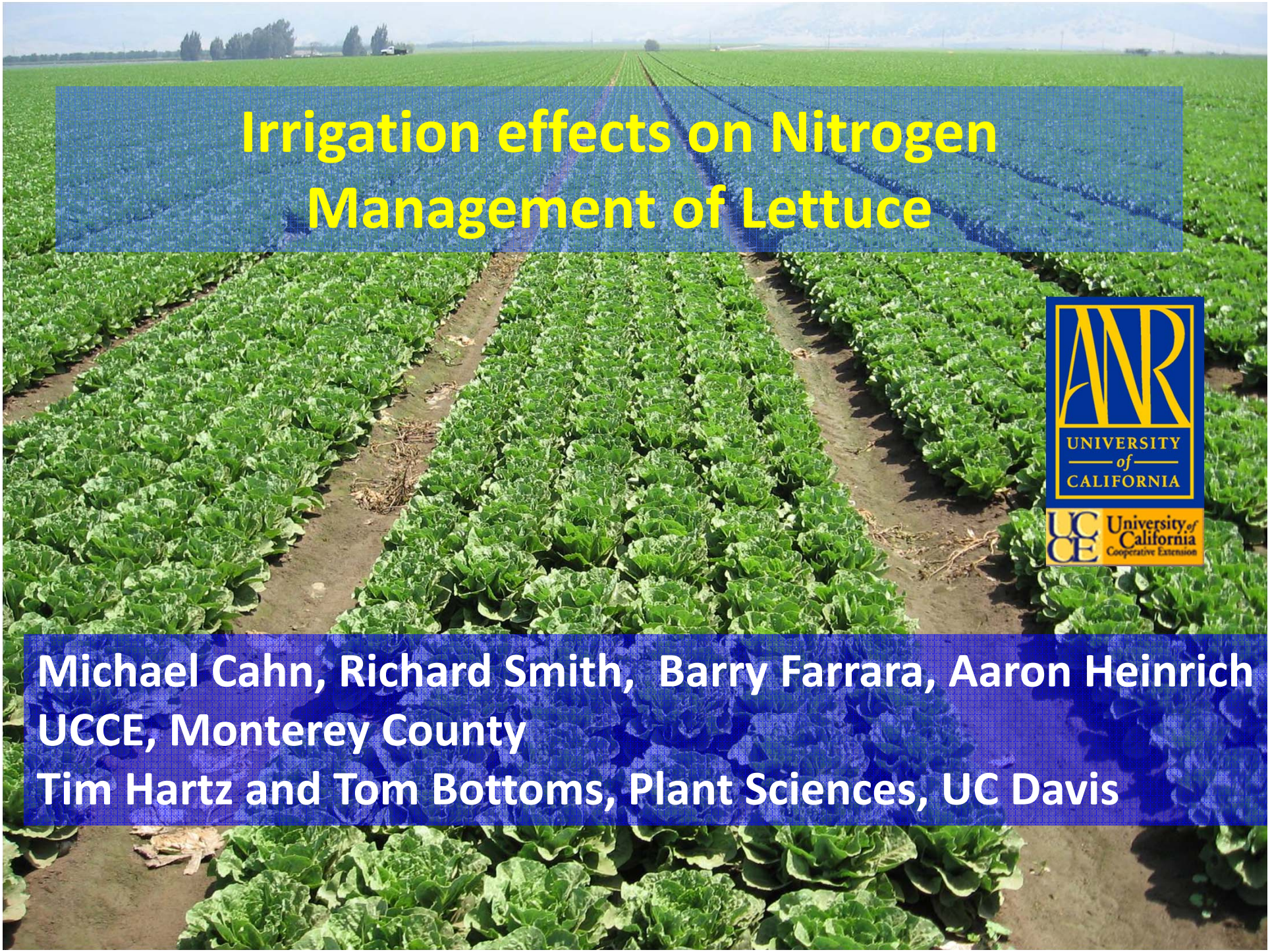
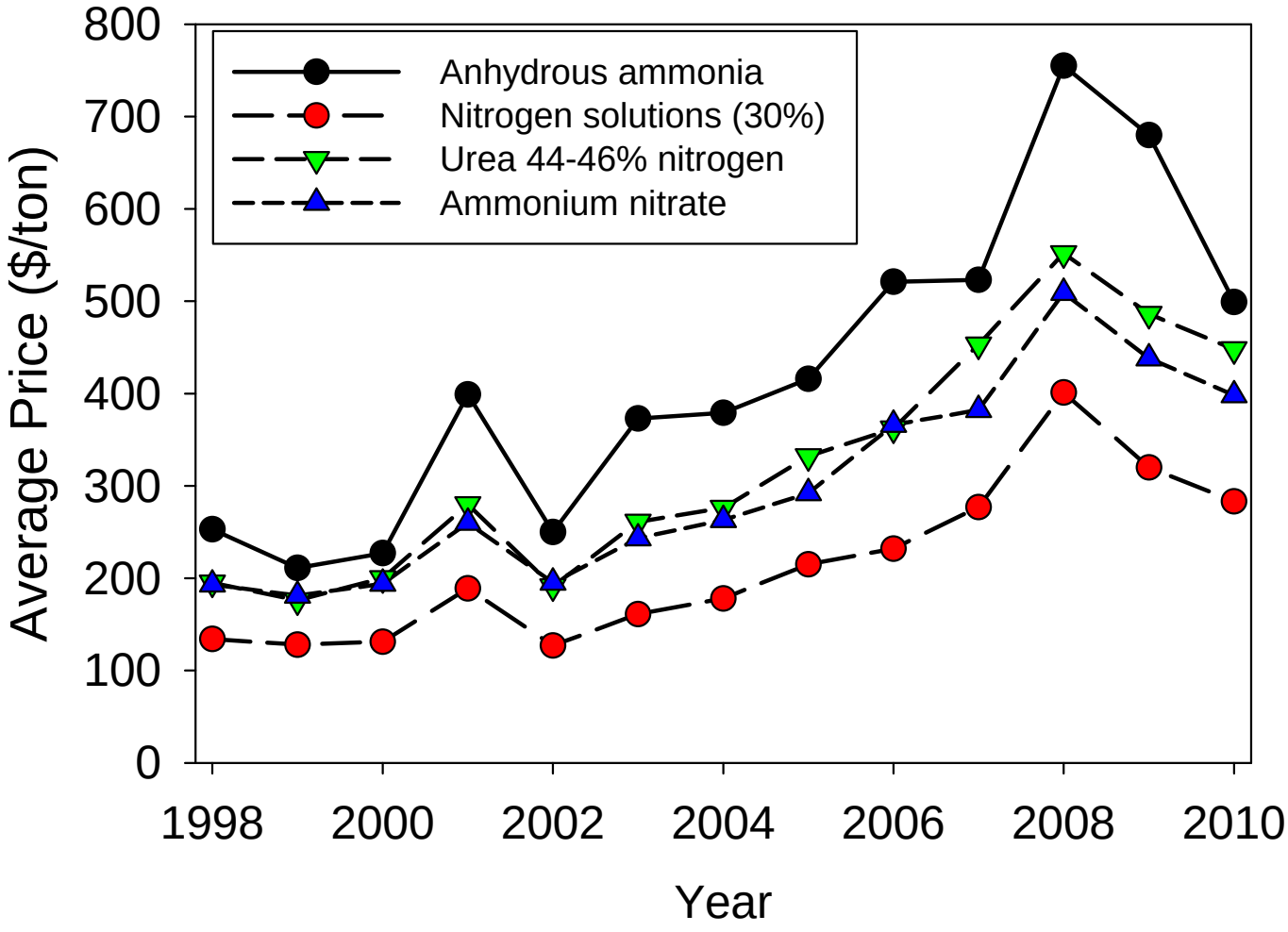


Irrigation effects on Nitrogen Management of Lettuce

Michael Cahn, Richard Smith, Barry Farrara, Aaron Heinrich
UCCE, Monterey County
Tim Hartz and Tom Bottoms, Plant Sciences, UC Davis

Saving on Nitrogen Fertilizer Costs

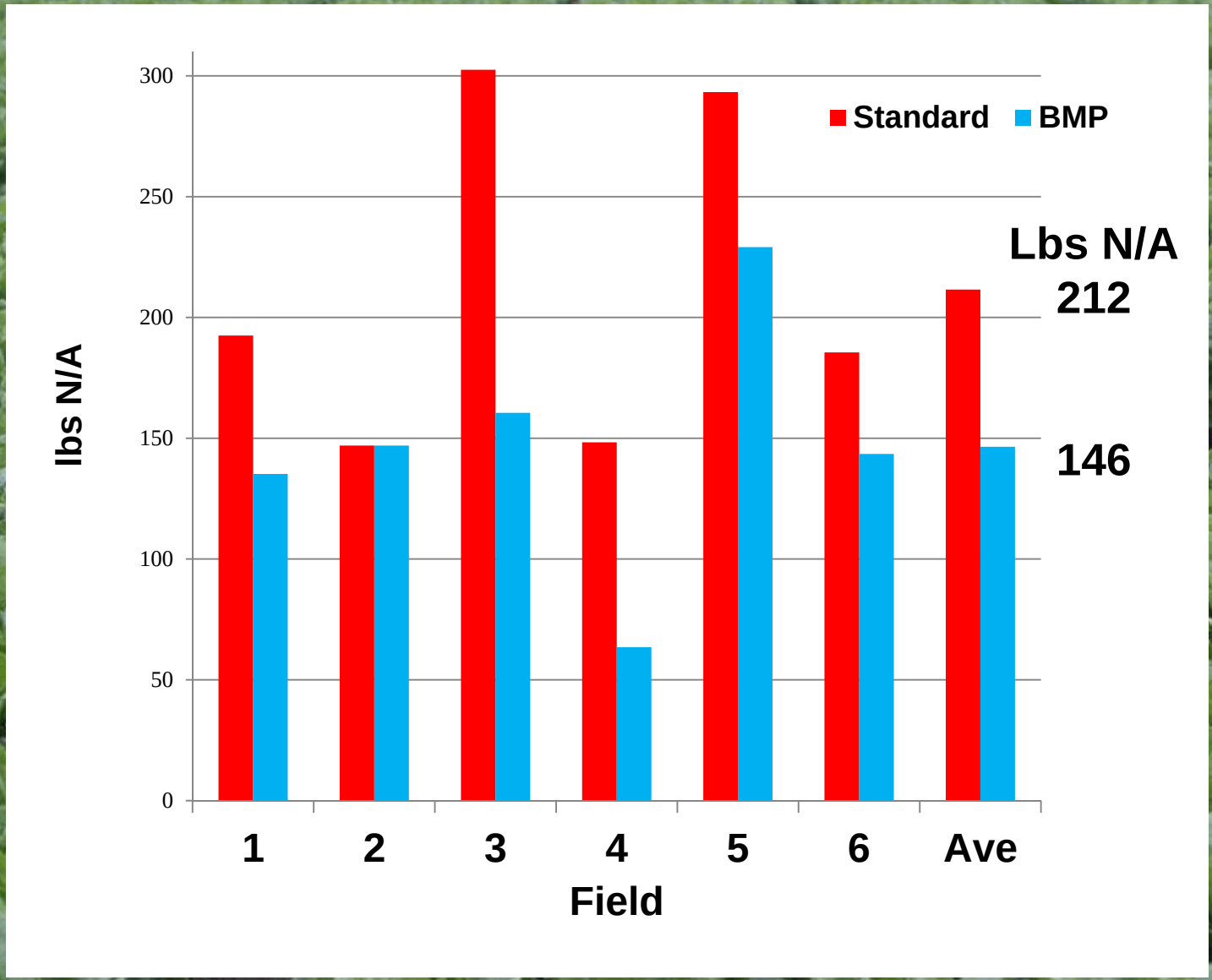


Source: Agricultural Prices, National Agricultural Statistics Service, USDA.

