Nutrient Management Update for Vegetables

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Nitrogen Management of Leafy Vegetables

- **Nitrogen management of vegetables in the coastal production districts has come under scrutiny due to regulations that have been issued by the Central Coast Regional Water Quality Control Board**

Nitrogen Management of Leafy Vegetables

- **To help growers comply, we have been evaluating various aspects of nitrogen management:**
  - **Nitrogen uptake by vegetables**
  - **Evaluation of residual soil nitrogen**
  - **Fertilizer technology to improve nitrogen use efficiency (NUE)**
  - **Strategies to better utilize nitrogen deeper in the soil profile**

Nitrogen Management of Leafy Vegetables

- **Nitrogen management in leafy vegetables needs to be looked at on a crop by crop basis**
- **But it should also be looked at on a yearly cycle basis in which we monitor and utilize residual N mineralized from prior crop residues and nitrate deeper in the soil profile**

Nitrogen Management of Leafy Vegetables

- **The main difficulty is that nitrate is highly mobile and can be pushed downwards with excess irrigation/rain beyond the reach of vegetables such as lettuce and spinach**

Nitrogen Dynamics of Spinach

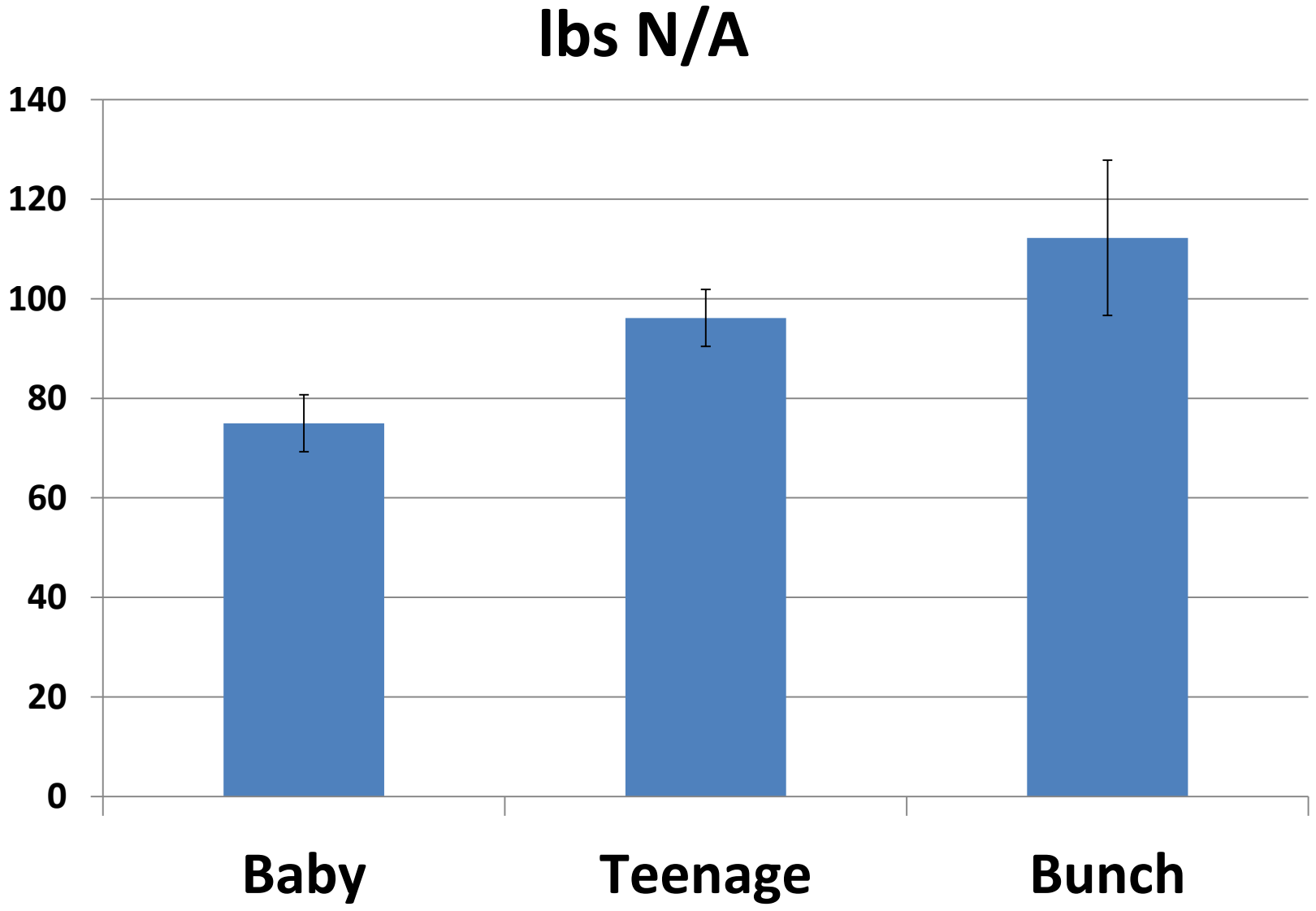
Spinach Nitrogen Dynamics

- **Spinach needs adequate N nutrition to produce well, but also to meet stringent quality standards**
- **The deep green color demanded by the market often goes beyond the agronomic need to optimize crop yield**

Spinach Nitrogen Dynamics

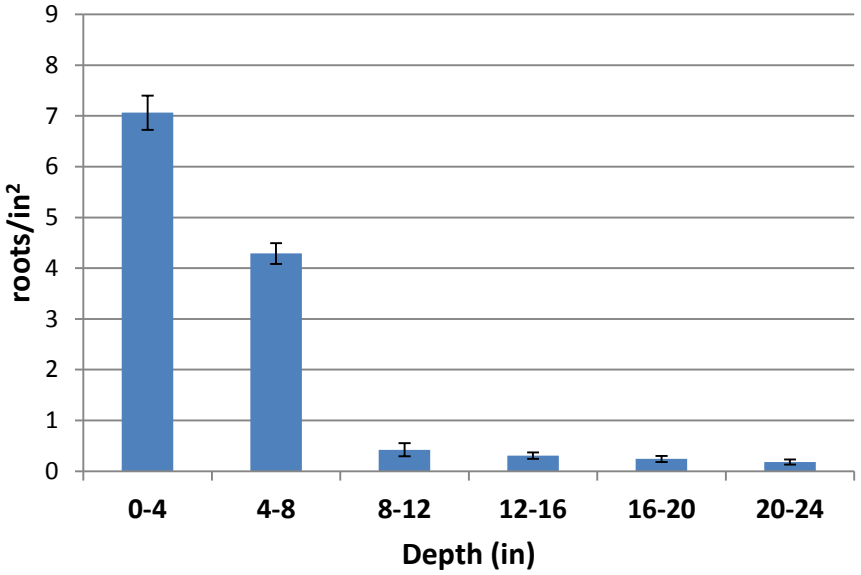
- **Spinach is probably one of the most difficult crops to achieve good nitrogen use efficiency:**
  - **All sprinkler irrigation**
  - **High N demand**
  - **Shallow rooted**

