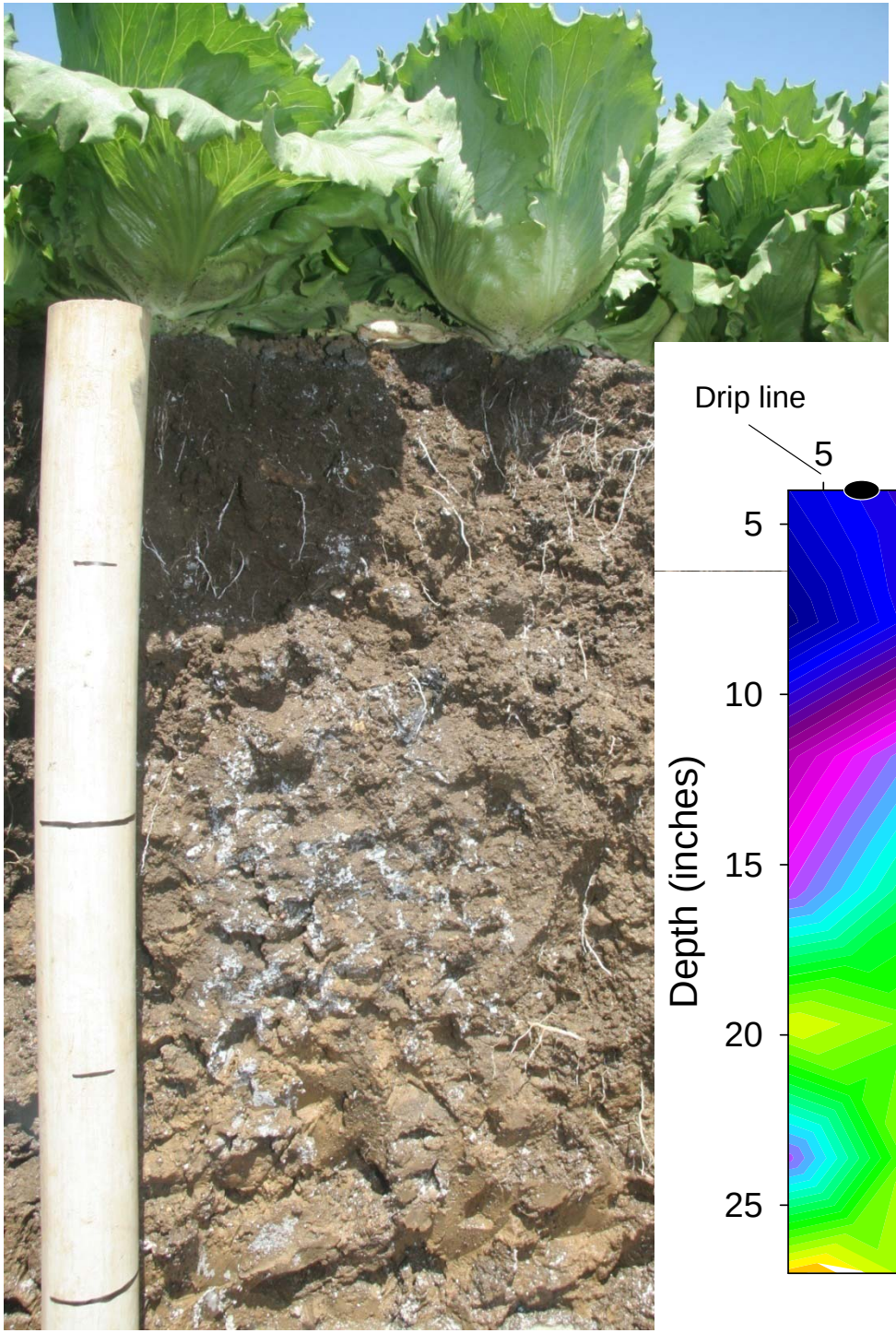
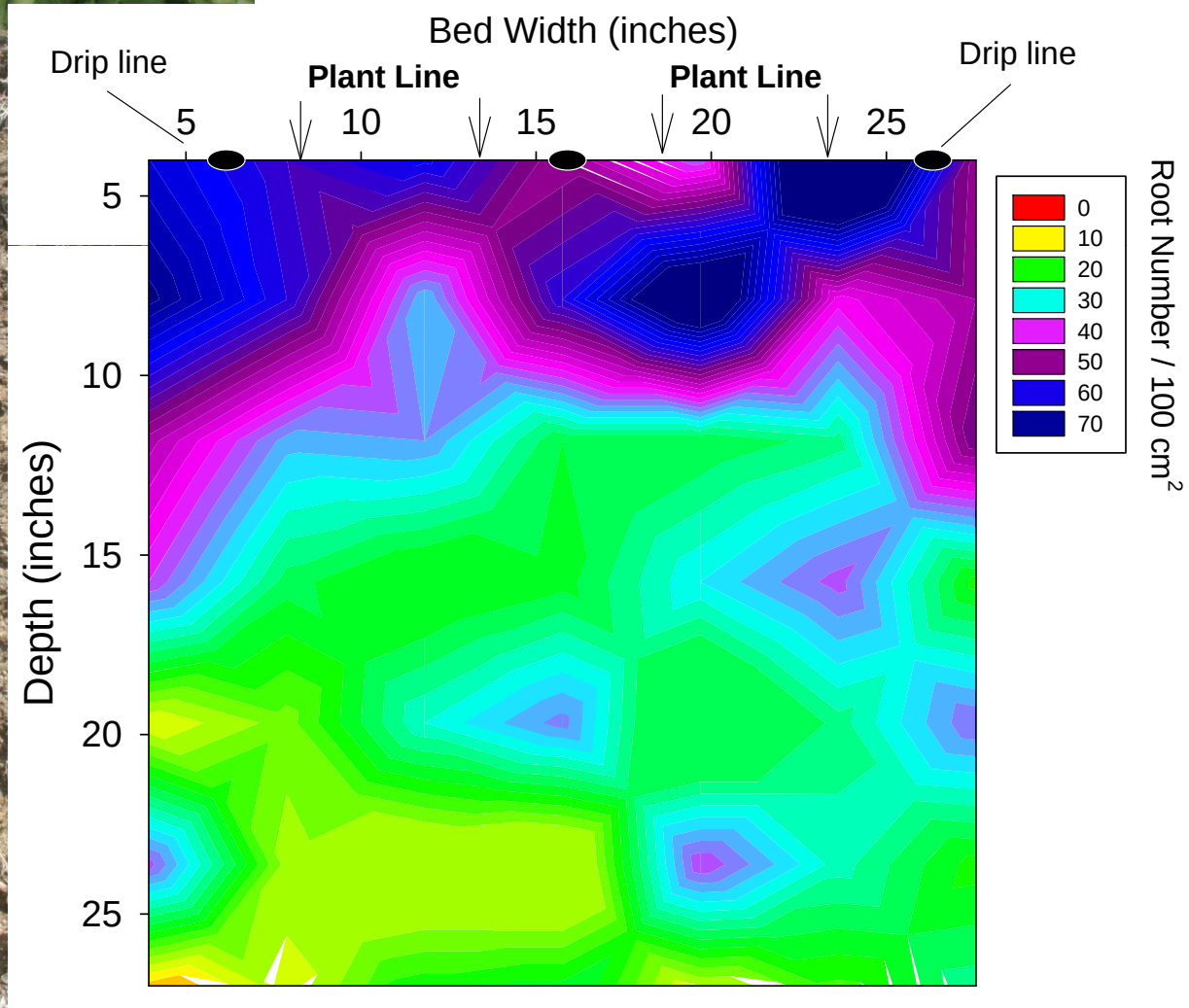
Integrating Irrigation and Nitrogen Fertilizer Management of Vegetables

