



Irrigation effects on Nitrogen Management of Lettuce



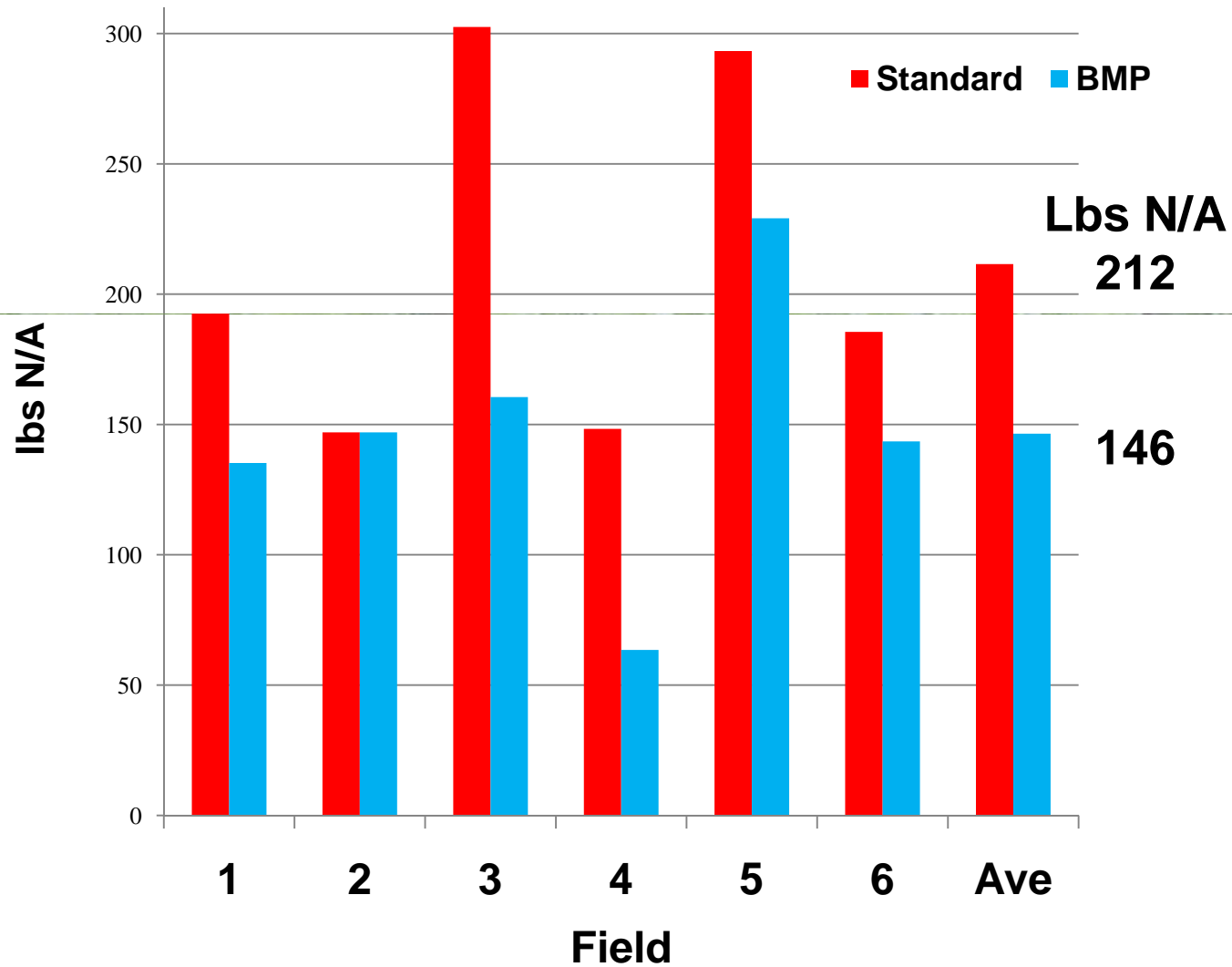
**Michael Cahn, Richard Smith, Barry Farrara, Aaron Heinrich
UCCE, Monterey County
Tim Hartz and Tom Bottoms, Plant Sciences, UC Davis**

Quick Nitrate Test: Soil nitrate status

(20 ppm $\text{NO}_3\text{-N}$ = 70 to 80 lbs of N/acre)



