Nitrogen Uptake Dynamics of Spinach

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Background

- Spinach is an “at risk” crop in the new regulations by the Central Coast Regional Water Quality Control Board (CCRWQCB)
- Due to the nitrogen uptake dynamics, rooting depth and non-agronomic quality demands from the market place (e.g. deep green color), it is going to be difficult to comply with the 1.0 nitrogen balance goal stipulated by the Regional Water Quality Control Board

2011 Trials

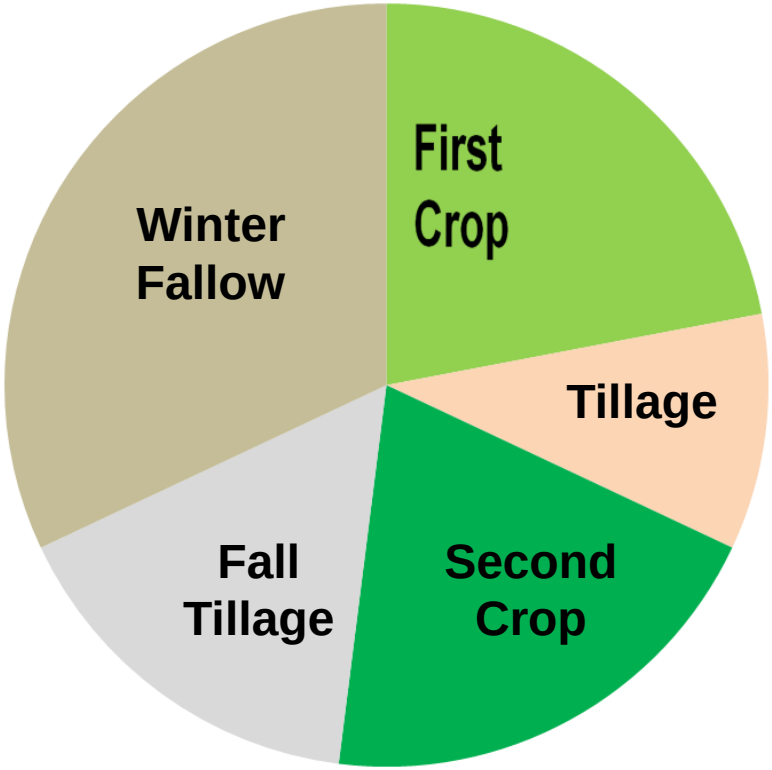
- Four fertilizer trials and surveys of the nitrogen uptake dynamics of 11 spinach fields were conducted

2011 Trials

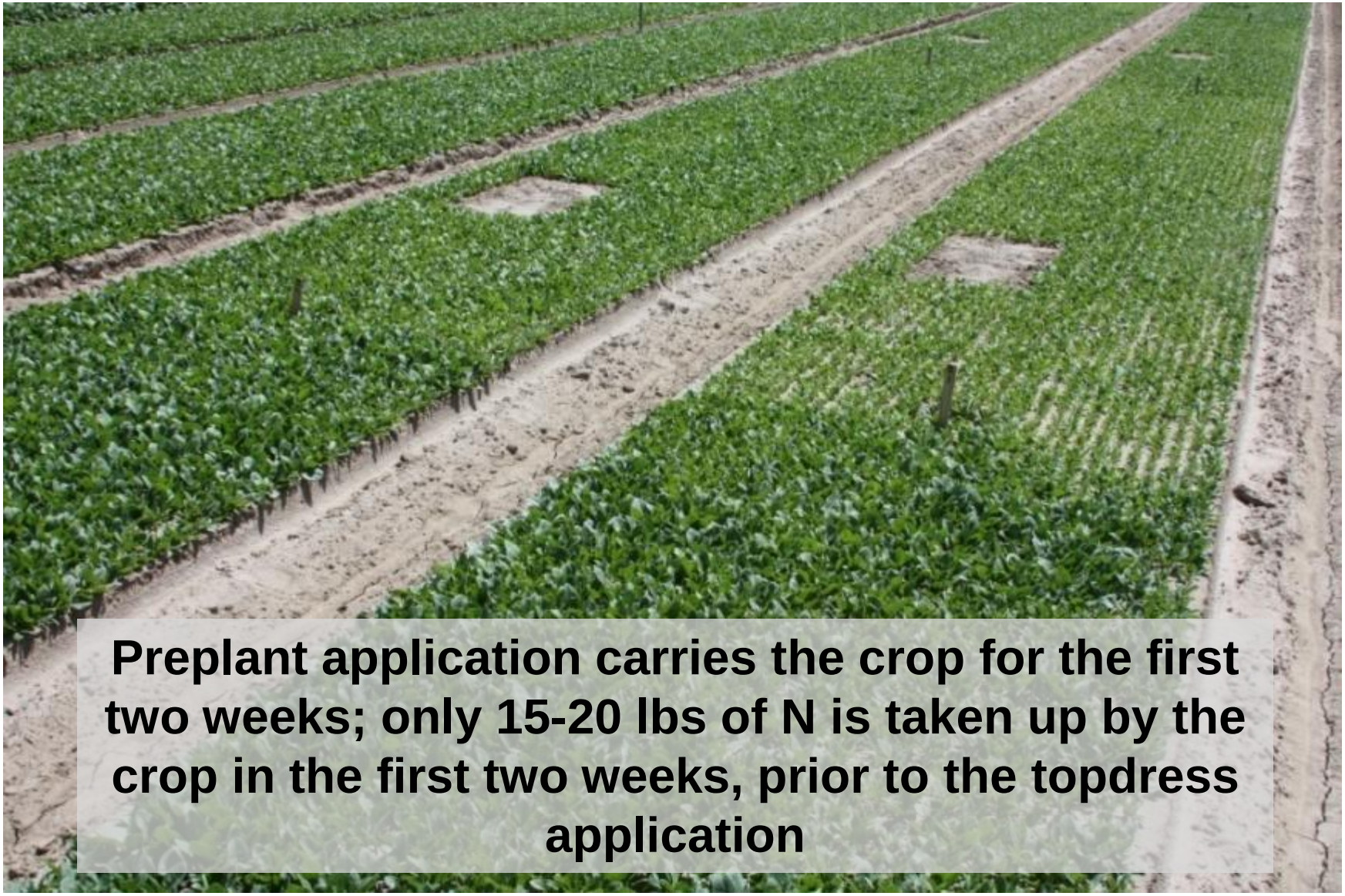
- **Fertilizer trials:**
  - **Two first crop sites with low residual soil nitrate (one light and one heavier soil type)**
  - **Two second crop sites with high residual soil nitrate (one medium and one heavier soil type)**

First Crop vs Second Crop

- **First crop – Low residual soil nitrate following winter fallow**
- **Second crop – Higher residual soil nitrate from residual fertilizer, soil mineralization, crop residue mineralization of the prior crop**

