

# **Crop Growth, Rooting Depth, Nitrogen Uptake and Nitrogen Removal**

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# Crop Growth

- **Direct Seeded**
  - **Lettuce, broccoli, high density (spinach, spring mix, baby lettuce)**
- **Transplanted**
  - **Cauliflower, celery, leeks, peppers, broccoli**

# **Crop Growth Rate**

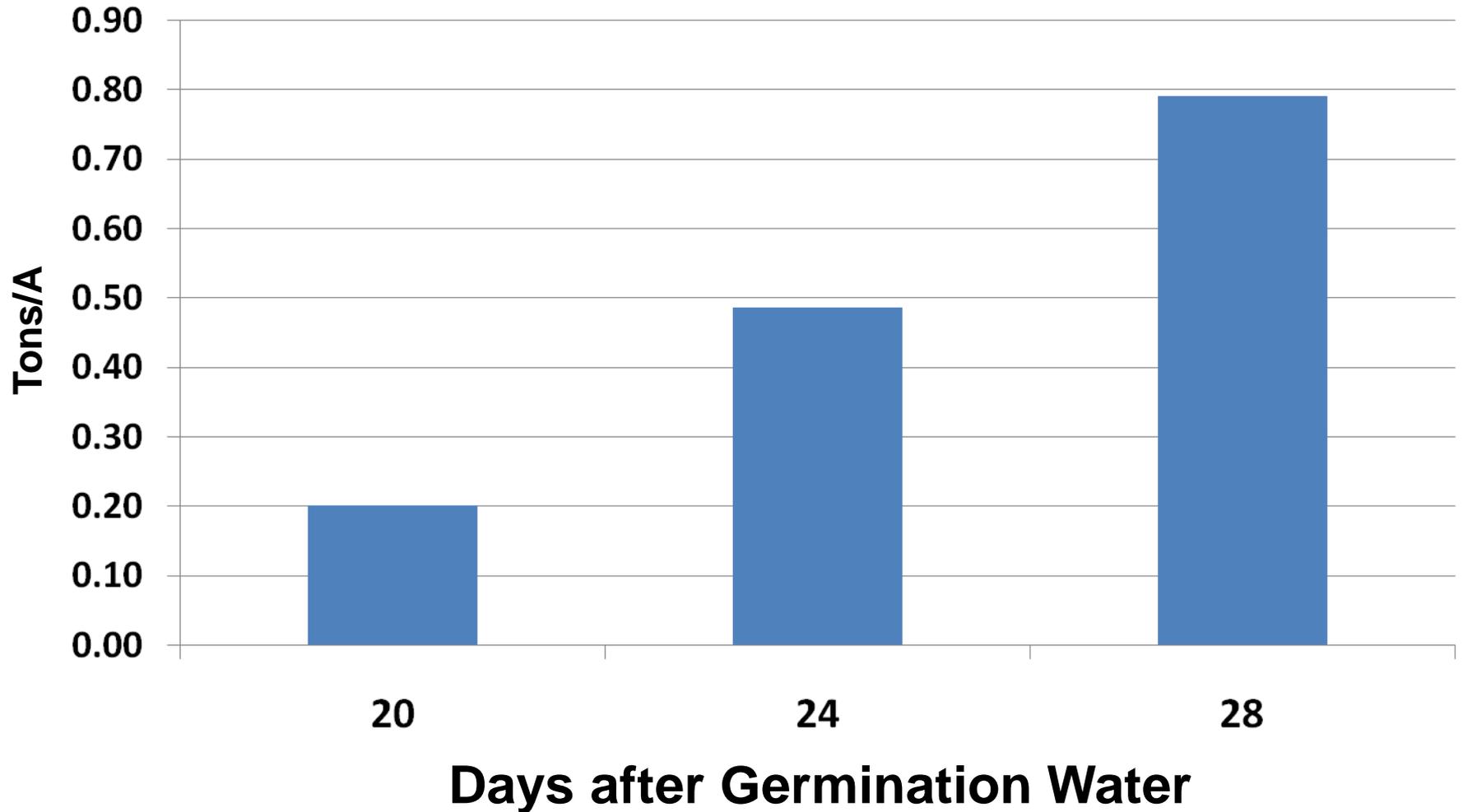
- **All vegetables initially have a slow growth rate, at which time little in the way of biomass accumulation or nitrogen uptake is taking place**

# **Crop Growth Rate**

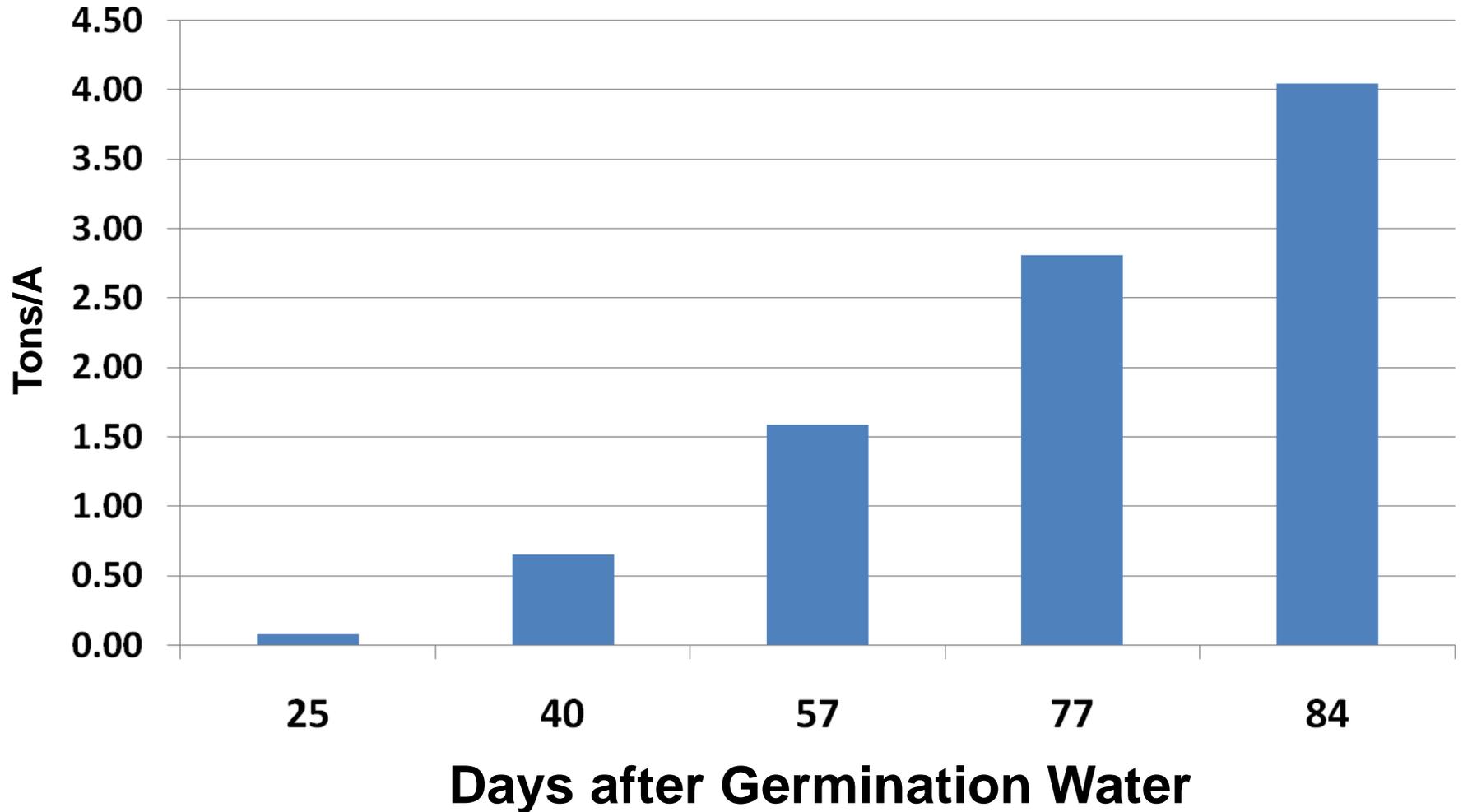
- **About 30 days or so after seeding or transplanting the crops begin to grow rapidly**
- **This growth rate can be linear**
- **Some crops such as spinach may grow rapidly until the day of harvest**
- **For other such as broccoli & lettuce the growth rate may slow prior to harvest**

