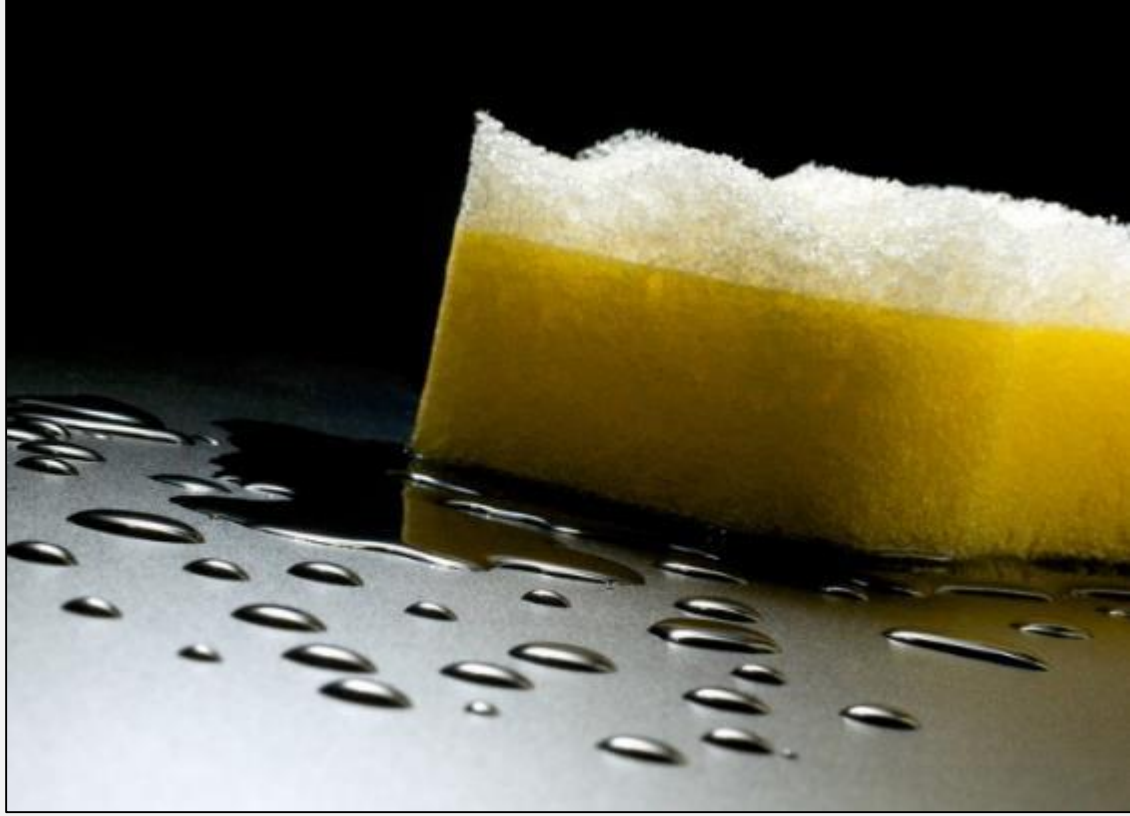
Irrigation effects on nitrogen efficiency

- Nitrate-nitrogen (NO_3-N) moves freely with water in the soil
- Irrigation in excess of soil water holding capacity takes NO_3-N with it as it leaches

How much NO_3-N can leachate carry?

- Soil test NO_3-N commonly in the range of 5 - 20 PPM (dry soil basis)
- *As a rough approximation*, multiplying a soil test NO_3-N concentration by 0.8 estimates the pounds of N contained in an acre inch of soil solution

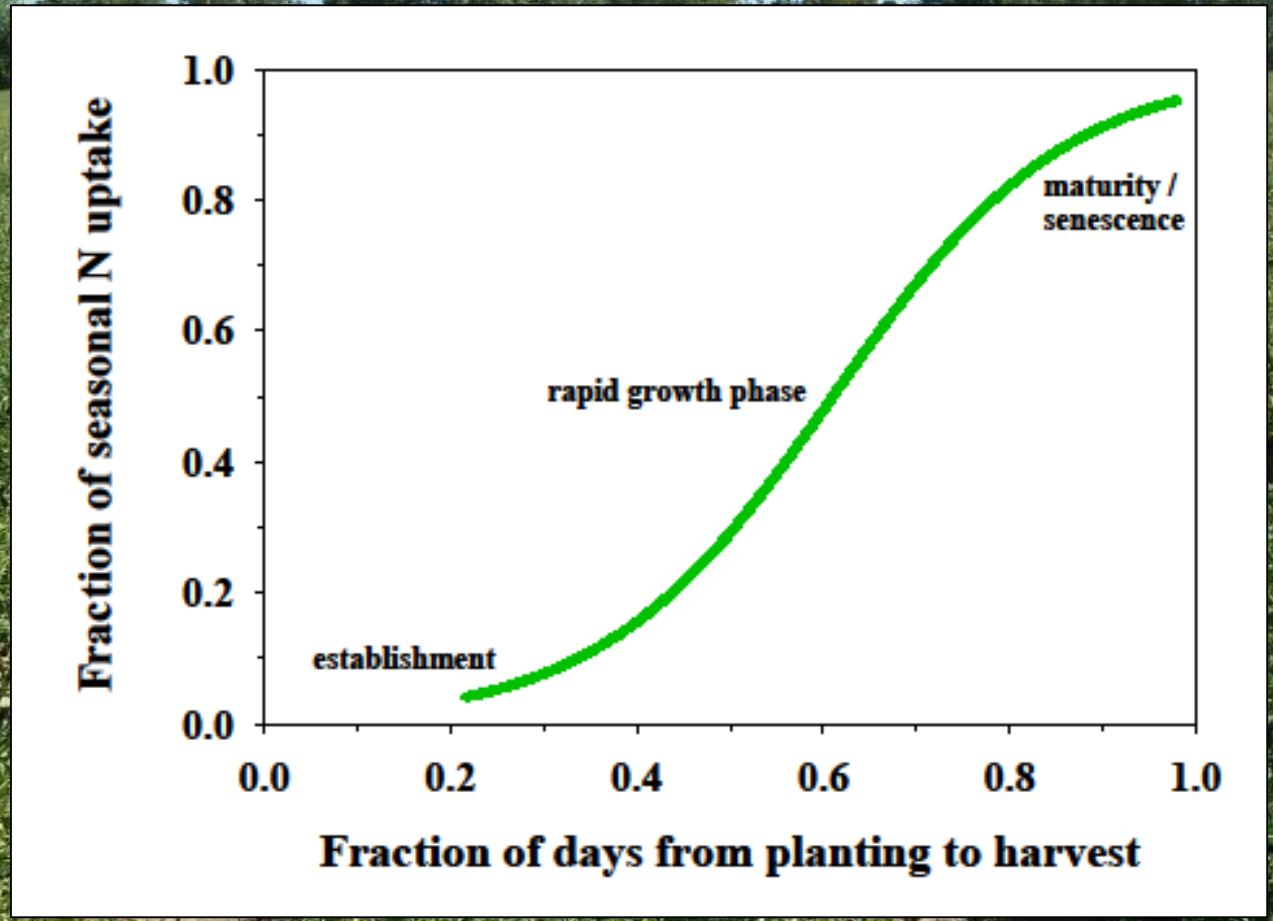
Example:
Soil NO_3-N of 10 PPM x 0.8 = 8 pounds of N per acre inch of soil solution



Efficient nitrogen uptake requires extended '*residence time*' in the active root zone:

