Fertilization of Organic Vegetables

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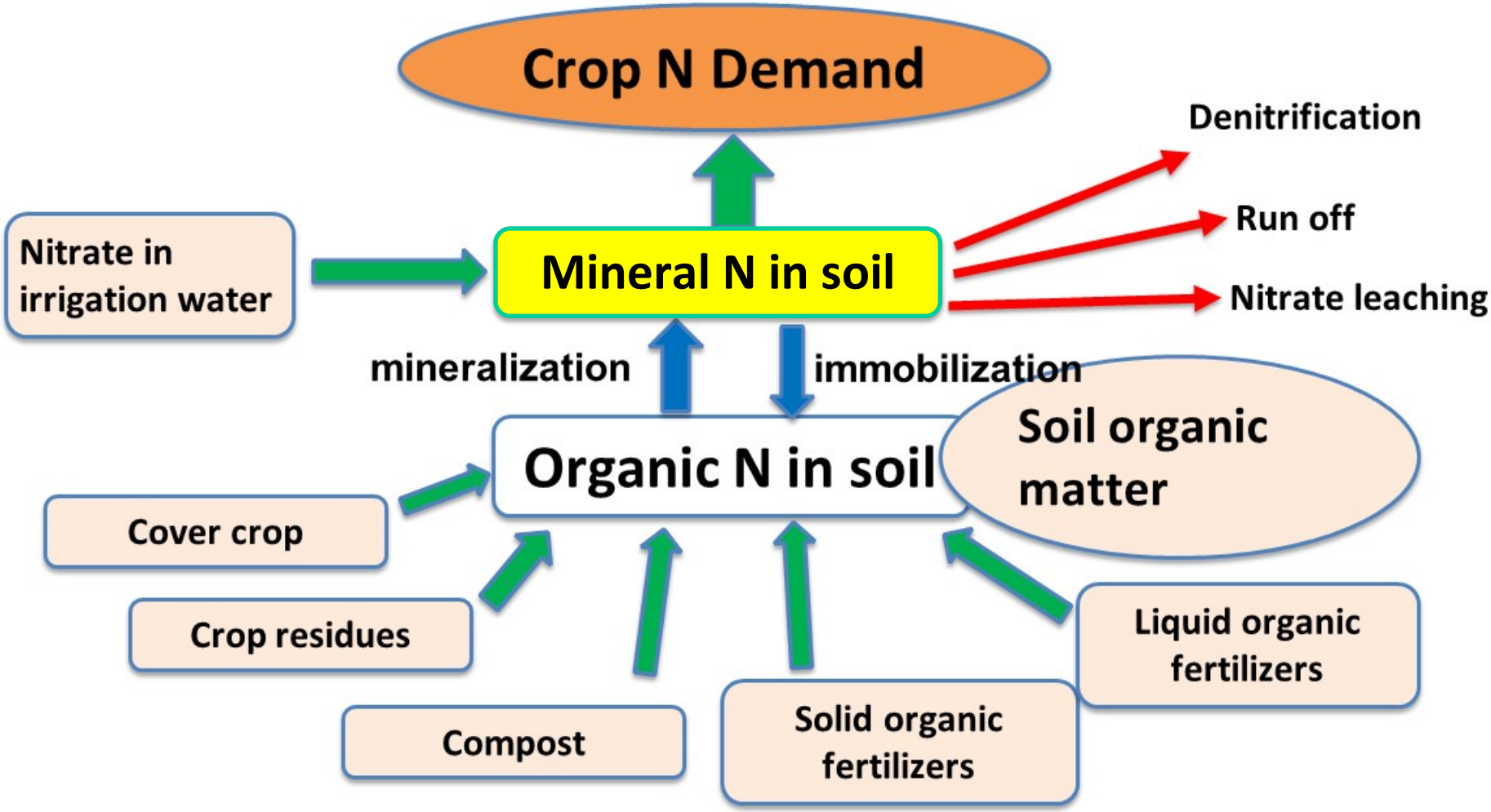
Nitrogen dynamics in an organic farming system