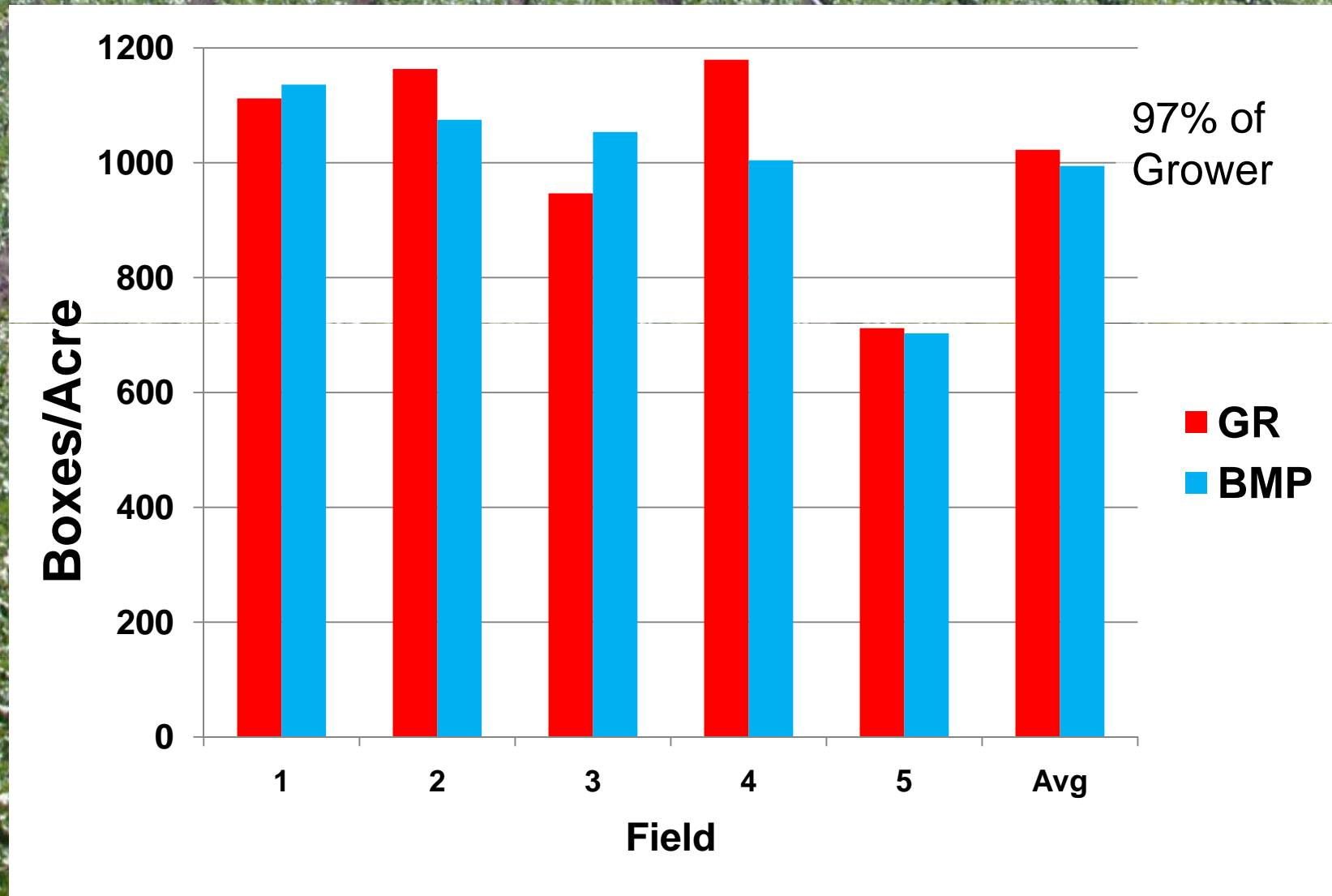
2010 Nitrogen Fertilizer Trials



Difference
66 lbs/A

@ 0.60/lb N
=\$40/A

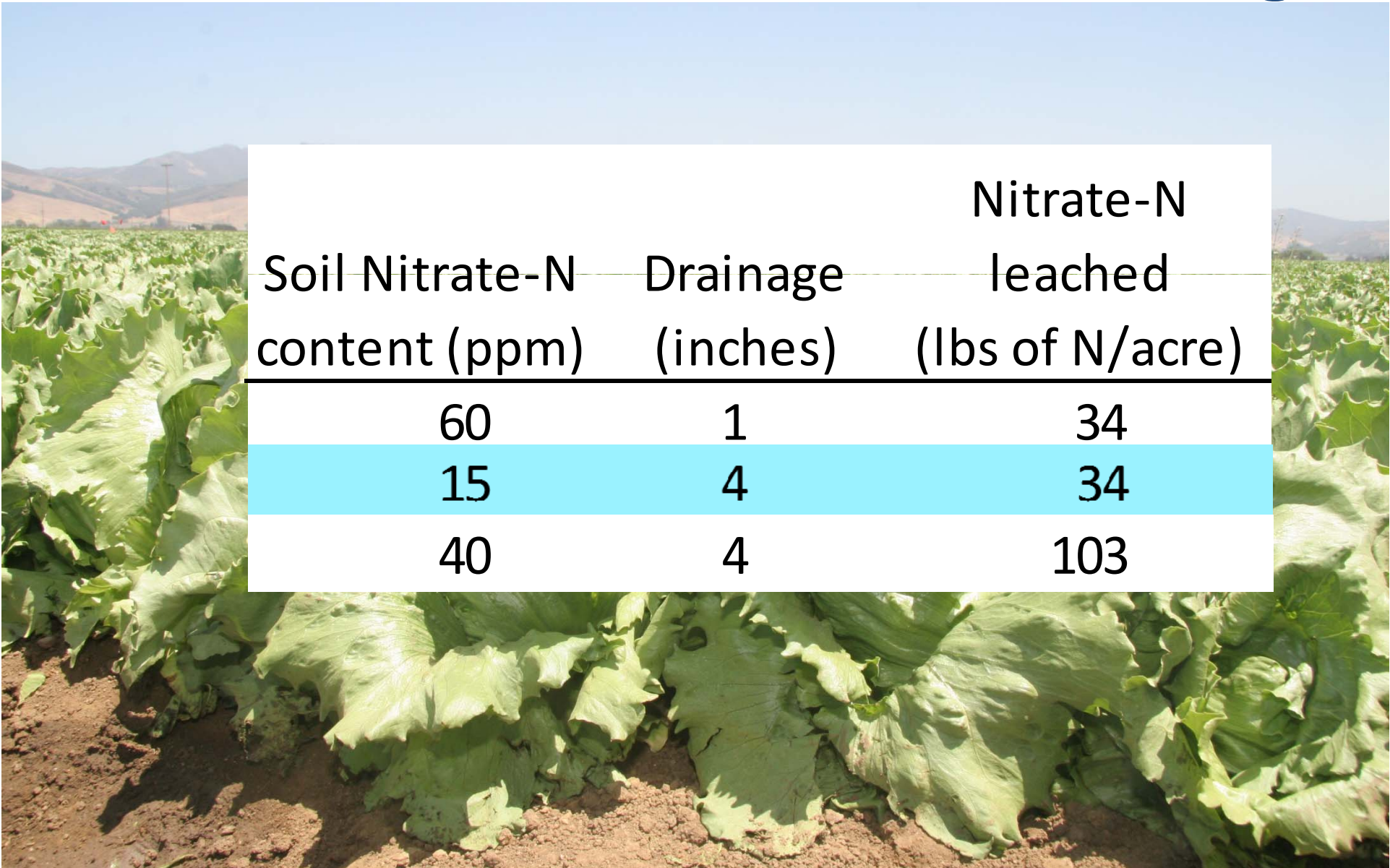
Commercial Yield



**How much does irrigation management matter
for optimizing nitrogen fertilizer?**

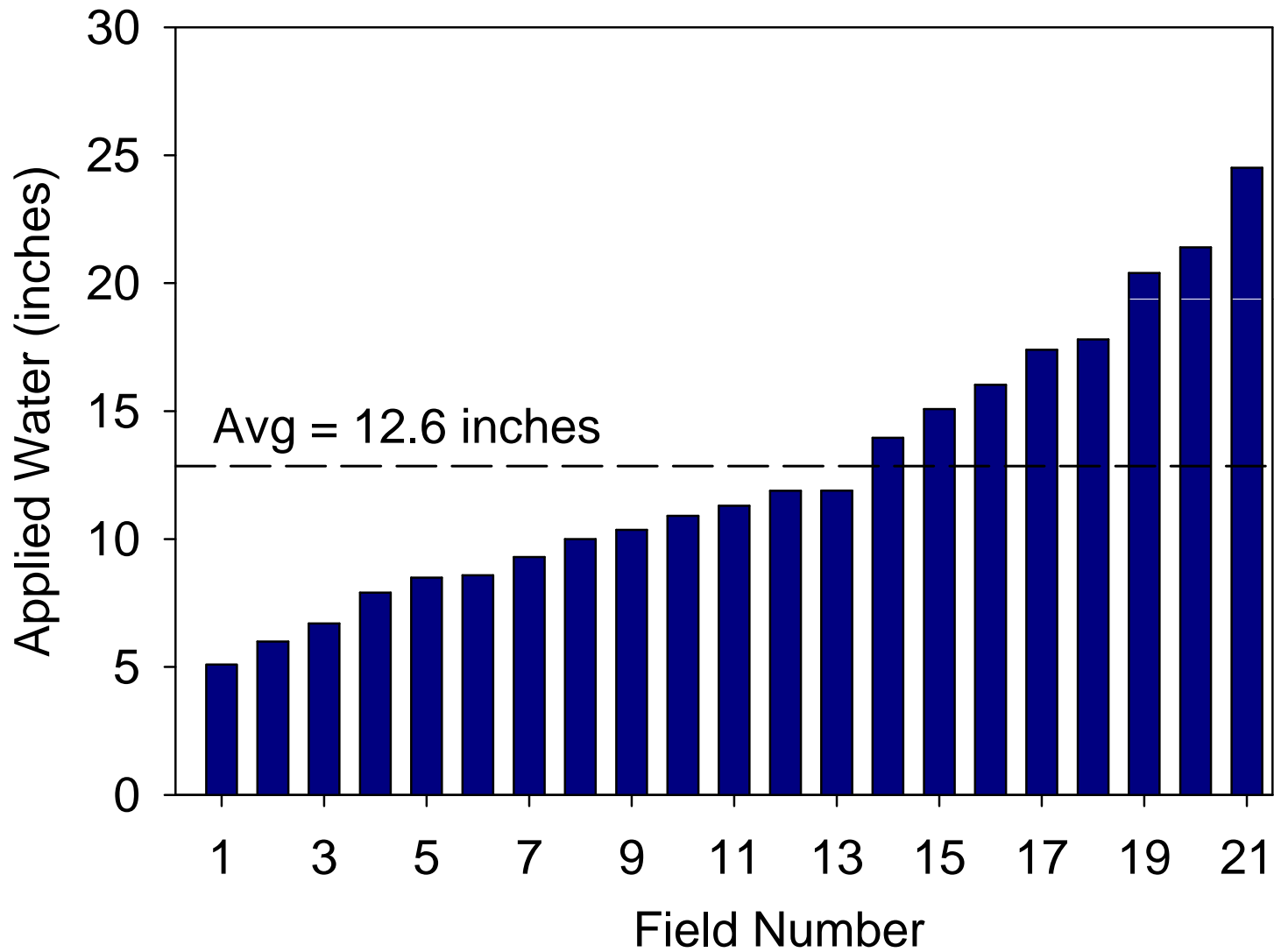


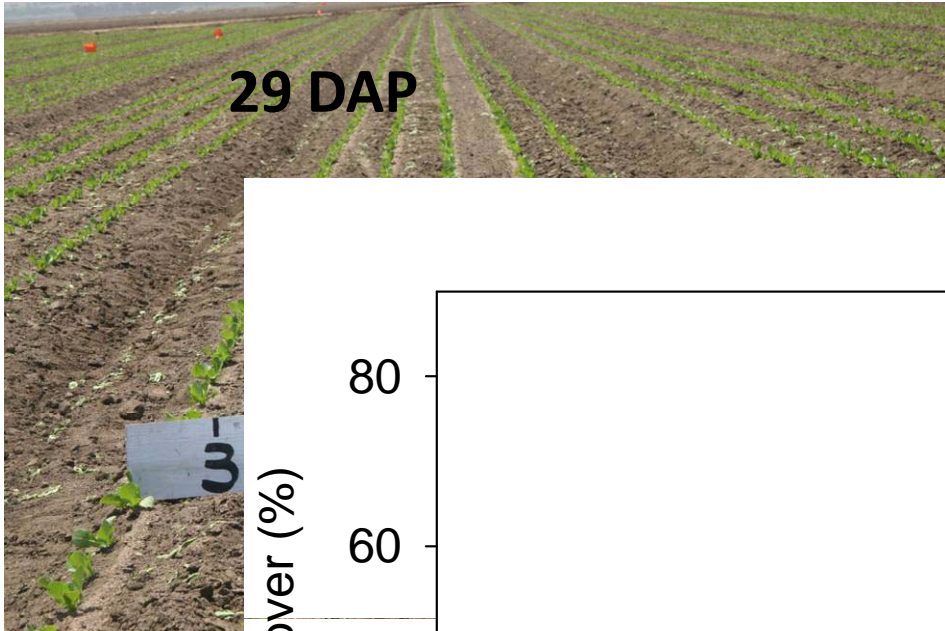
Lbs of N lost by leaching depends on soil nitrate concentration and drainage



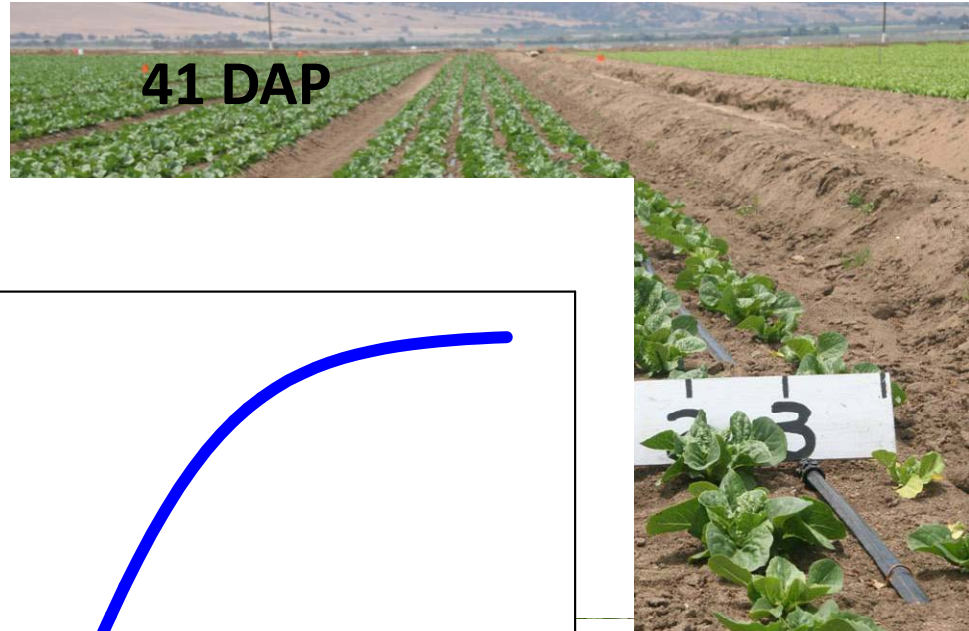
Soil Nitrate-N content (ppm)	Drainage (inches)	Nitrate-N leached (lbs of N/acre)
60	1	34
15	4	34
40	4	103