Quick Nitrate Test: Soil nitrate status

(20 ppm NO_3-N = 65 to 75 lbs of N/acre/ft)

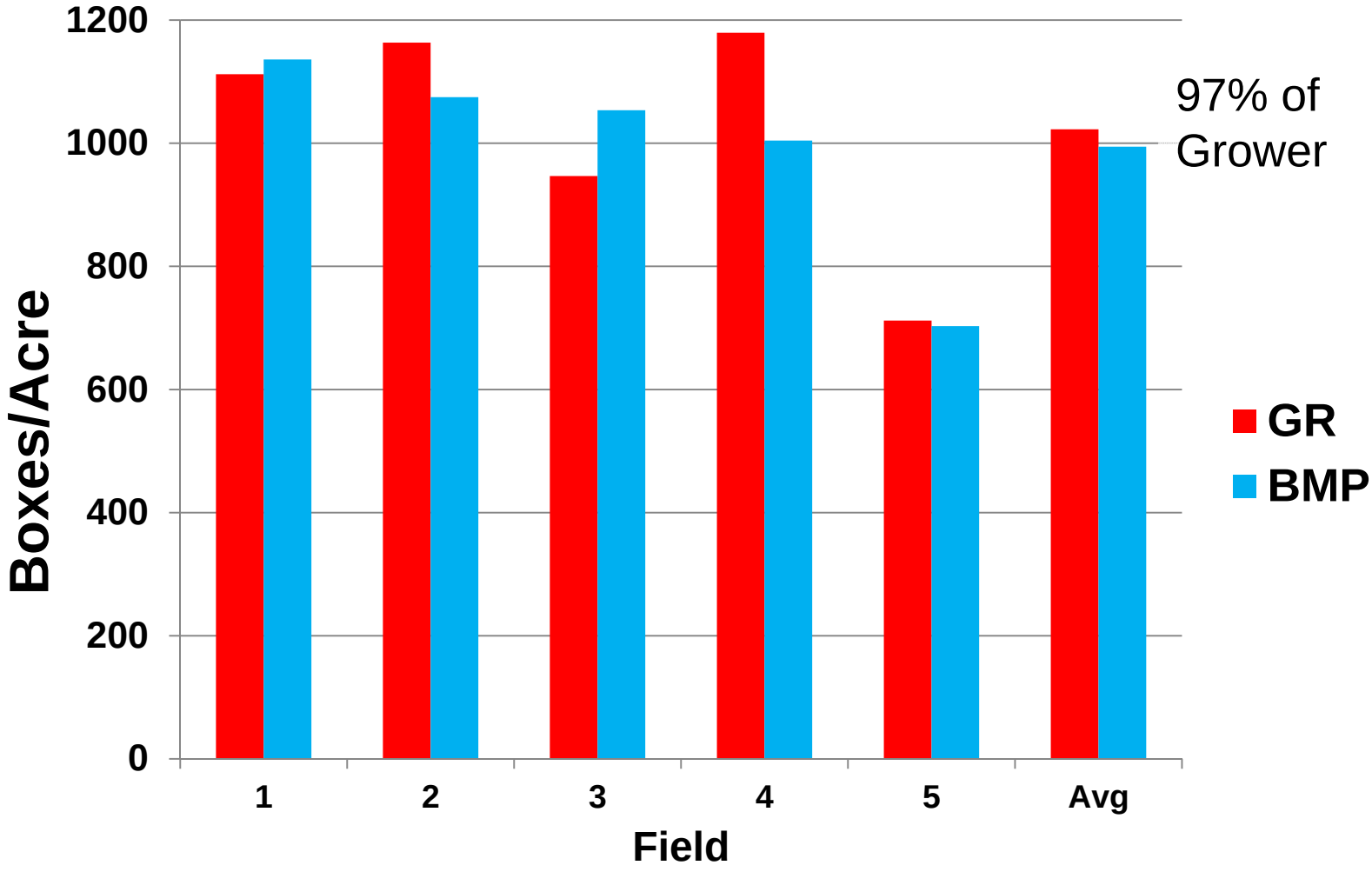
2010 Nitrogen Fertilizer Trials



Difference
66 lbs/A

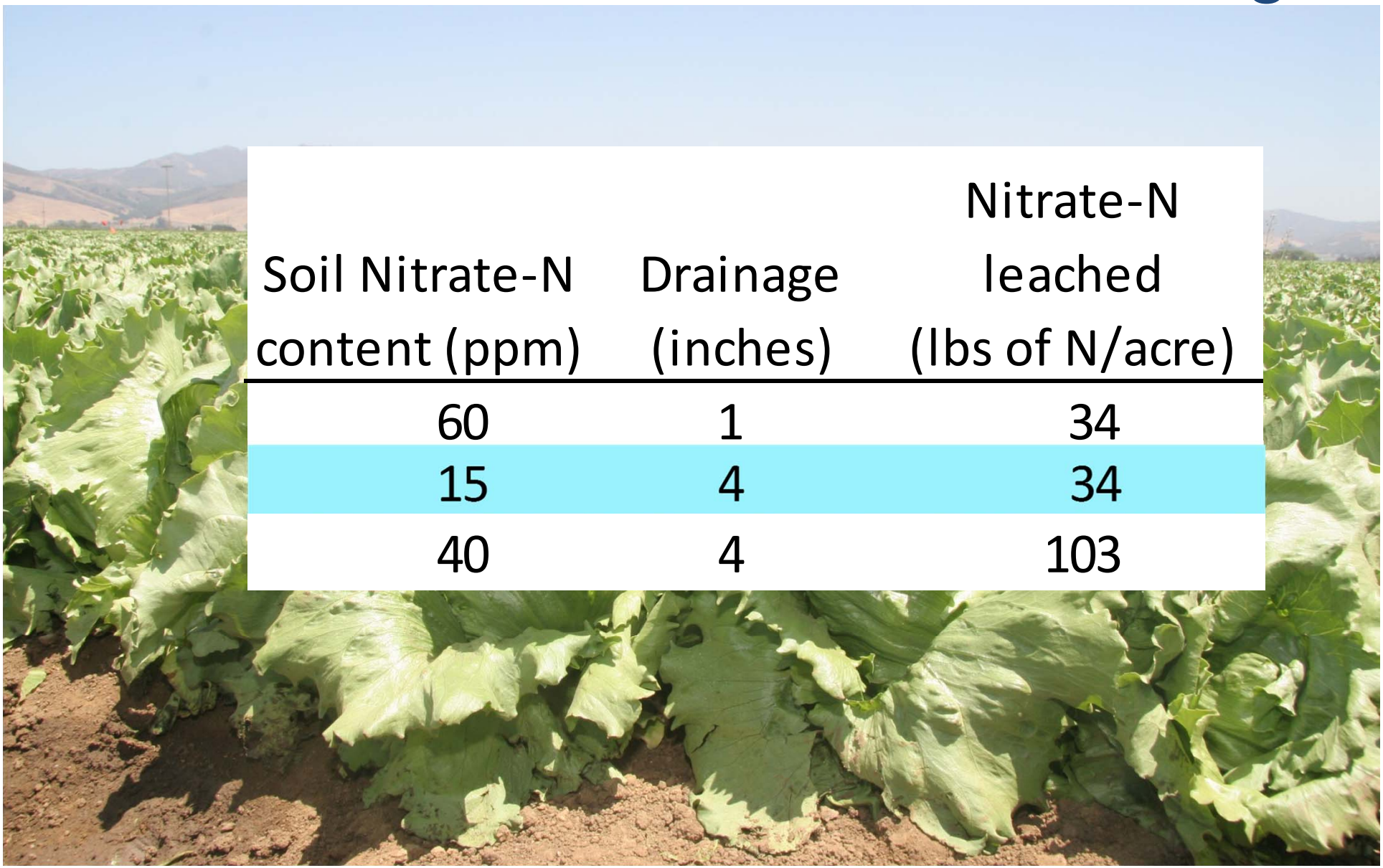
@ 0.60/lb N
=$40/A

Commercial Yield



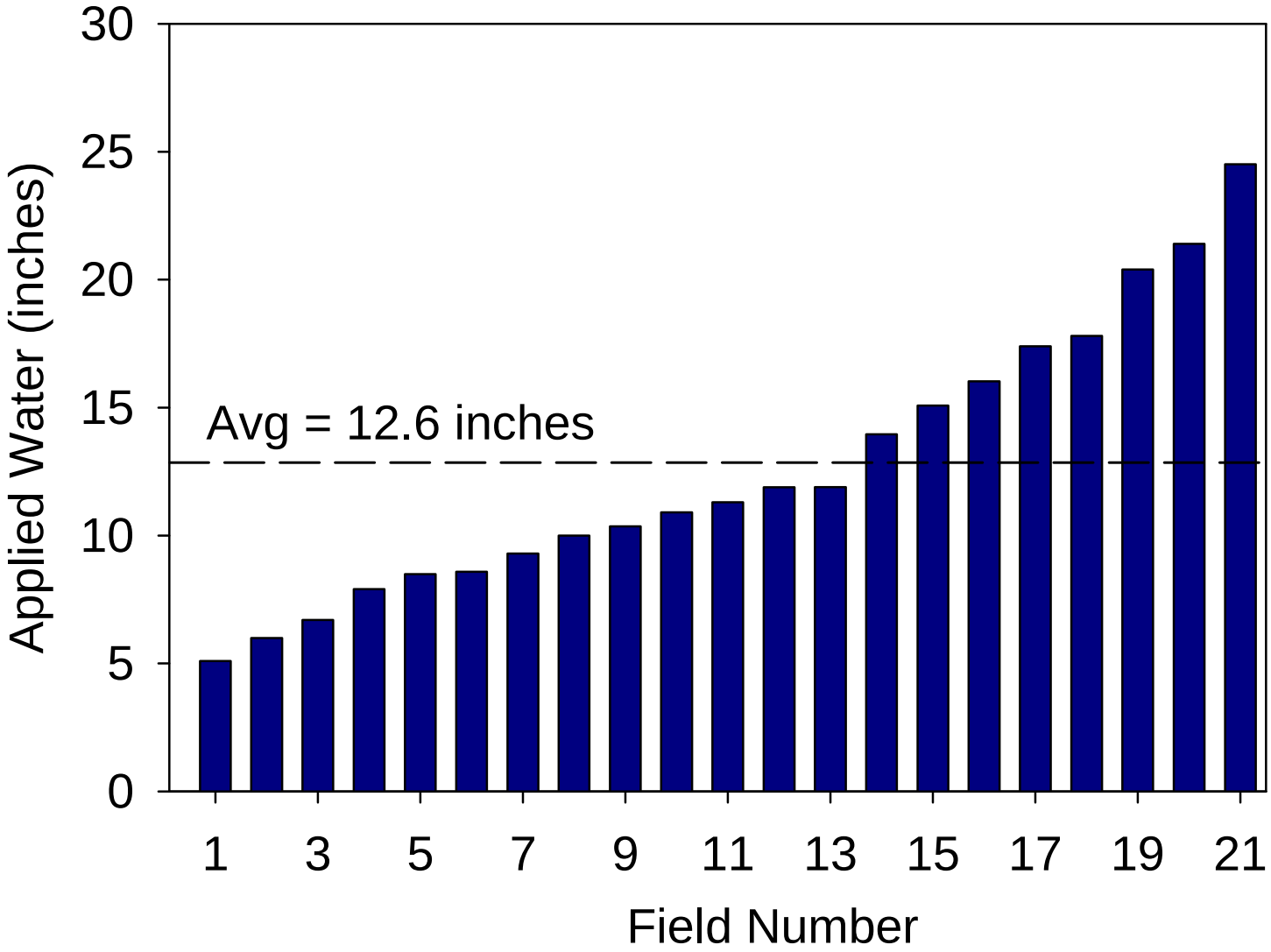
How much does irrigation management matter for optimizing nitrogen fertilizer?

