Nutrient Management in Vegetable Production

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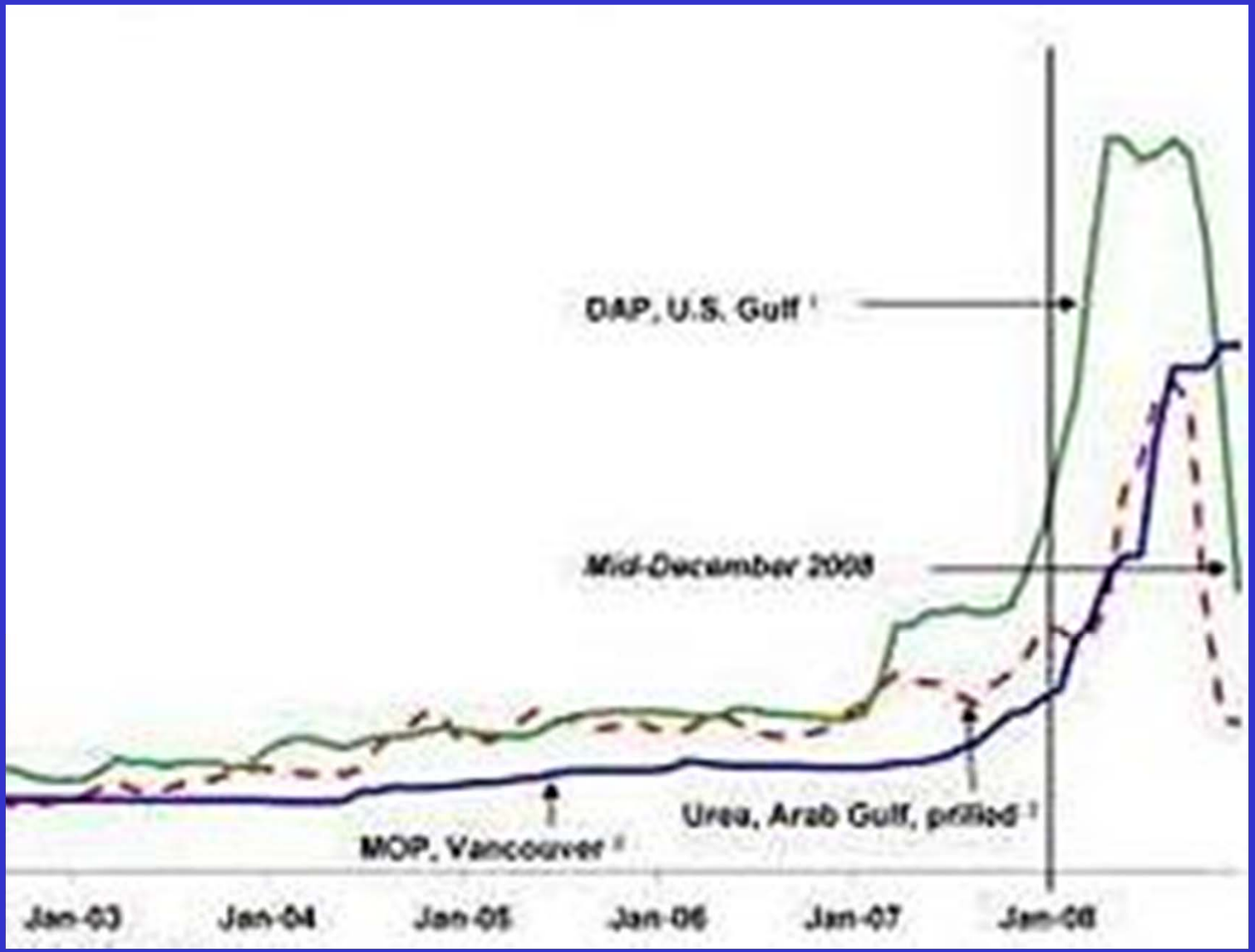
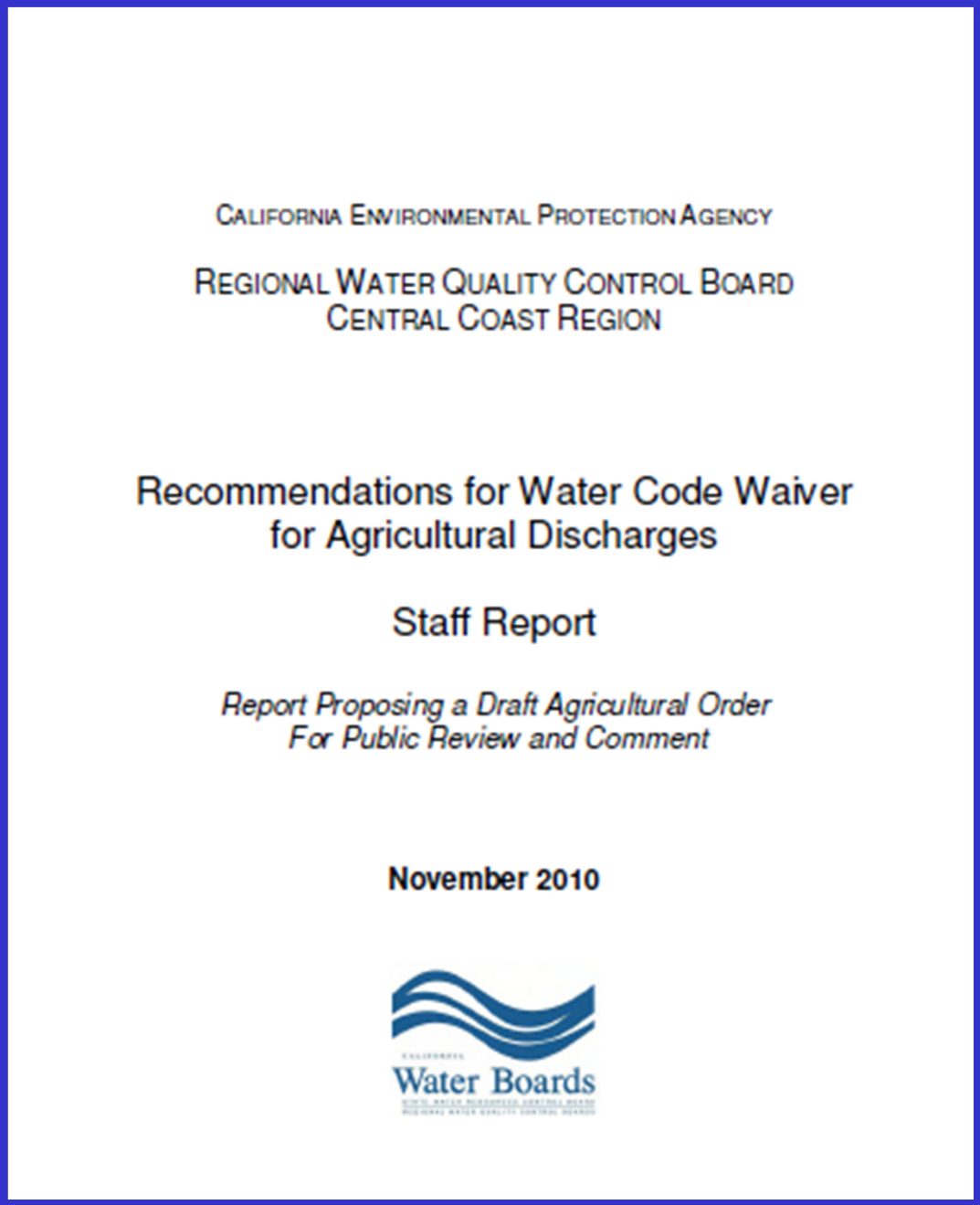
Volatility in Fertilizer Prices

