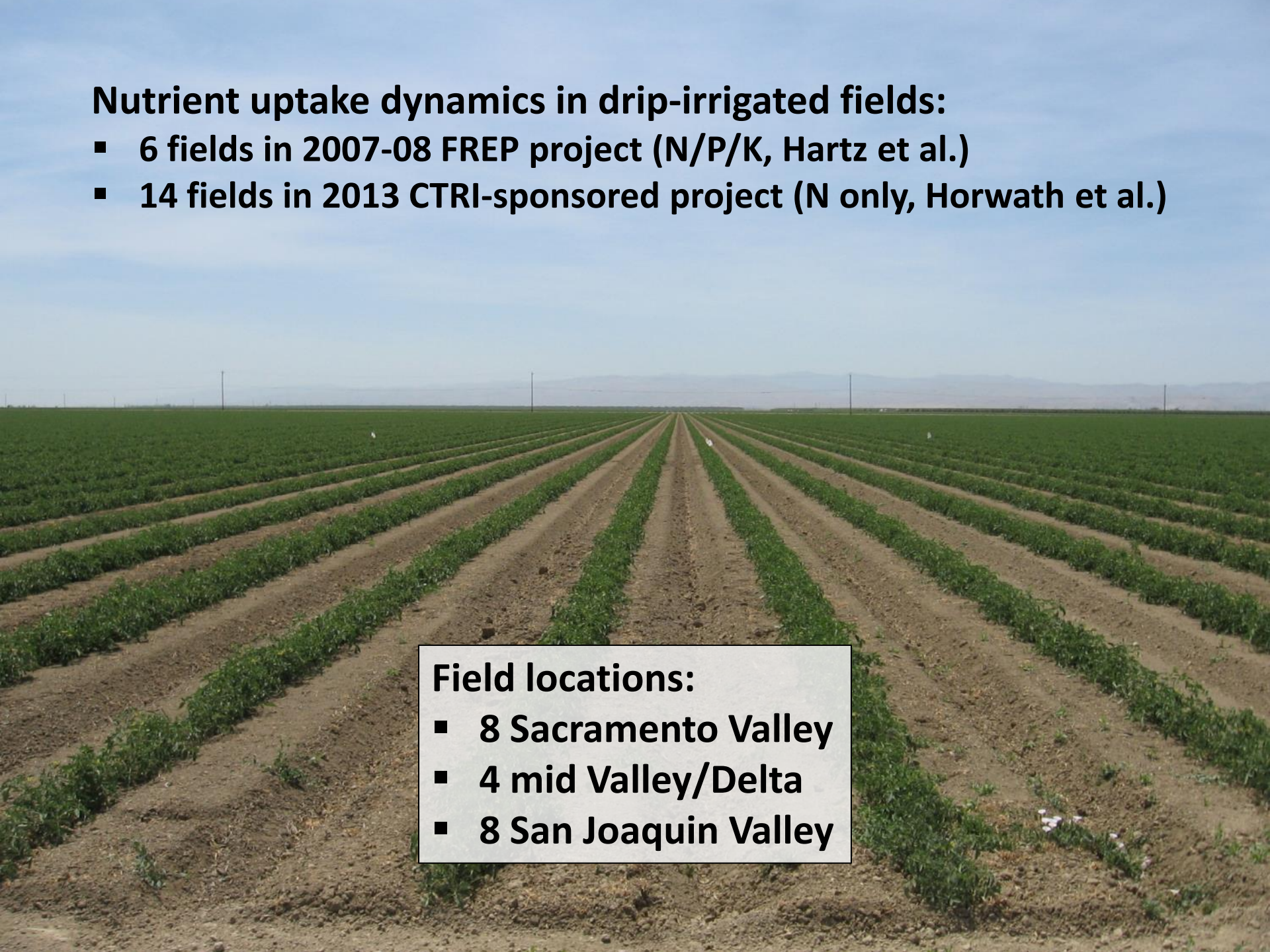
Fertility management in drip-irrigated processing tomato production

Nutrient uptake dynamics in drip-irrigated fields:

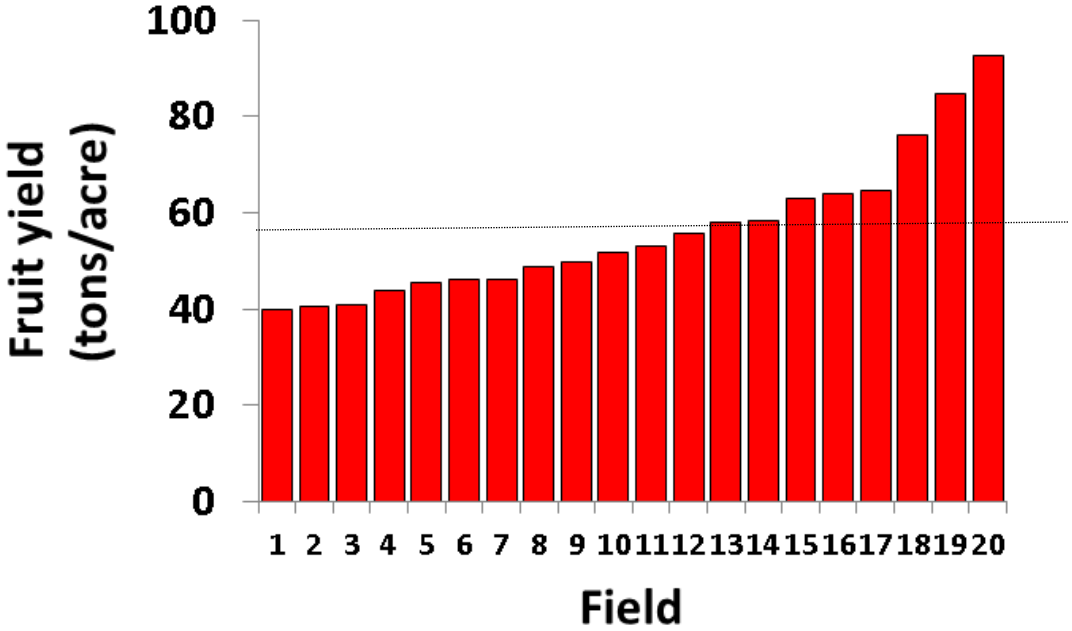
- 6 fields in 2007-08 FREP project (N/P/K, Hartz et al.)
- 14 fields in 2013 CTRI-sponsored project (N only, Horwath et al.)