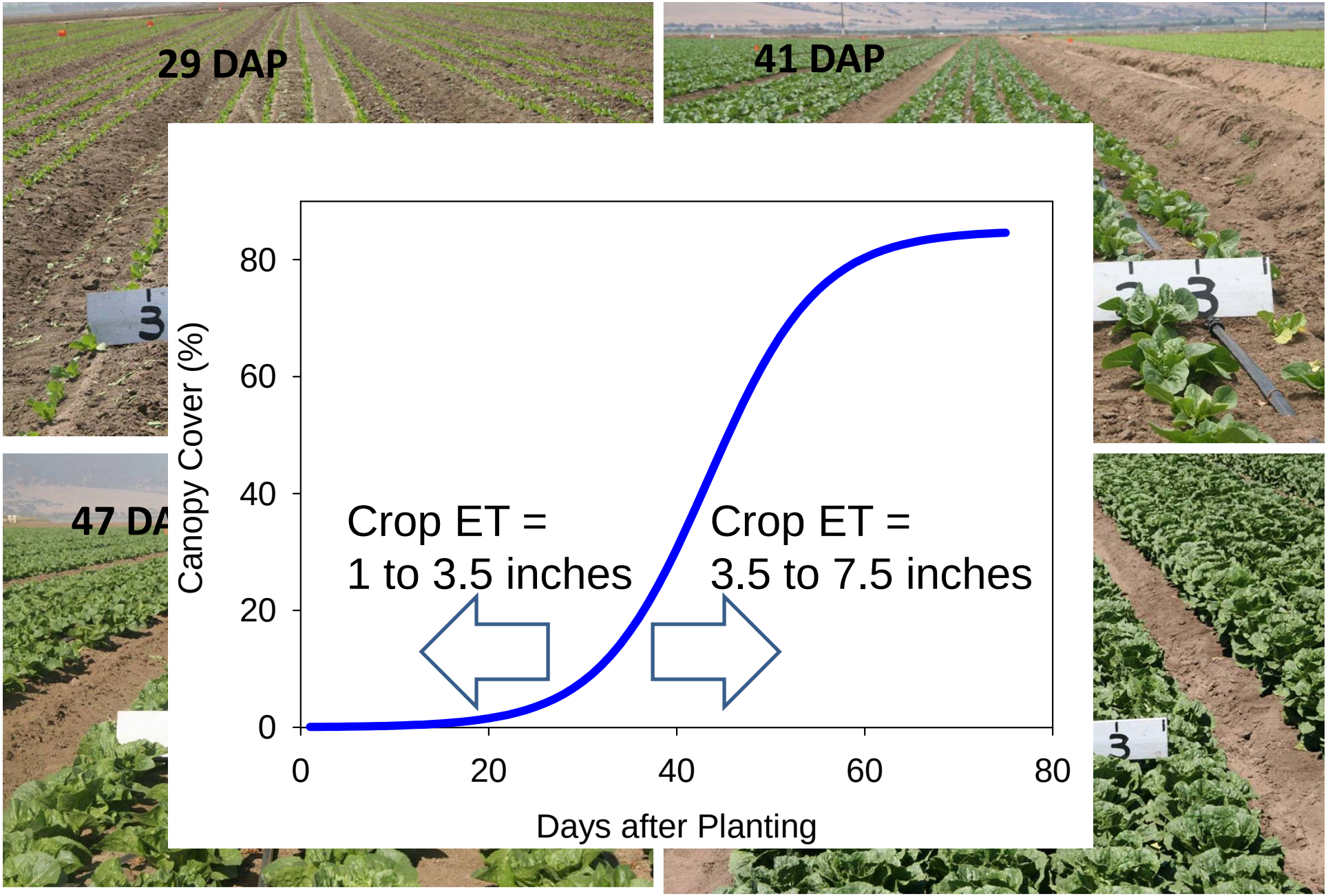
Lbs of N lost by leaching depends on soil nitrate concentration and drainage



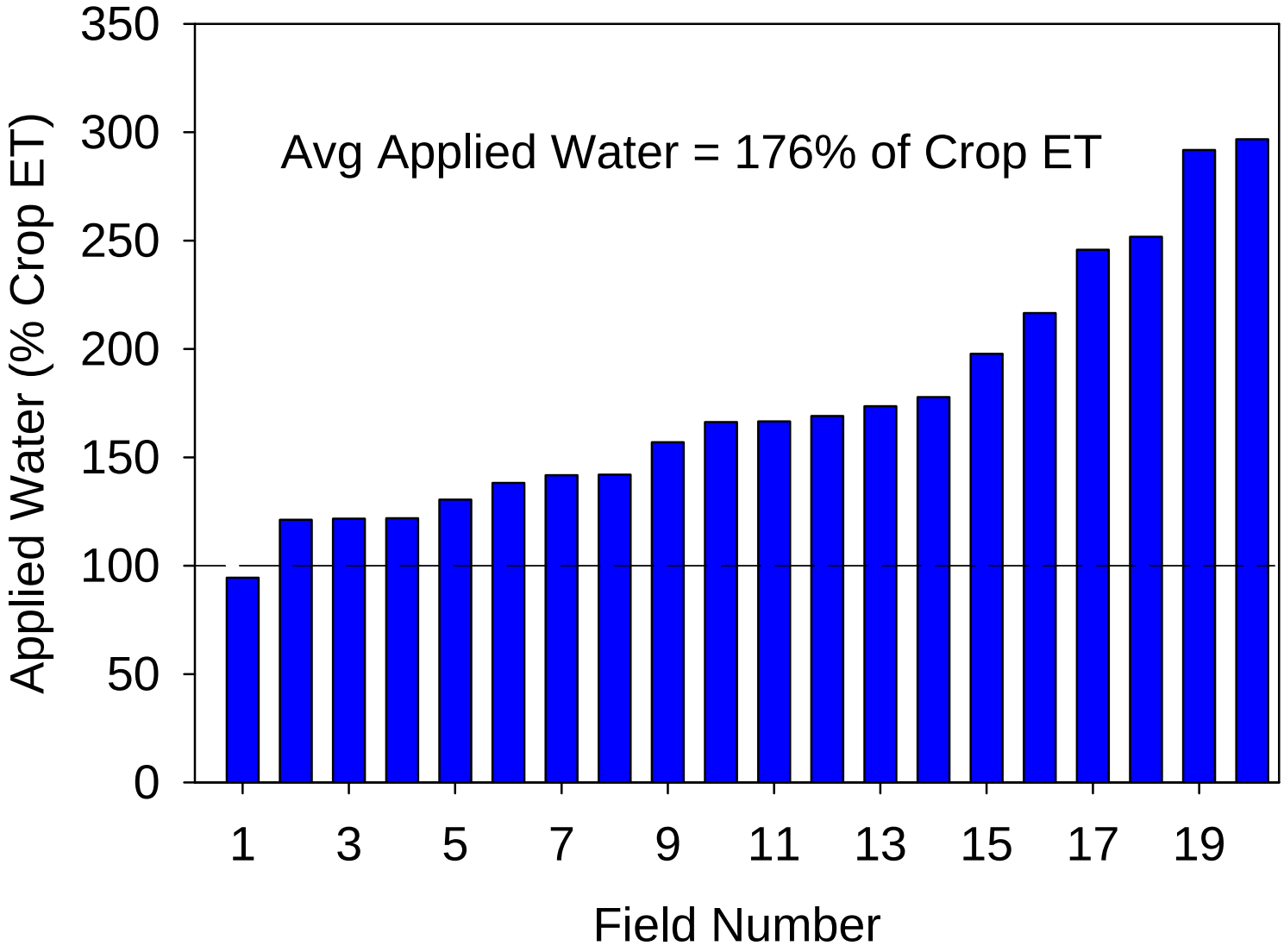
Soil Nitrate-N content (ppm)	Drainage (inches)	Nitrate-N leached (lbs of N/acre)
60	1	34
15	4	34
40	4	103

Total Water Applied to Lettuce

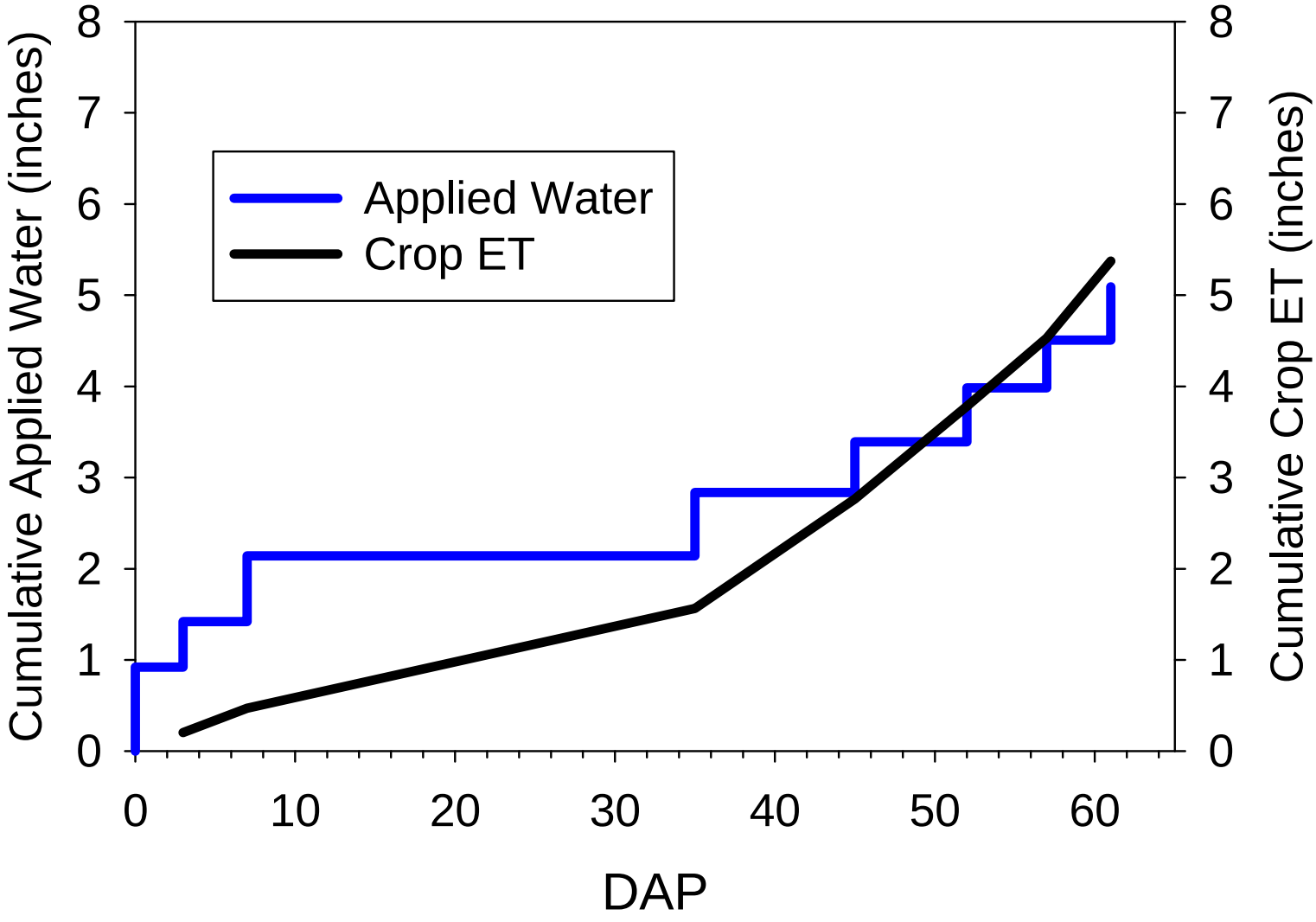



29 DAP
41 DAP
47 DA
Canopy Cover (%)
0
20
40
60
80
Crop ET =
1 to 3.5 inches
Crop ET =
3.5 to 7.5 inches
0
20
40
60
80
Days after Planting