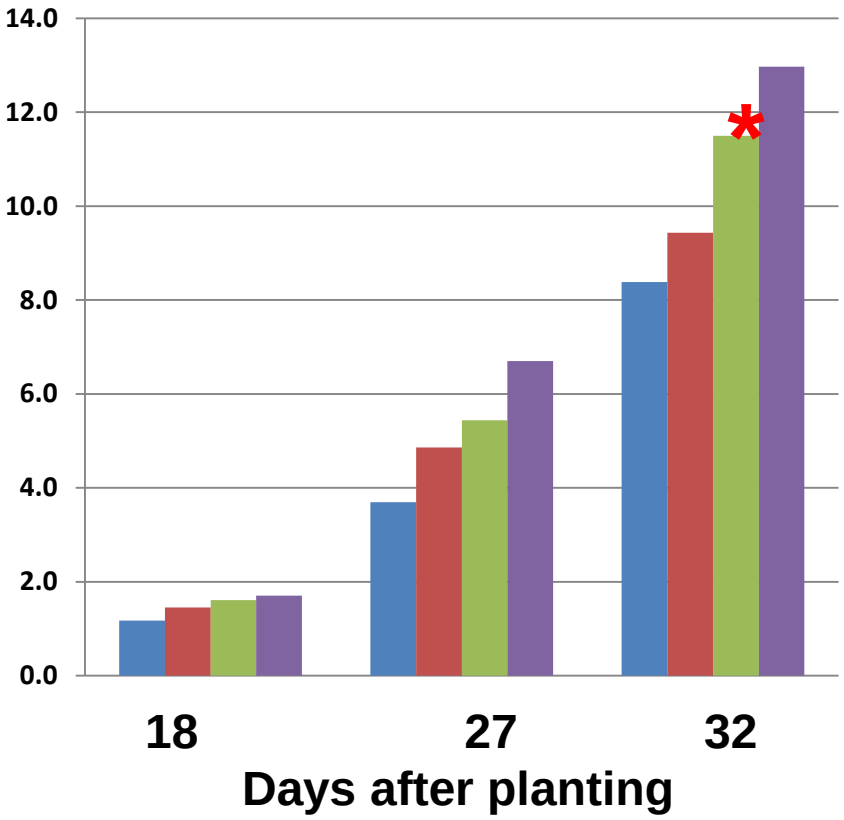


First Crop Spinach Fertilizer Trial



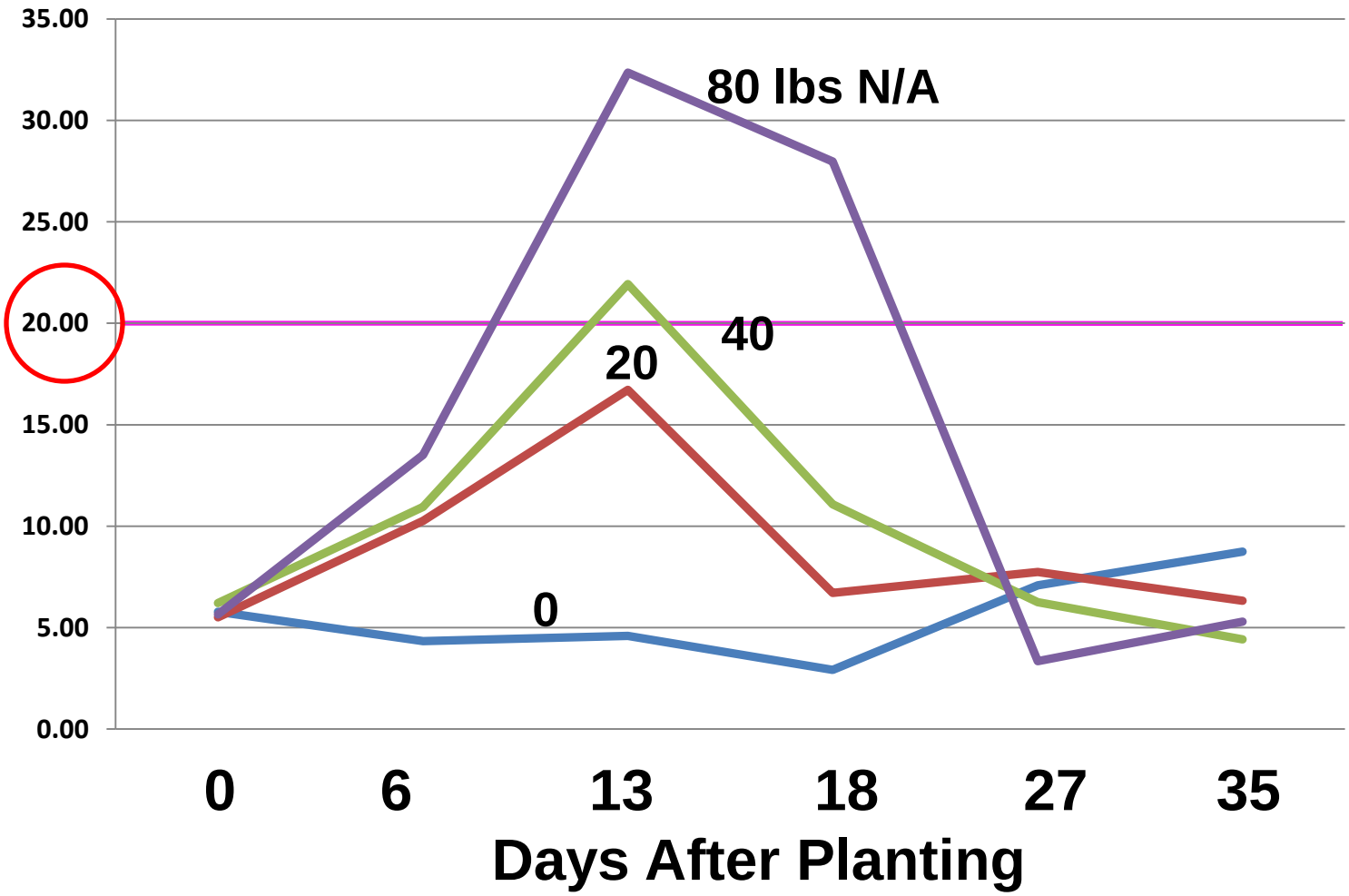
Preplant application carries the crop for the first two weeks; only 15-20 lbs of N is taken up by the crop in the first two weeks, prior to the topdress application

First Crop Spinach on Sandy Loam Soil Yield (T/A)



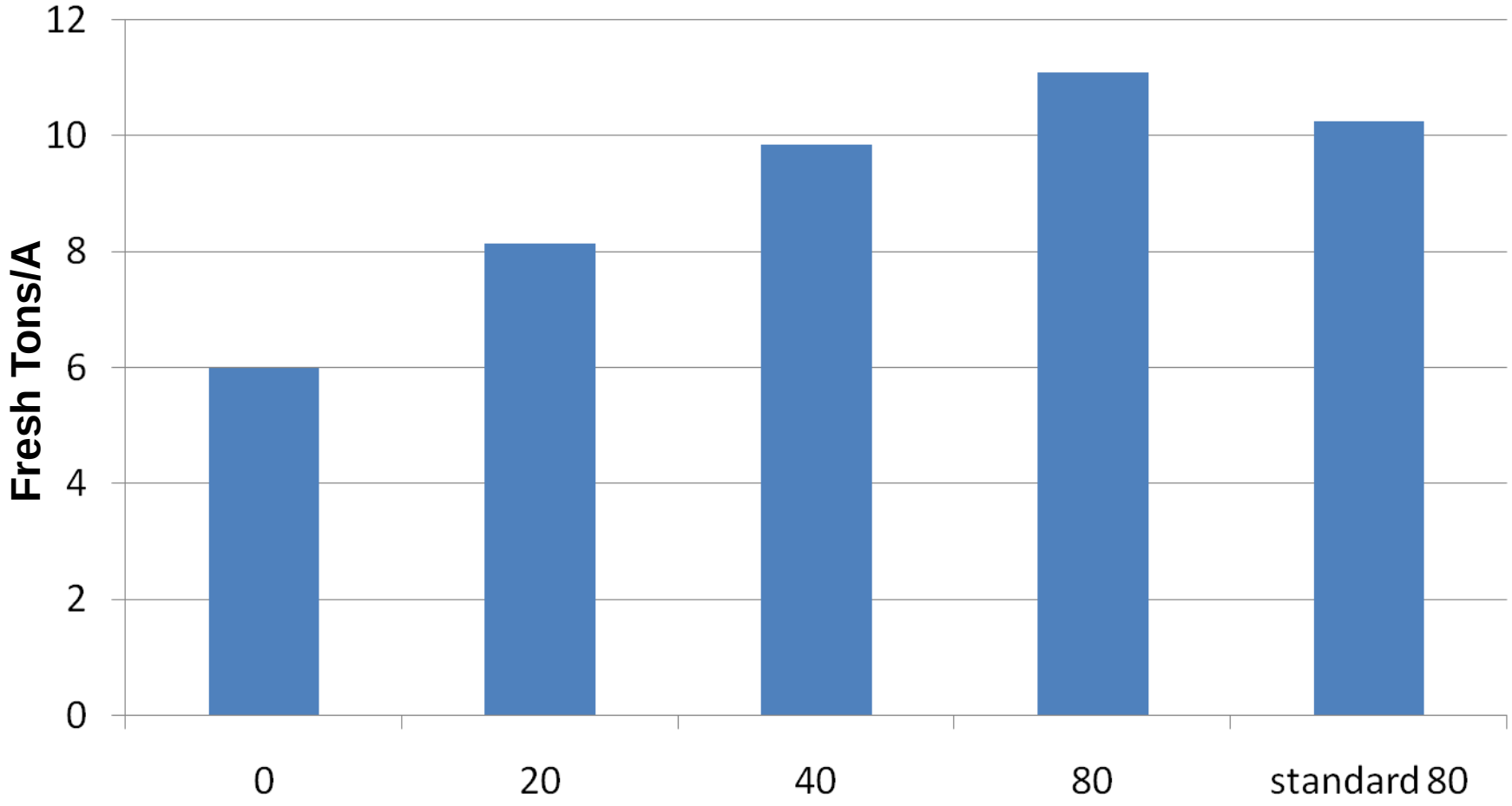
- At planting treatments (ammonium sulfate):
  - 0, 20, 40 & 80 lbs N/A
- Top dress applications:
  - 18 DAP 63 lbs N/A
  - 25 DAP 39 lbs N/A
  - 29 DAP 32 lbs N/A
  - Total <u>134 lbs N/A</u>