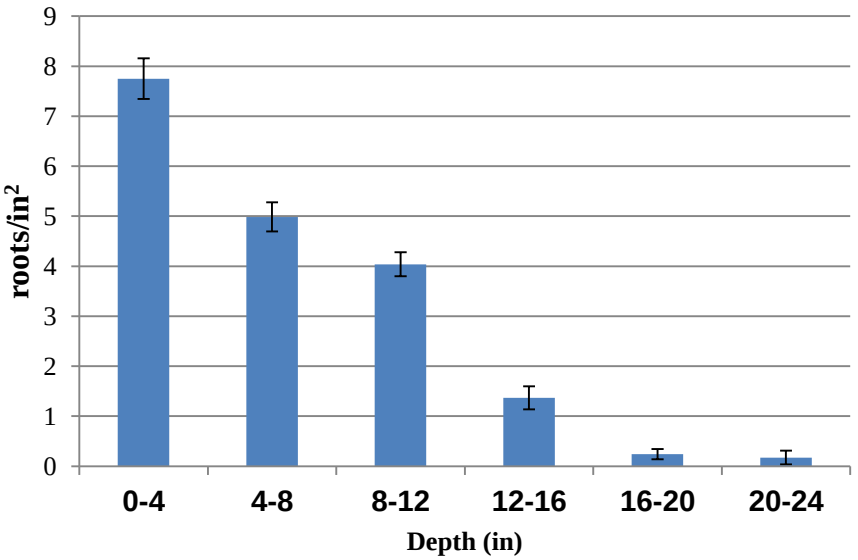
Nitrogen Uptake by Spinach Products



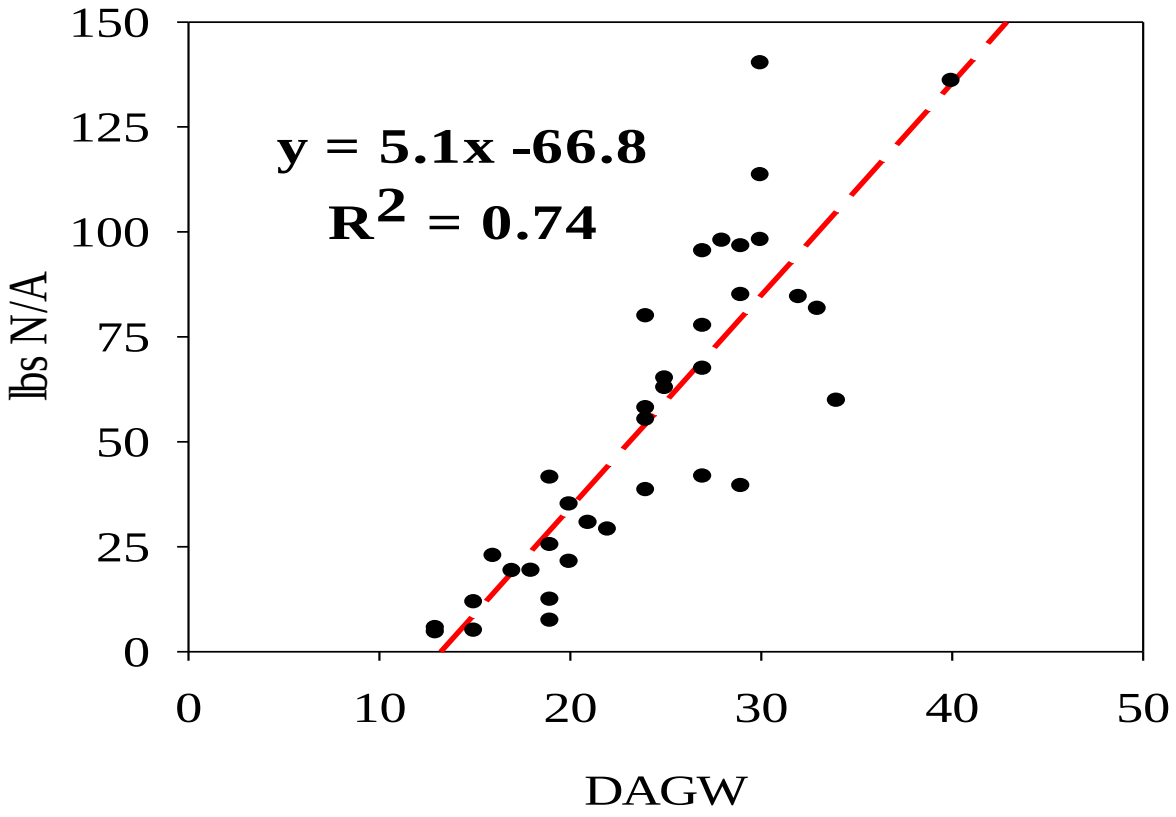
Spinach Root Distribution

Two Examples

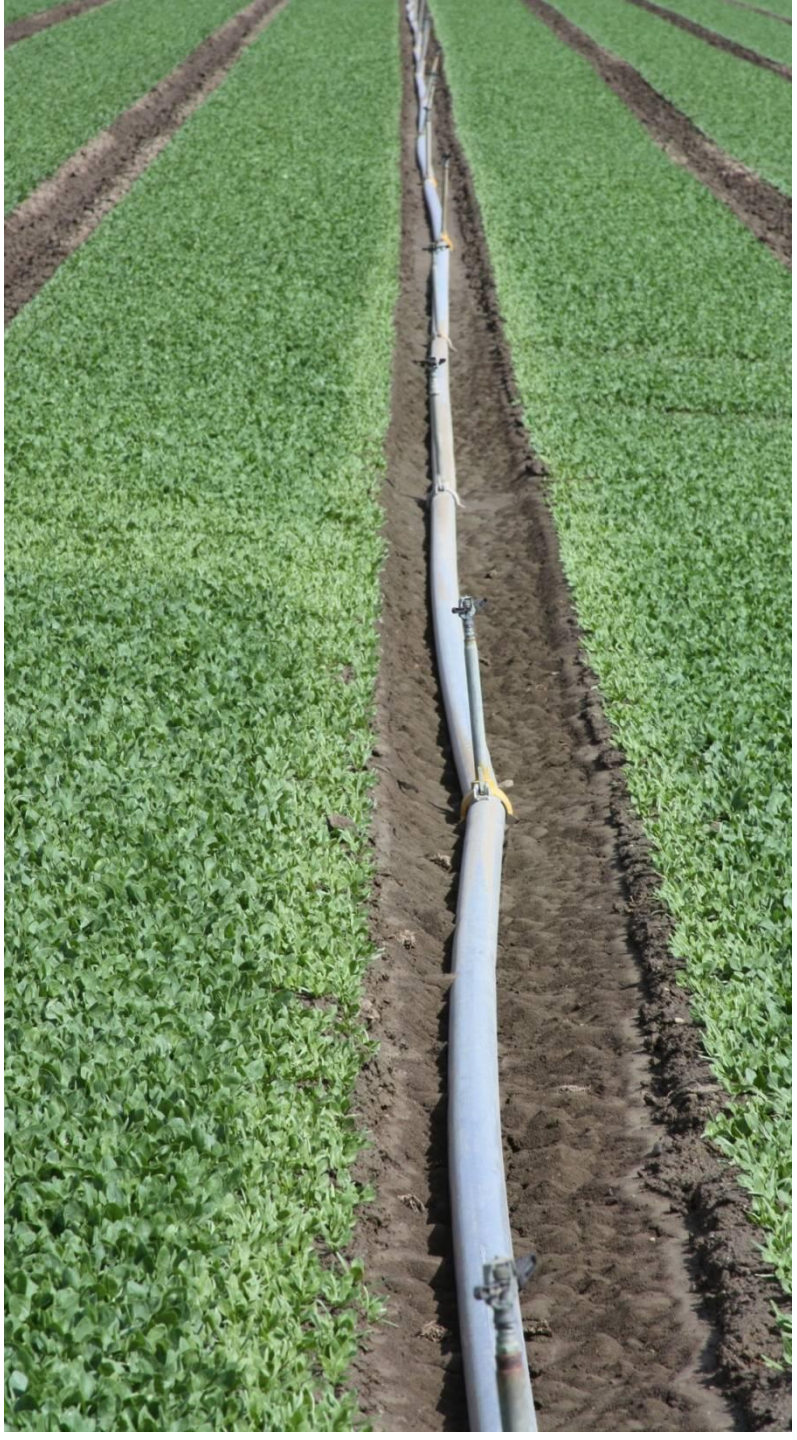




