

Managing fertilization and irrigation for water quality protection



Nitrogen budget in coastal vegetable production :

	lb N / acre		
	Pepper	Lettuce	Celery
Typical seasonal N application	250	190	275
Crop uptake	200	120	200
Removal in harvest	80	80	140
Fertilizer ‘unaccounted for’	> 150	> 100	> 100

With 2 crops per year the ‘unaccounted for’ N is very high

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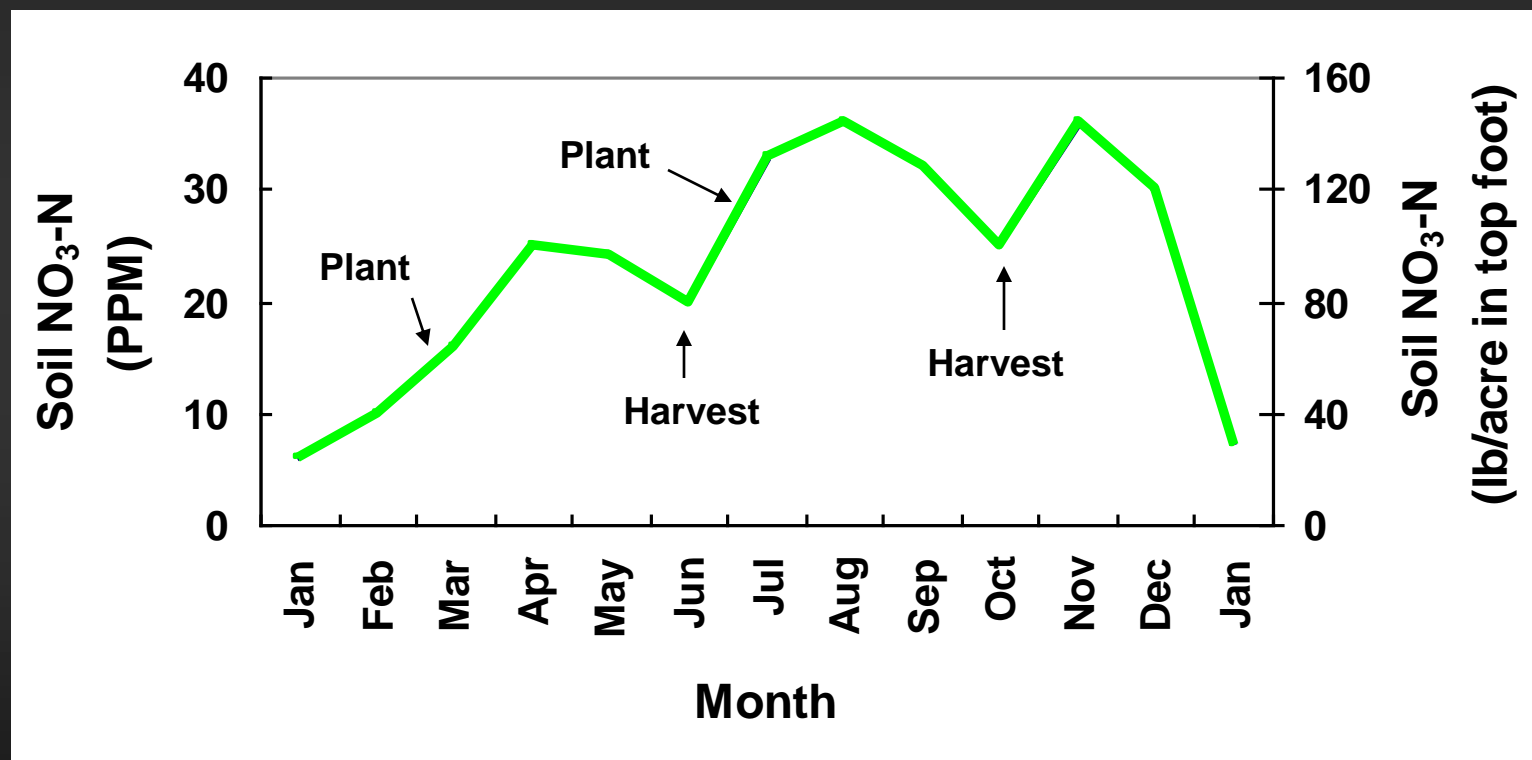
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- lost through leaching or runoff
(the fate of the majority of 'unaccounted for' N)

Typical annual cycle of soil NO₃-N availability :



Environmental standards are very tough :



Federal drinking water standard is 10 PPM $\text{NO}_3\text{-N}$



How tough is the 10 PPM $\text{NO}_3\text{-N}$ standard?

- An annual leaching loss of 120 lb N / acre would require > 4 feet of annual leaching volume to average 10 PPM $\text{NO}_3\text{-N}$
- To average 10 PPM $\text{NO}_3\text{-N}$ in leachate, soil would need to average < 3 PPM



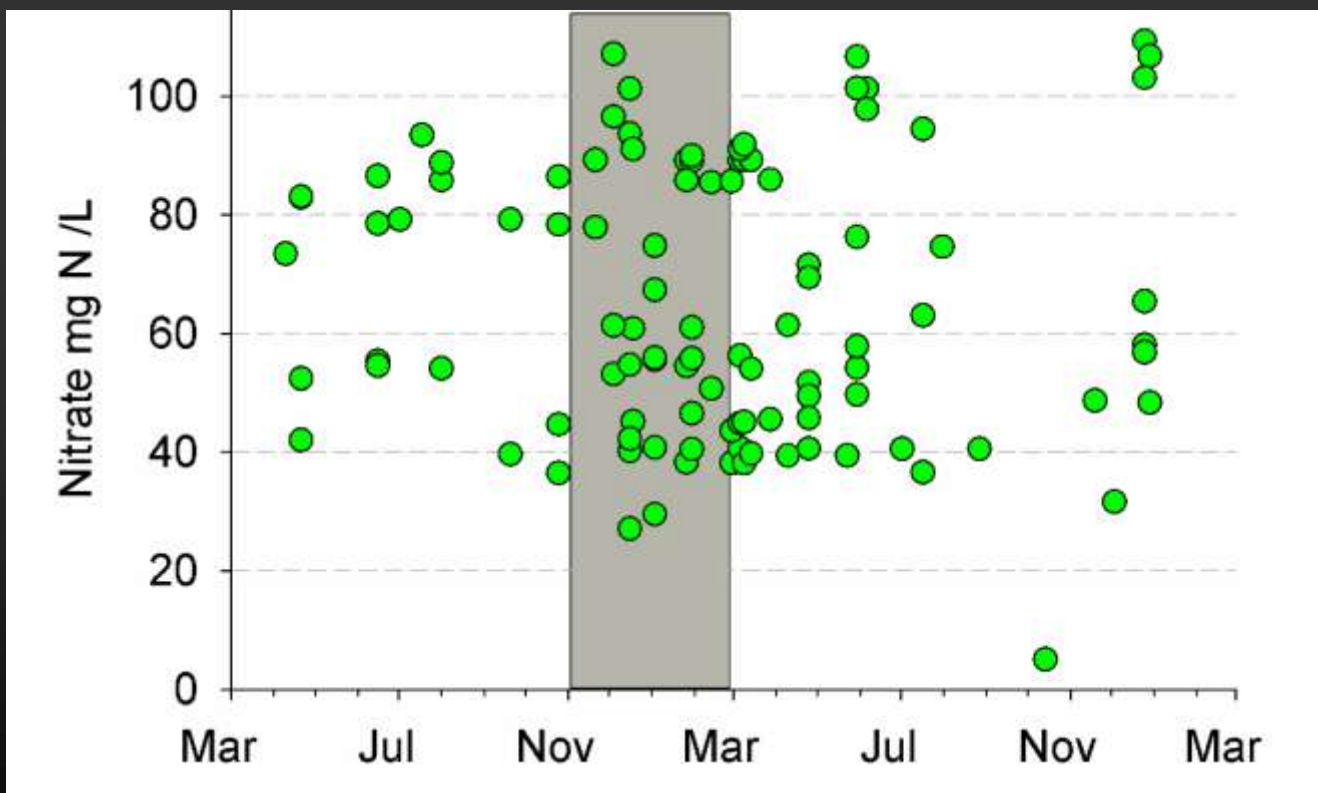
Relationship between soil $\text{NO}_3\text{-N}$ and leachate $\text{NO}_3\text{-N}$:

- ❖ all $\text{NO}_3\text{-N}$ is in the soil solution, not attached to soil particles
- ❖ soil solution only 20-30% the weight of soil

Soil $\text{NO}_3\text{-N}$ (PPM)	$\text{NO}_3\text{-N}$ in soil solution (PPM)	
	Sandy loam	Clay
10	50	30



2002-04 drain tile sampling in the Salinas Valley :





Bottom line :

- water leaving vegetable fields will likely exceed 10 PPM $\text{NO}_3\text{-N}$
- reducing groundwater $\text{NO}_3\text{-N}$ loading requires:
 - reduced fertilizer application, and better timing
 - improved irrigation efficiency to minimize leaching volume

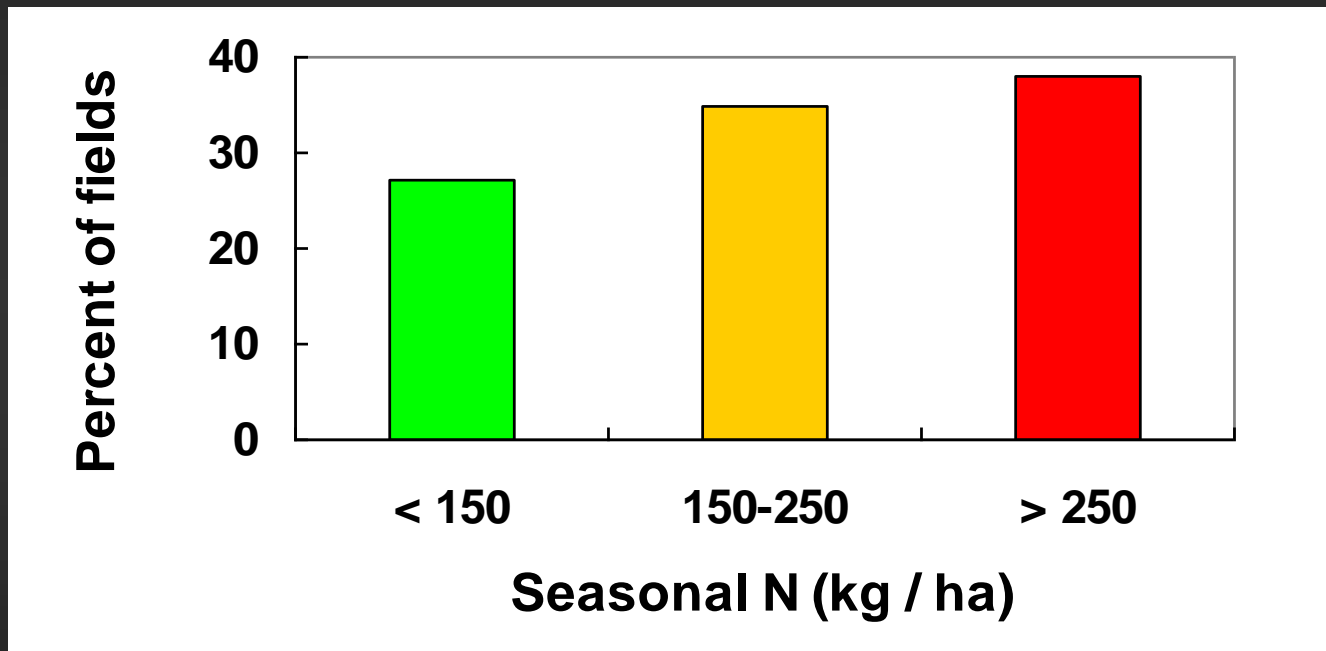
More efficient fertilizer use :

- ✓ reduced fertilizer application
- ✓ improve fertilizer timing



Reevaluate general crop nitrogen requirements :

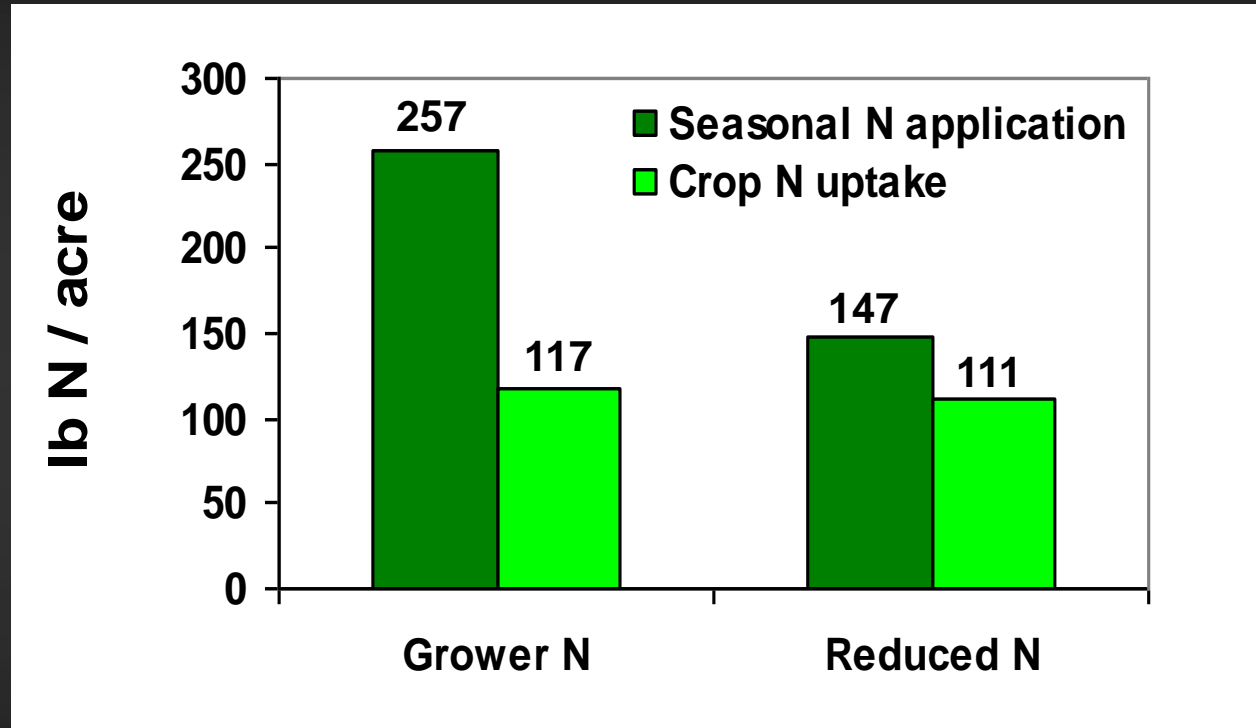
- ❖ a lettuce crop contains about 100-120 lb N/acre at harvest, yet some growers commonly apply much more N



2004-05 survey of 70 commercial lettuce fields :

What happens when excess fertilizer is applied ?