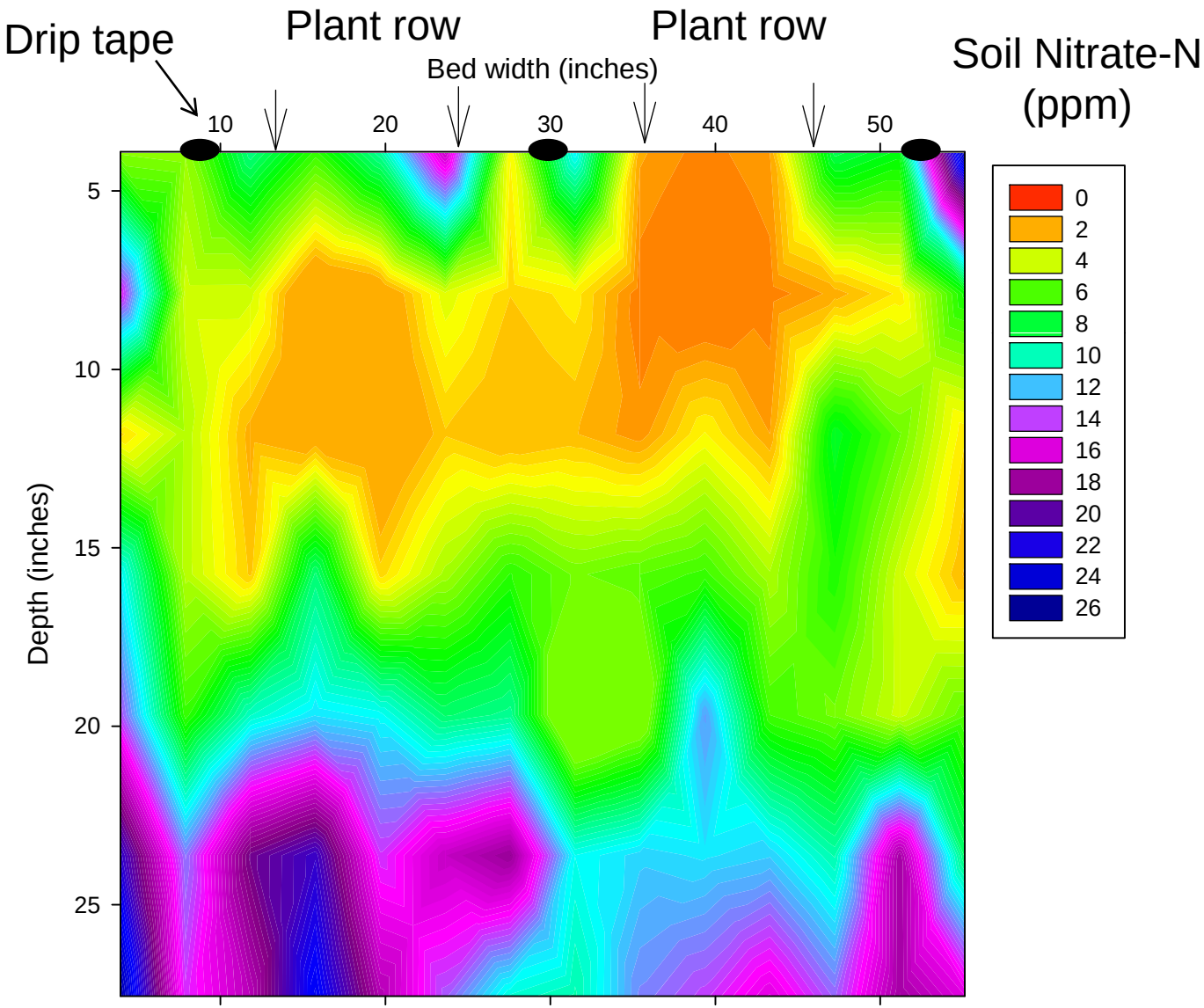
Michael Cahn, Richard Smith, Barry Farrara, Aaron Heinrich
University of California, Cooperative Extension, Monterey County