Spinach Nitrogen Uptake



- **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



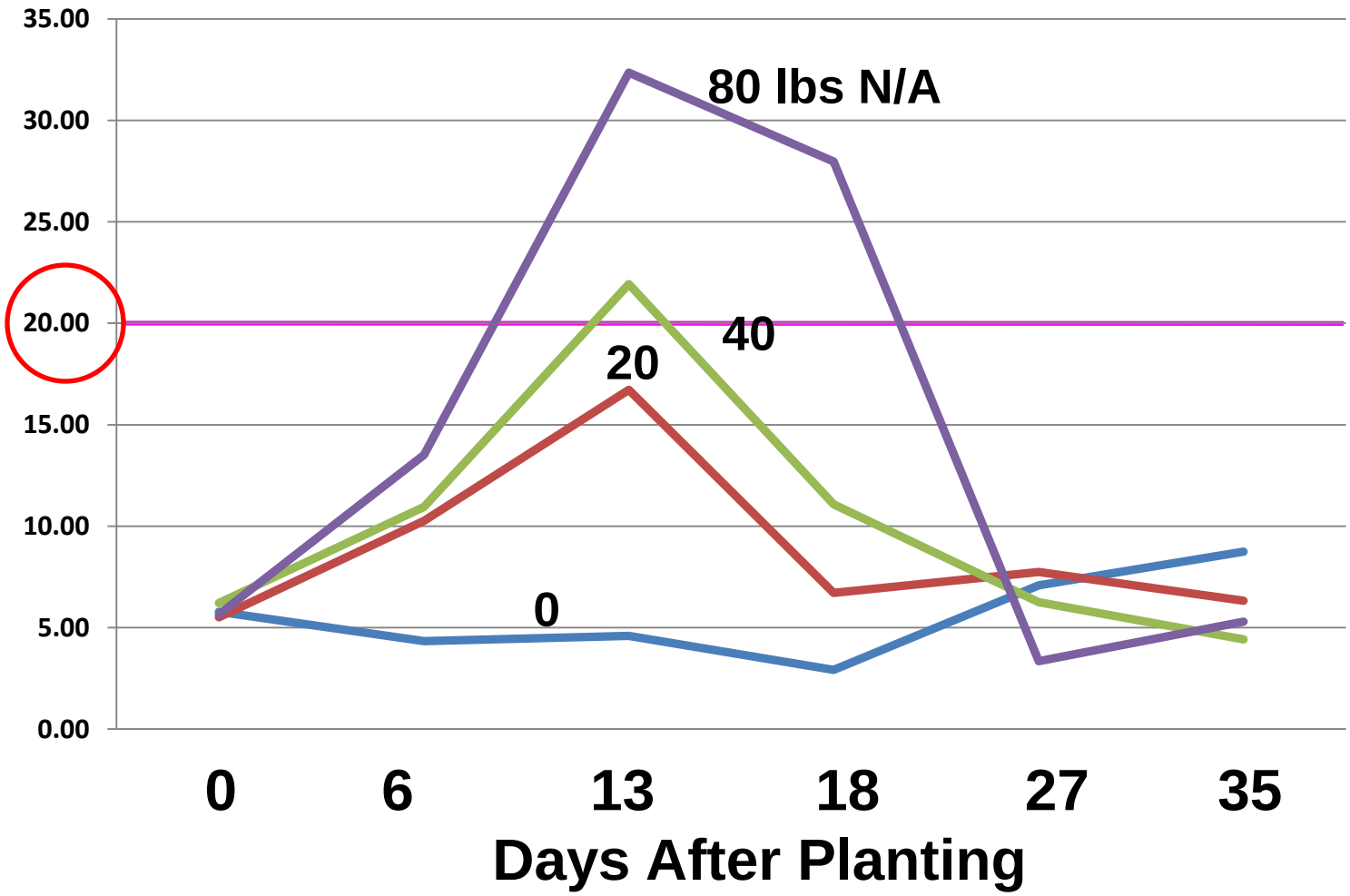
Inefficiencies with sprinkler irrigation on 80 inch beds

