

Nitrification Inhibitors for Improving Nitrogen Use Efficiency in Lettuce Production

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Why Nitrification Inhibitor

- To improve the efficiency of applied nitrogen – Nitrogen Use Efficiency
- In order to make improvements in NUE it is important to link nitrogen supply with nitrogen demand, while minimizing nitrogen losses

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

Recommendations for Water Code Waiver
for Agricultural Discharges

Staff Report

*Report Proposing a Draft Agricultural Order
For Public Review and Comment*

November 2010

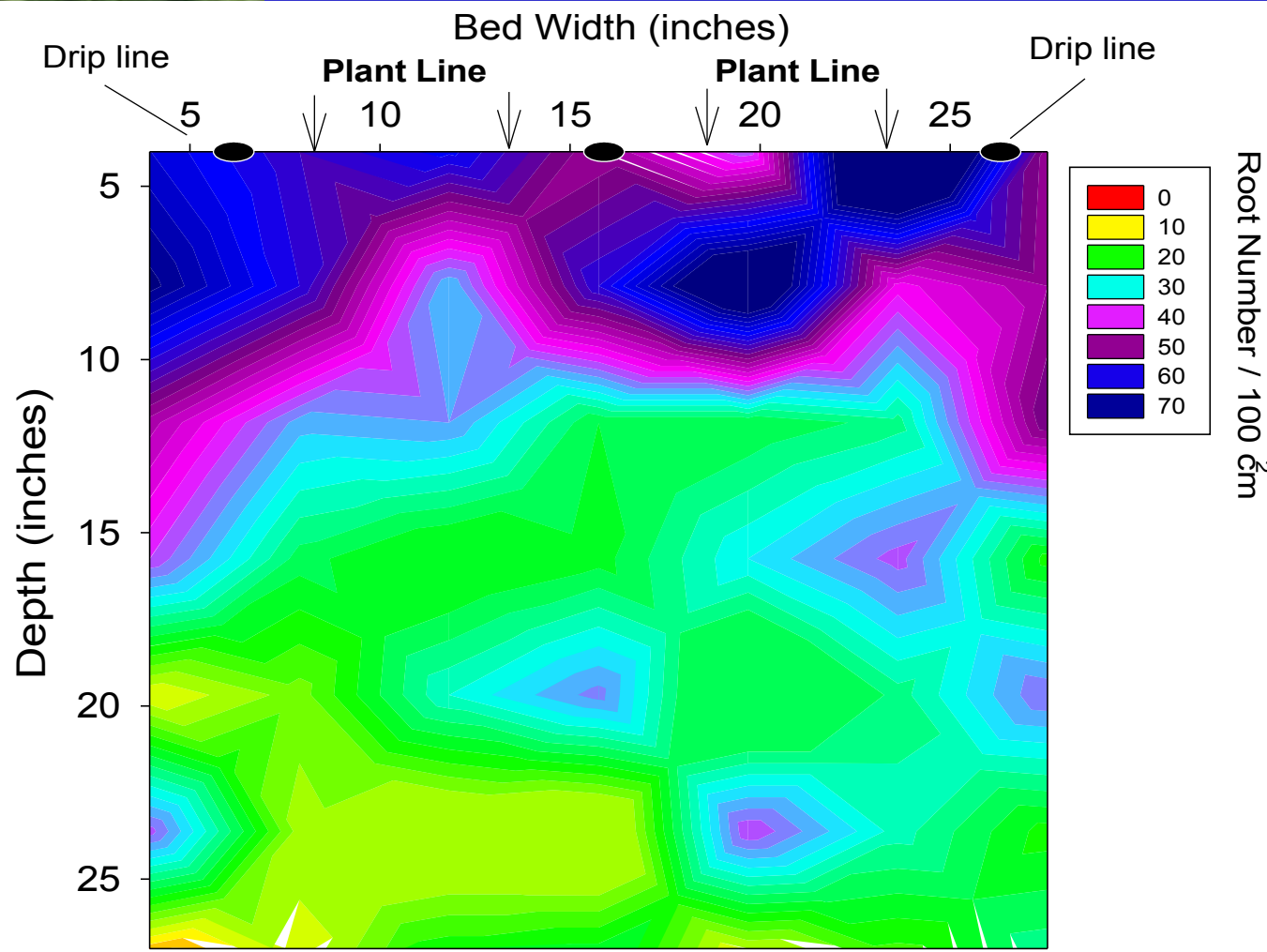
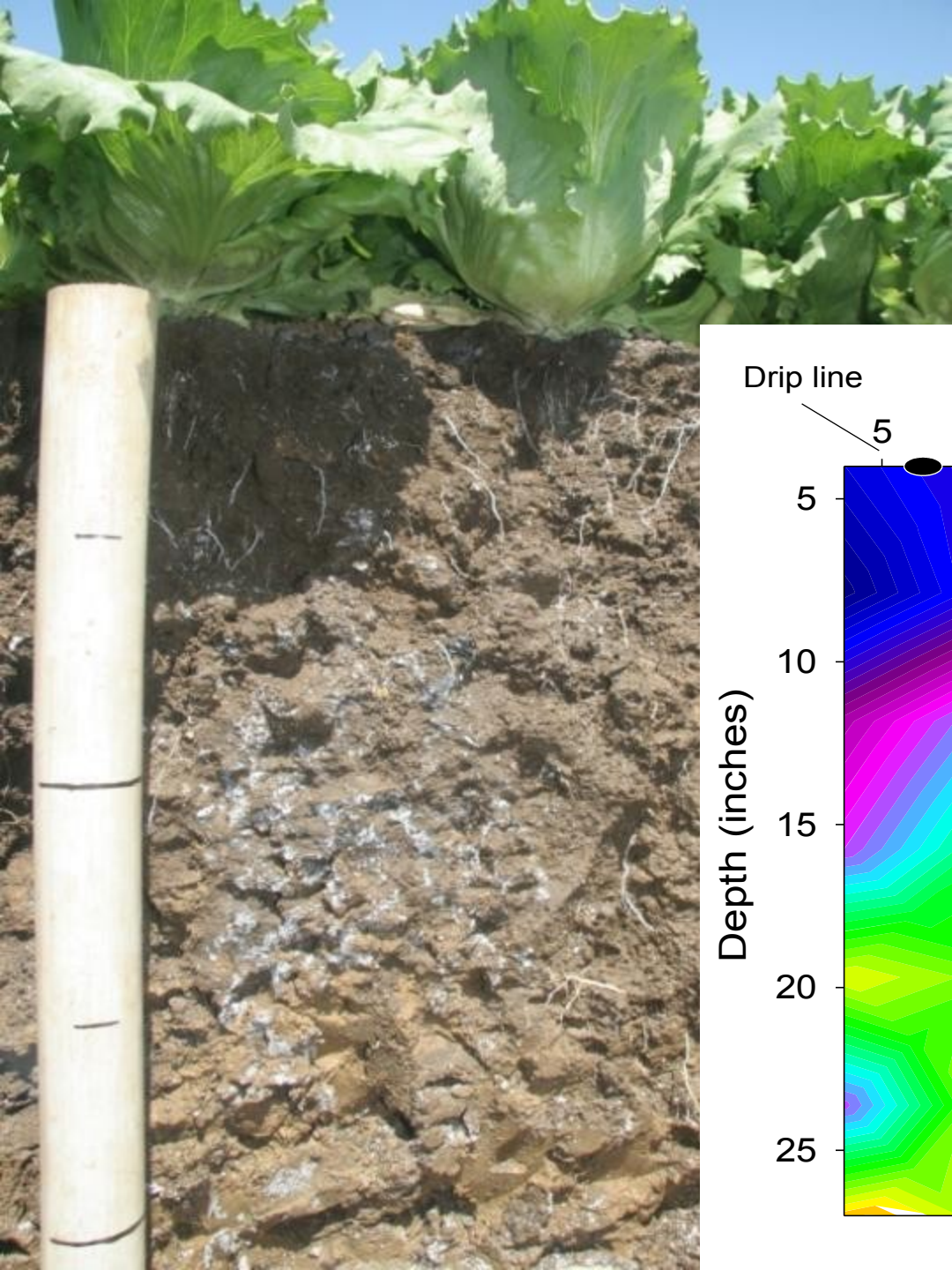


**Concerns over
nitrogen use
efficiency of lettuce
production has
greater urgency due
to the issuance of
the agricultural
order by the Central
Coast Regional
Water Quality
Control Board on
November 19, 2010**

- **The proposed regulations stipulate that growers must not apply more nitrogen than the crop removes:**
 - **1.0 factor for applied fertilizer vs what is removed by the crop for double cropped vegetables**