Root Distribution of Lettuce

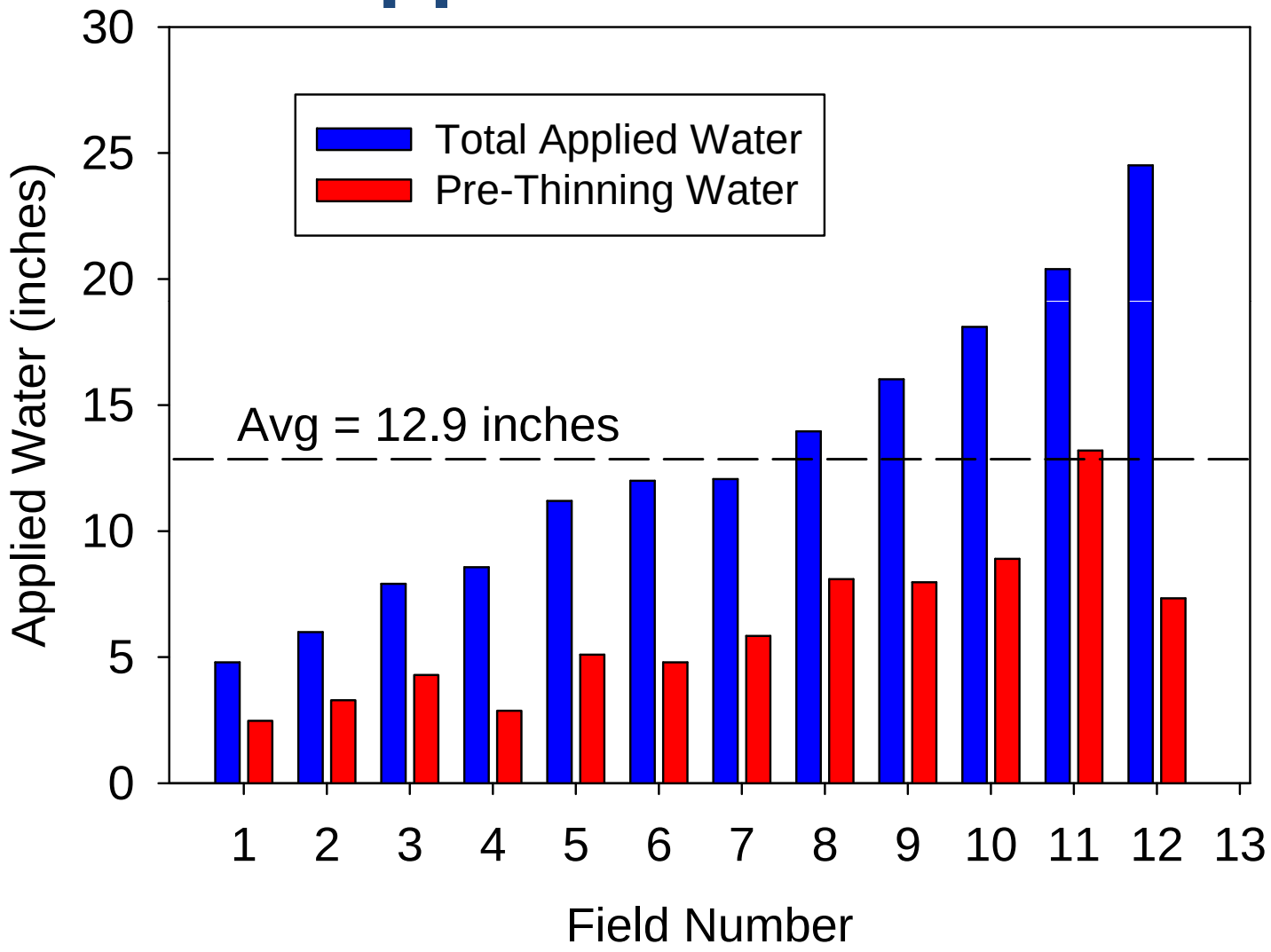




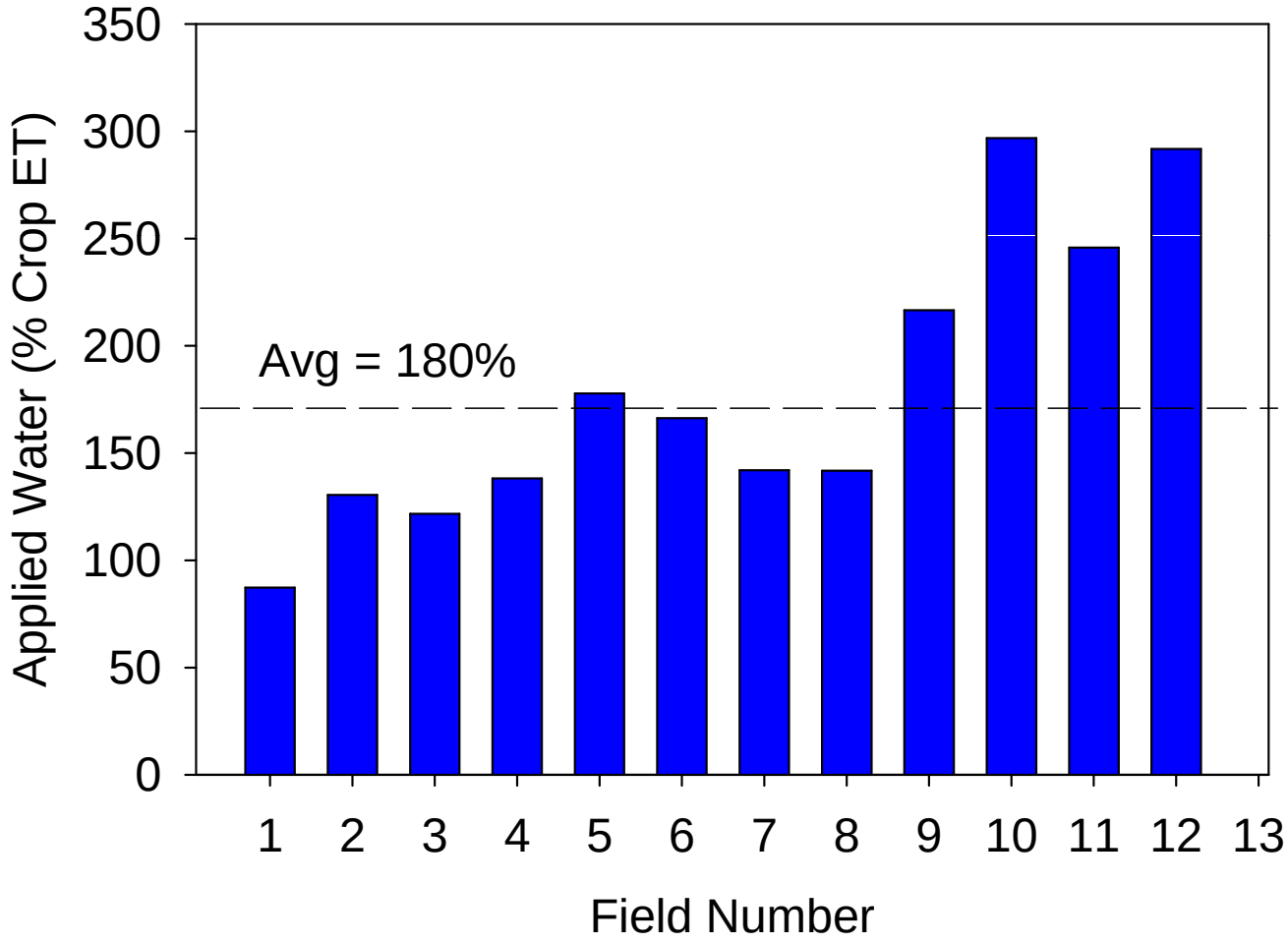
Soil Nitrate Distribution



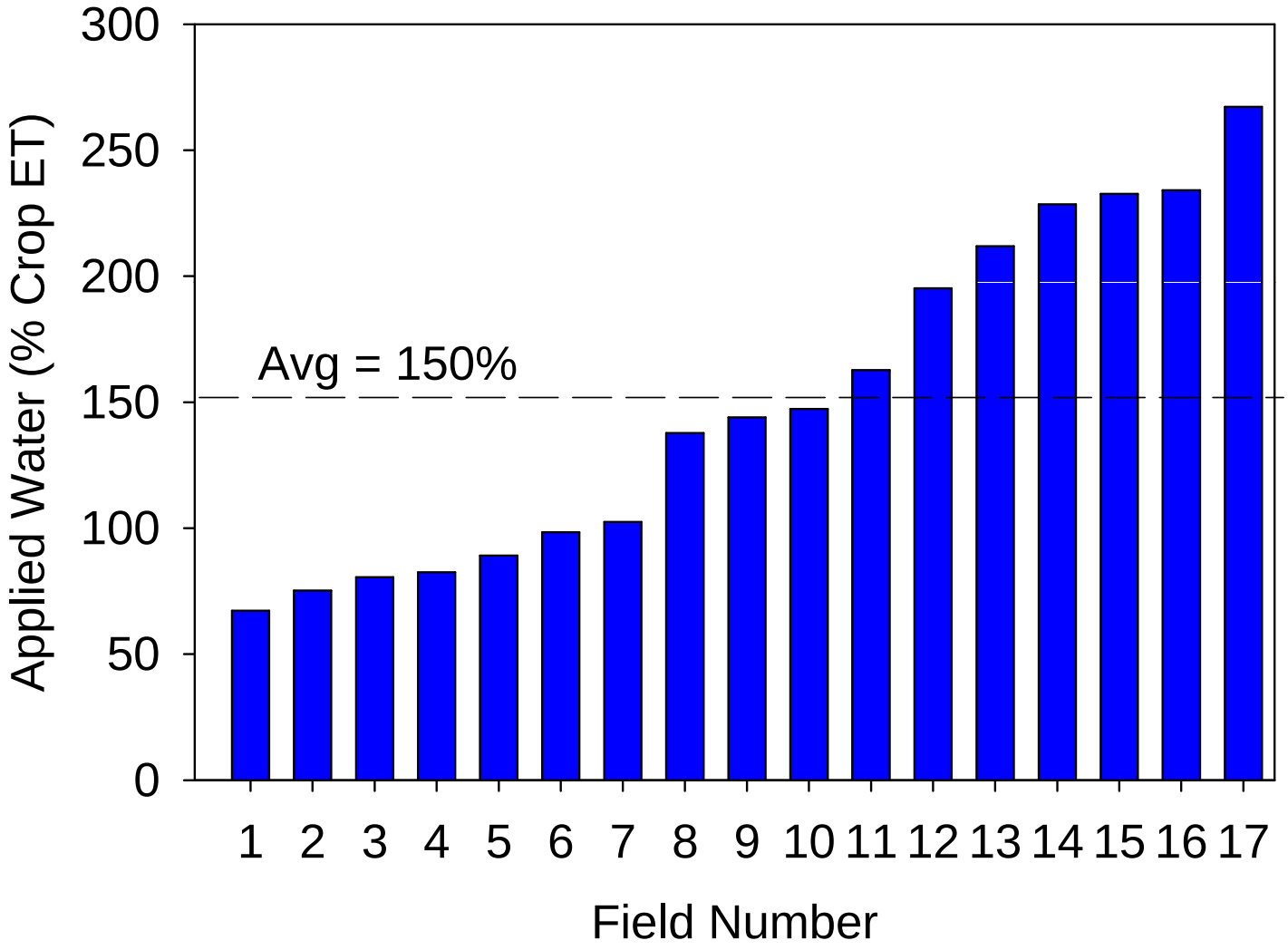
Total and Pre-thinning Water Applied to Lettuce