Spinach Nitrogen Evaluations

Spinach Fertilization

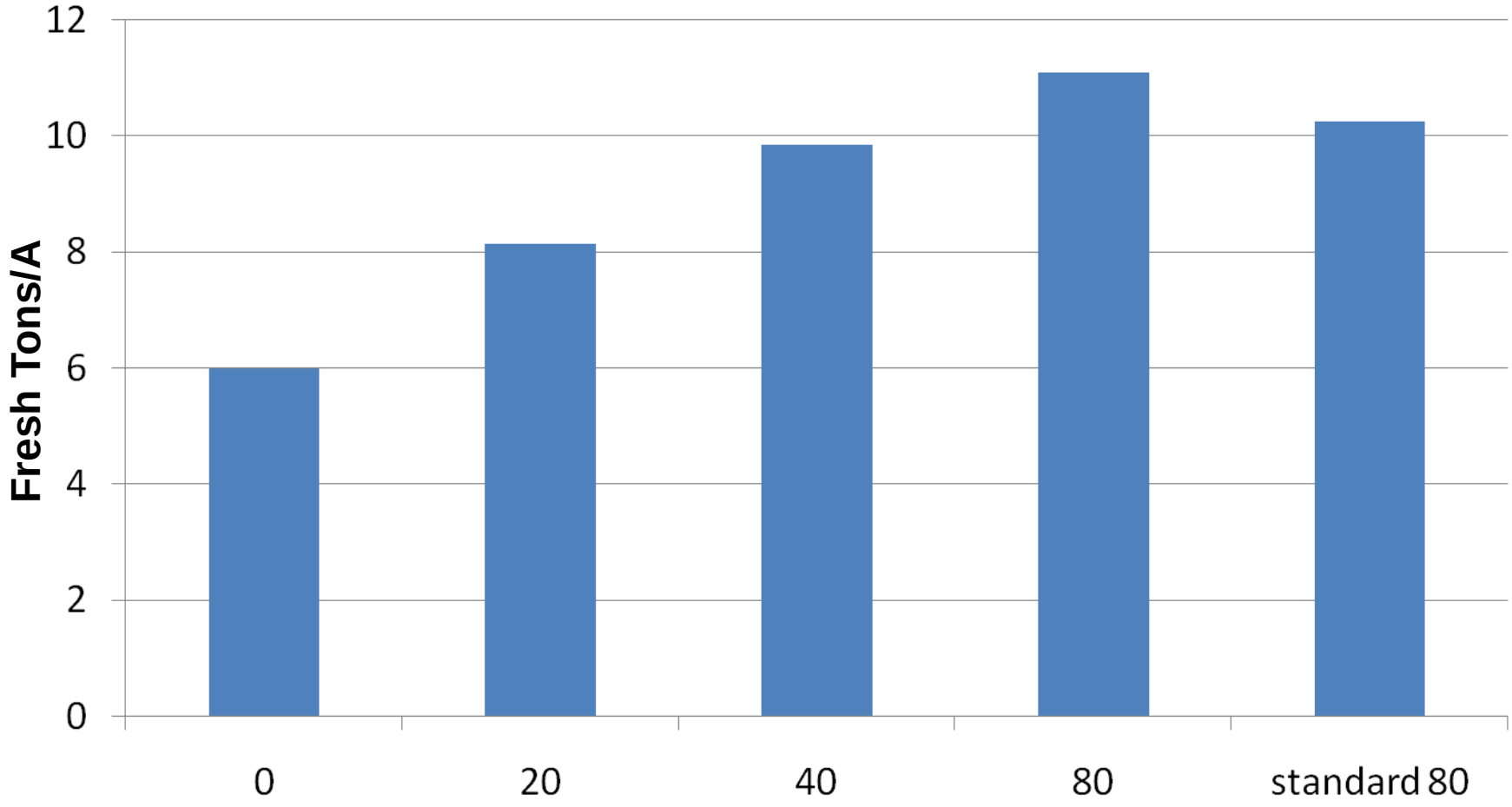
- **Spinach uptake in the first two weeks is low: 10-15 lbs N/A**
- **There is intensive competition between the spinach plants and good levels of N are essential**
- **However, Spinach needs 20-25 ppm nitrate-N in the top foot of soil through out the crop cycle to optimize yield**