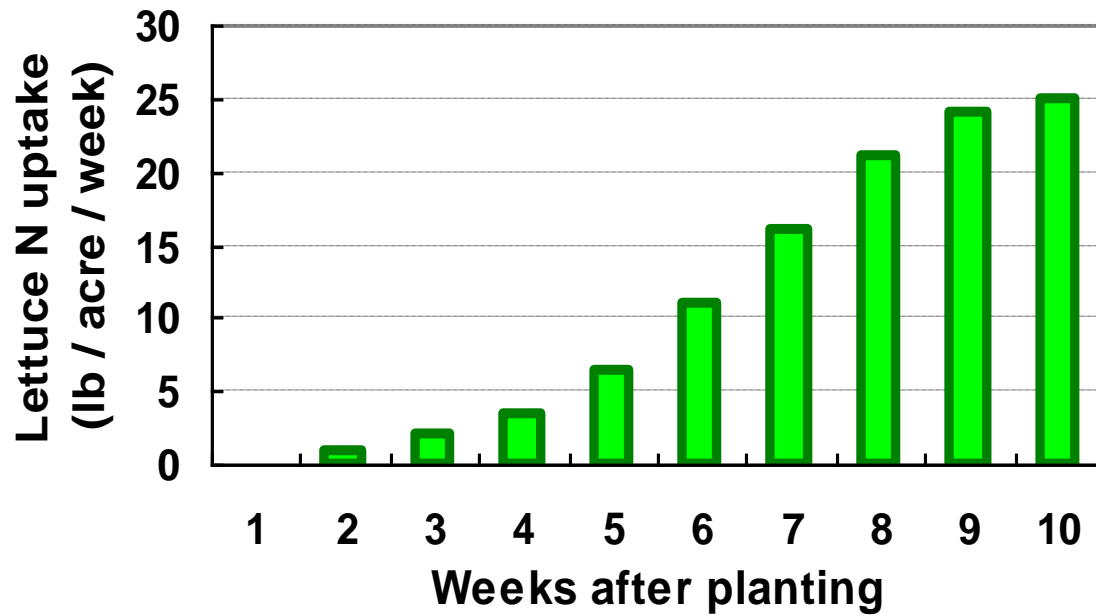
Mean of 11 commercial lettuce trials in which one or more N sidedressings were skipped :



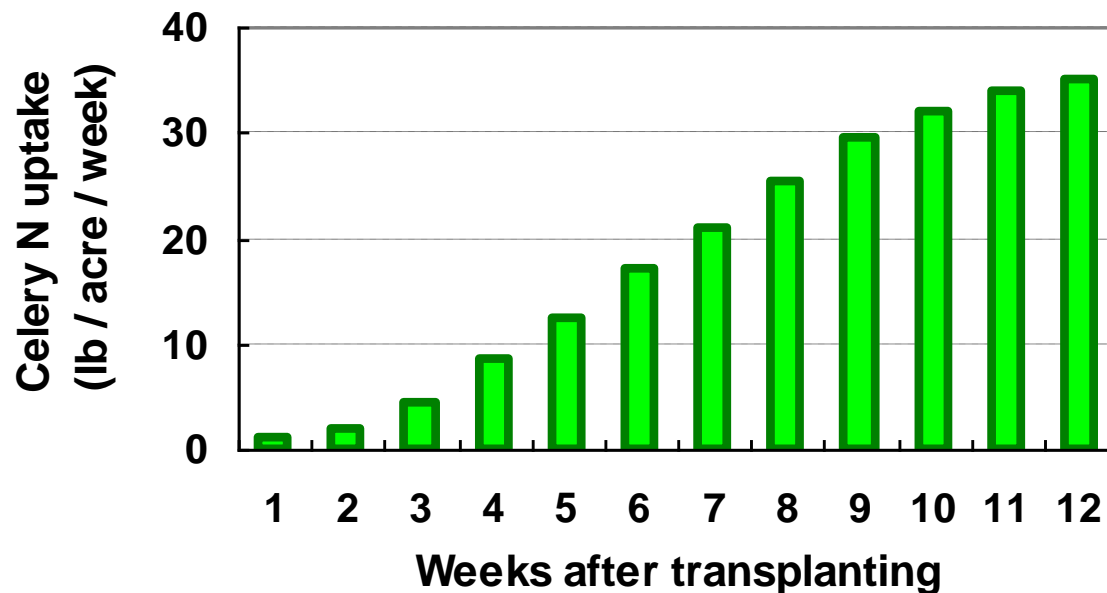
Conclusion :

- ✓ most excess fertilizer is not even taken up by the plant; it remains in the soil, at risk of leaching

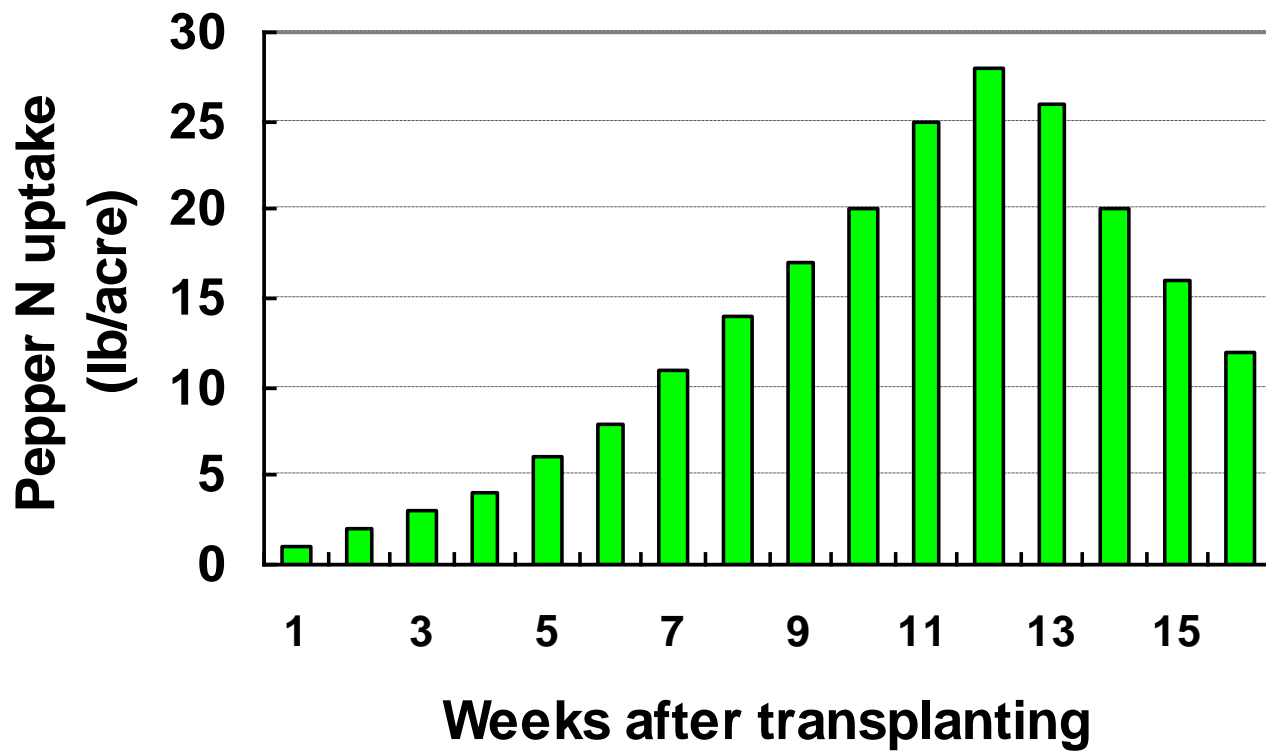
Crop N uptake pattern :