Applied Water as Percentage of Crop ET



Applied Water Post Thinning as Percentage of Crop ET

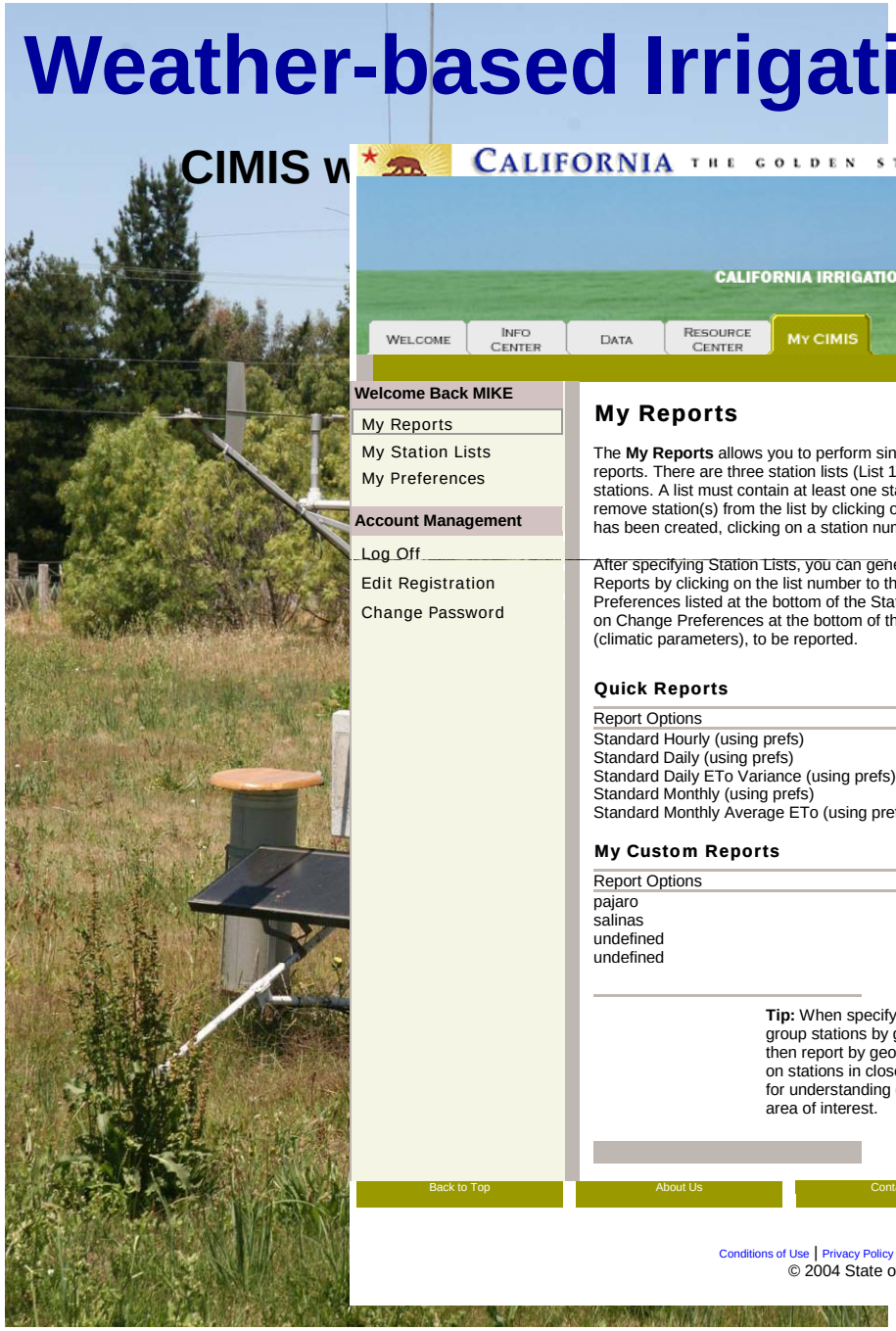


Tools for Managing Water and Nitrogen Fertilizer in Lettuce

- Quick nitrate soil test
  (20 ppm NO_3-N = 76 lb of N/acre)
- Weather-based irrigation scheduling

Weather-based Irrigation Scheduling

CIMIS w



CALIFORNIA THE GOLDEN STATE

CALIFORNIA HOMEPAGE | GOVERNOR'S HOMEPAGE

CIMIS

CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM
DEPARTMENT OF WATER RESOURCES
OFFICE OF WATER USE EFFICIENCY

WELCOME | INFO CENTER | DATA | RESOURCE CENTER | MY CIMIS

Welcome Back MIKE

- My Reports
- My Station Lists
- My Preferences

Account Management

- Log Off
- Edit Registration
- Change Password

My Reports

The **My Reports** allows you to perform single-click reporting, select report preferences, and prepare custom reports. There are three station lists (List 1, List 2, and List 3) and each list can hold up to a maximum of 10 stations. A list must contain at least one station before executing reports from this page. You can add and remove station(s) from the list by clicking on Create/Change Station Lists and clicking on Remove. Once a list has been created, clicking on a station number will provide detailed information about the station.

After specifying Station Lists, you can generate a report in any one of the report options listed under Quick Reports by clicking on the list number to the right (list 1, list 2, or list 3). These reports are generated using the Preferences listed at the bottom of the Station Lists. Preferences for Quick Reports can be changed by clicking on Change Preferences at the bottom of the Station Lists. Custom reports allows the user to select the options (climatic parameters), to be reported.

Quick Reports

Report Options	
Standard Hourly (using prefs)	list 1 | list 2 | list 3
Standard Daily (using prefs)	list 1 | list 2 | list 3
Standard Daily ETo Variance (using prefs)	list 1 | list 2 | list 3
Standard Monthly (using prefs)	list 1 | list 2 | list 3
Standard Monthly Average ETo (using prefs)	list 1 | list 2 | list 3

My Custom Reports

Report Options	
pajaro	list 1 | list 2 | list 3 | customize
salinas	list 1 | list 2 | list 3 | customize
undefined	| customize
undefined	| customize

Tip: When specifying the stations for station-lists, group stations by geographic proximity. You can then report by geographic region. Reports based on stations in close proximity can be a useful tool for understanding data patterns in and around the area of interest.

My Station Lists

List 1	List 2	List 3
037	111	019
129	129	028
177		053
--	--	089
--	--	116
--	--	--
--	--	--
--	--	--
--	--	--
--	--	--

Create/Change Station Lists

My Preferences

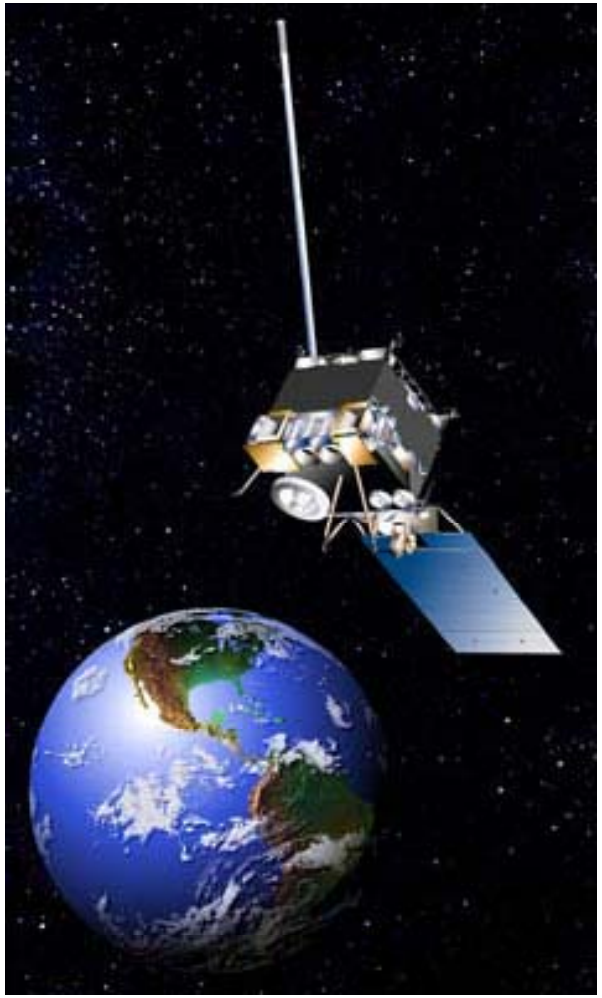
Name	Value
Zip Codes	
Units	English
Output	WEB Report
Hourly Report	7 Days
Daily Report	7 Days
Monthly Report	12 Months