Soil Nitrate-N First Crop Spinach



Yield of First Crop Spinach

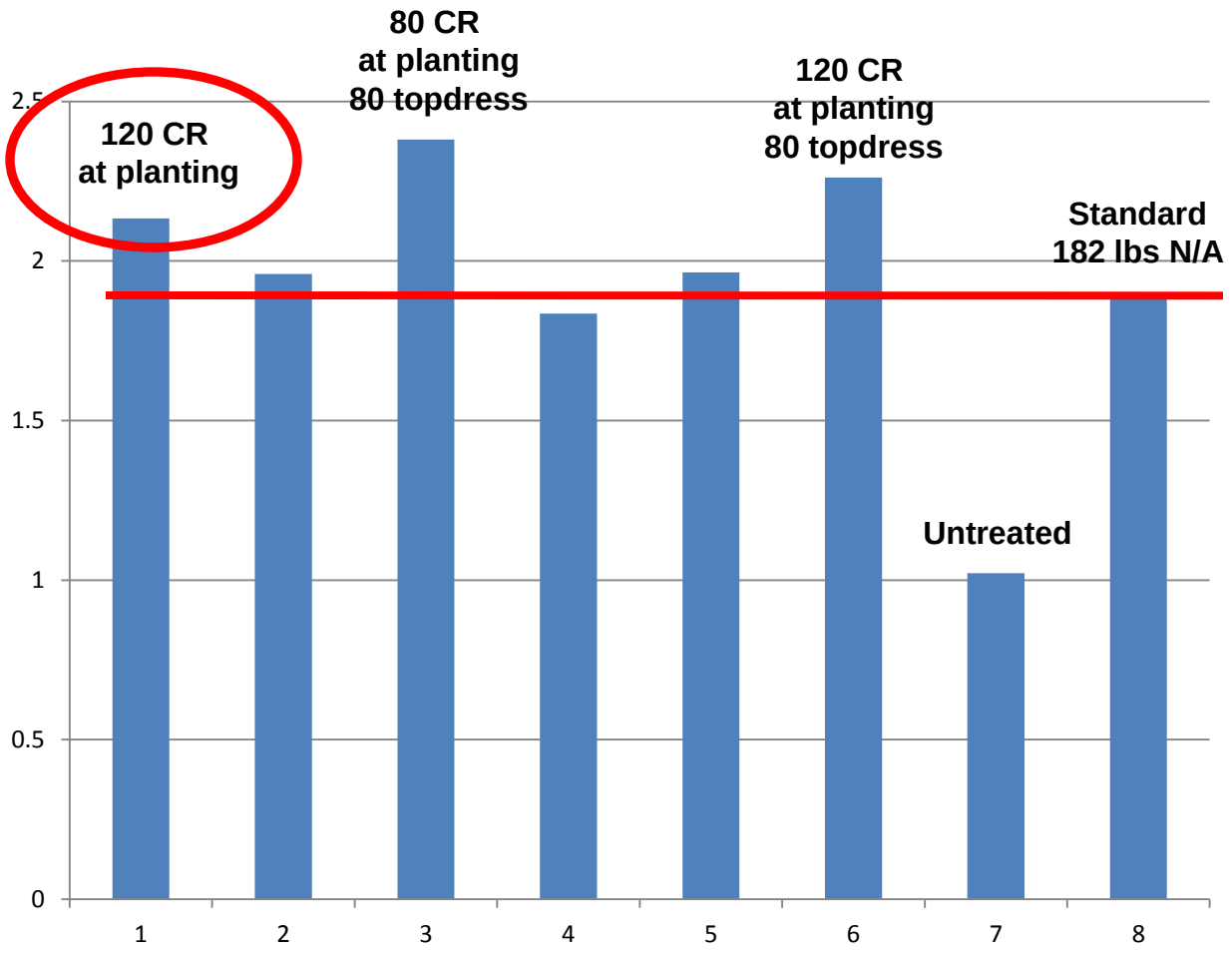
Mean of Two Trials



Spinach Fertilization

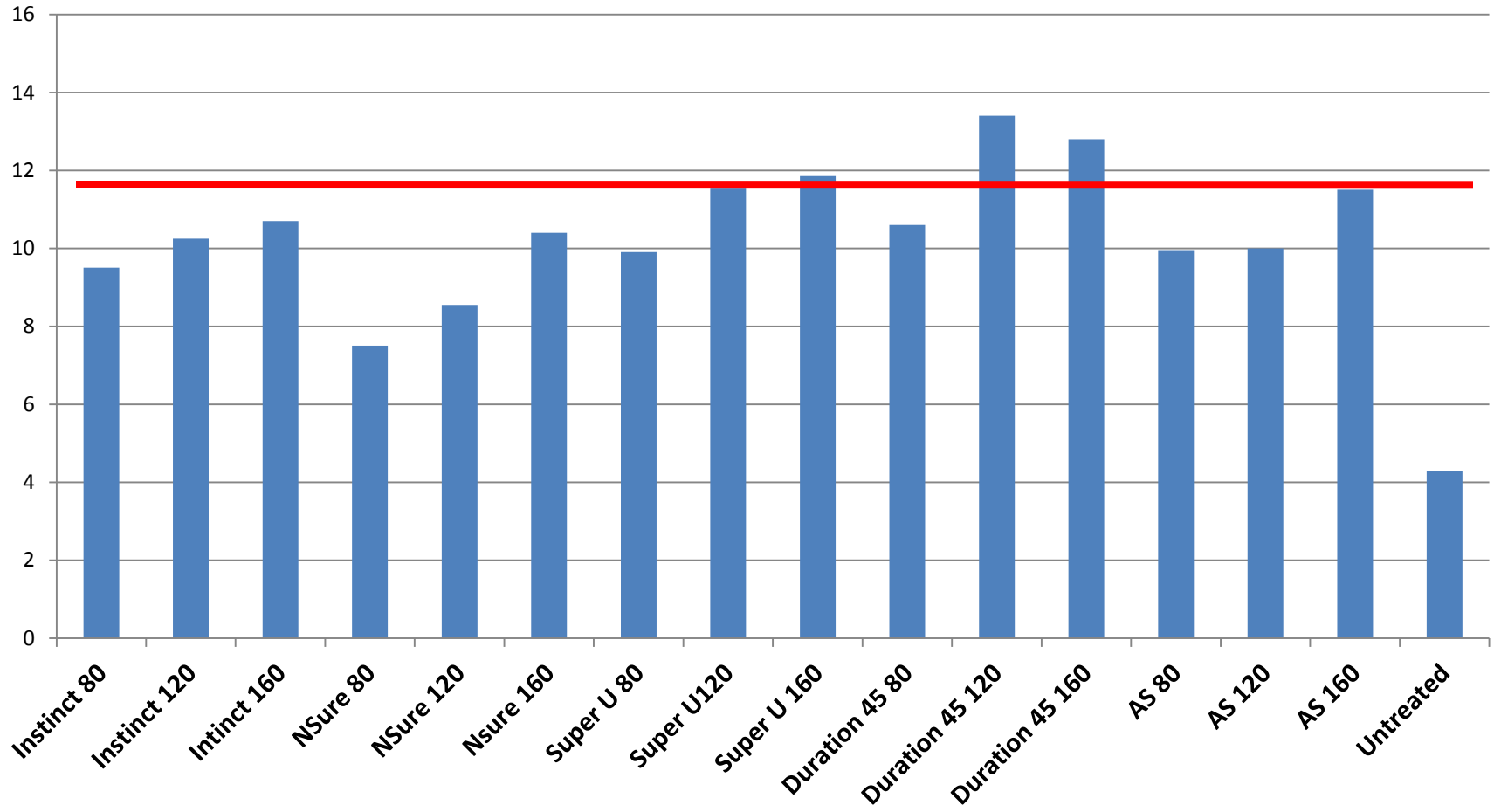
- **We are interested in testing ways to effectively put on amounts of N on spinach that are closer to the amounts taken up by the crop**
- **Fertilizer technologies such as controlled release fertilizers show promise for moving us closer to this goal**