Mineral N = <u>nitrate-N</u> and ammonium-N

Management of Fertilization of Organic Vegetables

- Organic operations will also be subject to A/R (applied to removal) regulations in Ag Order 4.0 (Central Coast RWQCB)
  - There is a need to evaluate if N applications can be fine tuned
    - Utilizing N budgeting
    - Testing for the pool of residual soil nitrate
    - Improvements in irrigation management

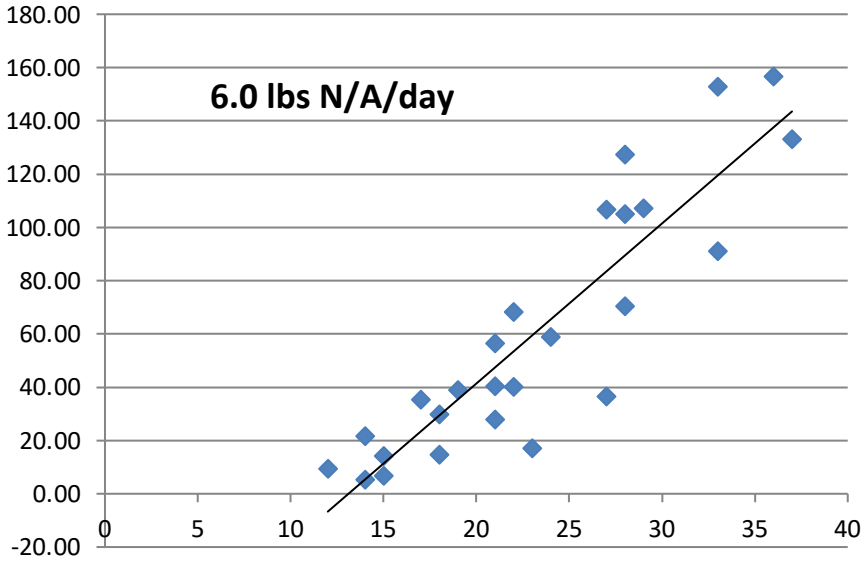
Management of Nitrogen Fertilizer

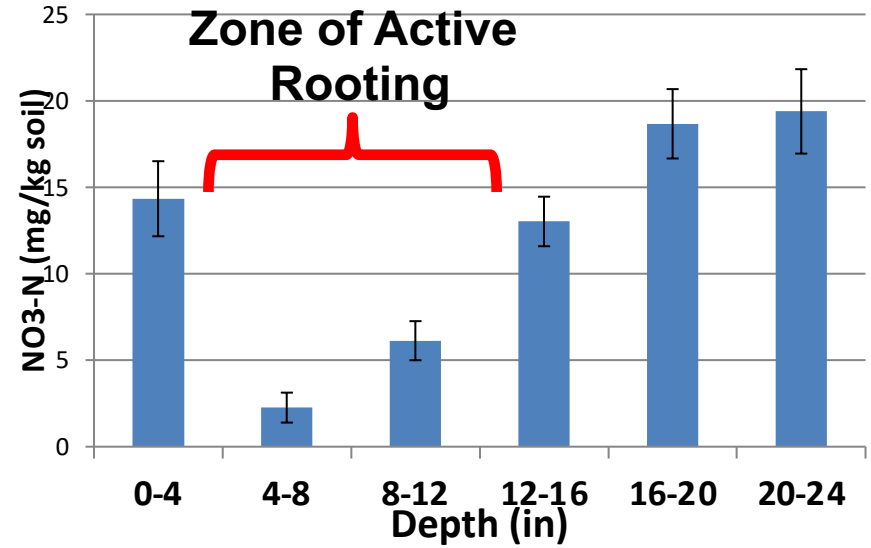
- How much and when to apply N fertilizer for vegetable crop production is an interesting and complex question:
  - Many of the processes for understanding N made available for crop growth have been discussed in this class
  - In this discussion we'll focus on indicators for adjusting fertilizer applications
    - Grower's experience and skills
    - Soil nitrate testing

Uptake of Nitrogen by Crops: A starting point for understanding the N needs of vegetable crops