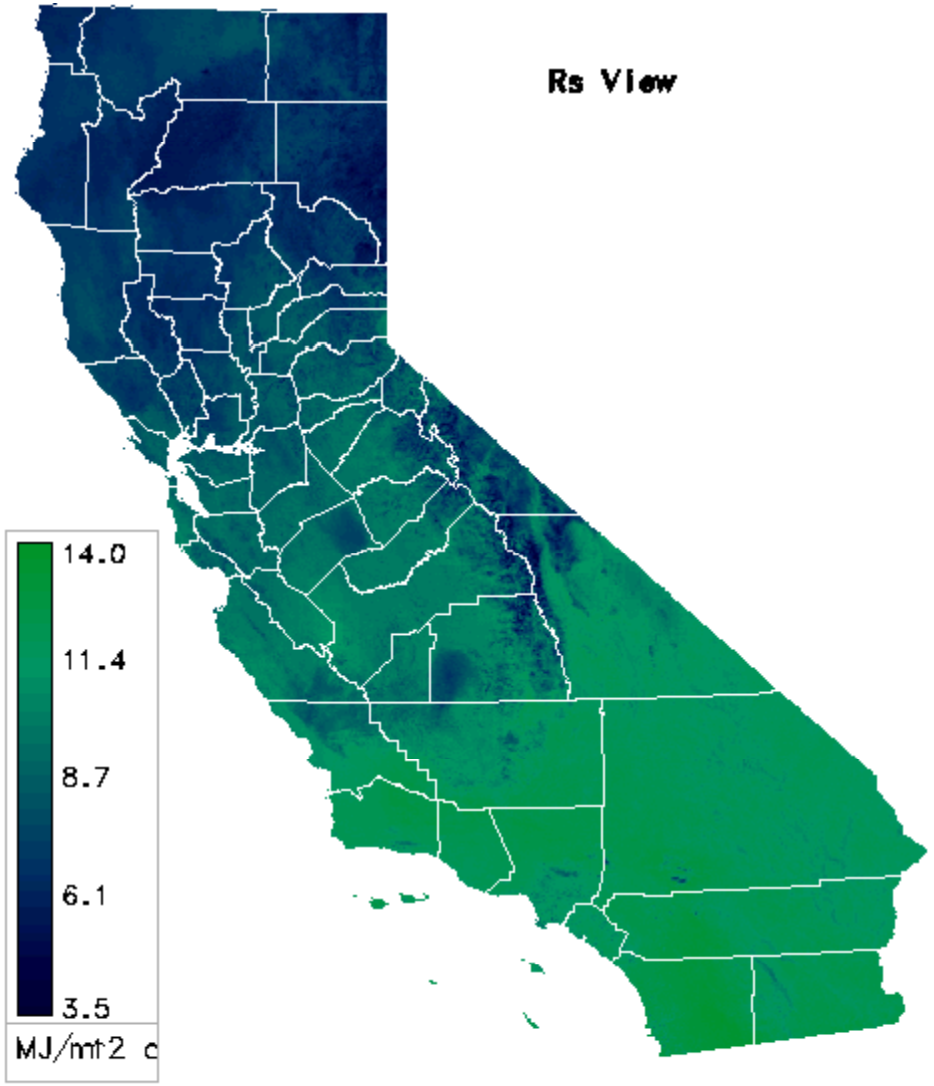
Change Preferences

Back to Top | About Us | Contact Us | Site Map

Conditions of Use | Privacy Policy | Comments or Suggestions?

