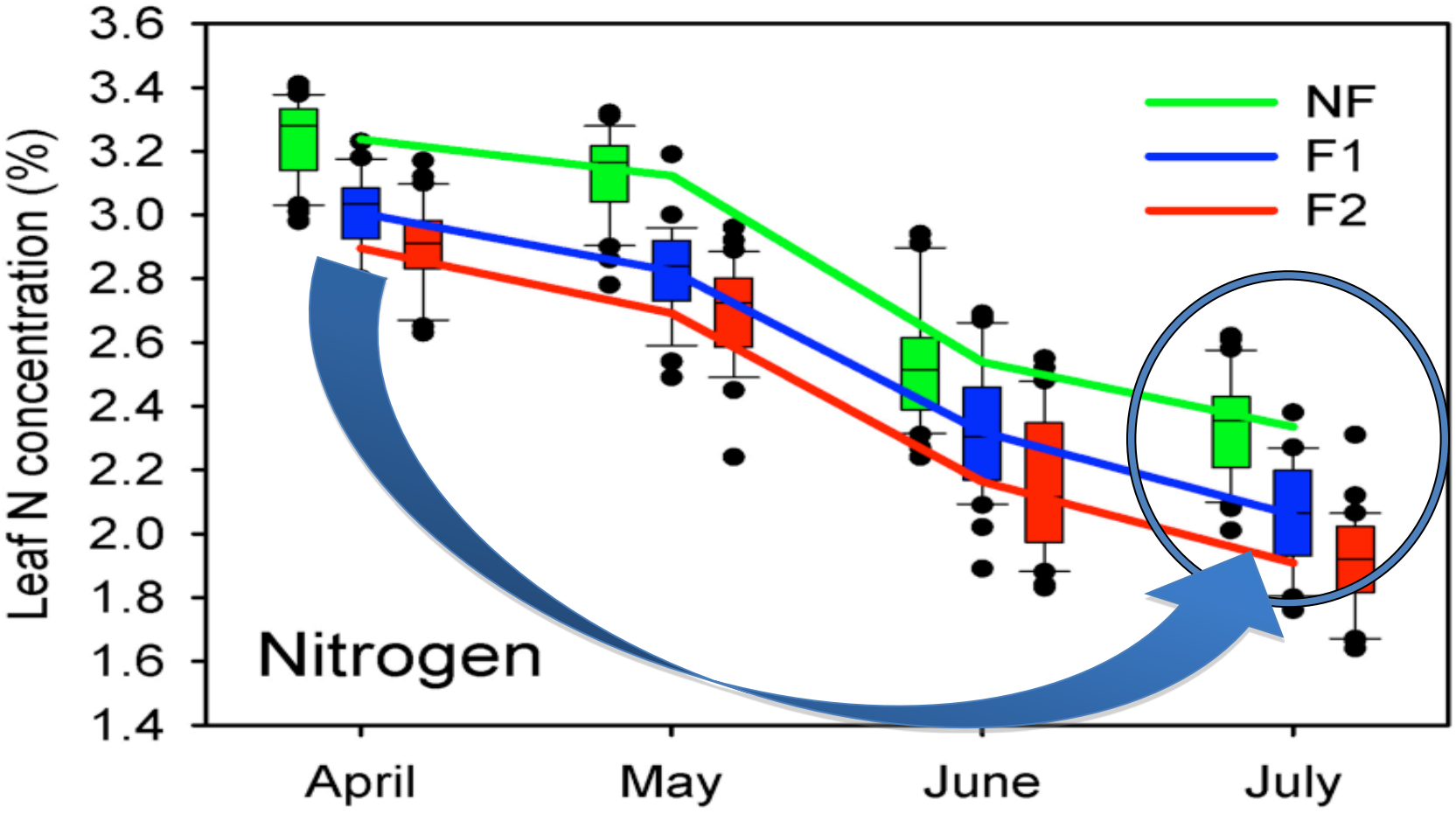
- 114 trees x 4 Sites x 3 years.
- Yield.
  (About 1,130 data points)
- 5 in-season nutrient samples.
  (8,500 x 11 = 93,500 data points)





Time Problem.

Can we sample in April and predict July?



Approach: Multi site, multi year, multi tissue and multi element analysis.

Two Models to Answer the same Q.

