



# **Improving N Use Efficiency of Cool Season Vegetable Production Systems with Broccoli Rotations**

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# Broccoli Nitrogen Dynamics

- In the FREP-funded project, “Survey of nitrogen uptake and applied irrigation water in broccoli, cauliflower and cabbage” we observed that these cole crops have the potential to scavenge nitrogen from the soil



# Survey of Summer Production Fields

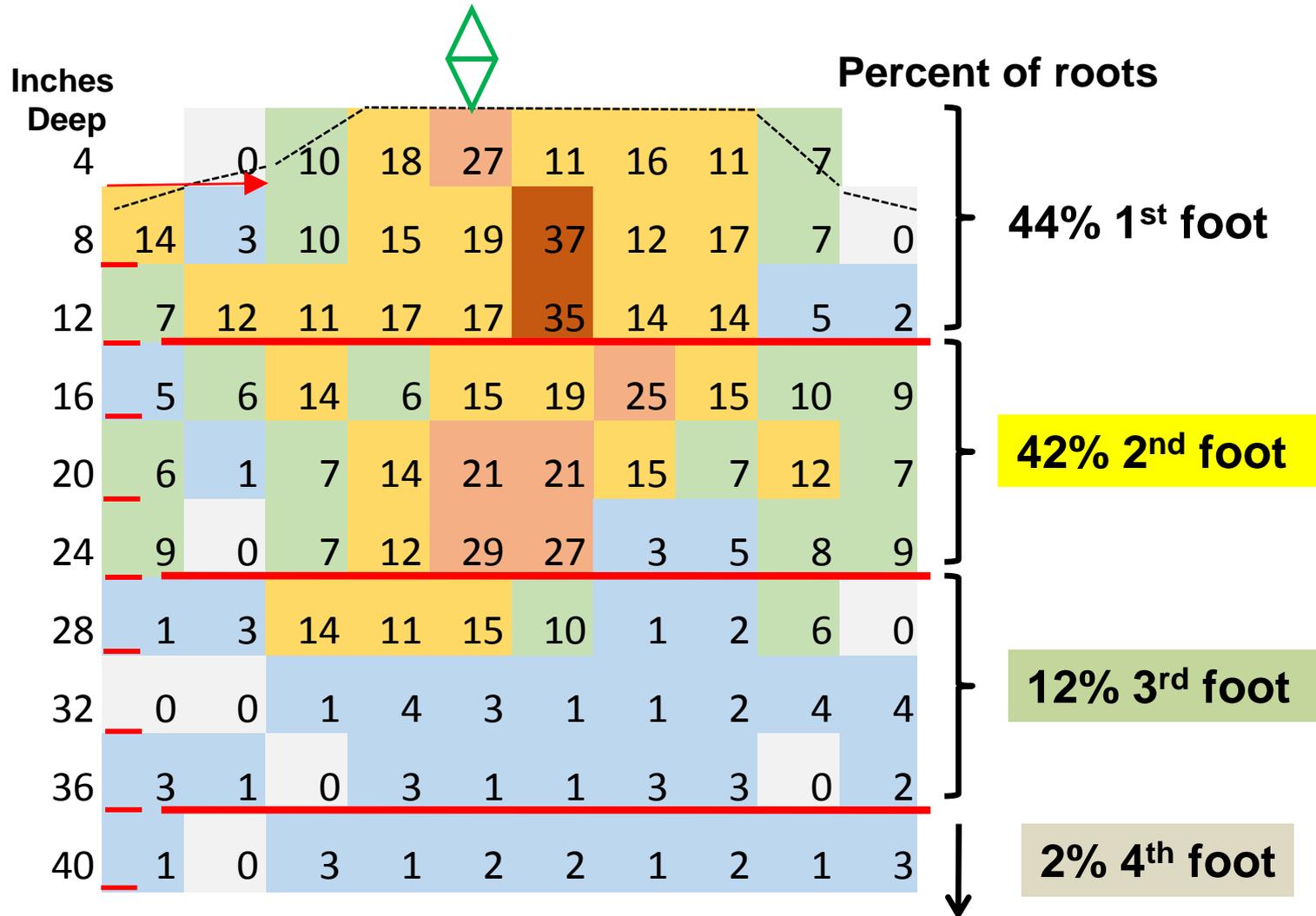
<b>Crop</b>	<b>Fertilizer applied</b>	<b>Crop Uptake</b>	<b>Scavenged from soil</b>
<b>Broccoli</b>	<b>181</b>	<b>337</b>	<b>155</b>
<b>Cauliflower</b>	<b>260</b>	<b>285</b>	<b>21</b>
<b>Cabbage</b>	<b>215</b>	<b>337</b>	<b>97</b>