Spatial CIMIS ETo Reporting

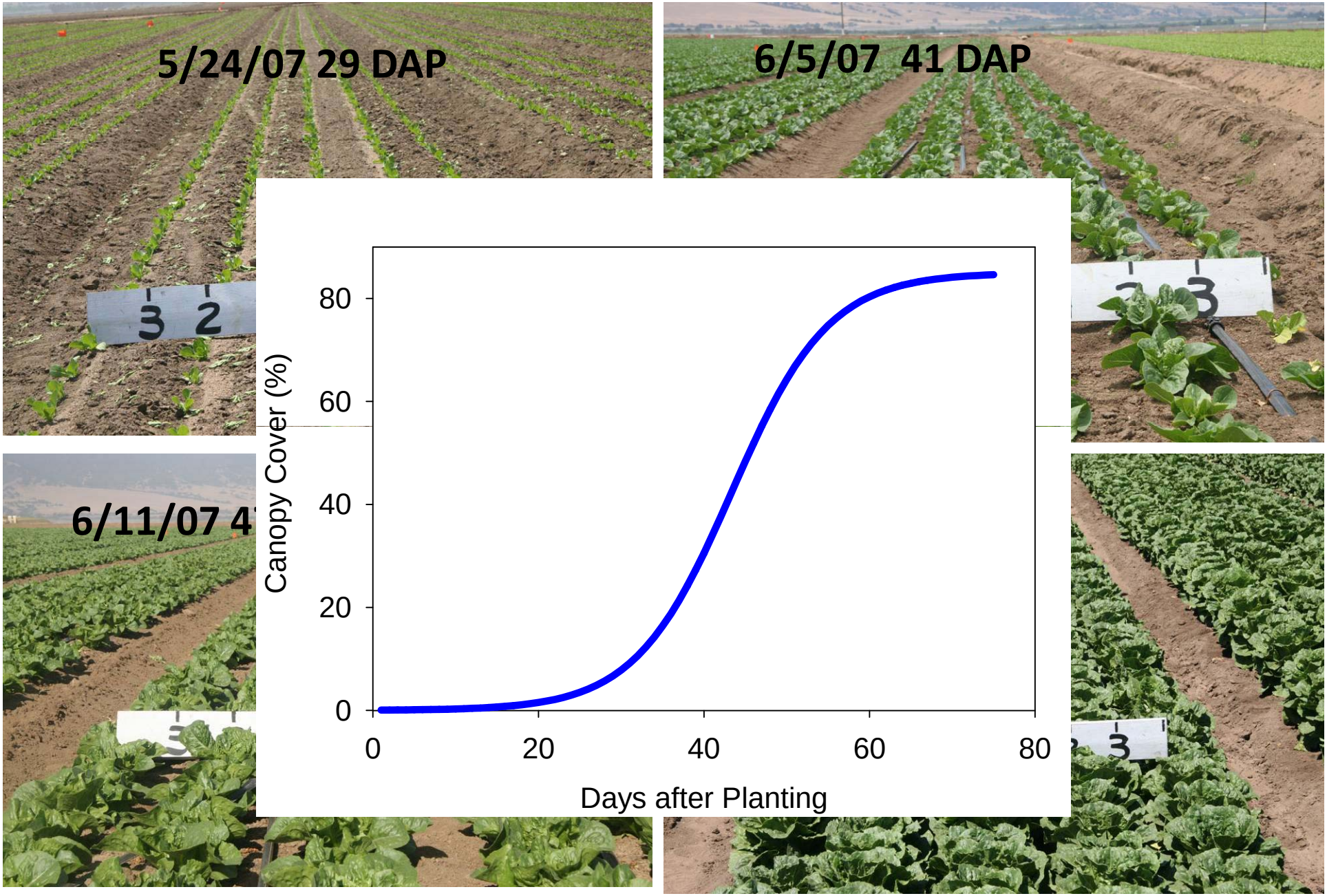




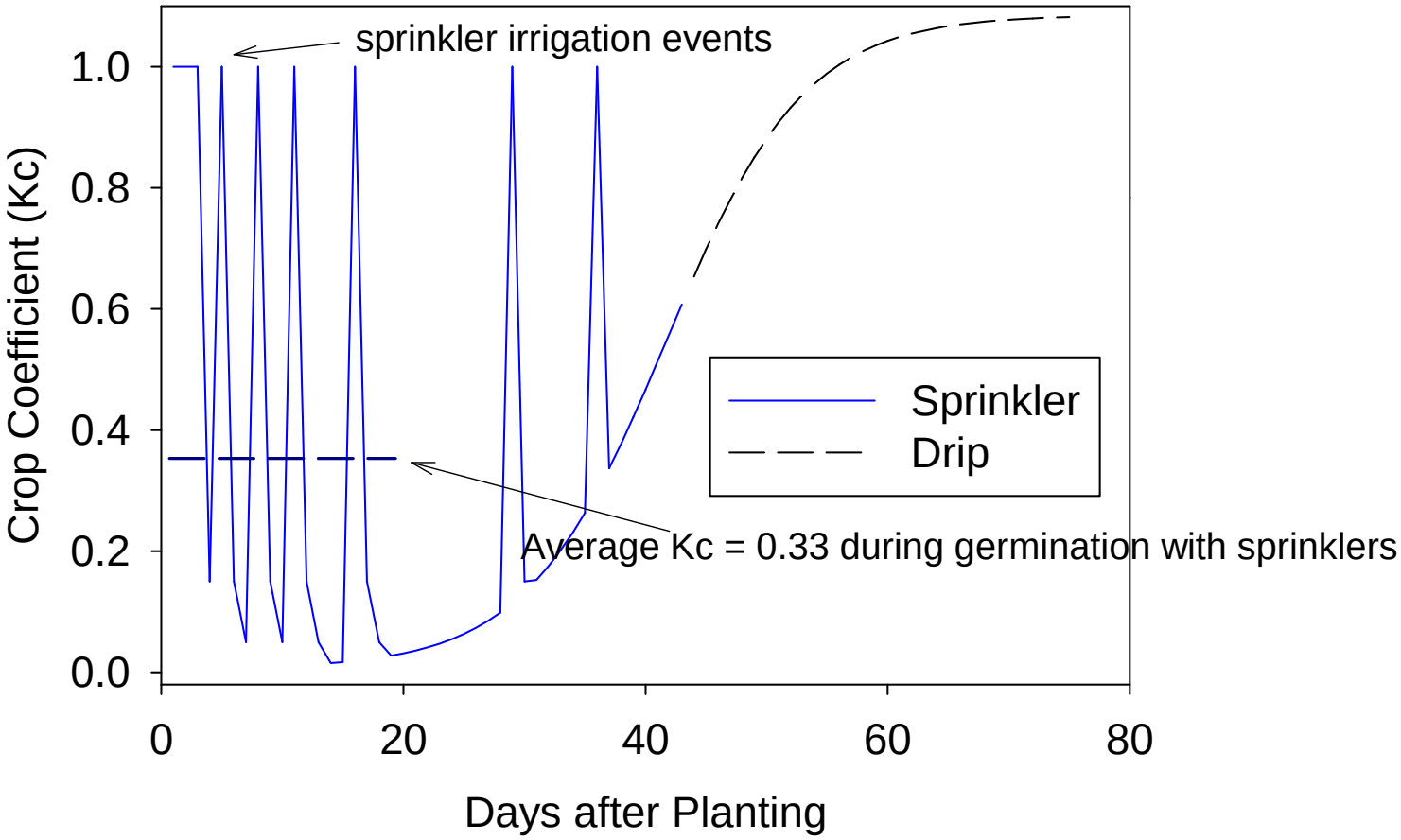
Converting Reference ET to Crop ET:

$$ET_{crop} = ET_{ref} \times K_{crop}$$

K_c can vary from 0.1 to 1.2


5/24/07 29 DAP
6/5/07 41 DAP
6/11/07 4
Canopy Cover (%)
0
20
40
60
80
Days after Planting

Estimated Kc of Lettuce



Irrigation Scheduling Spreadsheet

Irrigation Date	Irrigation Method	Rooting Depth (feet)	Kc x 100 or Canopy Cover (%)	Allowable Depletion (in)	Avg Reference Crop ET (in/day)	Avg Crop ET (in/day)	Total Crop ET (inches)	Recom-mended Irrigation Interval (days)	Actual Irrigation Interval (days)	Irrigation Time (hours)	Irrigation Amount (inches)
5/15/2009	sprinkler	0.25	100	0.12	0.20	0.20	0.20	0.6	1	0.9	0.00
5/16/2009	sprinkler	0.25	100	0.12	0.22	0.22	0.22	0.6	1	1.0	0.29
5/18/2009	sprinkler	0.25	70	0.12	0.19	0.13	0.27	0.9	2	1.2	0.35
5/23/2009	sprinkler	0.5	40	0.25	0.18	0.07	0.36	3.4	5	1.6	0.48
6/3/2009	sprinkler	0.5	15	0.25	0.15	0.02	0.25	11.0	11	1.1	0.33
6/16/2009	drip	1	20	0.49	0.18	0.04	0.47	13.7	13	4.0	0.52
6/26/2009	drip	1.5	50	0.63	0.18	0.09	0.90	7.0	10	7.7	1.00
6/30/2009	drip	1.5	90	0.63	0.18	0.16	0.65	3.9	4	5.5	0.72
7/4/2009	drip	1.75	100	0.70	0.18	0.18	0.72	3.9	4	6.2	0.80
7/8/2009	drip	2	100	0.76	0.19	0.19	0.76	4.0	4	6.5	0.84
7/12/2009	drip	2	100	0.76	0.19	0.19	0.76	4.0	4	6.5	0.84
7/16/2009	drip	2	100	0.76	0.21	0.21	0.84	3.6	4	7.2	0.93
7/20/2009	drip	2	100	0.76	0.17	0.17	0.68	4.5	4	5.8	0.76

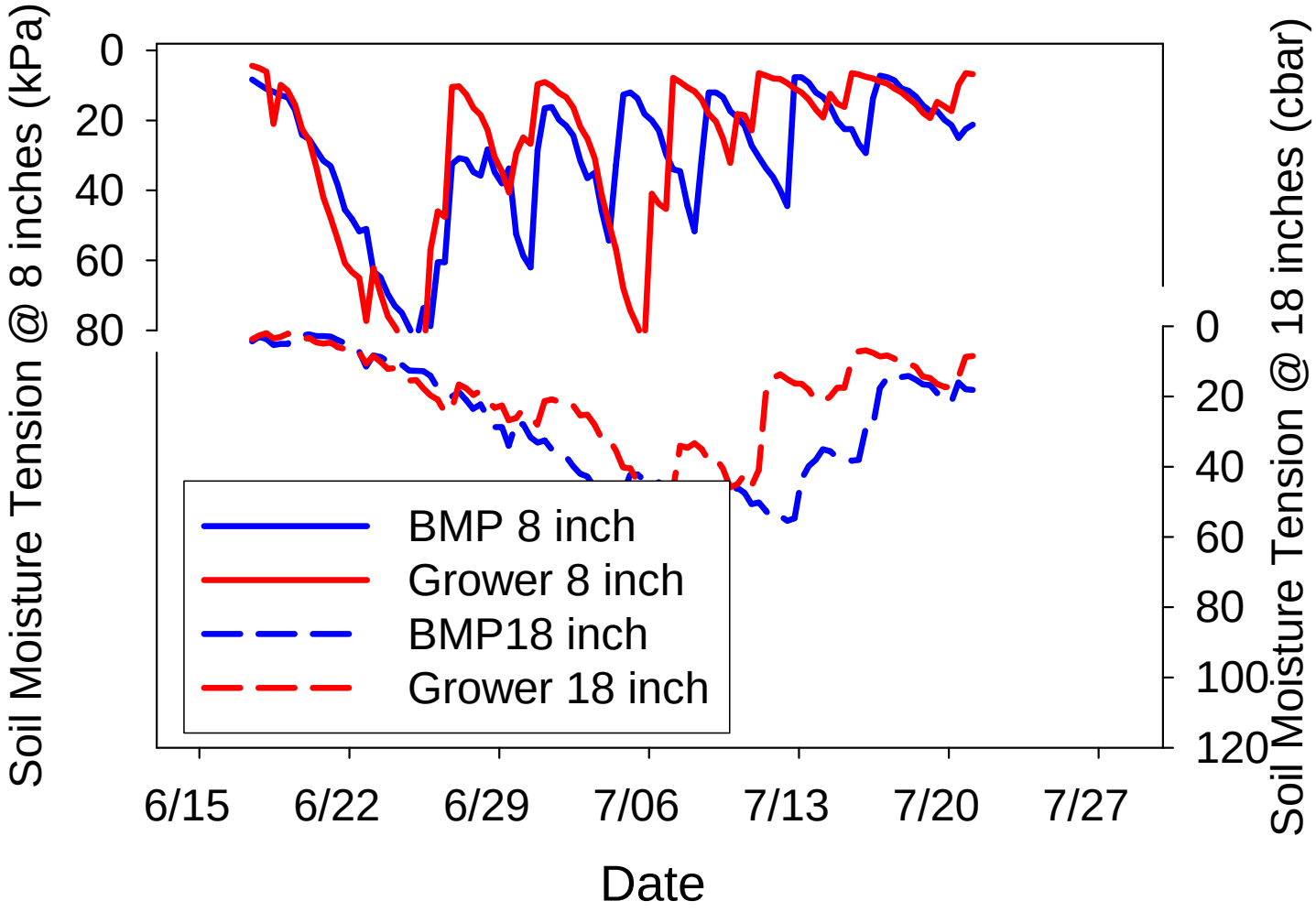
Demonstration Trials of Irrigation Scheduling and Quick Nitrate Test