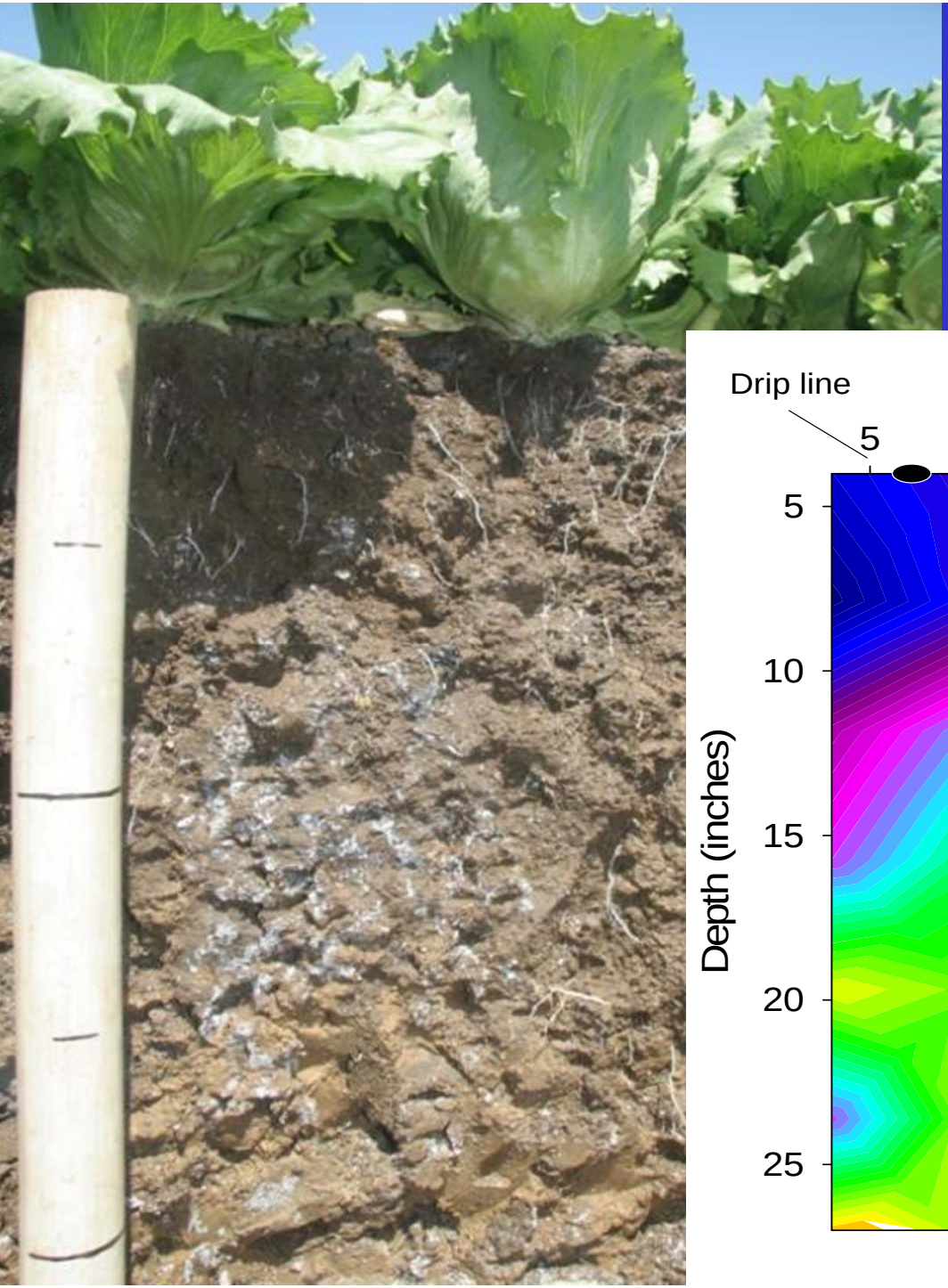


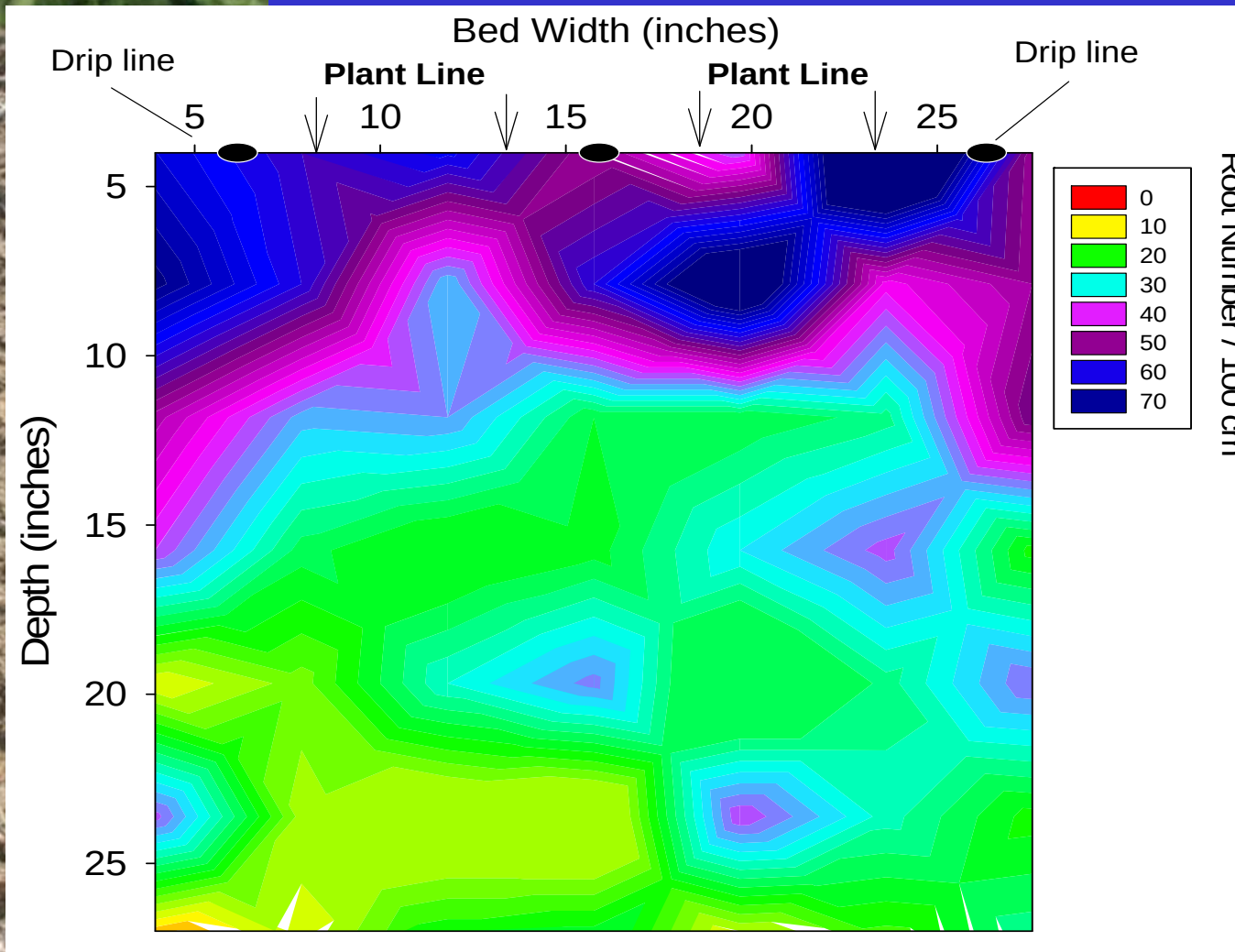


Concerns over nitrogen use efficiency of lettuce production has greater urgency due to the issuance of the agricultural order by the Central Coast Regional Water Quality Control Board