100 - 120 lb N/acre
at harvest

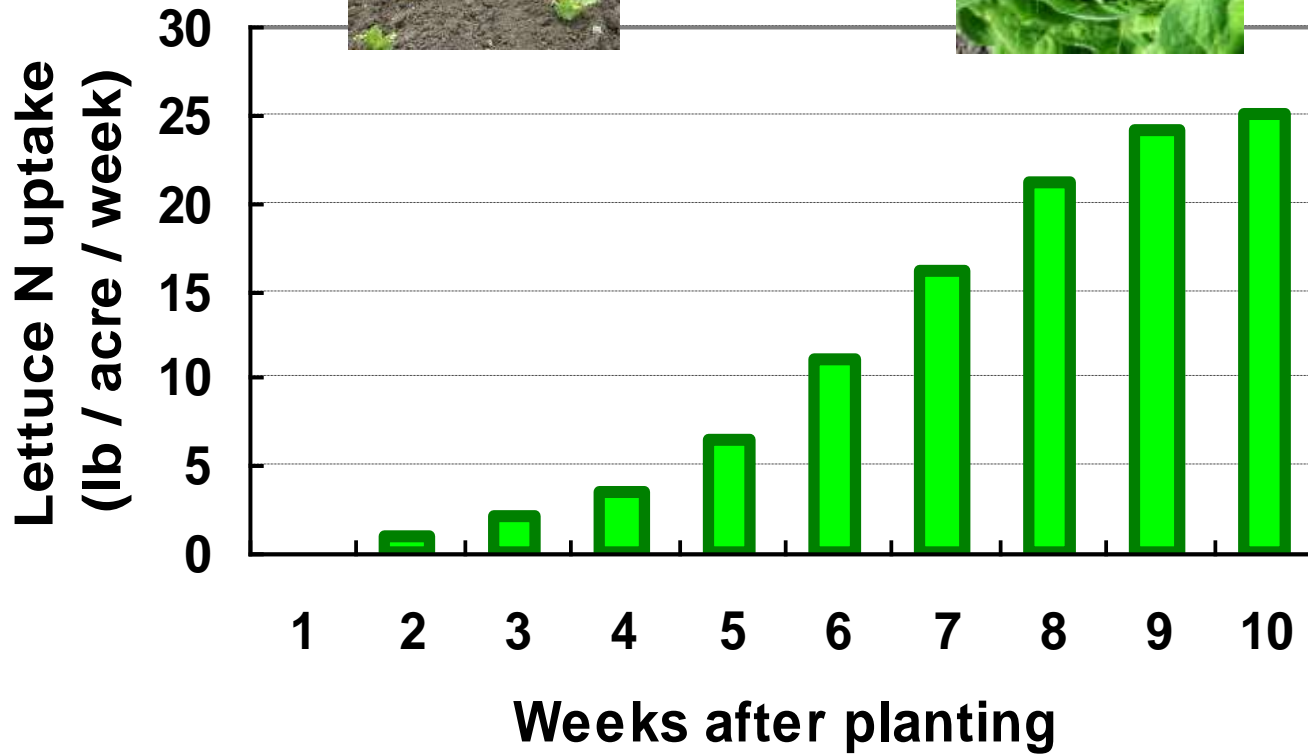


180 - 220 lb N/acre
at harvest



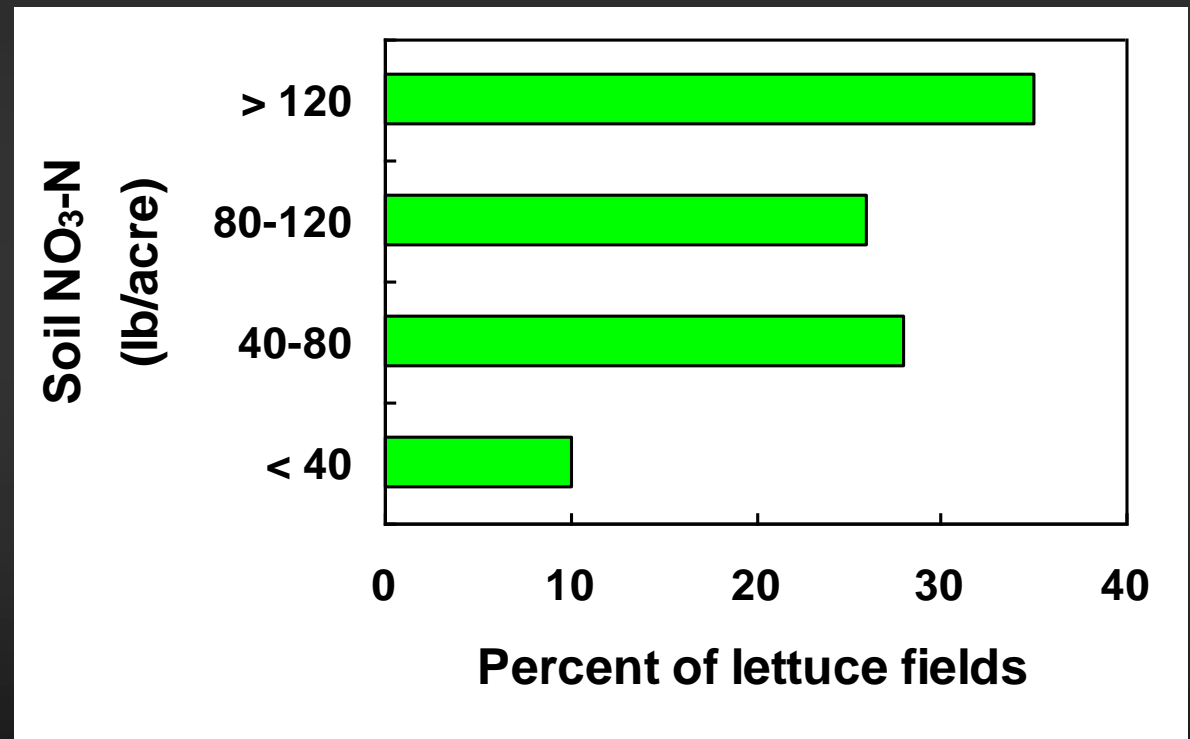
**180-220 lb N/acre
seasonal total**

Limit N application until plants can use it :



Take advantage of residual soil N :

Not all crop N uptake comes from fertilizer :



2004-05 survey of commercial lettuce fields, thinning stage



**Value of Presidedress Soil Nitrate Testing (PSNT)
in lettuce production :**

In 25 commercial lettuce field trials:

- ❖ **first sidedressing was skipped in 75% of fields**
- ❖ **overall N application reduced by > 40%**
- ❖ **no loss of yield or quality**