- 5 locations (North Salinas, South Salinas, King City, San Ardo)
- Commercial Iceberg and Romaine Fields (15 to 27 acres trials)
- Management treatments from wet date to harvest (Grower vs BMP)
- Relied on grower irrigation and fertilizer methods
- 3 replicate strips of each treatment
- Commerical and small plot harvests

Applied Water at Trial Sites

Trial Site	Total Applied Water (inches) Standard	Total Applied Water (inches) BMP	Estimated Crop ETc (inches)	Irrigation requirement [1] (inches)	Water use reduction (%)
King City	17.7	14.7	10.1	13.4	17
S. Salinas	9.9	8.7	7.6	8.9	12
San Ardo	19.4	11.9	6.7	8.7	39
N. Salinas	10.7	10.4	7.0	8.4	3
S. Salinas 2	10.9	10.1	6.1	7.6	7
Average	13.7	11.2	7.5	9.4	16

Soil Moisture Tension
N. Salinas



Applied Nitrogen Fertilizer

Trial Site	Standard (lbs N/acre)	BMP (lbs N/acre)	N Fertilizer Reduction (lbs N/acre)
	Total Applied Nitrogen		
King City	248	110	139
S. Salinas	77	65	12
San Ardo	200	154	46
N. Salinas	188	142	47
S. Salinas 2	160	130	31
Average	175	120	55

Comparison of Average Soil Nitrate levels in BMP and Grower Practice

	Standard	BMP
	Total N Uptake at Harvest	
Trial Site	(lbs N/acre)	
King City	133.8	141.5
S. Salinas	148.8	133.0
San Ardo	86.4	93.4
N. Salinas	165.0	173.0
S. Salinas 2	120.0	118.5
Average	130.8	131.9

Comparison of Average Soil Nitrate levels in BMP and Grower Practice

Average Soil Nitrate levels (1 foot depth)

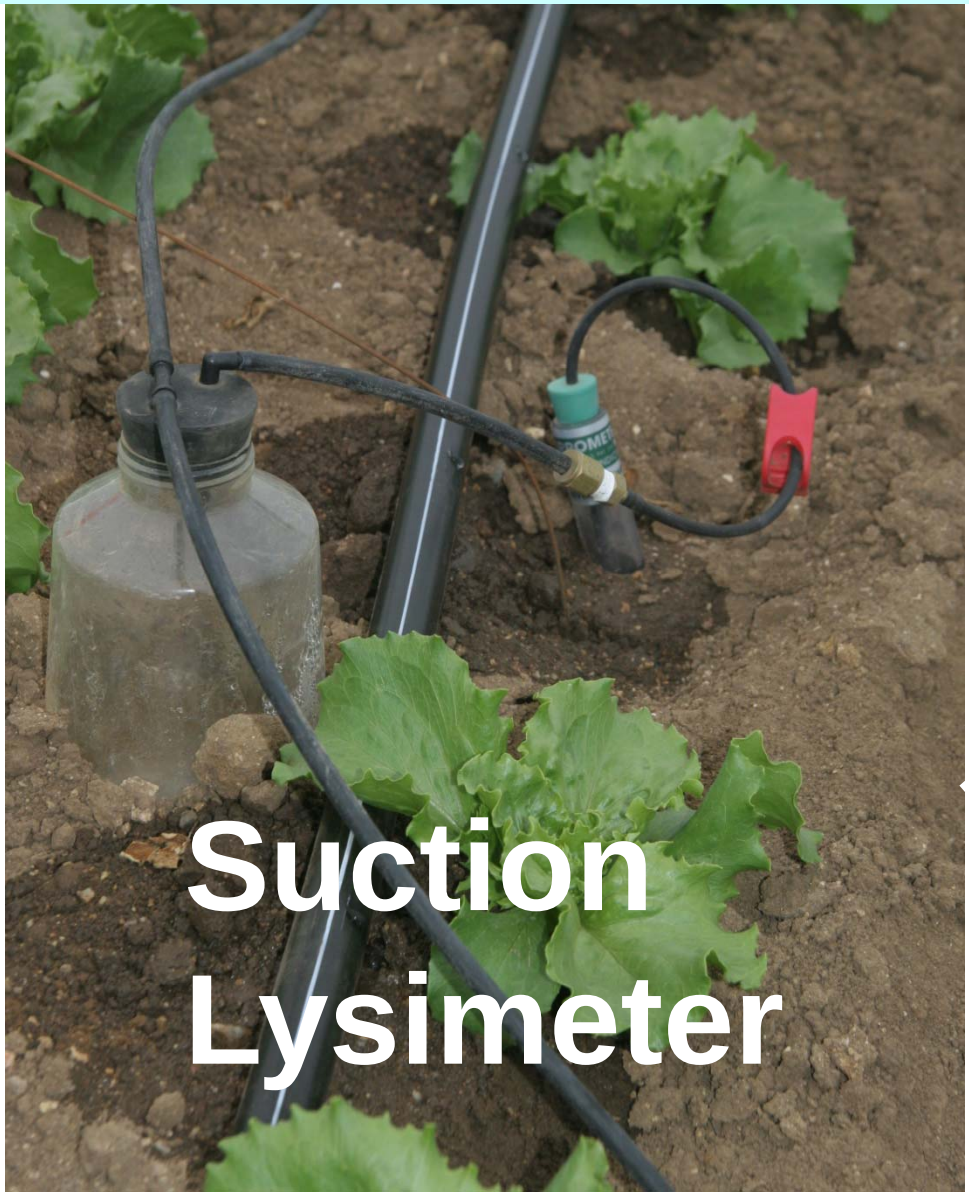
	Standard	BMP
	Mean Soil Nitrate (over season)	
Trial Site	(ppm NO3-N)	
King City	33.3	47.0
S. Salinas	18.3	19.5
San Ardo	19.5	20.4
N. Salinas	18.7	17.7
S. Salinas 2	41.3	26.9
Average	26.2	26.3

Commercial and Small Plot Yields

	small plot harvest			commerical harvest		
	Grower	BMP	BMP relative	Grower	BMP	BMP relative
Trial Site	Total CFR[1] Yield (tons/acre)		to Grower %	Total CFR[1] Yield (tons/acre)		to Grower %
King City	27.3	27.8	102	21.6	21.4	99
South Salinas	26.5	23.0	87	13.9	14.0	100
San Ardo	12.1	10.5	87	--	--	--
North Salinas	38.6	40.2	104	30.0	29.5	98
South Salinas 2	14.4	14.8	103	9.0	9.0	101
Average	23.8	23.2	97	17.8	17.7	100

