Fertilization Trials on Spinach and Nitrogen Fertilizer Technology Update

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Background

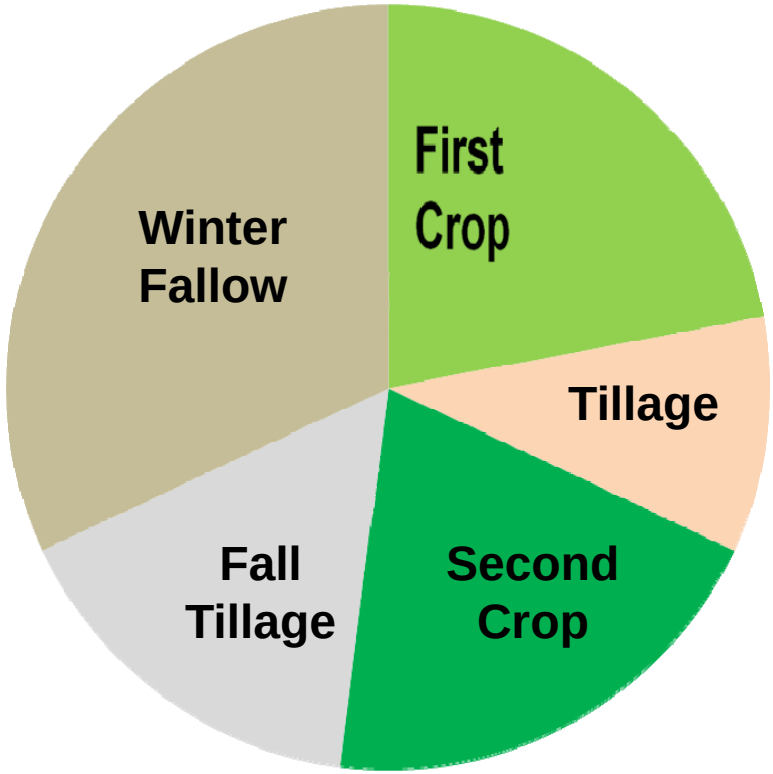
- Spinach is an “at risk” crop with regards to proposed regulations by the Central Coast Water Quality Control Board
- Due to non-agronomic quality demands from the market place (e.g. deep green color), it is going to be difficult to hit the proposed 1.0 nitrogen balance factor
- This is especially true for the first crop

2011 Trials

- **Four fertilizer trials were conducted:**
  - **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)**