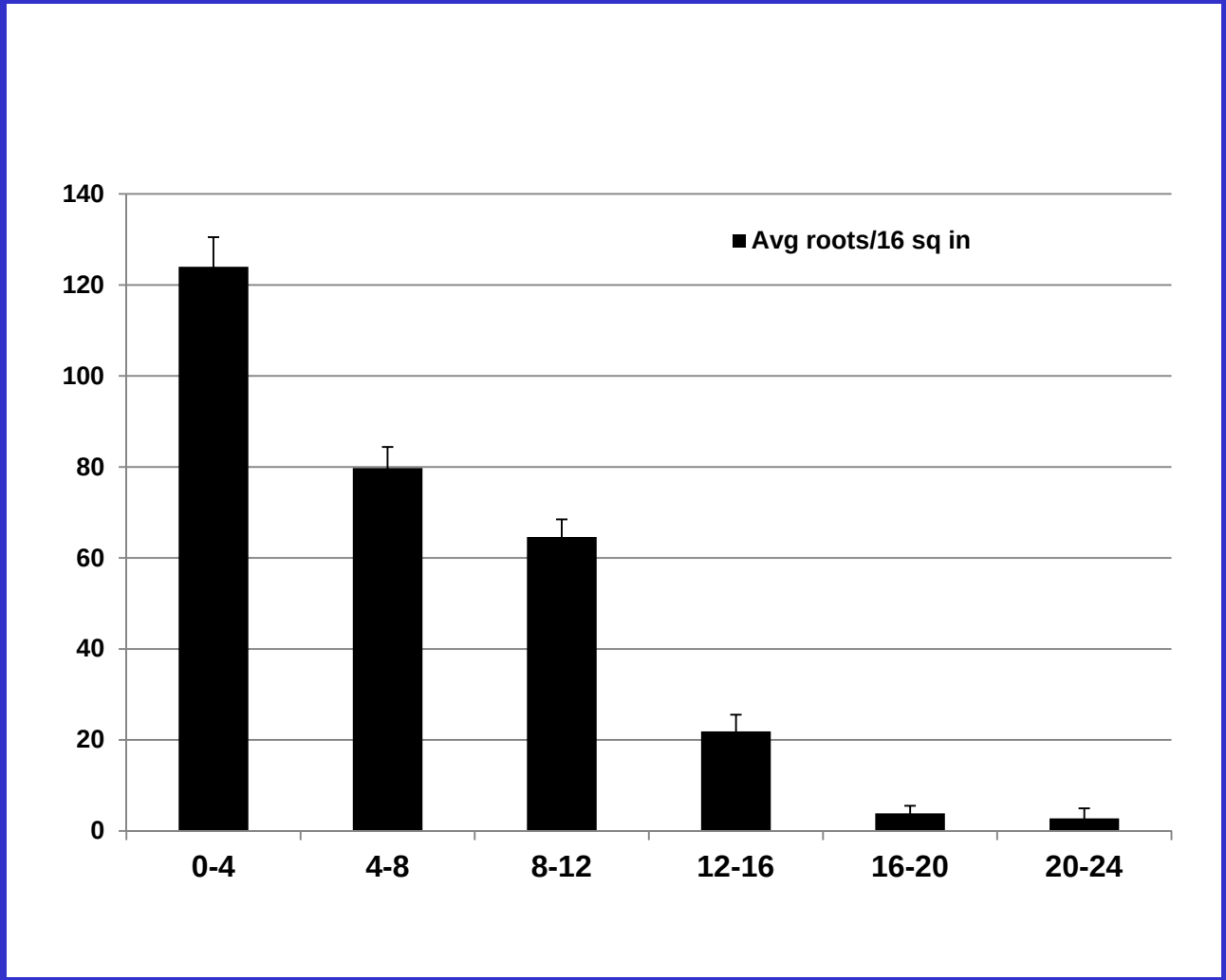
Challenges of Improving Nitrogen Use Efficiency in Lettuce Production

Root Distribution of Lettuce

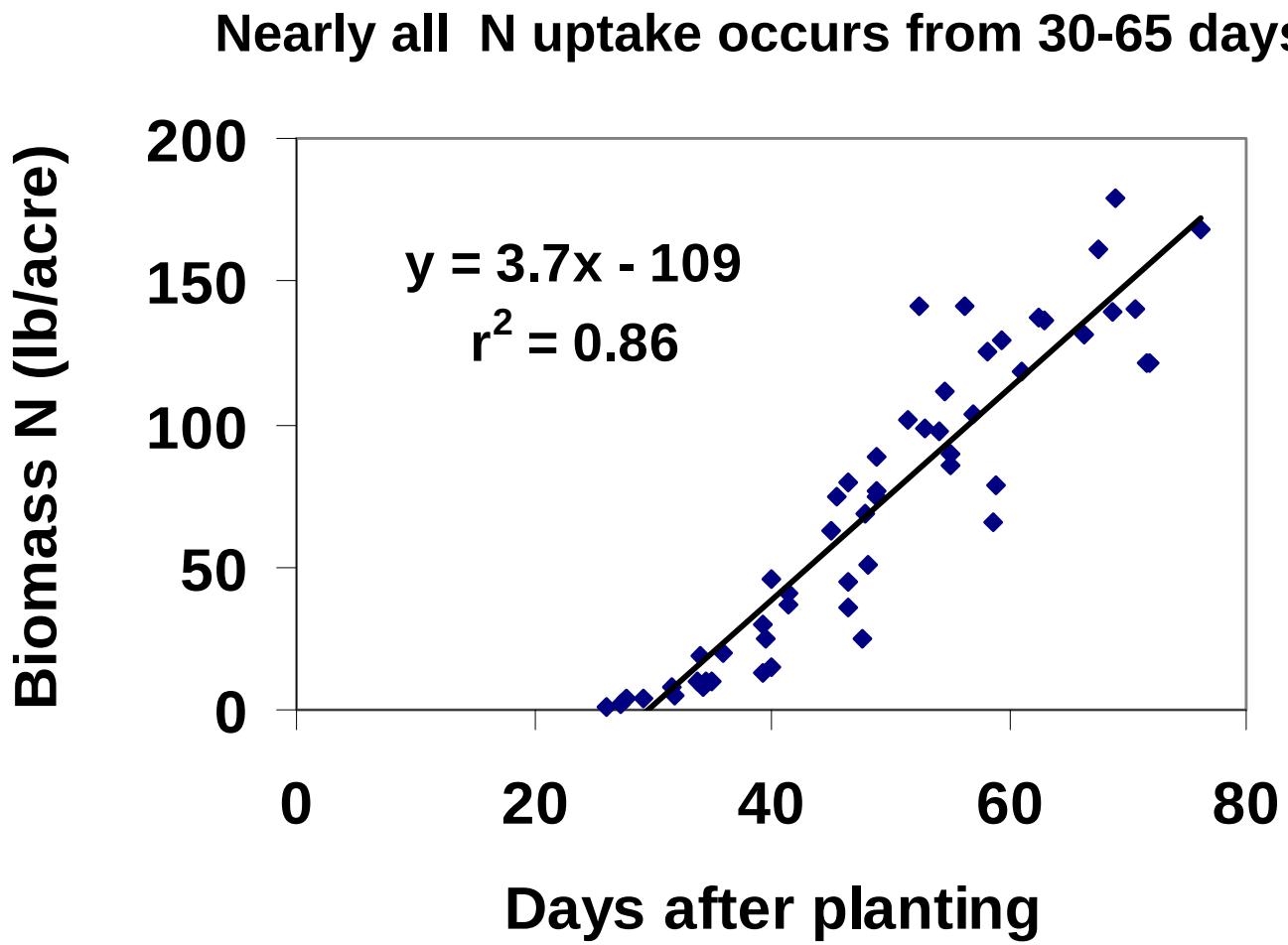




Root Distribution of Spinach



Intensive Nitrogen Uptake in 30 Days



Intensity of Production Impact on Nitrate Losses

- Double cropping builds up levels of nitrate in soils as one crop leads to the other and leaves crop residues and unused fertilizer N

Loss of Effective Rotational Crops to Absorb Winter Nitrate Losses

(Salinas Valley in thousands of acres)

Date	Lettuce	Small Grains	Sugar Beets
1950	68	63	24
1970	55	63	14
1990	58	14	3
2008	150	10	0