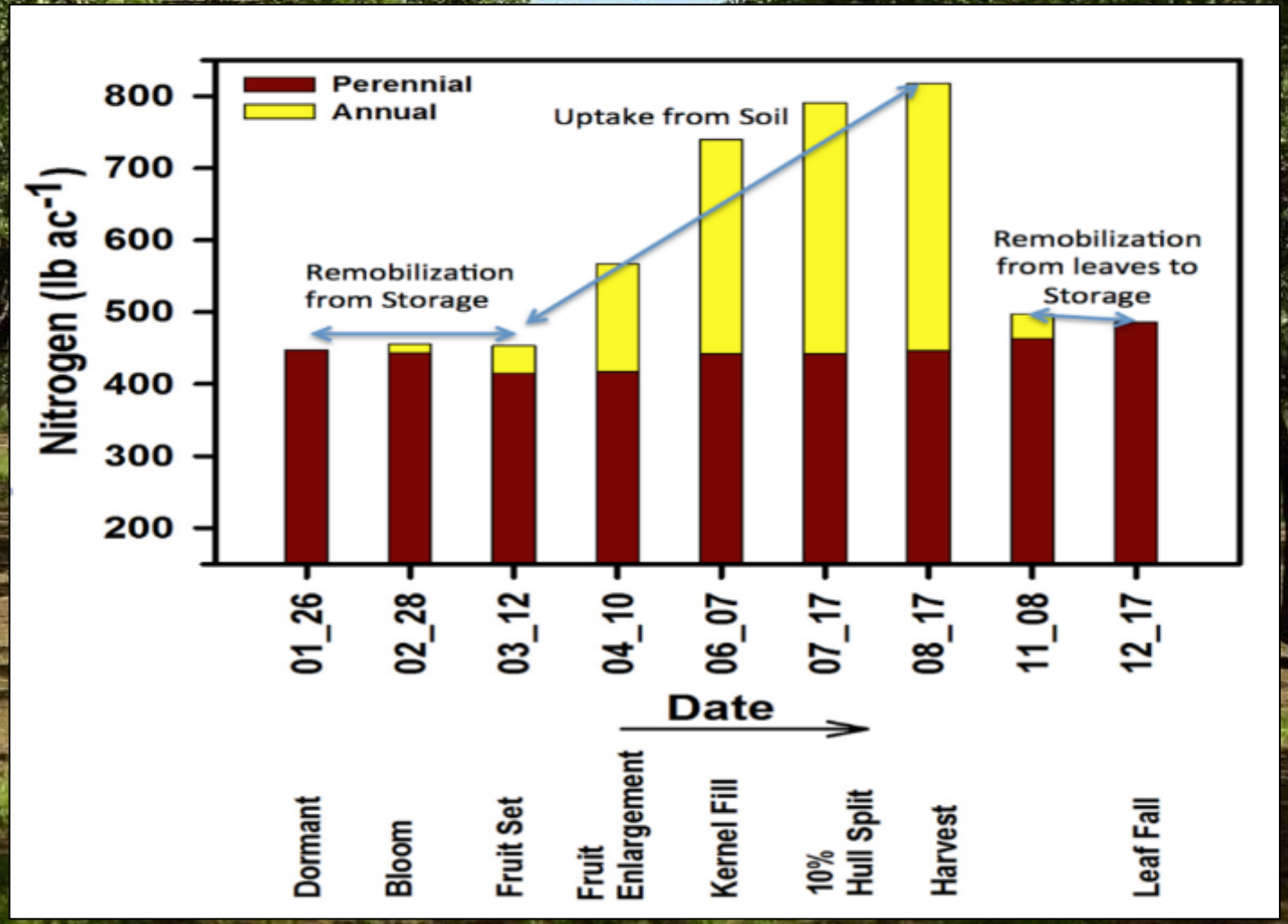
- Plants do not soak up N like a sponge; rather, N is taken up selectively, *as needed*, to support new growth
- Therefore, fertilizer N must remain in the active root zone for an extended period to be efficiently utilized

Crop N uptake follows a predictable pattern:
Tomato:



Crop N uptake follows a predictable pattern :

Almond:



Crops vary in peak N uptake rate:

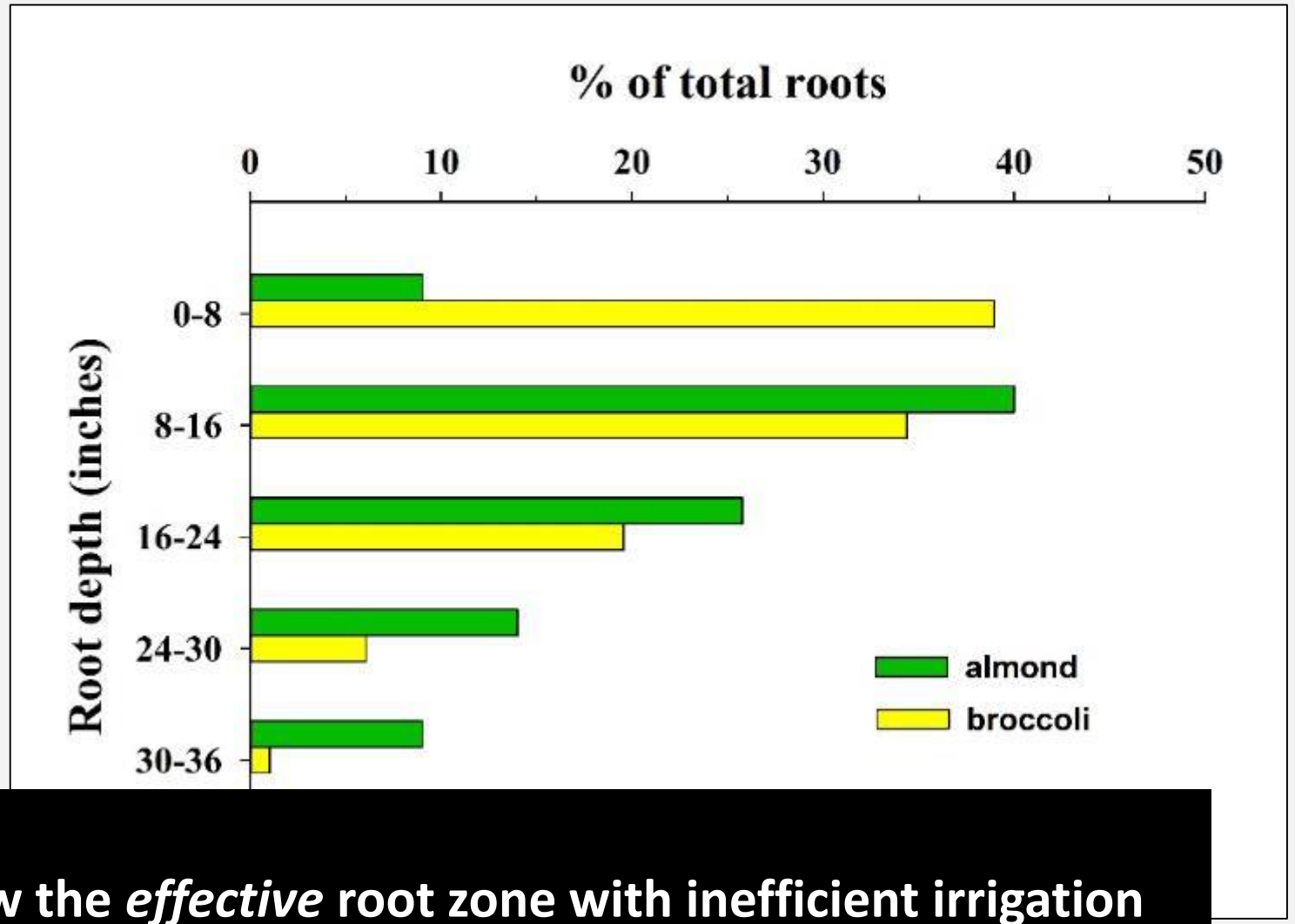
- Pounds of N per acre per day during rapid growth

Low (< 3 lb/A/d)	Medium (3-5 lb/A/d)	High (> 5 lb/A/d)
Almond	Cotton	Corn (grain or silage)
Citrus	Melon	
Grape	Tomato	
Pistachio		