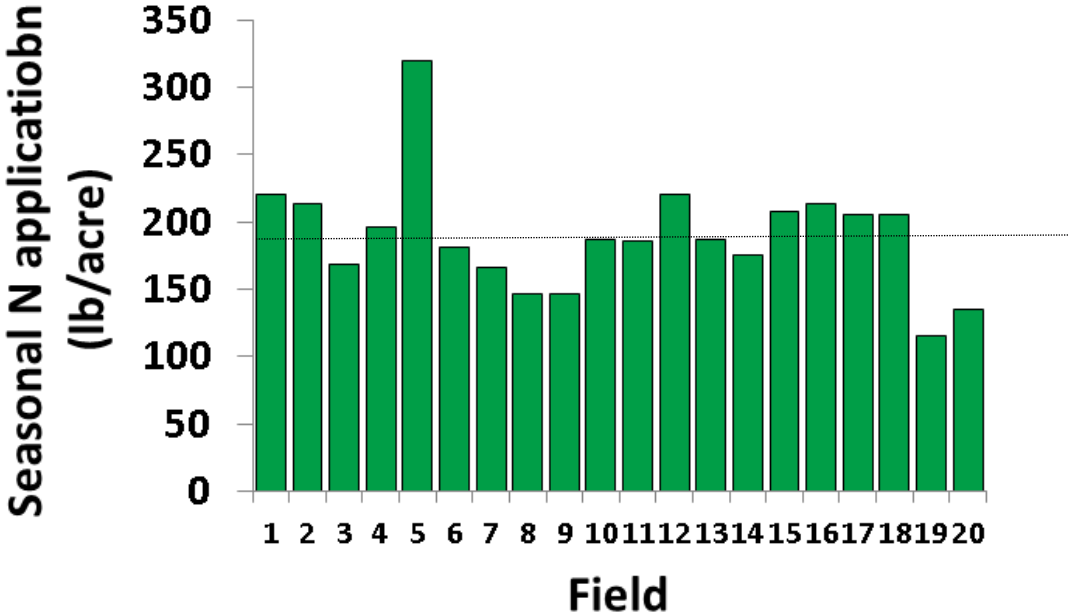
Field locations:

- 8 Sacramento Valley
- 4 mid Valley/Delta
- 8 San Joaquin Valley

Fruit yield and N fertilizer application in monitored fields

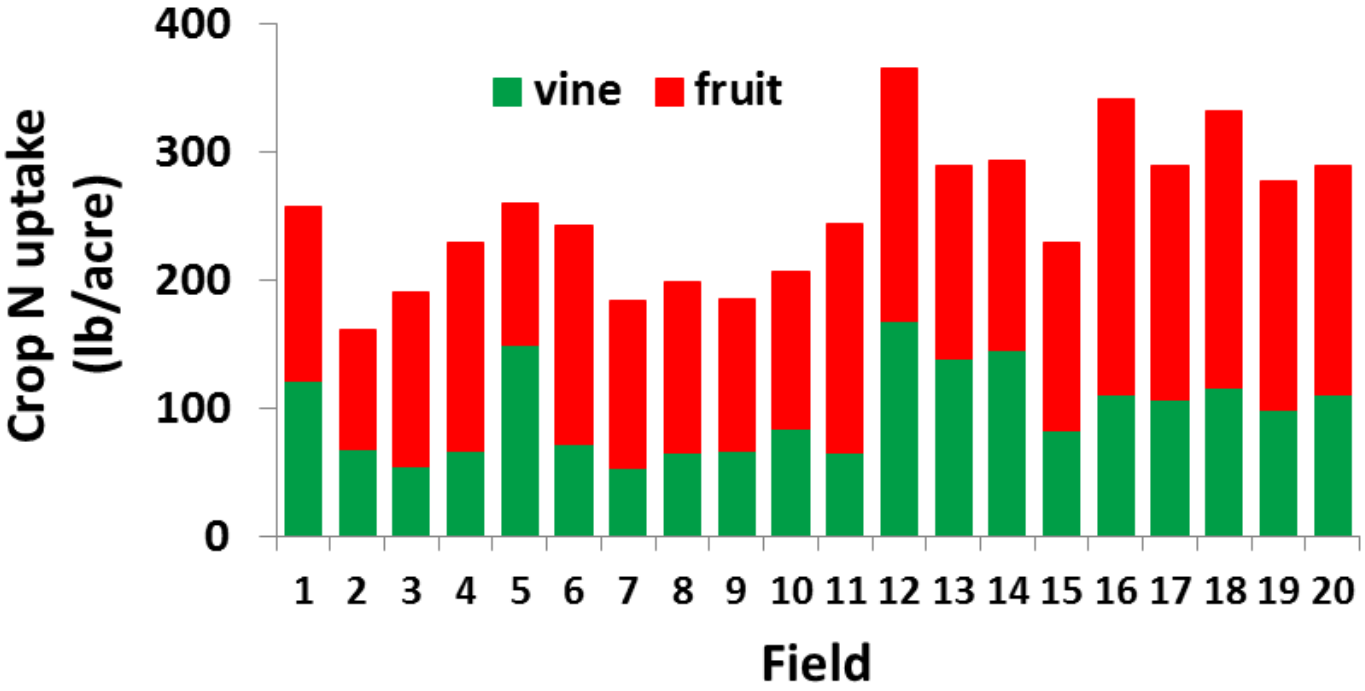


Mean 56 tons/acre *total* fruit yield



Mean 190 lb N/acre seasonal N application

How much N does a tomato crop take up, and how is it partitioned?