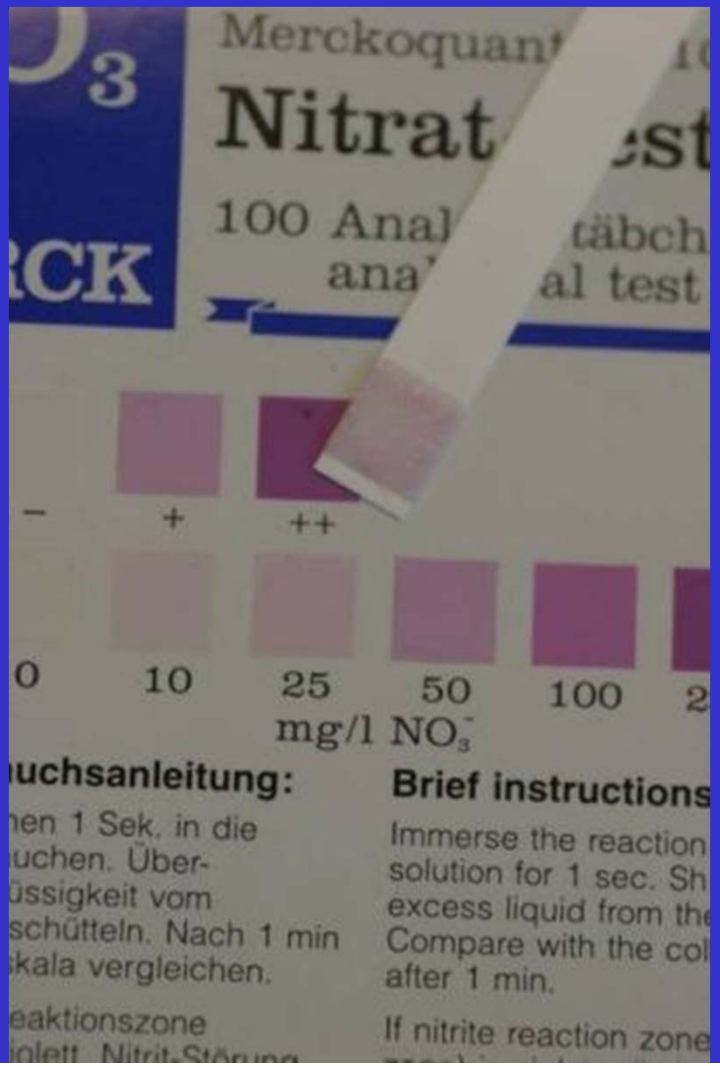
Irrigation Impact on Nitrogen Use Efficiency

- One inch of leached water carries 23 lbs of N/A @ 100 ppm nitrate-N in the soil solution

Tools to Improve Efficiency

- Testing the soil for nitrate prior to nitrogen application provides the most dramatic and clear cut method for improving nitrogen use efficiency