# Biomass Accumulation by Spinach

## Dry Weight



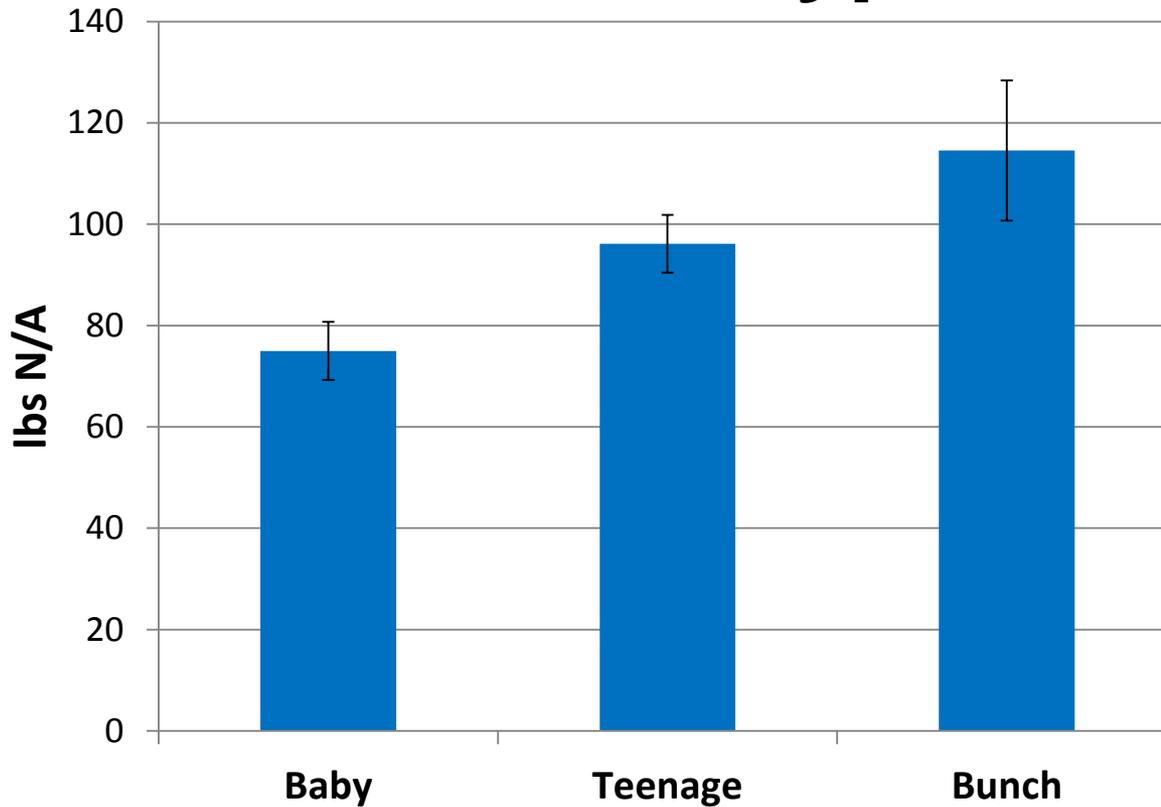
# Biomass Accumulation by Broccoli



# **Rate of Nitrogen Accumulation**

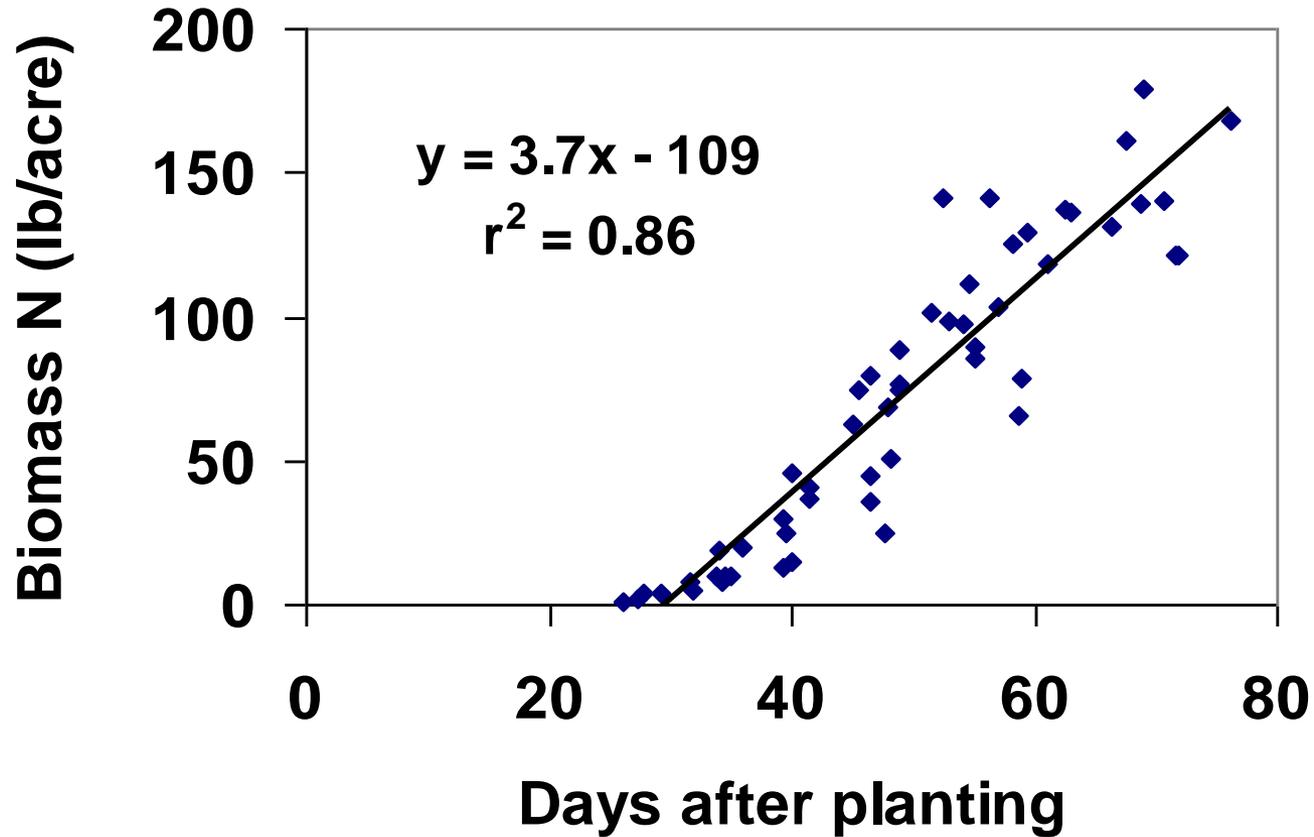
- Nitrogen accumulation closely follows the rate of biomass accumulation**
- Although the concentration of nitrogen in the crop tissue may decline to some degree, total nitrogen accumulation in the crop biomass increases dramatically as crops mature**