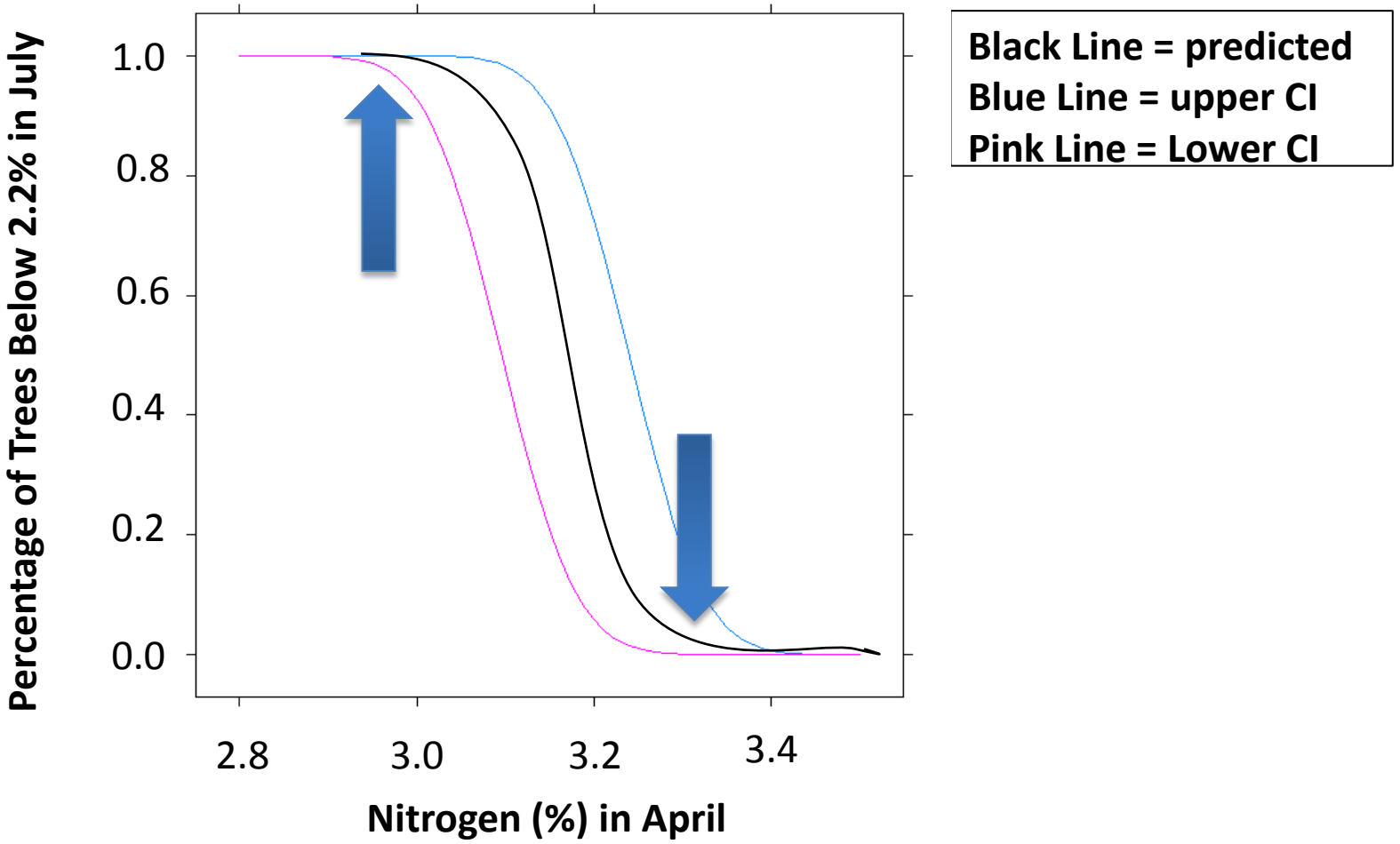
- Model one uses all the April information from F2 spurs to predict the July nitrogen value.
- Model two uses the nitrogen NF information from April to predict the July nitrogen value.
- Both models also predict what percentage of the trees are above or below the current July nitrogen critical value.
- Both models work well but we do not yet know which model is best (validation will be done this year).