Means

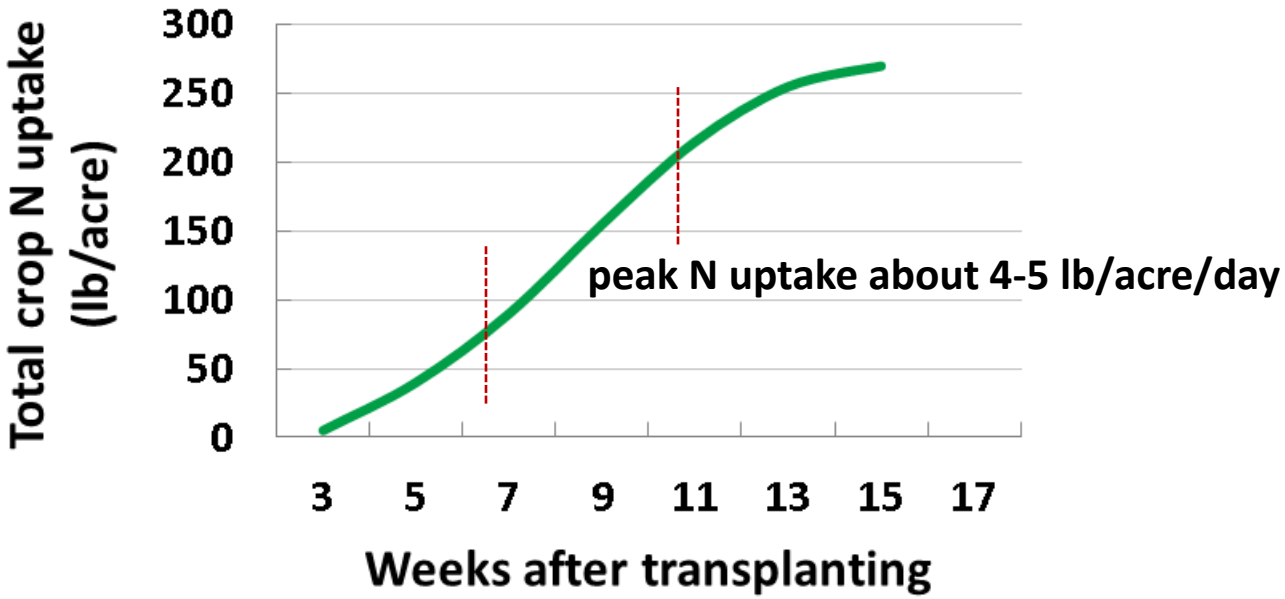
253 lb N total

156 lb N fruit

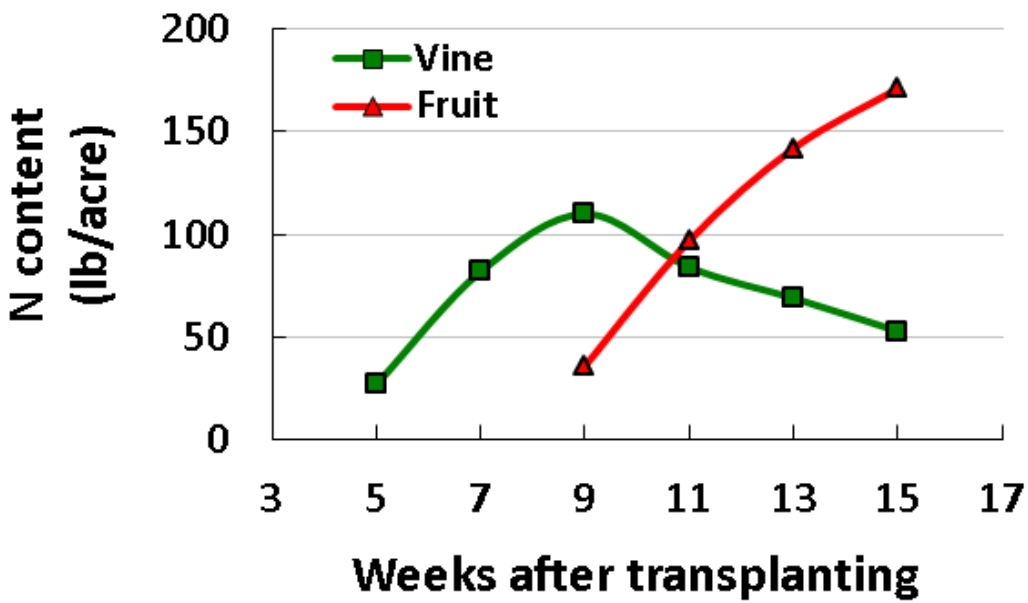
97 lb N vine

- **Fruit N content ranged from 1.9 - 3.6 lb N/ton, averaging 2.8 lb/ton**
- **Fruit represented 60-70% of total N uptake in most fields**

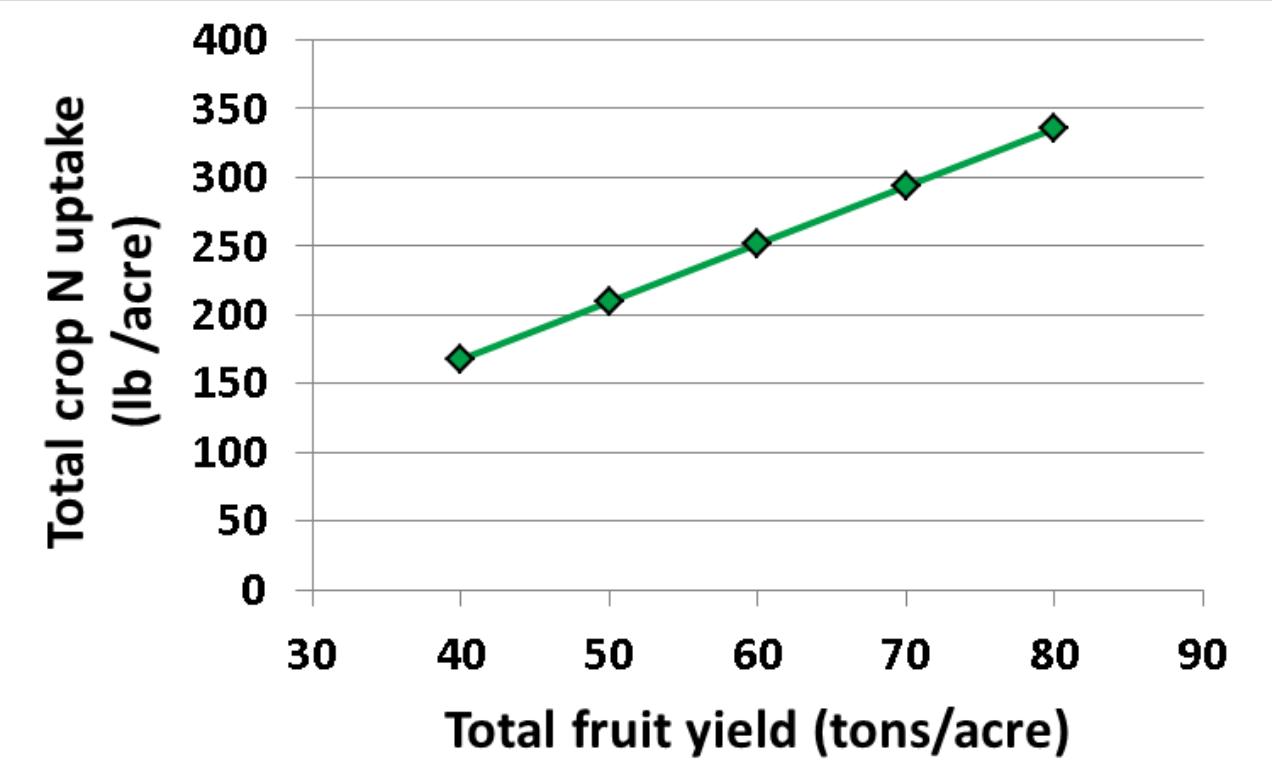
Seasonal N uptake pattern:



N partitioning:



How much N do high-yield tomatoes *need* to take up?

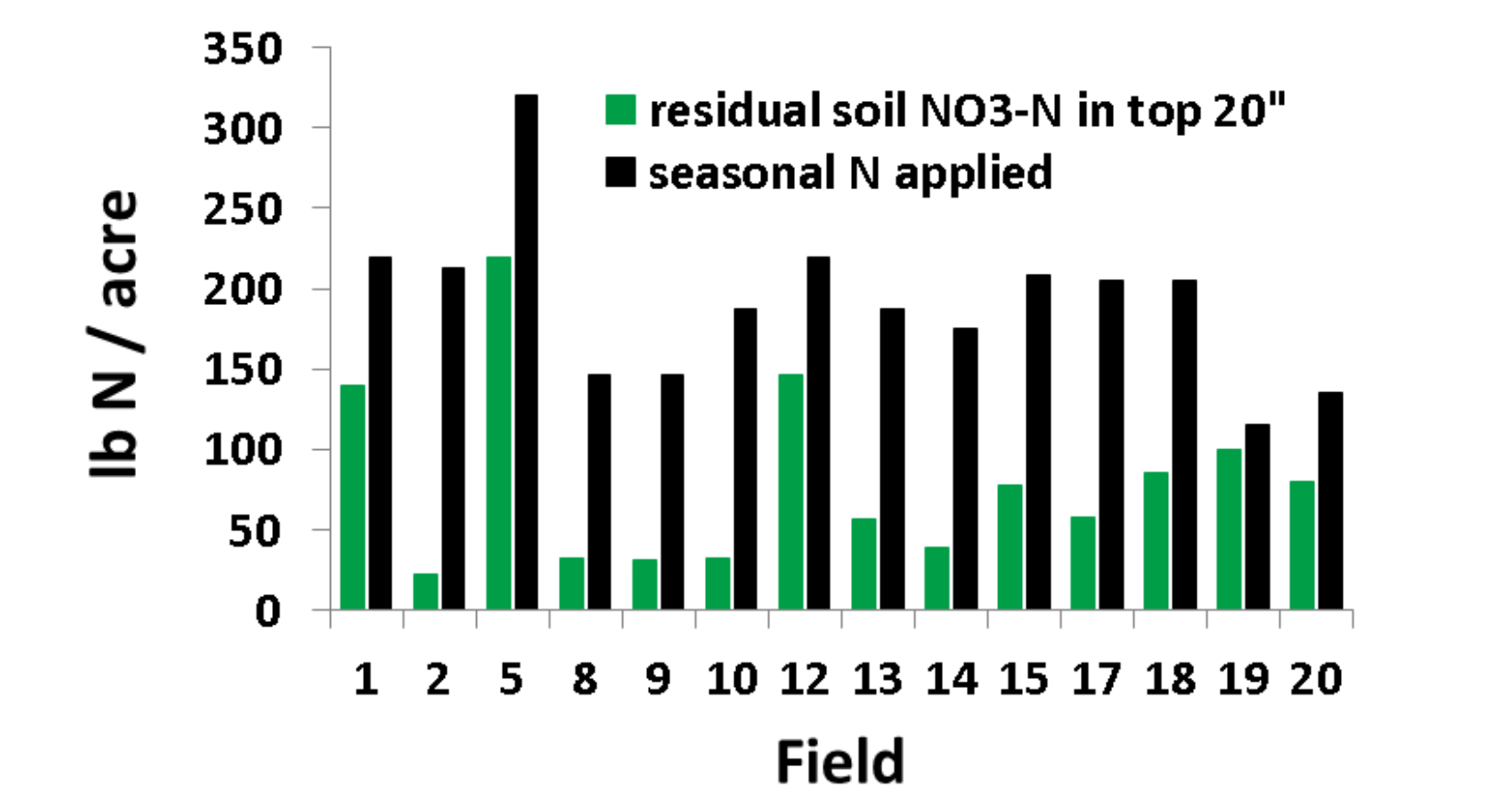


Assumptions:

- **Fruit contains 2.6 lb N/ton**
- **Fruit represents 62% of crop N uptake**

Note: this overstates actual N requirement because some of the survey fields had substantial luxury N uptake; N uptake requirement > 300 lb N/acre unlikely