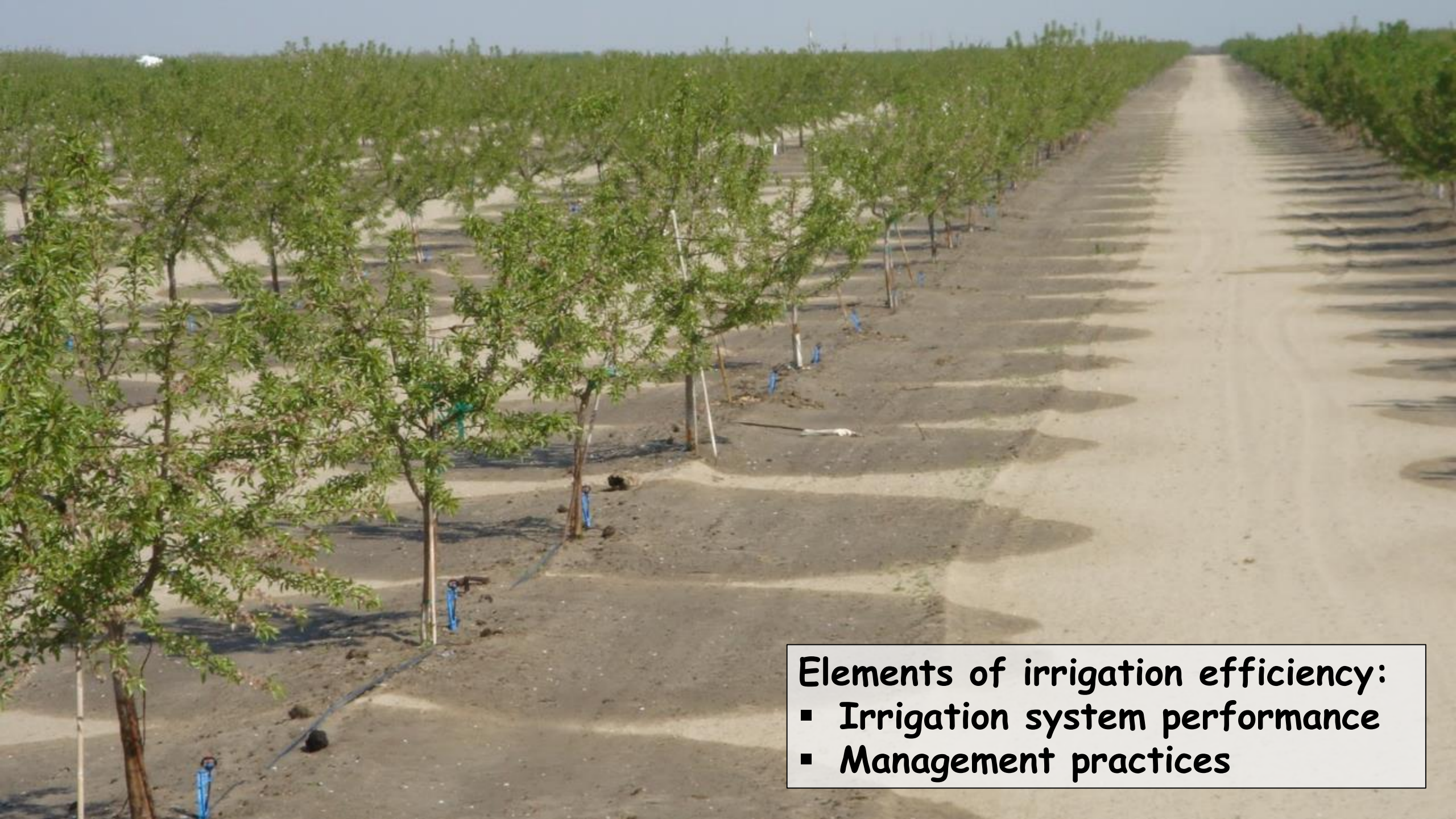
a typical N sidedressing or fertigation takes many days (and multiple irrigations) to be taken up by the crop

Efficiency of N recovery declines with soil depth:

≈ 75% of roots in top half of the root zone



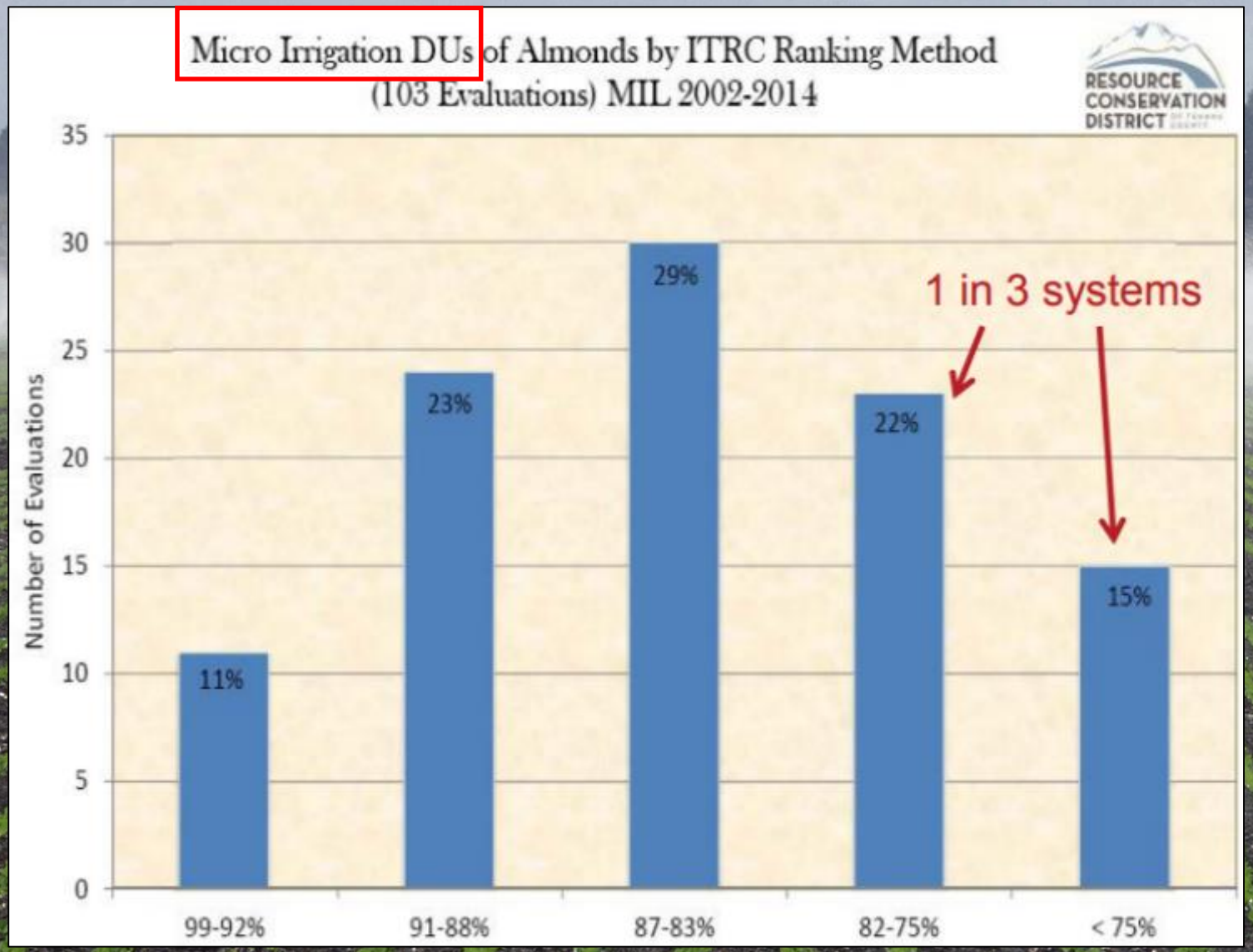
Bottom line:
It is easy to move nitrogen below the *effective* root zone with inefficient irrigation



Elements of irrigation efficiency:

- Irrigation system performance
- Management practices

Irrigation system performance:
Distribution uniformity (D.U.)
% D.U. = (inches applied to driest quarter of field / field average inches applied)*100



Source: Allan Fulton, UCCE

N efficiency is impossible with poor irrigation efficiency:

	Tomato	Almond
Irrigation D.U.	Applying 24" to the driest quarter requires an average application of	Applying 48" to the driest quarter requires an average application of
90%	27"	54"
80%	30"	60"
70%	34"	67"

Irrigation management:

- **How much water does my crop use, and when?**

How much water does my crop use, and when?