# Spinach Nitrogen Uptake by Product Type



# Lettuce Nitrogen Uptake

## Salinas, Summer



# Vegetable Nitrogen Uptake

**Lbs N/A/Day**

<b>Crop</b>	<b>Nitrogen Uptake Lbs N/A/Day</b>	<b>Days of highest nitrogen uptake</b>
<b>Lettuce (north valley)</b>	<b>3.7</b>	<b>30-35</b>
<b>Lettuce (south valley)</b>	<b>4.4</b>	<b>30-35</b>
<b>Spinach</b>	<b>5.1</b>	<b>15</b>
<b>Broccoli (summer)</b>	<b>5.7</b>	<b>60</b>
<b>Broccoli (winter)</b>	<b>2.6</b>	<b>90</b>

# Nitrogen Uptake

- **The total amount of N taken up by the crop depends on the length of the crop cycle and the daily demand by the crop**
- **Crops like spinach and lettuce have peak demands that last 15 and 30 days, respectively**
- **Summer broccoli may last for 50-60 days**

# **Nitrogen Uptake**

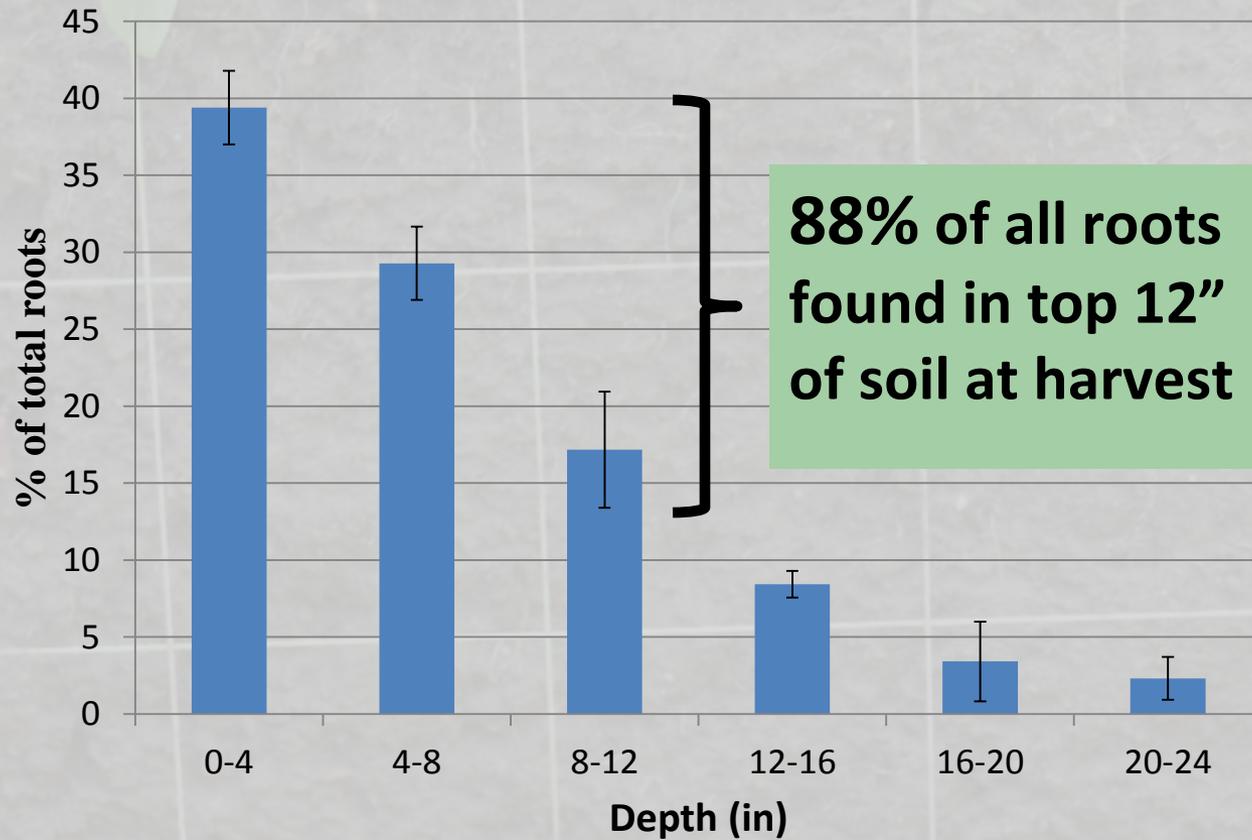
- **High nitrogen demand for short periods of time necessitates keeping robust quantities of nitrate in the root zone during the periods of peak demand**
- **This can be challenging given the mobility of nitrate with excess irrigation or rain water**

# **Nitrogen Uptake**

- **The rooting depth of the crops becomes an issue in the crops ability to effectively access the nitrate in the soil**
- **If the roots do not grow deep enough, nitrate can be pushed below their root zone and they may not access all the nitrate in the soil profile**