Results Cross-Validation Model 1

Site	Year	July Nitrogen Predicted	July Nitrogen Observed
Arbuckle	8	2.4	2.3
Belridge	8	2.4	2.4
Madera	8	2.5	2.4
Modesto	8	2.4	2.4
Arbuckle	9	2.4	2.6
Belridge	9	2.4	2.4
Madera	9	2.6	2.4
Modesto	9	2.6	2.7
Arbuckle	10	2.4	2.5
Belridge	10	2.3	2.7
Madera	10	2.3	2.3
Modesto	10	2.4	2.5

Results: Model 2

Expected % of trees below 2.2% in July



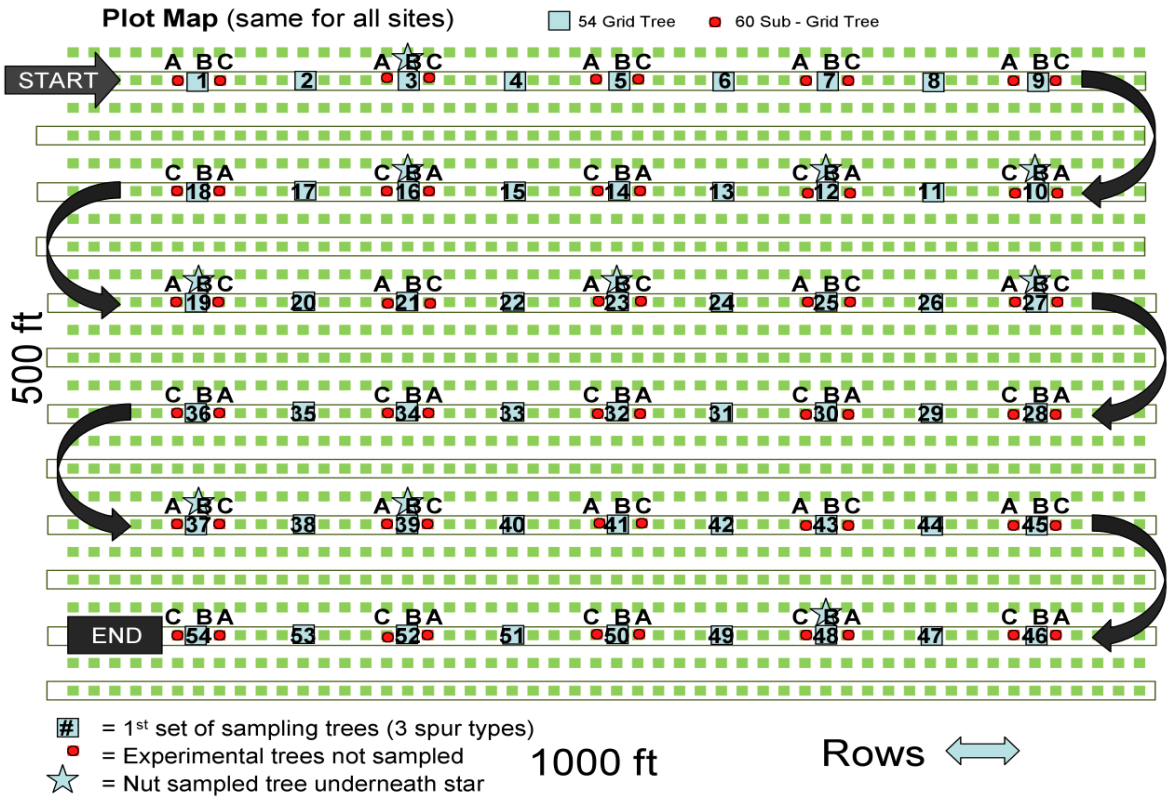
How Do we use the models?

Distance from Tree to Tree

Number of Trees

Criteria

Distance From Tree to Tree



- Analysis of Spatial Correlation: Samples Collected at least 30 yards away.

Number of trees needed in April to Estimate the true mean of Nitrogen

Number of Acres	Trees needed at 95% Confidence	Trees needed at 90% Confidence
2	25	18
5	27	19
10	28	19
50	28	20
100	28	20
Note: 1 acre is assumed to be 100 trees		

Pooled trees = Number of trees from which leaves must be collected and pooled into a single bag for a single nutrient analysis

Sampling Criteria

- Collect leaves from 18 to 28 trees in one bag.
- 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.

New Approaches to Almond Nutrient Management

Part 2: Nutrient Budget Approach

- Applying the Right Rate
  - Match demand with supply (all inputs- fertilizer, organic N, water, soil).
- At Right Time
  - Maximize uptake minimize loss potential.
- In the Right Place
  - Ensure delivery to the active roots.
- Using the Right Source
  - Maximize uptake minimize loss potential.