- Reference evapotranspiration (ET_o) x crop coefficient (K_c) = crop evapotranspiration (ET_c)

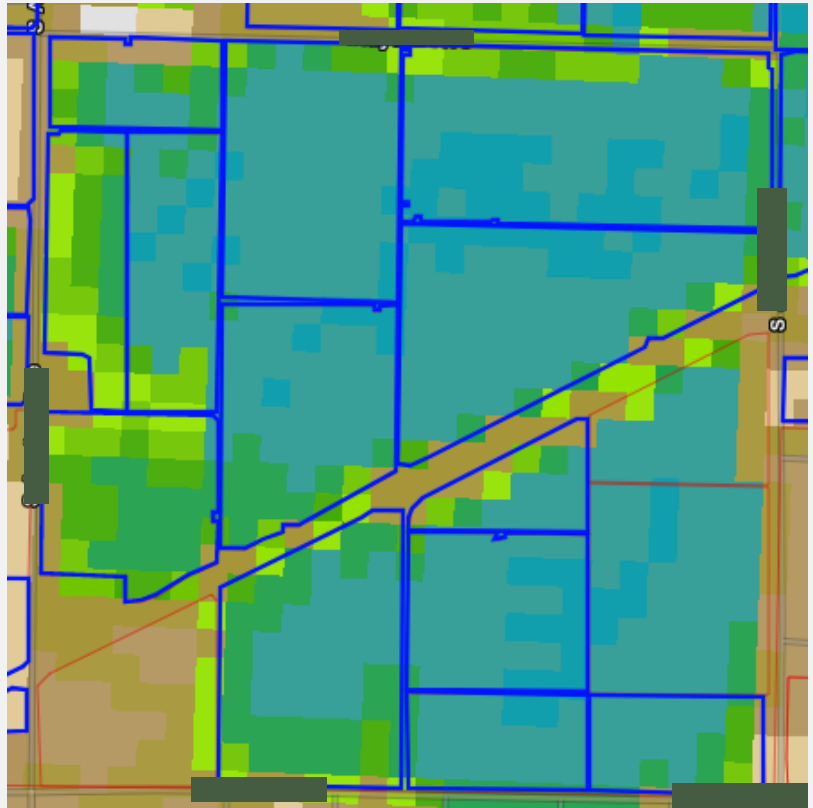
Almond crop coefficients (*UC Publication 8515*):

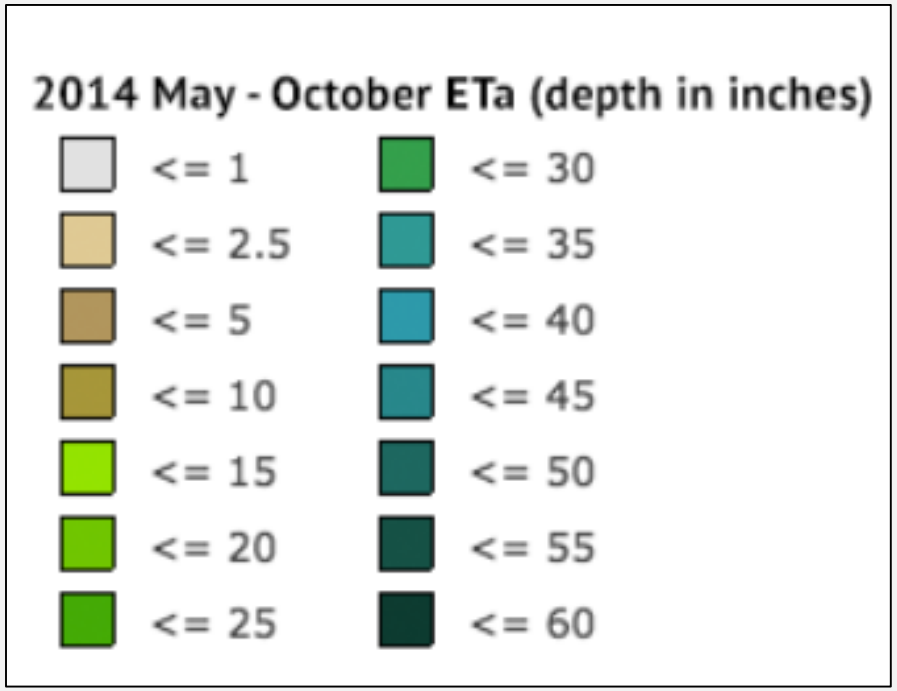
		Zone 12[4]		Zone 14[5]		Zone 15[6]	
Month	**K_c[3]**	**ET_o**	**ET_c**	**ET_o**	**ET_c**	**ET_o**	**ET_c**
Jan	0.40	1.24	0.50	1.55	0.62	1.24	0.50
Feb	0.41	1.96	0.81	2.24	0.92	2.24	0.92
Mar	0.62	3.41	2.11	3.72	2.30	3.72	2.30
Apr	0.80	5.10	4.09	5.10	4.09	5.70	4.57
May	0.94	6.82	6.44	6.82	6.44	7.44	7.02
Jun	1.05	7.80	8.20	7.80	8.20	8.10	8.51
Jul	1.11	8.06	8.93	8.68	9.61	8.68	9.61
Aug							
Sep							
Oct	0.92	3.72	3.41	4.03	3.69	4.03	3.69
Nov	0.69	1.80	1.23	2.10	1.44	2.10	1.44
Dec	0.43	0.93	0.40	1.55	0.66	1.24	0.53
Total (in)			49.73		52.61		53.73

Published Kc values tend to represent highest vigor, fully watered fields

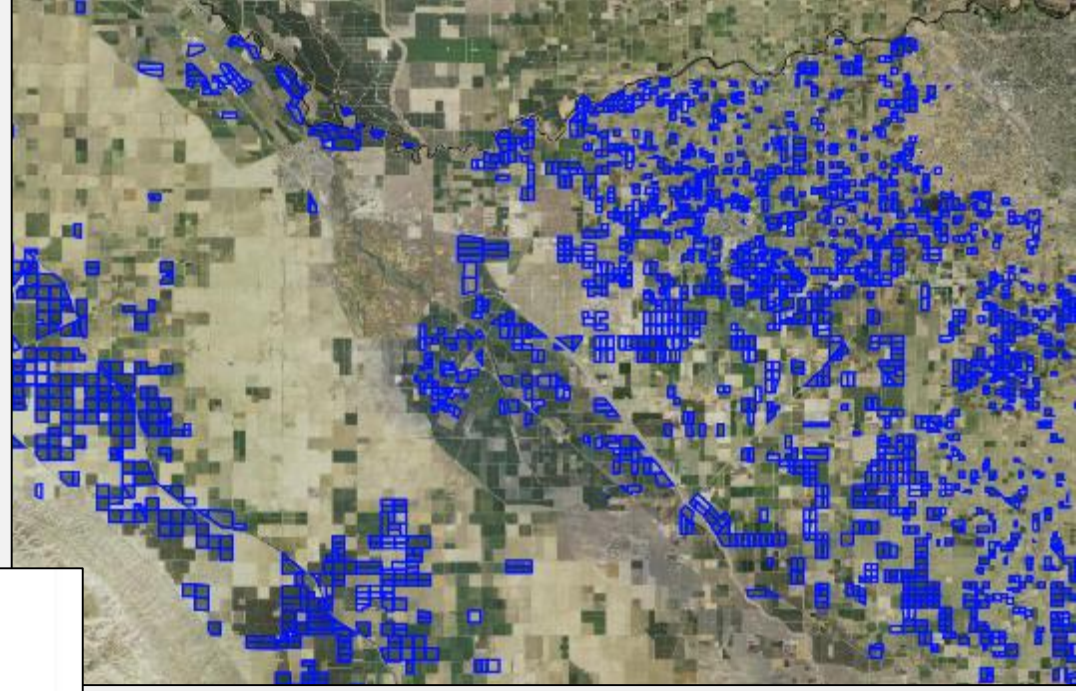
Actual crop evapotranspiration (ET_a):