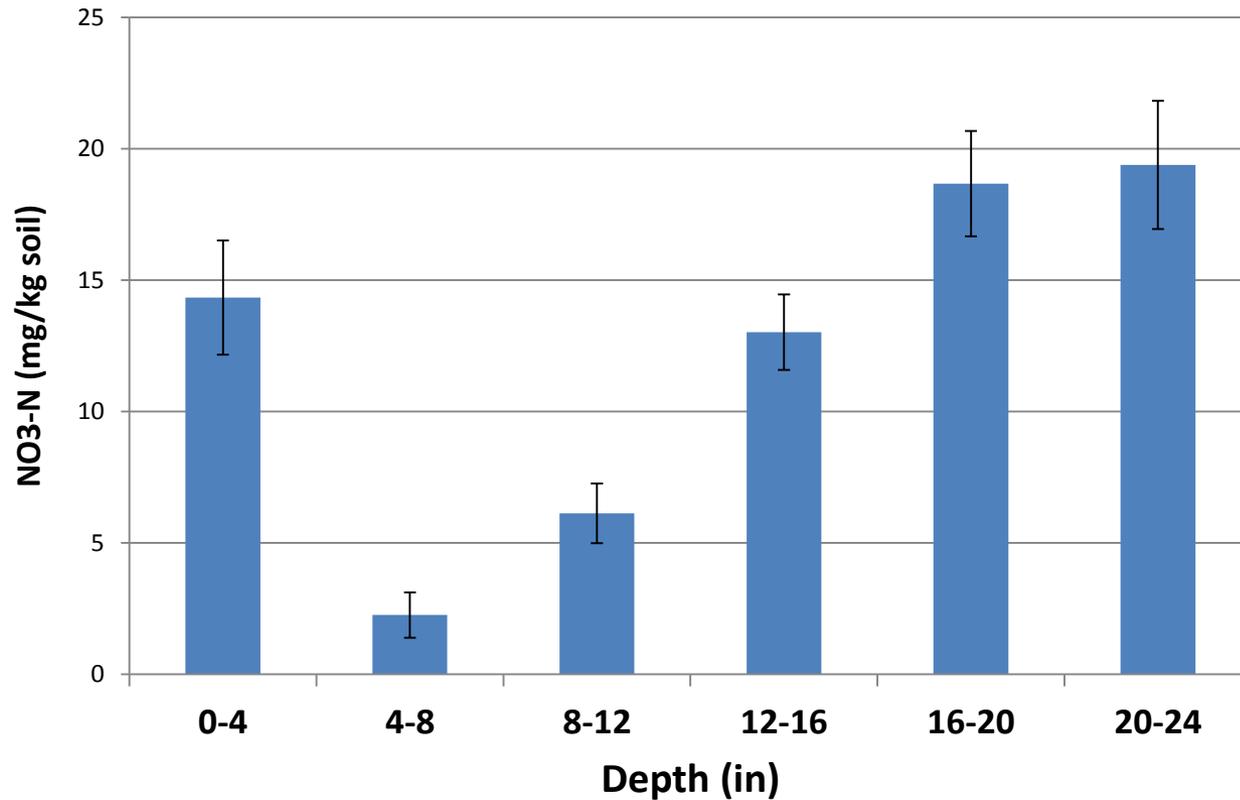
# Rooting Depth

# Rooting Depth of Spinach

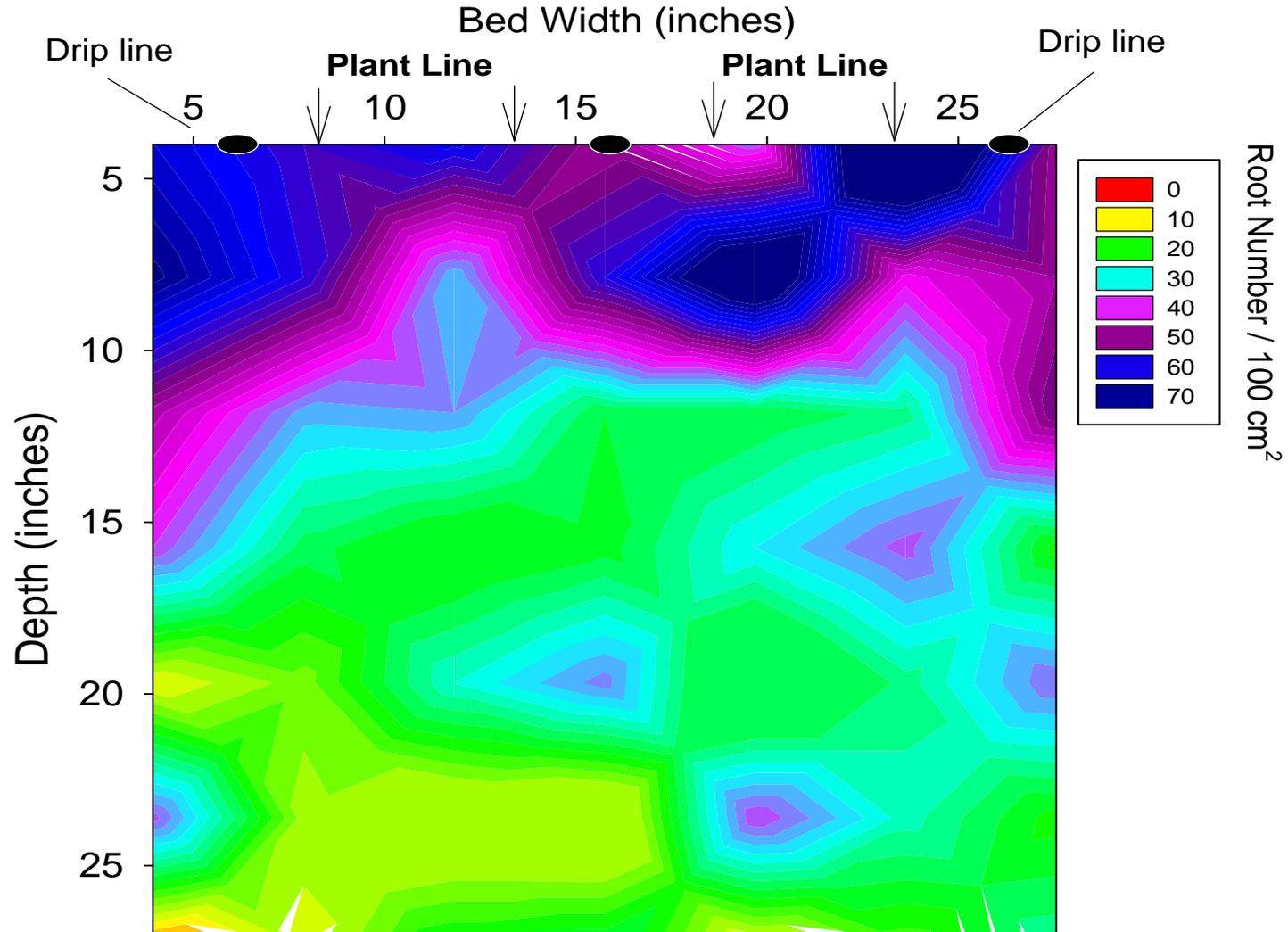


# Nitrate Distribution in Spinach Beds After Harvest