Crop	Crop Uptake lbs N/A	Percent removed in the harvested portion
Bell pepper	240-350	65-75
Broccoli	250-350	25-35
Brussels sprouts	350-500	30-50
Cabbage	280-380	50-60
Cauliflower	250-300	25-35
Celery	200-300	50-65
Lettuces	120-160	50-60
Baby lettuces	60-70	65-75
Onion	150-180	60-75
Spinach	90-130	65-75

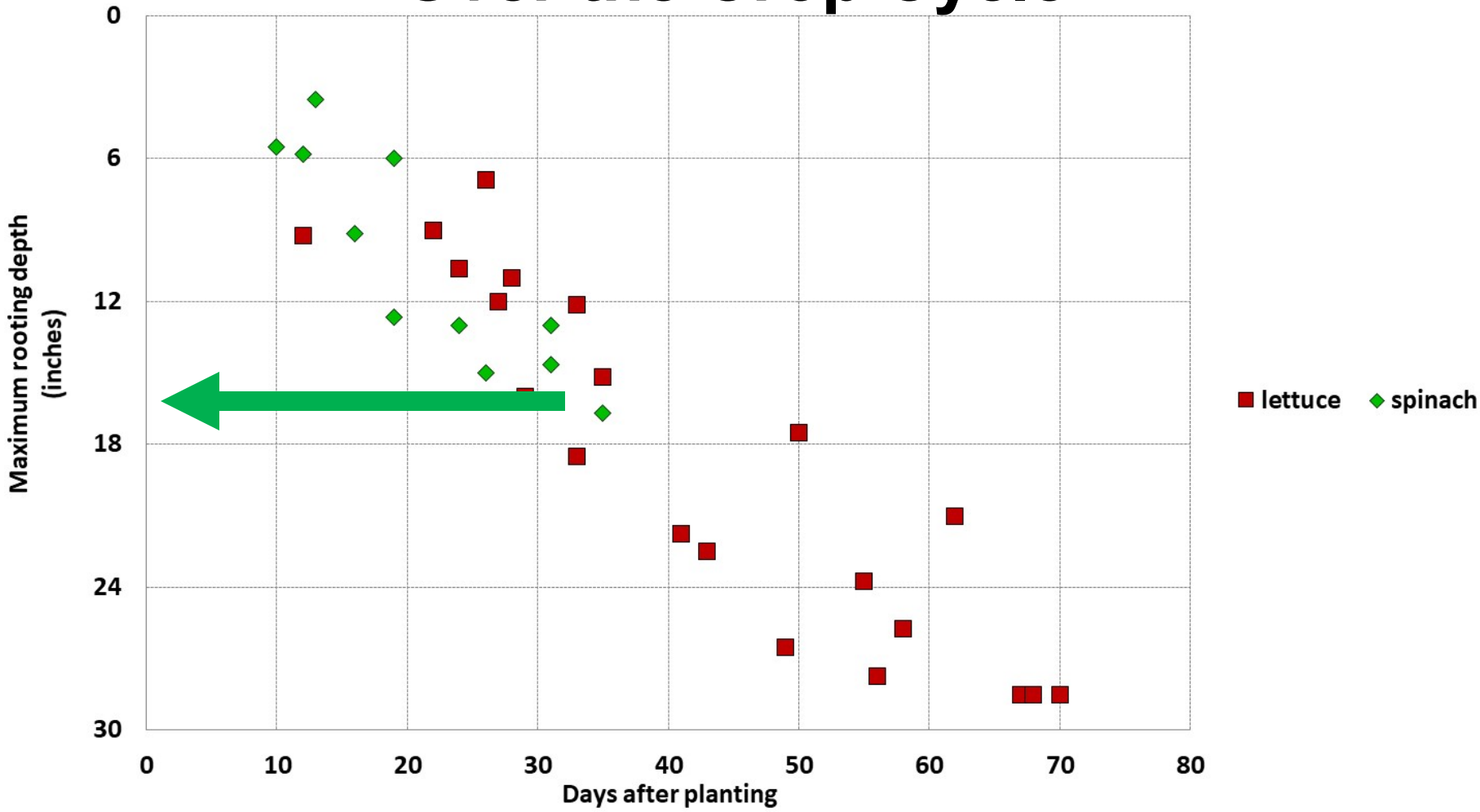
Spinach (and baby vegetables) – 30 days





Nitrogen uptake varies by days to harvest. Baby and teenage spinach takes up 80-100 lbs N/A. Bunched spinach takes up 100-125 lbs N/A.