Controlling irrigation to limit leachate is critical



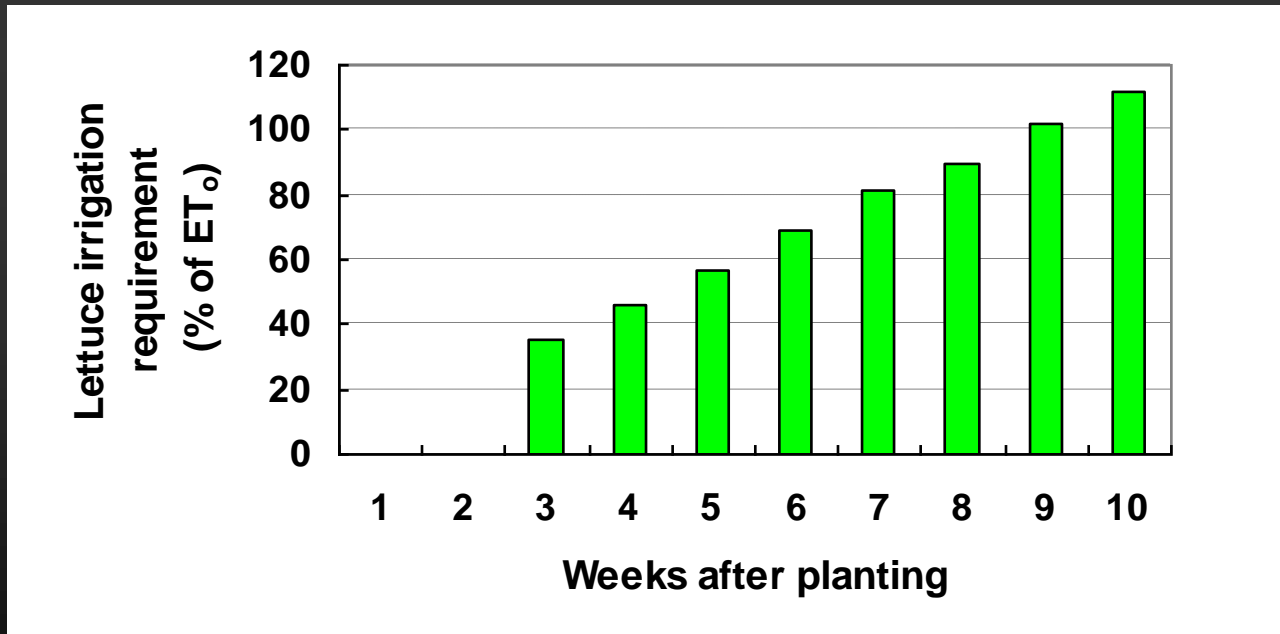
... and drip irrigation is the ideal tool



Leaching during stand establishment
a particular problem

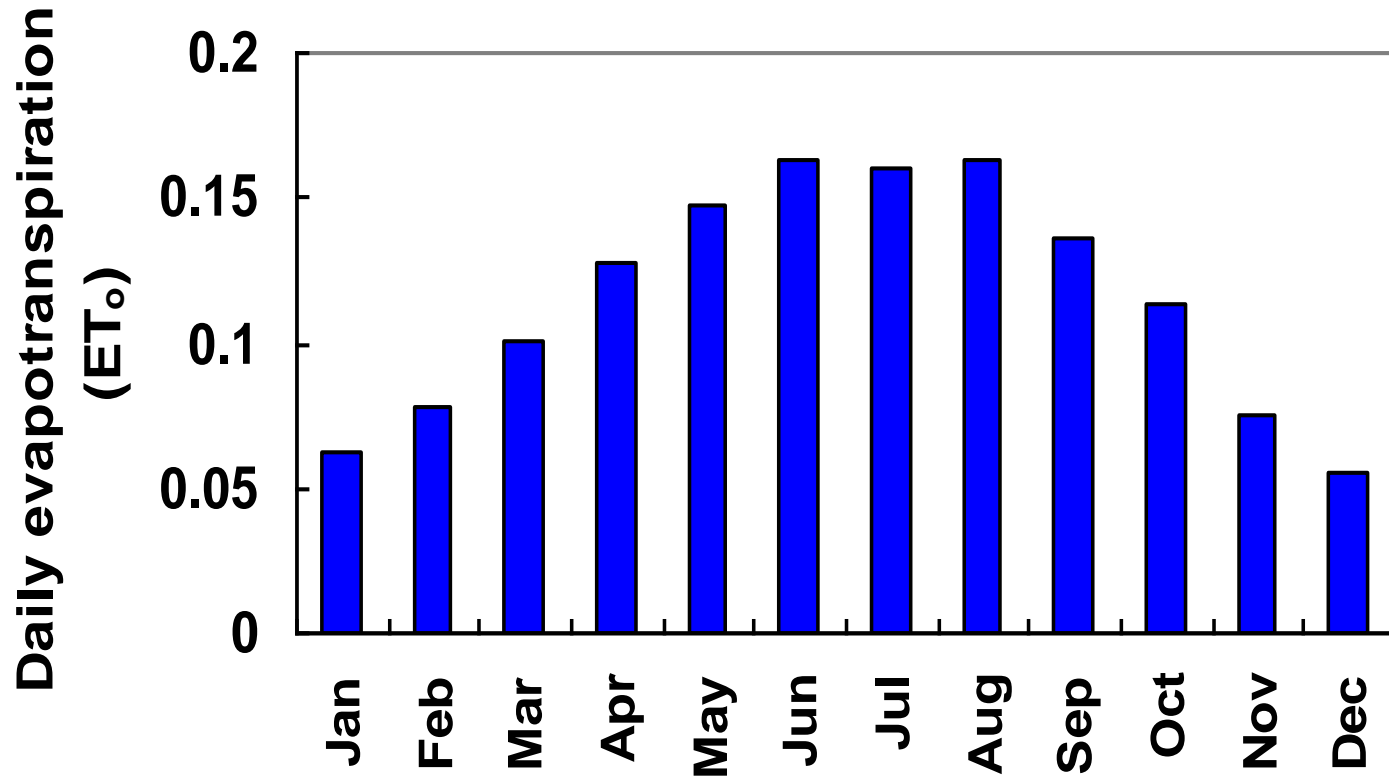


Irrigation requirement can be predicted by canopy size and ET_0 :