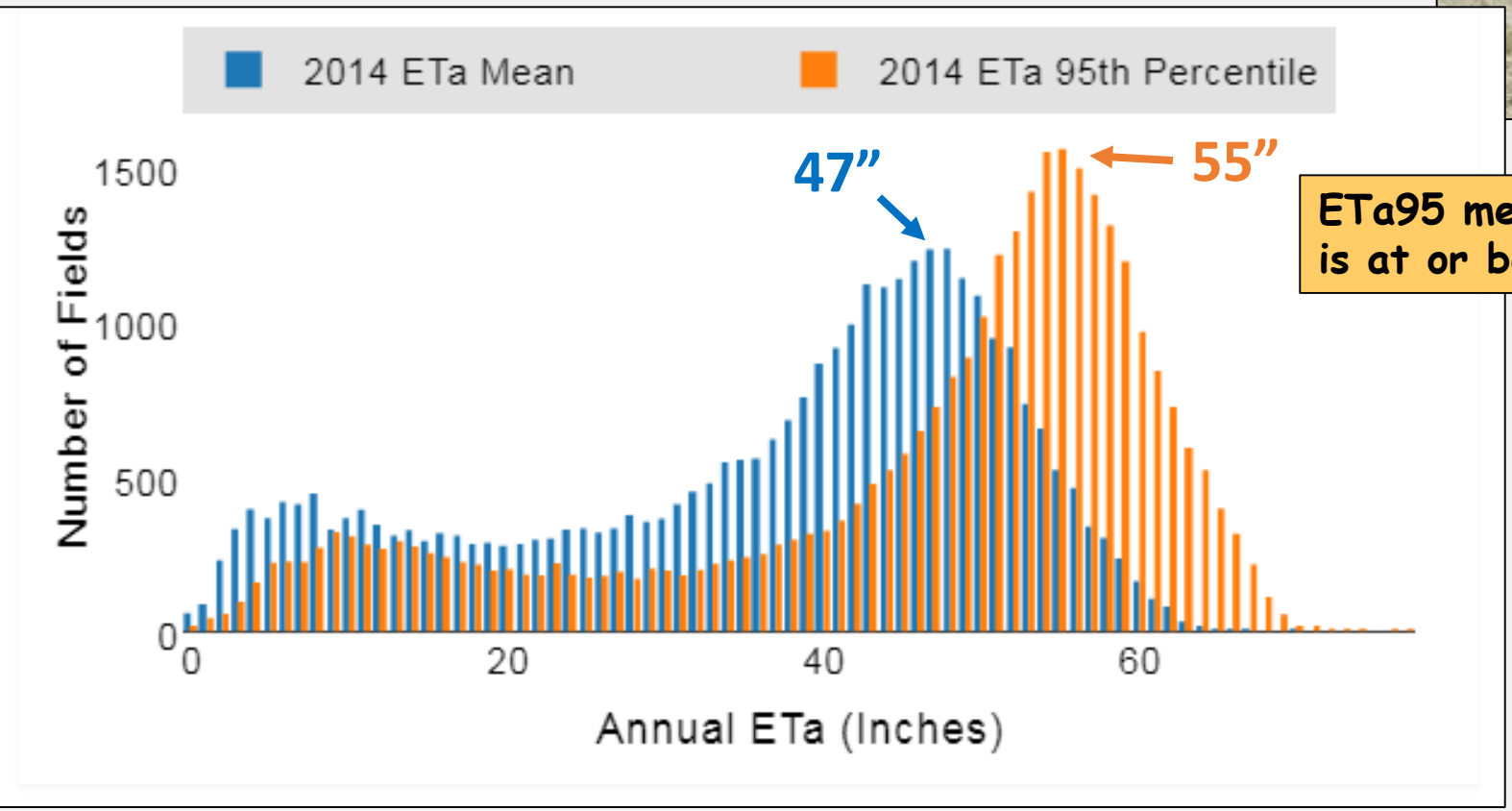
- 30 m (100 ft) spatial resolution satellite data, augmented by spatial CIMIS
- Provides field-by-field ET_a data from 2010-2016
- Shows within-field variability in ET_a
- Provides data on 'typical' ETa for each crop





ET_a data from > 30,000 almond orchards …





ETa95 means 95% of the field is at or below this level

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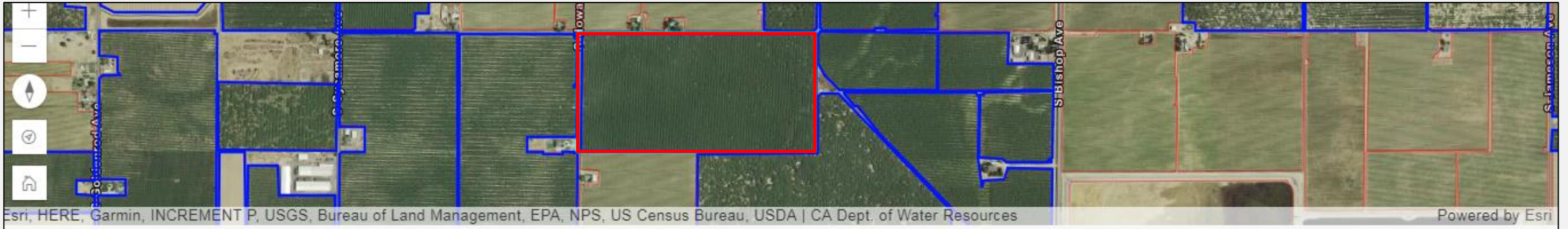
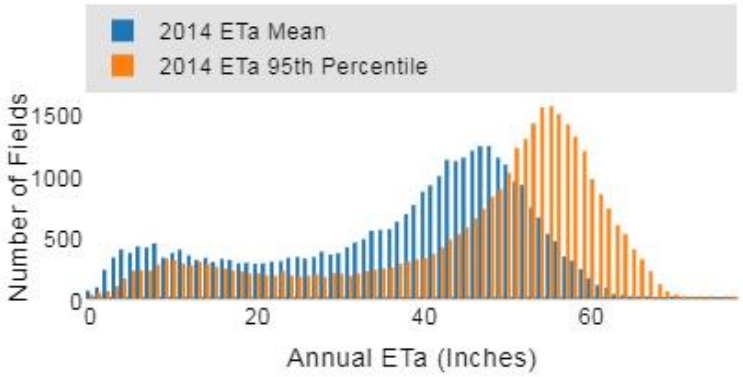


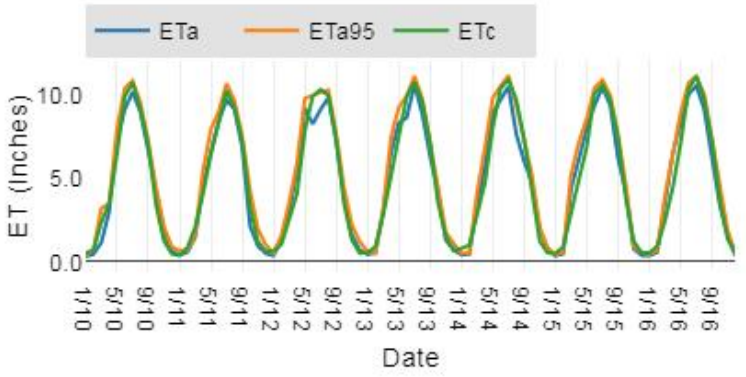
Field Summary for FieldID: 236195 | Acreage: 76.1