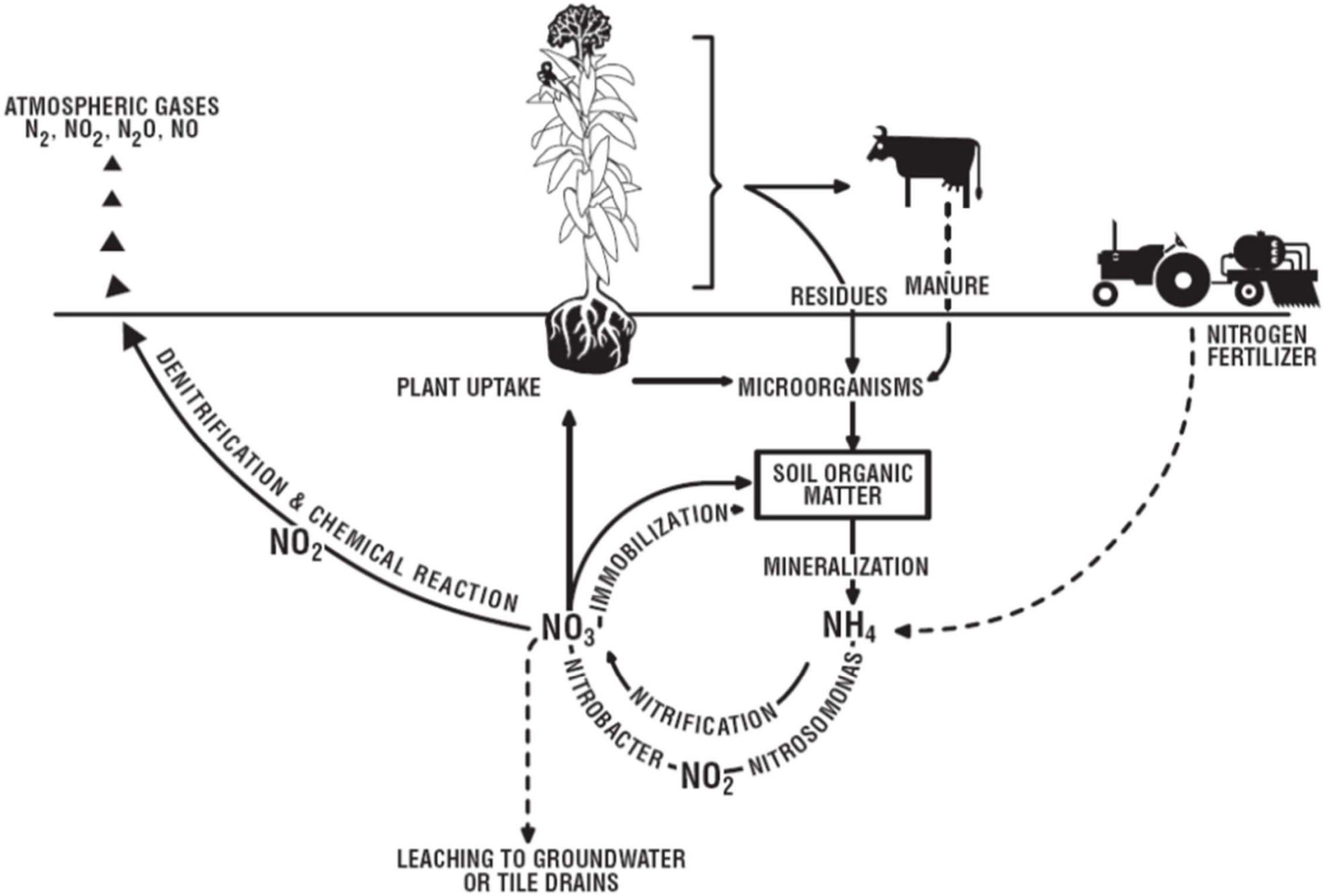
Accounting for Residual Nitrogen

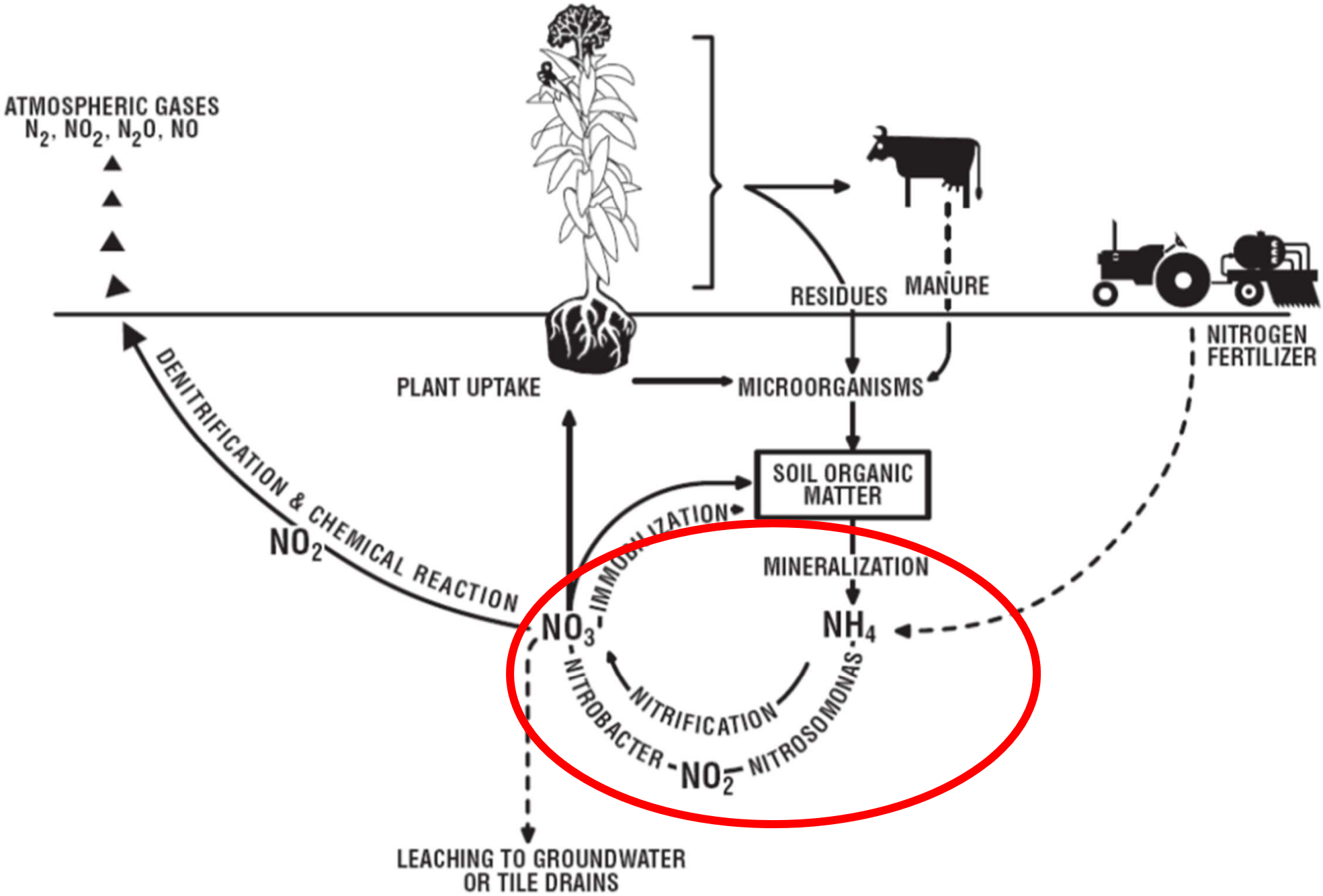


Further Techniques to Improve Nitrogen Use Efficiency

- Nitrification inhibitors
- Foliar nitrogen applications

Nitrification Inhibitors


ATMOSPHERIC GASES
N_2, NO_2, N_2O, NO
RESIDUES
MANURE
NITROGEN FERTILIZER
PLANT UPTAKE
MICROORGANISMS
SOIL ORGANIC MATTER
IMMOBILIZATION
MINERALIZATION
DENITRIFICATION & CHEMICAL REACTION
NO_2
NO_3^-
NH_4^+
NITRIFICATION
NITROBACTER
NITROSOMONAS
NO_2^-
LEACHING TO GROUNDWATER OR TILE DRAINS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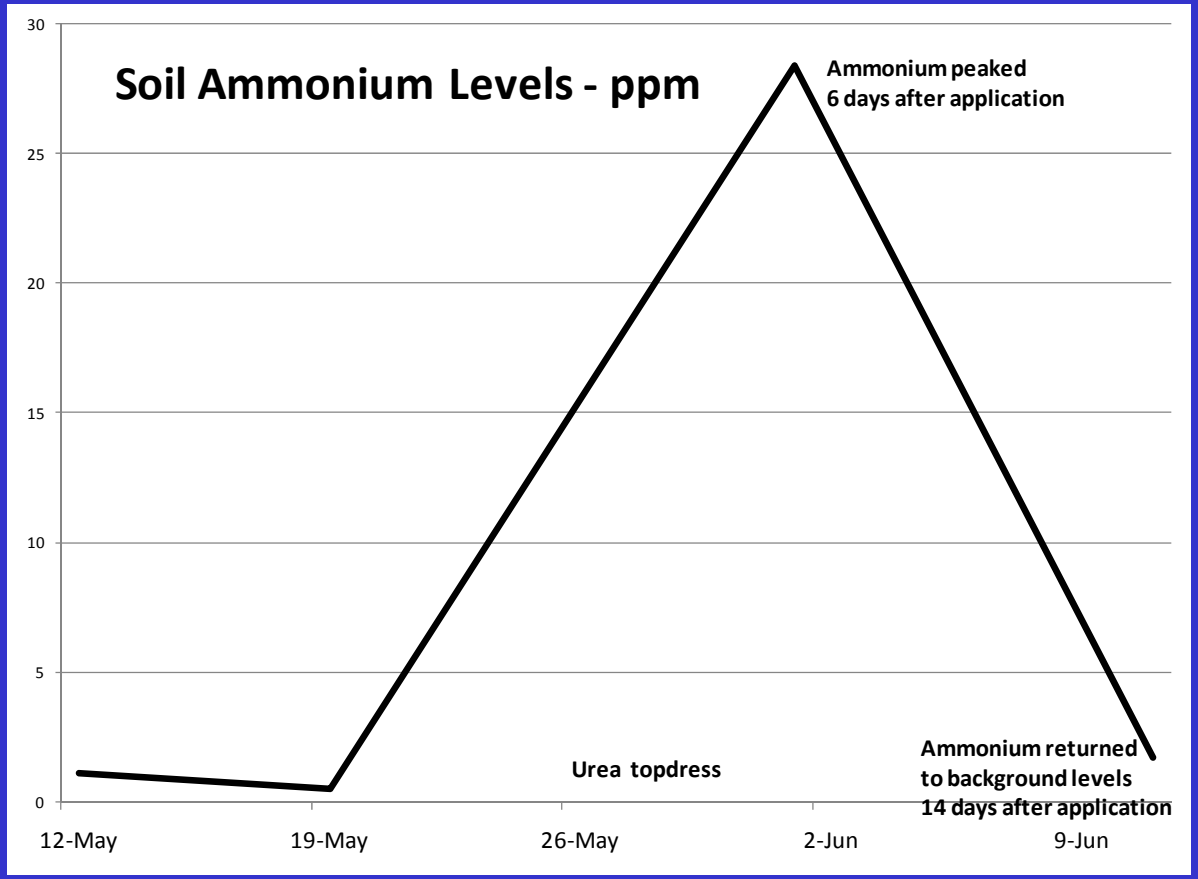
NITROBACTER
NO_2^-
NITROSOMONAS
LEACHING TO GROUNDWATER
OR TILE DRAINS

$NH_4^+ \not\rightarrow NO_3^-$

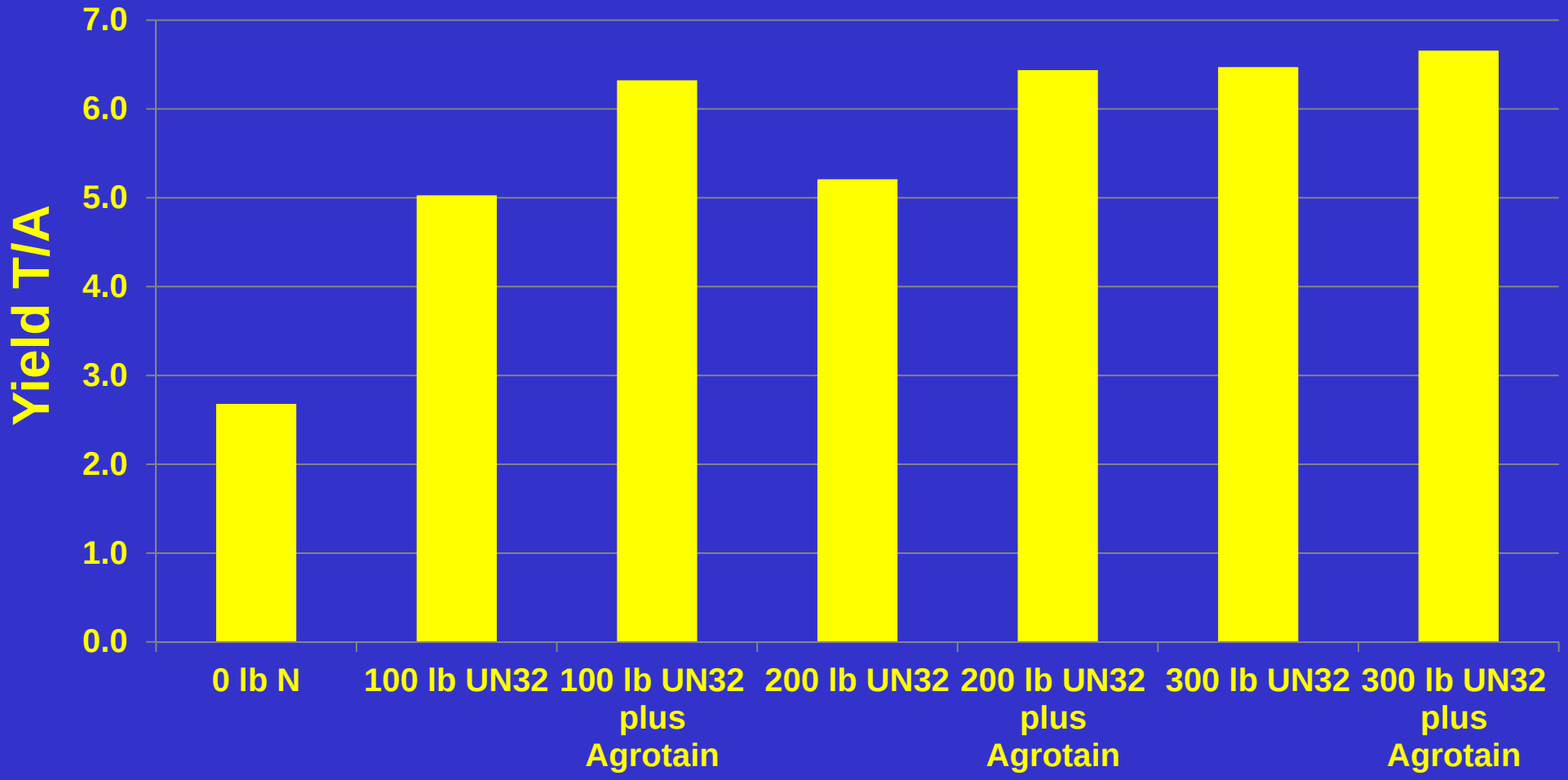
Nitrification - conversion of ammonium to nitrate