Rooting Depth of Lettuce and Spinach Over the Crop Cycle



Measuring Residual Soil Nitrate in the Soil

- Testing for residual soil nitrate-N is common in conventional production
- It can also be useful in organic, but for intensive fast maturing crops such as spinach, the tests have to be done prior to planting to have sufficient time to make adjustments in fertilizer application rates
- Later in the crop cycle is too late for the fertilizer to be effective in spinach

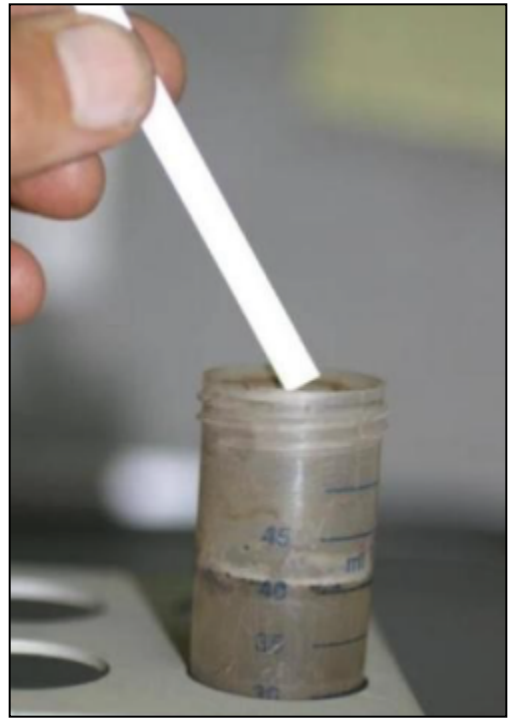
20 PPM NO_3-N threshold for cool-season leafy's

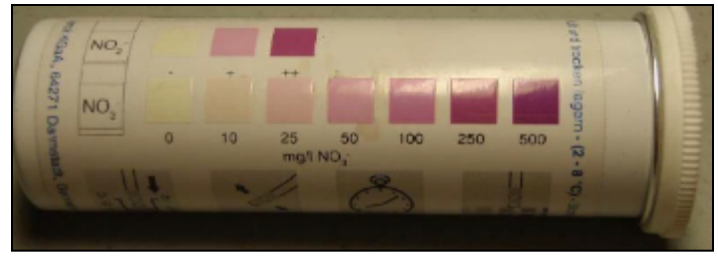
- At 12 " depth, 20 PPM NO_3-N ≈ 75 lb N/acre
- Since crops have different rates of N uptake, 75 lb N/acre would supply growth for different periods of time

Peak N uptake rate:

- Brassicas, spinach 6+ lb N/acre/day
- Lettuce 4 lb N/acre/day
- Strawberry < 1.5 lb N/acre/day

Using a lab analysis or the nitrate quick test you can determine the quantity of residual soil nitrate





Go to Salinas Valley Agriculture Blog:

Details on the Nitrate Quick Test

April 1, 2019

Spinach Evaluations

- **It is the most challenging of all crops to efficiently fertilize give its characteristics**

Impact of Residual Soil Nitrogen No. 1

Timing	Fertilizer N/A	Net Fert. N/A	Mineral N/A*	Yield Tons/A
---	0	0	64	6.4
Listing	80	52	64	7.1
Planting	80	32	64	6.7
Listing Planting	160	52 32	64	6.9

- * 18 ppm Nitrate-N at planting
- Clay loam soil with moderate residual soil N
- Weak yield increase with fertilization with either 80 or 160 lbs N/A
- Probably low leaching over the season

Impact of Residual Soil Nitrogen No. 2

Timing	Fertilizer N/A	Net Fert. N/A	Mineral N/A*	Yield Tons/A
---	0	0	99	6.1
Top dress	80	28	99	6.5
Planting	80	28	99	6.9
Planting	160	56	99	7.7