2012 Controlled Release Fertilizer Evaluation Spinach



2013 Spinach Evaluations - Castroville

Average of Two Trials



Fertilizer Technology for High Density Short-term Crops

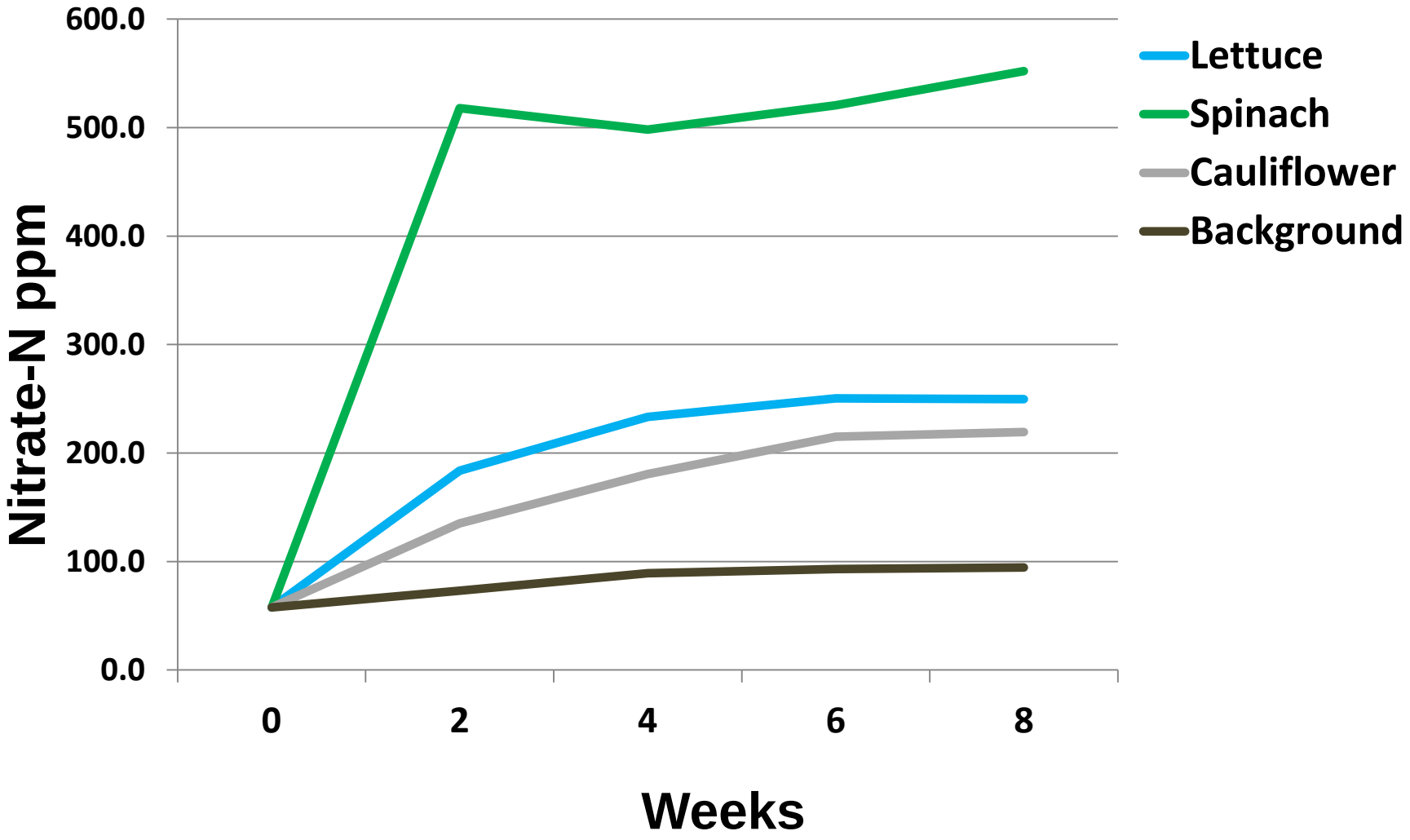
- **Results with controlled release fertilizers have not been as consistent in the south end of the Salinas Valley where it is hotter**
- **We still have a great deal to learn about how they work and how best to use them**

Nitrogen Over the Cropping Season

- **Thus far we have discussed managing nitrogen on a crop by crop basis**
- **However, is there a way to manage sources of N other than from fertilizer, such as N mineralized from crop residue, soil organic matter and N that may be deeper in the soil profile**

Nitrogen in Crop Residue

Mineralization of Crop Residue



CropManage

Integrating Irrigation and Residual Soil Nitrate Managements

- **The nitrate quick test is the best measure of the pool of available soil nitrate that is available from all sources:**
  - **Fertilizer**
  - **Residual fertilizer**
  - **Mineralized organic matter and crop residue**

Retrieving Nitrate Deeper in the Soil Profile

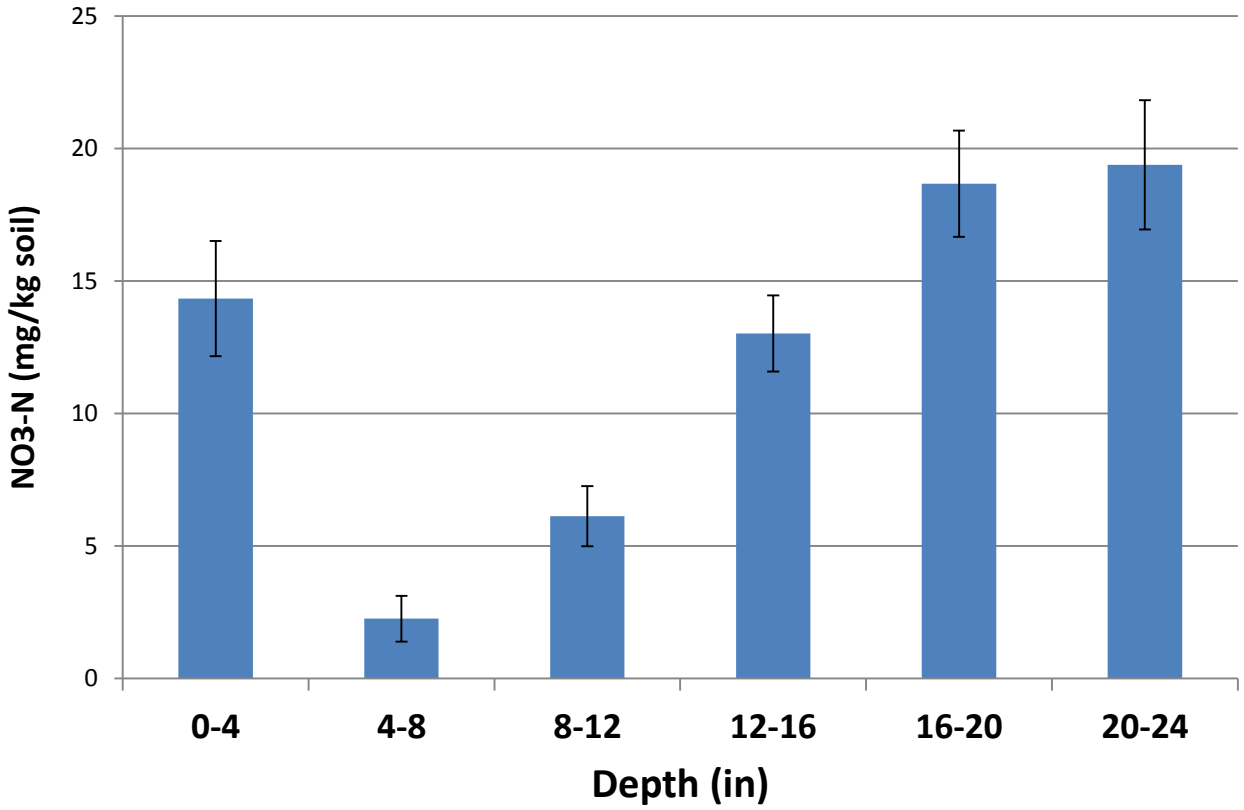
- **In many cropping systems in other parts of the world, growers can utilize rotational crops that are deeper rooted and can utilize nitrate that has been leached to deeper in the soil profile**
- **In our area, given the economics of production, we have lost many of these important rotational crops**