Nitrification Inhibitors

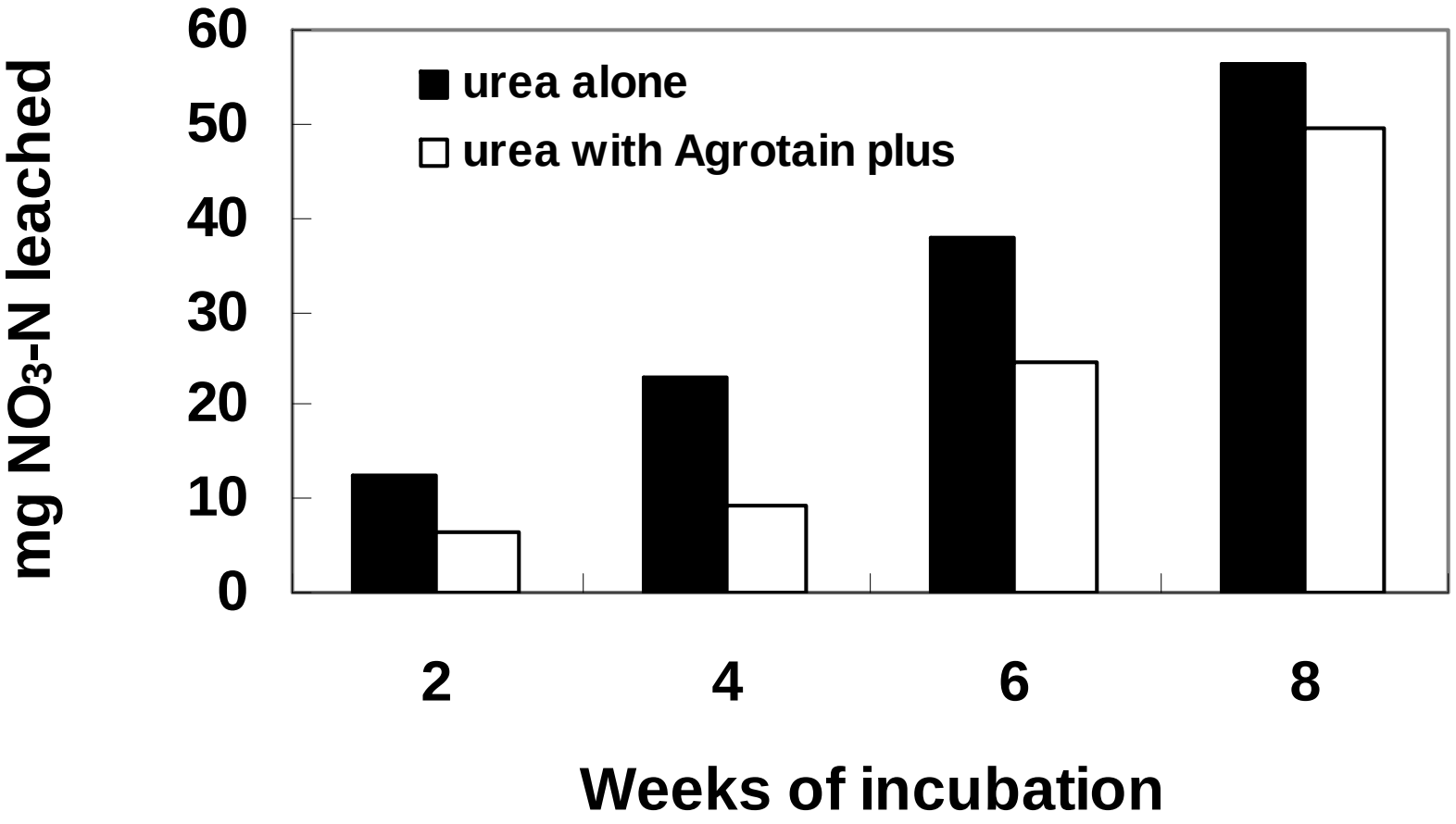
- **These chemicals disrupt the activity of *Nitrosomonas* and *Nitrobacter* bacteria**
- **There are a number of types of nitrification inhibitors, but at present, only Agrotain Plus (DCD) and Instinct™ (formerly N-serve) are available in the US, and only Agrotain Plus is available for use on vegetables**

Impact of Agrotain Plus (DCD) Nitrification Inhibitor on NoTill Corn Yield, UC Davis, 2007



Mitchell and Jackson

Water Soluble Nature of DCD



Hartz, Unpublished

Lettuce Nitrification Inhibitor Trials

- Materials were injected in two – three applications at thinning and 7-10 days following thinning
- Agrotain Plus applied at 15 lbs/ton of UN32 (wt/wt)