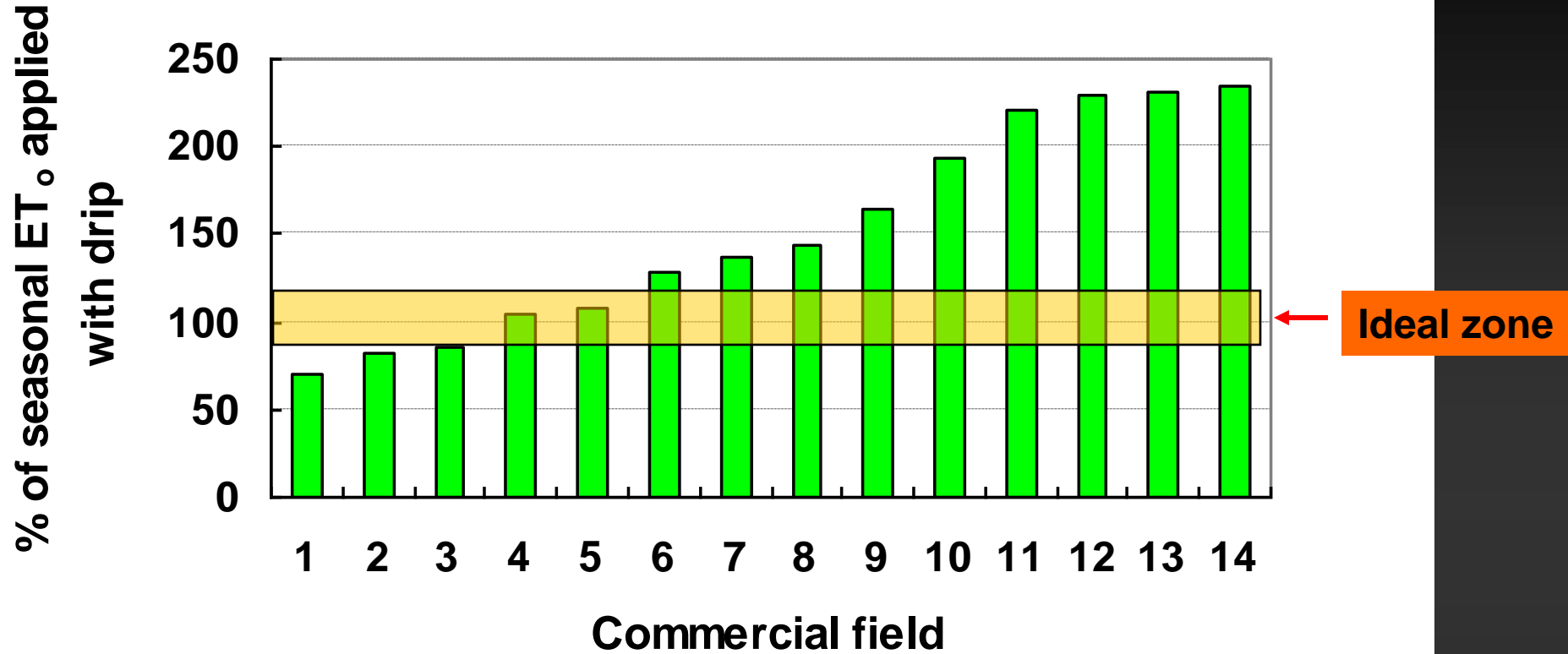


Efficient seasonal drip irrigation volume \approx 80 – 120 % of ET_0 .

Average daily ET_0 for Morro Bay :

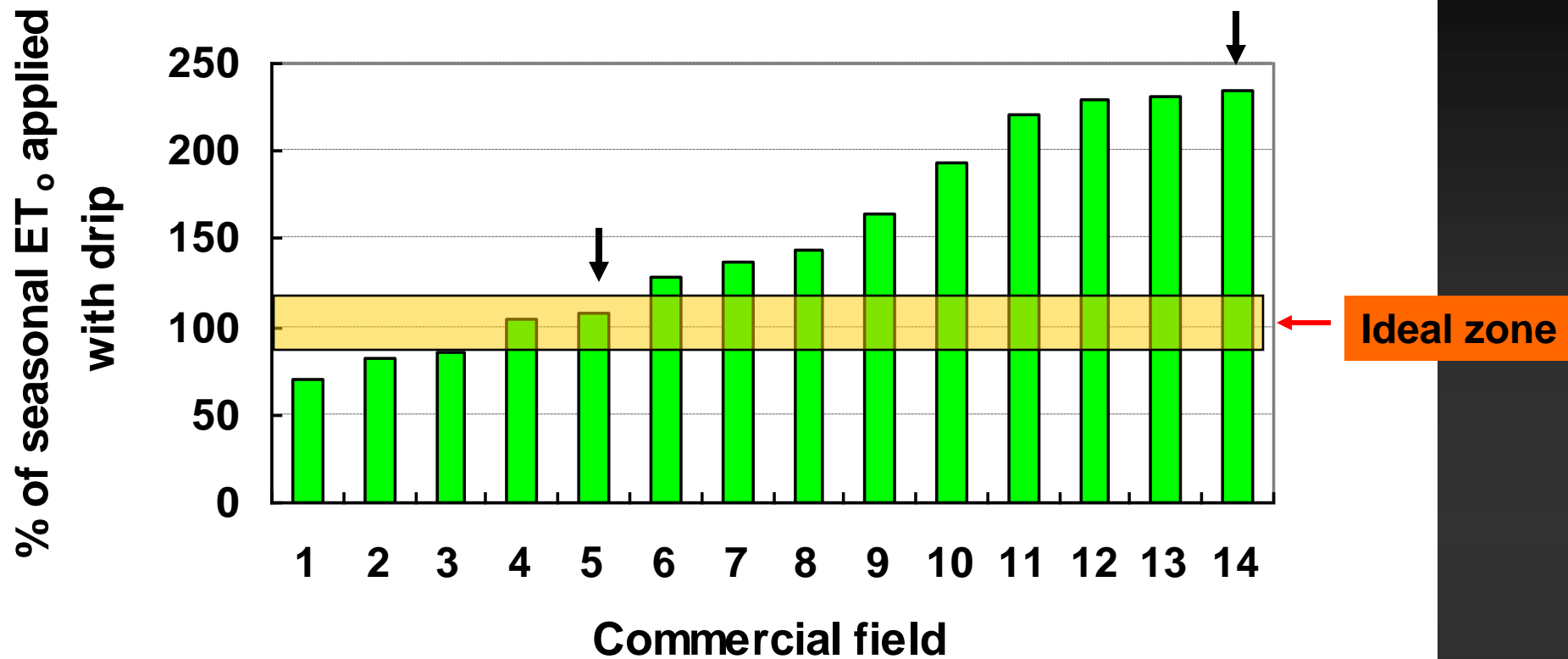


Irrigation management varies greatly among growers :



Drip-irrigated lettuce fields in the Salinas Valley

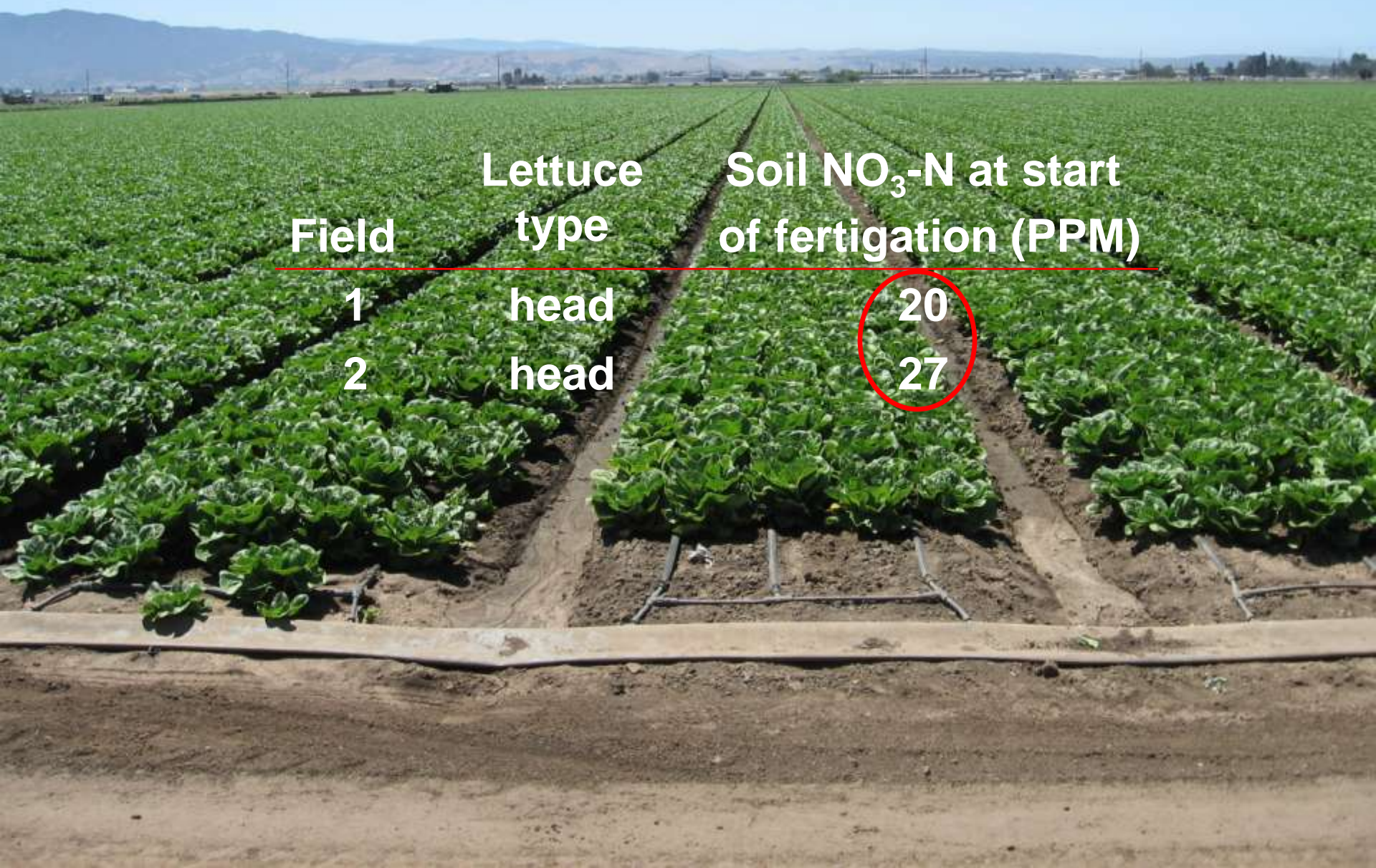
Consequences of excessive irrigation :