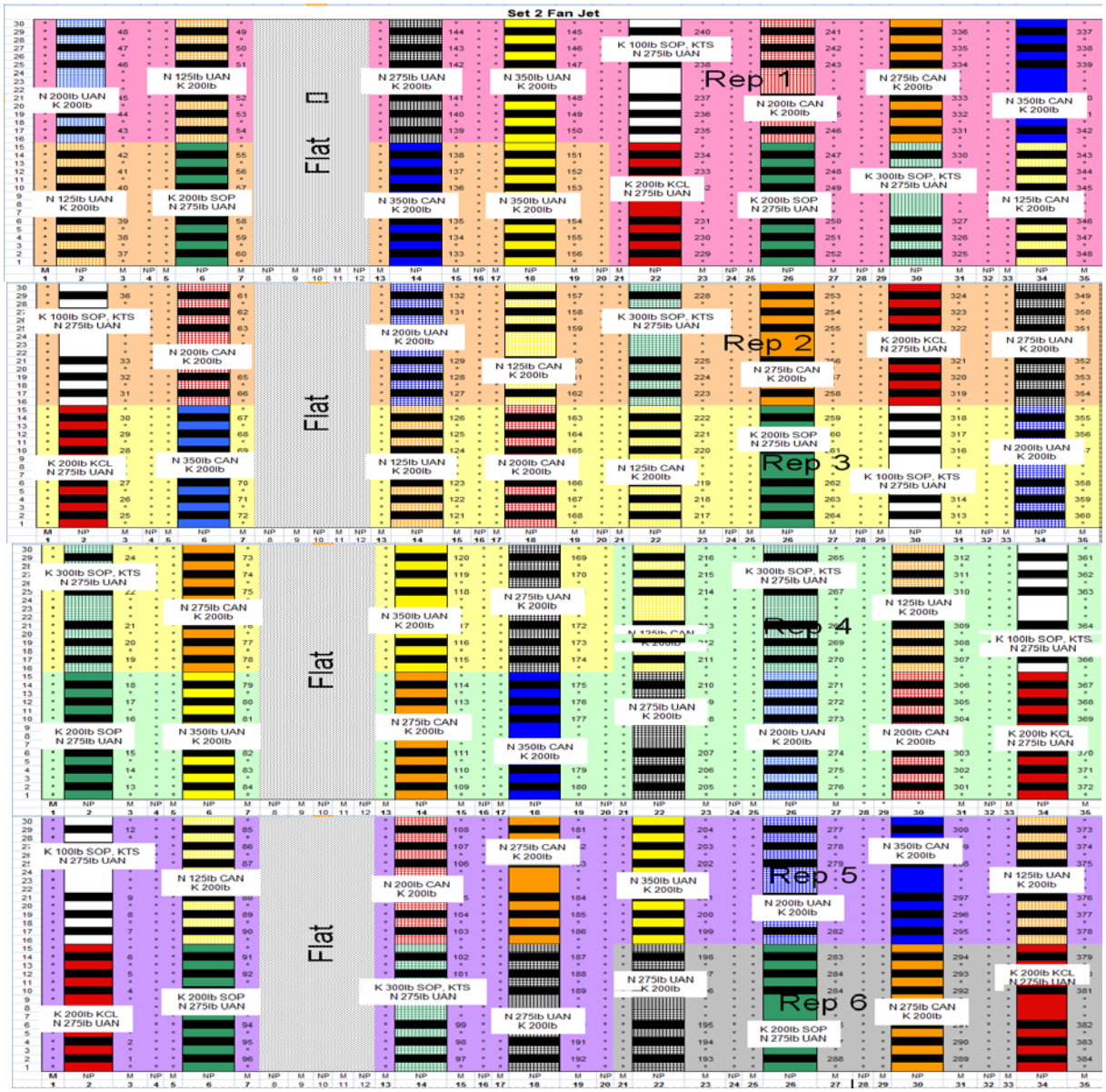
Fertility Experiment

- Treatments
- 4 Nitrogen rates – 125, 200, 275 and 350lb/ac
- 2 Nitrogen Sources- UAN 32 and CAN 17
- 3 Potassium Rates- 100, 200 and 300lb/ac
- 3 Potassium Sources- SOP, SOP+KTS and KCl @200lb/ac
- Irrigation Types
- Fan Jet and Drip