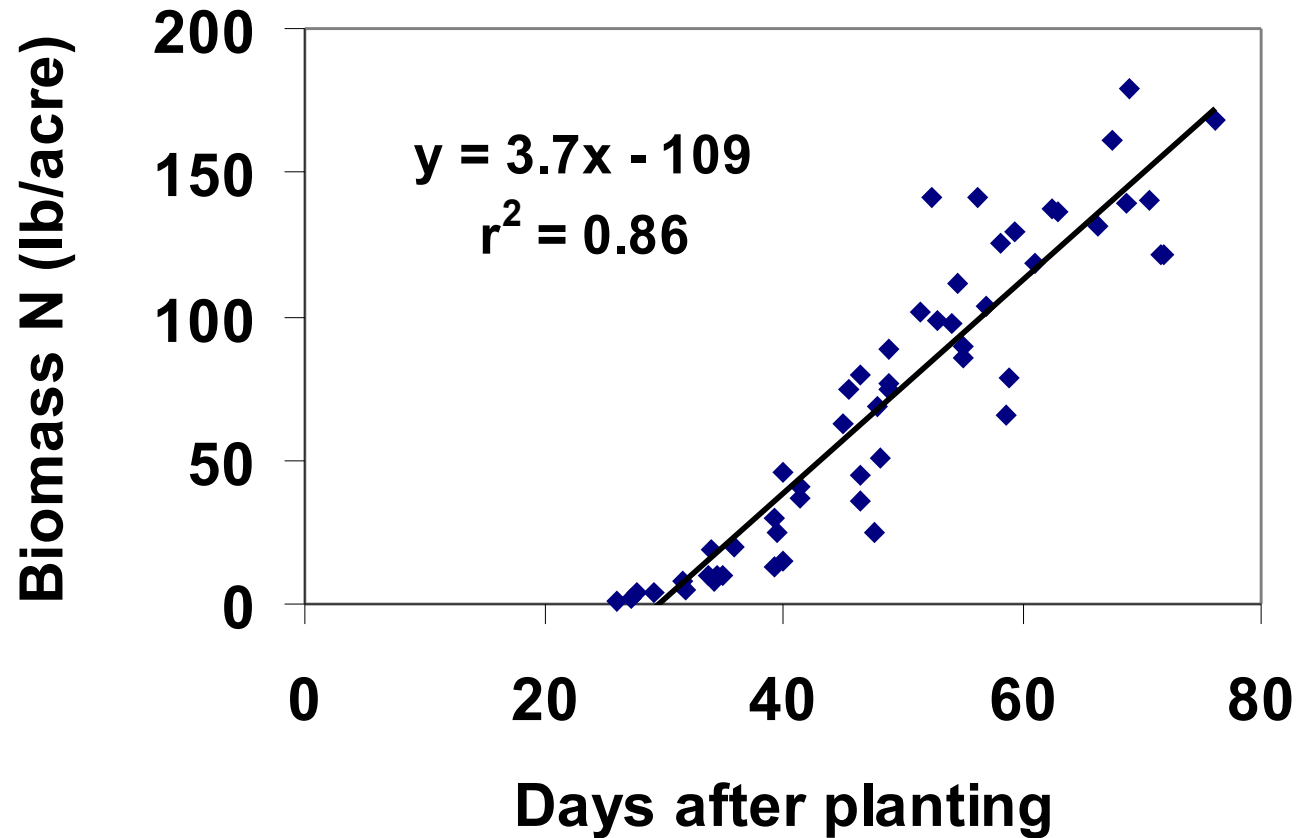
Challenges of Improving Nitrogen Use Efficiency in Lettuce Production

Root Distribution of Lettuce



Nitrogen Uptake by Head Lettuce Over Growing Season

Nearly all N uptake occurs from 30-65 days

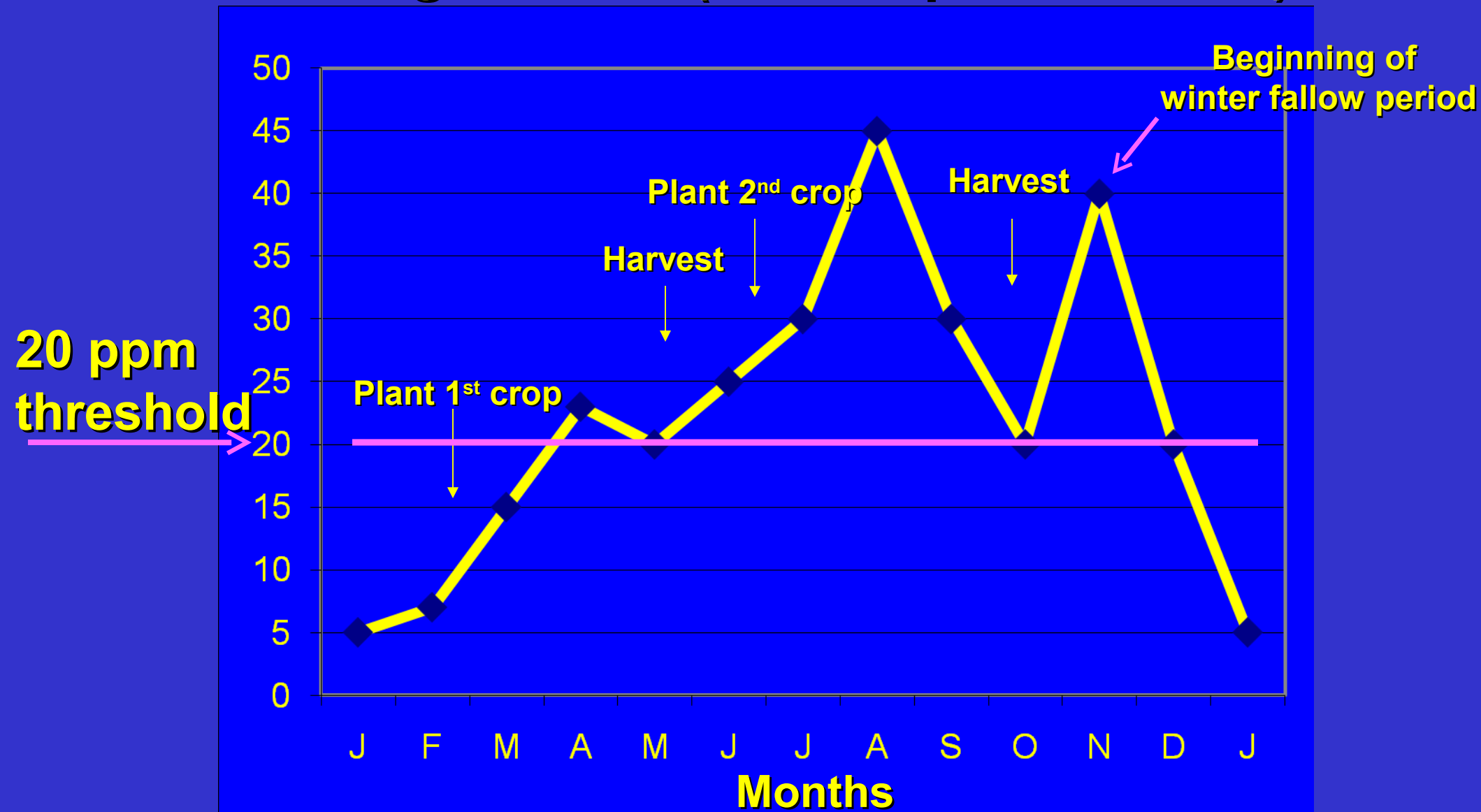


Intensity of Production Impact on Nitrate Losses



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

Residual Nitrate-Nitrogen in Soil Over Growing Season (two crops of lettuce)



Lettuce and Winter Rotational Crops

Acres Trends
(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

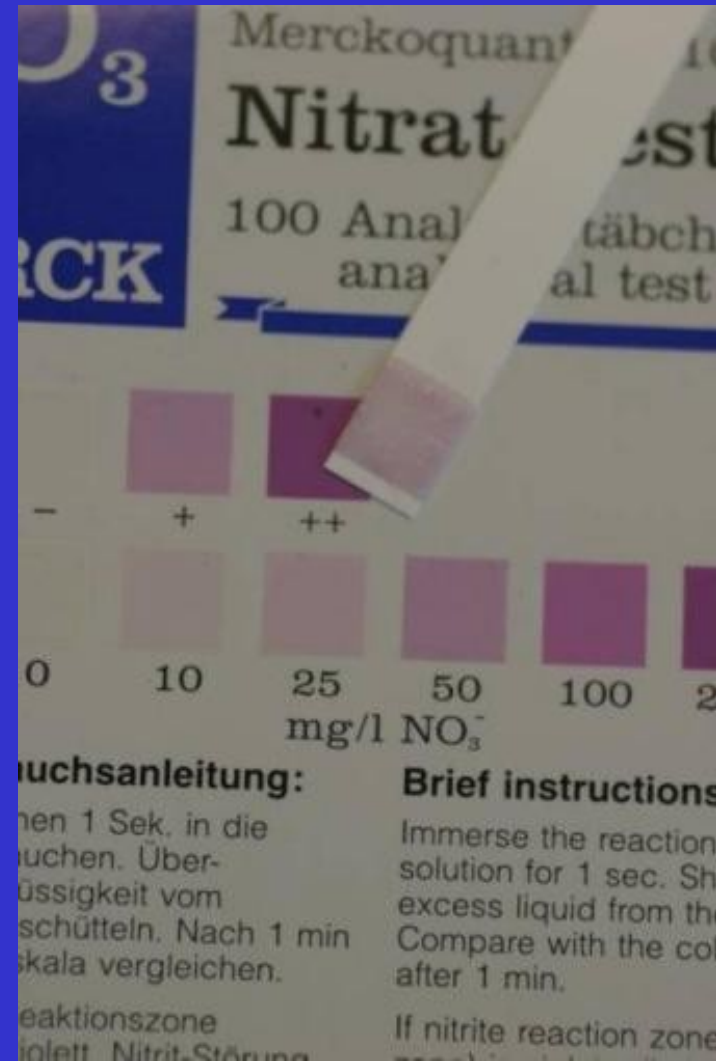
- One inch of leached water carries 23 lbs of N/A
 - @ 100 ppm nitrate-N in the soil solution