2014 Crop: Almonds, DWR Legend: D | DECIDUOUS FRUITS AND NUTS

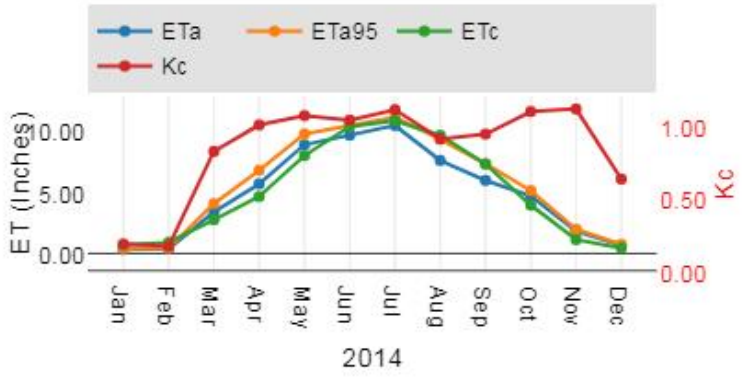
Within a given field ETa tends to be relatively consistent across years

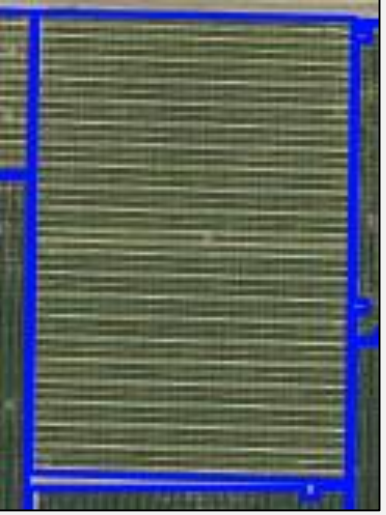
Statewide (32580 fields in 2014):



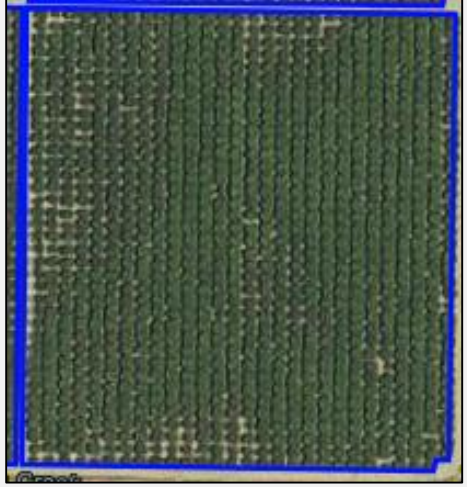


Selected Field: 2014 | Annual Totals: ETc=60.1, ETa=58.8, ET95=66.9

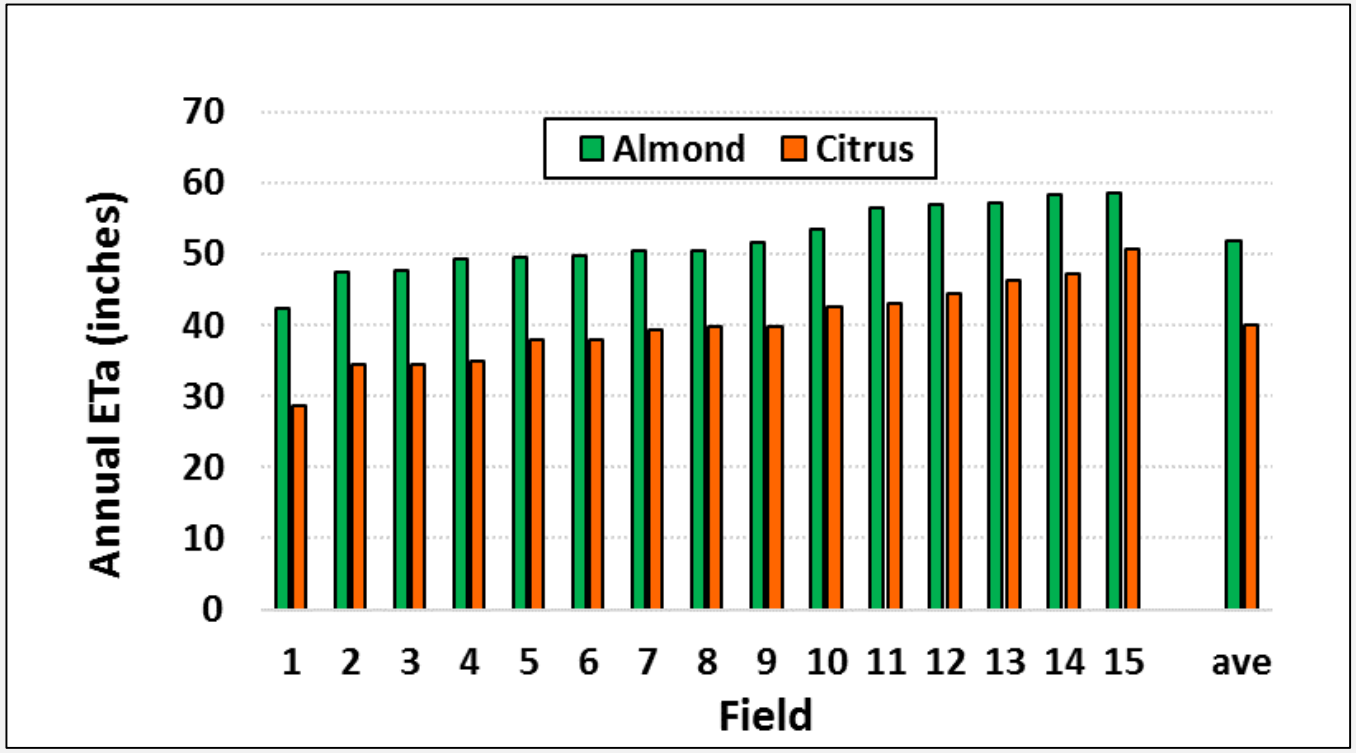




There is significant variability in ETa among fields



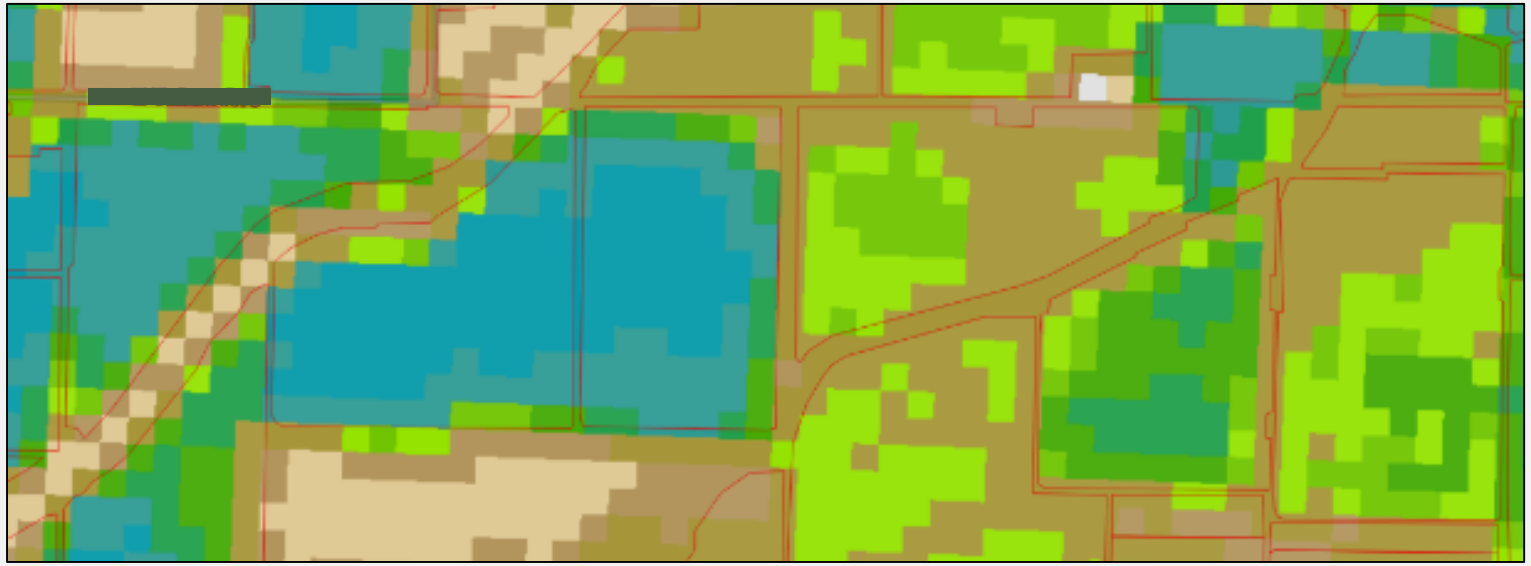
ET_a of representative *mature* almond orchards and citrus groves in the Kings River Water Quality Coalition area