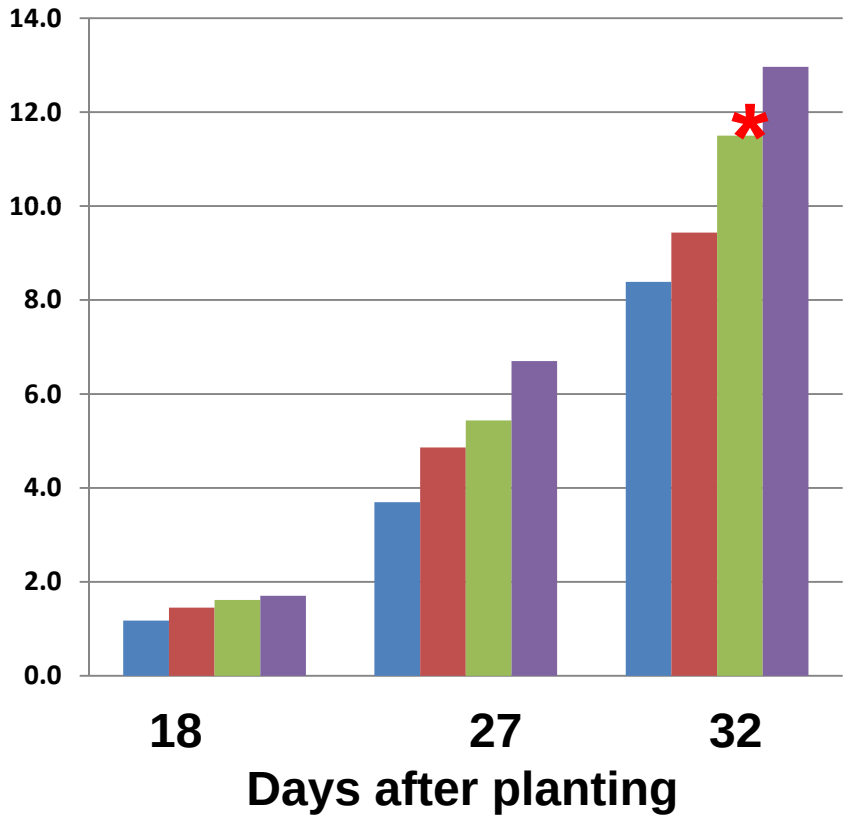
First Crop vs Second Crop

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



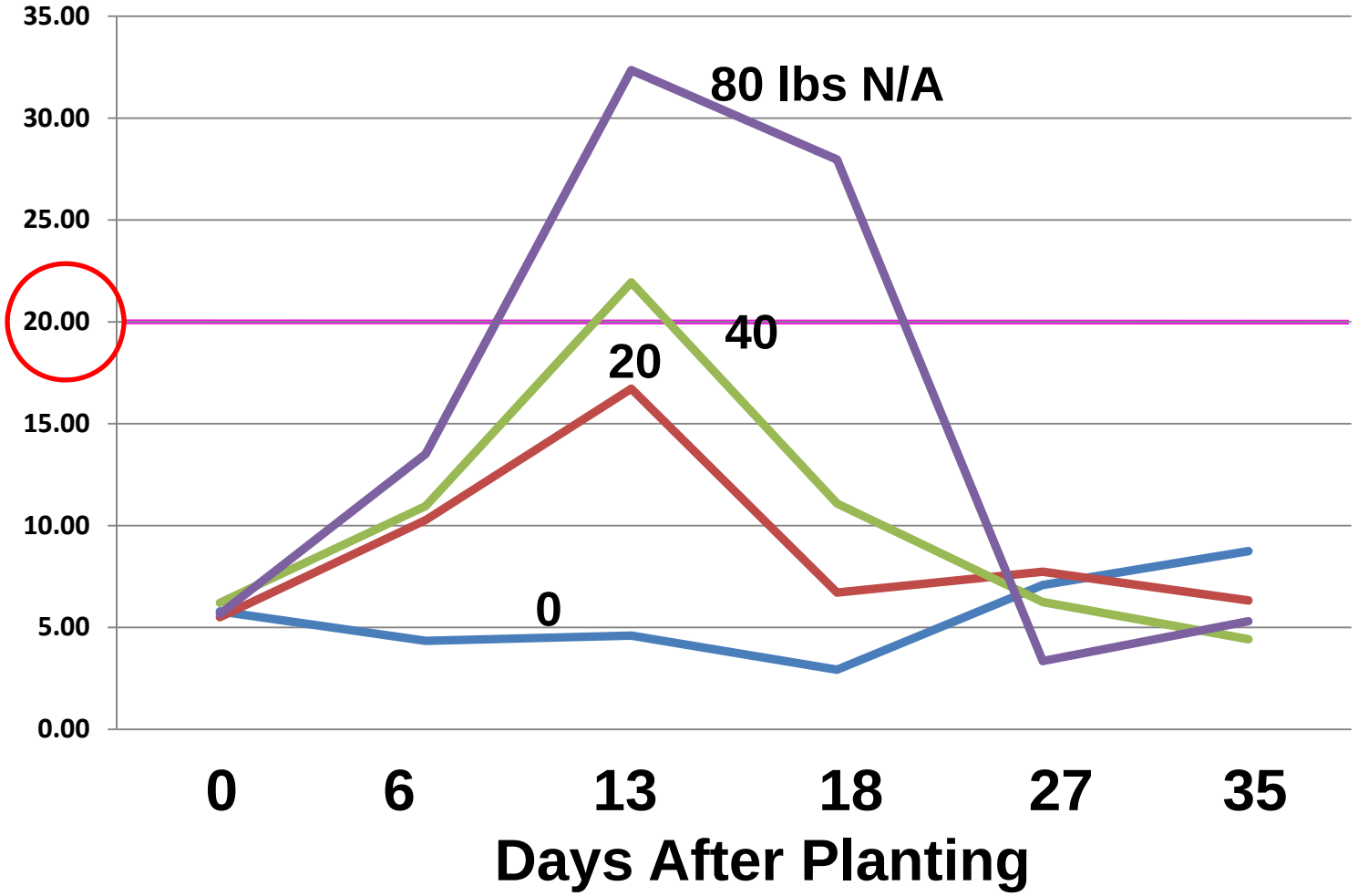
First Crop Spinach Fertilizer Trial

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

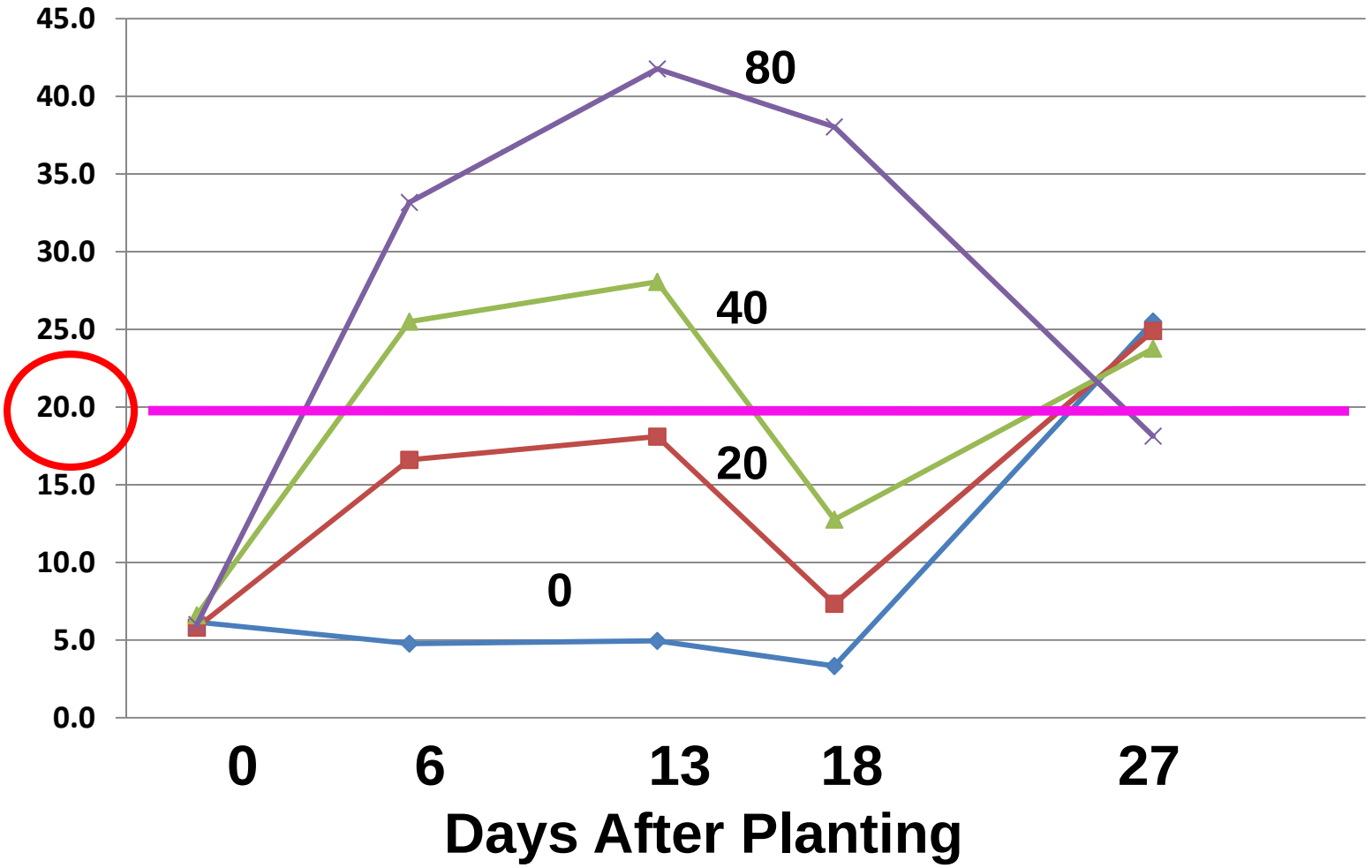


- At planting treatments (ammonium sulfate):
  - 0, 20, 40 & 80 lbs N/A
- Top dress applications:
  - 18 DAP 63 lbs N/A
  - 25 DAP 39 lbs N/A
  - 29 DAP 32 lbs N/A
  - <u>134 lbs N/A</u>