Fertigation

- 4 times during the season
    - 20, 30, 30 and 20% in February, April, June and October
- Samples Collection
- Leaf and Nut samples collected from 768 individual trees five time in season
- All trees individually harvested

Experimental Layout



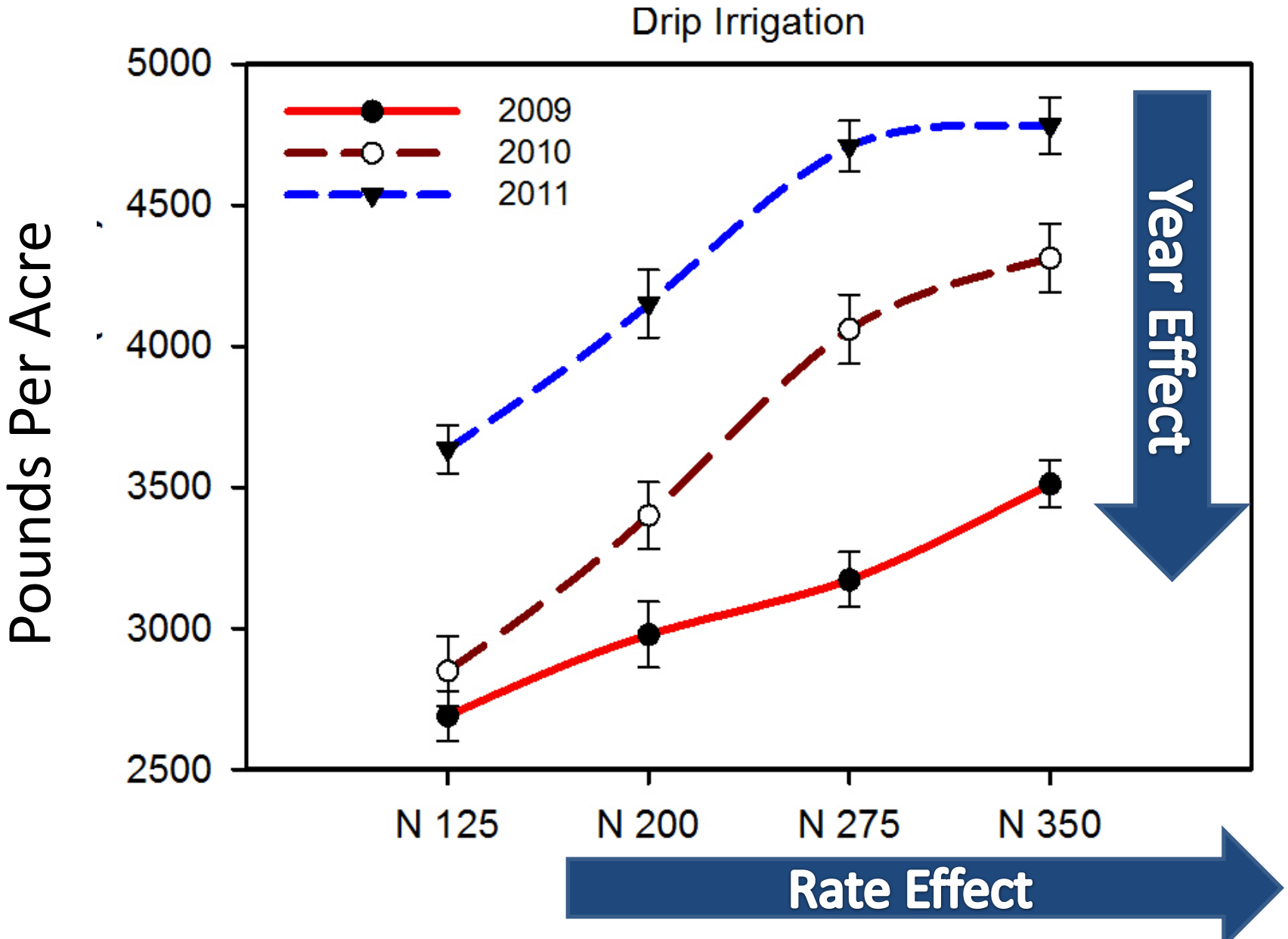
Large experiment covering approximately 100 acres.

768 trees individually monitored for nutrients, yield, light interception, disease, water.