Soil Nitrate-N Over the Growth Cycle



Yield of First Crop Spinach

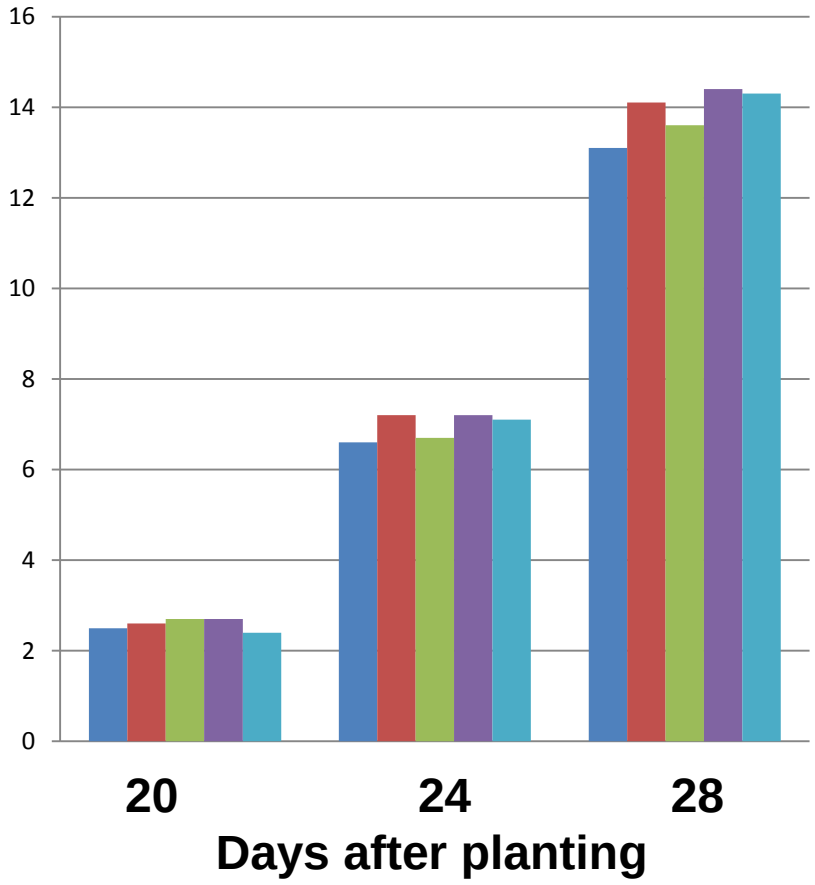
Mean of Two Trials



Second Crop Spinach

- Following lettuce and cole crops
- High residual soil nitrogen
- Better growing conditions

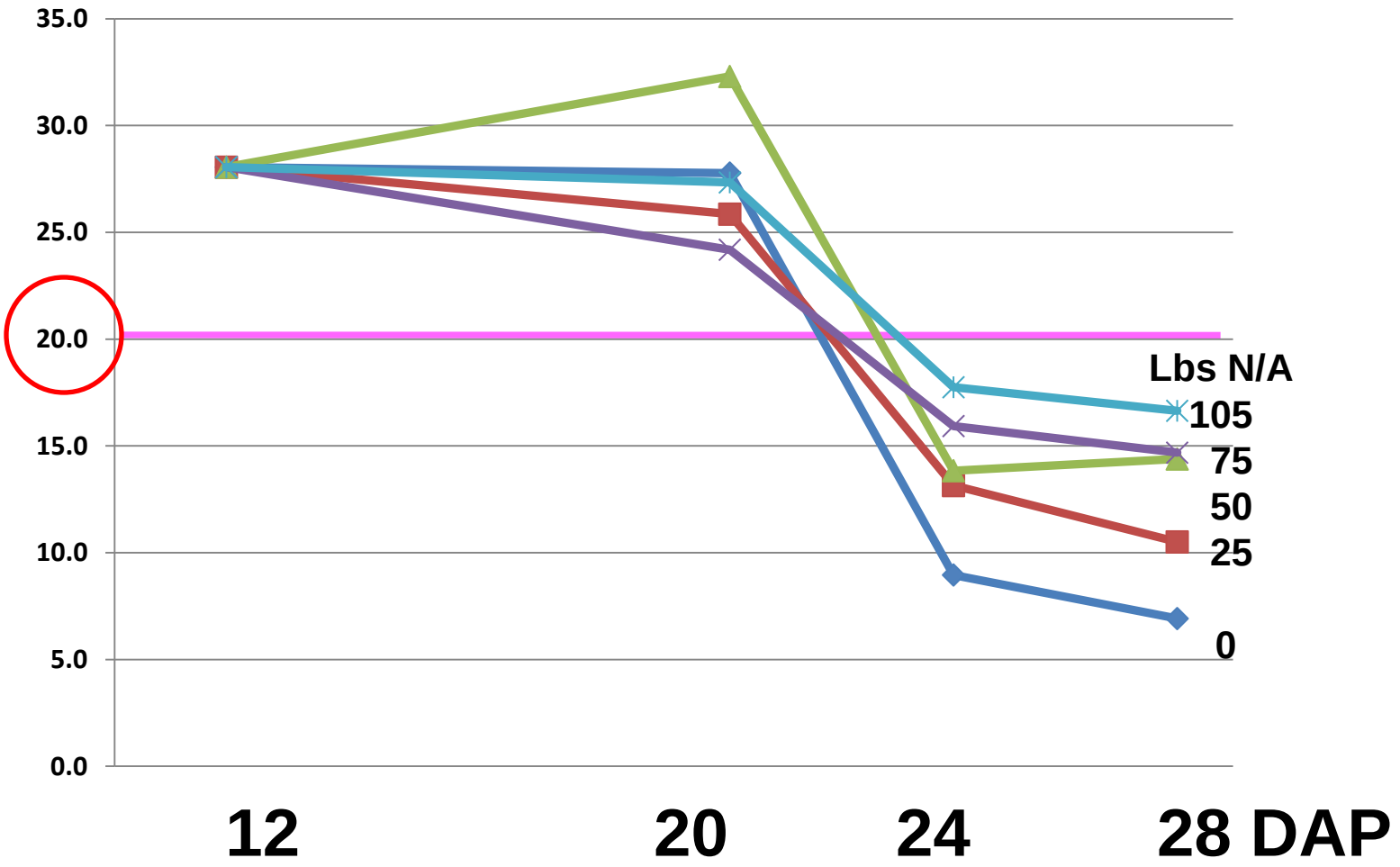
Second Crop Spinach on Loam Soil Yield (T/A)



- At planting treatments:
  - None were applied due to high residual soil nitrate
- Top dress applications applied at 17 DAP:
- 0, 25, 50, 75, 105 lbs N/A