- * 28 ppm Nitrate-N at planting
- Sandy loam soil with high residual soil N
- Significant yield increase with fertilization with 160 lbs N/A
- Probably significant leaching over the season

Impact of Residual Soil Nitrogen No. 3

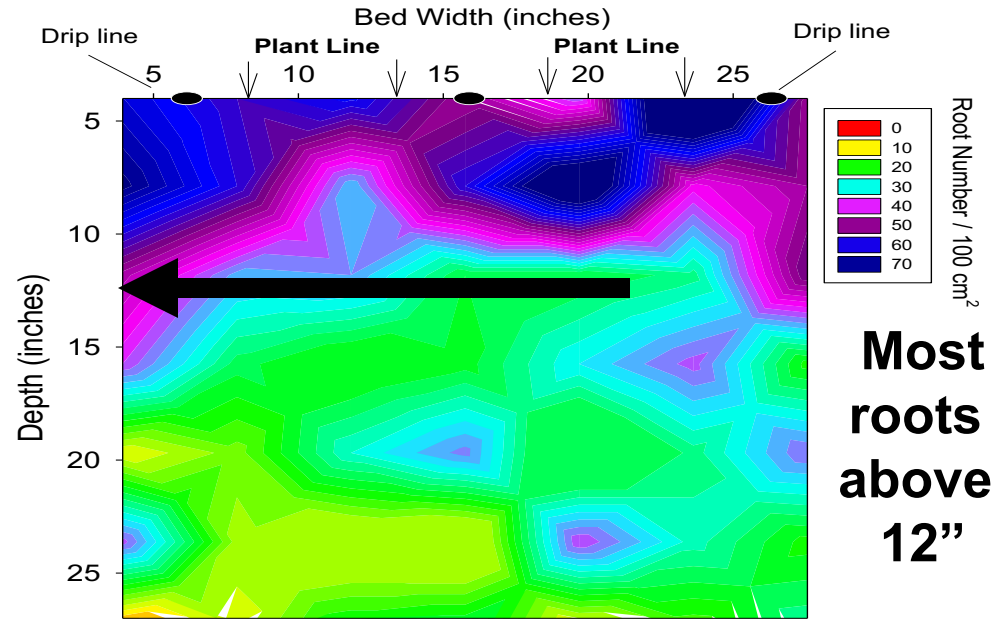
Timing	Fertilizer N/A	Net Fert. N/A	Mineral N/A*	Yield Tons/A
---	0	0	117	10.1
Listing Planting	80	40	117	9.3
Listing Planting	160	80	117	8.8

- * 33 ppm Nitrate-N at planting
- Clay loam soil with very high residual soil N
- No yield increase with fertilization
- Probably low leaching over the season

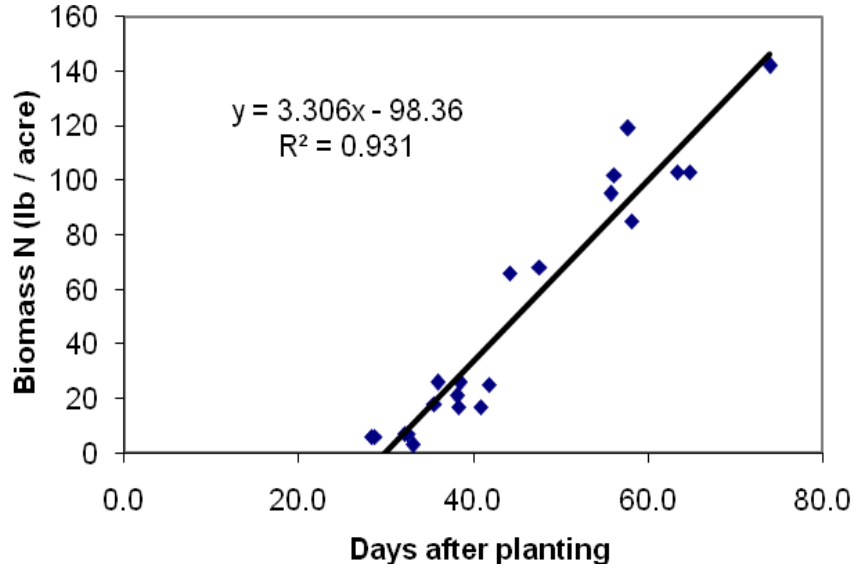
What is the Bottom Line

- **A crop with characteristics like spinach (high N demanding, shallow rooted) needs a robust amount of fertilizer in the root zone for 2 weeks**
- **Soil tests for residual soil nitrate can be useful**
- **Preplant or at-planting are the only two times to effectively make applications (after crop establishment was too late)**
- **Leaching reduces the amount of nitrate-N in the root zone on sandy soils**