# Reason that scavenging nitrogen is common in these crops:

- **Biomass production is relatively high**
  - 4.3 T/A broccoli
  - 3.4 T/A cauliflower
  - 6.0 T/A cabbage
- **High N concentration**
  - 4.0% broccoli
  - 4.1% cauliflower
  - 3.0% cabbage
- **Relatively long-season growing season**
- **Grown in areas with large quantities of residual soil nitrogen**
- **Deep rooted and can access mineral nitrogen deeper in the soil profile**

# Cauliflower

## 113 days after planting



# **Improving N Use Efficiency with Broccoli Rotations**

- **Given the observation that these crops scavenge nitrogen from the soil, we proposed another project to FREP to evaluate the potential of broccoli\* to mitigate nitrate leaching in Salinas Valley vegetable rotations**

**\* Broccoli is the dominant brassica family crop grown in the Salinas Valley (67% of acreage)**

# Objectives

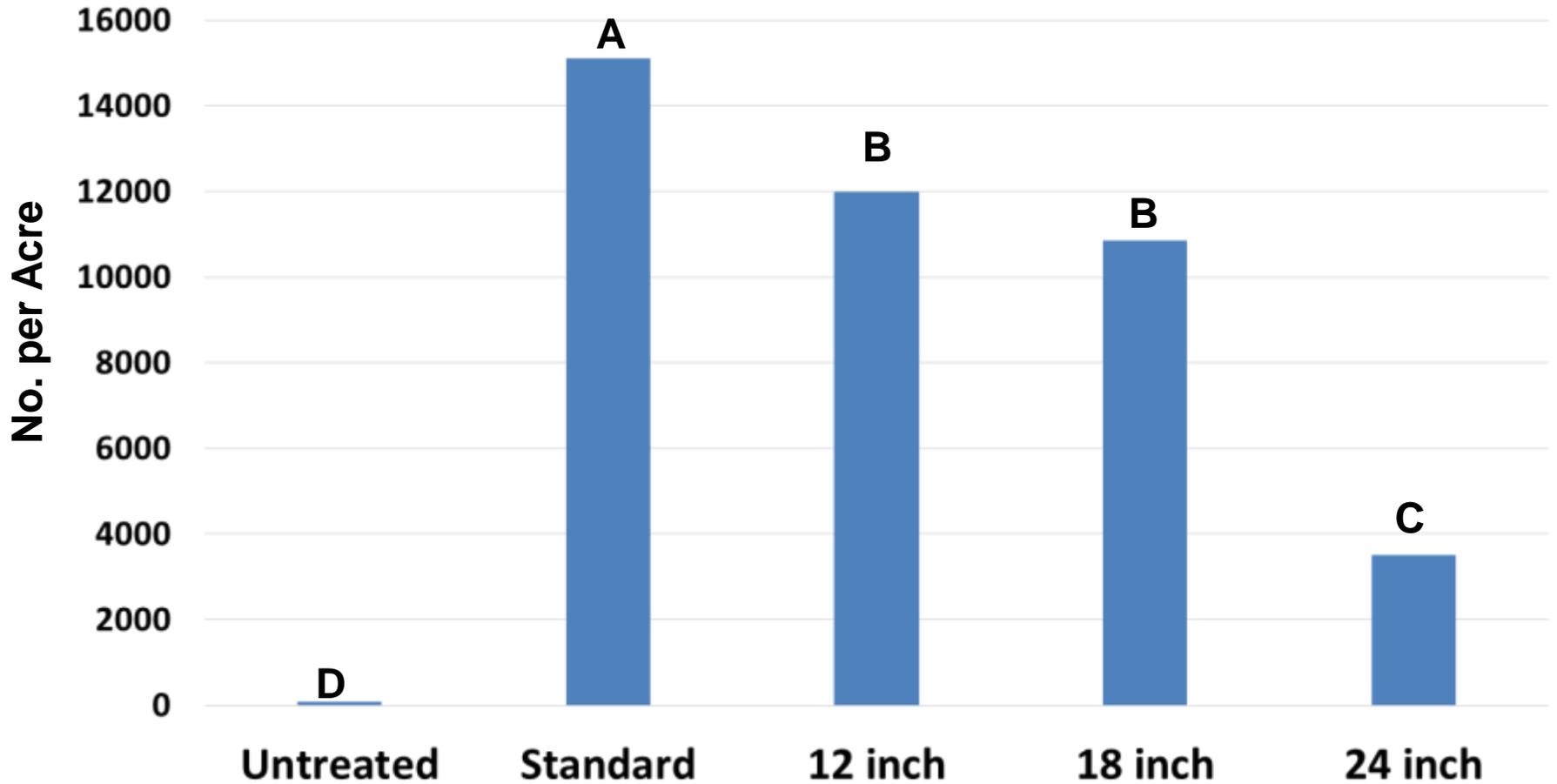
- 1. Evaluate the rooting depth of broccoli and examine how deep in the soil profile that it is removing nitrogen for crop growth**
- 2. Evaluate soil sampling to two feet with the nitrate quick test to determine soil nitrate threshold for guiding N fertilizer applications in broccoli**
- 3. Evaluate the ability of broccoli to remove residual nitrate from the soil following a lettuce crop under normal production practices**
- 4. Examine the mineralization rate and quantity of nitrate mineralized from broccoli residue to assist its utilization by subsequent crops**