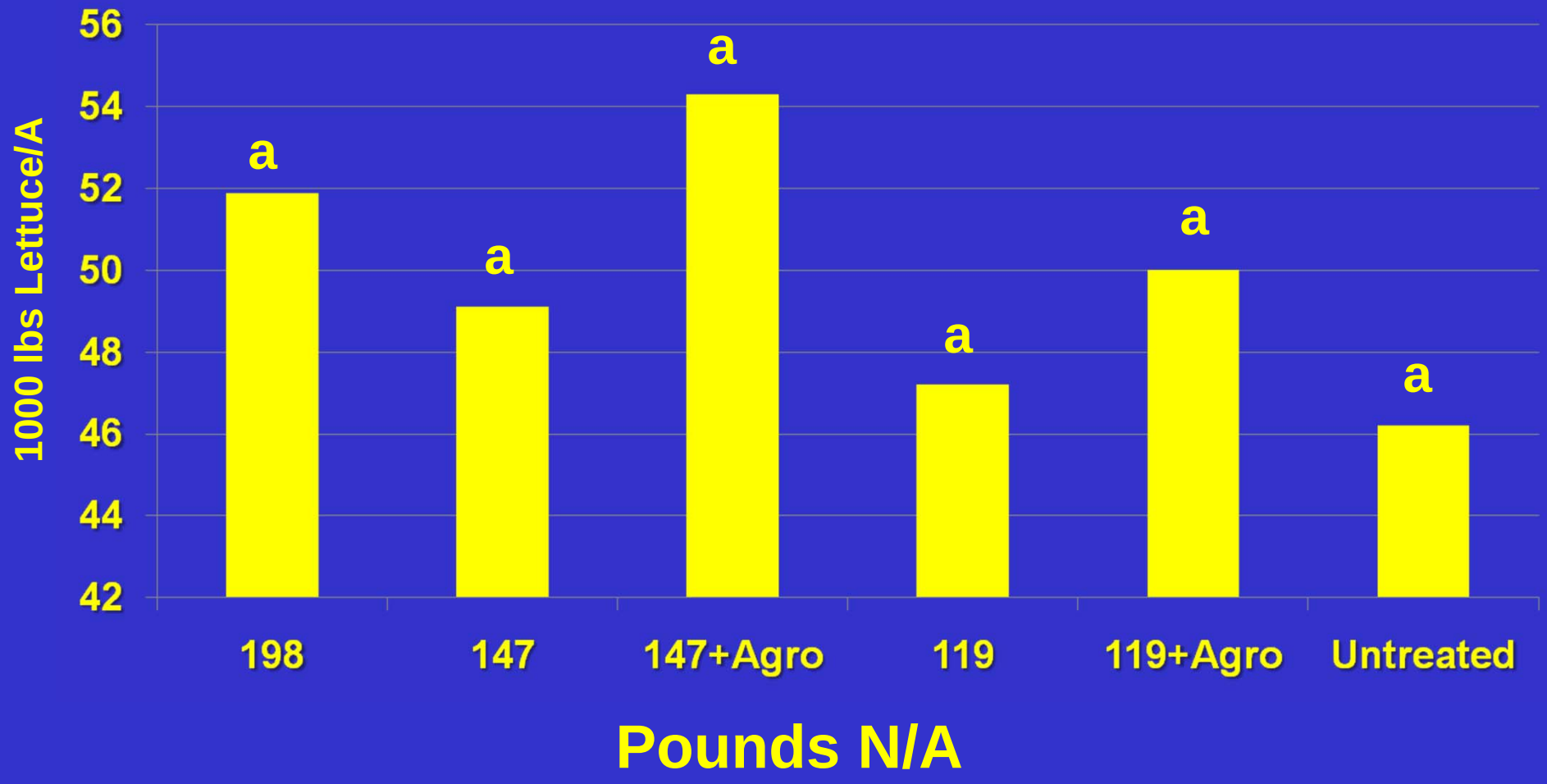
Materials Injected into Drip System

Agrotain Plus in UN32

Injection Manifolds

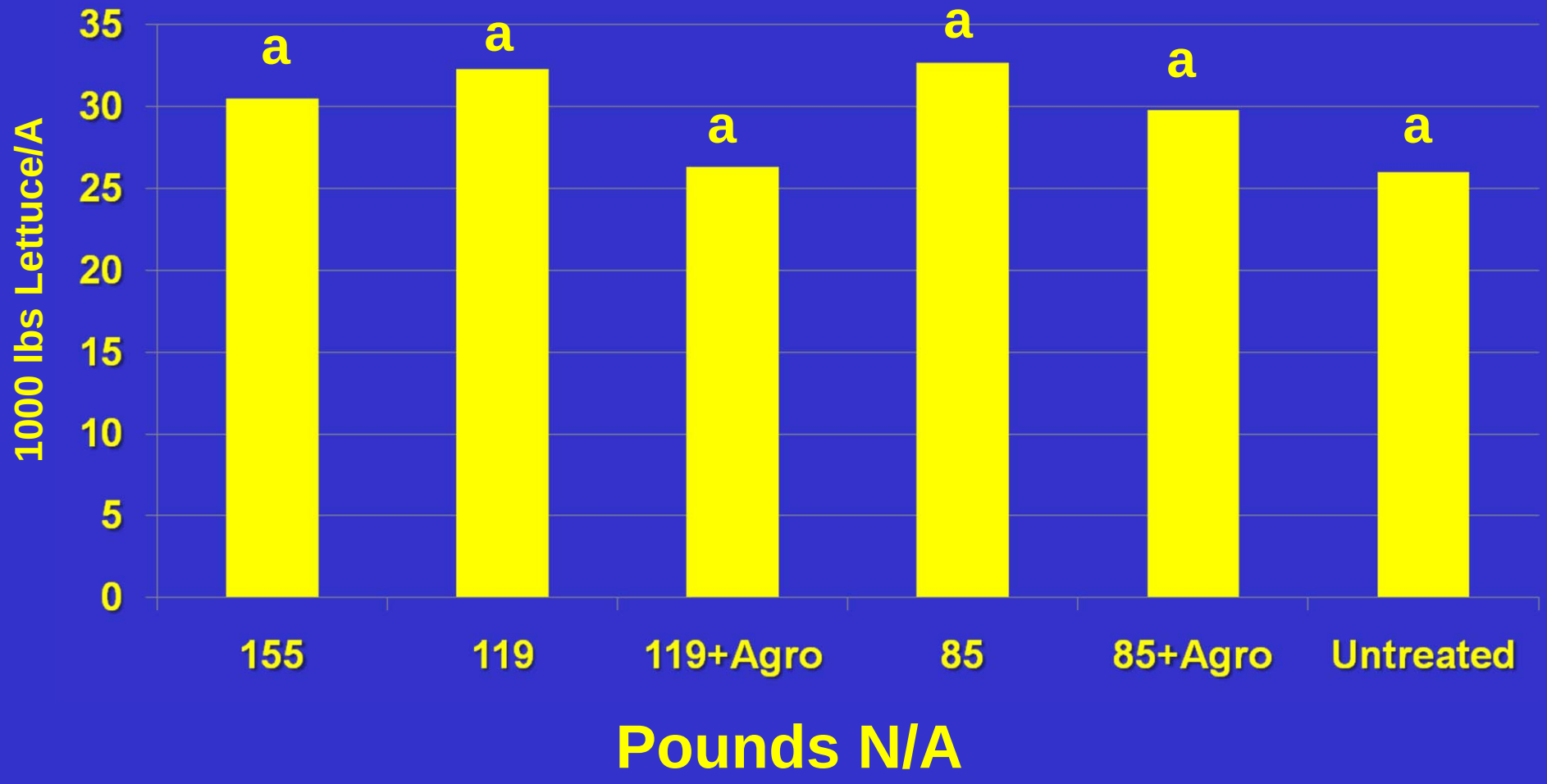
Lettuce Yield

2008 On-Farm Trial



Lettuce Yield

2008 Hartnell Trial

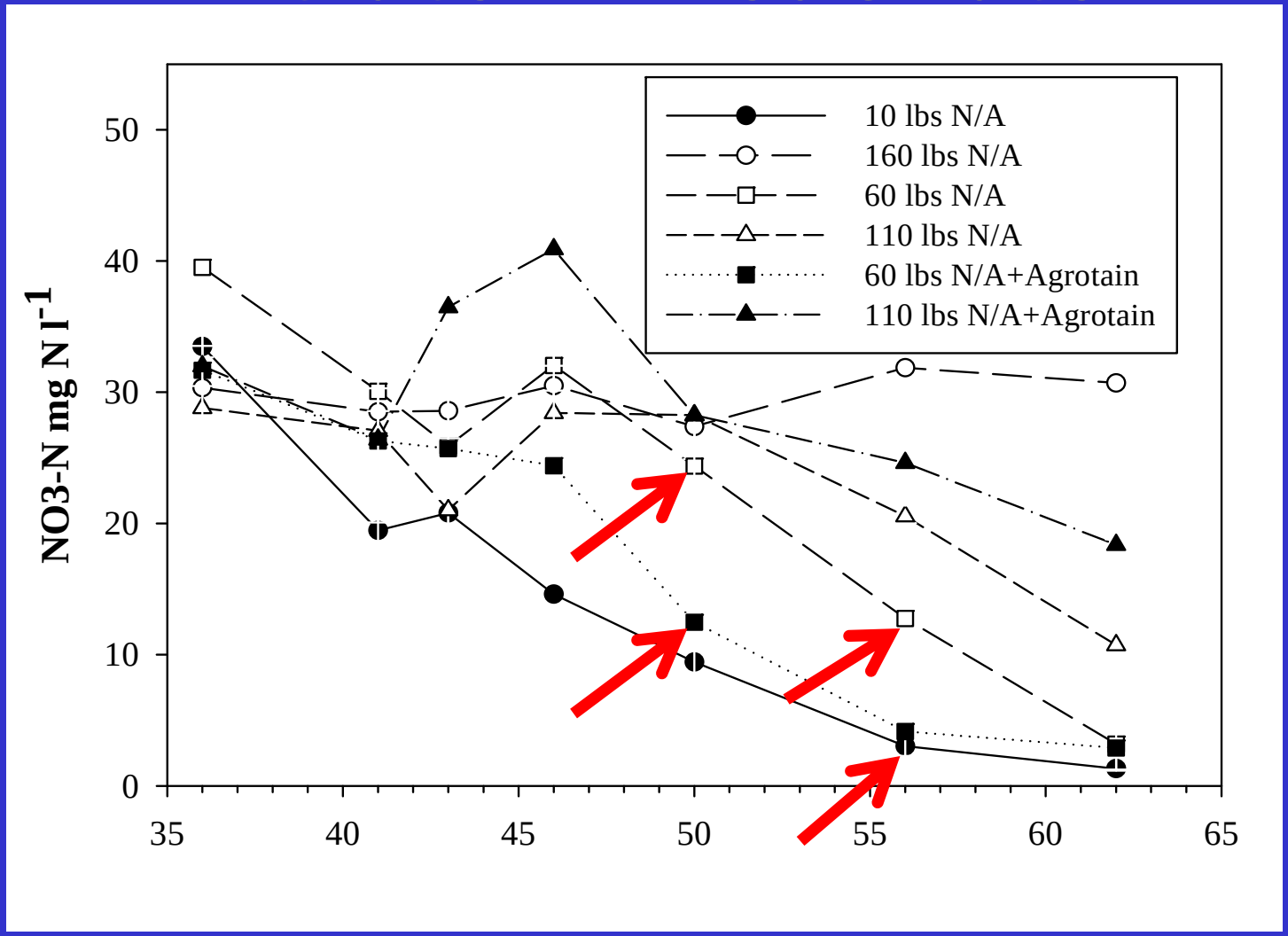


2010 Trial

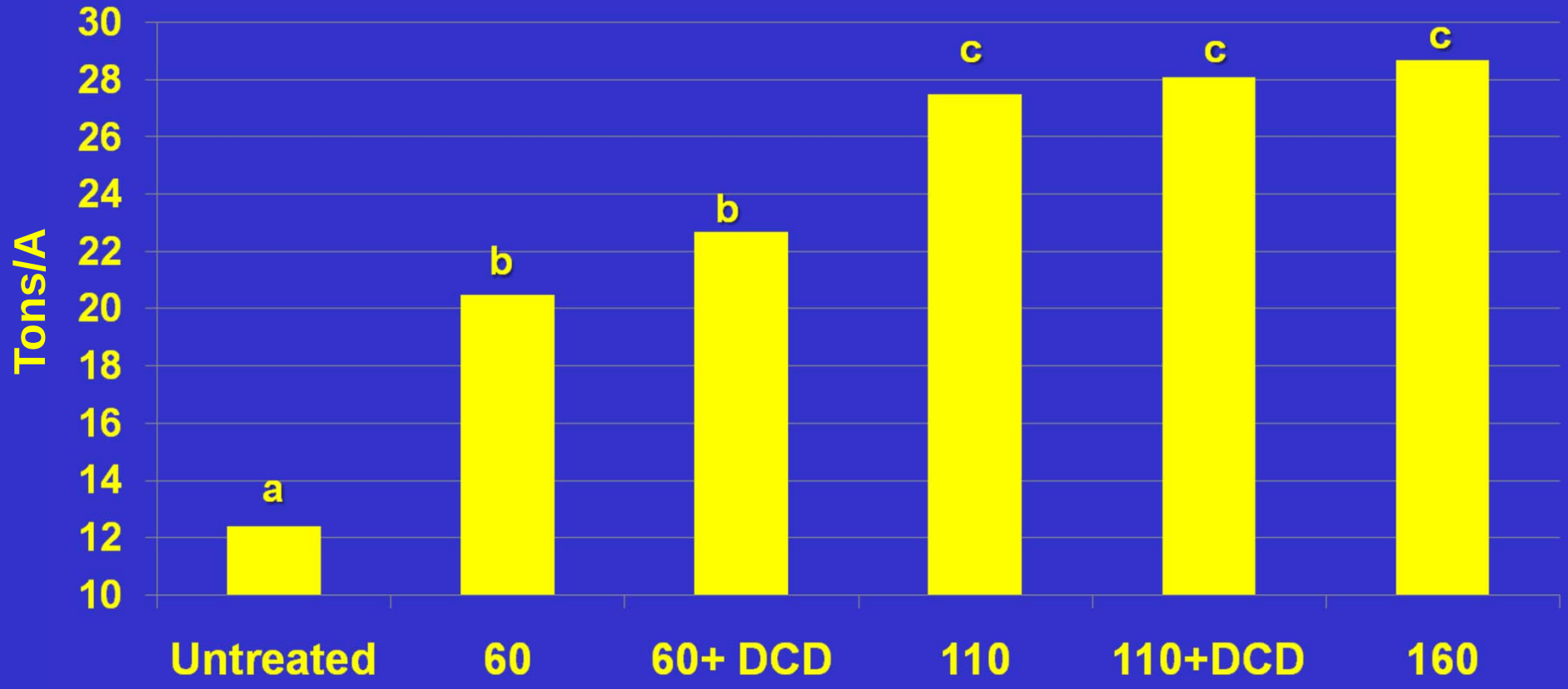
Untreated

Standard

2010 Nitrification Inhibitor Impact on Nitrate in Leachate



Lettuce Yield
2010 Nitrification Inhibitor Trial
(application lbs N/A)



2011 Nitrification Inhibitor Trial on Romaine

Treatment	Lbs N/A	Yield Tons/A	Head Wt lbs
Untreated	10	11.2	0.8
Standard	150	19.8	1.4
Medioum	100	17.5	1.2
Medium + Agrotain	100	19.4	1.4
Medium + 4% DCD	100	17.8	1.3
Medium + 8% DCD	100	18.1	1.3

Foliar Nitrogen

2010 Foliar N Trial on Romaine

Treatment	Formulation	Application method	Number applications	Total applied lbs N/A
Untreated	---	---	---	0
Standard	UAN32	Drip	2	150
Impact	15-0-0-7	Foliar	5	9
Coron	28-0-0-0	Foliar	5	15

2010 Foliar N Trial on Romaine

Treatments	Mean head wt (lbs)	Yield, fresh (ton/A)	Total N in Plant %	Total N in Plant lbs N/A