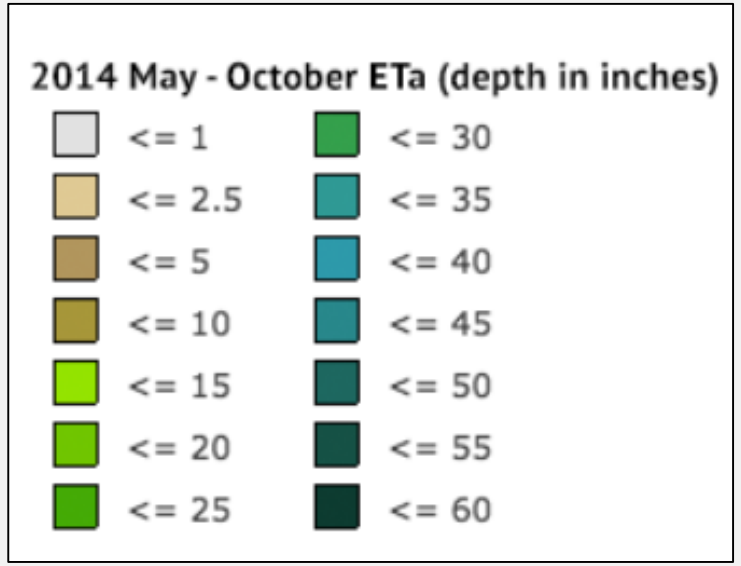


ETa data can inform irrigation management:

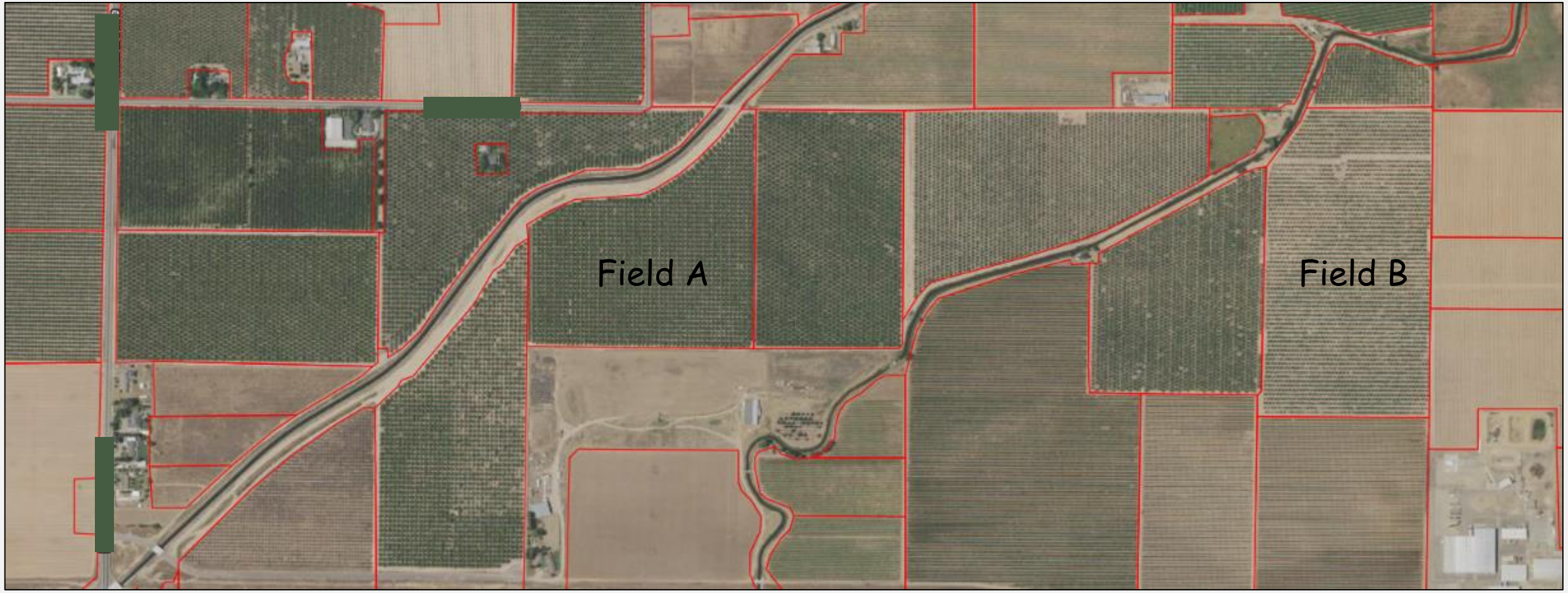
- Are you keeping up with crop water demand?
- Are you irrigating too much?
- Do you have high spatial variability of ET_a?

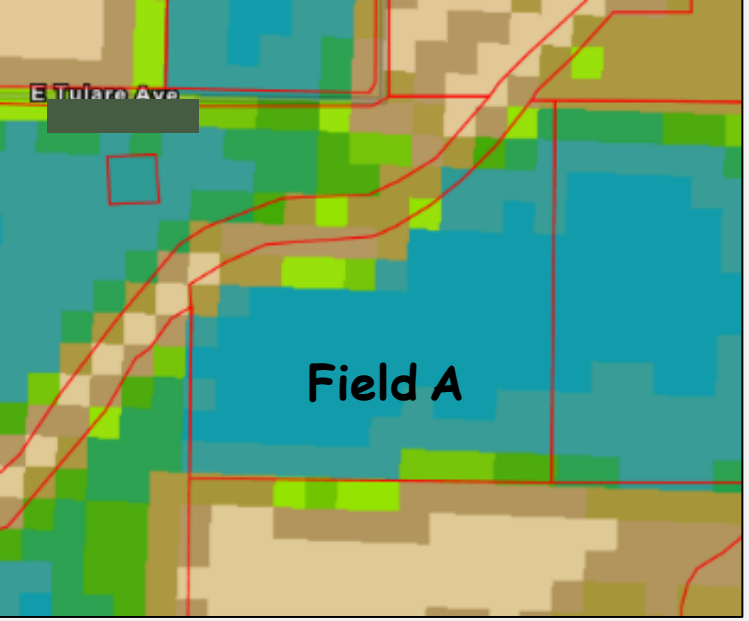
Within-field variability in ET_a:





Comparing ET_a in highly uniform and highly variable orchards:



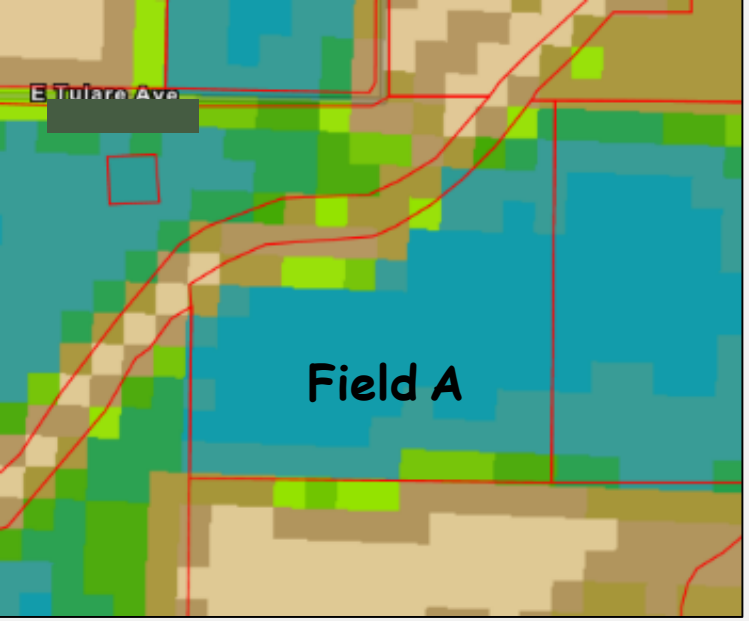


Highly uniform orchard (91% ET_a D.U.)