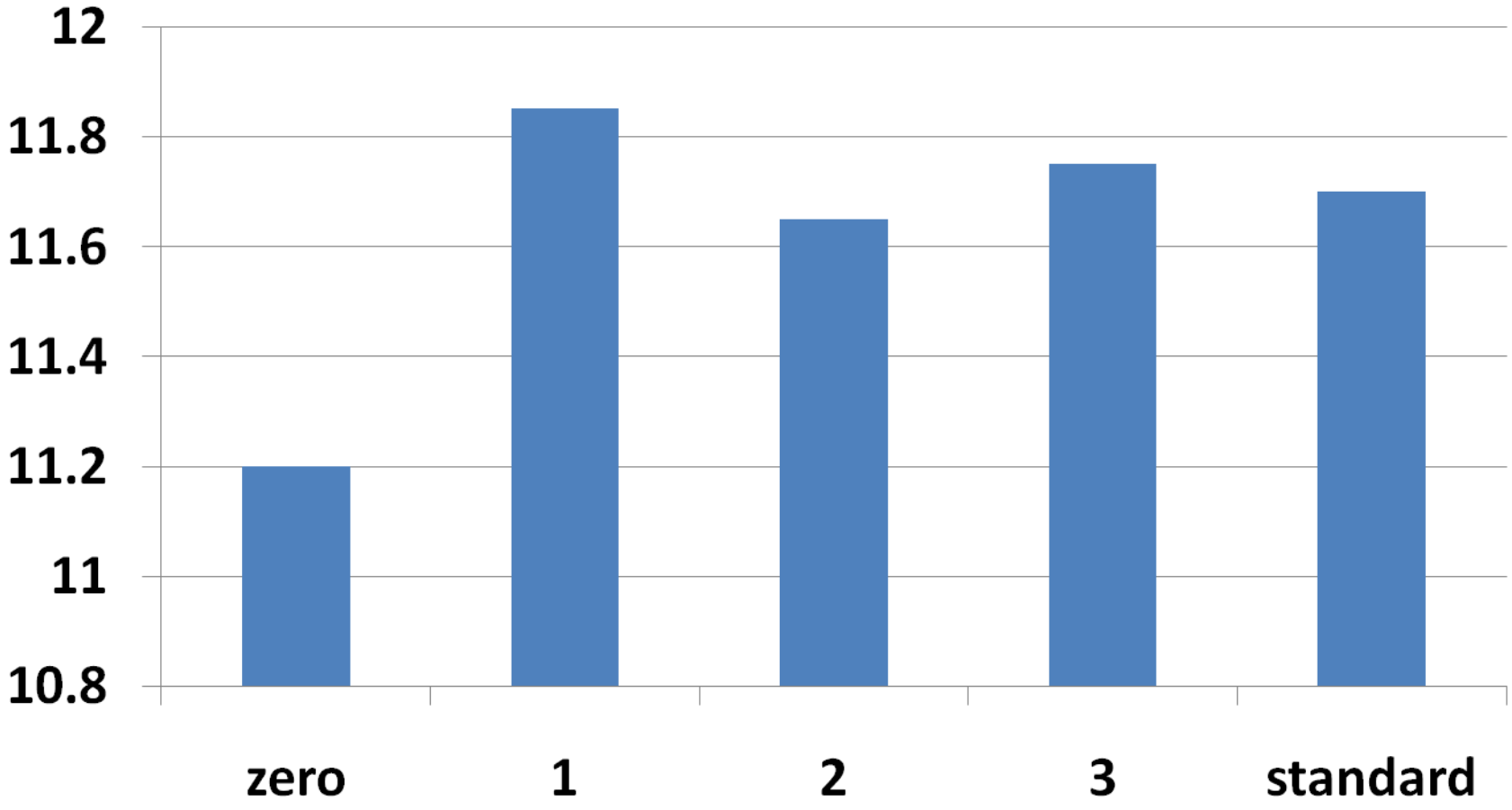
Soil Nitrate Over the Growth Cycle

Second Crop Spinach



Yield of Second Crop Spinach

Mean of Two Trials



Comparison of Spinach vs Lettuce
Biomass and N Uptake

Lettuce

- Dry Biomass (lbs/A)
  - 3000 to 5000
- N Uptake (lbs/A)
  - 120 to 140 or more
- Percent N at harvest
  - Generally 3.0 to 3.5
- Overall N Uptake/day
  - 3.5 to 4.5 lbs/A/day

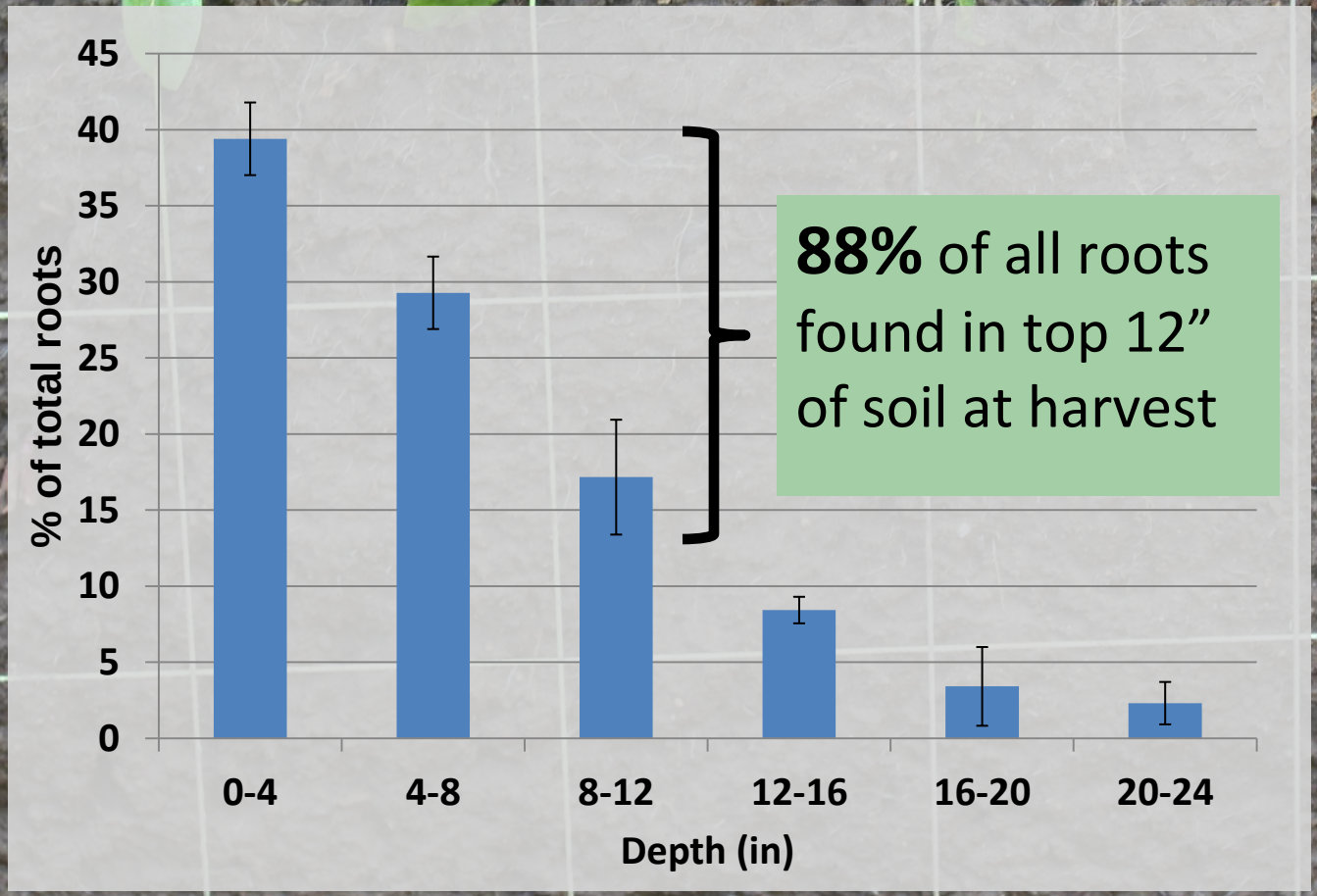
Clipped Spinach

- Dry Biomass (lbs/A)
  - 1200 to 2400
- N Uptake (lbs/A)
  - 80 to 100
- Percent N at harvest
  - 4.5 to 6.4
- Overall N Uptake/day
  - 4.2 to over 7.0 lbs/A/day