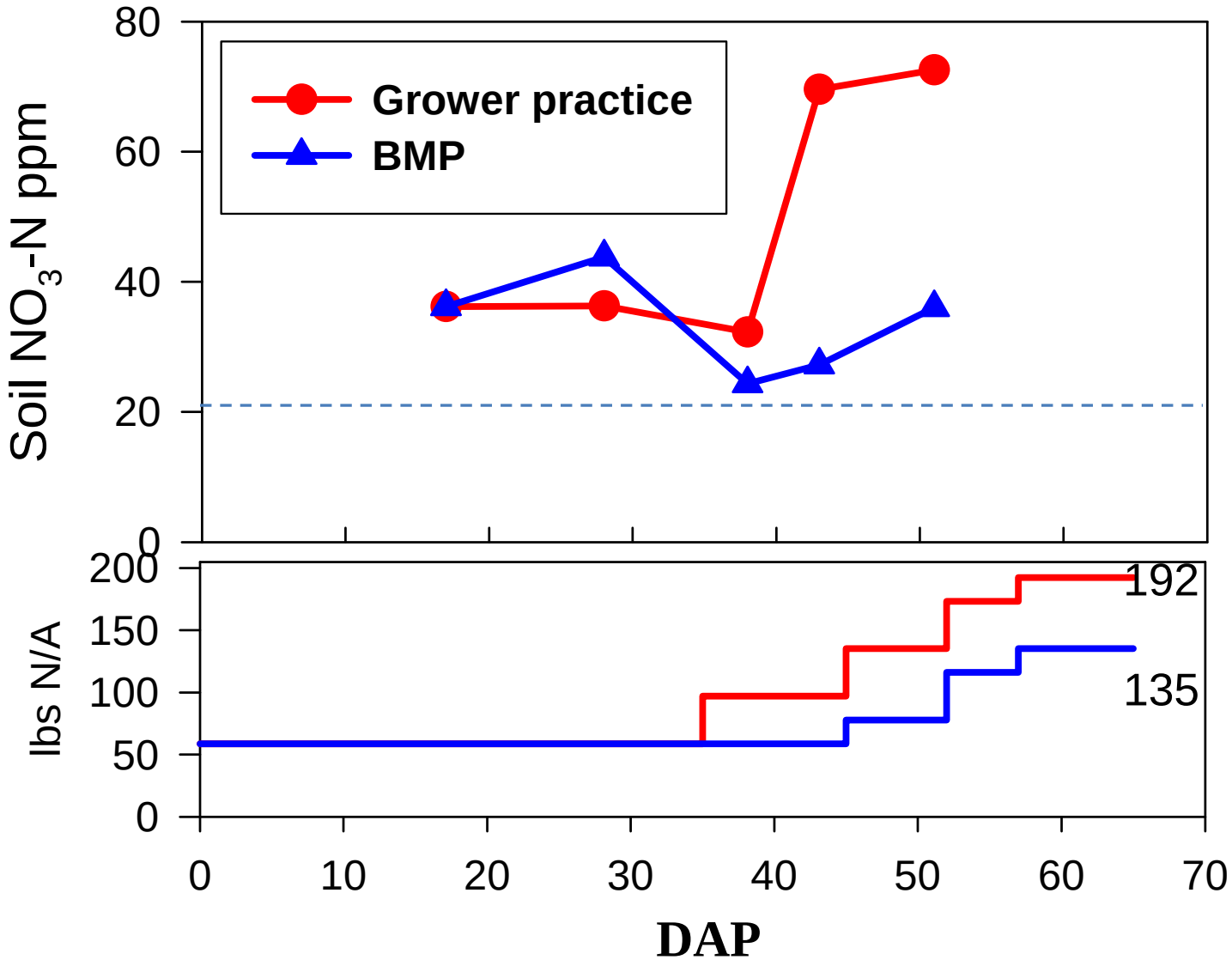
Applied Water as Percentage of Crop ET



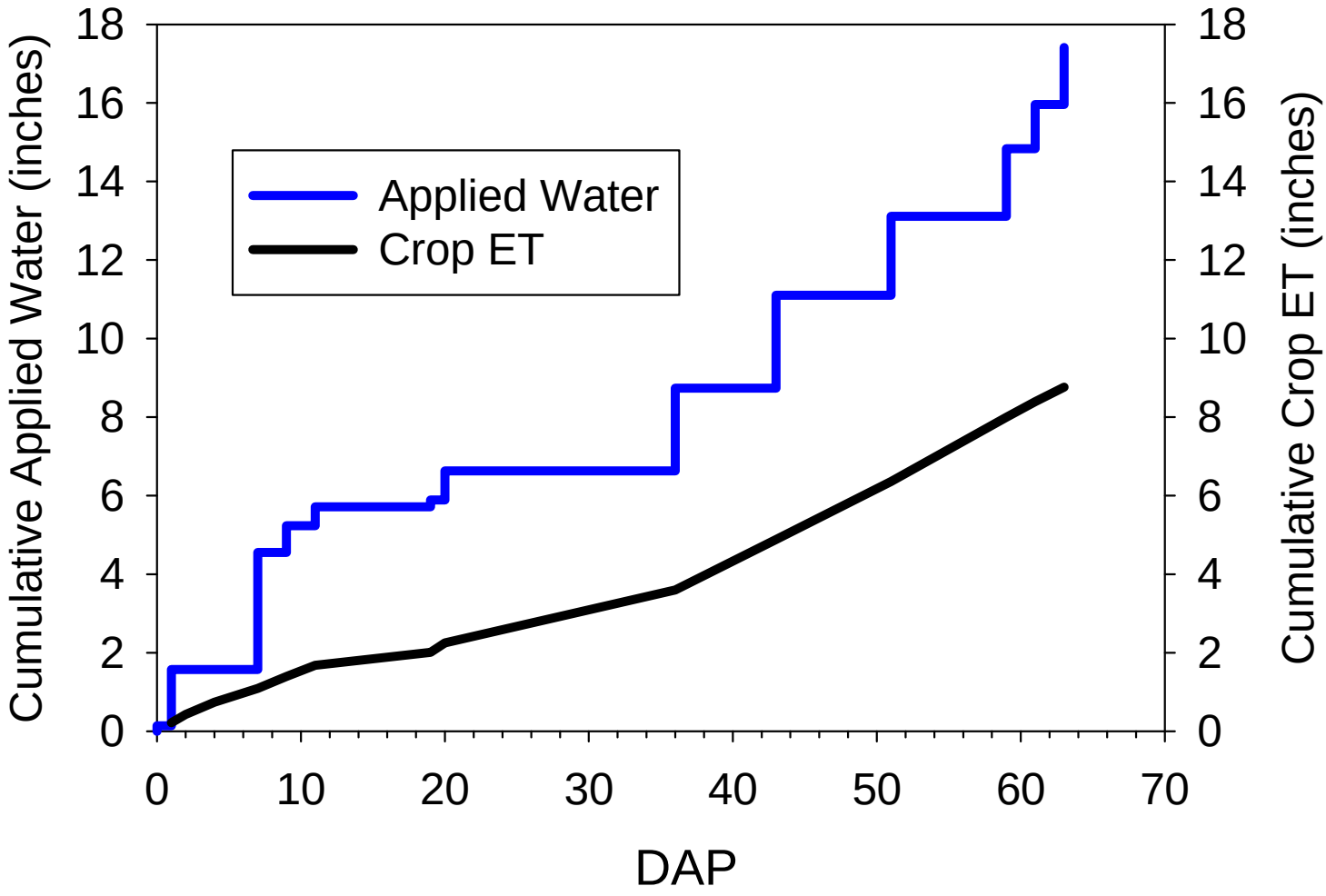
Applied Water and Crop ET (site 1)



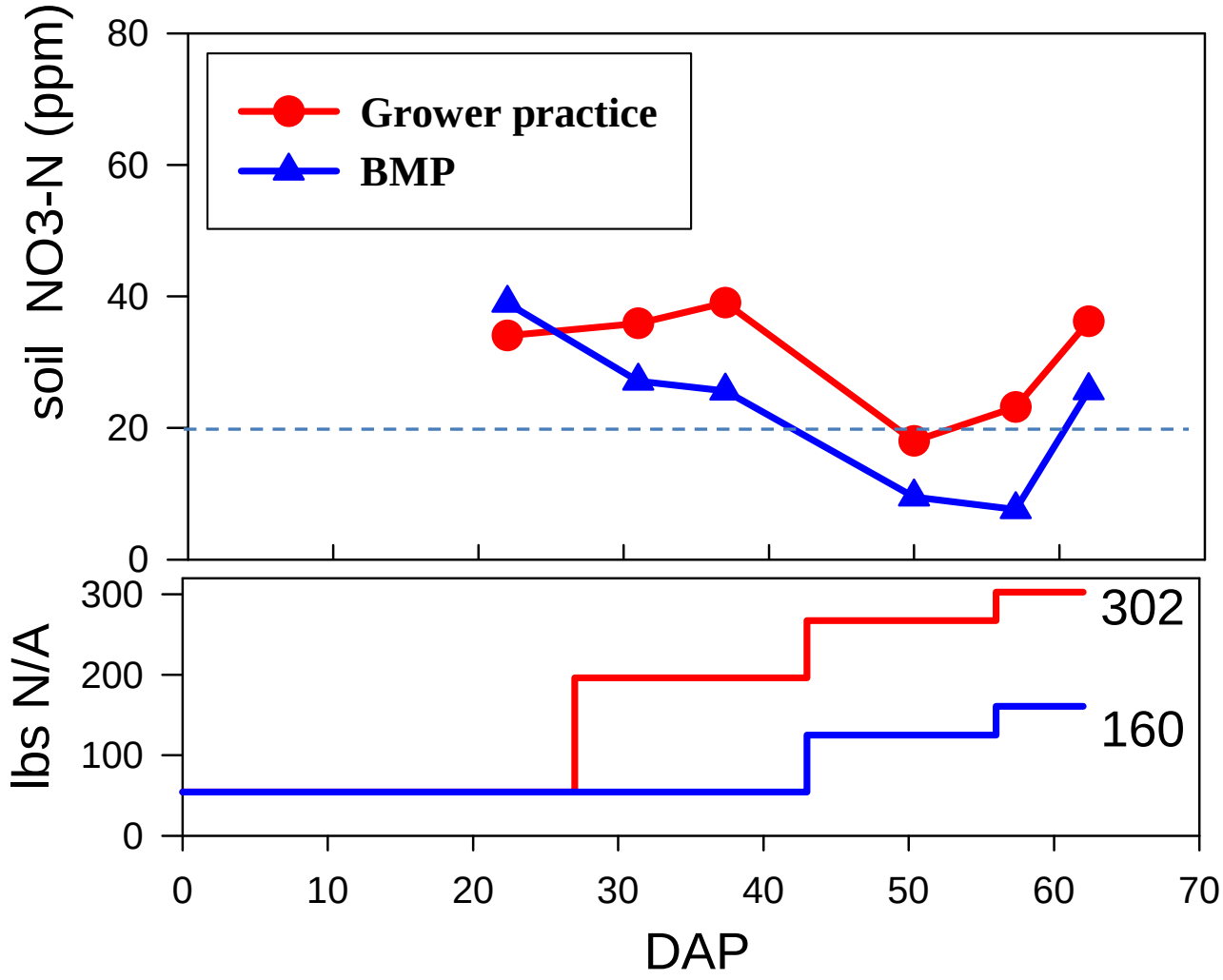
Applied N and soil nitrate (site 1)