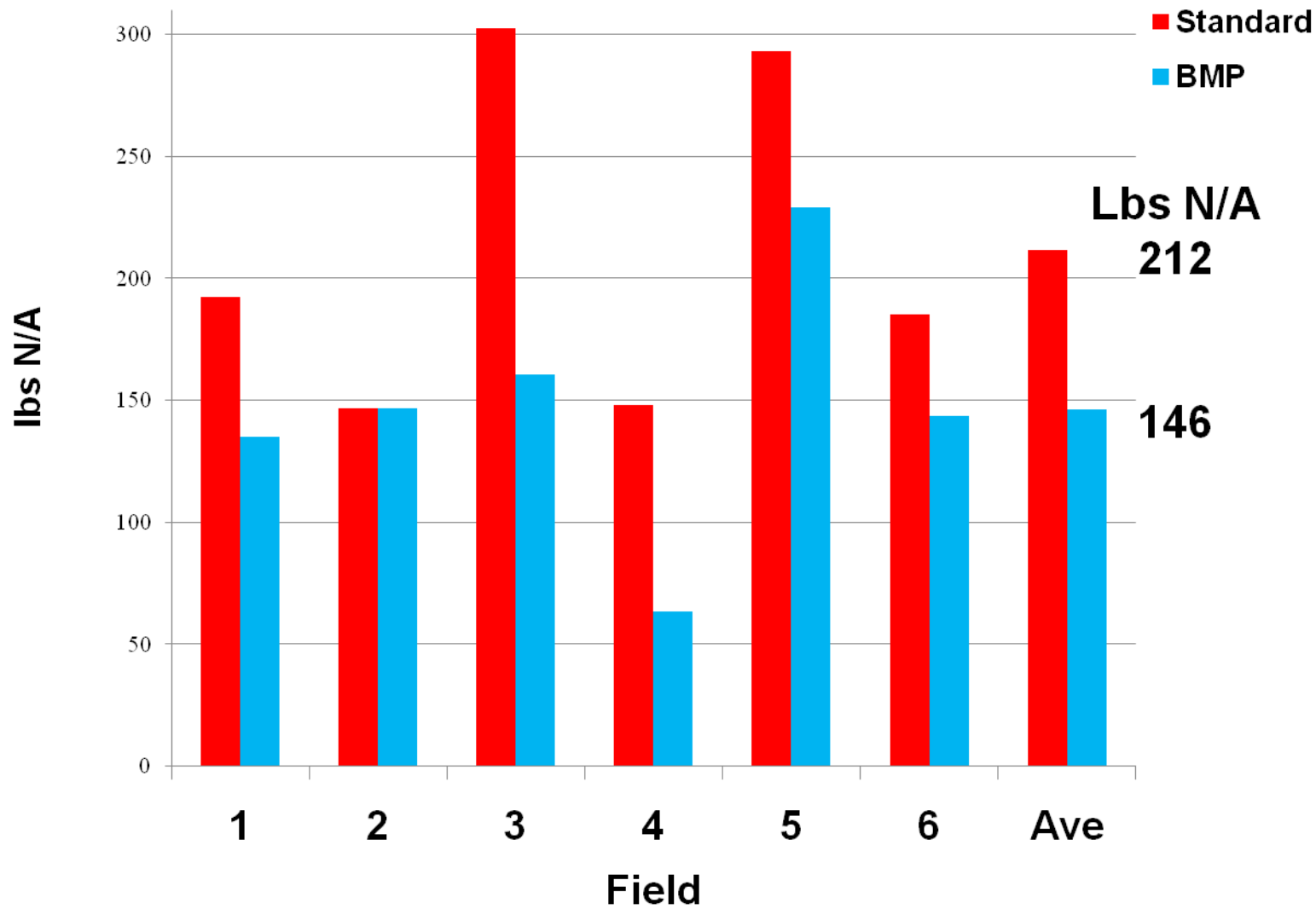
Tools to Improve Efficiency

- **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



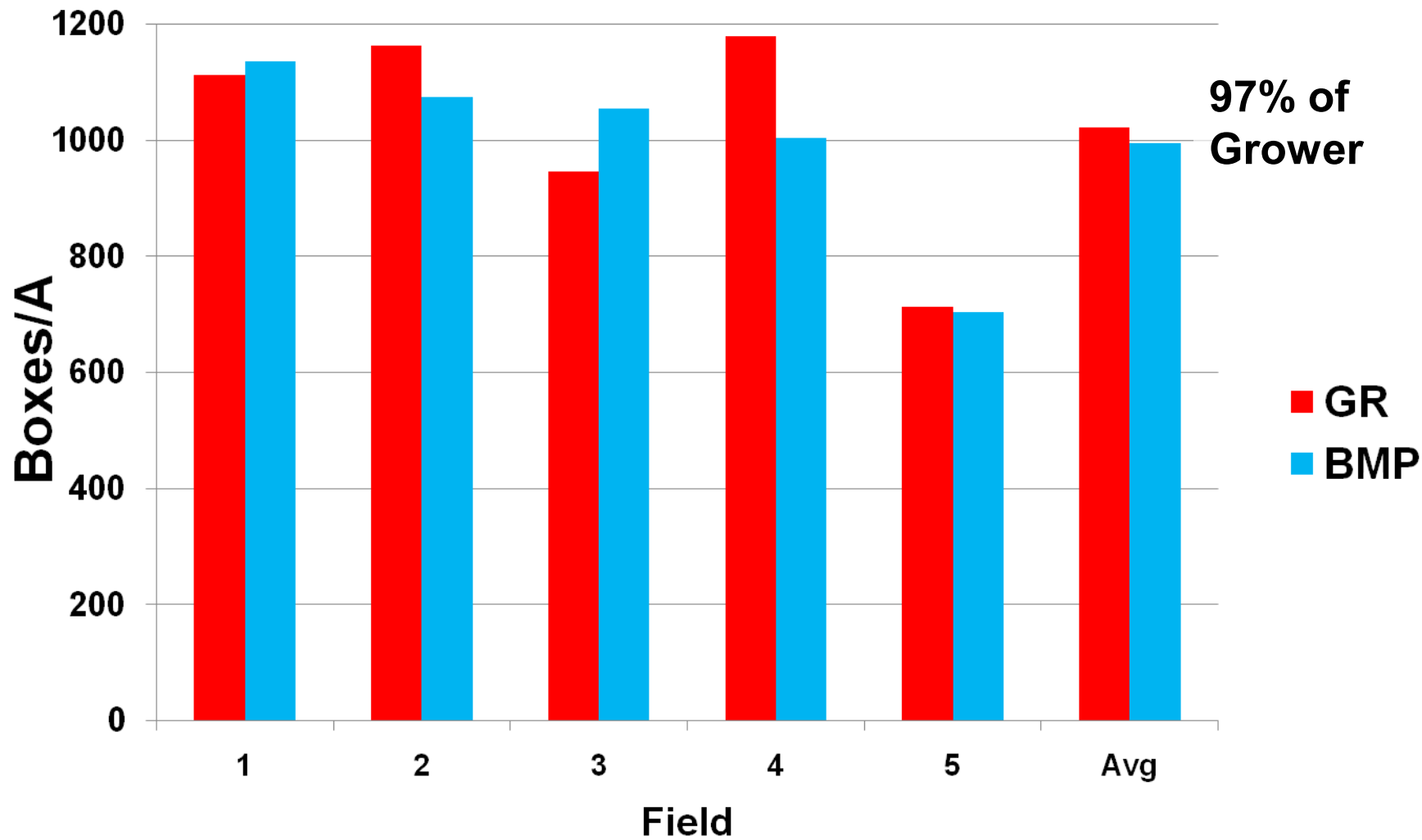
2010 Nitrogen Fertilizer Trials



**Difference
66 lbs/A**

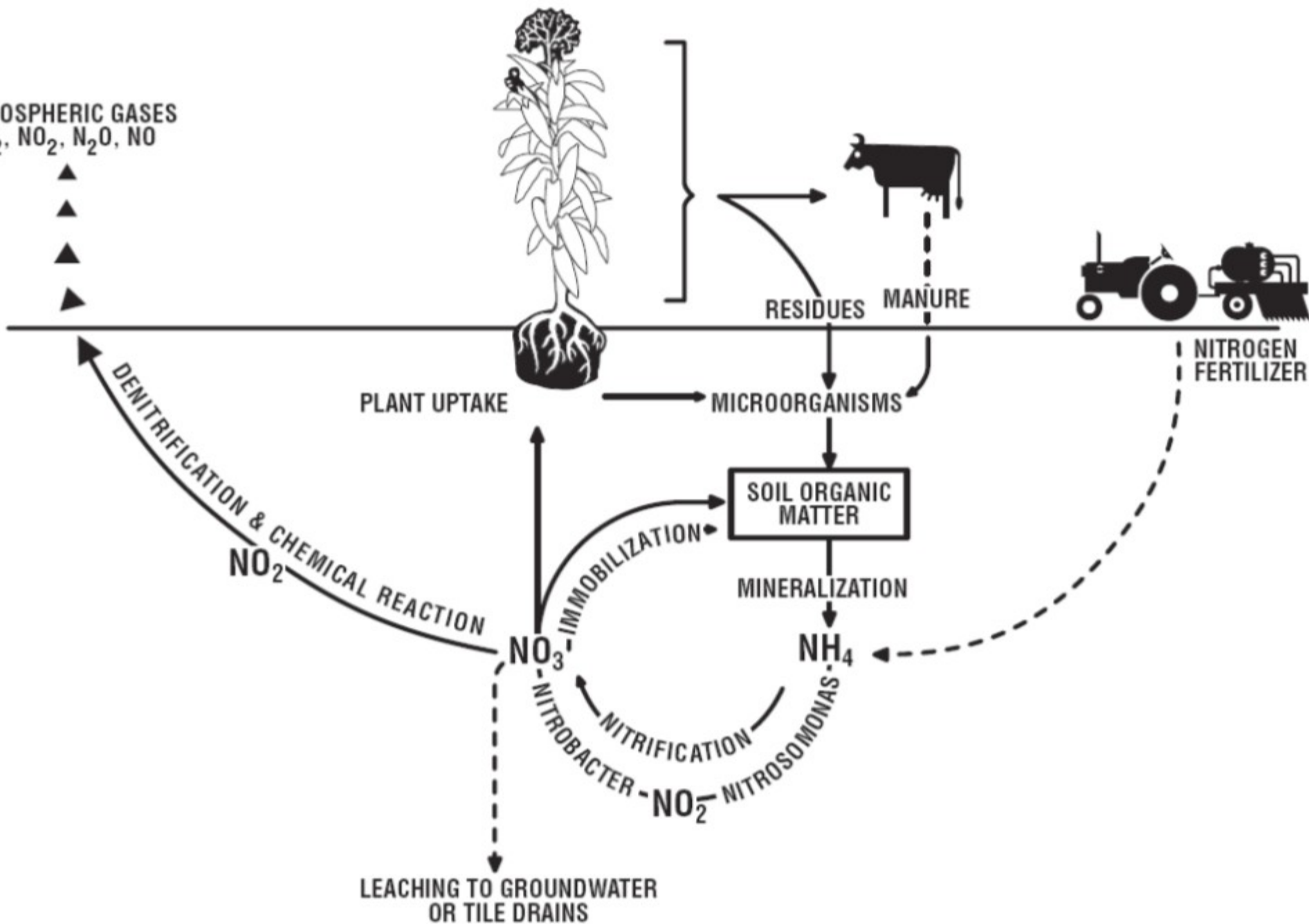
**@ 0.60/lb N
=\$40/A**

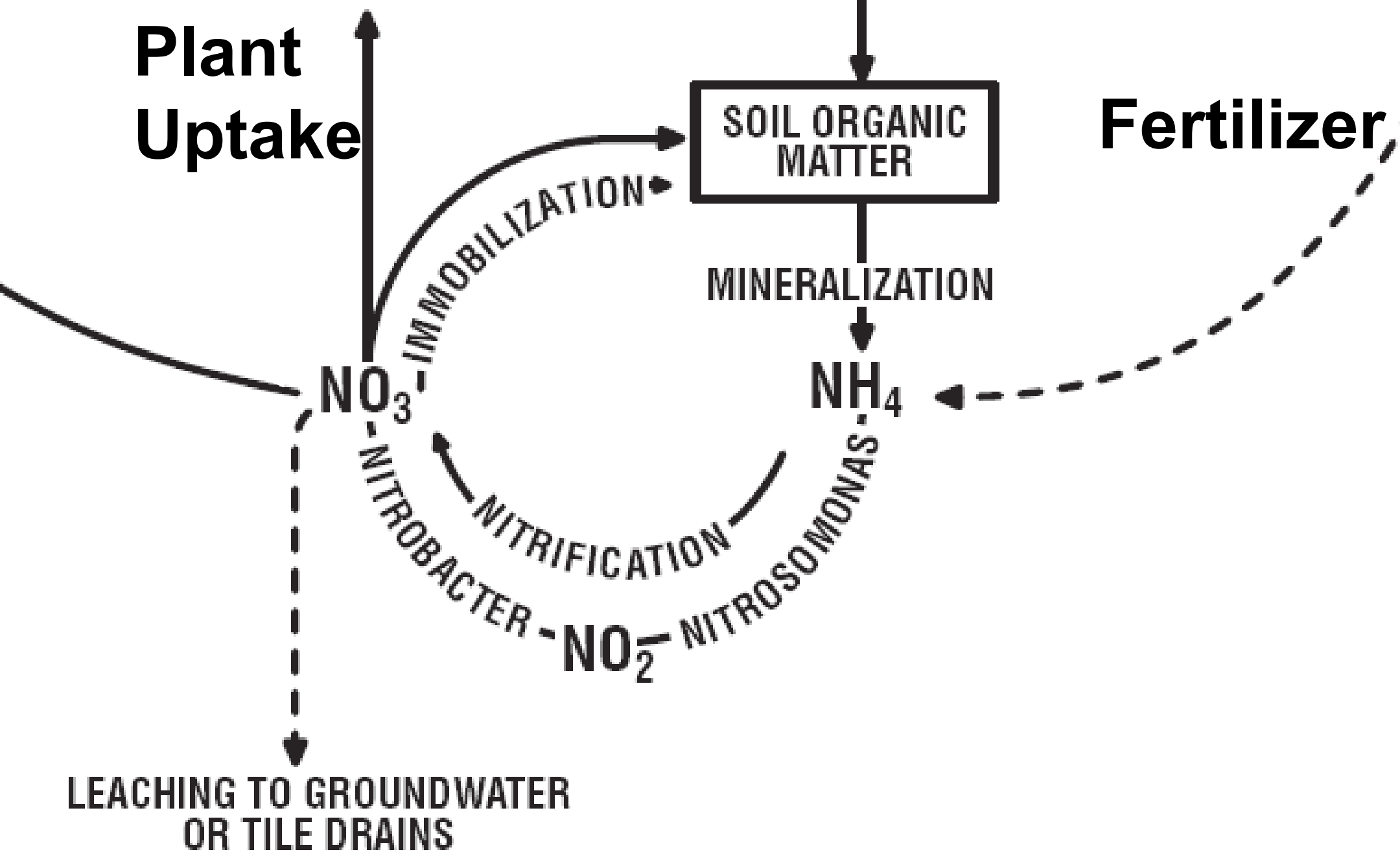
Commercial Yield



**Potential of Nitrification
Inhibitors to Improve Nitrogen
Use Efficiency in Lettuce
Production**

ATMOSPHERIC GASES
 N_2 , NO_2 , N_2O , NO







Nitrification - conversion of ammonium to nitrate

- In warm soils (>50 °F), it occurs in 2-3 weeks

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 lettuce

Nitrification Inhibitors

- **Two forms of Agrotain**
 - **Agrotain**
 - **Urease inhibitor**
 - **Only of interest where Urea is surface broadcast (not common here)**
 - **Agrotain plus**
 - **Urease inhibitor + DCD**