Fertilizer application vs. preplant soil residual NO_3-N

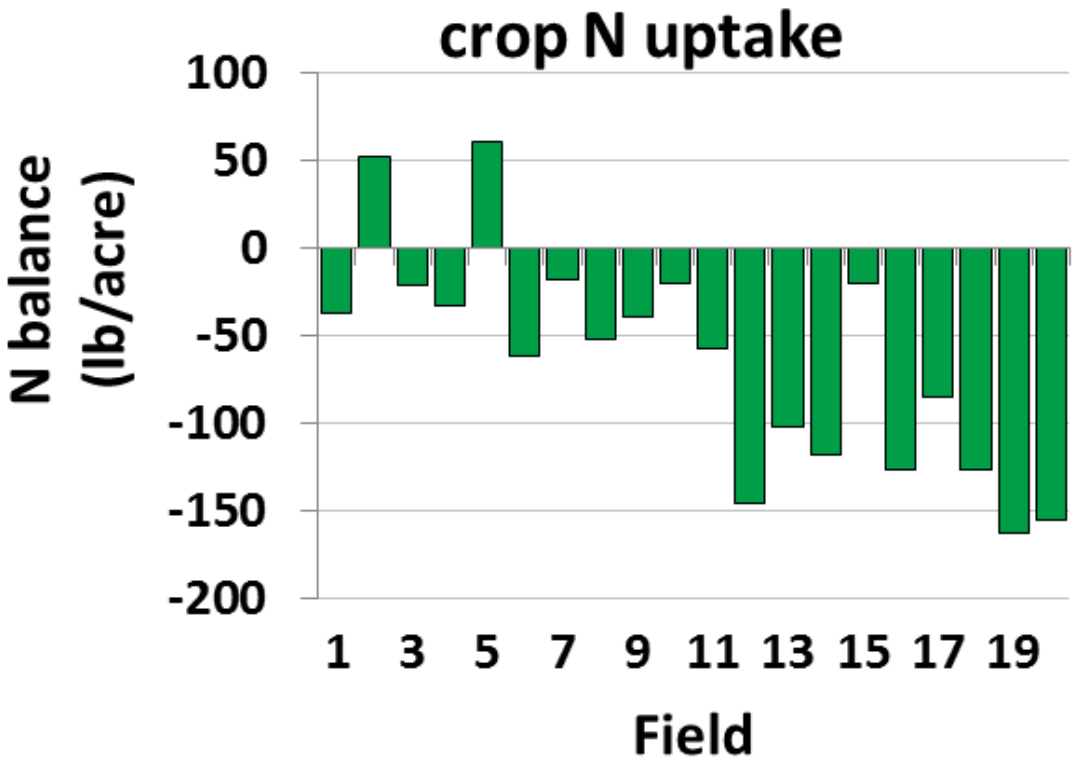


- Soil residual NO_3-N varied from 23-219 lb/acre, averaged 80 lb/acre
- Grower N application did not reflect this difference; ranged from 115-320 lb/acre, averaged 190 lb/acre

Data only from Horwath et al., 2013

Simplified N balance:

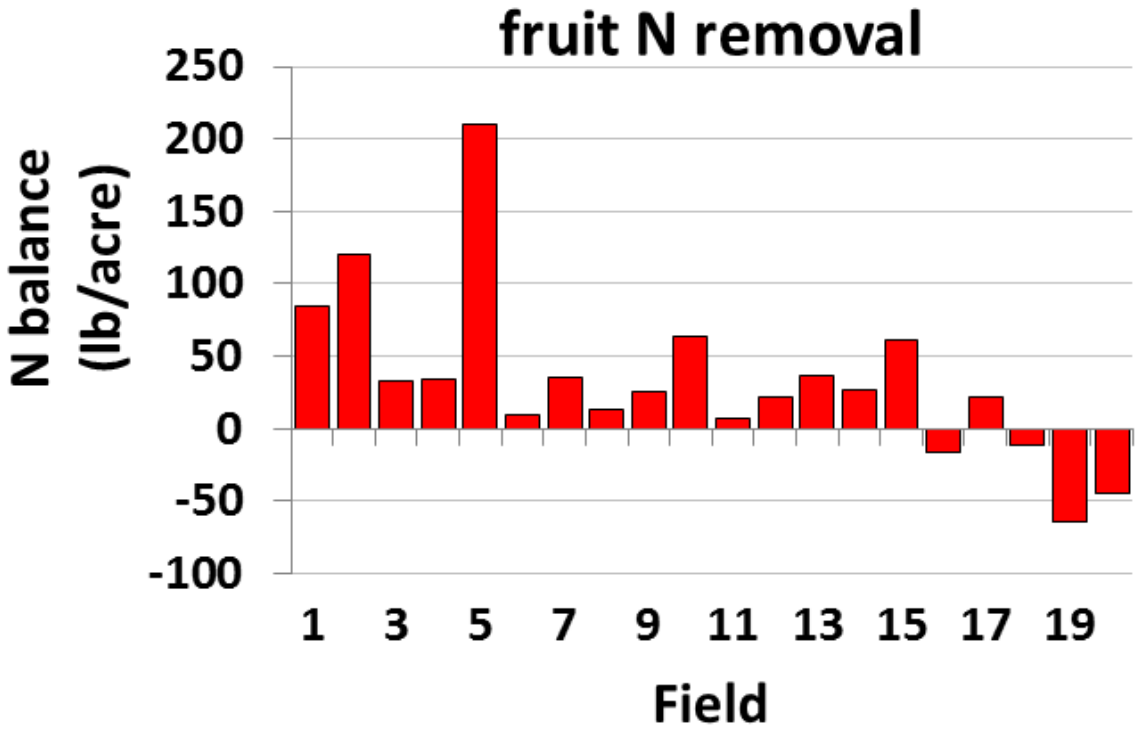
N application – crop N uptake



- **Processing tomato typically recovers a significant amount of soil N**
  - **residual soil NO_3-N**
  - **in-season soil N mineralization**

Simplified N balance:

N application – fruit N removal



- **If efficiently fertilized, N loading to the environment can be minimized**

N management guidelines:

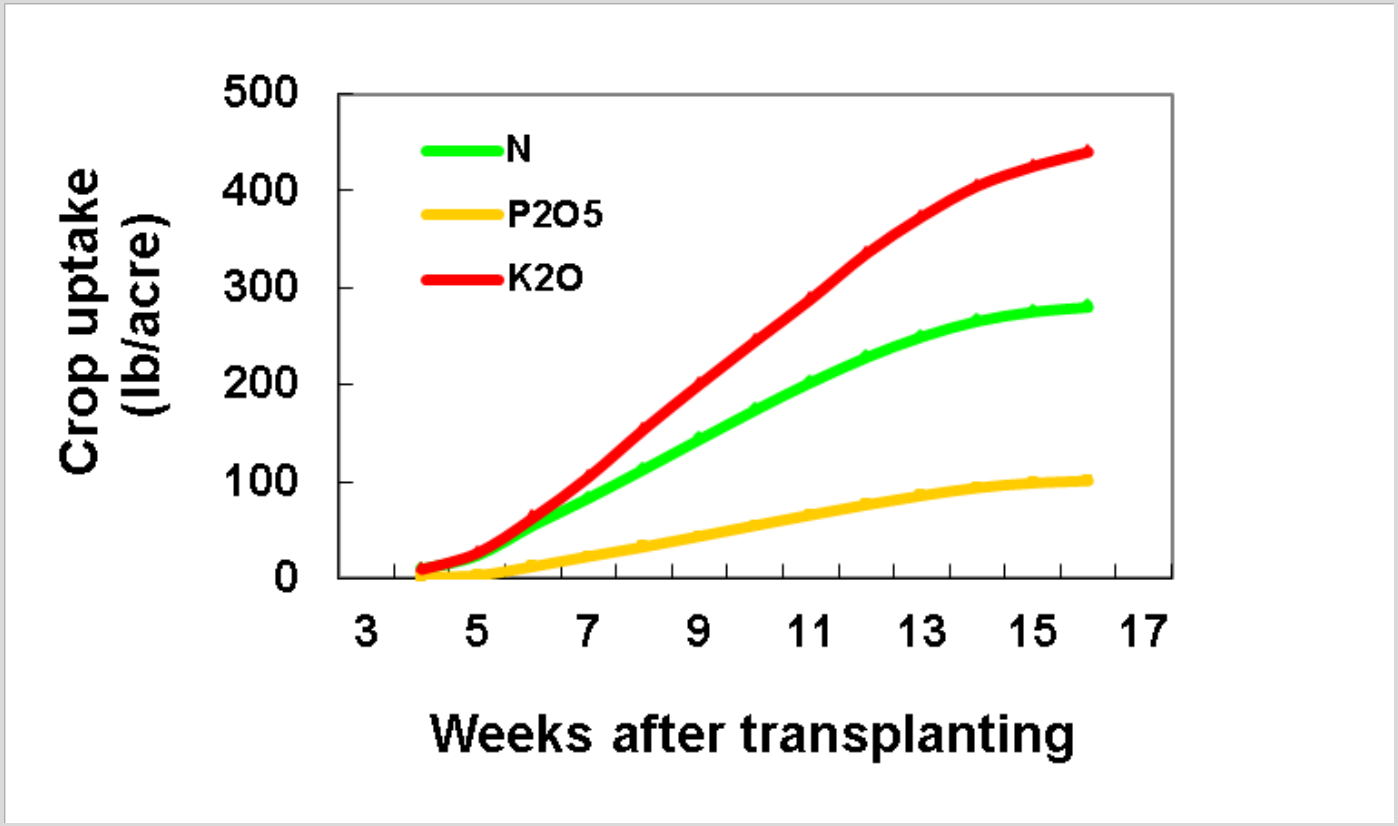
- Develop a fertigation template based on realistic yield potential, and soil type (in-season N mineralization potential)
- Determine residual soil NO_3-N early in the season, and modify the template to reflect the residual, primarily by delaying / reducing fertigation on the front end
- If irrigation water NO_3-N is high, adjust for N content

Bottom line:

The need for > 200 lb/acre seasonal N application is uncommon

How about Phosphorus and Potassium?

- **Uptake pattern roughly similar to N, but of different magnitude**



- **P uptake varies from approximately 70-100 lb P_2O_5/acre**
- **K uptake varies more widely (250-500 lb K_2O/acre) depending on yield and soil K supply**

How does drip irrigation change P and K management?

	Full bloom stage	
	1996-97 furrow fields	2007-08 drip fields
Yield	38 tons	56 tons
Leaf P	0.38%	0.27%
Petiole P	2,700 PPM	1,600 PPM
Leaf K	2.8%	2.3%
Petiole K	6.8%	4.2%
Fruit K	5.2%	3.6%

P and K fertilizer requirements will likely be higher than with furrow irrigation

P fertilization

When:

- **preplant, or at planting; with appropriate management, in-season application should not be necessary**

How:

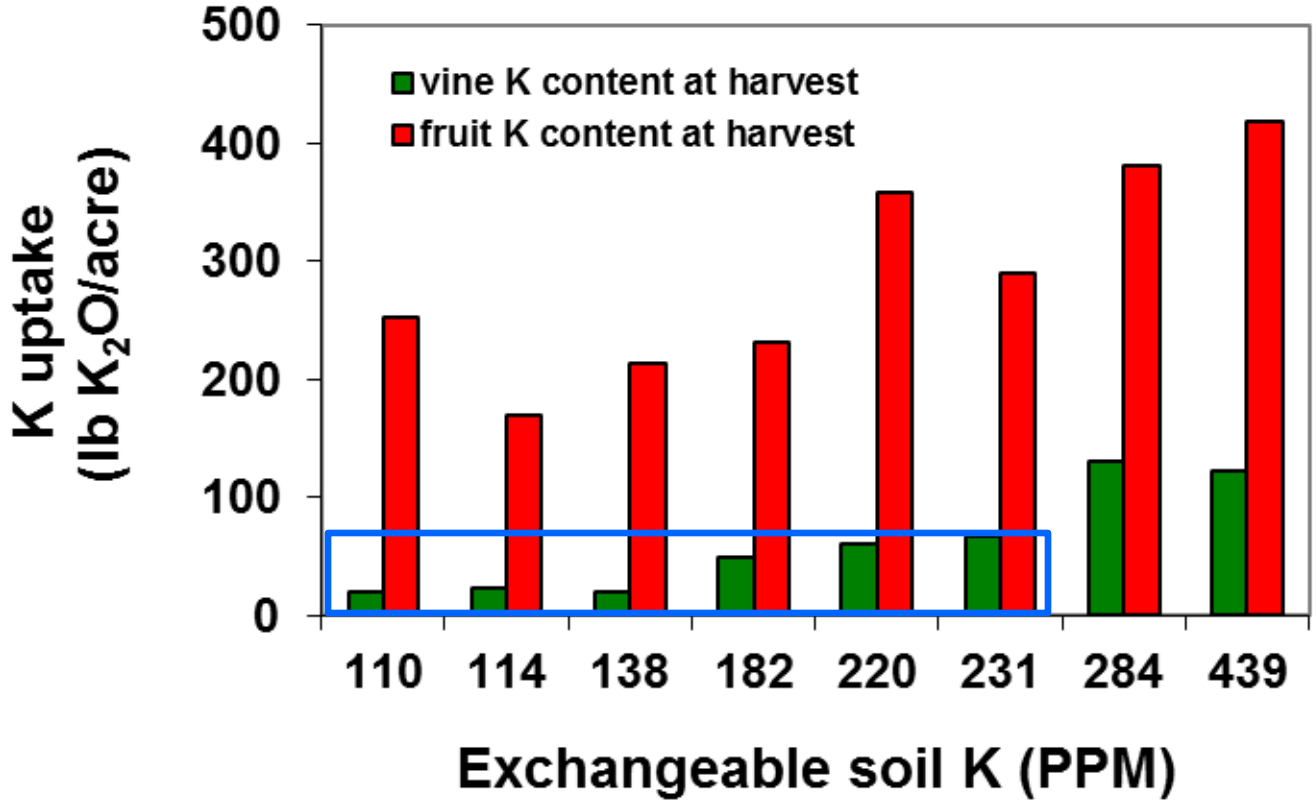
- **get at least some P close to the transplant to support early growth**