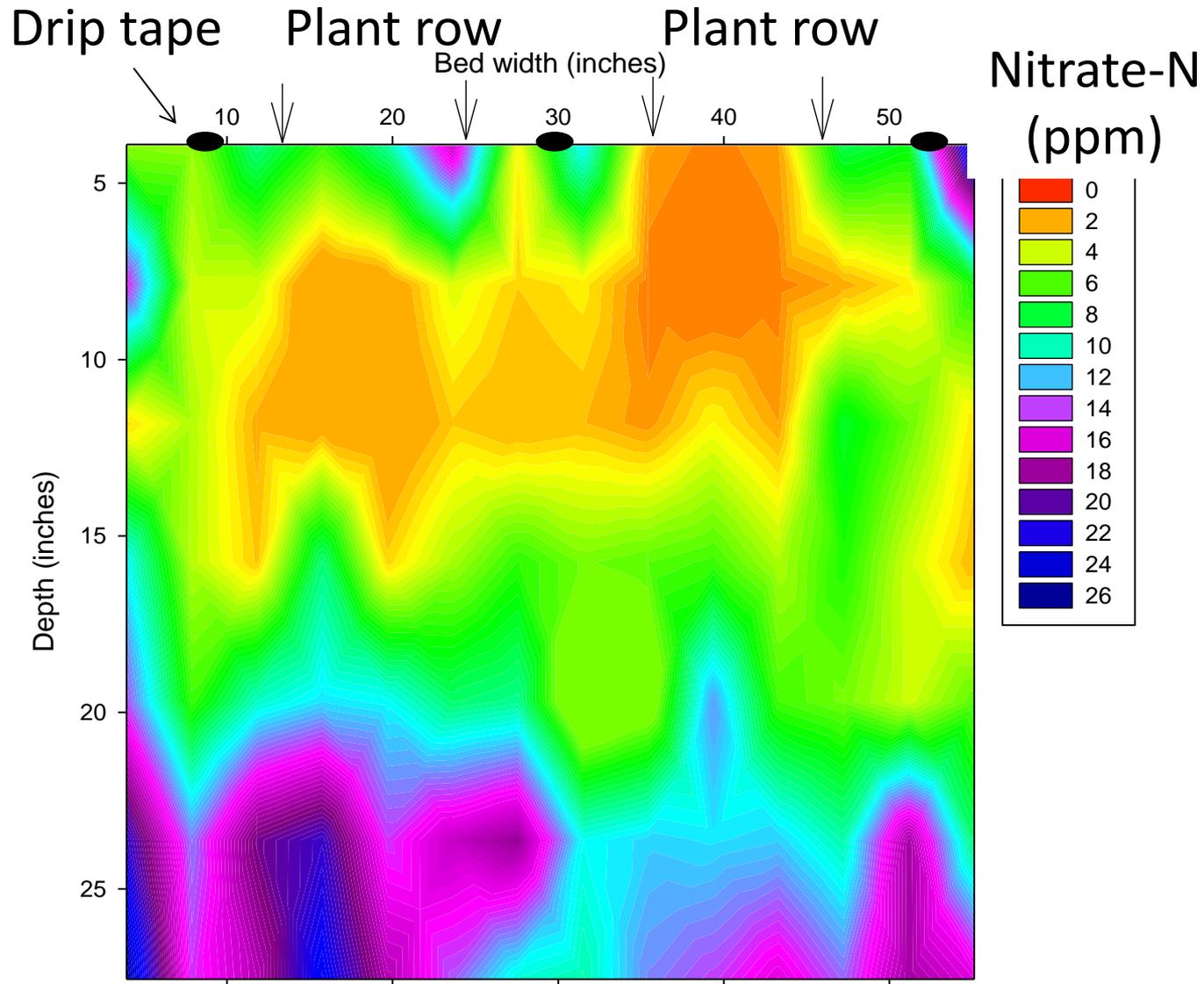
Nitrate can slip below this shallow rooted crop



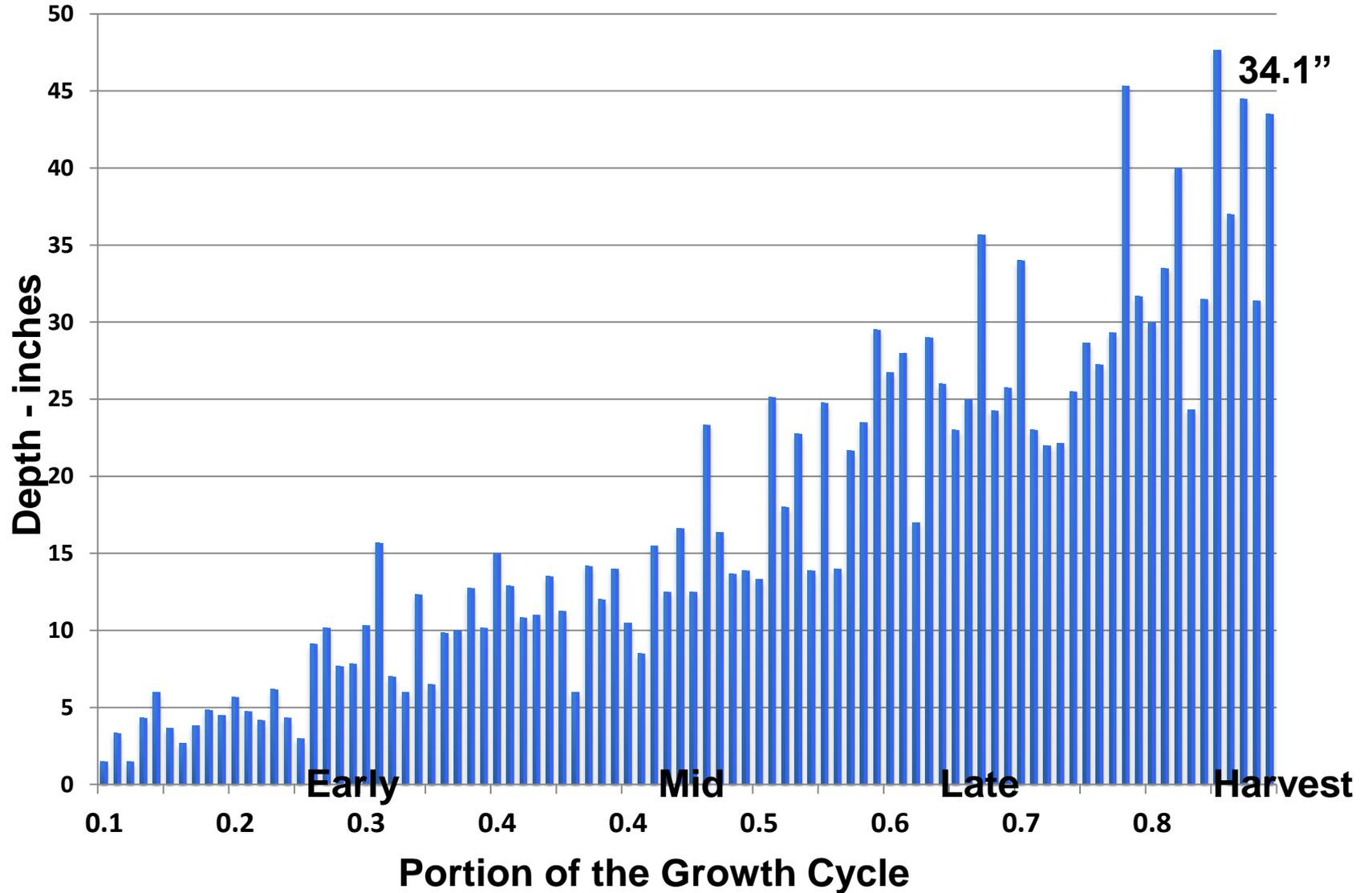
# Root Density of Lettuce at Various Soil Depths