Soil Nitrate-N Over the Growth Cycle

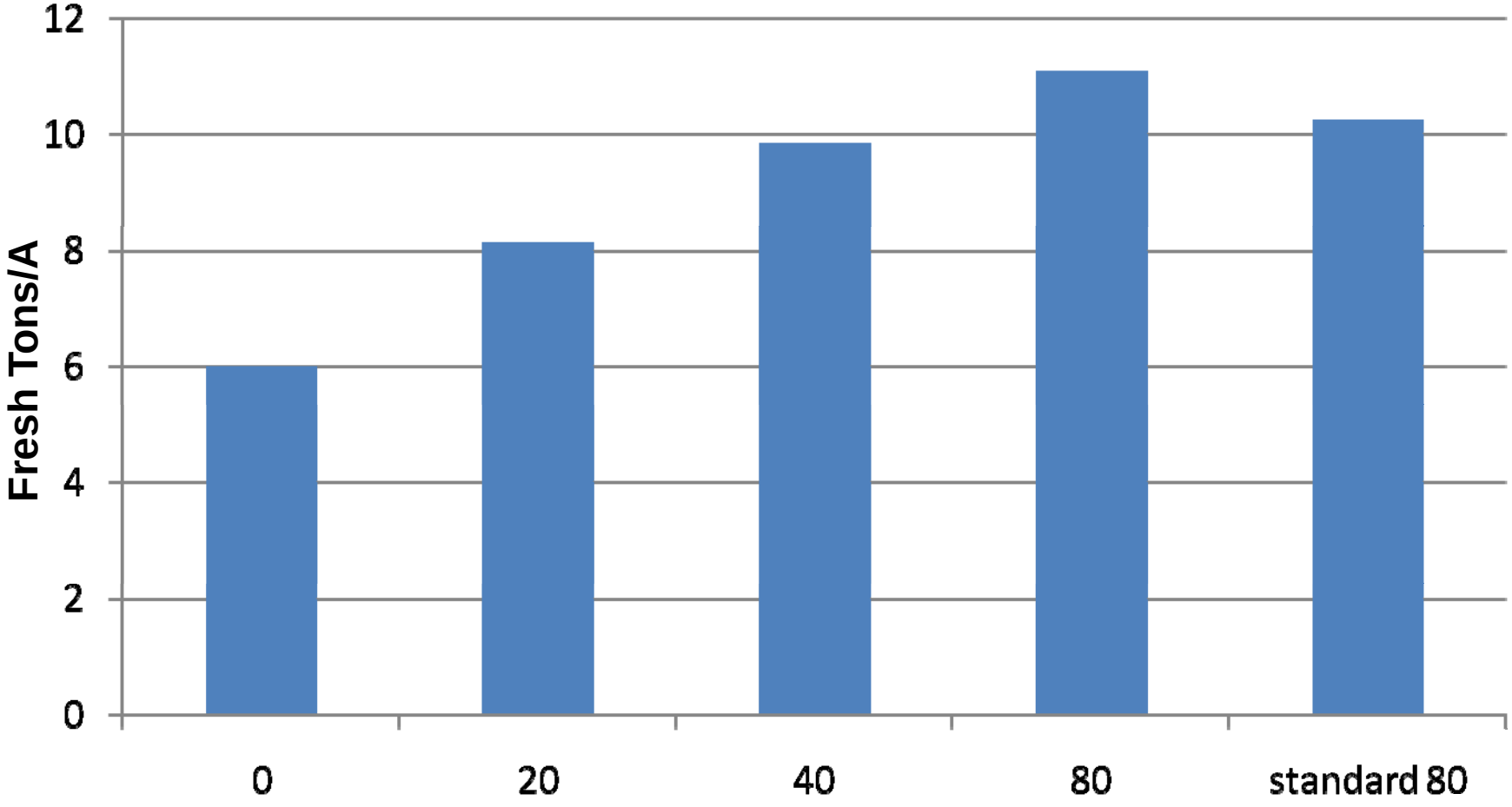


Soil Nitrate-N + Ammonium-N Over the Growth Cycle



Yield of First Crop Spinach

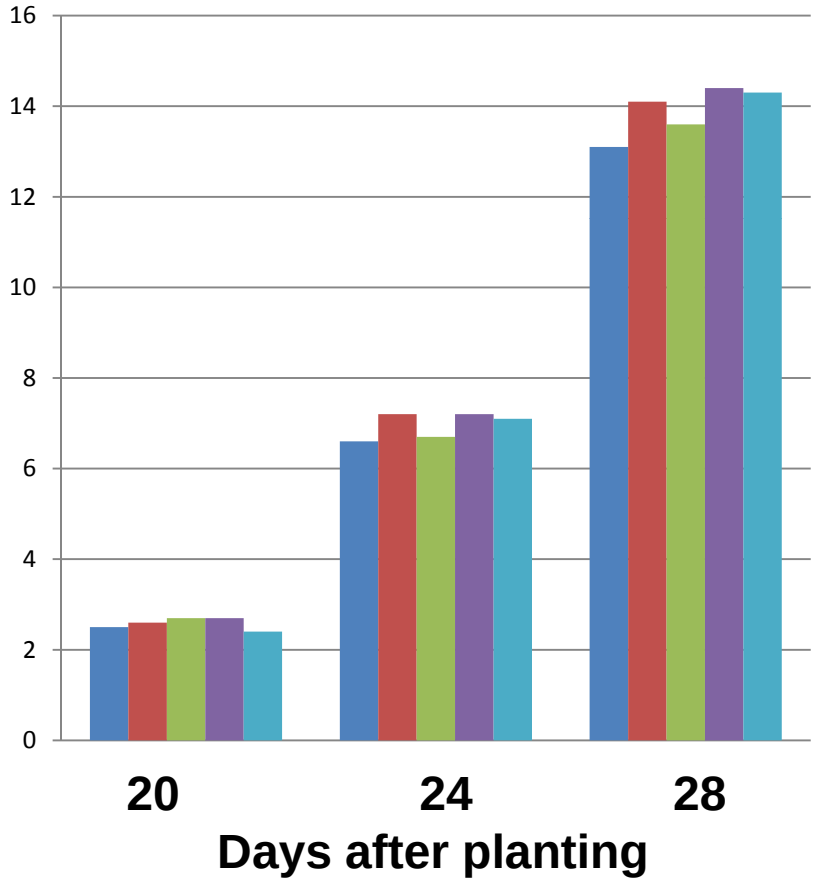