1. CFR = Cored for region

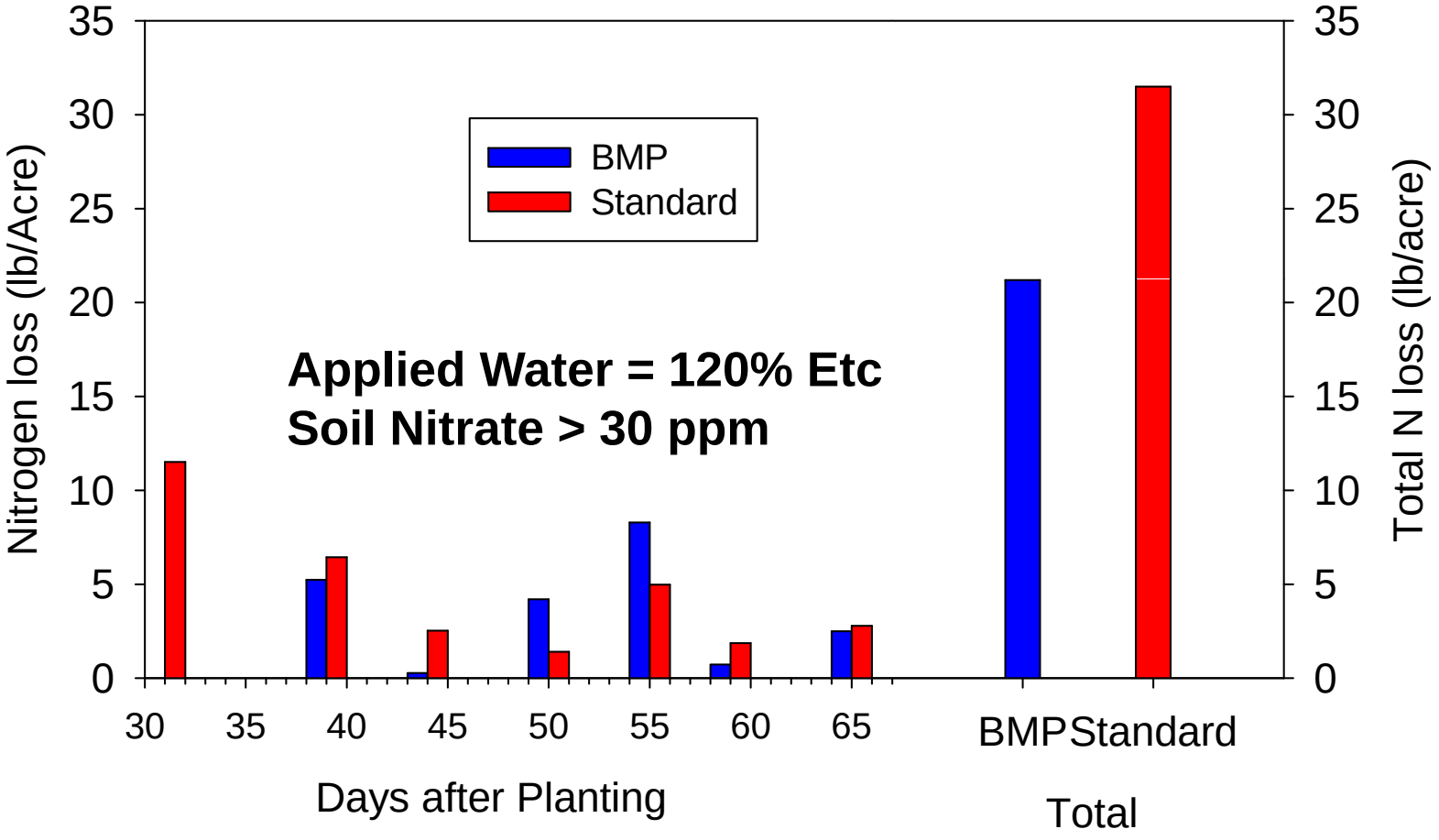
Did improving water management reduce nitrate leaching?



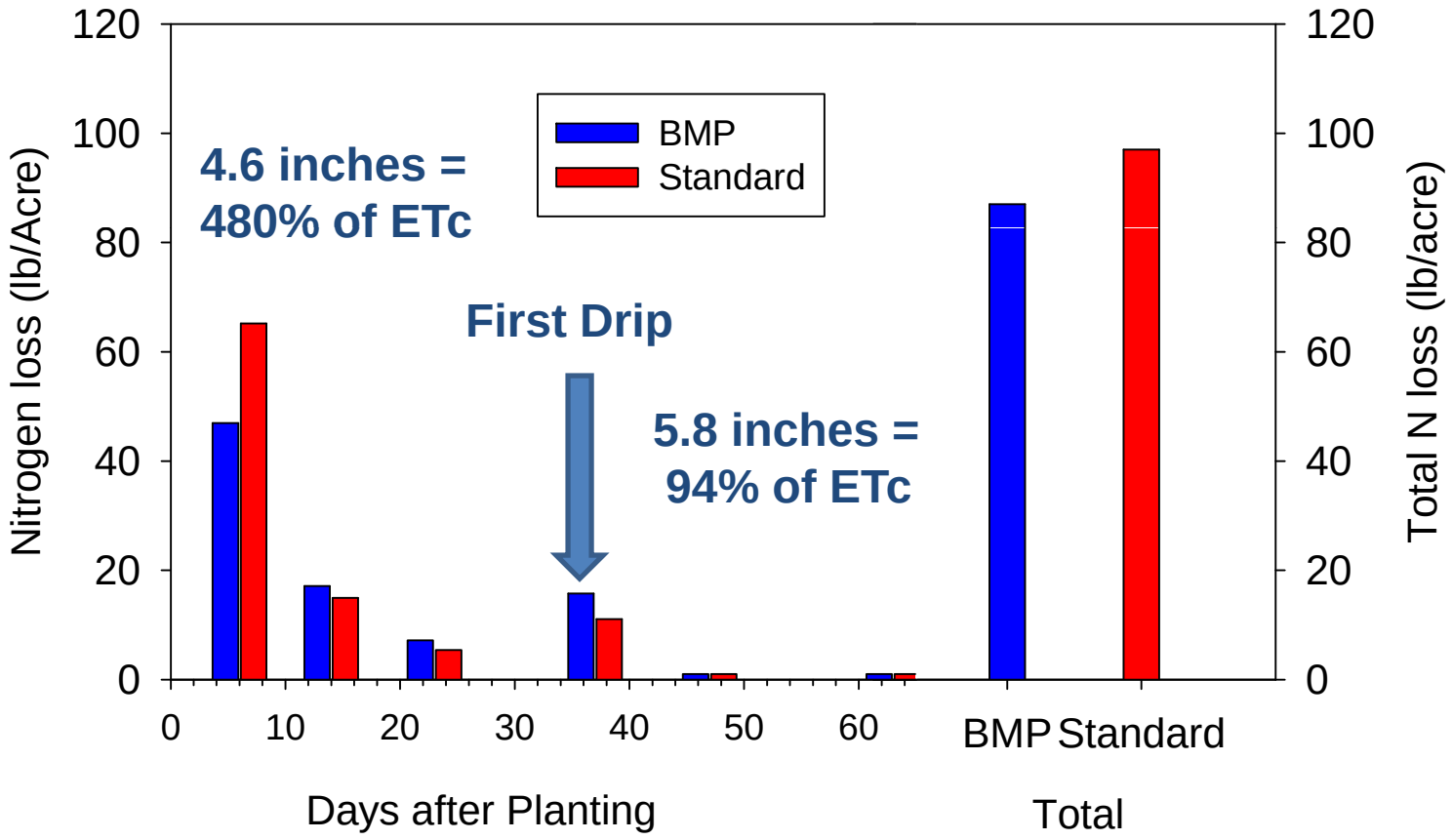
Estimated Nitrogen Losses due to Leaching (Sprinklers, King City July 25-July 29)

Management Treatment	Applied Water[1]	Crop ET	Soil Moisture Storage	Percolation	NO3-N concentration in leachate	Nitrogen loss by leaching
	---------- inches ----------				ppm	lb/acre
BMP	0.8	0.6	0.0	0.3	173.9	11.2
Grower	1.4	0.6	-0.1	0.9	178.4	37.3

Nitrate leaching losses post thinning (S. Salinas 2)



Nitrate leaching losses (N. Salinas)



Estimated Nitrogen Losses due to Leaching (S. Salinas, Germination Water July 10-July 24)

Management Treatment	Applied Water[1]	Crop ET	Soil Moisture Storage	Percolation	NO3-N concentration in leachate	Nitrogen loss by leaching
	---------- inches ----------				ppm	lb/acre
BMP	2.4	1.2	0.0	1.2	116.4	31.4
Grower	3.5	1.2	0.3	2.1	104.9	49.5

Summary

- CIMIS ET data can be used to guide irrigation scheduling in lettuce.

- Large scale trials demonstrated that combining the quick nitrate test with careful irrigation scheduling saved water, fertilizer, and reduced nitrate leaching

Irrigation strategies to consider for lettuce

- Efficient application of germination water (< 3 inches)
- Interval without water between pre-thinning and post thinning should not be excessively long.
- Irrigation amount should refill soil profile but not over-saturate soil.
- After thinning, period between irrigations should not be so long as to cause water stress in the crop.

Recommended Steps to Improve Irrigation Management

- Irrigator training.
- Measure irrigation applications.
- Evaluate irrigation system uniformity.
- Evaluate Scheduling (CIMIS ET, soil moisture).
- System maintenance.
- Take advantage of NRCS cost sharing


Thank you!