# Examine how deep broccoli is removing nitrogen from the soil profile

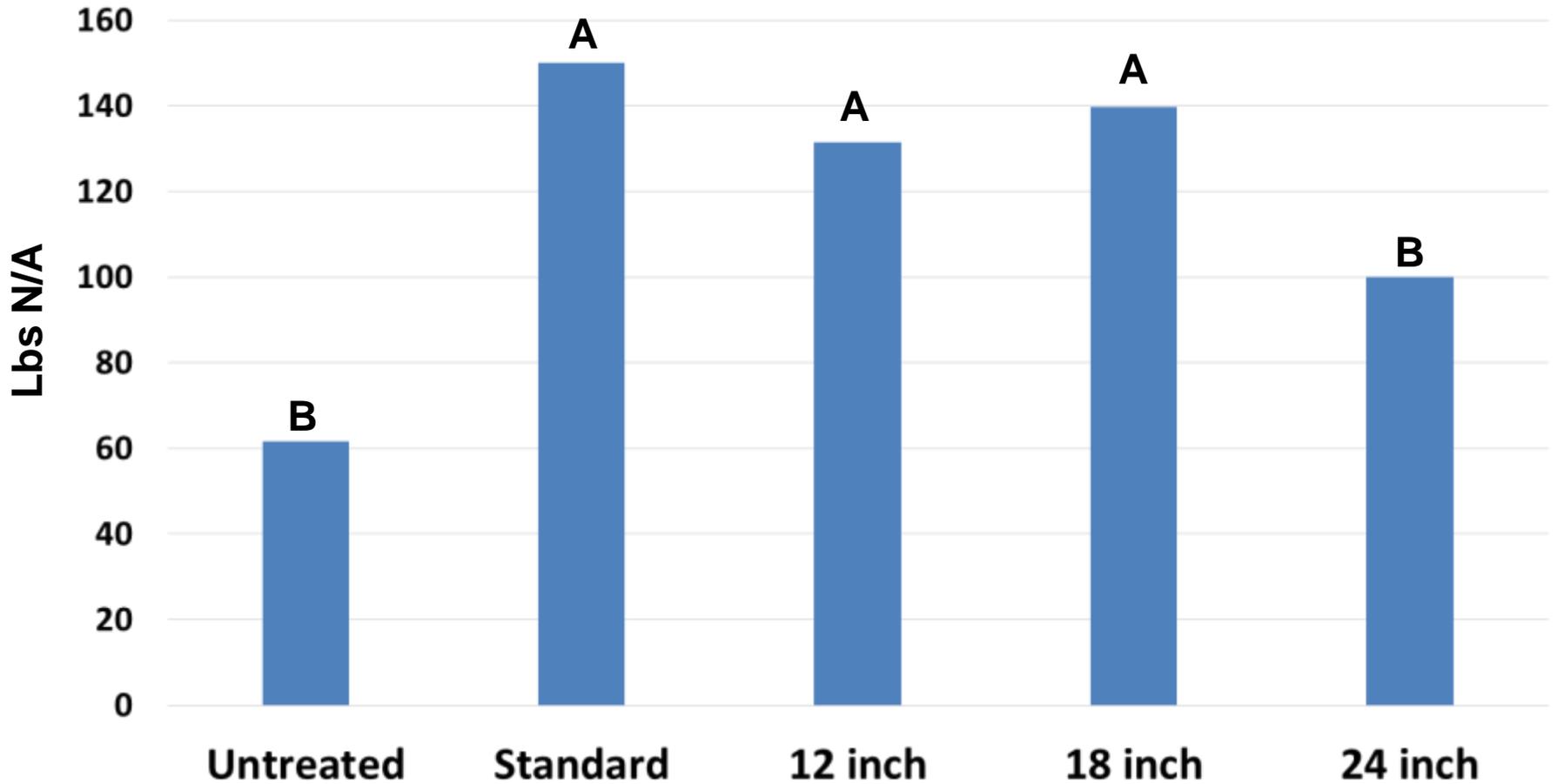
- Conducted trials in 2014 & 2015 at the Spence Research Station
- Injected drip tape 12, 18 and 24 inches deep
- Compared with Standard (surface drip tape) and an untreated
- Applied 150 lbs N to all treatments (the deep treatments CN9 was used as N source)
- Soil nitrate was low at onset of trial