Trees were 9 leaf in 2008.

Nonpareil - Monterey

Yield Response to Nitrogen



Cumulative Kernel Yield 2009-11

Cumulative Kernel Yield 2009-2011 (lb/ac)

Irrigation	N UAN 32				N CAN 17			
	125	200	275	350	125	200	275	350
Drip	**9,328**	**10,642**	**11,667**	**12,356**	**8,796**	**10,298**	**11,844**	**12,139**
	d	c	b	a	c	b	a	a
Fan Jet	**9,156**	**10,245**	**11,201**	**11,314**	**9,563**	**10,345**	**11,539**	**11,109**
	c	b	a	a	c	b	a	a

Means not followed by the same letter are significantly different at 10%.
Statistics are only within irrigation type.

The rate response has been independently from the type of source.

In the long Term:
275 pounds and 350 pounds of N have ended in approx. 4,000 pounds per year.
While 125 pounds of N have ended in approx. 3,000 pounds per year.

N Fertilization increases Shelling Percentage

Shelling Percentage (%)

Irrigation	N UAN 32				N CAN 17			
	125	200	275	350	125	200	275	350
Drip	25.8	28.7	28.4	29.8	25.5	27.4	29.9	28.0
	b	a	a	a	c	b	a	b
Fan Jet	26.2	28.0	28.3	28.2	26.6	27.5	30.4	28.0
	b	a	a	a	b	b	a	b

Means not followed by the same letter are significantly different at 10%.
Statistics are only within irrigation type.
Shelling percentage is on the basis of clean 4lb sample

NPK Export by 1000lb Kernel at Harvest 2009-10 Added Together

NPK Export by 1000lb Kernel in 2009-10 (lb)

Average of 2009 and 2010				
Nutrient	**Nitrogen Rate (lb/ac)**			
	125	**200**	**275**	**350**
N	**57**	**59**	**66**	**65**
	b	ab	a	a
P	**8.1**	**7.8**	**8.1**	**6.7**
	a	a	ab	b
K	**82**	**77**	**77**	**77**
	ab	b	b	b

Means not followed by the same letter are significantly different at 10%.

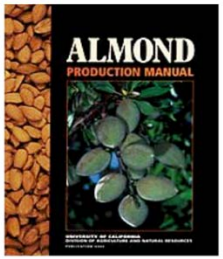
If you produce around 3,500 pounds , then you export: around 240# of N; 23.4# of P; and 270# of K.

Conclusions: In the past

- We only had the Almond Fruit Production Manual table.

Table 26.2 Critical nutrient levels (dry-weight basis) in almond leaves sampled in July.

Nitrogen (N)	
Deficient below	2.0%
Adequate	2.2–2.5%
Phosphorus (P)	
Adequate	0.1–0.3%
Potassium (K)	
Deficient below	1.0%
Adequate over	1.4%
Calcium (Ca)	
Adequate over	2.0%
Magnesium (Mg)	
Adequate over	0.25%
Sodium (Na)	
Excessive over	0.25%
Chlorine (Cl)	
Excessive over	0.3%
Boron (B)*	
Deficient below	30 ppm
Adequate	30–65 ppm
Excessive over	300 ppm
Copper (Cu)	
Adequate over	4 ppm
Manganese (Mn)	
Adequate over	20 ppm
Zinc (Zn)	
Deficient below	15 ppm



*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.

Conclusions: In the present

- We have developed two models to predict July Nitrogen concentration using April data.
- Both models measure orchard variability and calculate the percentage of the trees that will be above or below the current July critical value.
- In other words, both models can provide the information needed to maximize productivity.

Conclusions: In the present

- …However, guaranteeing maximal productivity does not guarantee maximal profitability nor best management.
- We have assumed that field variability exists and cannot be managed – that is not correct.
- To really optimize sustainability, leaf sampling and analysis and subsequent management must also consider economic and environmental factors.