Mean of Two Trials



Second Crop Spinach

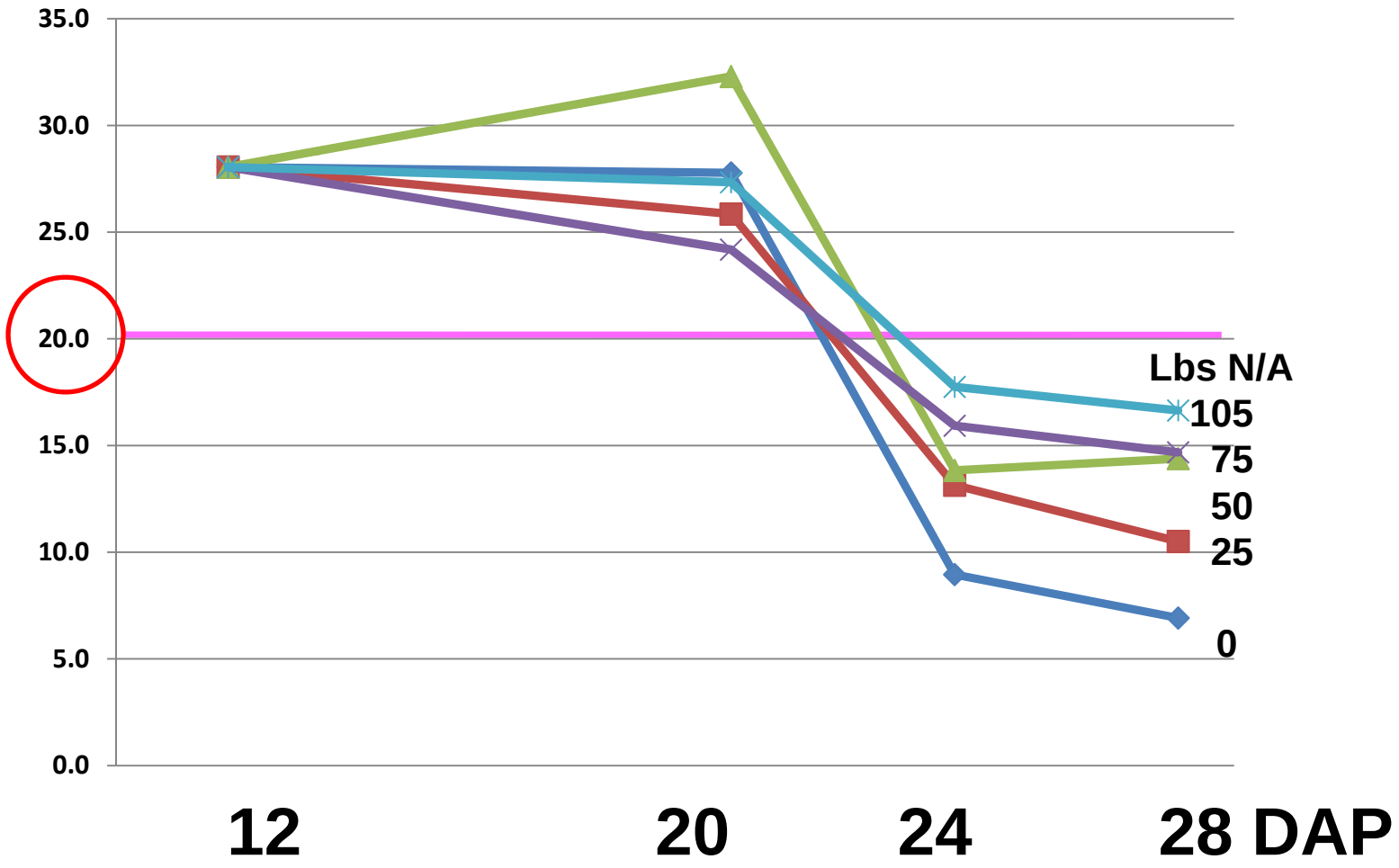
- Following lettuce and cole crops
- High residual soil nitrogen
- Better growing conditions