Full-term Lettuce – 60 days

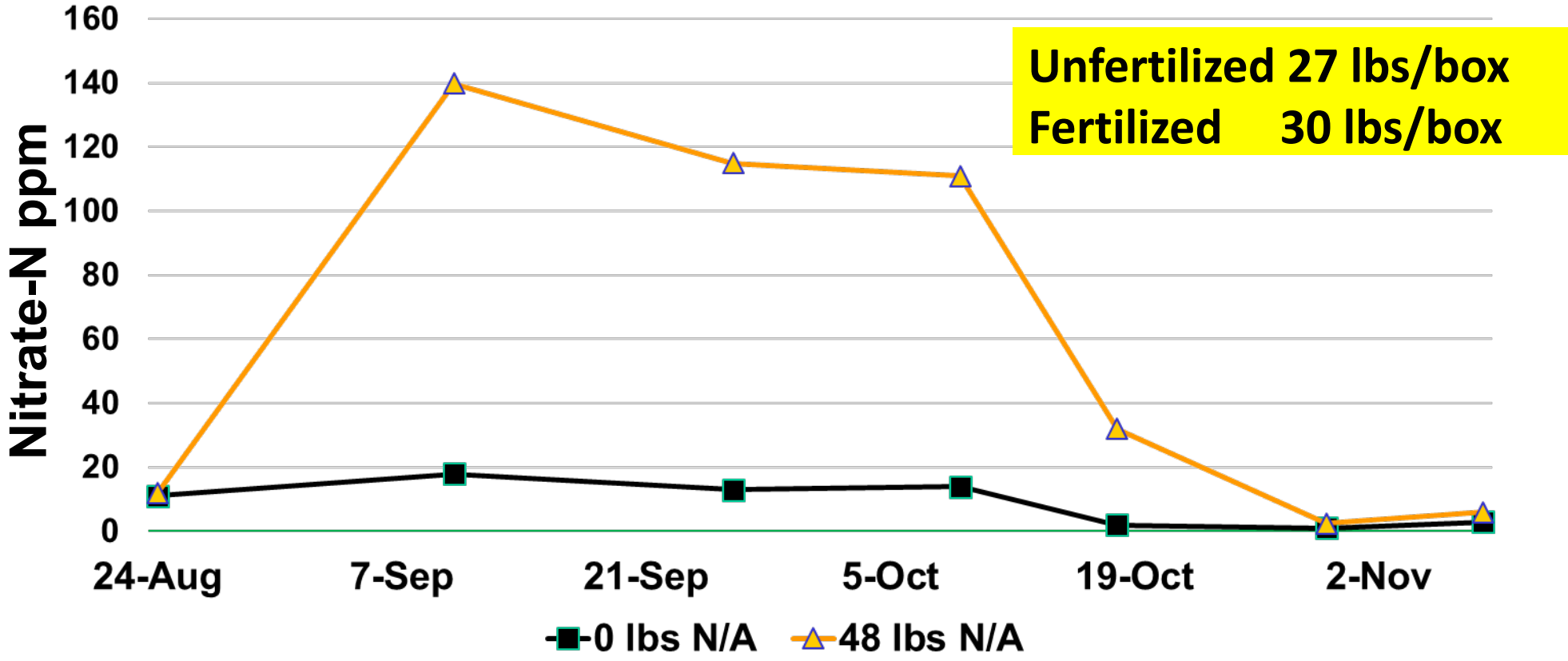


Most roots above 12”



Depending on the planting configuration full term lettuce take up 120-170 lbs N/A, most of it after thinning.