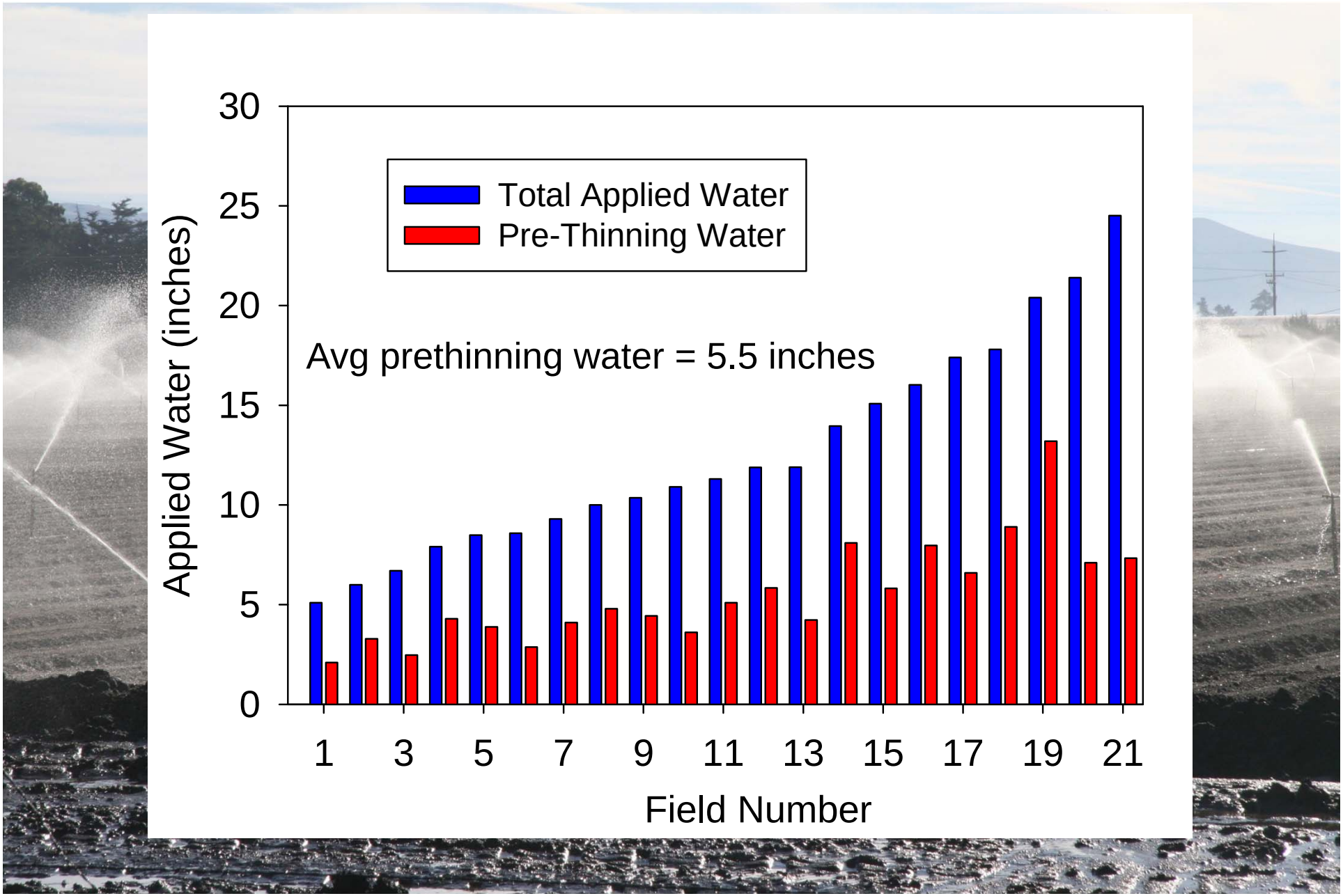
Applied Water and Crop ET (site 3)



Applied N and soil nitrate (site 3)



Pre-thinning Water Applied to Lettuce

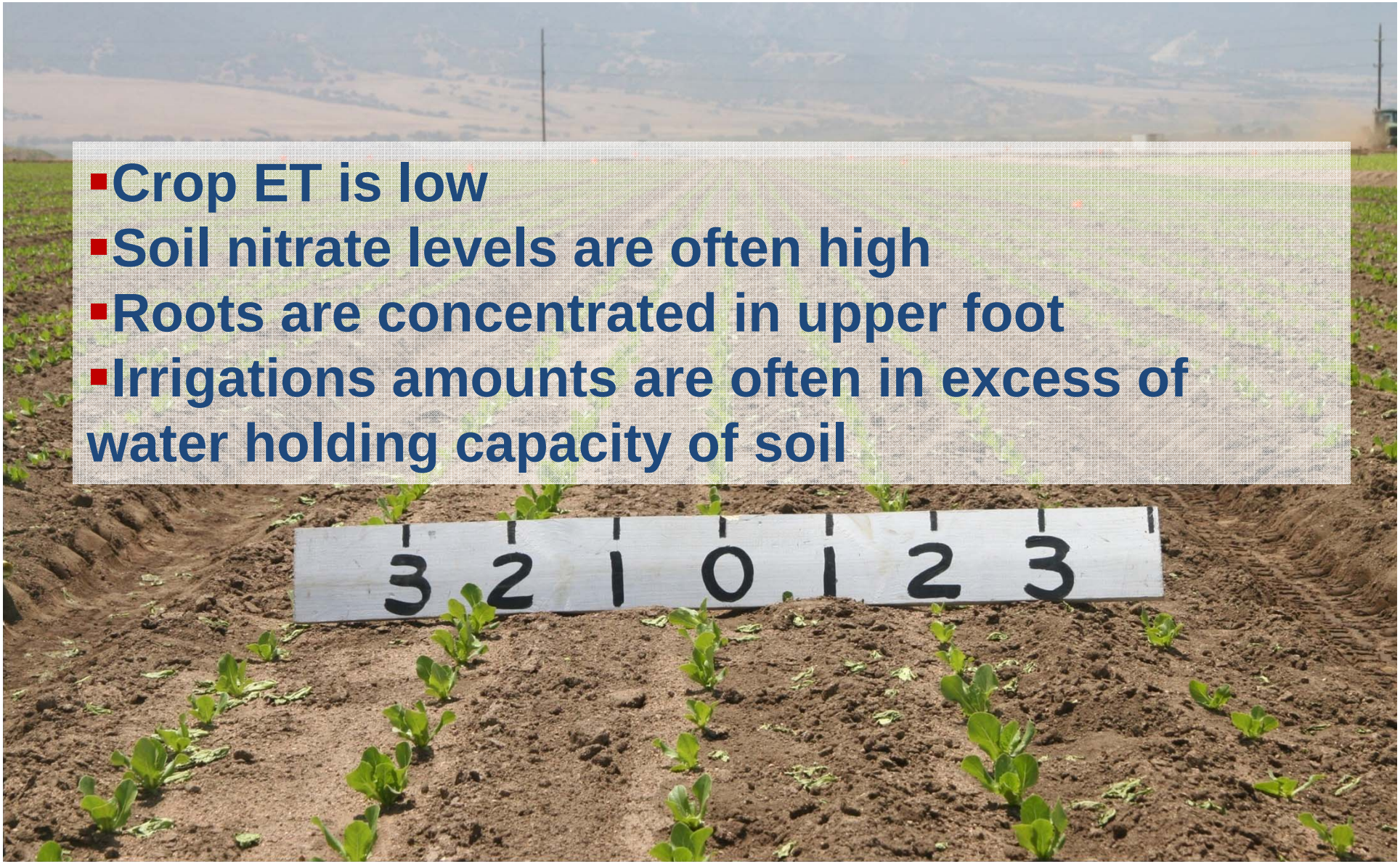


Potential N losses during crop establishment:

- **Evaporation and transpiration losses during first 2 weeks of a lettuce crop < 2 inches**

Management	Crop and Evaporation losses	Germination water amount	N loss
	----- inches -----		lb/acre
Reduced irrigation	1.2	2.4	31
Normal irrigation	1.2	3.5	50

First irrigation after thinning can contribute to N losses



- Crop ET is low
- Soil nitrate levels are often high
- Roots are concentrated in upper foot
- Irrigations amounts are often in excess of water holding capacity of soil

Amount of water applied during a single irrigation can contribute to nitrate losses

	establishment		post-thinning	
Irrigation method	**avg**	**max**	**avg**	**max**
	---------- inches per irrigation -------			
sprinkler	0.5 - 1.1	0.9 -1.4	0.5 - 1.5	1.1 - 2.2
drip	0.6	0.9	0.5 - 1.0	0.7 - 1.7
furrow	--	--	1.5	3.9

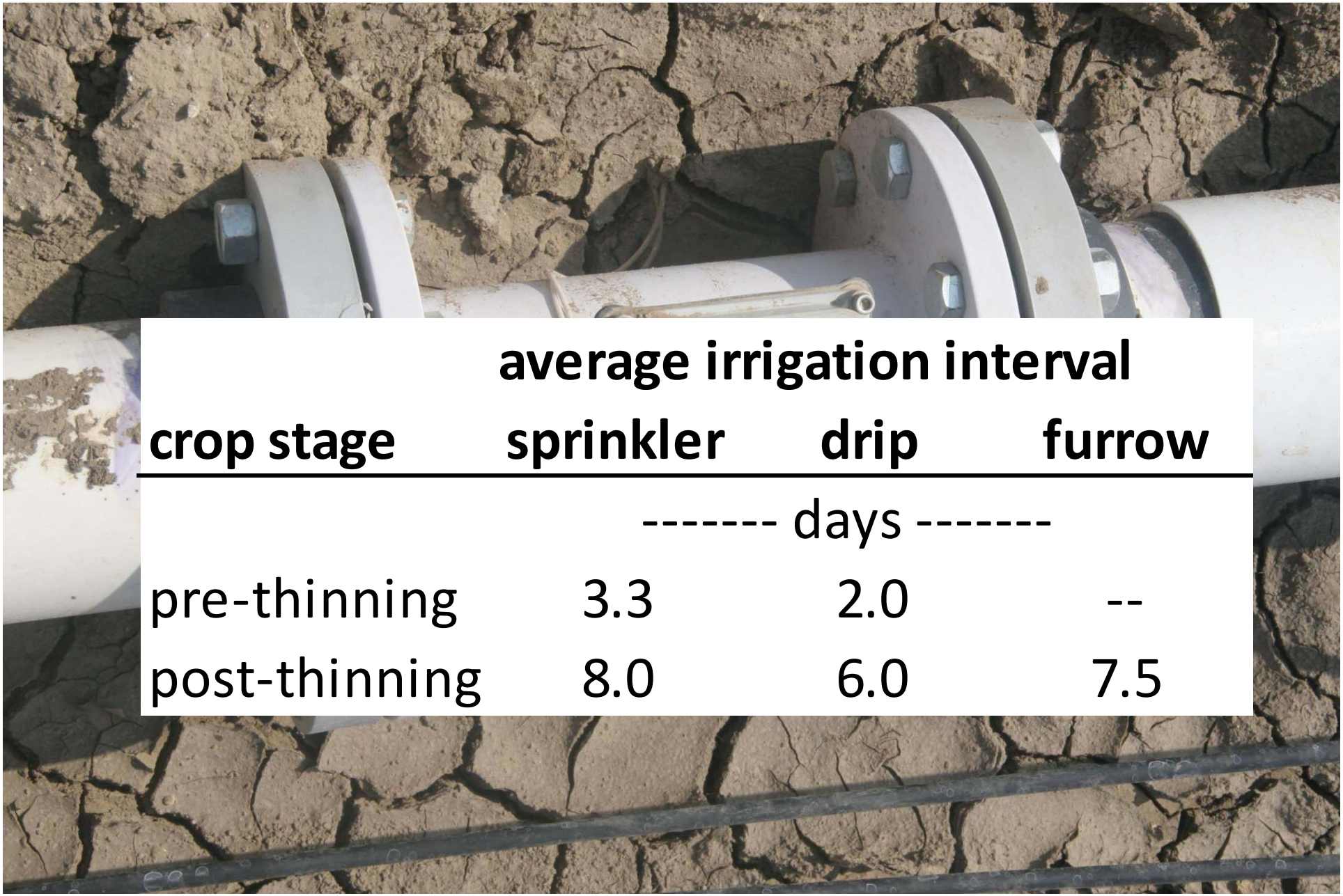
Soil Moisture Tensions > 30 cbars slows lettuce growth

Soil Moisture Available for Lettuce Growth

Days after Planting	15	30	45	60
Root depth (ft)	0.5	1.25	1.75	2
	-------	inches of available water		-------
Silty clay	0.2	0.5	0.7	0.7
Silty clay loam	0.2	0.5	0.7	0.8
Loam	0.2	0.6	0.8	0.9