# Marketable Heads



# Biomass N Uptake

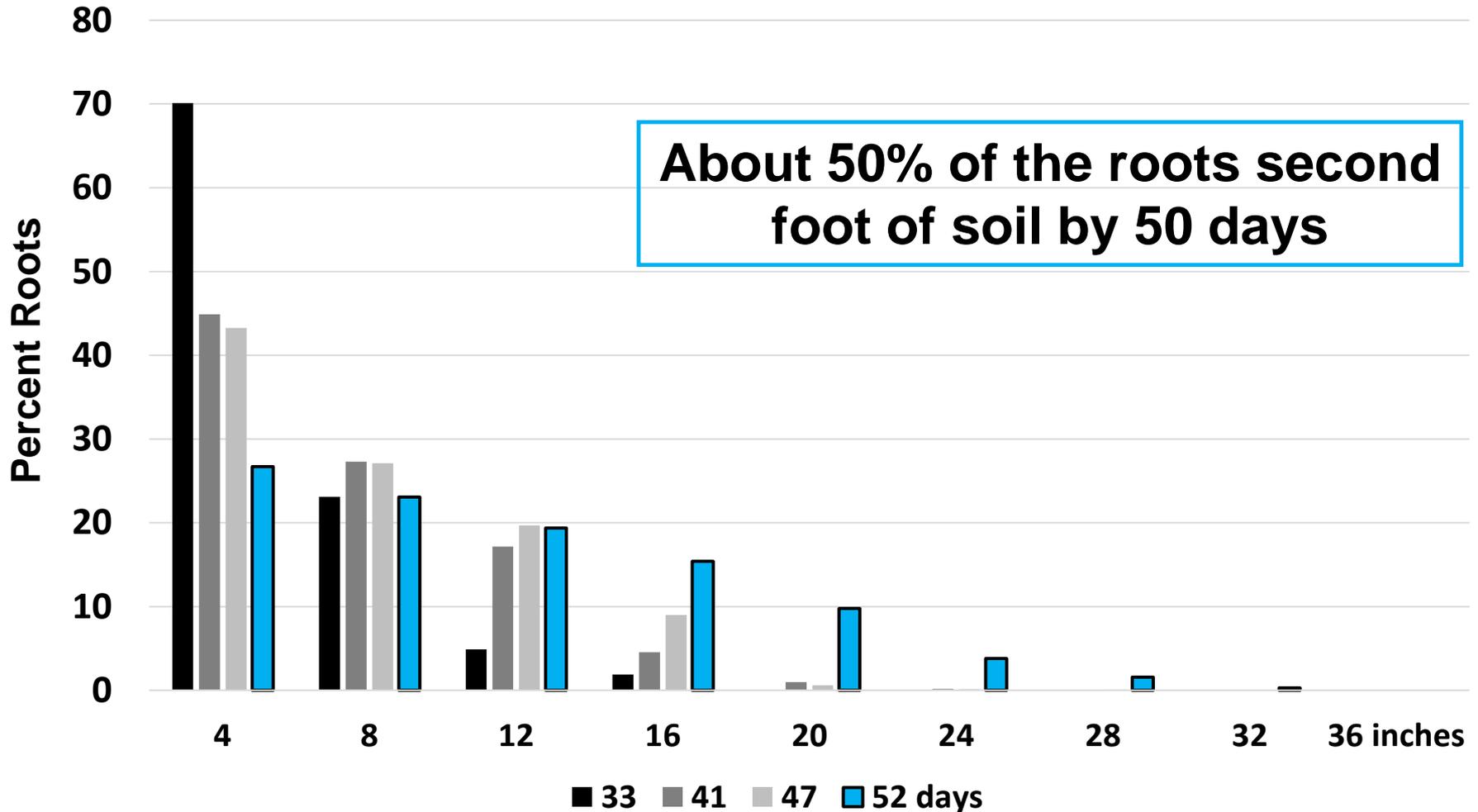


# **Examine how deep broccoli is removing nitrogen from the soil profile**

- Results indicated that broccoli can take up N from deeper in the profile**
- However, the plants need to develop the root system before it is capable of doing so**
- Good initial soil fertility is needed to develop the crops until it can take advantage of nitrate deeper in the soil profile**

# The Percent Roots in the 2<sup>nd</sup> Foot of Soil Increase after 50 days

Percent Roots at Soil Depths over Time



# **Evaluate the ability of broccoli to remove residual nitrate from the soil following a lettuce crop under normal production practices**

- In 2014 & 2015 ten broccoli fields grown following lettuce were evaluated**
- Soil nitrate levels down to three feet were evaluated over the course of the growing season**
- Total crop N uptake and applied water were evaluated**
- Estimates of potential scavenging and leaching were made**

# Broccoli N Dynamics

2014

Site	Initial residual soil nitrate <sup>1</sup>	Nitrogen applied	Total available	Percent N taken up by Broccoli crop
1	146	178	324	97
2	372	178	550	67
3	134	190	324	82
4	183	190	373	99
5 <sup>2</sup>	257	240	497	44

1 - In the top three feet of soil; 2 – loamy sand soil

# Broccoli N Dynamics

2014

Site	Crop uptake	Final residual <sup>1</sup>	Unaccounted
1	313	9	32
2	370	132	77
3	268	19	67
4	369	48	-14
5 <sup>2</sup>	220	92	214