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



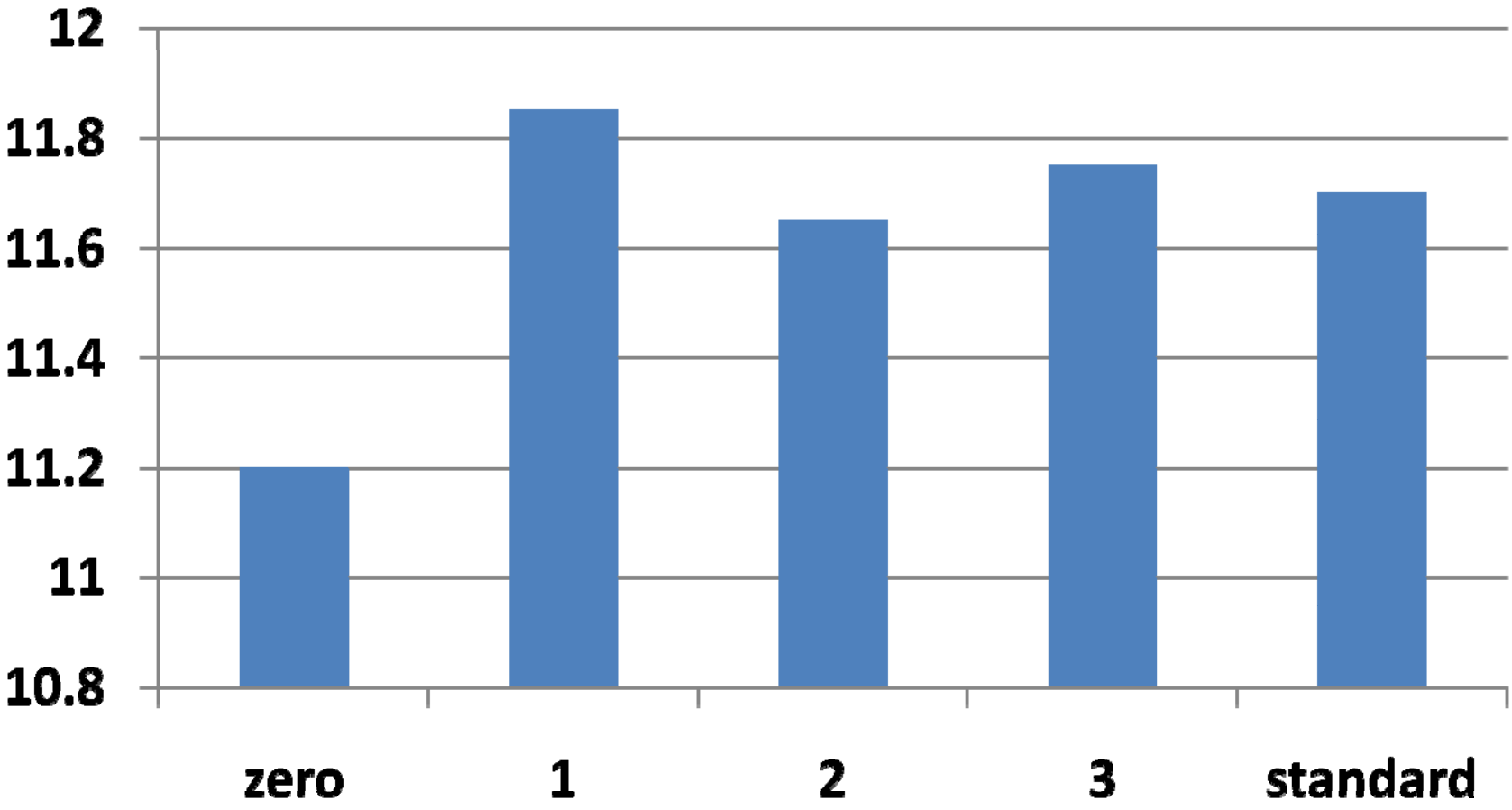
- At planting treatments:
  - None were applied due to high residual soil nitrate
- Top dress applications applied at 17 DAP:
- 0, 25, 50, 75, 105 lbs N/A

Soil Nitrate in the Treatments over the Growth Cycle



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

Spinach Nitrogen Nutrition Evaluations

- These evaluations dealt with the early-season applications of N for spinach
- This is an area where we can explore the agronomic aspects of spinach production
- The top dress applications should also be evaluated, but they are more problematic because of application methods
- They also are under non-agronomic demands for color

Spinach Nitrogen Nutrition Evaluations

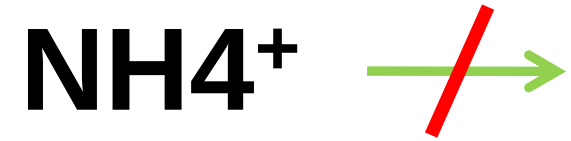
- First crop spinach on light ground are going to be difficult to effectively cut back on at planting N applications, even though the crop only takes up 15-20 lbs N/A in the first 2 weeks
- Second crop spinach will be much easier to come closer to the 1.0 nutrient balance ration proposed by the CCRWQCB
  - Knowledge of the levels of residual soil nitrate will be very important (nitrate quick test)

Enhanced Nitrogen Fertilizer Technology

- Nitrification inhibitors
- Foliar fertilizers

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 - conversion of ammonium to nitrate