Low Distribution Uniformity increases Irrigation Requirement and Drainage

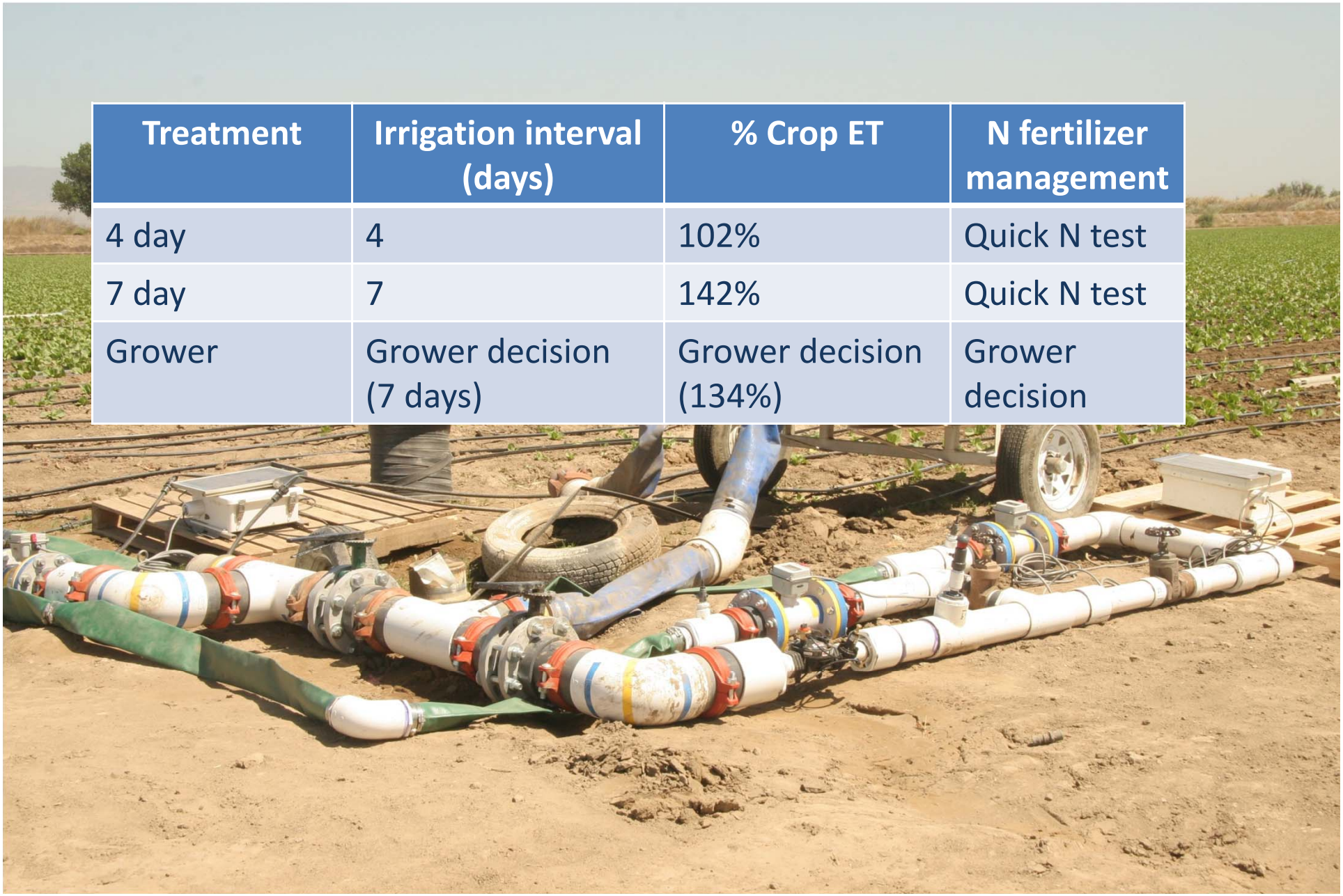
Average irrigation intervals in Lettuce



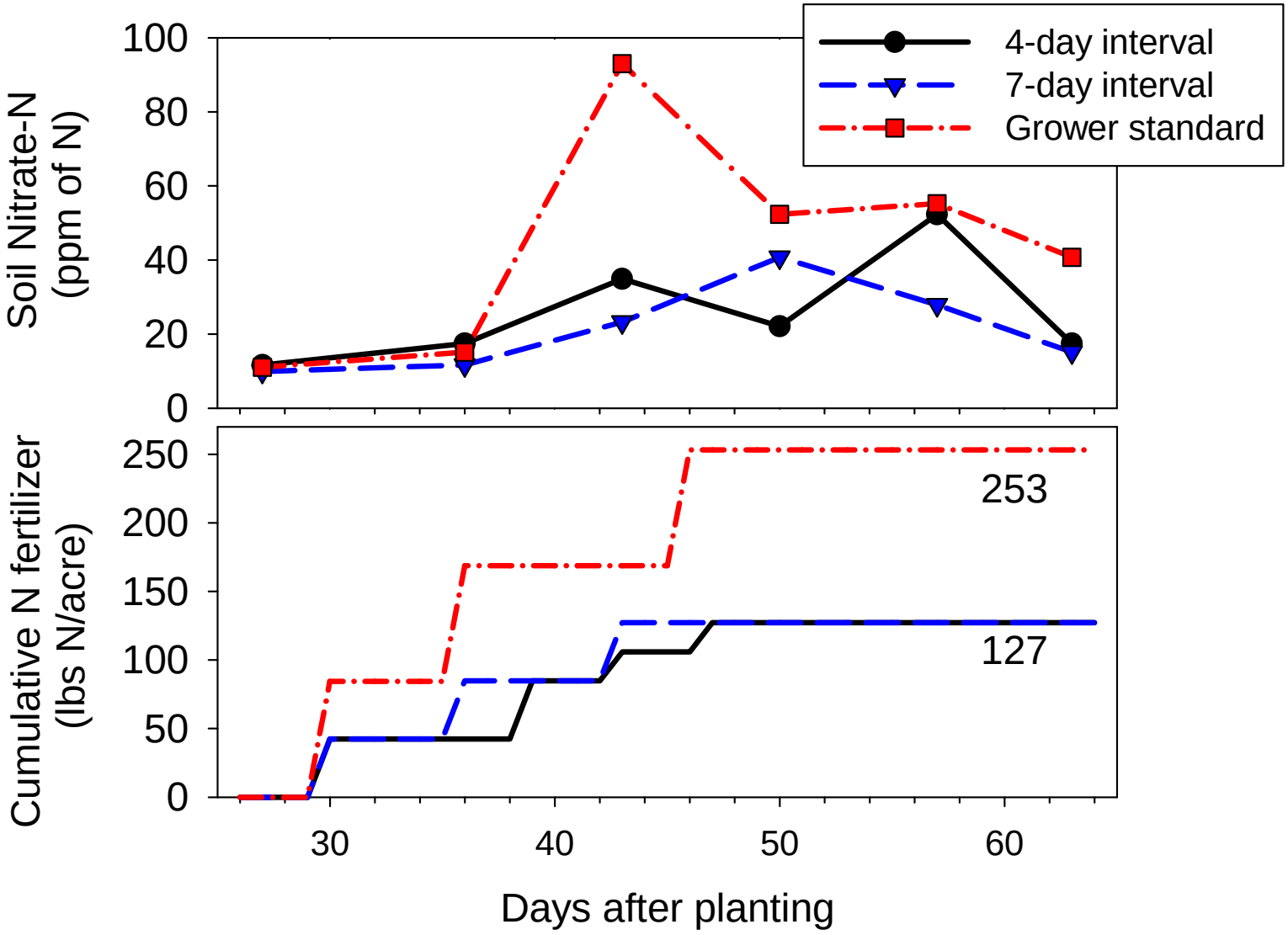
	average irrigation interval		
crop stage	**sprinkler**	**drip**	**furrow**
	------- days -------		
pre-thinning	3.3	2.0	--
post-thinning	8.0	6.0	7.5

Effect of irrigation interval on N management

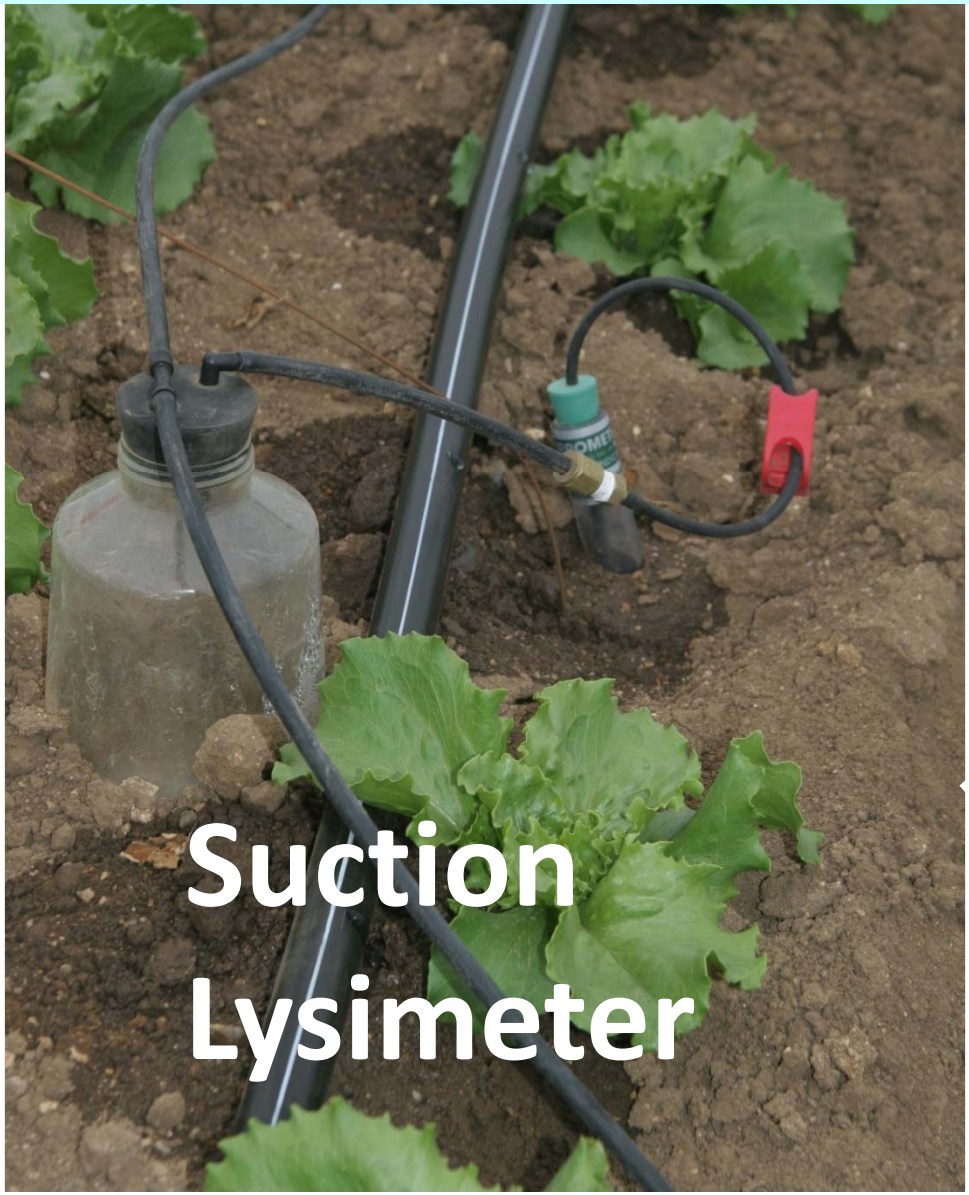
Treatment	Irrigation interval (days)	% Crop ET	N fertilizer management
4 day	4	102%	Quick N test
7 day	7	142%	Quick N test
Grower	Grower decision (7 days)	Grower decision (134%)	Grower decision