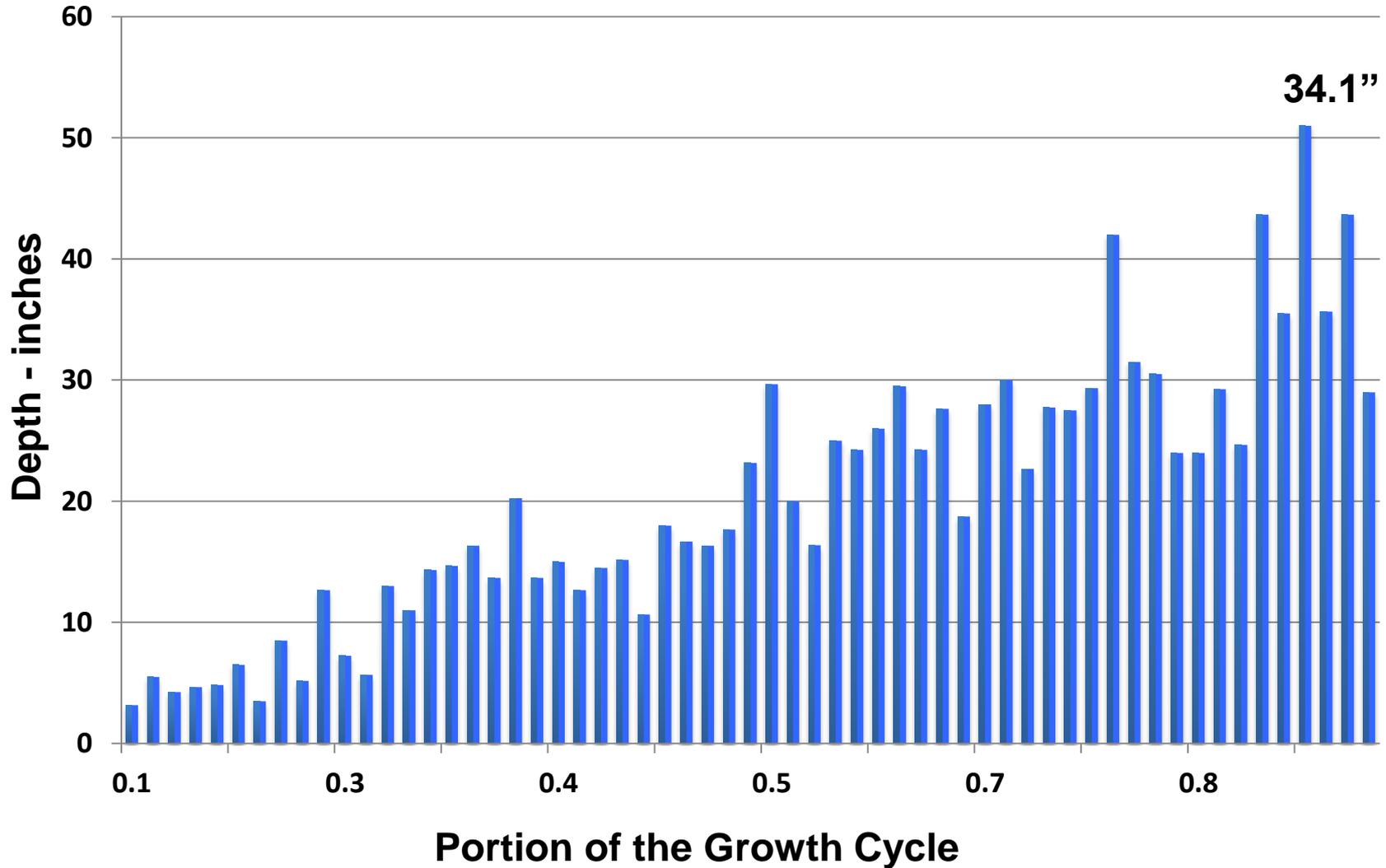
# Soil Nitrate Distribution in Lettuce



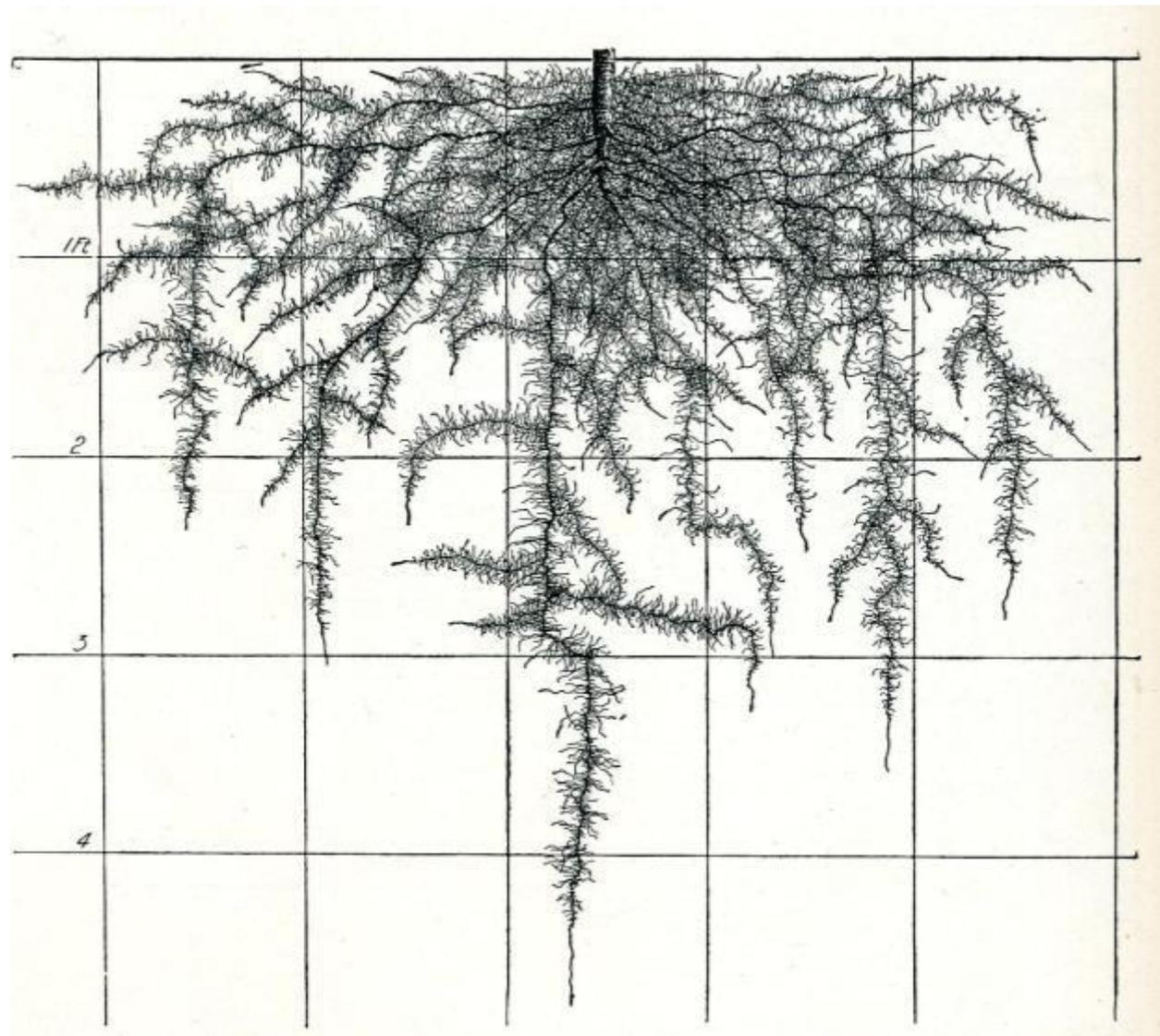
# Broccoli Rooting Depth



# Cauliflower Rooting Depth

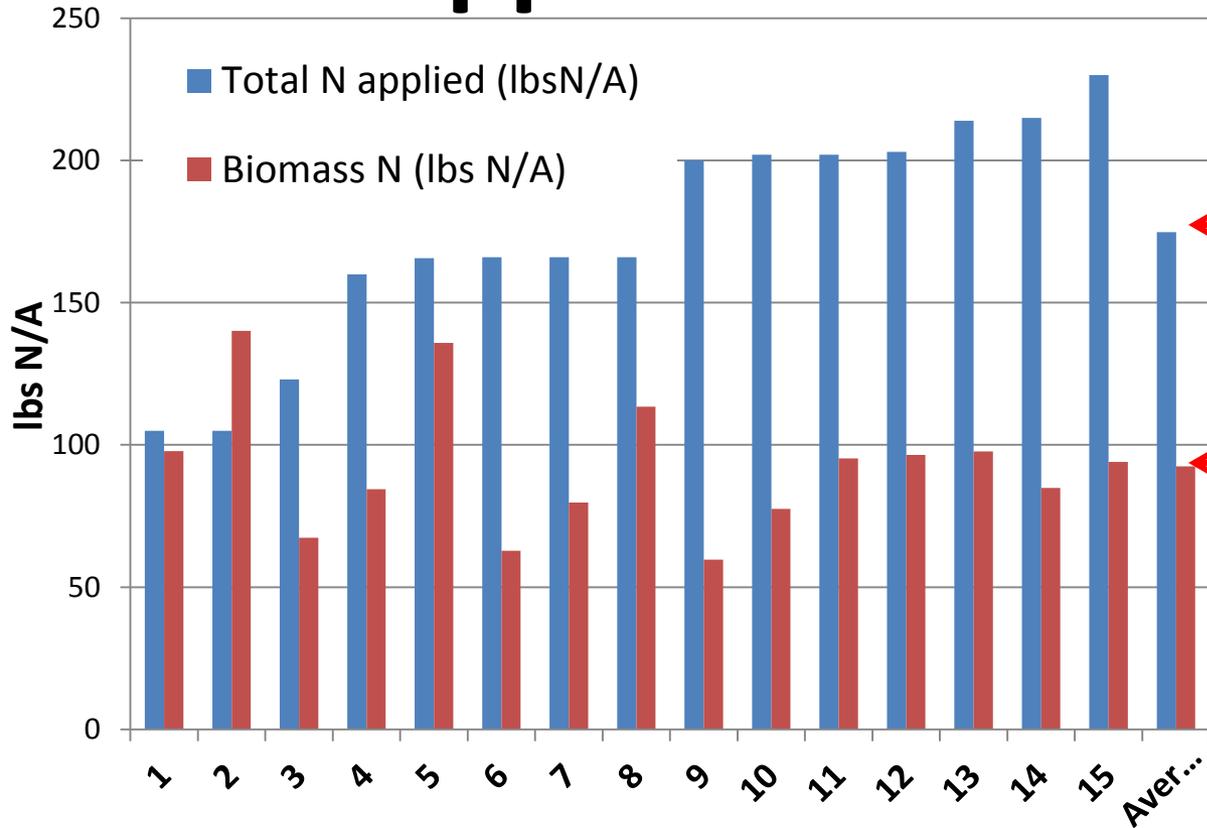


# 90 Day Old Cauliflower Roots



# **Nitrogen Removal by Crops**

# Spinach Nitrogen Uptake and Application Rates



← 175 lbs N/A applied  
(66 at planting +109 midseason)  
← 93 lbs N/A uptake

# Lettuce Uptake and Application Rates

Mean of >100 fields