Assume summer conditions, sandy loam soil :

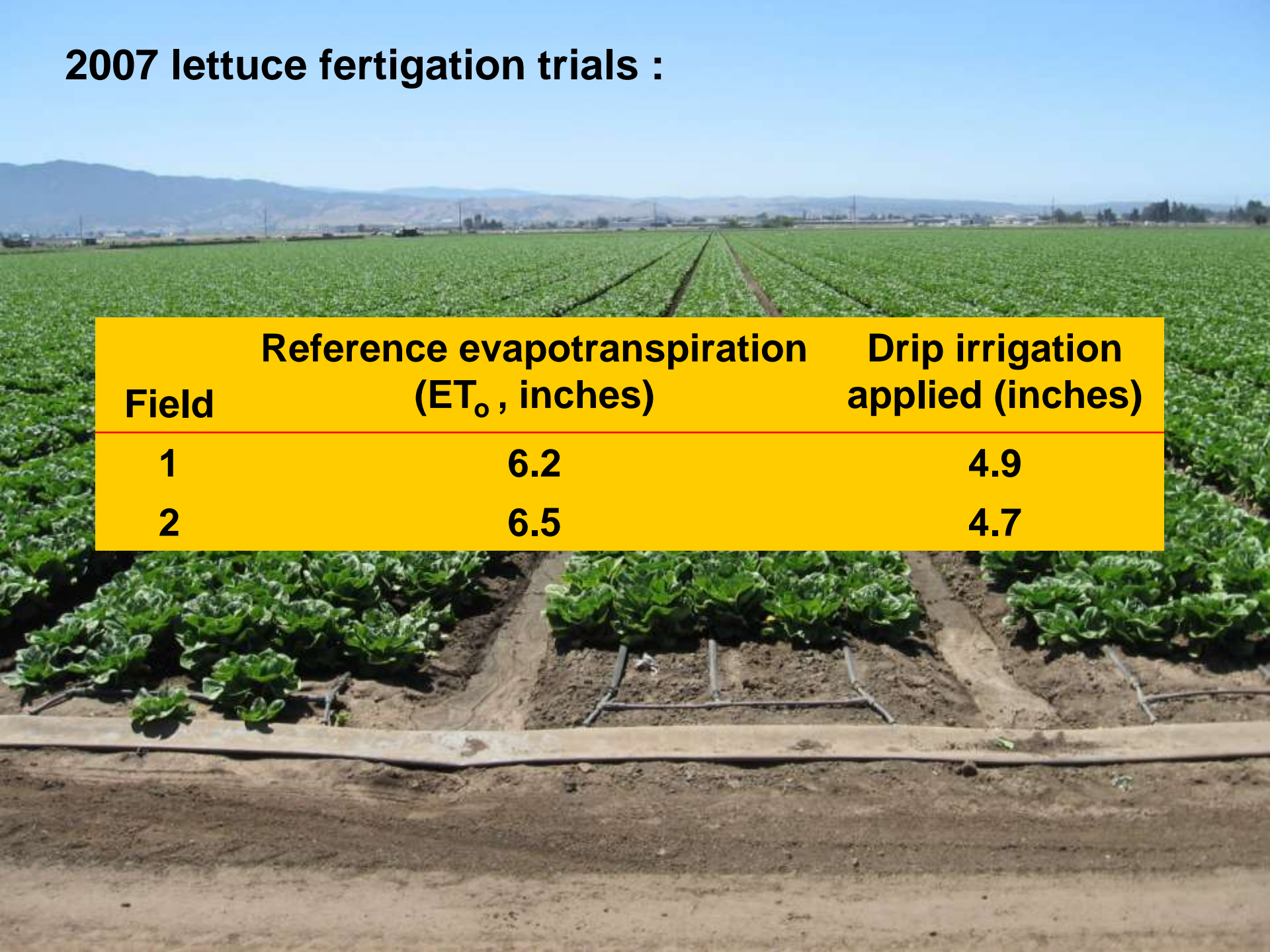
- If field 5 applied 5 inches of water with drip, then field 14 applied 10 inches
- If soil is 10 PPM NO_3-N , field 14 lost ≈ 50 lb N/acre in leaching !

2007 lettuce fertigation trials :

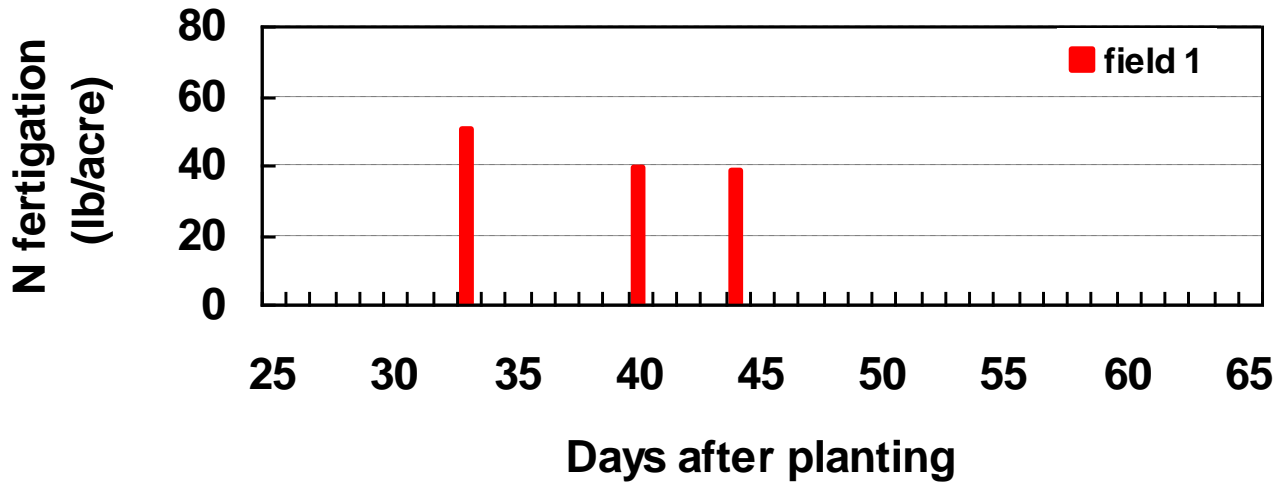


Field	Lettuce type	Soil NO ₃ -N at start of fertigation (PPM)
1	head	20
2	head	27