Nitrogen Uptake by Broccoli, Cauliflower and Cabbage

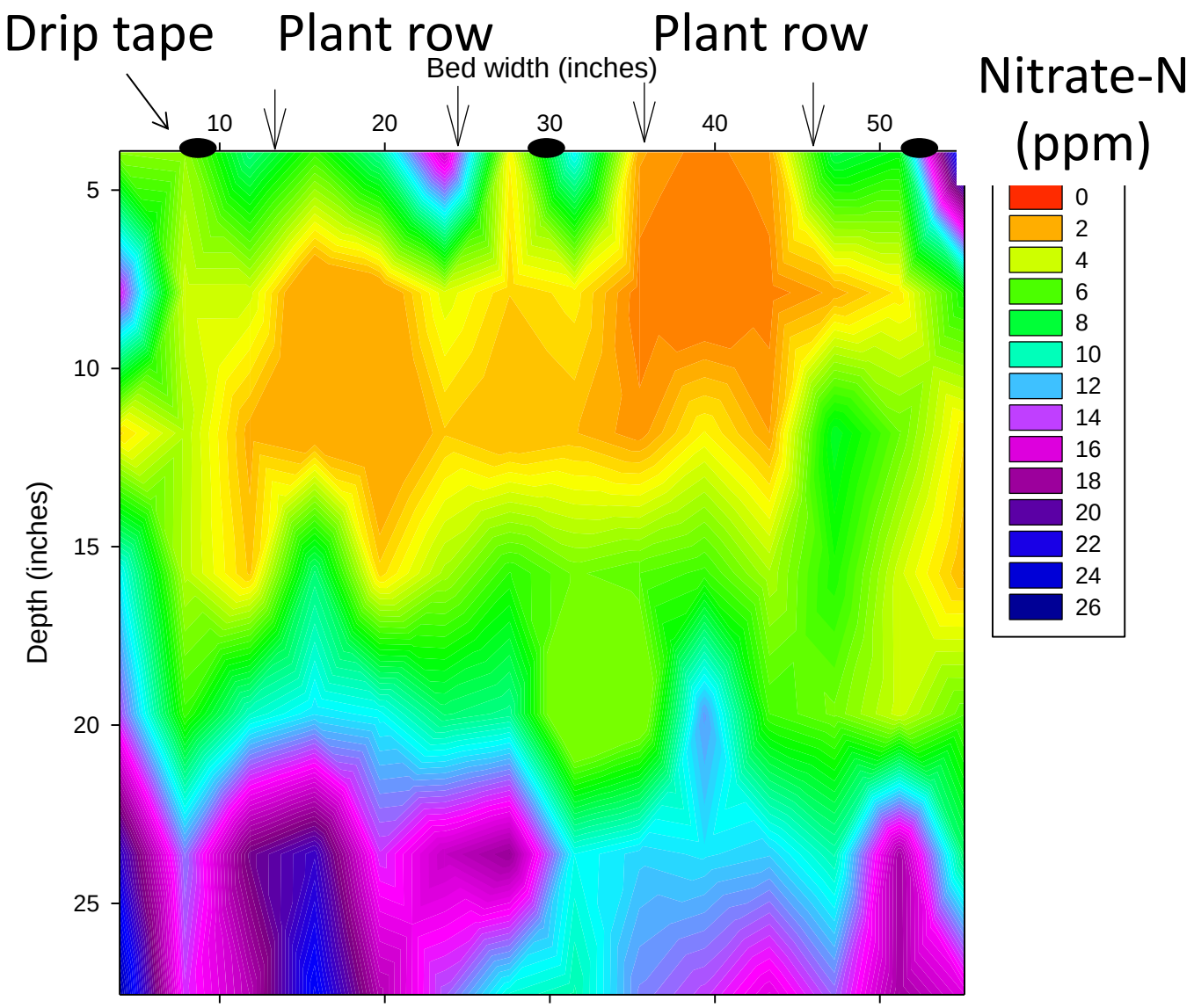
Fates of Nitrogen in Cole Crops Production and Harvest Summer

Crop	Fertilizer applied	Crop Uptake	Scavenged from soil	Removed in harvest	Residue after harvest
Broccoli	181	329	149	87	243
Cauliflower	260	281	21	52	230
Cabbage	215	330	115	188	142

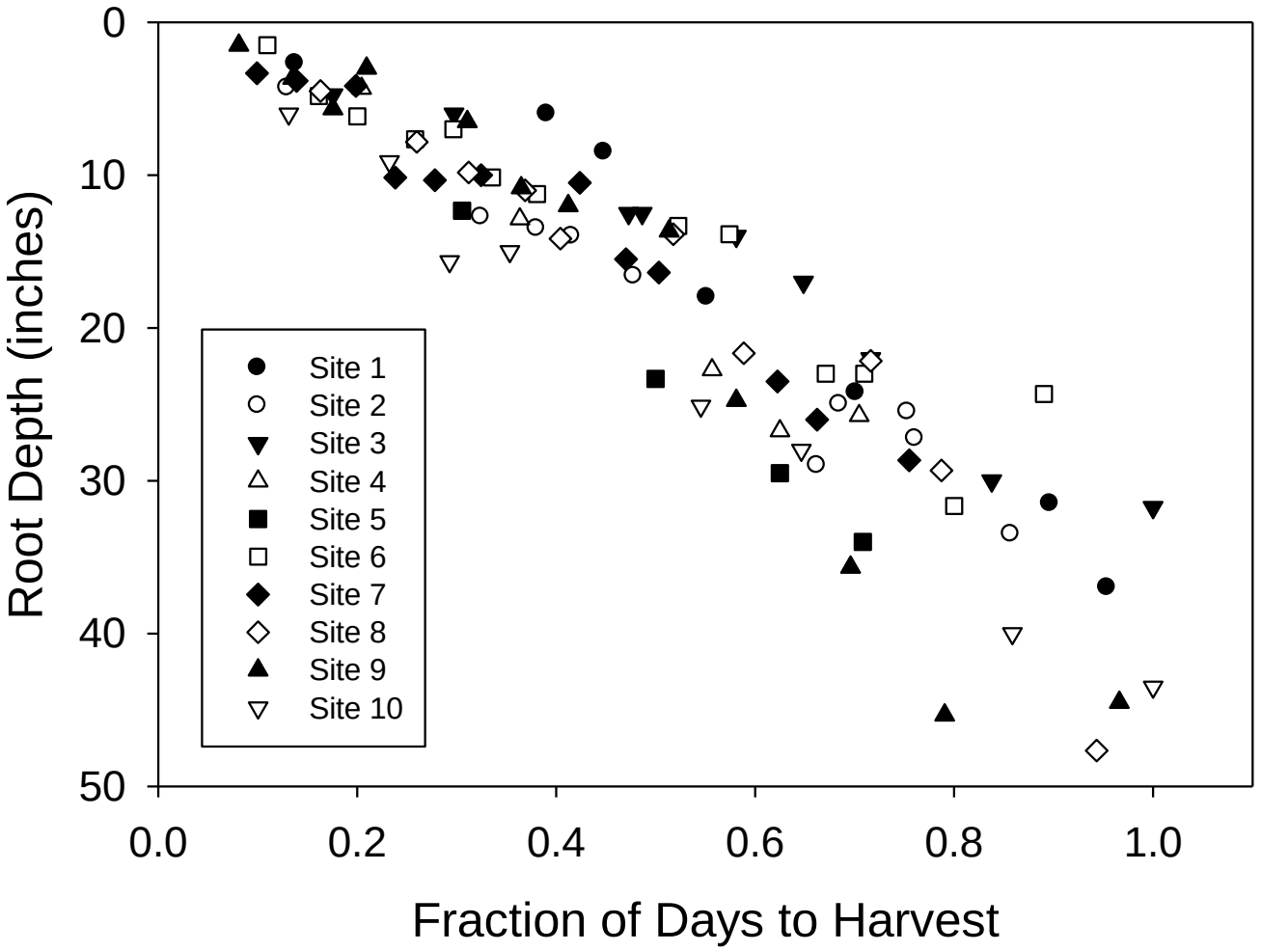
Nitrate Distribution in Spinach Beds at Harvest