Lettuce nitrogen uptake varies from 120 to 140 lbs N/A  
Depending on planting configuration and type

<b>Nitrogen application to lettuce lbs N/A</b>		
	<b>Spring</b>	<b>Summer</b>
<b>Highest field</b>	<b>392</b>	<b>306</b>
<b>Lowest field</b>	<b>70</b>	<b>27</b>
<b>Overall Average</b>	<b>215</b>	<b>152</b>
<b>Average of highest 50% of fields</b>	<b>281</b>	<b>198</b>
<b>Average of lowest 50% of fields</b>	<b>149</b>	<b>106</b>

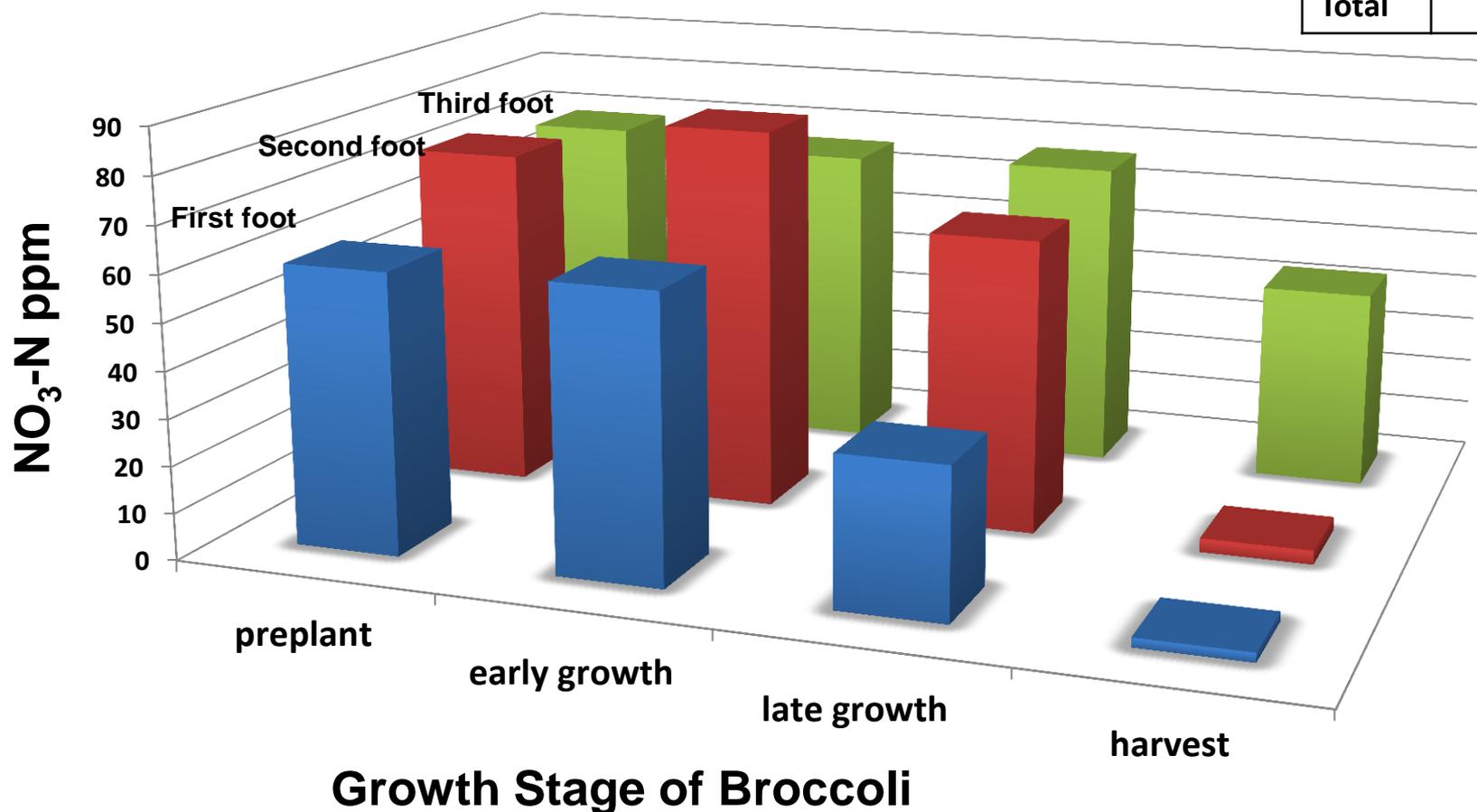
# Cole Crop Uptake and Application Rates