How much:

- **soil test between > 15 PPM Olsen P**
  - ***fruit removal rate*** **(50-70 lb P_2O_5/acre) usually adequate**
- **soil test < 10 PPM Olsen P**
  - ***crop removal rate*****, or more (> 80 lb P_2O_5/acre)**

Potassium is the most commonly deficient element in California tomato fields:

2007-08 fields:



Predicting response to K fertilization

Soils tests give K availability both as PPM, and % of cation saturation

Sample ID	Exchangeable cations (PPM)				Percent cation saturation					Cation exchange capacity (meq/100g)
	K	Ca	Mg	Na	K	Ca	Mg	Na	H	
Smith Block 7	70	1147	992	272	1.2	37.3	53.8	7.7	0.0	15.4
Jones Block 2-N	331	4325	438	638	2.9	74.9	12.6	9.6	0.0	28.9
Miller Block 4	48	878	187	67	1.6	58.6	20.8	3.9	15.0	7.5
Ruiz Block 1W	416	2826	436	60	5.4	71.8	18.5	1.3	3.0	19.7

K fertilizer recommendation is an inexact science:

- **< 150 PPM exchangeable K - yield response likely**
- **150-200 PPM K, ≤ 2.5% cation saturation - good chance of yield response**
- **> 200 PPM, > 2.5% - declining chance of yield increase**

K fertilization

When:

- during fruit set

How much:

- first 100 lb K_2O/acre will be the most effective
- applying less than fruit K removal reduces long-term soil K supply

Can K fertigation reduce fruit color disorders?

Yes, but 'curing' color disorders may take an impractical amount of K

Can tissue analysis guide N fertigation management?