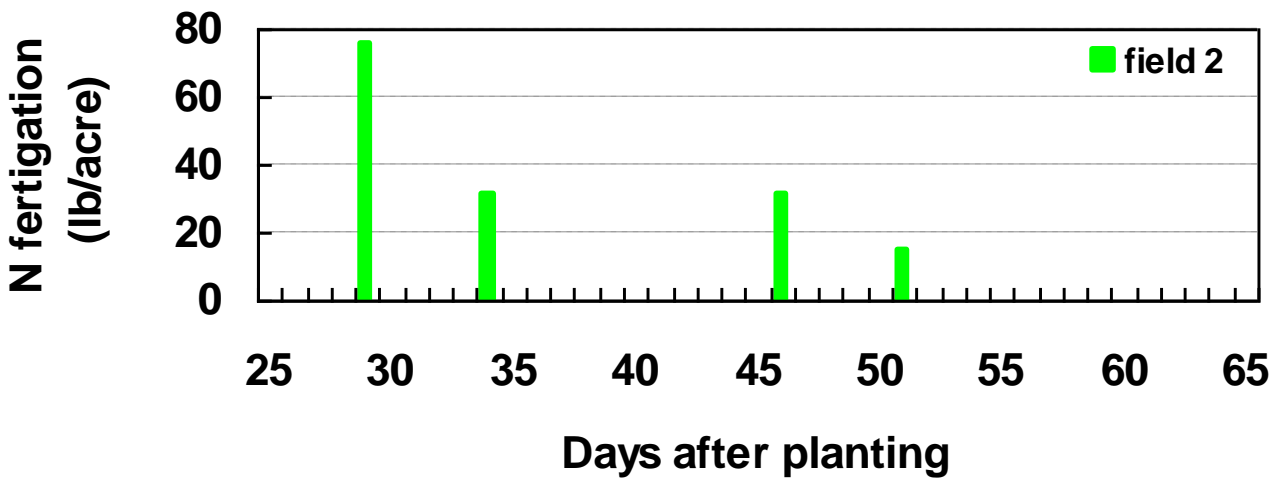
2007 lettuce fertigation trials :



Field	Reference evapotranspiration (ET_o , inches)	Drip irrigation applied (inches)
1	6.2	4.9
2	6.5	4.7

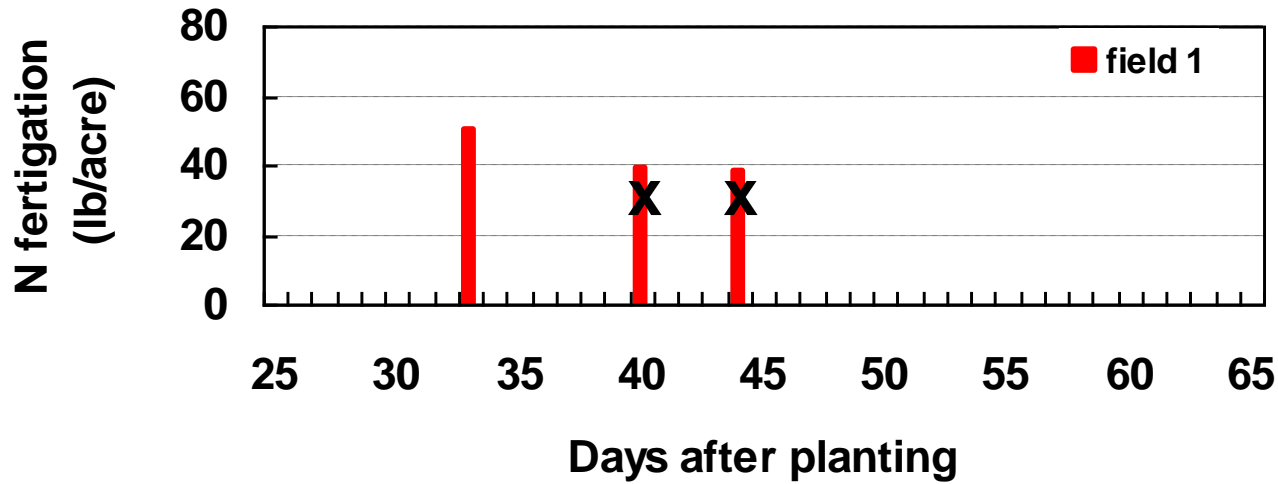


127 lb N fertigated
169 lb N total

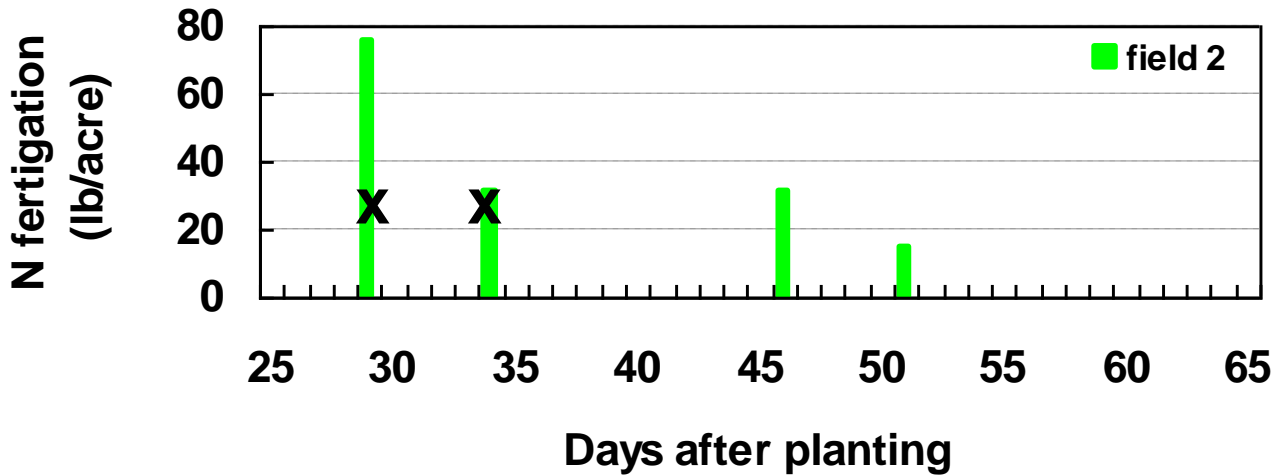


153 lb N fertigated
171 lb N total

Reduced N treatment created by eliminating some N fertigation :



50 lb N fertigated
92 lb N total



46 lb N fertigated
64 lb N total

Results :

Field	Treatment	lb N / acre		Mean	Crop N
		total	fertigated	plant wt (lb)	uptake (lb / acre)
1	Grower	169	127	2.29	98
	Reduced N	92	50	2.31	91
2	Grower	171	153	2.16	103
	Reduced N	64	46	2.27	101



What about winter ?

- ✓ Leave as little $\text{NO}_3\text{-N}$ in the profile as possible after fall crop
- ✓ Employ winter cover crop where practical



Cover crops :

- consistently reduce sediment loss
- inconsistently reduce nutrient loss