Soil Nitrate Distribution in Lettuce



Rooting Depth of Broccoli



Fates of Nitrogen in Cole Crops Production and Harvest Winter

Crop	Fertilizer applied	Crop Uptake	Scavenged from soil	Removed in harvest	Residue after harvest
Broccoli	272	249	23+	94	156
Cauliflower	351	274	78+	70	175

End of Season Nitrogen Management

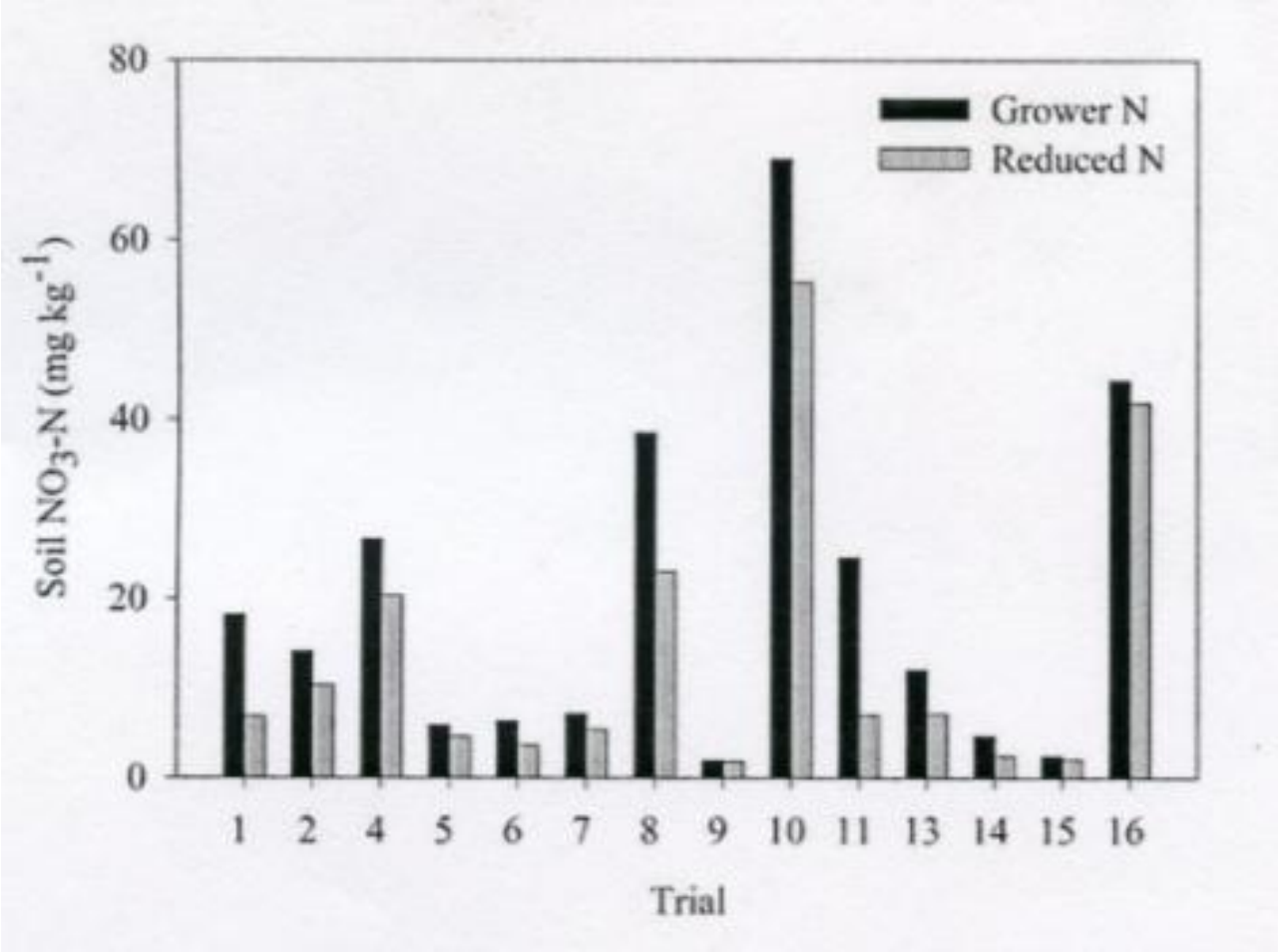
- **The quantity of nitrogen in the soil at the end of the production season will affect the quantity of N that is subject to leaching losses during the winter rainy season**
- **Ways to address this issue are:**
  - **Manage the final crop of the season to draw down soil nitrates to low levels**
  - **Use cover crops take up residual soil nitrate and sequester in the crop biomass**

End of Season N Management

- **Careful use of the nitrate quick test can help guide fertilizer applications and avoid over application of N**
- **Studies conducted on numerous fields have shown that use of the quick test can reduce N application resulting in lower levels of nitrate in the soil at the end of the season**

Residual Soil Nitrate at End of Growth Cycle

Evaluation of 16 Commercial Fields



End of Season N Management

- **The bottom line is that efforts to utilize residual soil nitrate in place of applying additional fertilizer reduces the load of nitrate in the soil at the end of the season and can reduce the quantity of nitrate moved downward during the fallow period and rainy season**

Cover Crops

- **Cover crops provide the best means of sequestering the end-of-season residual soil nitrate**
- **Unfortunately, they cannot be used on a high percentage of acreage**

Summary

- **Nitrogen management for leafy vegetable production to safeguard yield and reduce nitrate losses to the environment is complicated**
- **It can be achieved, but requires taking into consideration available residual soil nitrate and making fertilizer decisions accordingly**