Total Water Applied to Lettuce





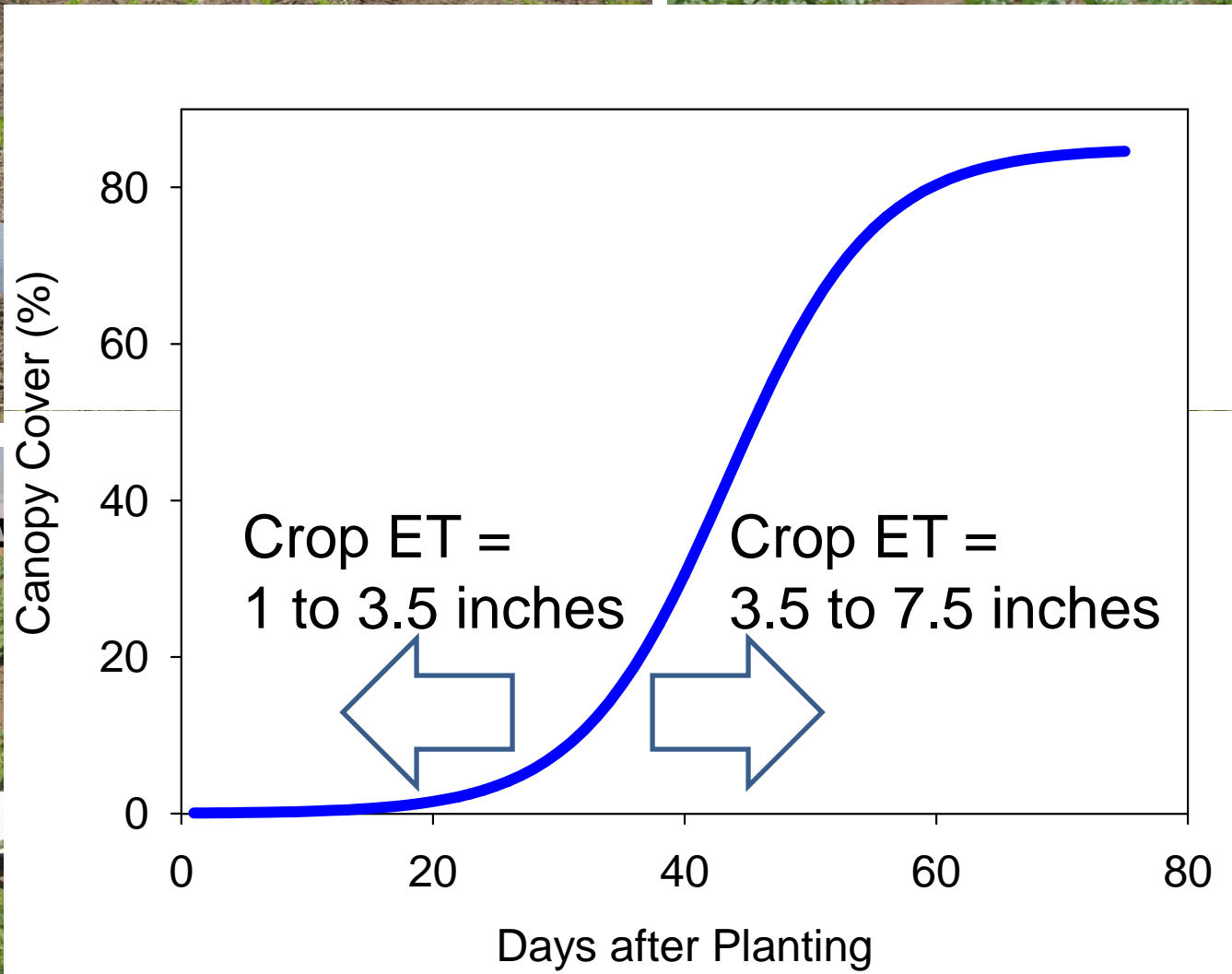
29 DAP



41 DAP



47 DAP

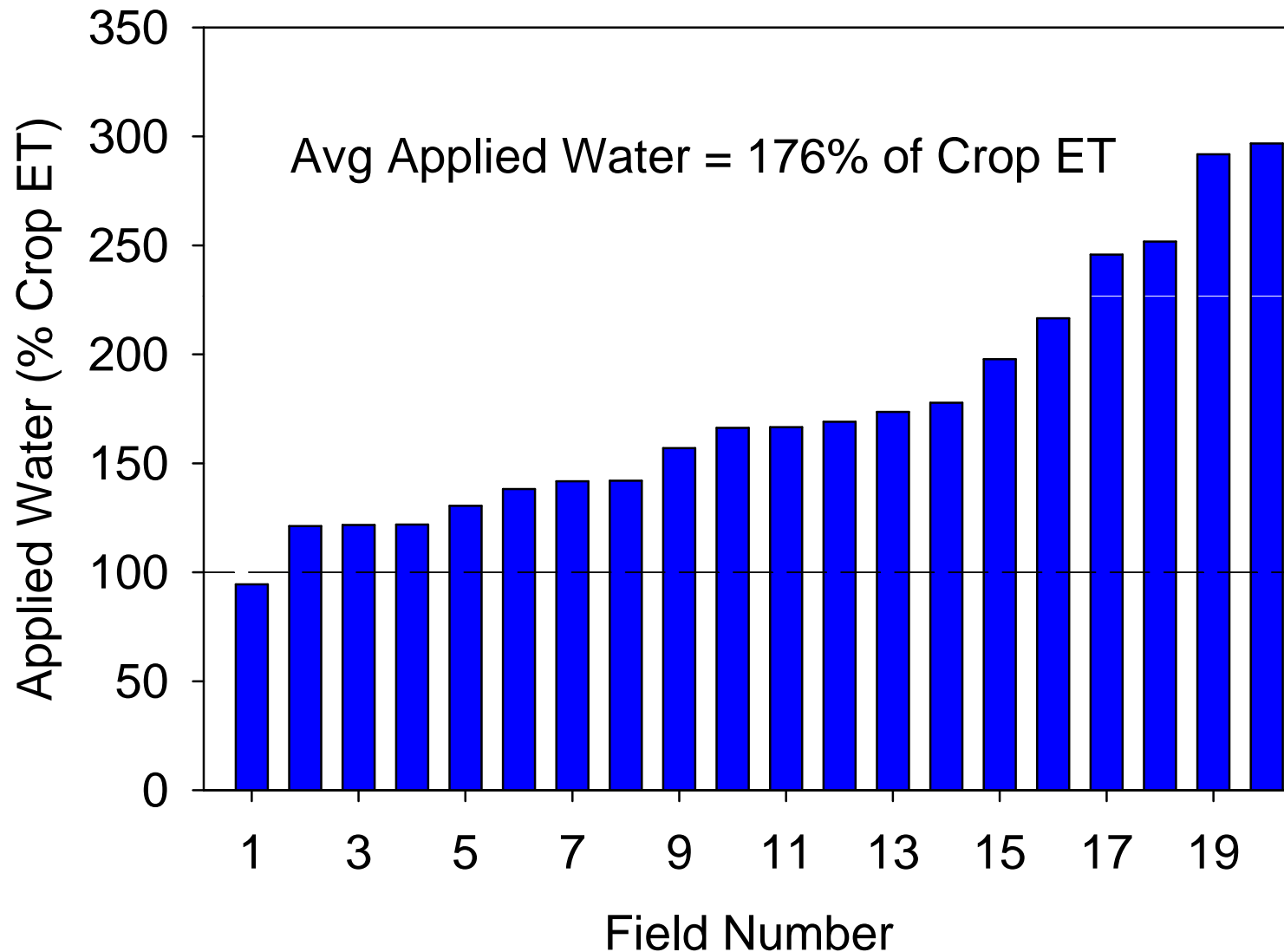


Crop ET =
1 to 3.5 inches

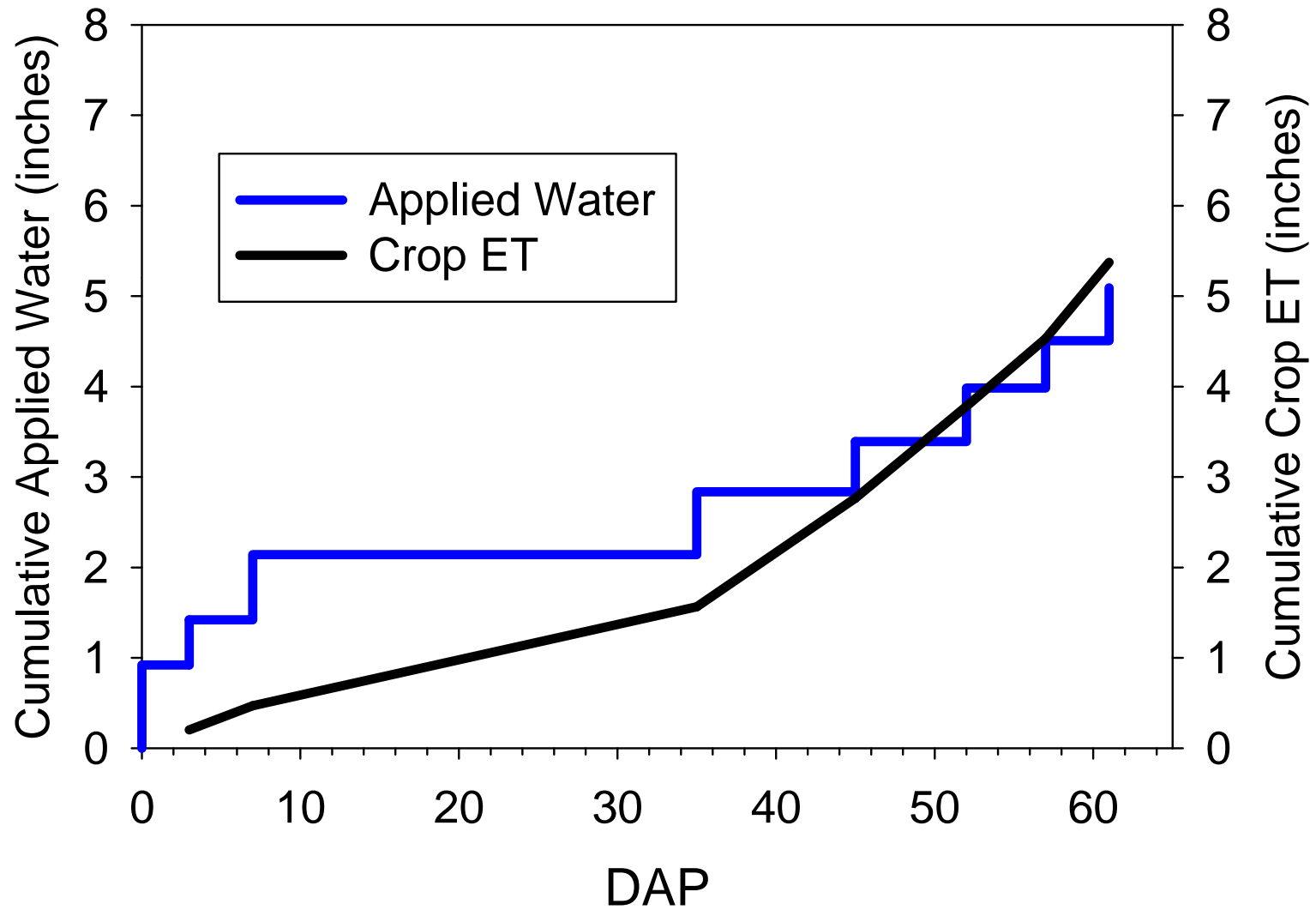