Romaine Lettuce Fertility Trial
Long-term Organic Farm



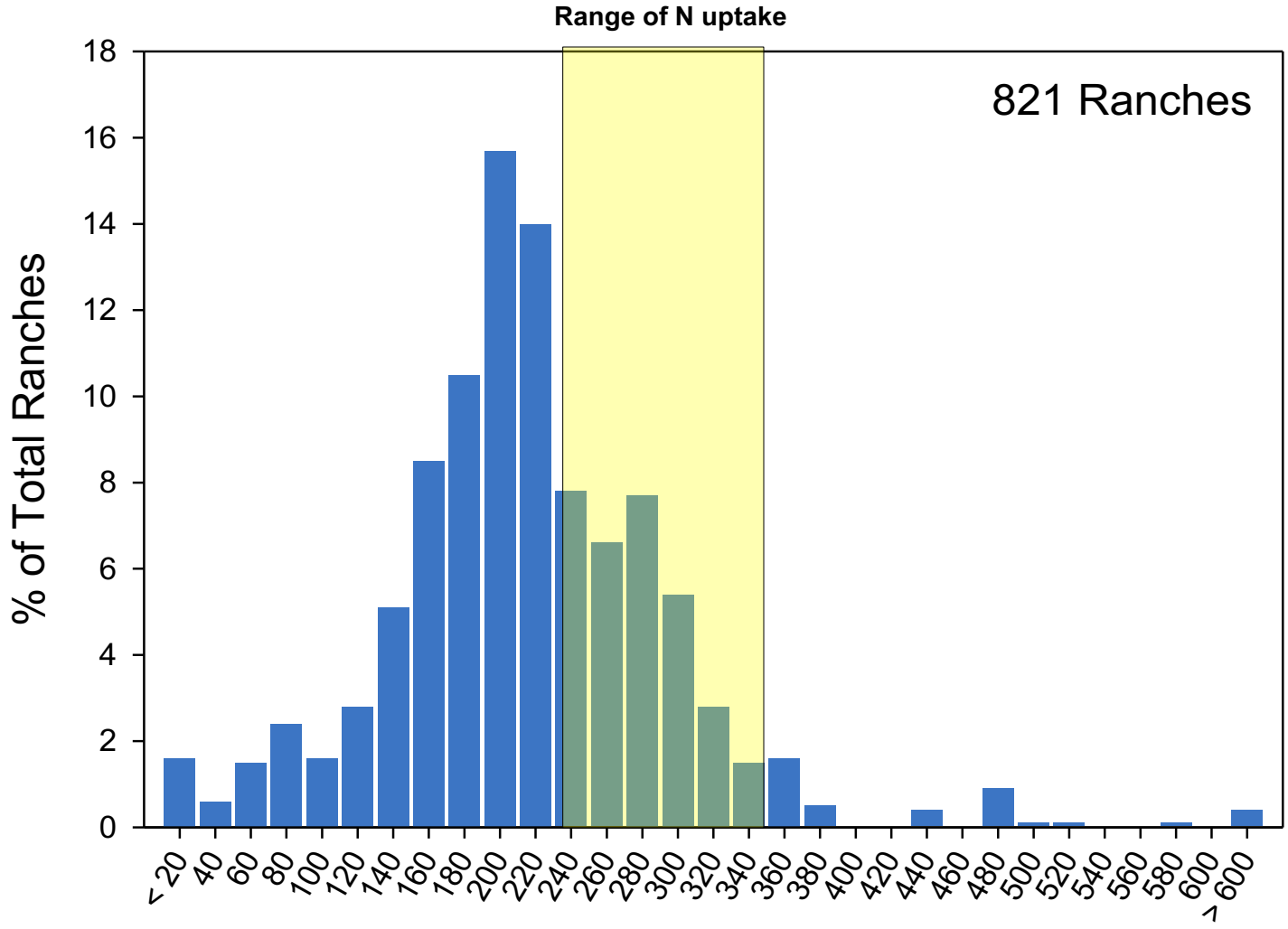
Grower was not planning to fertilize because prior crop was snap beans; added 400 lbs 12-0-0 (48 lbs N/A injected); yield increased measured