Conclusions: In the present

- We know total tree demand and when it happens:

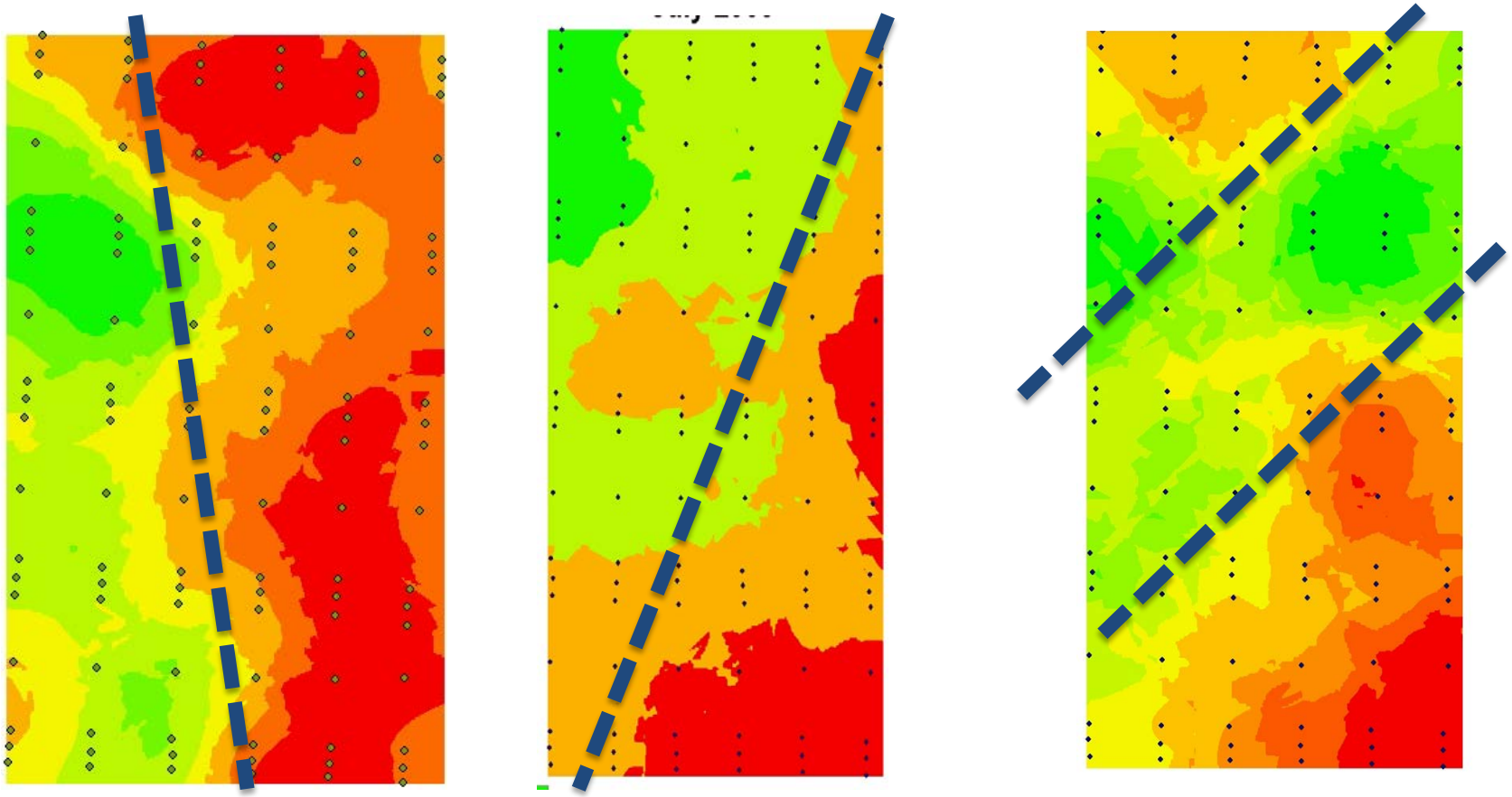
  80% of N, 75% of P and K accumulates in the fruit before 120 DAFB (mid June in 2010).

- In this trial a N rate of 275lb/ac maximized yield (4,700 lb acre in the last year of study) and there was no benefit from N application in excess of this value.

- Although significant differences in leaf K status were observed in 2010; no statistically significant differences in yield have been observed.

Conclusions: In the future

- We must not only recognize and interpret orchard variability, we should attempt to control (or reduce) it.



Conclusions: In the future

- Example of modifying orchard variability

Example

Nitrogen Demand by 20 acre block

Whole Field Average N demand = 150 lbs N

Take Home Message

- Adjust for yield.
- Manage each orchard as an individual - do not just give everything 250 lbs.
- Estimate yield (your best fair guess)
- Analyze leaves in April, estimate yield in April - Adjust accordingly.

Thanks!