Crop ET =
3.5 to 7.5 inches

Days after Planting

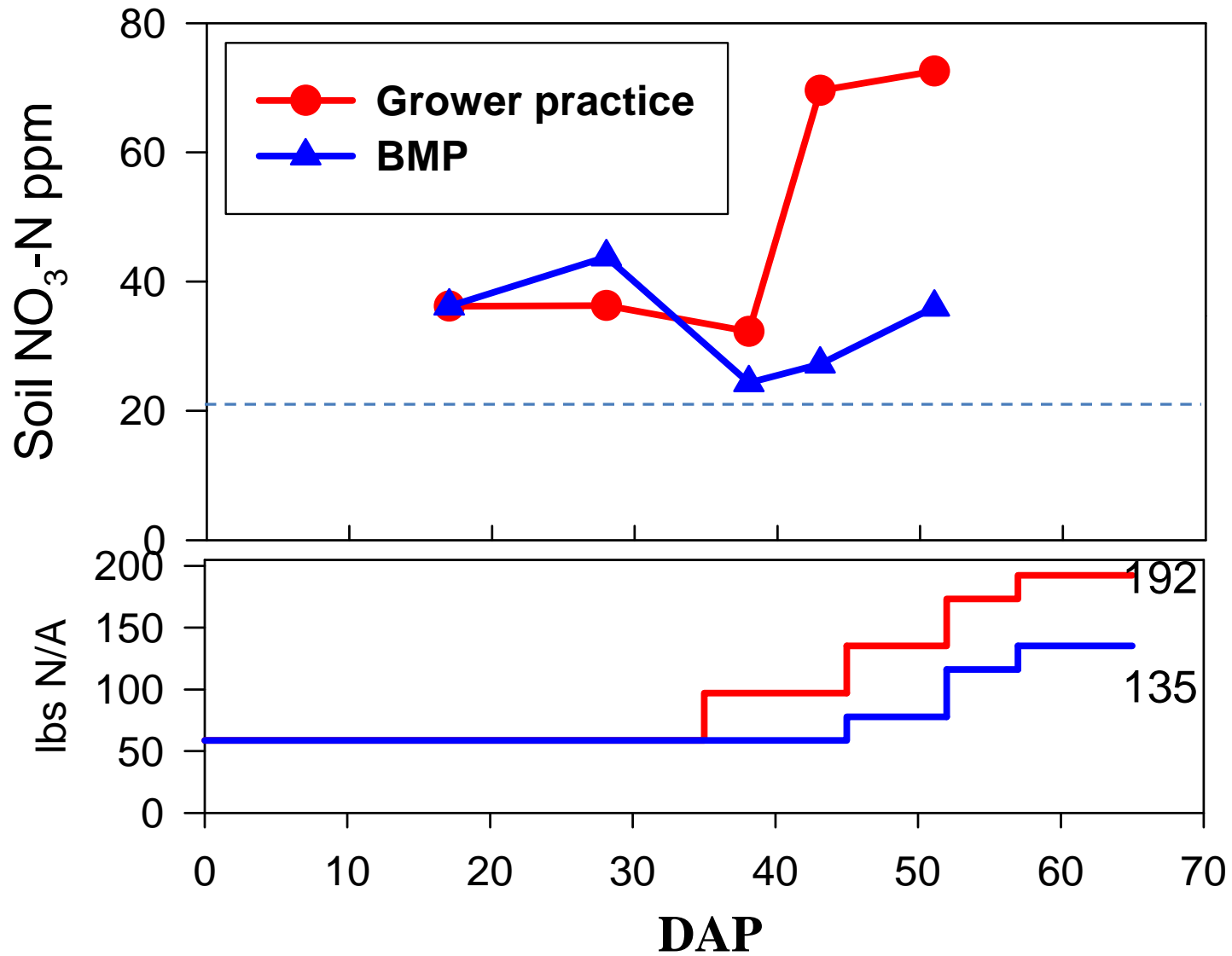
Applied Water as Percentage of Crop ET



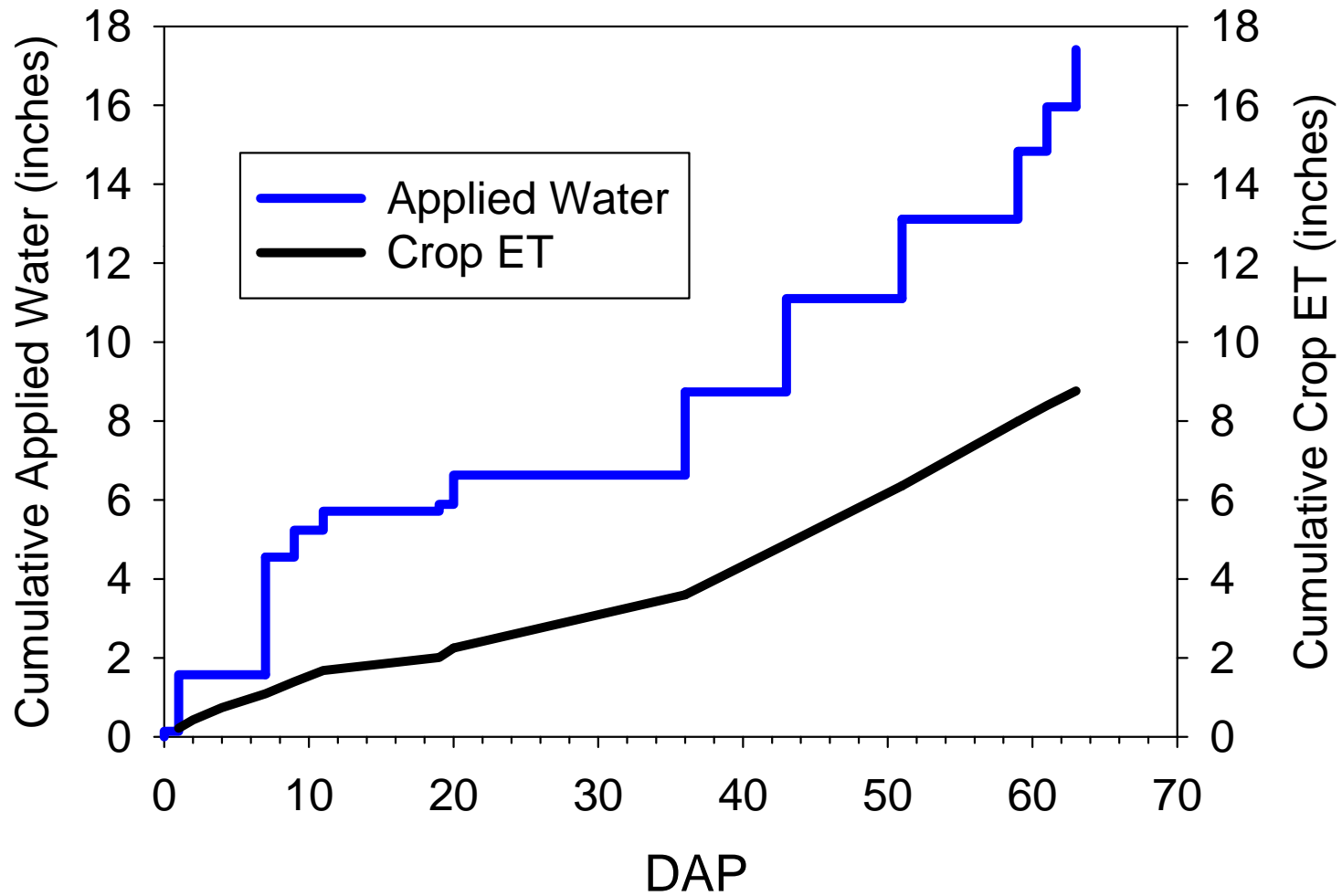
Applied Water and Crop ET (site 1)