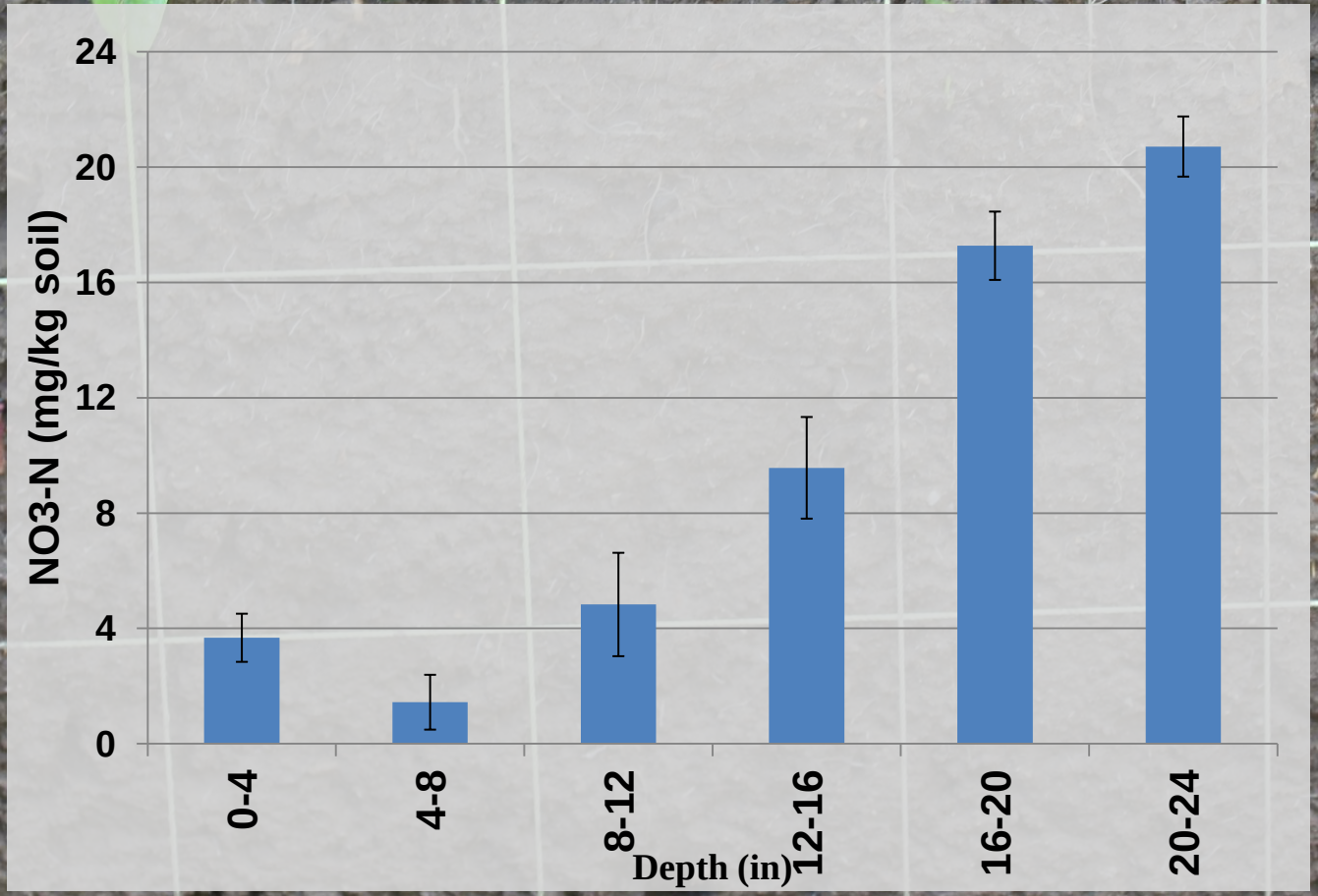
Rooting Depth Evaluations

- At harvest pits dug to 2 feet (4 sites)
- Roots exposed with pressurized sprayer
- Roots counted in each grid
- Nitrate measured in each grid

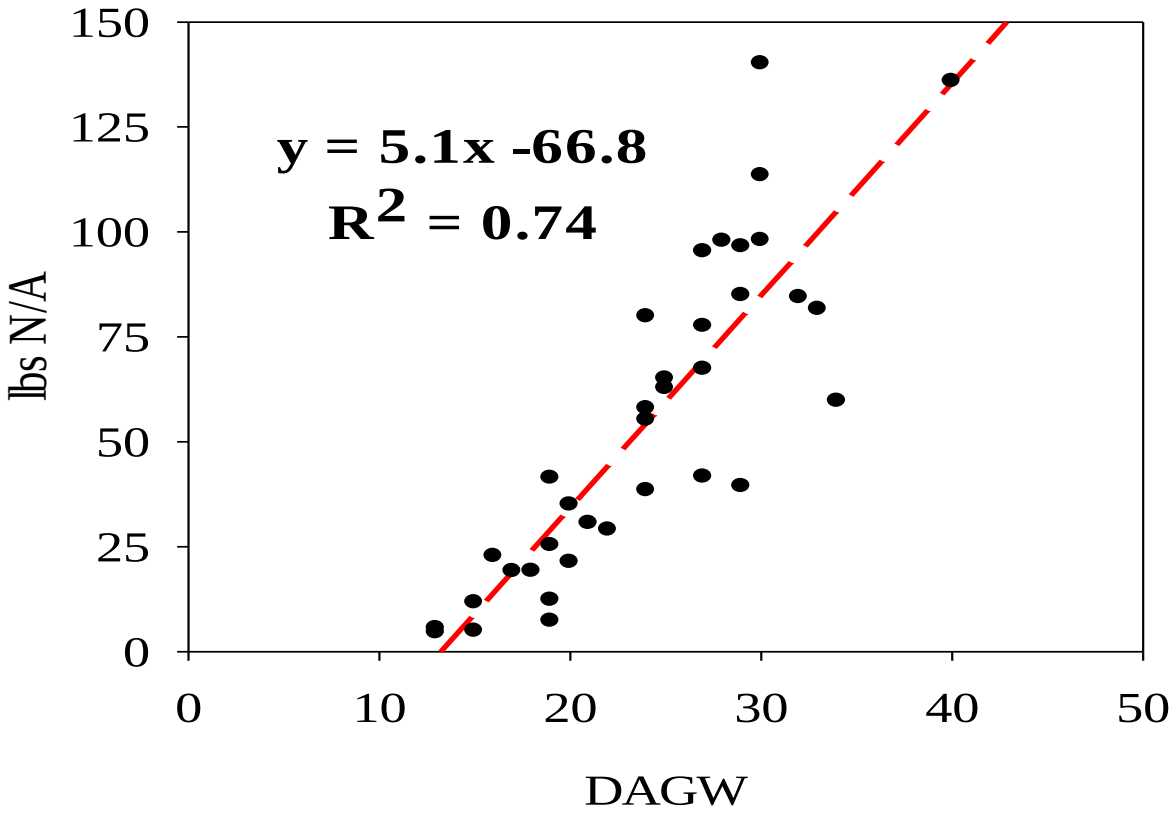
Root distribution



Nitrate distribution



Spinach Nitrogen Uptake - All Sites



- **11 lbs N/A in first 2 wks**
- **5.1 lbs N/A/d from 13 d to harvest**
- **7.3 lbs N/A/d in the week prior to harvest**

Nitrogen Content of Unharvested Spinach Residue

Clipped:

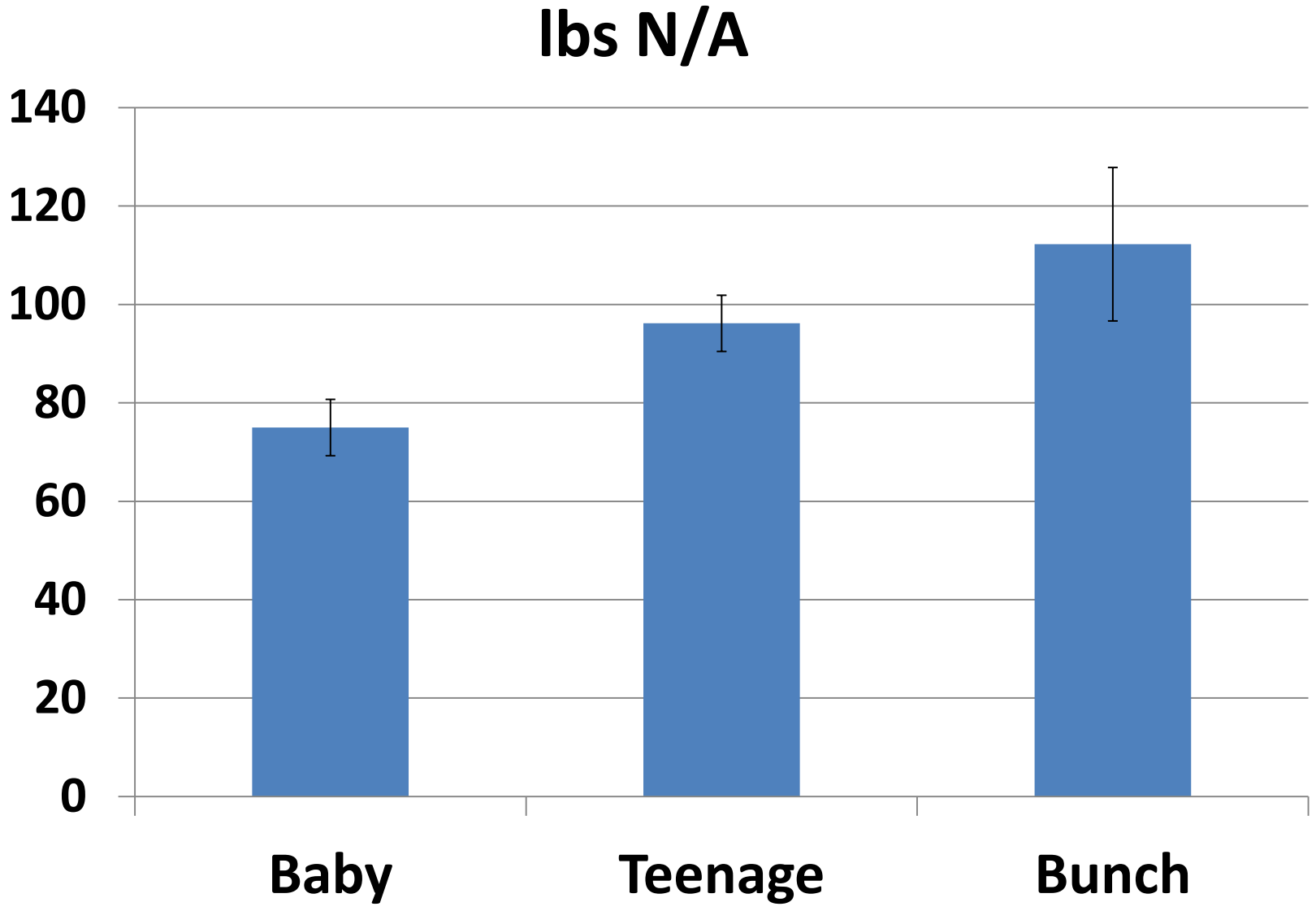
- **<u>44%</u> of N remains in the field**

Bunch:

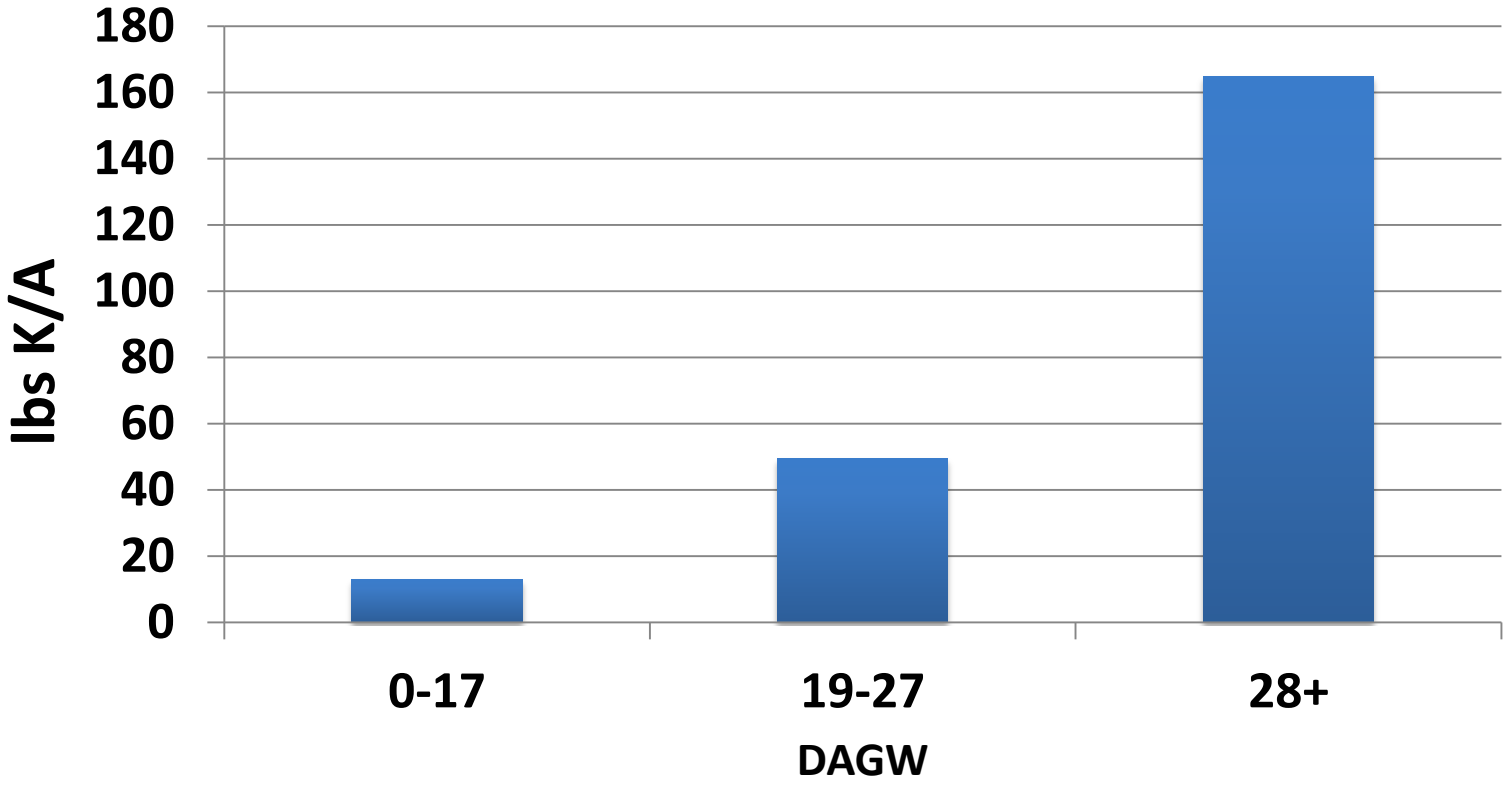
- **<u>35%</u> of N remains in the field**