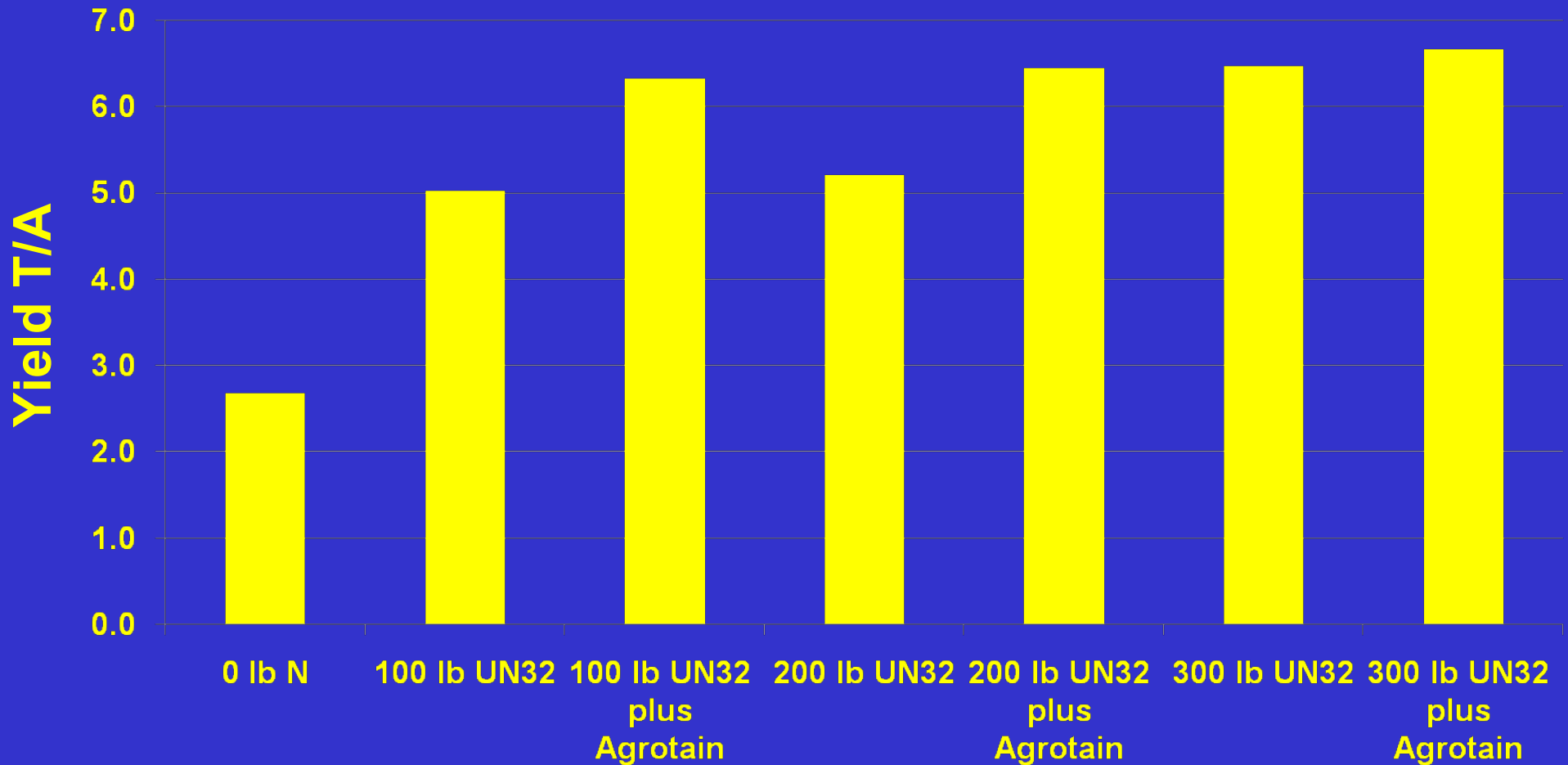
Effects of Nitrification Inhibitors

- **Instinct™ has been thoroughly studied over the past 30+ years in the corn belt, it has been shown to reduce nitrification for 4-6 weeks (depending on soil pH and temperature)**
- **Corn yields can be increased, but yield response depends on site factors**

Effects of Nitrification Inhibitors

- The highest probability of yield response occurs on coarse textured soils**
- Reductions in nitrate loss have been measured in these situations**
- The benefits of the use of nitrification inhibitors decrease as higher amounts of N are applied**

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

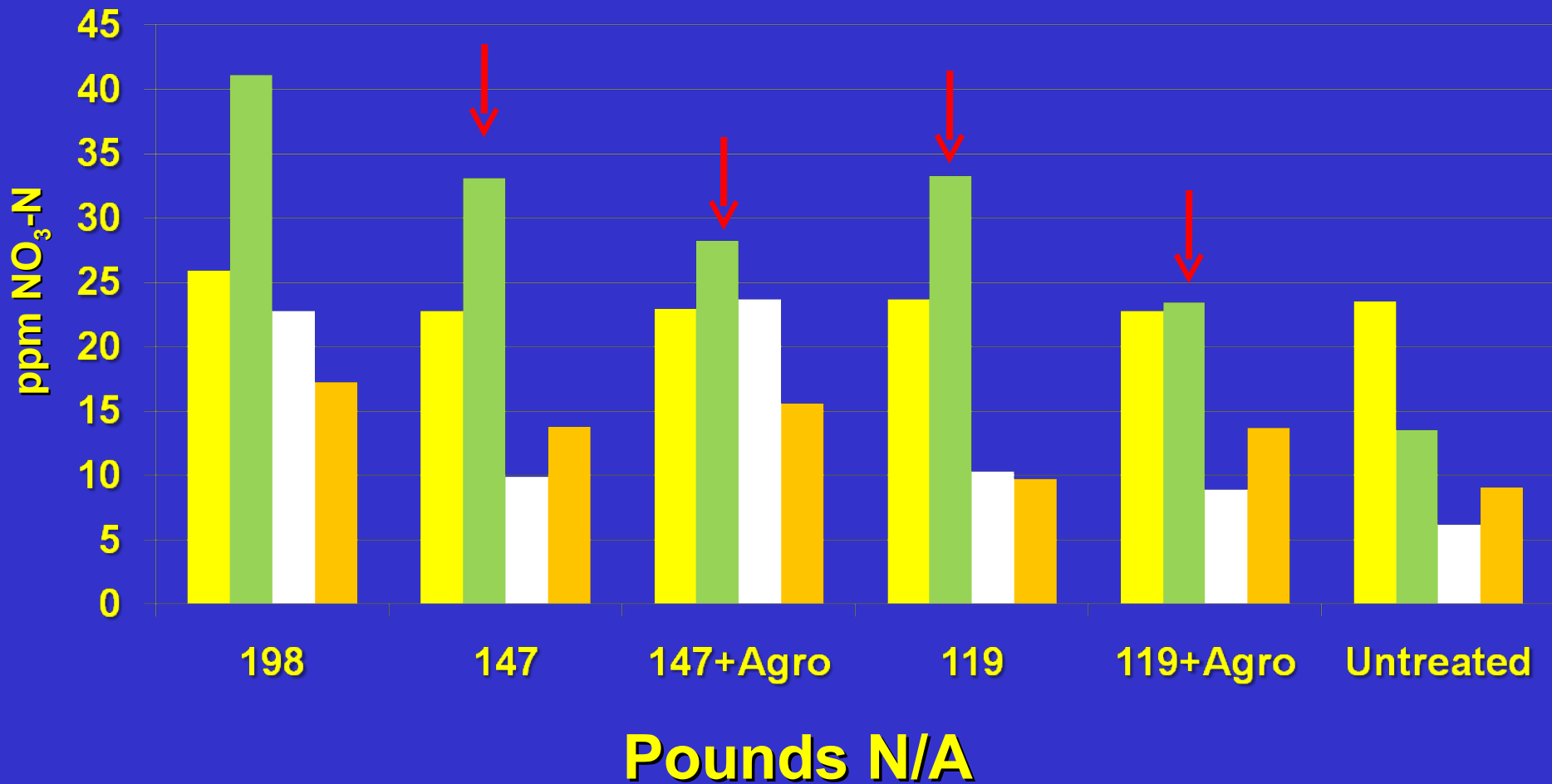


2008 and 2010 Lettuce Nitrification Inhibitor Trials

- Three trials conducted – one on-farm and two at Hartnell East Campus**
- 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)**