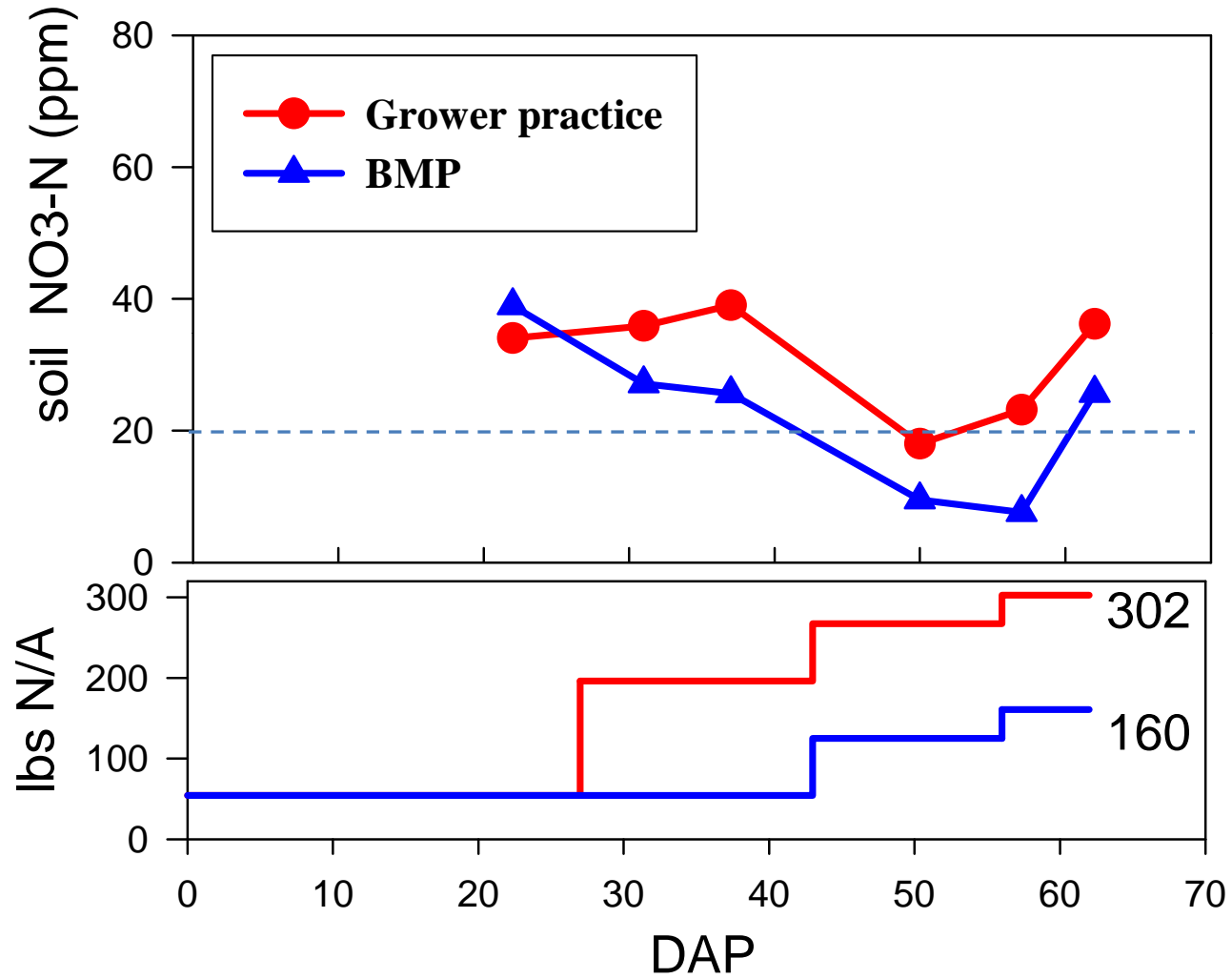
Applied N and soil nitrate (site 1)



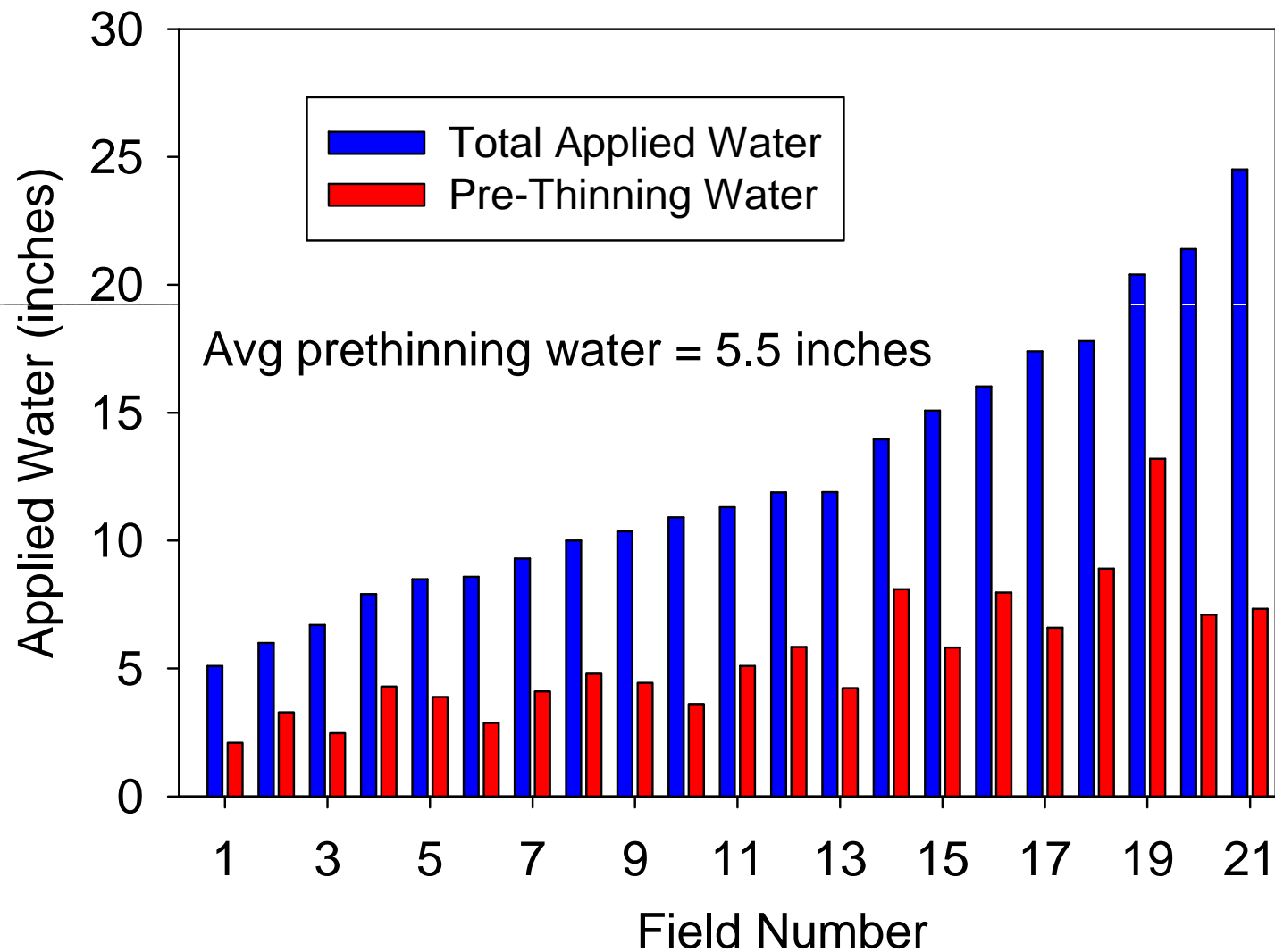
Applied Water and Crop ET (site 3)



Applied N and soil nitrate (site 3)



Pre-thinning Water Applied to Lettuce



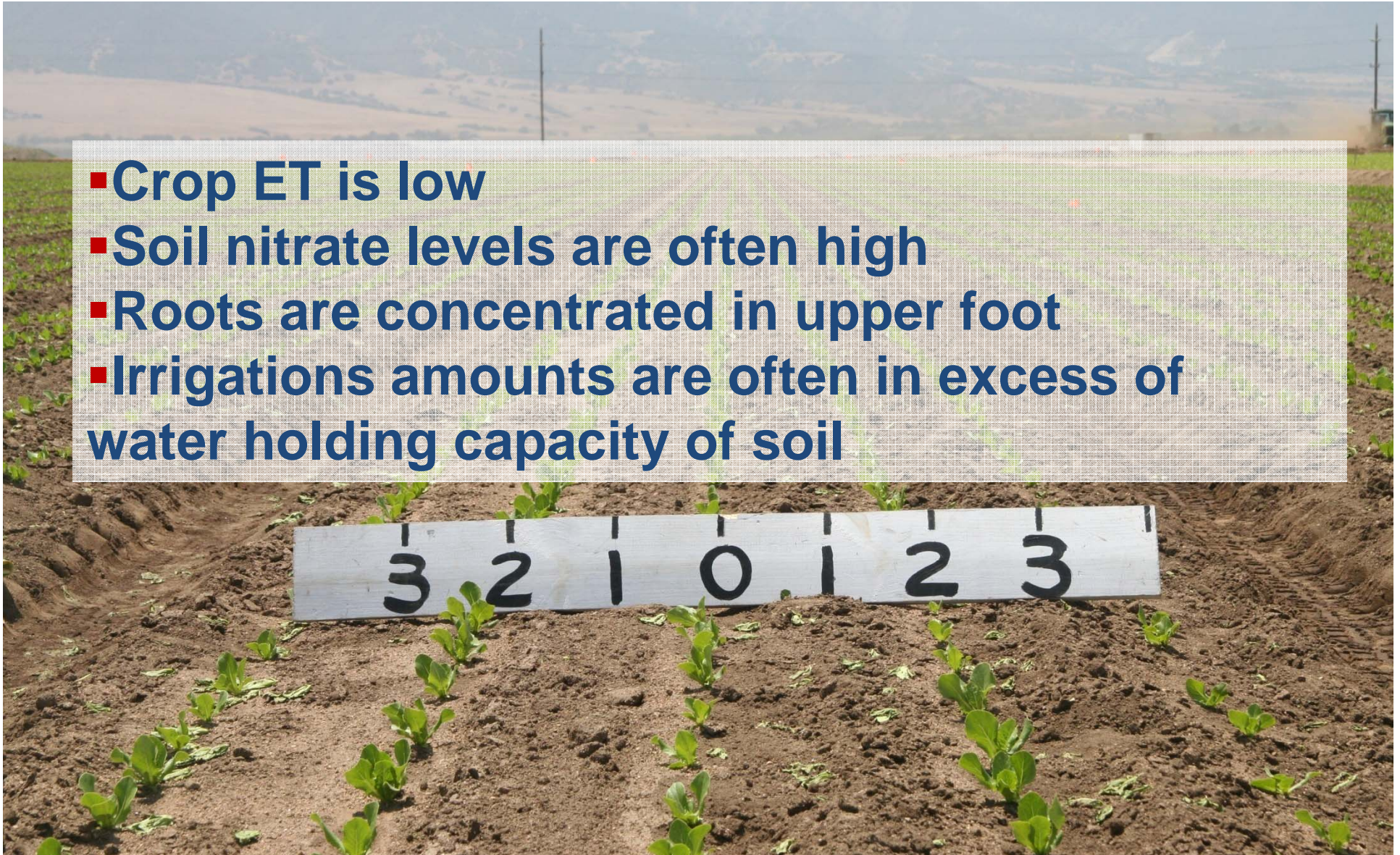
Potential N losses during crop establishment:

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

Management	Crop and Evaporation losses ----- inches	Germination water amount -----	N loss 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



Irrigation method	establishment		post-thinning	
	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



Factoring in Soil Water Holding Capacity in Irrigation Scheduling

Available Water Holding Capacity for Various Soil Textures

Soil Texture	Field Capacity (30 cbar)	Wilting Point (1500 cbar)	Available Moisture
	----- inches of water per foot of soil -----		
Sand	1.2	0.5	0.7
Loamy Sand	1.9	0.8	1.1
Sandy Loam	2.5	1.1	1.4
Loamy Sand	3.2	1.4	1.8
Silt Loam	3.6	1.8	1.8
Sandy Clay Loam	3.5	2.2	1.3
Sandy Clay Loam	3.4	1.8	1.6
Clay Loam	3.8	2.2	1.6
Silty Clay Loam	4.3	2.4	1.9
Silty Clay	4.8	2.4	2.4
Clay	4.8	2.6	2.2

Problematic for irrigation scheduling of cool season vegetables

Soil Moisture Tensions > 30 cbars
slows lettuce growth



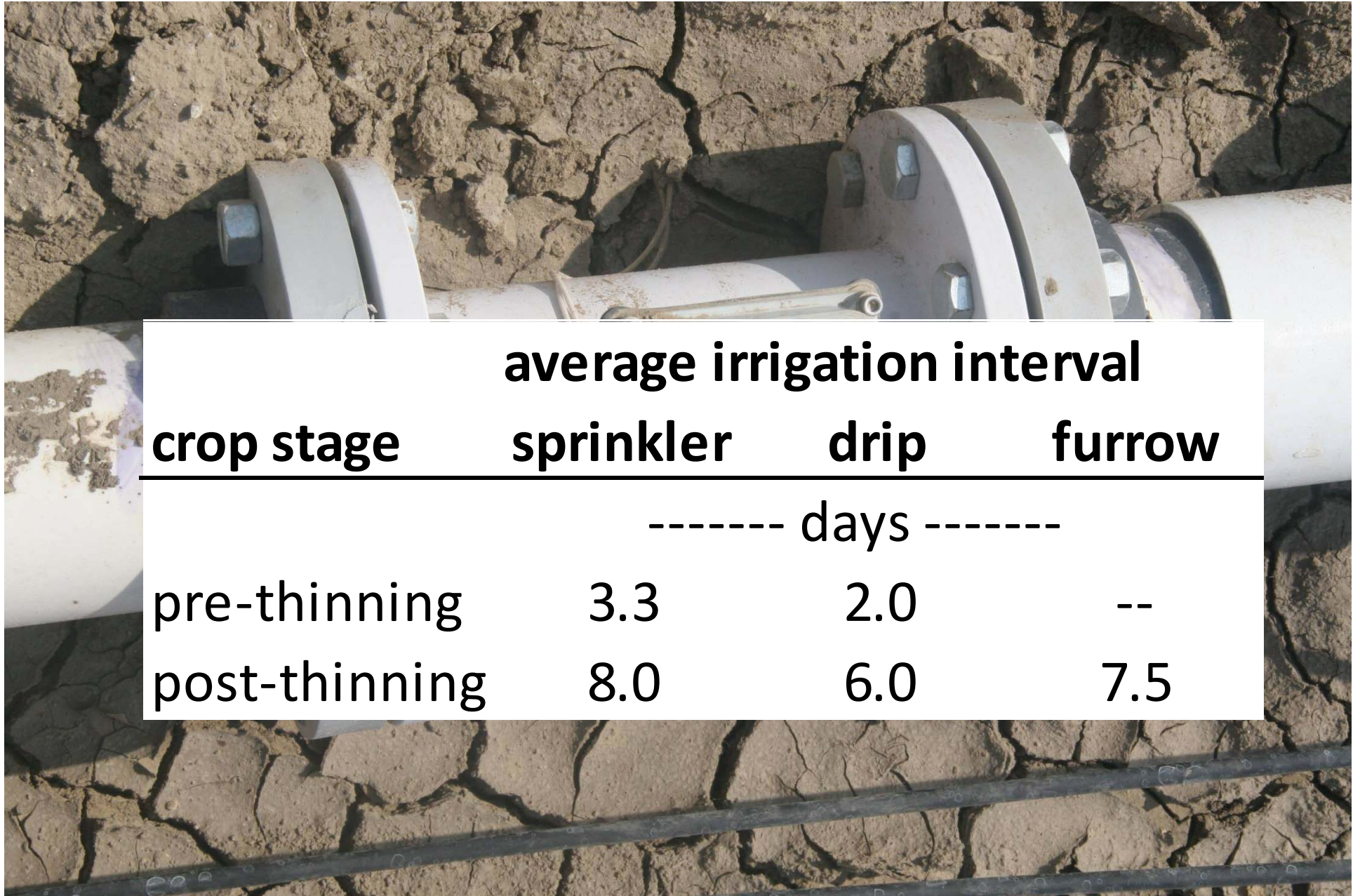
Soil Texture, Water Holding Capacity, and Available Moisture

Soil	Soil Texture	Saturated tension kPa	Saturated Volumetric Moisture %	Tension 30 kPa		Tension 80 kPa	
				Available Moisture %	Available Moisture inches/foot	Available Moisture %	Available Moisture inches/foot
1	Silty clay	5	45.7	3.1	0.37	4.8	0.58
2	Silty clay loam	5	38.6	3.1	0.38	4.9	0.58
3	Loam	5	31.1	3.9	0.47	6.1	0.73

Low Distribution Uniformity increases Irrigation Requirement and Drainage



Average irrigation intervals in Lettuce

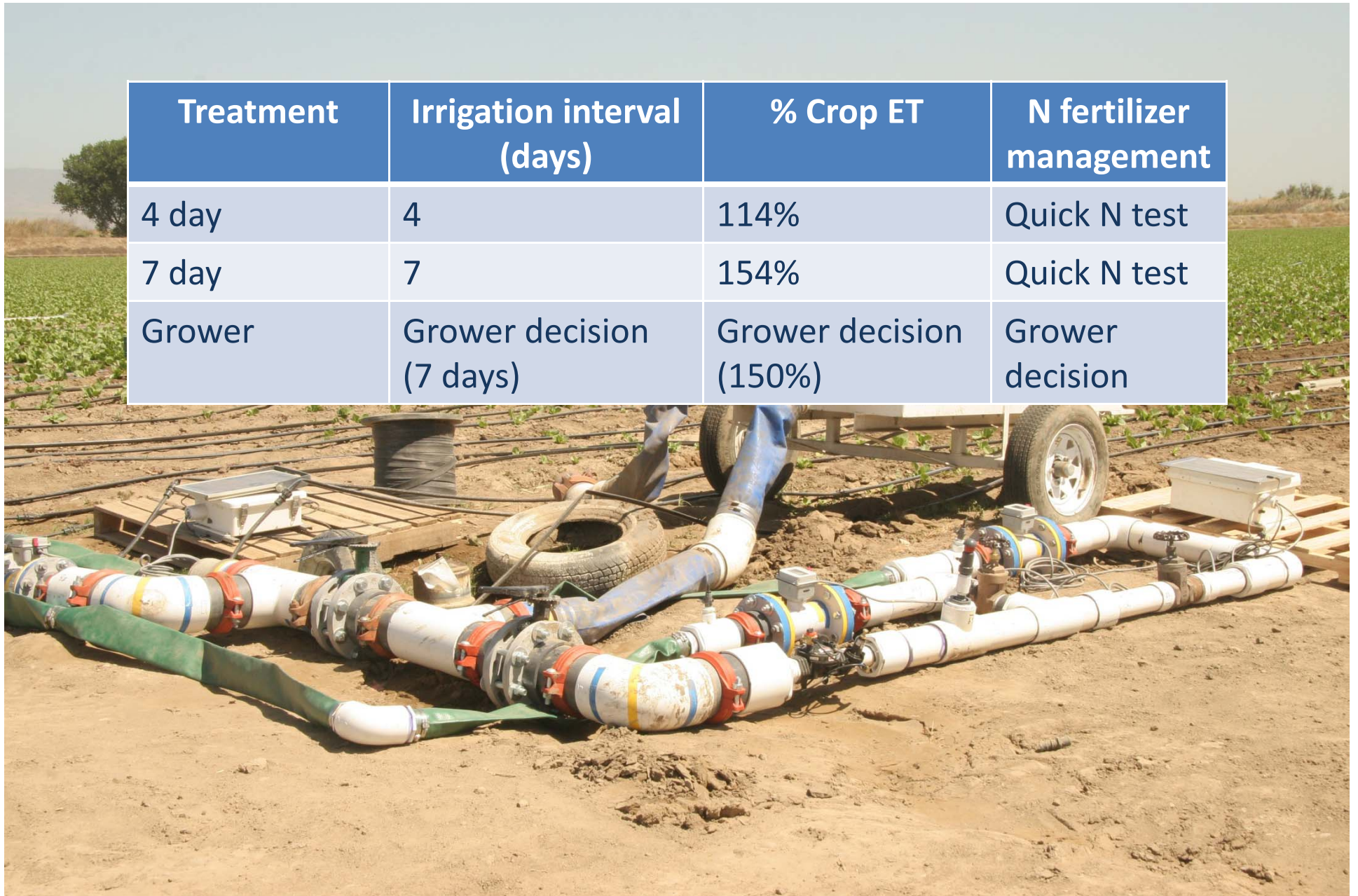


crop stage	average irrigation interval		
	sprinkler	drip	furrow
pre-thinning	3.3	2.0	--
post-thinning	8.0	6.0	7.5