1 - In the top three feet of soil; 2 - loamy sand soil type

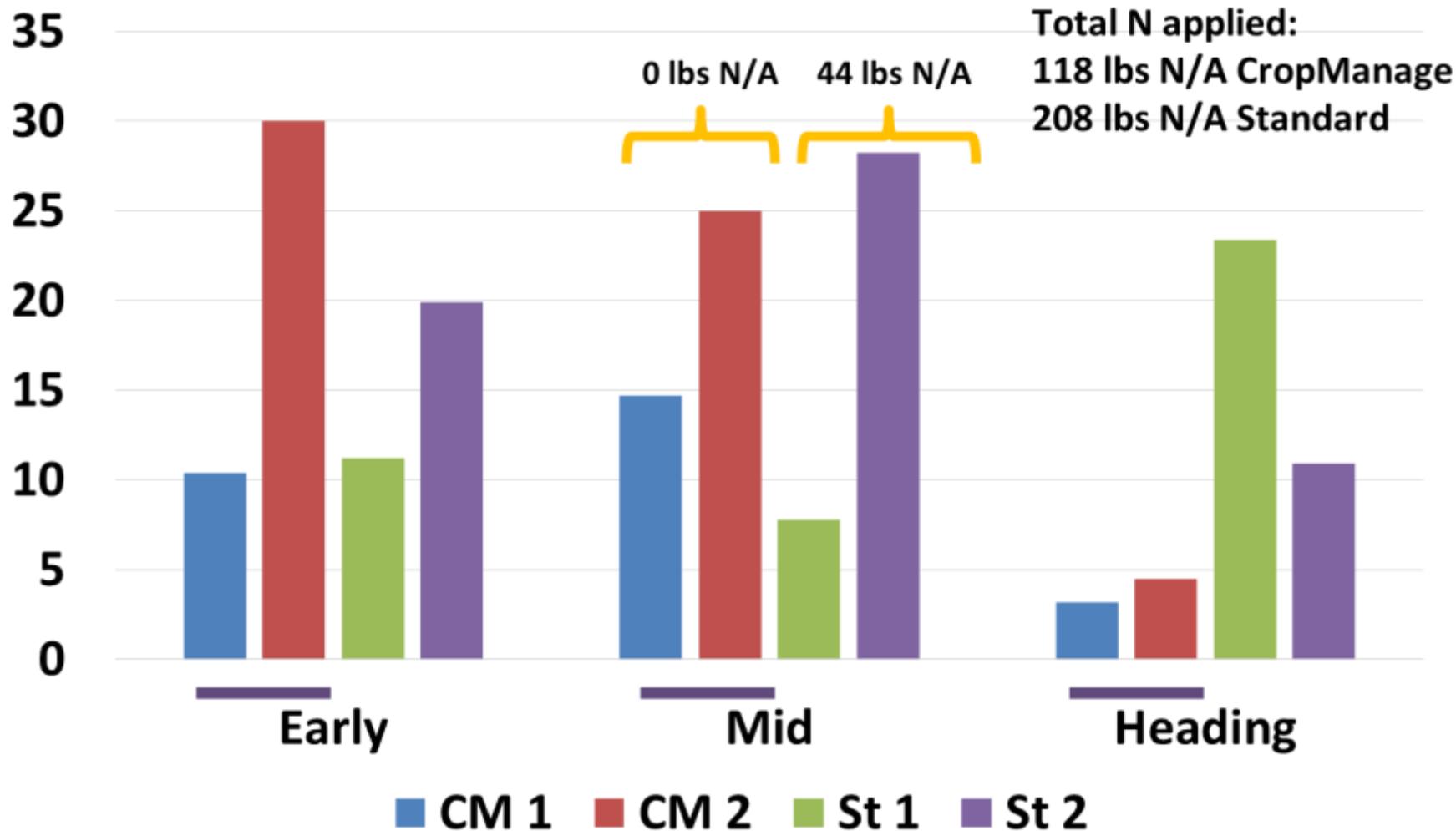
# **Evaluate soil sampling to two feet with the nitrate quick test to determine soil nitrate threshold for guiding N fertilizer applications in broccoli**

- Conducted a trial comparing grower standard practice with BMP guided by recommendations for N and water applications from CropManage**
- Conducted in a commercial field with a grower cooperator**

# Comparison of BMP vs Standard

<b>Crop</b>	<b>Irrigation Water Acre inches</b>	<b>Fertilizer applied Lbs N/A</b>	<b>Crop Uptake Lbs N/A</b>	<b>Commercial Yield Lbs/A</b>
<b>BMP</b>	<b>16.0</b>	<b>118</b>	<b>302</b>	<b>7,745</b>
<b>Standard</b>	<b>15.5</b>	<b>206</b>	<b>315</b>	<b>8,067</b>