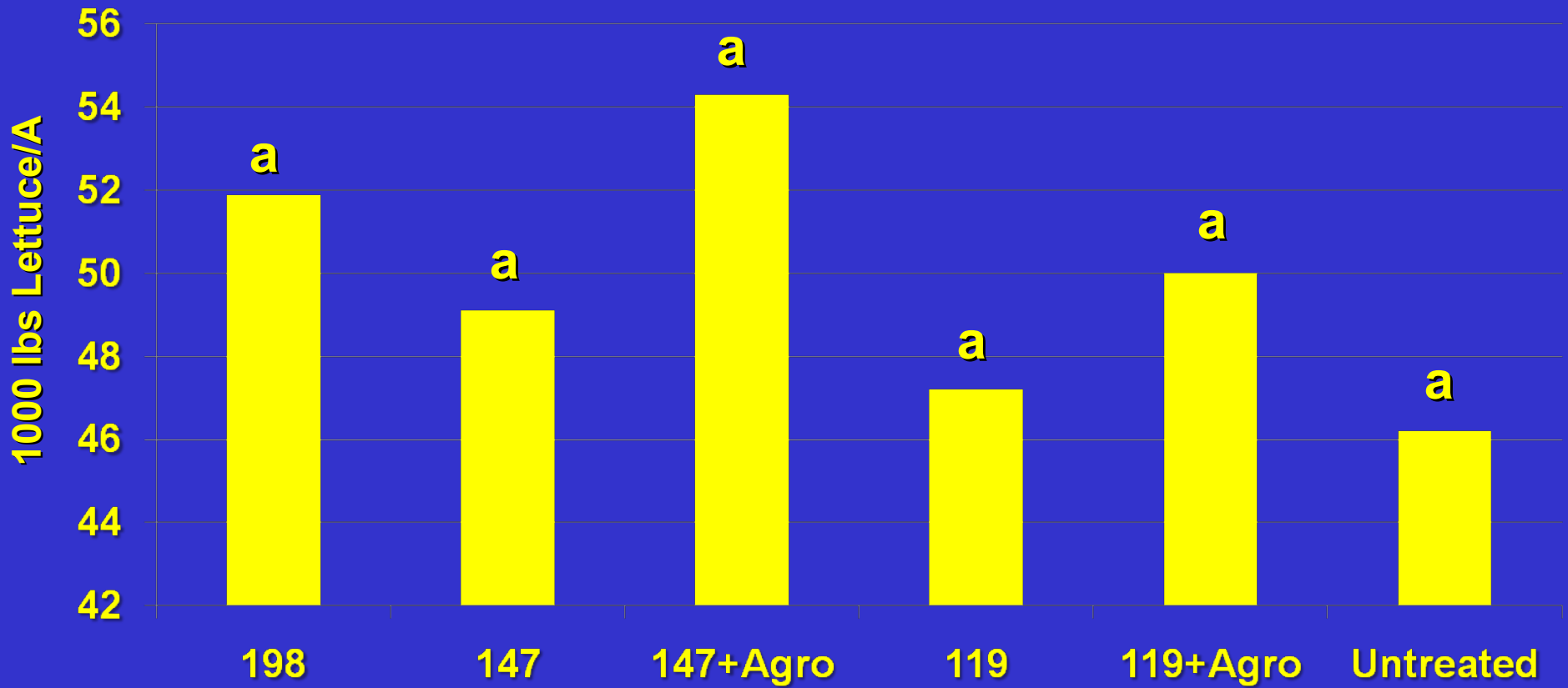
Soil Nitrate – Four Dates

2008 On-Farm Trial
Clay Loam Soil, Planted March 3



Lettuce Yield

2008 On-Farm Trial

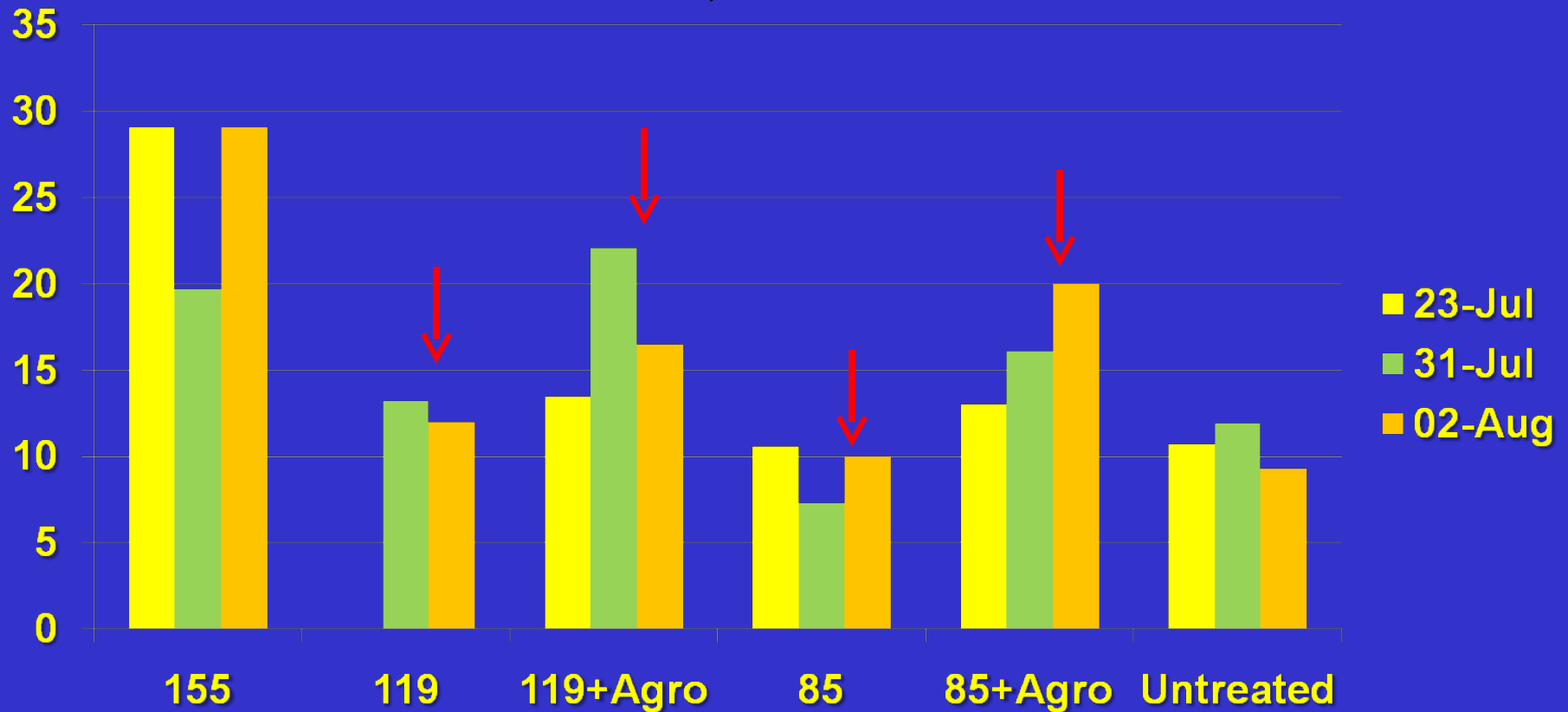


Pounds N/A

Soil Nitrate – Three Dates

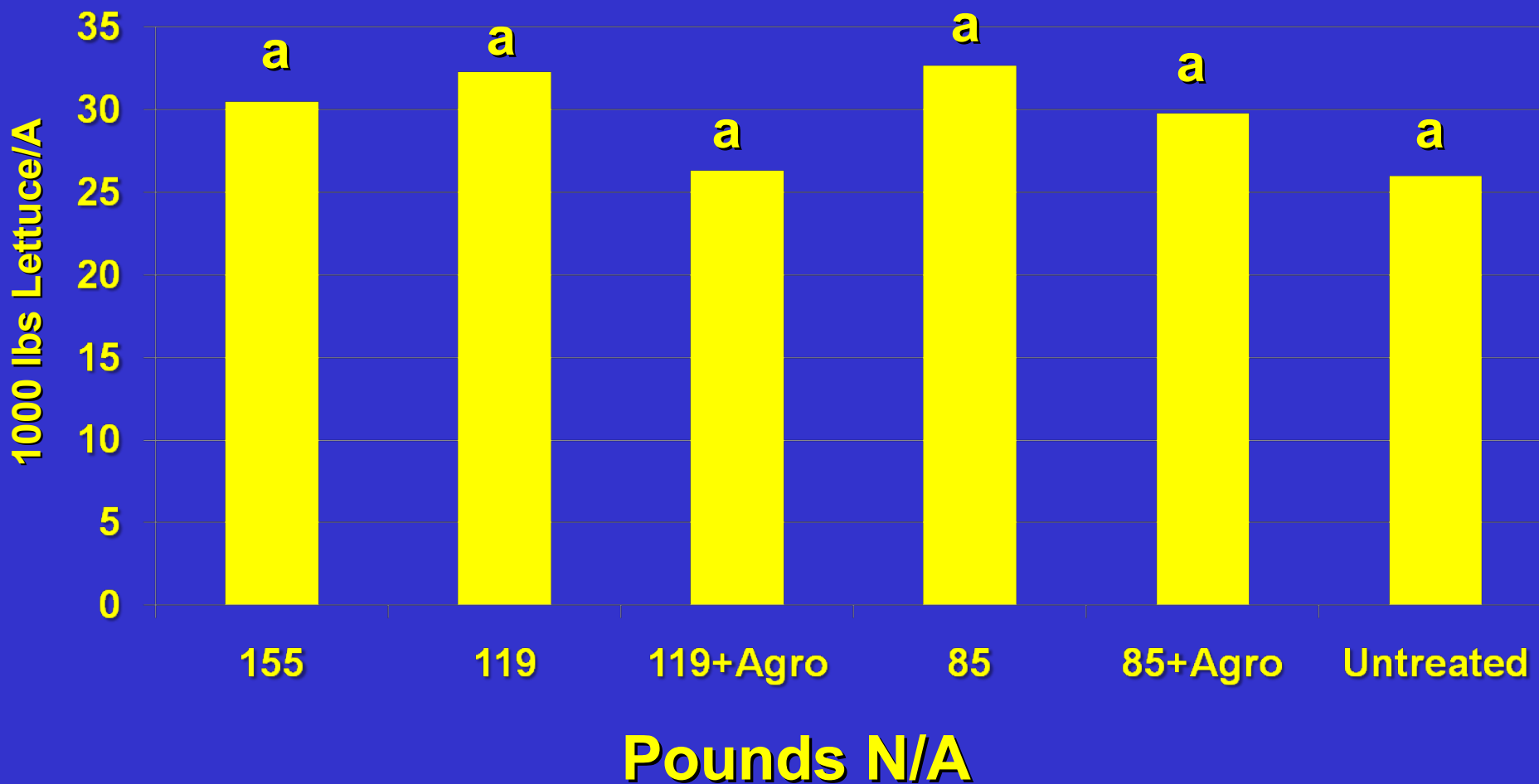
2008 Hartnell Trial

Loam Soil, Planted June 6