Residue ~5% Nitrogen

Nitrogen Uptake by Spinach Products

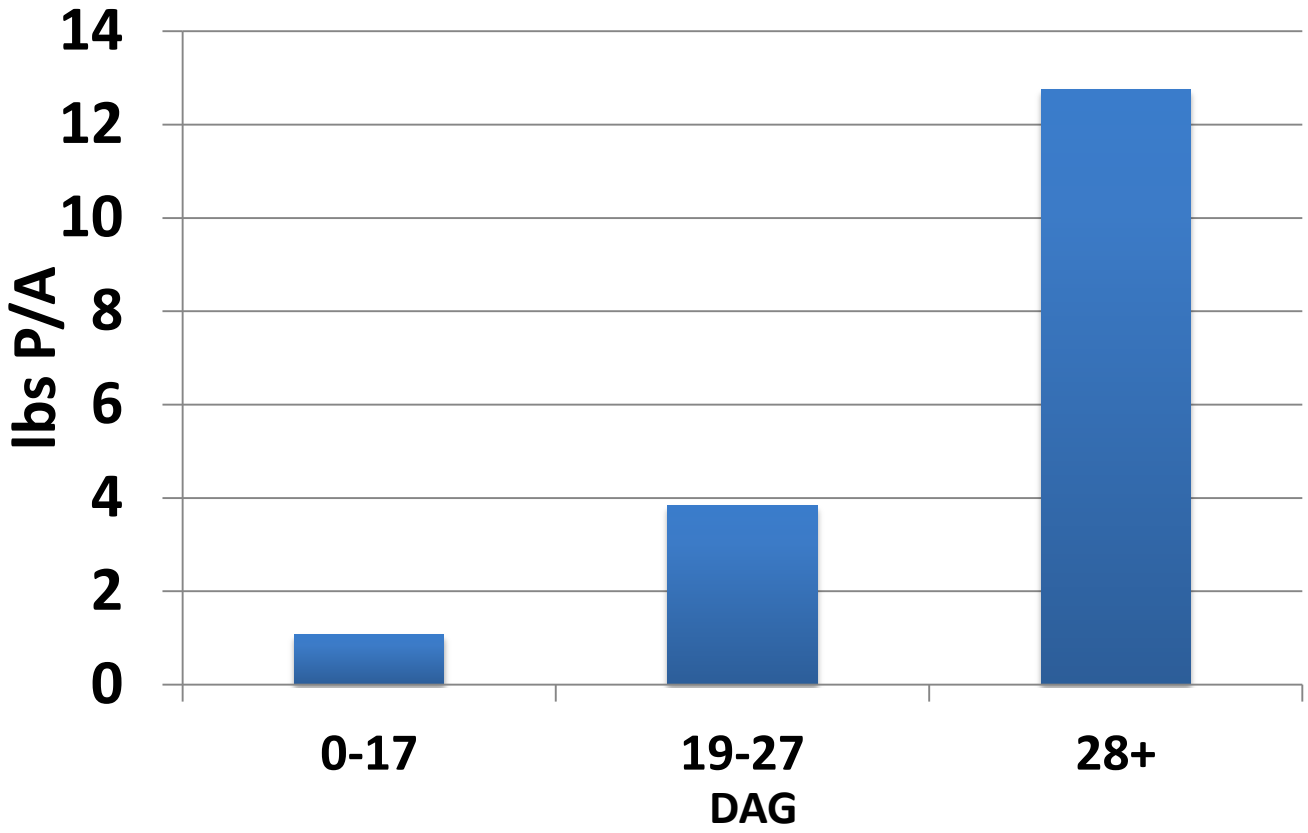


Spinach Potassium Uptake



- **7.2 lbs K/A in first 2 wks**
- **9.3 lbs K/A/day from 13 d to harvest**
- **~160 lbs K/A at harvest**

Spinach Phosphorus Uptake



- **0.7 lbs P/A in first 2 wks**
- **0.7 lbs P/A/d from 13 d to harvest**
- **12 lbs P/A at harvest**

Enhanced Nitrogen Fertilizer Technology

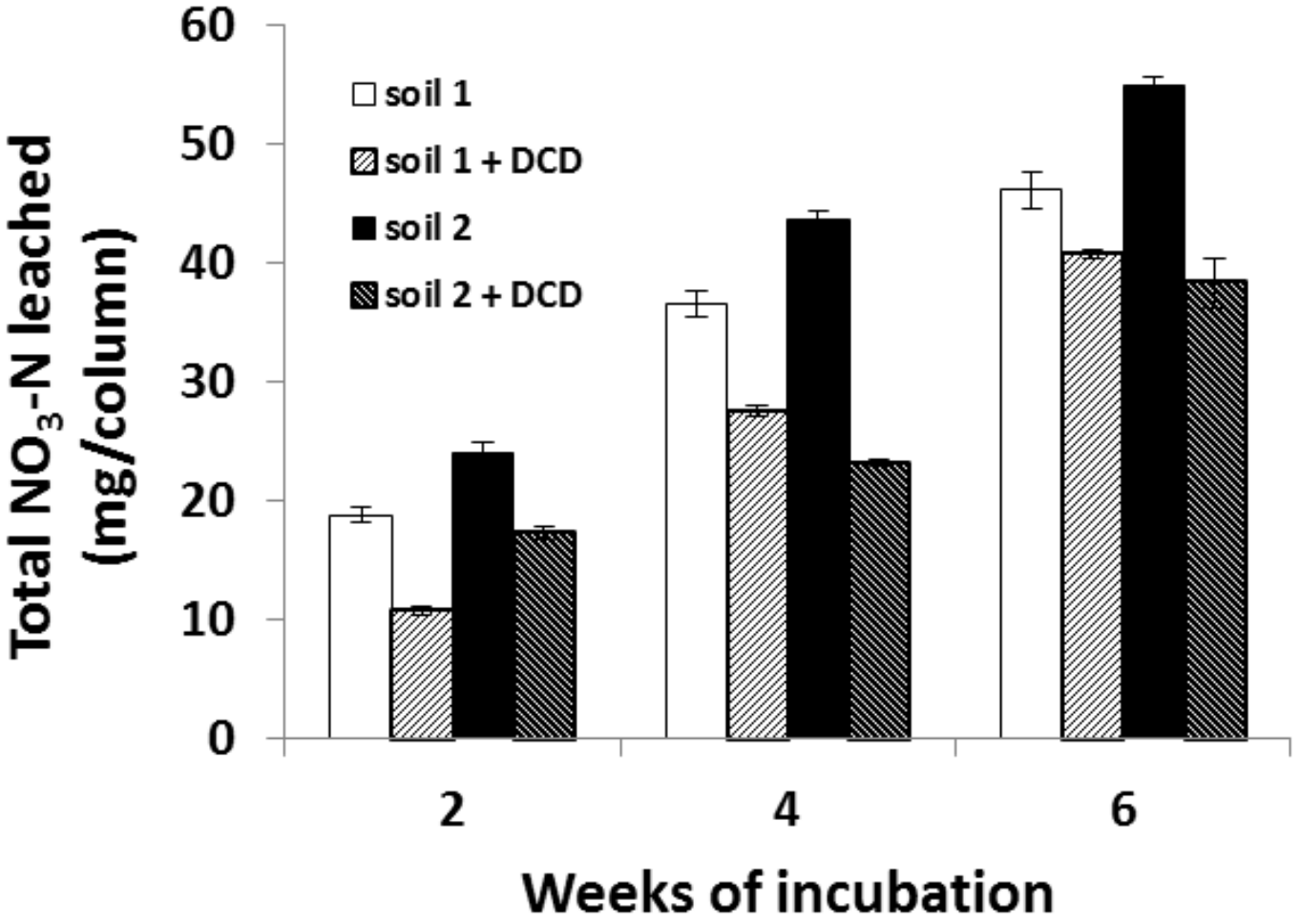
- Nitrification inhibitors
- Foliar fertilizers
- Controlled Release Fertilizers