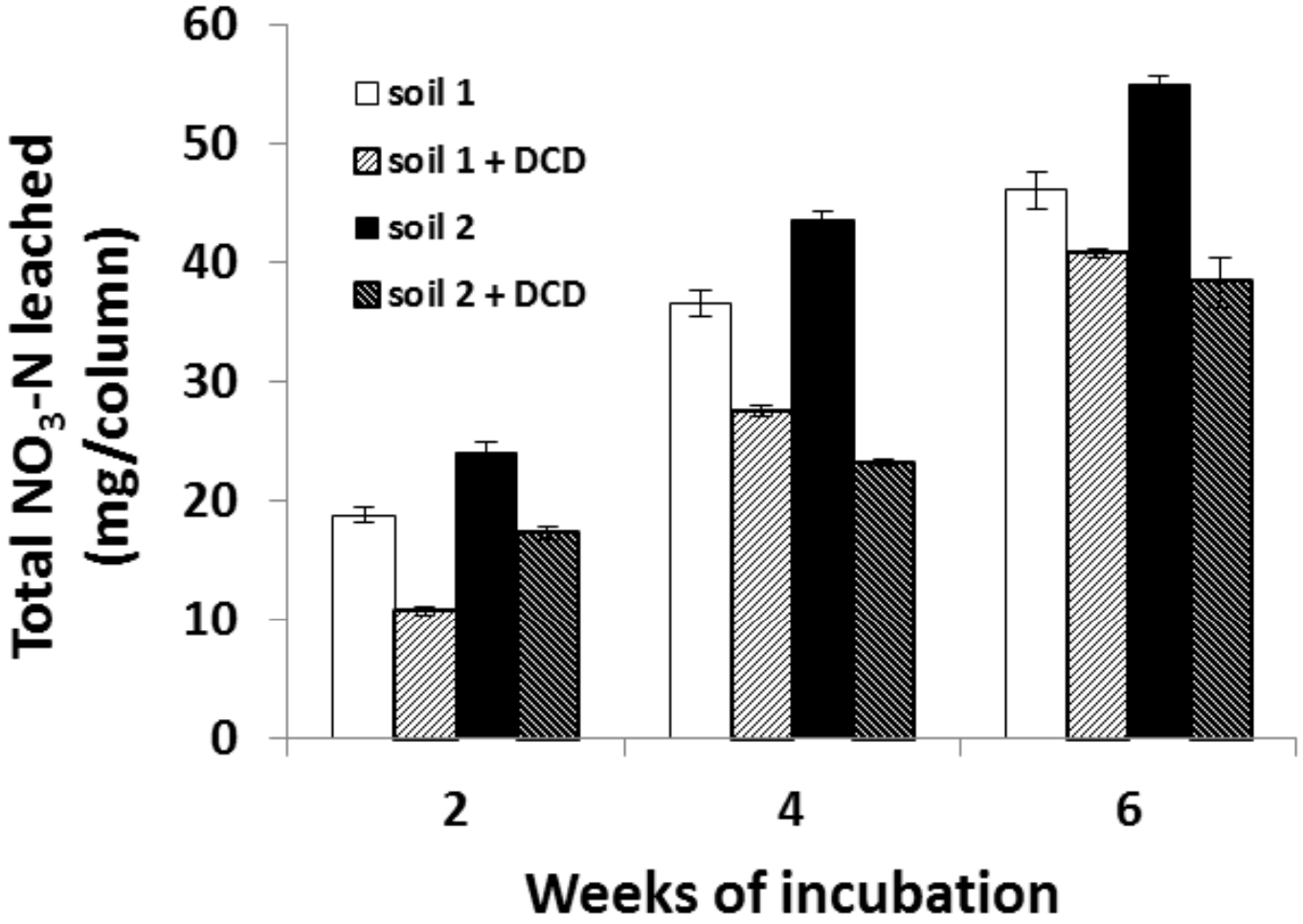
- **In warm soils (>50 °F), it occurs in 2-3 weeks**