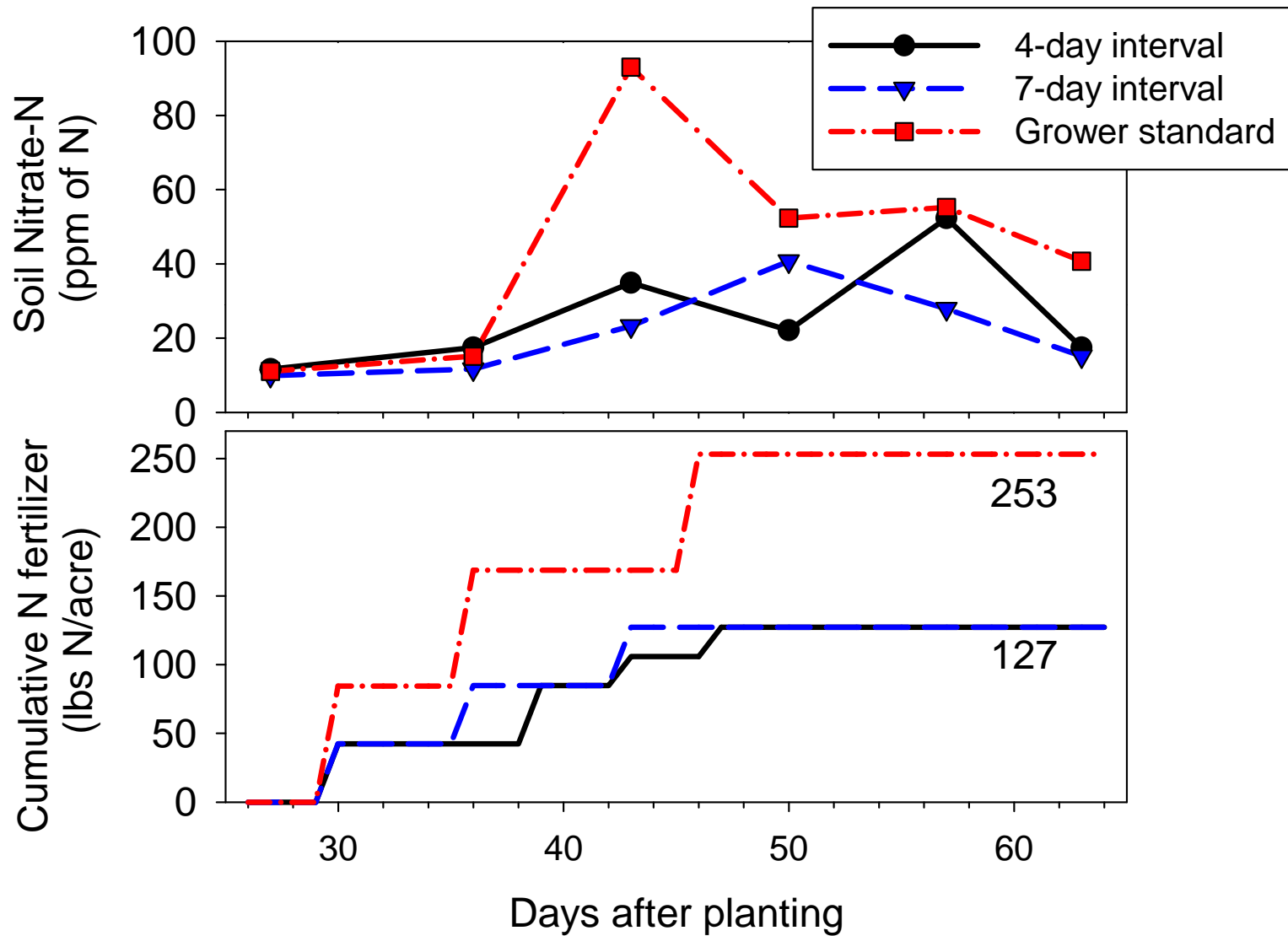
----- days -----

Effect of irrigation interval on N management

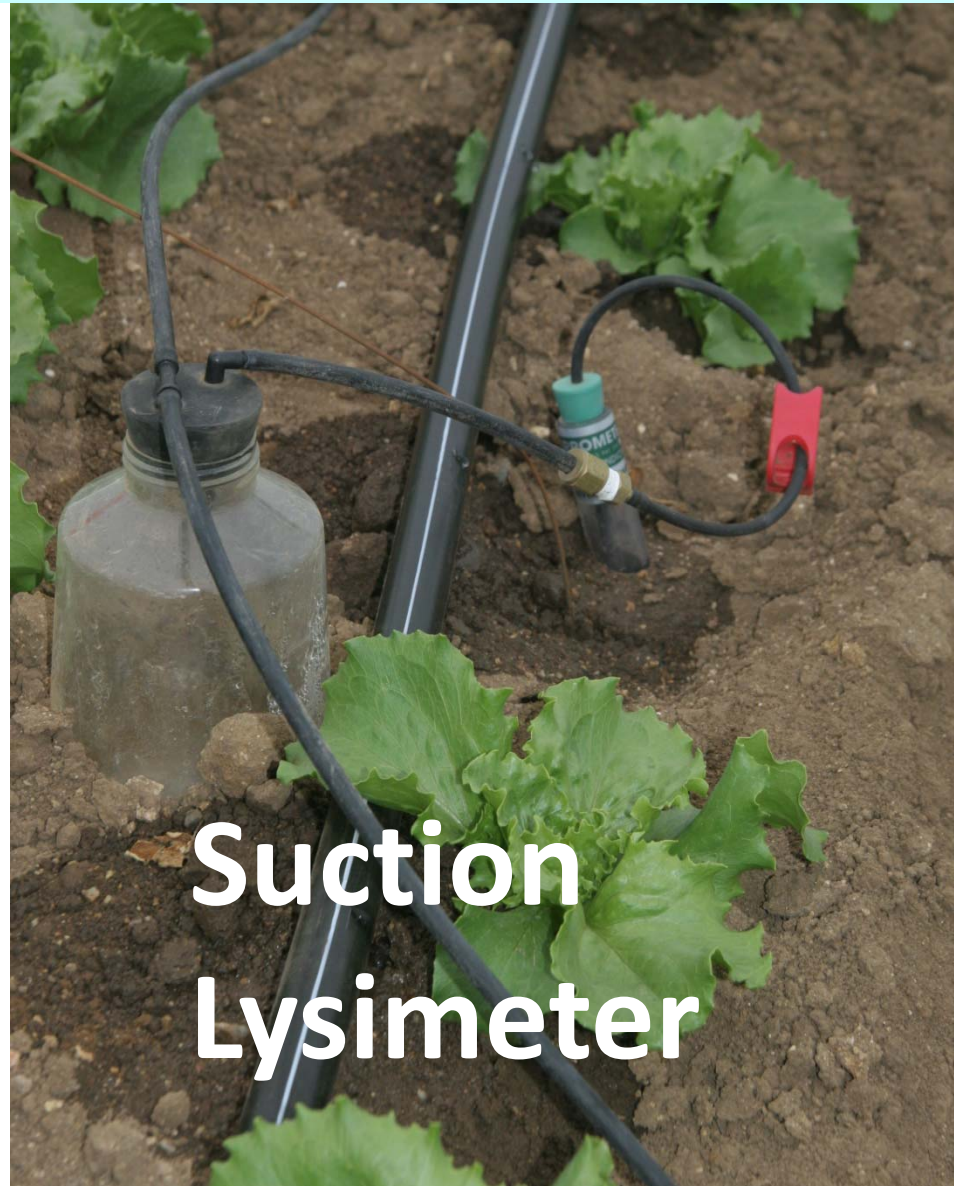
Treatment	Irrigation interval (days)	% Crop ET	N fertilizer management
4 day	4	114%	Quick N test
7 day	7	154%	Quick N test
Grower	Grower decision (7 days)	Grower decision (150%)	Grower decision