Lettuce Yield

2008 Hartnell Trial



2010 Hartnell Trial



Agrotain Plus in UN32



Injection Manifolds

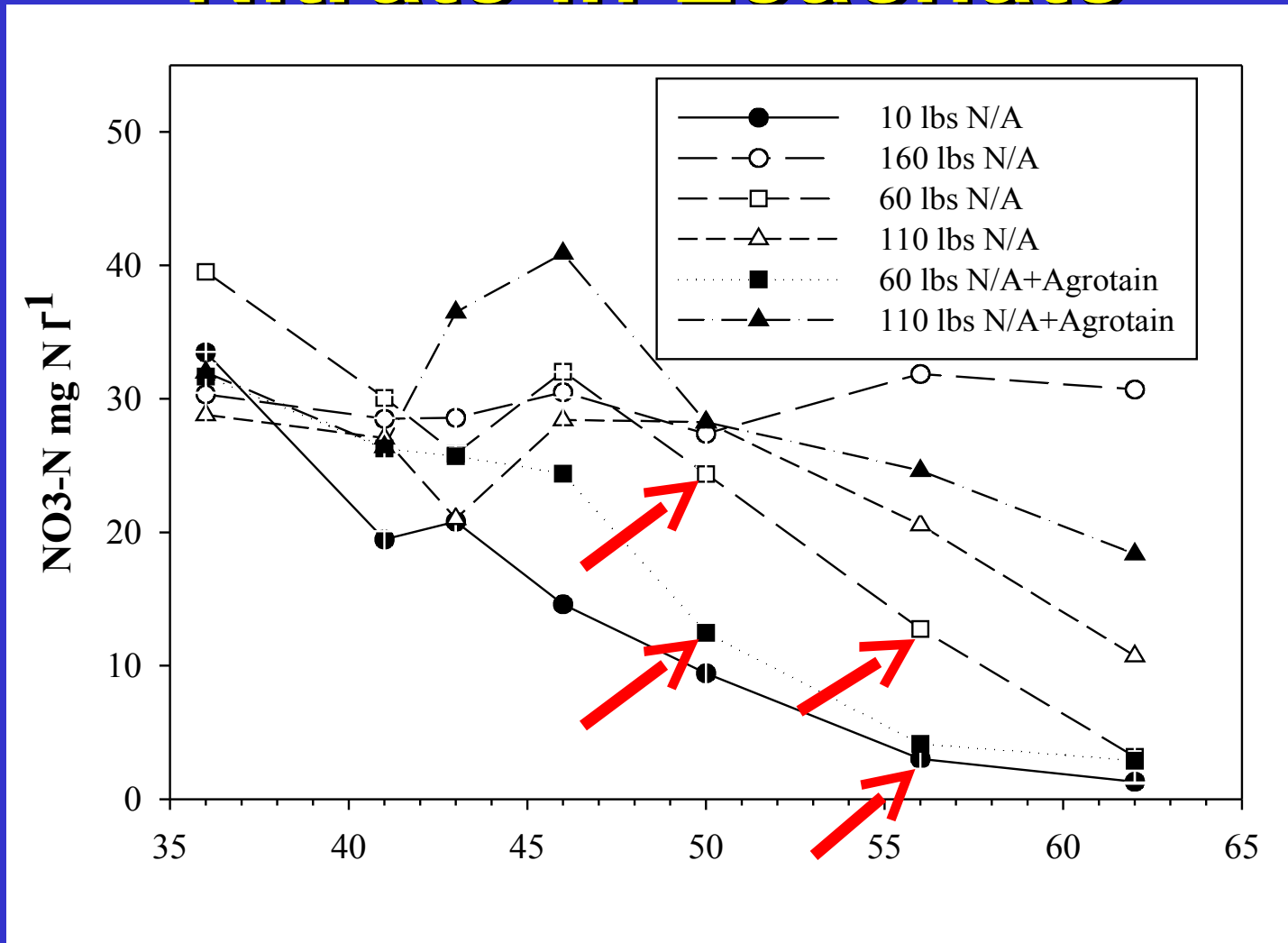
Excellent Response to Fertilizer



Untreated

Standard

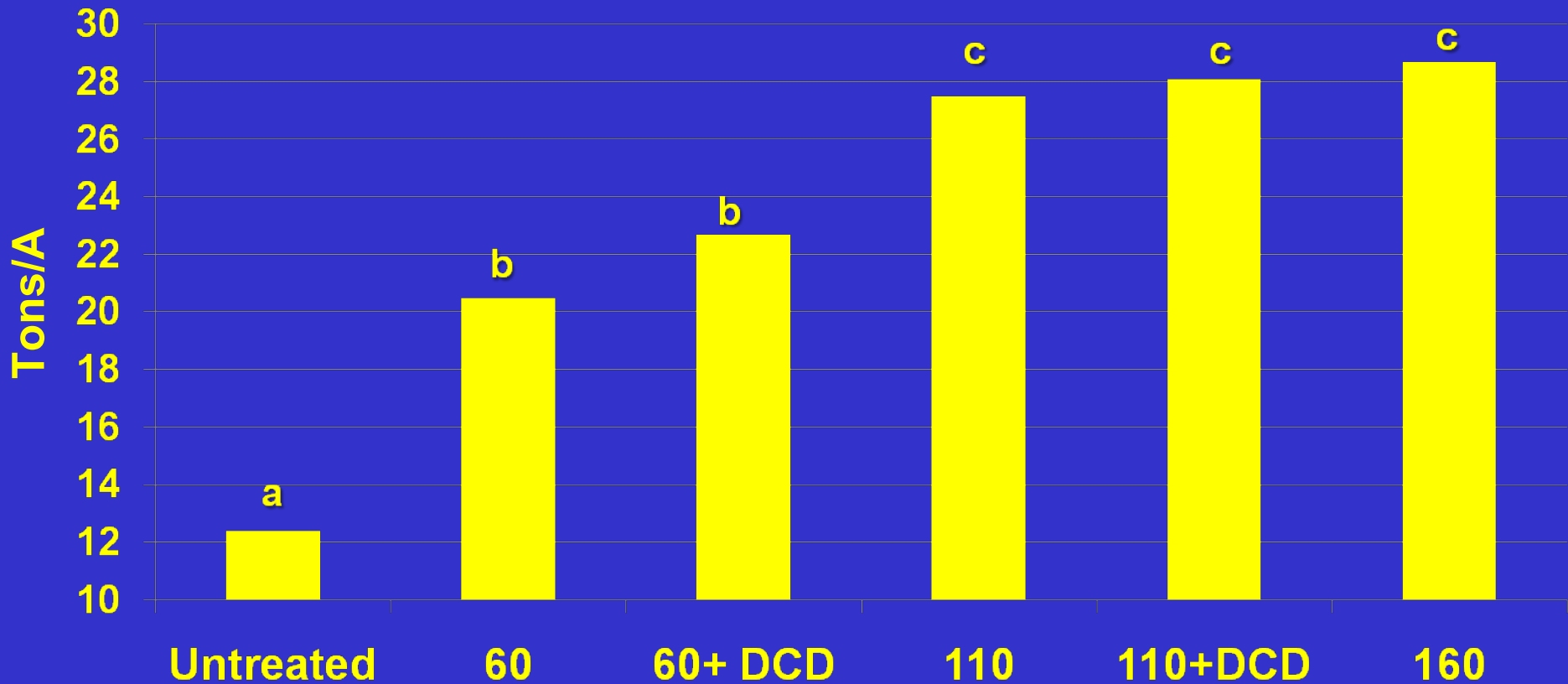
2010 Nitrification Inhibitor Impact on Nitrate in Leachate