# Making Use of Nitrate-N in the Second Foot

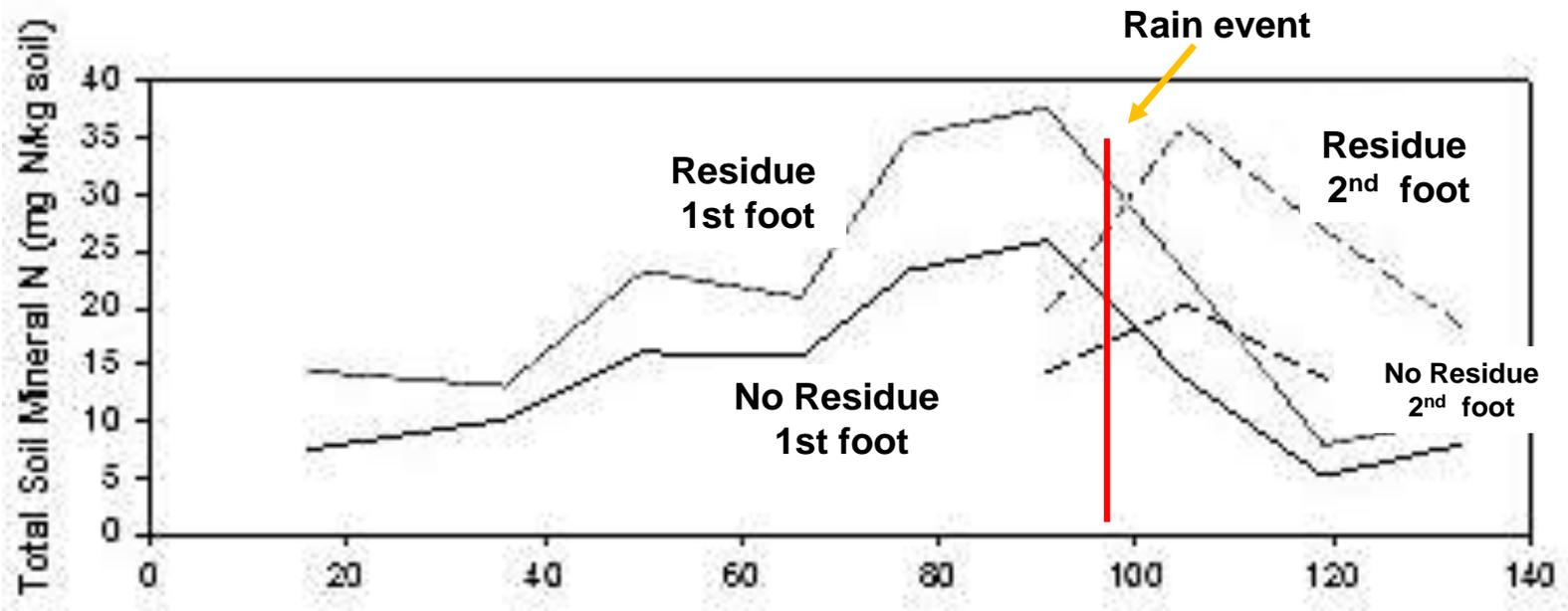


# **Examine the mineralization rate and quantity of nitrate mineralized from broccoli residue**

- We cleared broccoli residue from areas 40 feet x 40 feet after harvest and followed the mineralization of nitrate-N over the winter fallow period**
- Nitrate-N in the soil of these areas and uncleared areas was monitored over the winter fallow**

# Fate on Nitrogen Mineralized from Broccoli Residue

2014-15 Field Evaluations



# Summary

- **Broccoli is capable of taking up residual soil nitrate-N from deep in the soil profile**
- **It is therefore extremely useful in being able to reduce leaching of residual soil nitrate in the soil**
- **However, about 1/3 of biomass N is removed in the harvested crop**
- **The remaining crop residue mineralizes N rapidly**

# Summary

- **Residual soil nitrate from broccoli can be lost during winter fallows**
- **During the cropping season, if nitrate from broccoli residue is carefully monitored and utilized, it can help reduce fertilizer application**
- **Taking one measurement of nitrate in the 2<sup>nd</sup> foot of soil before the last fertilizer application can help guide fertilizer decisions and improve nitrogen use efficiency**

**Thanks to FREP for funding this research**