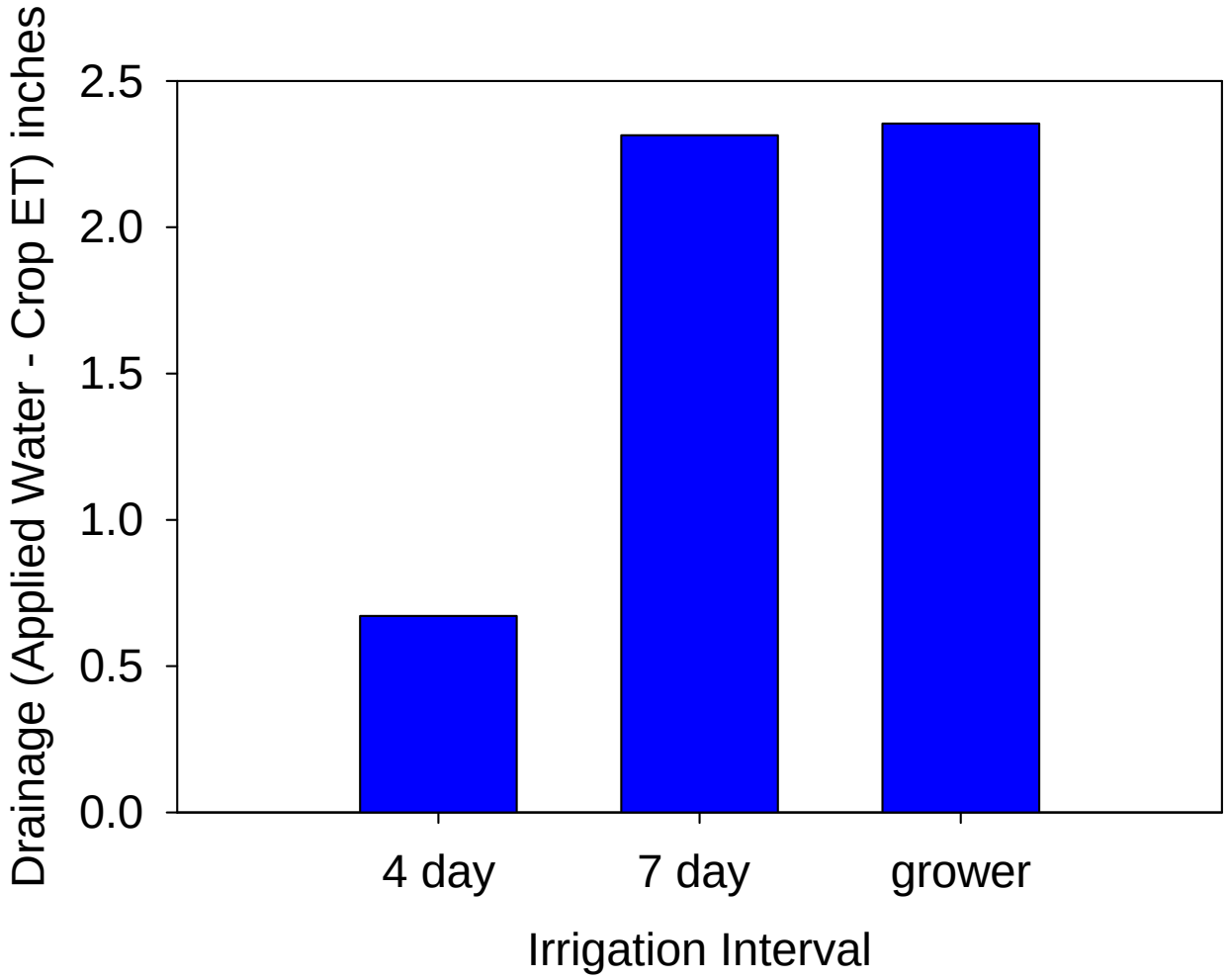
Soil Nitrate and Applied N of Irrigation Treatments



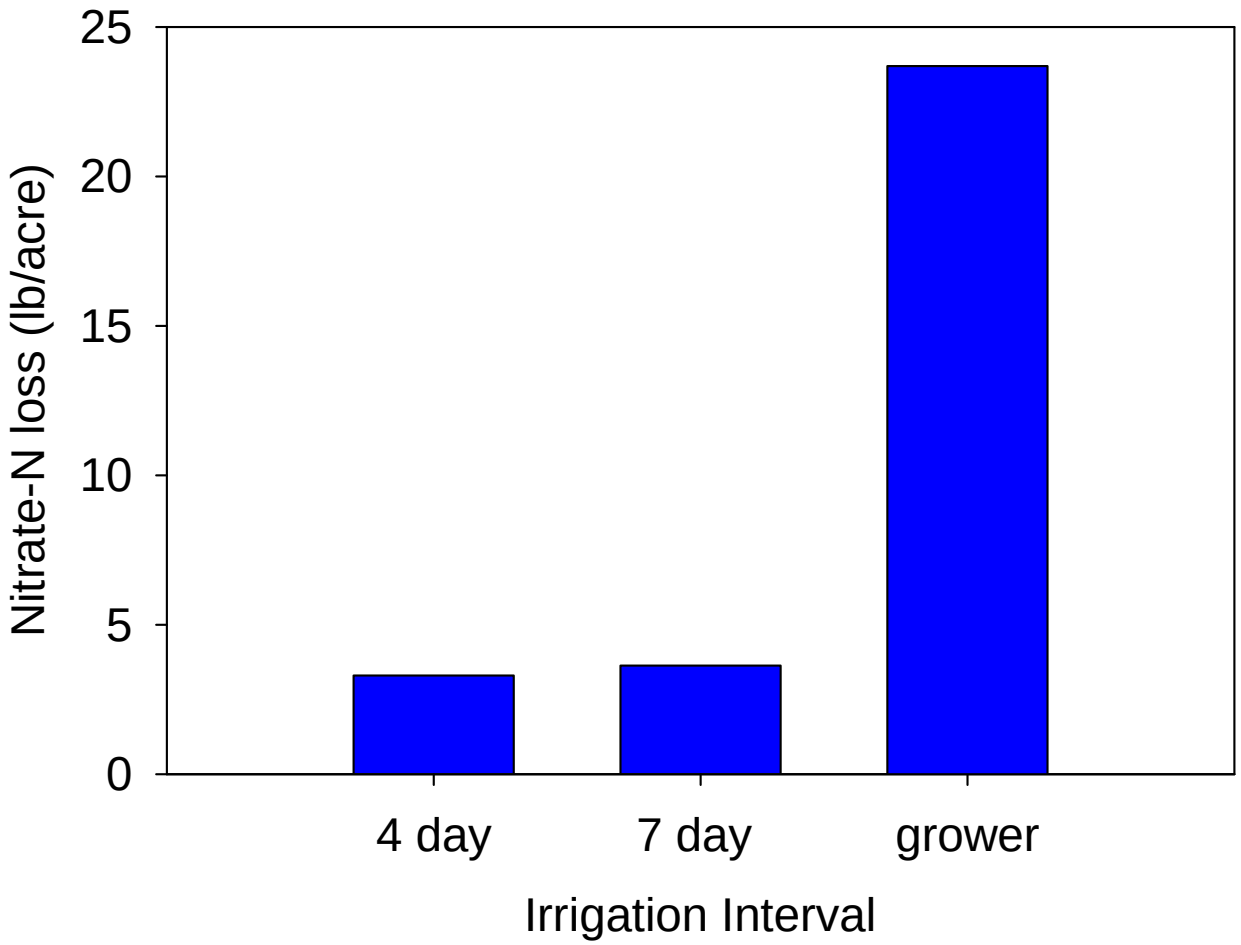
Did the irrigation treatments affect nitrate leaching?



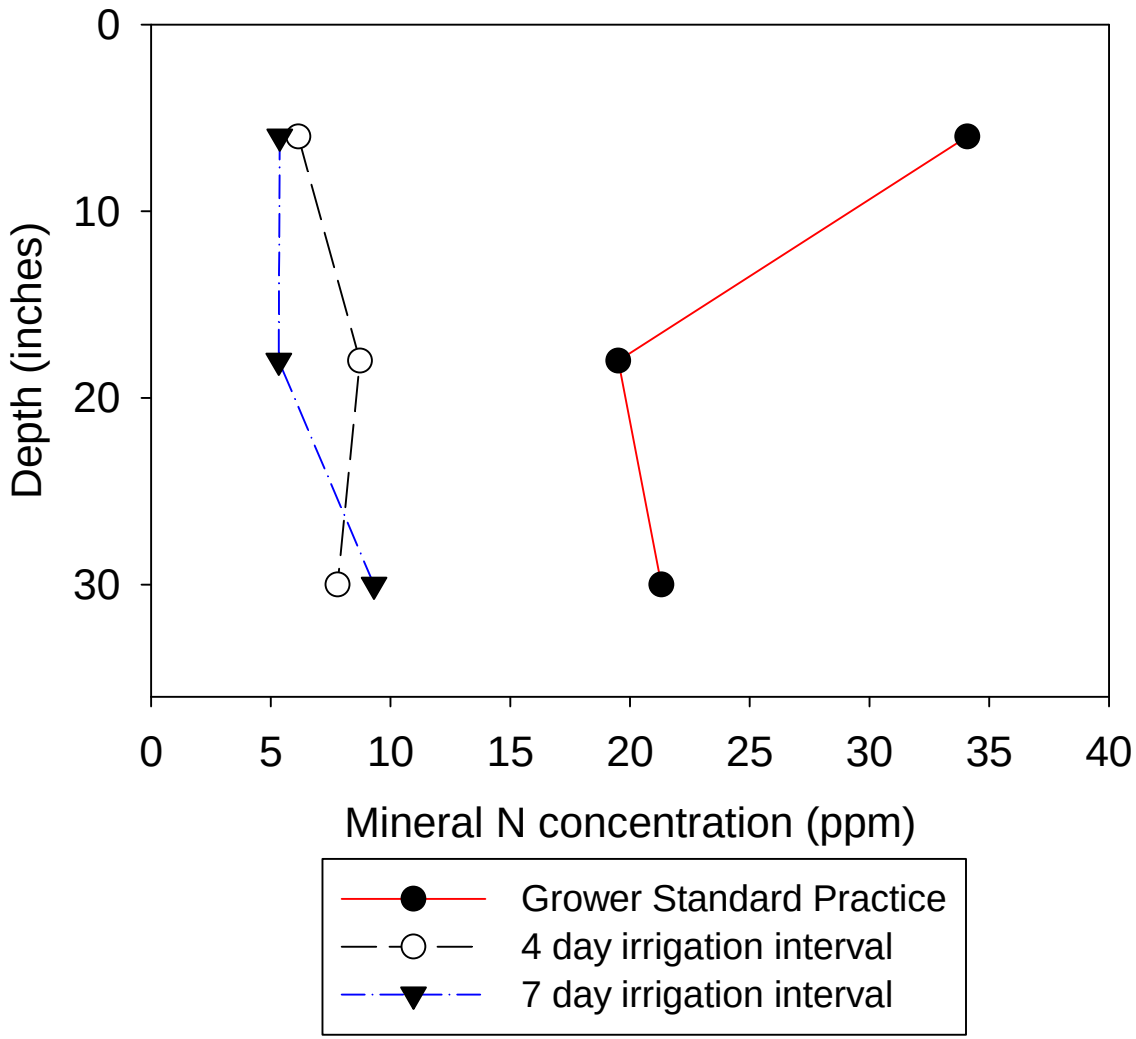
Estimated Drainage of Irrigation Treatments



Estimated Nitrate Leaching Losses



Residual Soil Nitrate



Yield Summary of Irrigation Treatments

	Head Weight		Plant population		Yield	
Treatment	Untrimmed	Trimmed	Marketable	Diseased	Marketable	Biomass
	---- lb/head ----		----- plants/acre ----		----- lbs/acre -----	
4-day	2.493	1.72	39685	883	68350	98909
7-day	2.483	1.68	41156	441	69363	102243
grower	2.546	1.72	40241	343	69023	102357
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns

Salinity Effects on Cool Season Vegetables

	Yield Potential [1]					
	100%		90%		75%	
Crop	EC_e	EC_w	EC_e	EC_w	EC_e	EC_w
	dS/m					
Broccoli	2.8	1.9	3.9	2.7	5.5	3.7
Cabbage	1.8	1.2	2.8	1.9	4.4	2.9
Celery	1.8	1.2	3.4	2.3	5.8	3.9
Lettuce	1.3	0.9	2.1	1.4	3.2	2.1
Spinach	2.0	1.3	3.3	2.2	5.3	3.5