## Summer Crops

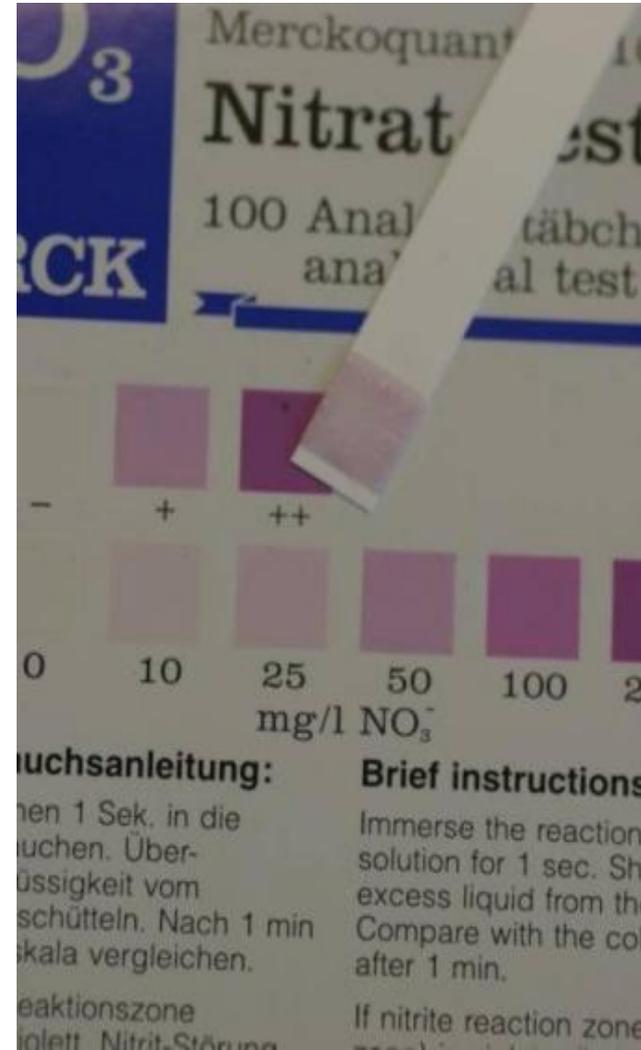
Crop	Dry Biomass Lbs/A	Percent Nitrogen	Harvest Product N/A	Residue N/A	Scavenged from soil
Broccoli	8,585	4.0	99	238	155
Cauliflower	6,930	4.1	61	224	21
Cabbage	11,564	3.0	188	163	97

# Residual Soil Nitrogen Utilized by the Broccoli Crop

Depth	Lbs N/A
1 <sup>st</sup>	58
2 <sup>nd</sup>	70
3 <sup>rd</sup>	26
<b>Total</b>	<b>154</b>



# Accounting for Residual Nitrogen



# Evaluation of Nitrate Test Strips



Strip Name	Measures NO <sub>3</sub> -N or NO <sub>3</sub>	Strips per pkg (\$ per strip)	Manufacturer's Color Chip Intervals (NO <sub>3</sub> mg/L)	NO <sub>3</sub> Concentration of Test Solution (mg/L)													
				0	5	10	20	40	50	80	90	100	110	160	200	220	250
				-----Mean Test Strip Readings (mg NO3/L)-----													
Hach Aquacheck	NO <sub>3</sub> -N	25 (\$0.35)	0, 4.4, 8.9, 22.2, 44.3, 88.6, 221.5**	0	0	11	20	44	x	x	89	x	x	x	x	170	x
LaMotte Instatest NO <sub>3</sub> /NO <sub>2</sub>	NO <sub>3</sub> -N	50 (\$0.25)	0, 22.15, 44.3, 110.8, 221.5***	0	x	x	21	44	x	x	x	x	111	x	x	207	x
API 5 in 1 *	NO <sub>3</sub>	25 (\$0.40)	0, 20, 40, 80, 160, 200	0	x	x	15	33	x	60	x	x	x	87	135	x	x
Tetra 6 in 1 EasyStrips	NO <sub>3</sub>	100 (\$0.25)	0, 20, 40, 80, 160, 200	0	x	x	13	23	x	47	x	x	x	123	135	x	x
LaMotte Instatest 5-way *	NO <sub>3</sub>	25 (\$0.55)	0, 20, 40, 80, 160, 200	0	x	x	15	33	x	63	x	x	x	133	160	x	x
Merckoquant NO <sub>3</sub> /NO <sub>2</sub>	NO <sub>3</sub>	100 (\$0.47)	0, 10, 25, 50, 100, 250, 500	0	x	10	25	x	56	x	x	95	x	x	x	x	250

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# Summary

- Both the Merckoquant  $\text{NO}_3/\text{NO}_2$  and the Hach Aquacheck strips were accurate for measuring concentrations of  $\text{NO}_3$  as low as 10 ppm
- This corresponds to 5 ppm  $\text{NO}_3\text{-N}$  in soil
- No brand of test strip measured  $\text{NO}_3$  accurately below 10 ppm.
- Several brands of strips that measure  $\text{NO}_3$  in addition to other constituents in water were found to under estimate  $\text{NO}_3$  concentration
- The strips tested in this study appear to be sufficiently accurate to estimate the level of residual mineral N in soil samples and for determining the  $\text{NO}_3$  contribution from irrigation water
- For more info google UCCE Monterey County and go to the blog