Untreated	1.63	24.4	3.5	94.2
Standard	2.07	30.9	4.0	132.5
Impact	1.72	25.3	3.5	95.7
Coron	1.69	25.6	3.4	95.4

Spinach Nitrogen Nutrition

Preliminary Study on Spinach Nitrogen Nutrition

Spinach Nitrogen Nutrition

- Various forms of spinach: clipped (baby and teen), bunched and freezer
- Strict quality criteria for harvested product (green color)
- Susceptibility to turning yellow in adverse conditions (spring rains, field conditions, etc)

Preliminary Study on Spinach Nitrogen Nutrition

Treatment Lbs N fertilizer/A	Harvest tons/A	N Uptake lbs/A
0	3.8	22.5
50	4.8	26.8
100	8.9	75.6
150	13.5	108.0
200	11.6	107.0
300	11.4	106.3

Preliminary Study on Spinach Nitrogen Nutrition

Treatment Lbs N fertilizer/A	% N in plant	Plant C:N ratio	N Uptake Rate lbs N/A/day
0	2.2	17.8	1.4
50	2.4	16.4	1.4
100	4.8	7.8	5.7
150	5.3	7.0	8.8
200	6.1	6.2	8.3
300	6.3	6.1	8.7

Summary

- Improvements in nitrogen use efficiency can be made and there are technologies that can help
- Evaluations of the improvements that can be gained from these technologies need to be evaluated from their impact on yield and nitrogen losses