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**

Impact of Dicyandiamide (DCD) on Nitrate Leaching

Tim Hartz, 2011

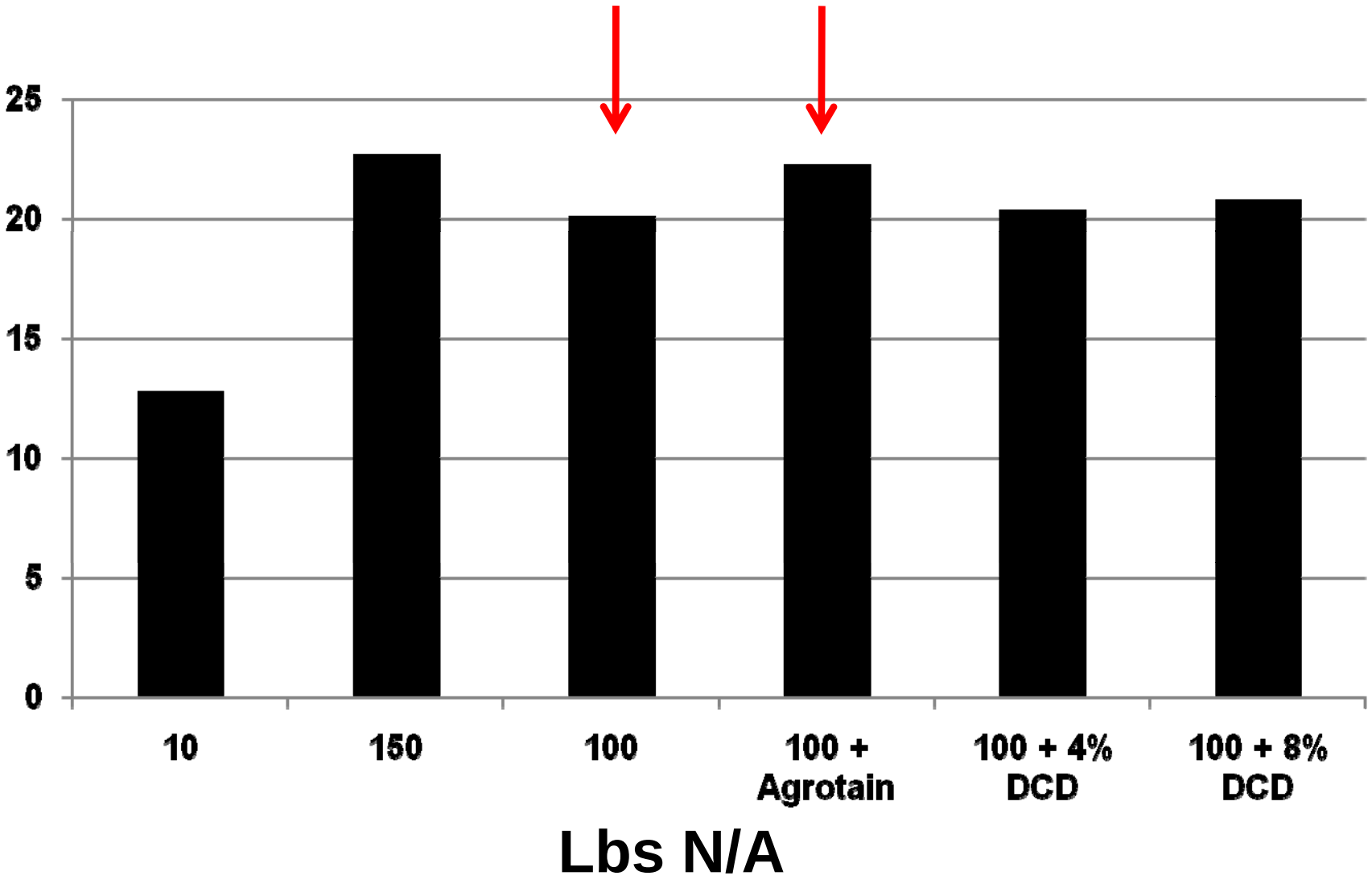


Nitrification Inhibitor

Agrotain Plus in UN32

Injection Manifolds

2011 Lettuce Yield (T/A)
Nitrification Inhibitor Trial



Nitrification Inhibitor Summary

- Thus far we have seen significant improvement in yield with the use of Agrotain Plus in one out of five trials (trends seen in other trials)
- All the trials have been with drip application of the fertilizer
- This year we will examine applying Agrotain Plus as a sidedress with a tractor to see if applying it as a bead may change the activity of the material