Soil Nitrate and Applied N of Irrigation Treatments

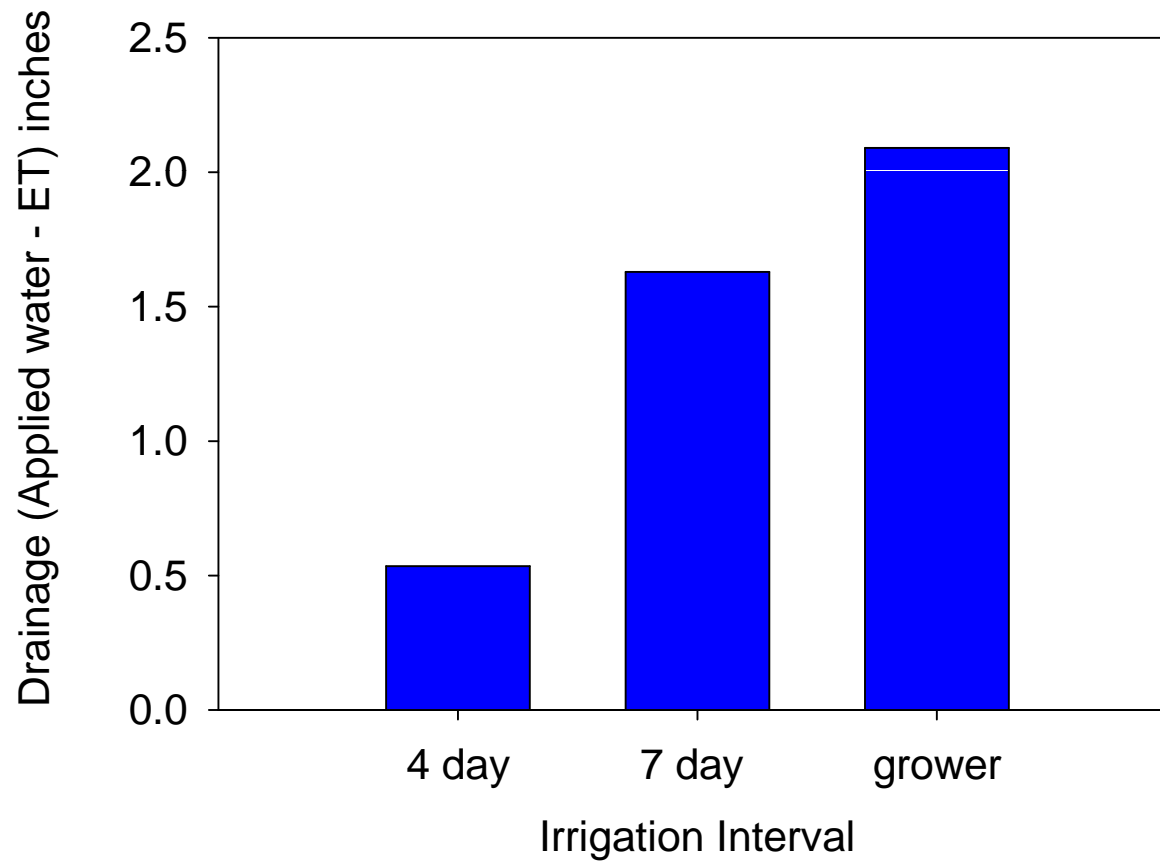


Did the irrigation treatments affect nitrate leaching?

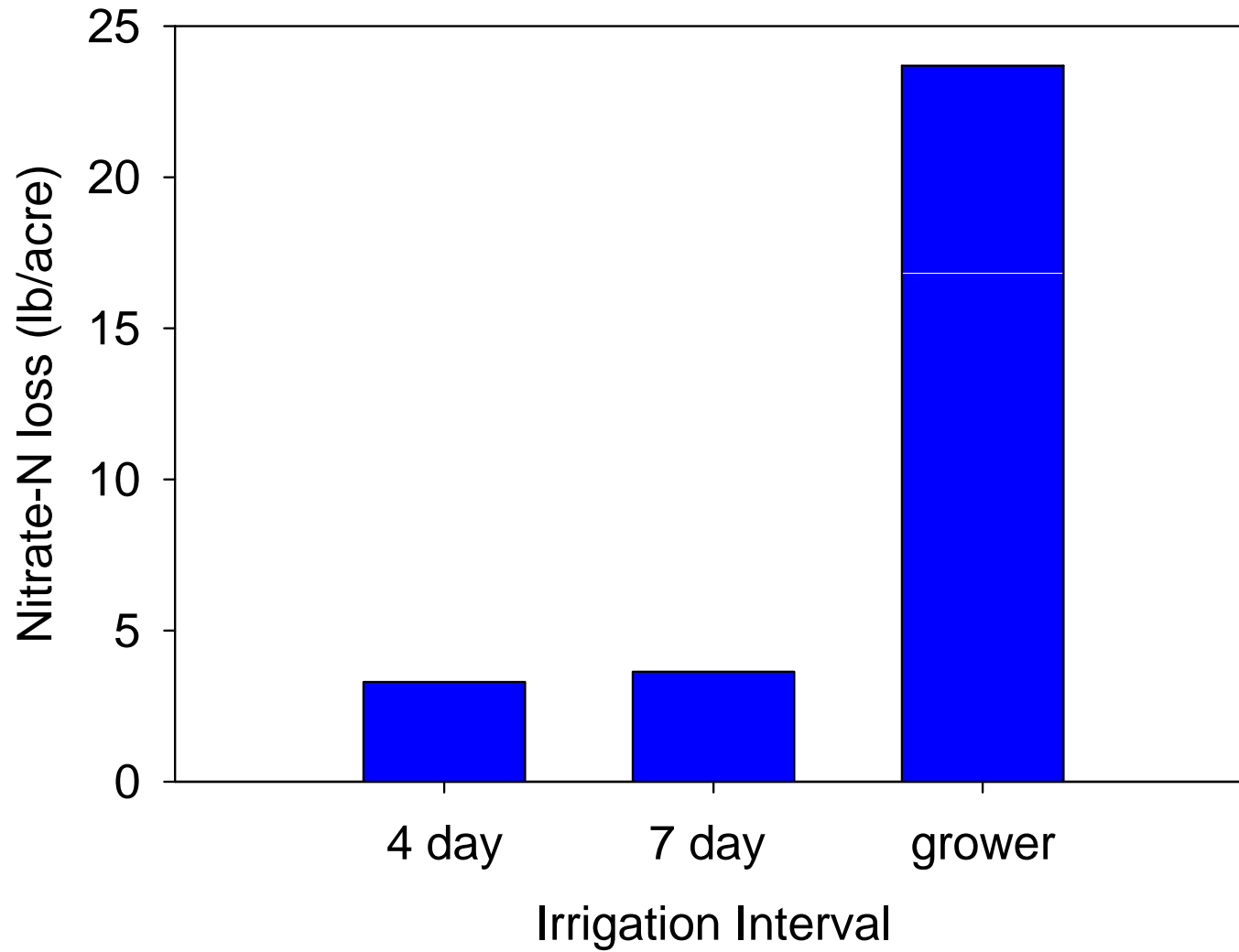


**Suction
Lysimeter**

Estimated Drainage of Irrigation Treatments



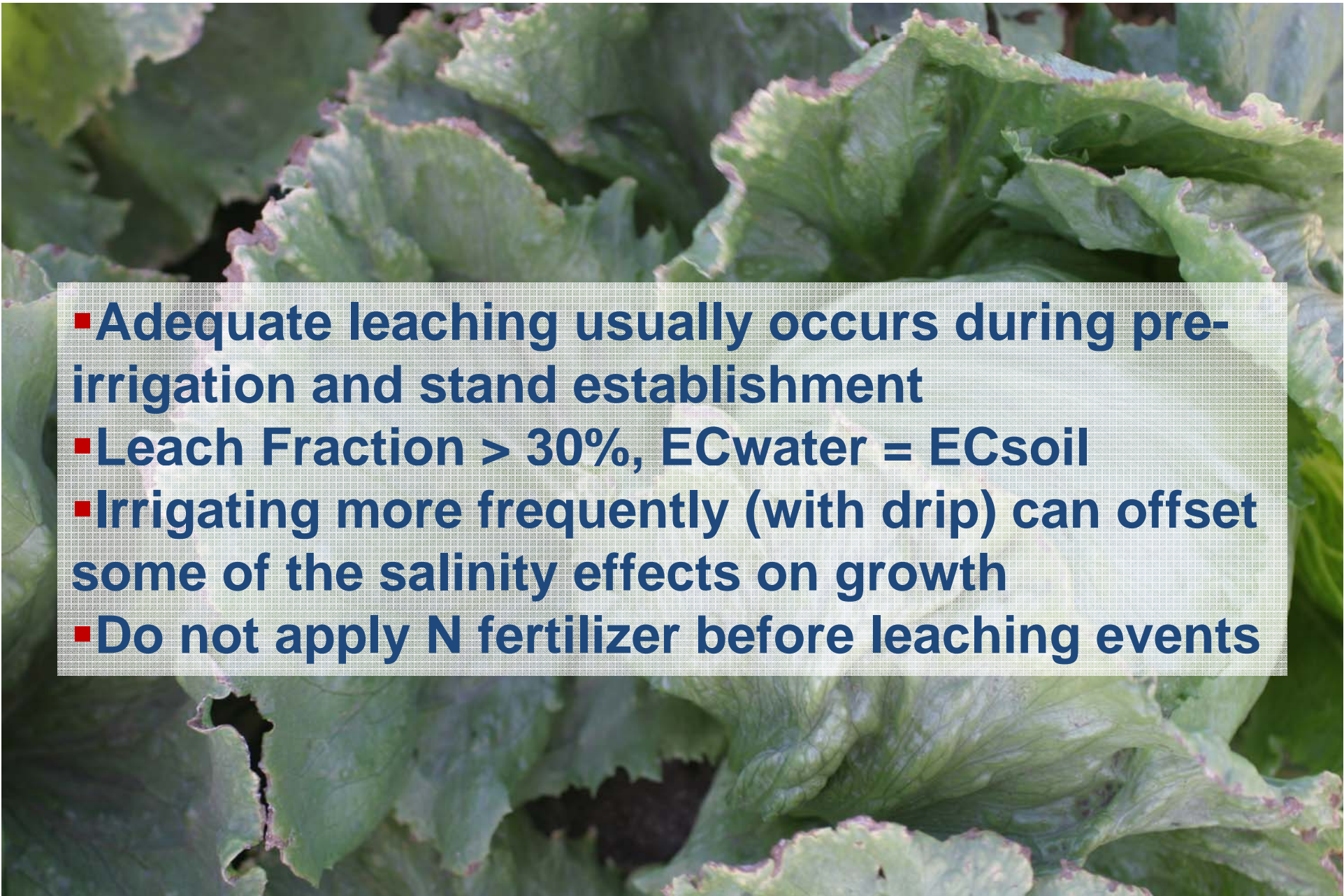
Estimated Nitrate Leaching Losses



Yield Summary of Irrigation Treatments

Treatment	Head Weight		Plant population		Yield	
	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

What about leaching for salinity management?

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

Irrigation strategies for using nitrogen fertilizer efficiently 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**