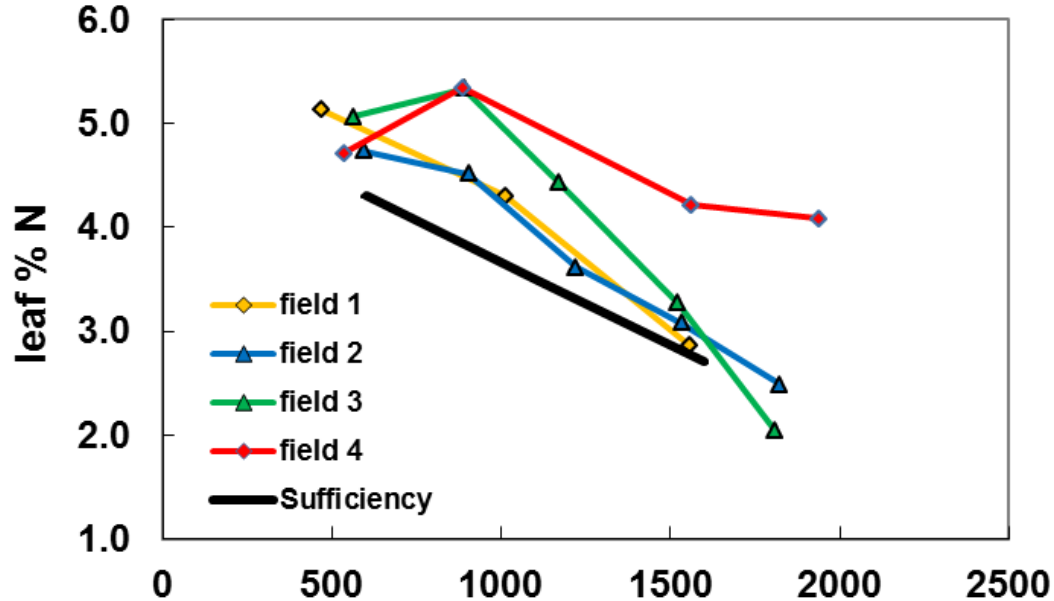
Leaf total N

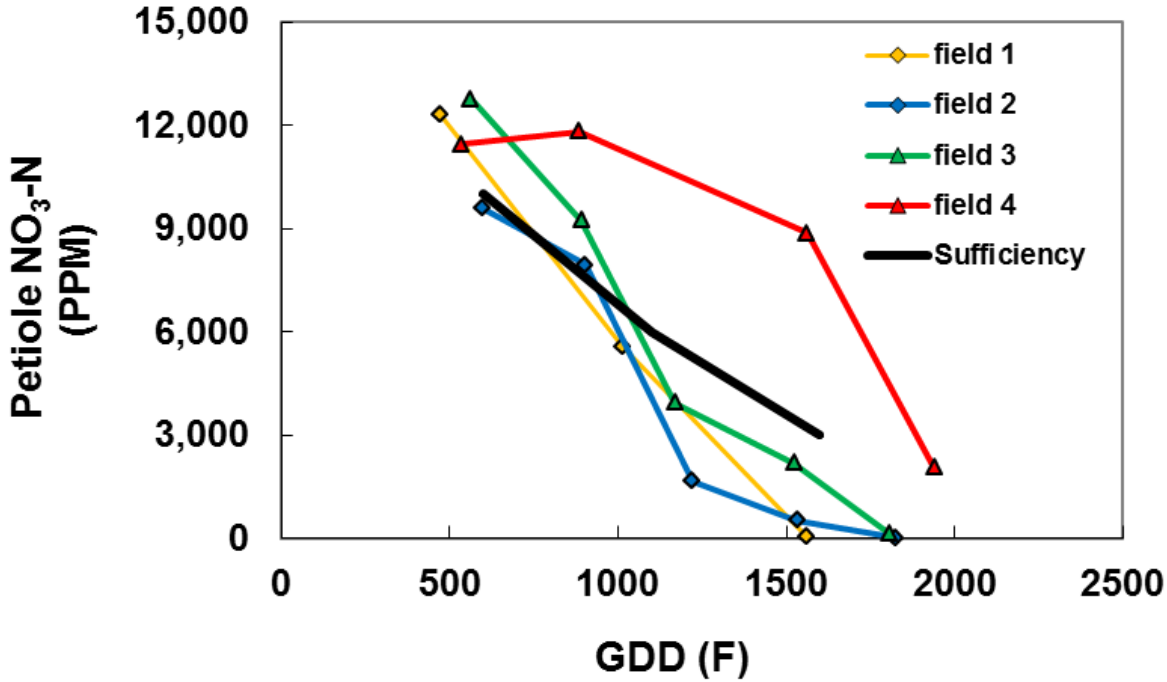
- **overall crop N status**

Petiole NO_3-N

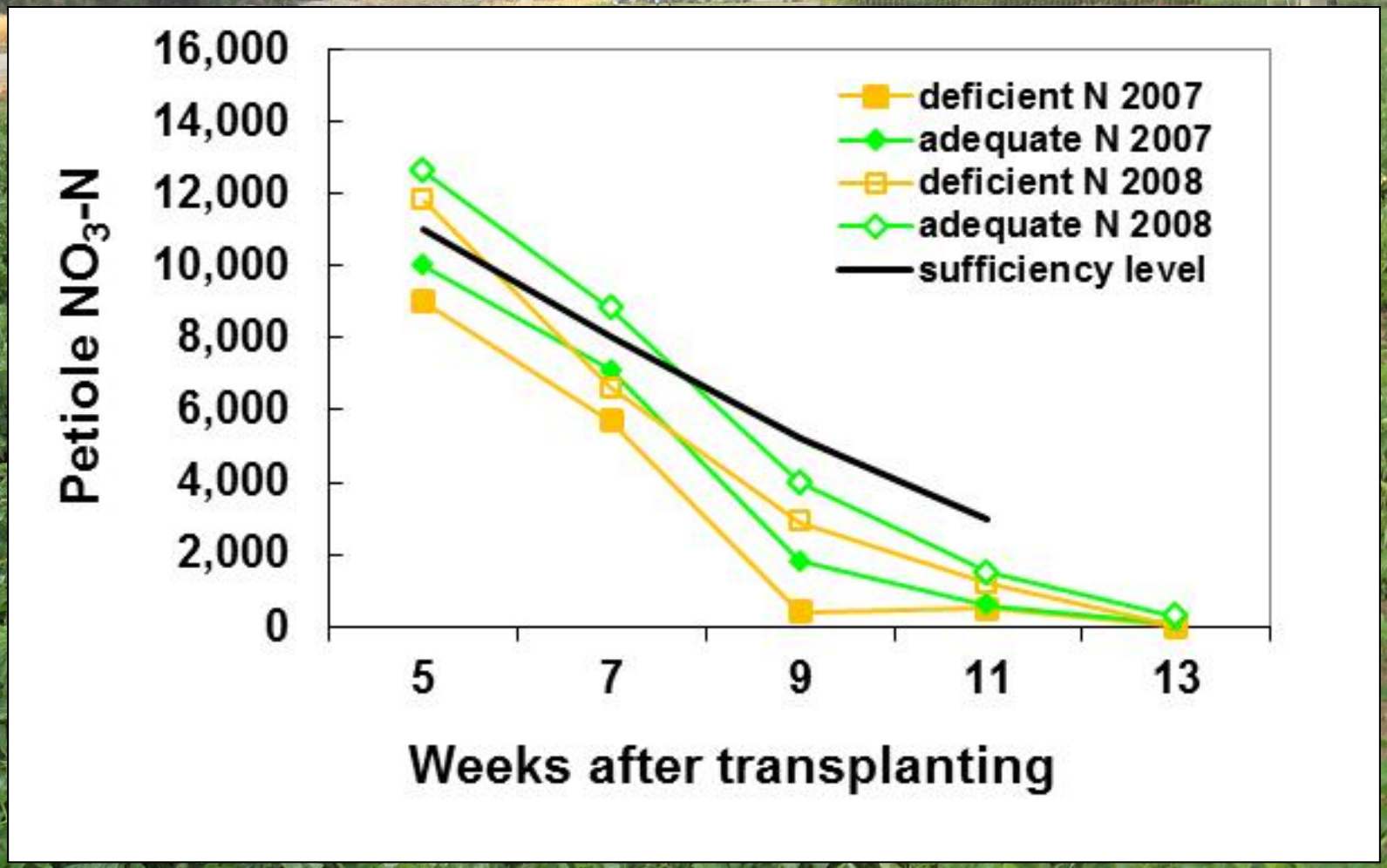
- **NO_3-N taken up but not yet assimilated into organic compounds**

High yield fields
(60+ tons total fruit yield)





Petiole NO_3-N affected by environmental variability



Bottom line on plant N testing :

- **leaf total N gives a good snapshot of current crop N status but, if it is in the 'adequate' range, does not 'project forward' more than 7-10 days to predict whether additional N application is required**
- **maintaining high petiole NO_3-N (based on current sufficiency standards) throughout the season will ensure crop N sufficiency; however, *using petiole analysis to determine fertigation requirements will often lead to unnecessary fertilization***

Questions ???