Nitrification - conversion of ammonium to nitrate

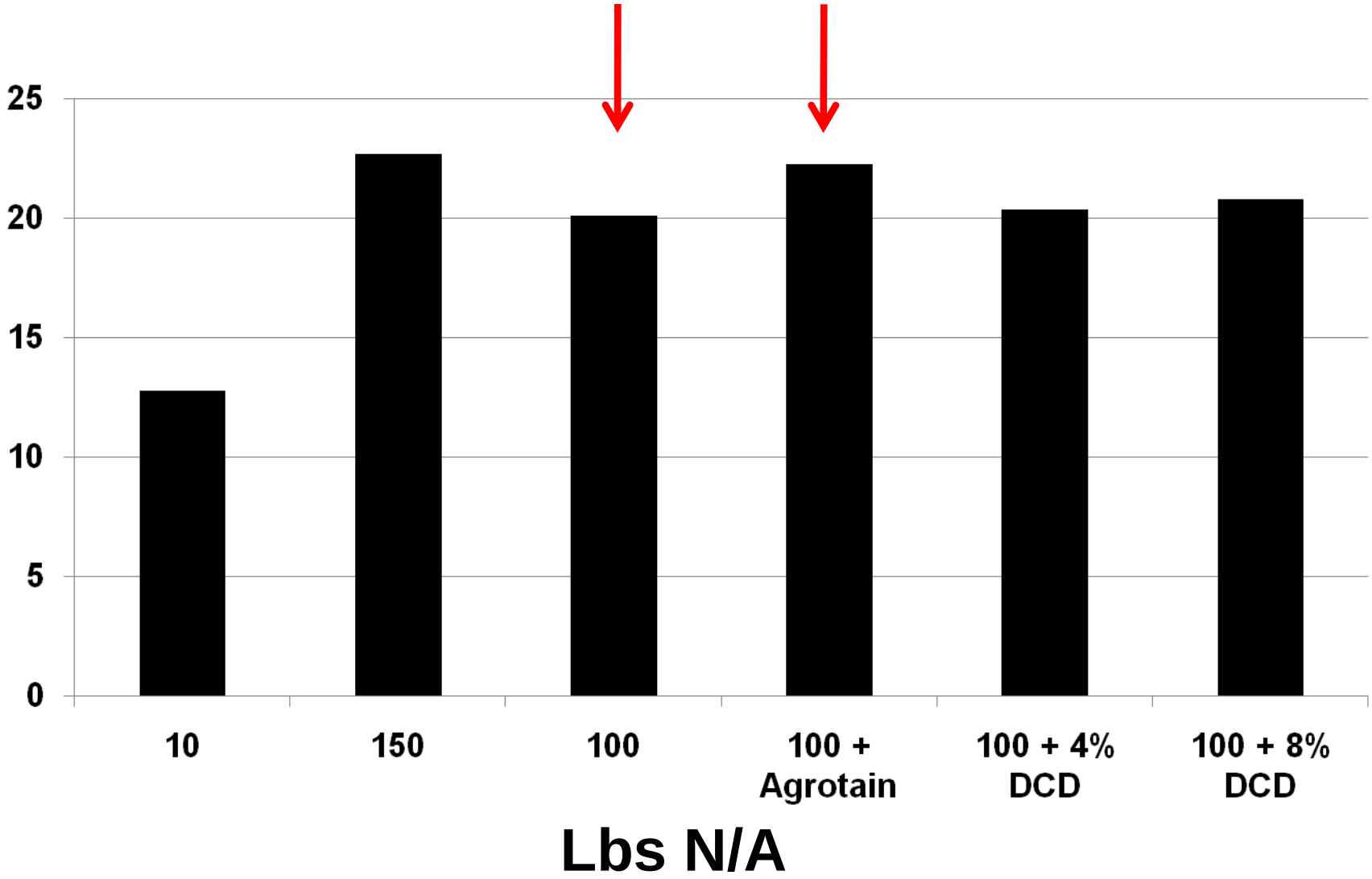
- **In warm soils (>50 °F), it occurs in 2-3 weeks**

Impact of Dicyandiamide (DCD) on Nitrate Leaching

Tim Hartz, 2011



2011 Lettuce Yield (T/A)
Nitrification Inhibitor Trial



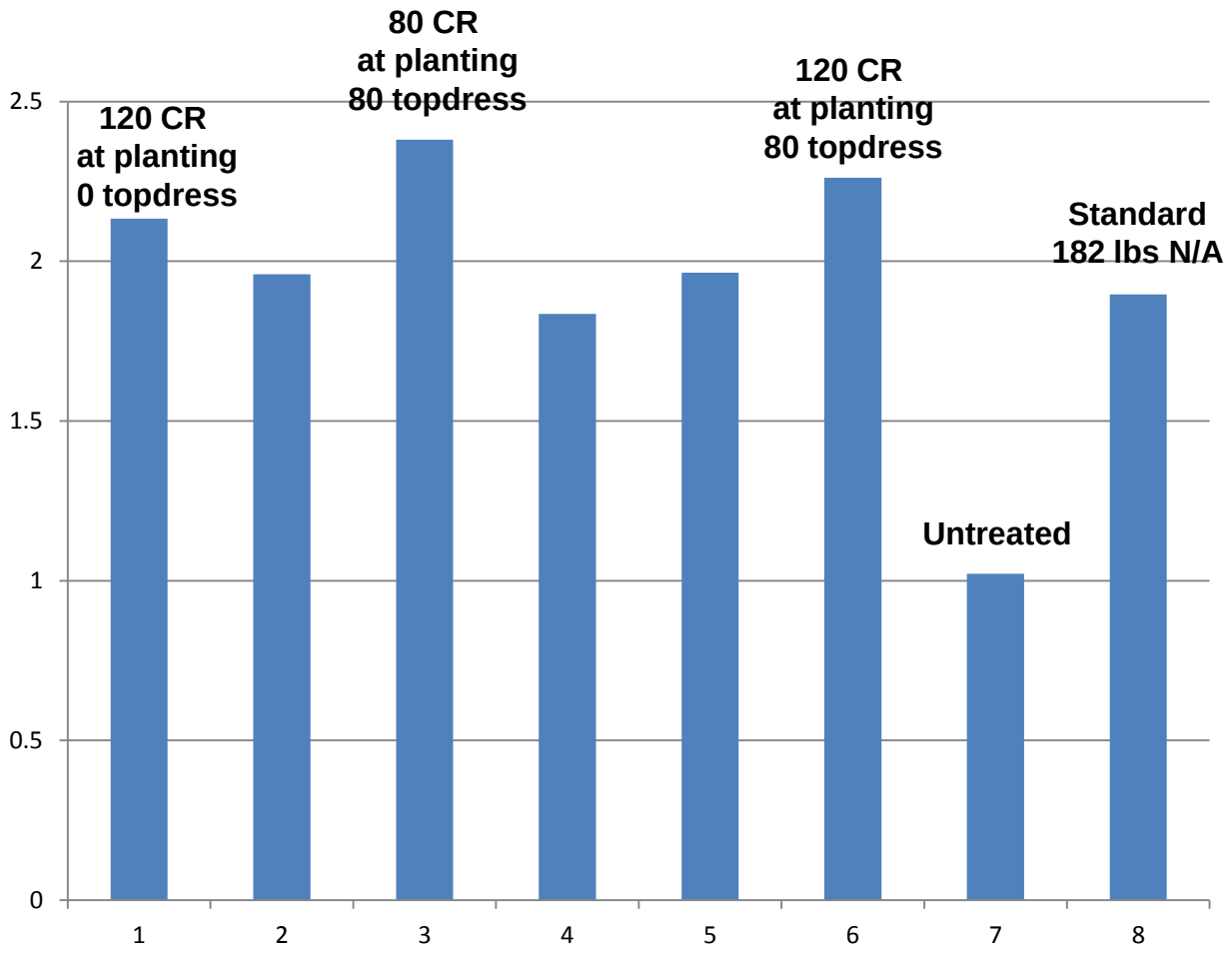
Foliar Fertilizer N Trial

Romaine 2011

Treatment	Total N/A applied Lbs/A	Fresh yield tons/A	Lettuce N content % N	Lettuce N content lbs N/A
Untreated	0.0	30.9	1.9	81
Impact – foliar	29.2	33.7	2.2	95
Green Feed - foliar	29.2	32.0	2.2	94
Standard fertilizer	138.4	38.4	2.7	125

2012 Evaluation of Controlled Release Fertilizer on Spinach Yield

Duration 45



Spinach Nitrogen Nutrition Evaluations

- These evaluations showed that it is very difficult to reduce nitrogen applications to first crop spinach when residual soil nitrate levels are low in the spring
- Residual soil nitrate may be more effectively utilized in second crop spinach
- Nitrogen uptake by spinach in the week prior to harvest is very high

Spinach Nitrogen Nutrition Evaluations

- Spinach is a heavy user of potassium
- Fertilizer technologies such as nitrification inhibitors and controlled release fertilizers may have a role to play in managing N

Herbicide Update on Coastal Vegetables

Lettuce

- Kerb is firmly in limbo for leaf lettuce
- Dual Magnum and Prowl H2O are in the registration pipeline for use on transplanted lettuces

Other Crops

- It finally looks like some progress will be made on the registration of prometryn on cilantro
- Chateau registered for use in the furrow bottom of peppers

Acknowledgements

- California Leafy Greens Research Board
- Koch Industries
- Agrium Corp.