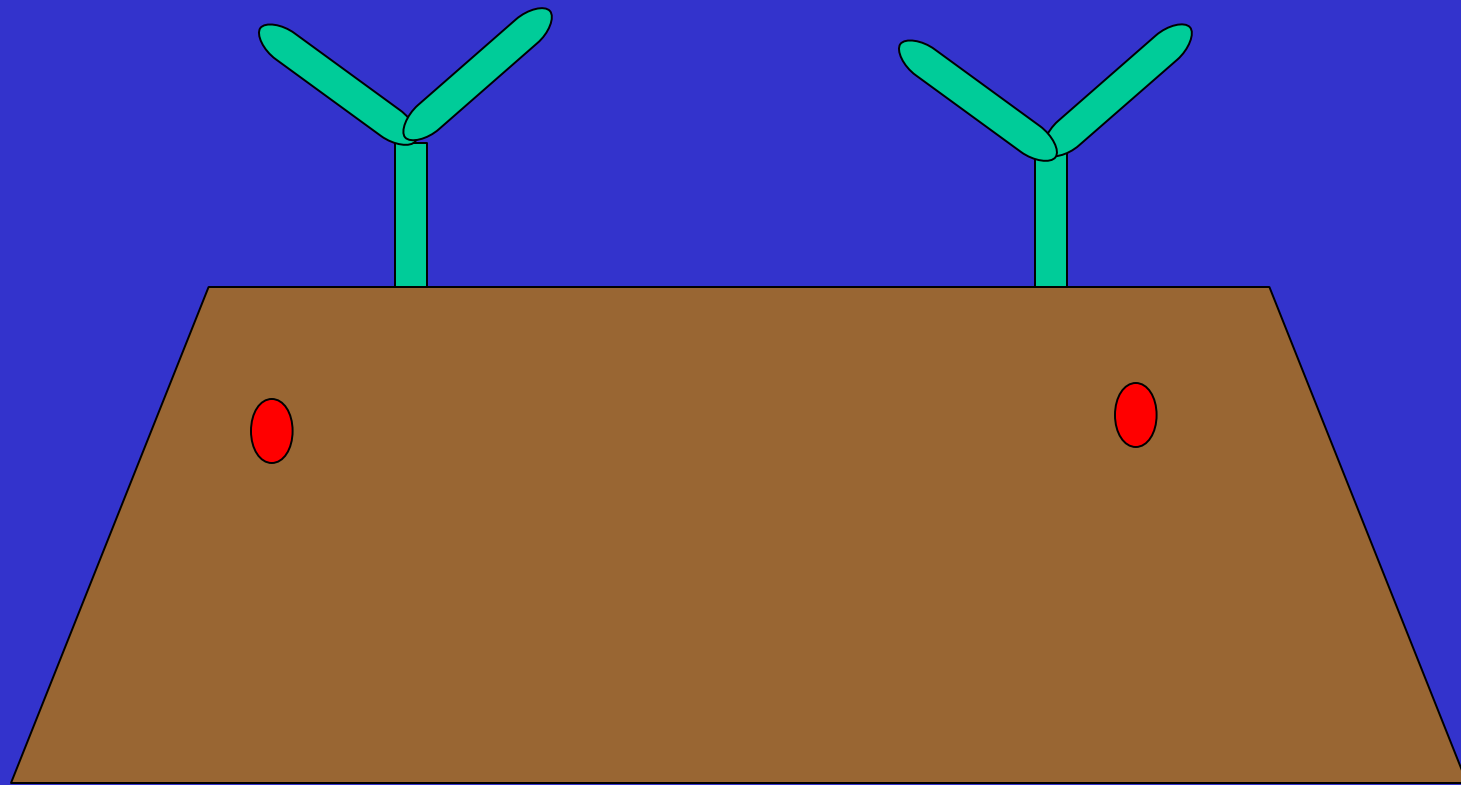
Lettuce Yield

2010 Nitrification Inhibitor Trial

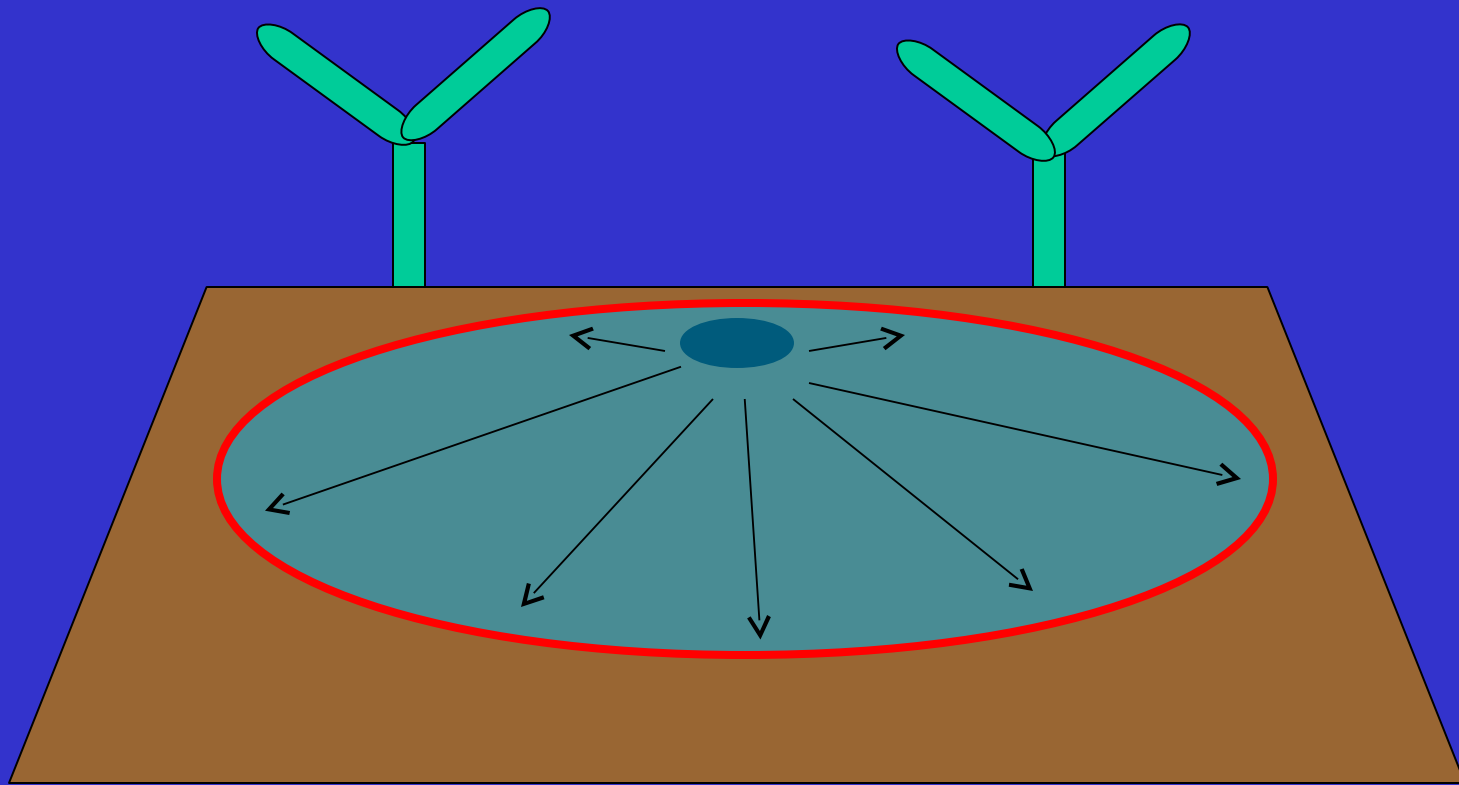
(application lbs N/A)



Why Not More Dramatic Results?

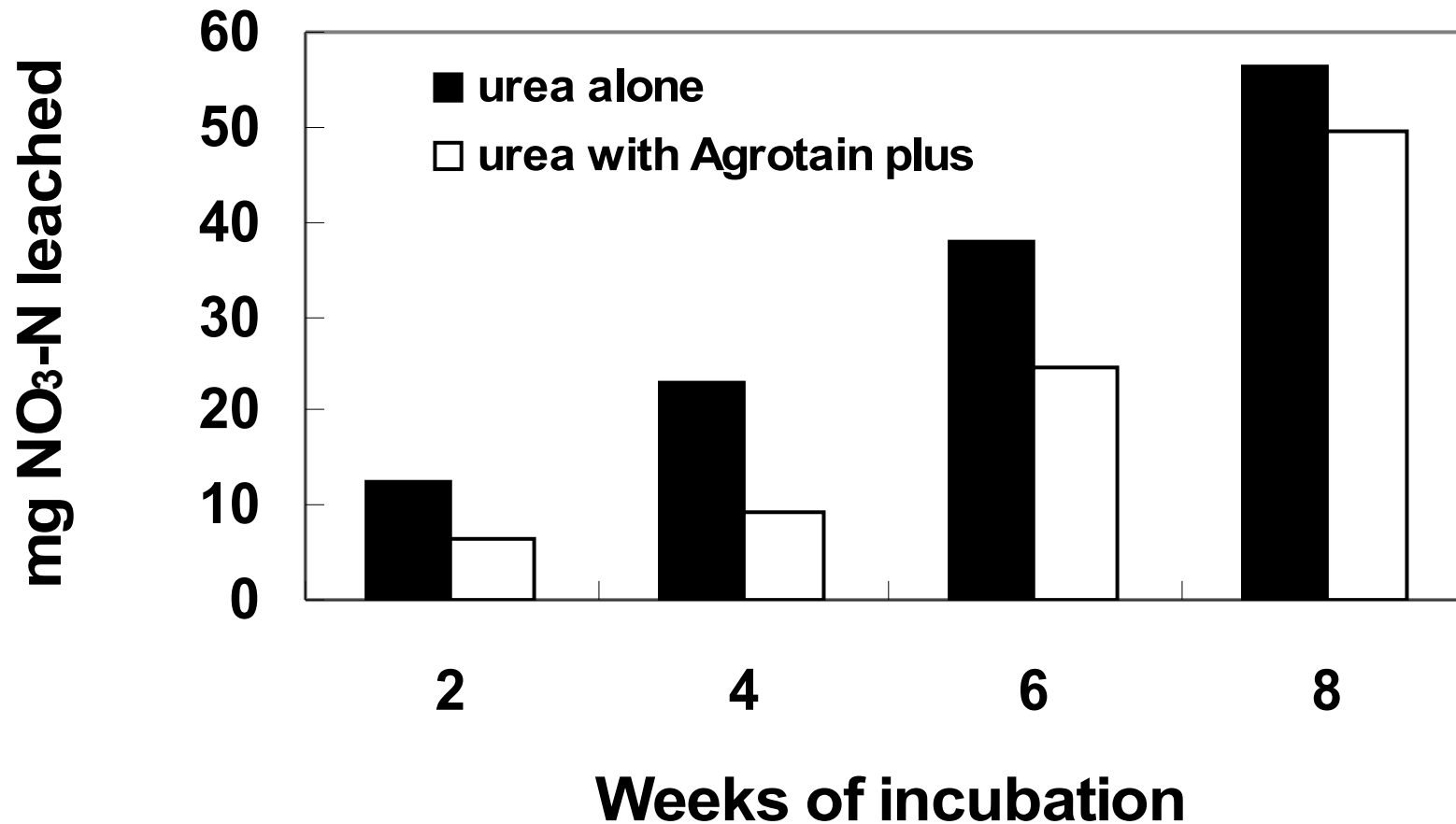


DCD banded with fertilizer is concentrated in a small volume of soil



**DCD applied in drip is diluted
in a greater volume of soil**

Water Soluble Nature of DCD



Summary of Nitrification Inhibitor Technology for Lettuce Production

- From the literature and from these studies, it is clear that nitrification inhibitors do reduce nitrification**
- They are limited in their ability to work effectively**
- They will be more effective in situations with moderate levels of nitrogen**

Summary of Nitrification Inhibitor Technology for Lettuce Production

- In these trials we were not able to show clear and statistically significant differences**
- Trends appear to be positive**
- There may be ways to improve the efficacy of DCD in lettuce production**