Mean ET_a = 34.5”

ET_{a95} = 36.7”

Difference of only 2.2”, or 6% of mean ET_a



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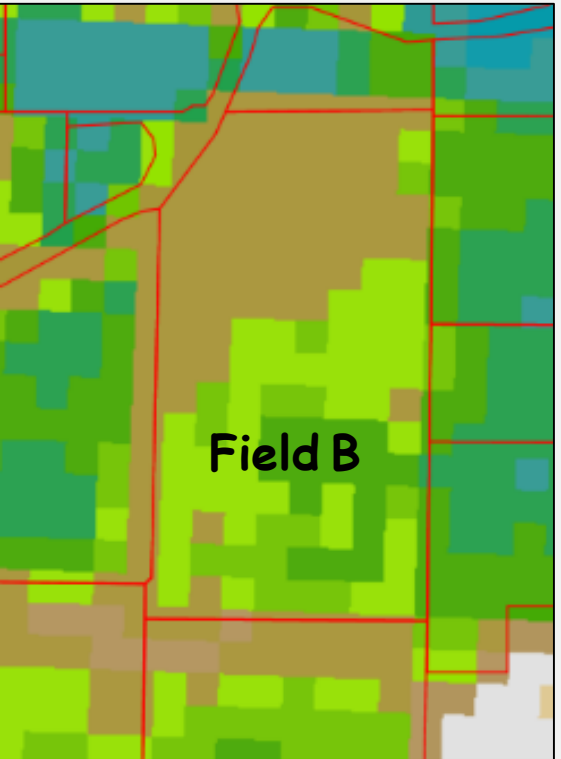
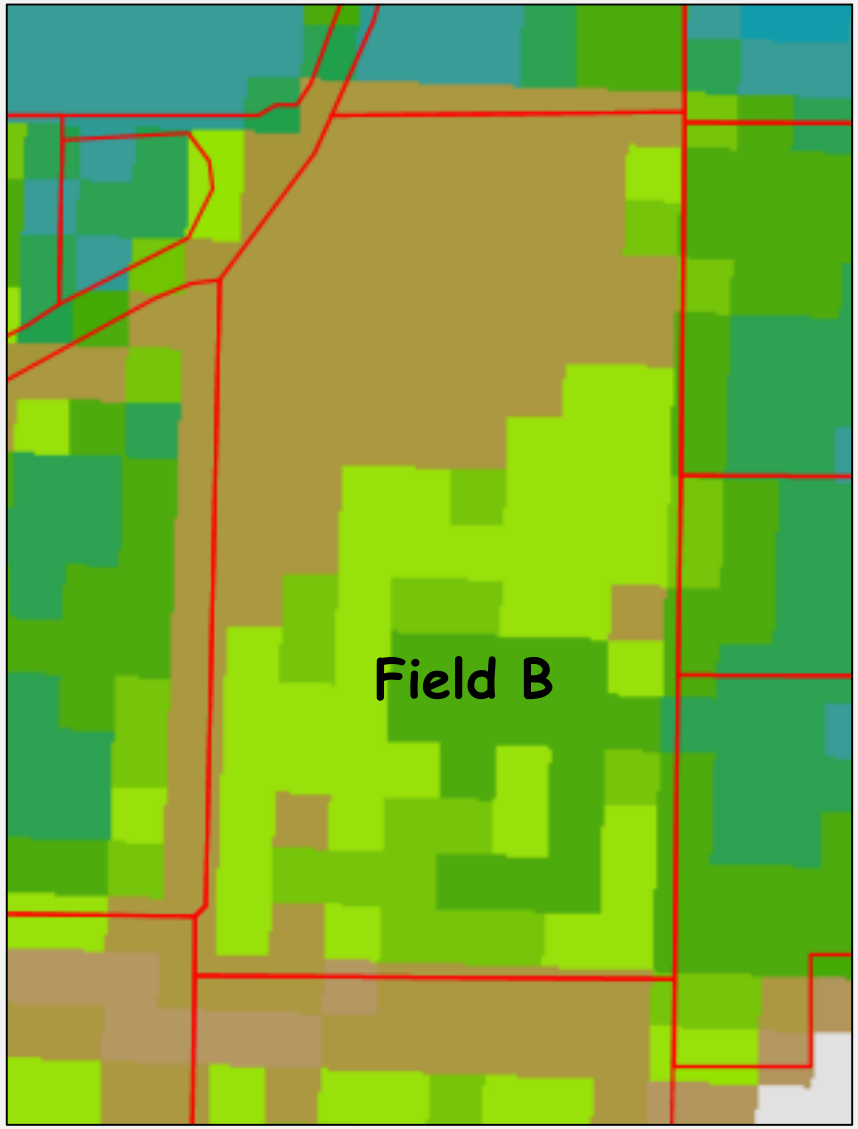
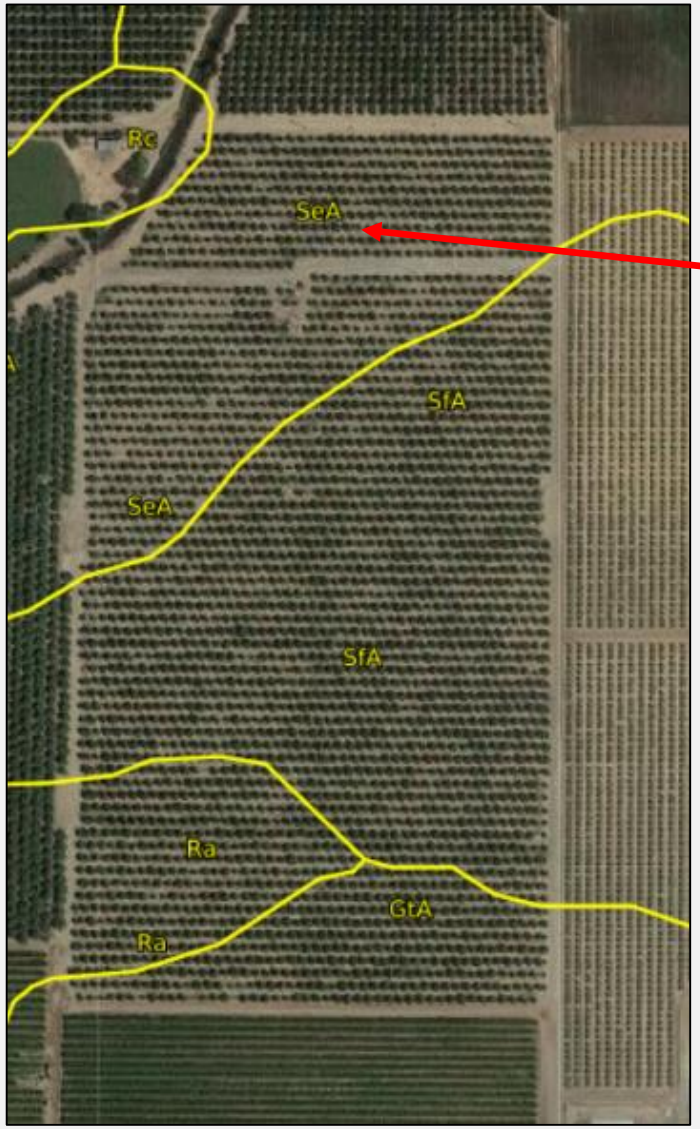


Low uniformity orchard (58% ET_a D.U.)
Mean ET_a = 11.4"
ET_{a95} = 18.9"

Difference of 7.5",
or 66% of mean ET_a

What is the cause of this non-uniformity in ET_a?





Lower soil water holding capacity; water stress between irrigations?

In summary :

- NO_3-N loss in leached water can be substantial
- Maximizing N residence time in the active root zone is a priority
- Irrigation management can make or break N efficiency; use of ET_a data can make you a better irrigator