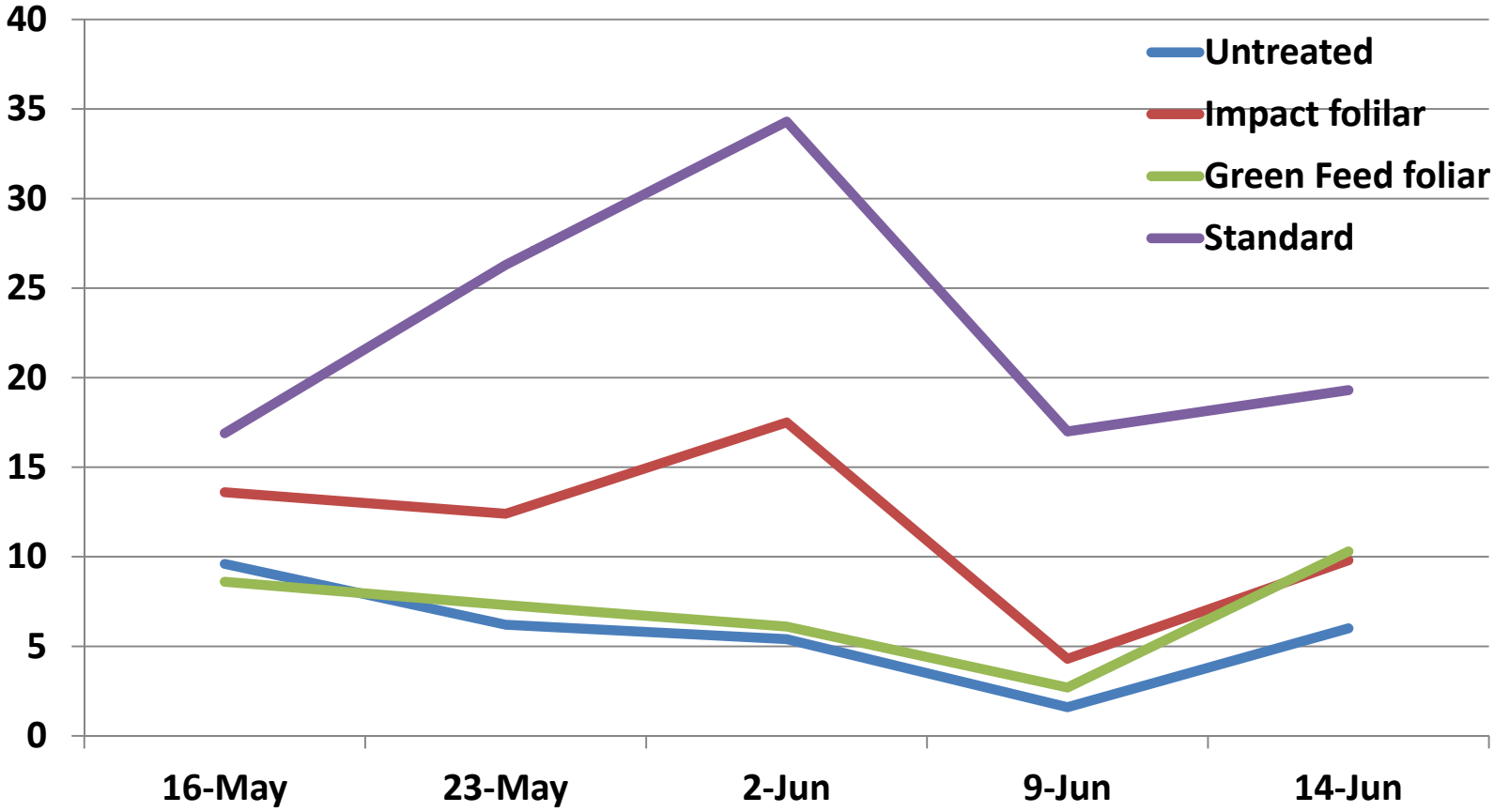
Foliar Fertilizer N Trial

First Crop 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

Soil Nitrate-N in Foliar Treatments

First Crop Romaine



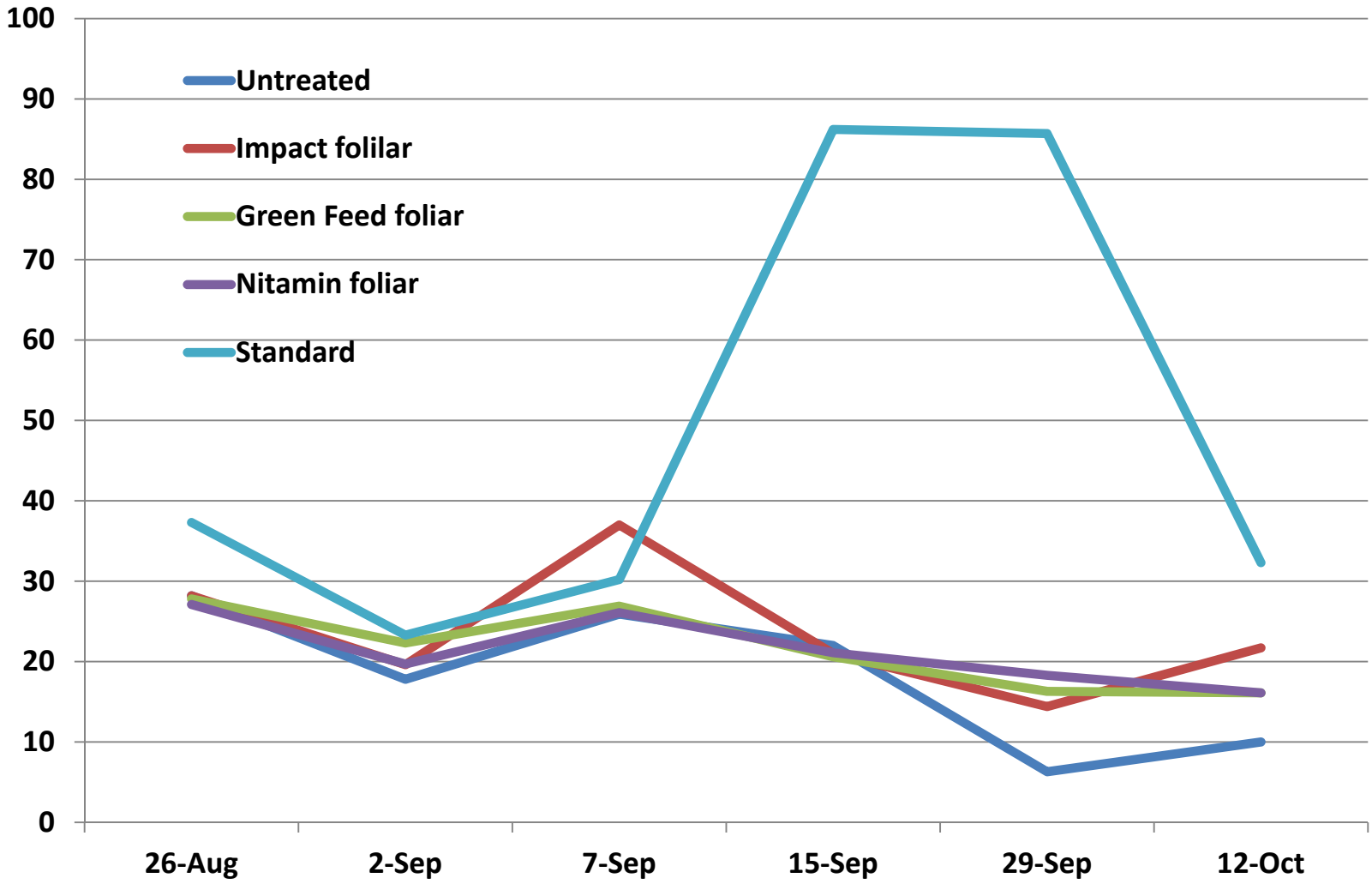
Foliar Fertilizer N Trial

Second Crop Head Lettuce 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	34.5	3.5	97.5
Impact – foliar	51.8	35.0	3.8	110.3
Green Feed - foliar	51.8	34.7	3.5	101.8
Nitamin - foliar	51.8	35.0	3.6	103.2
Standard fertilizer	108.7	35.4	3.9	120.3

Soil Nitrate-N in Foliar Treatments

First Crop Head Lettuce



Foliar Trial Summary

- In low residual soil nitrate situations that foliar N applications may give a slight increase in yield
- Foliar applications did not increase loads of soil nitrate
- This may provide a measure of added insurance to situations where you may have sufficient residual soil N, but want to make sure the plant has sufficient N without adding further N to the soil

Acknowledgements

- California Leafy Greens Research Board
- Koch Industries
- Caltec