EC_e = EC of saturated soil extract

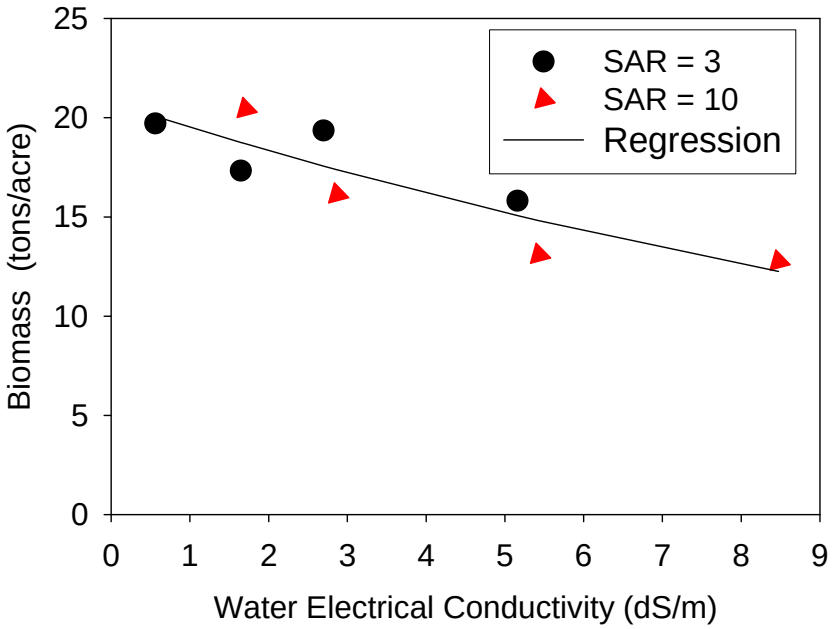
EC_w = EC of irrigation water

1. Adapted from FAO irrigation and drainage paper 29, 1985

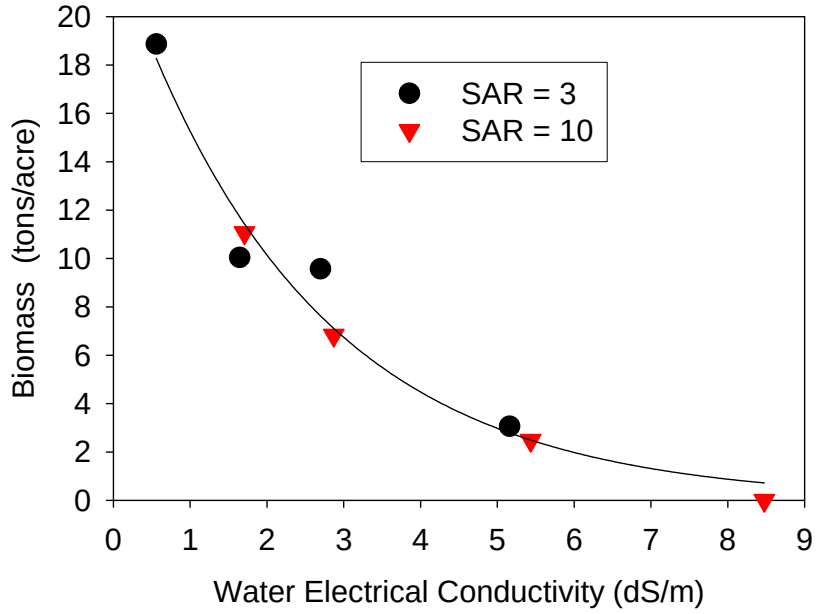
EC of sea water = 50- 60 dS/m

EC and SAR effects on Biomass Yield of 2 Head Lettuce Varieties

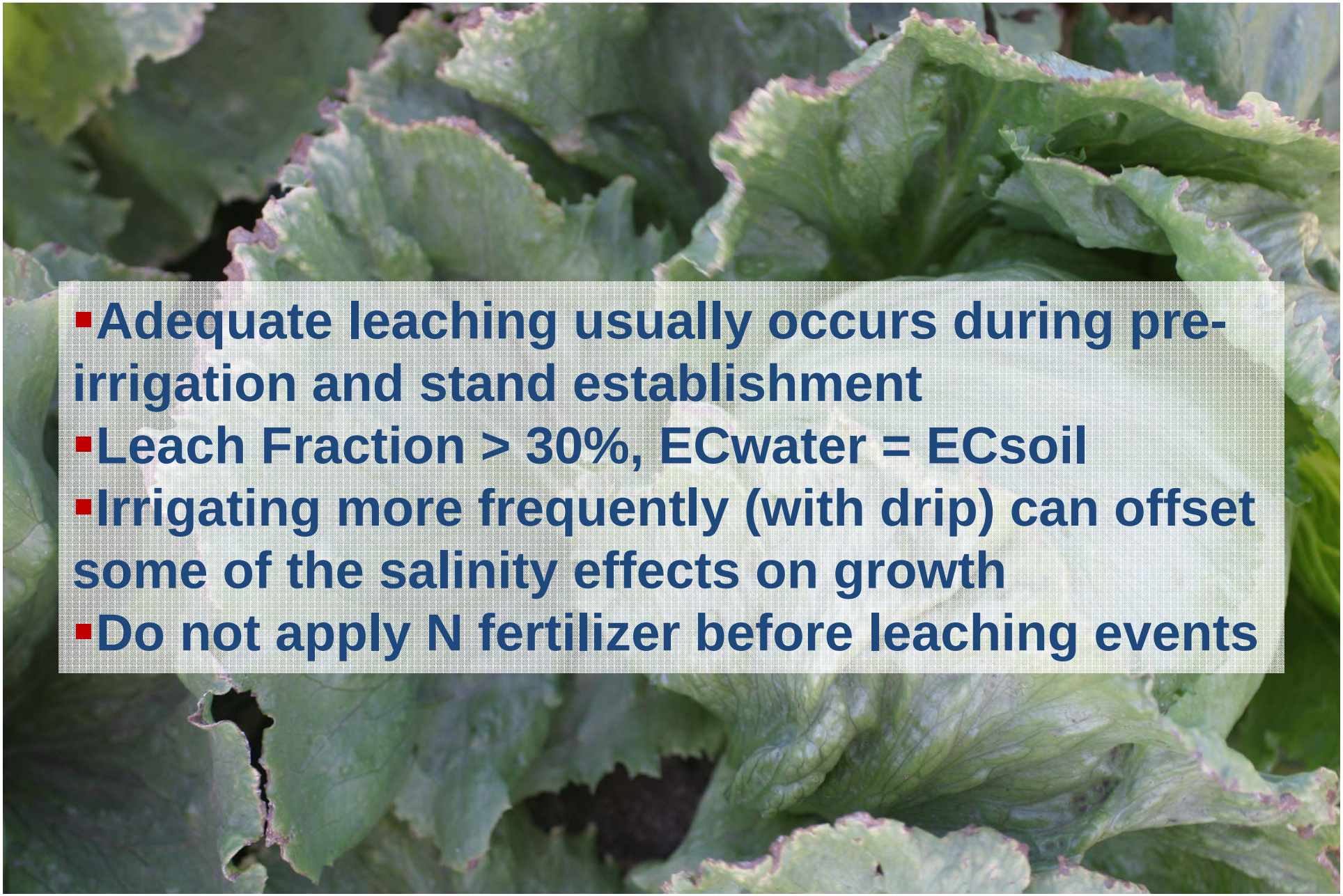
var. Sniper



var. Salinas

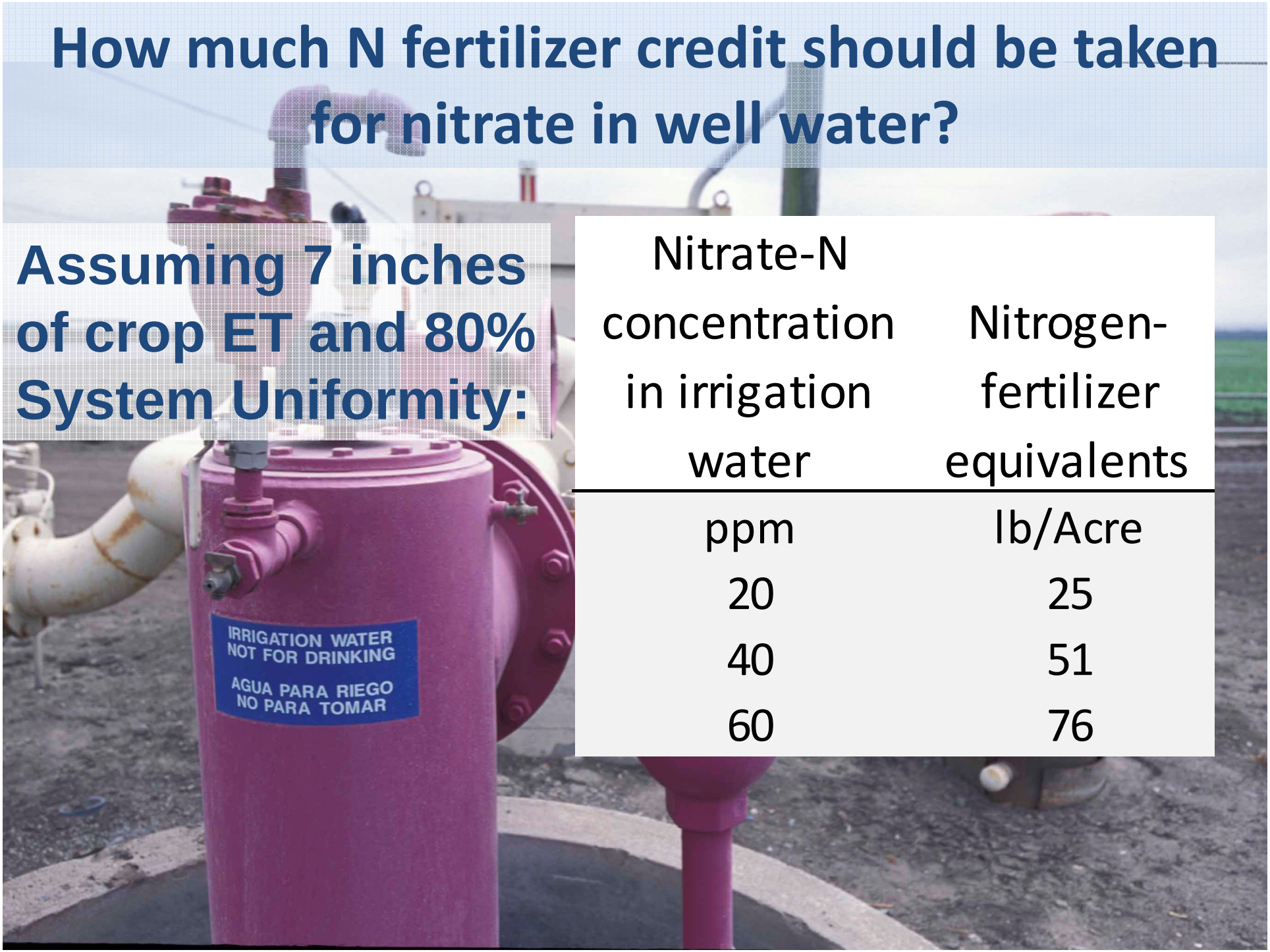


How much leaching for salinity management?



- Adequate leaching usually occurs during pre-irrigation and stand establishment
- Leach Fraction > 30%, ECwater = ECsoil
- Irrigating more frequently (with drip) can offset some of the salinity effects on growth
- Do not apply N fertilizer before leaching events

How much N fertilizer credit should be taken for nitrate in well water?



Assuming 7 inches of crop ET and 80% System Uniformity:

Nitrate-N concentration in irrigation water	Nitrogen-fertilizer equivalents
ppm	lb/Acre
20	25
40	51
60	76

Irrigation strategies for using nitrogen fertilizer efficently in lettuce

- Match irrigation schedule with crop ET to minimize nitrate leaching
- Assure that irrigation system has a high DU
- Minimize irrigation water for germination (< 3 inches)
- Avoid applying high amounts of water during a single irrigation (> 0.5 inch during prethinning, > 1 inch during post thinning)
- Avoid heavy irrigations after fertilizing