Broccoli – 75 days

Roots reach 3-4 feet deep at harvest

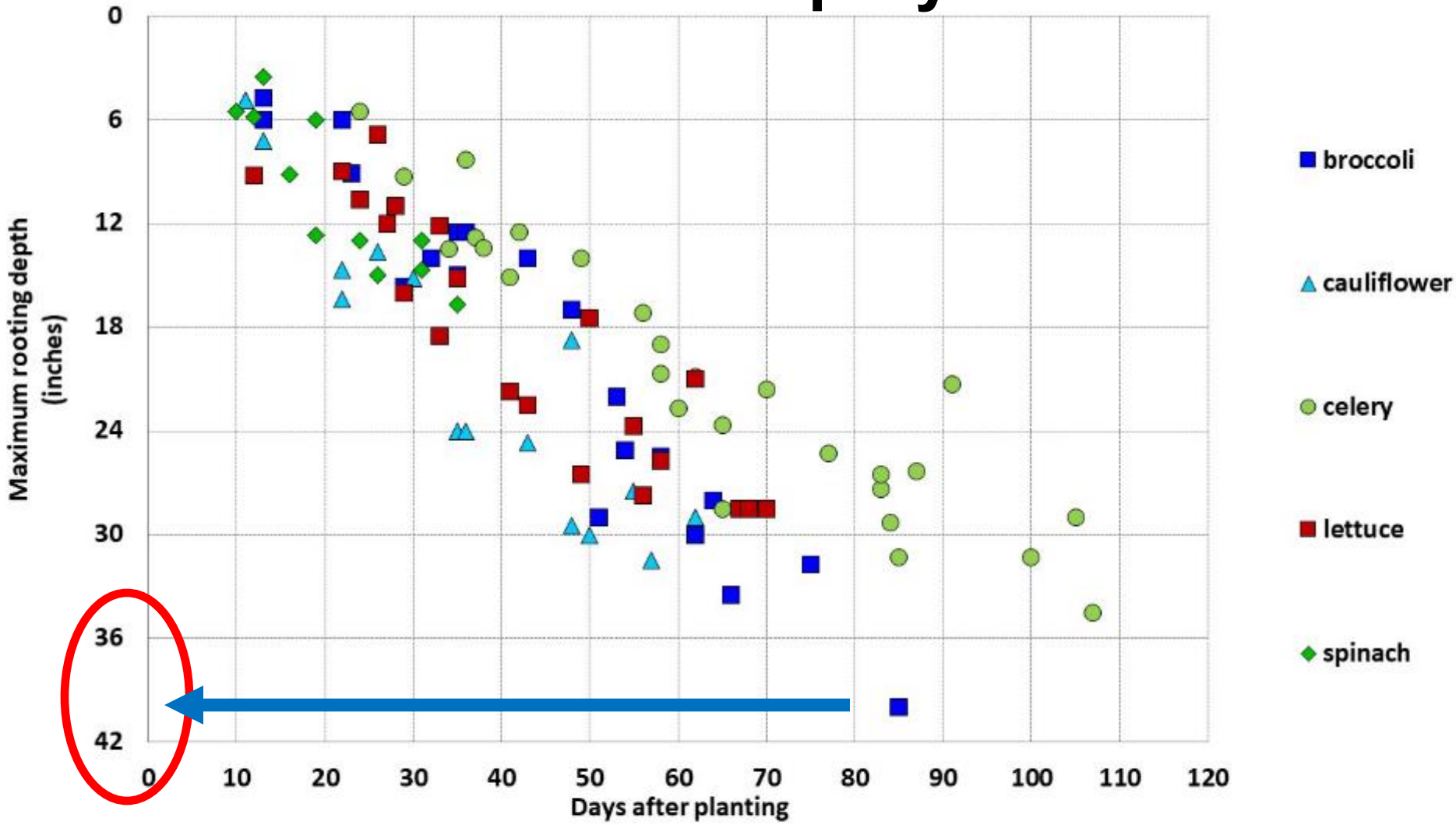
Crop	Fertilizer applied	Crop Uptake	Scavenged from soil
Broccoli	181	337	155
Cauliflower	260	285	21
Cabbage	215	337	97

2017 Broccoli Application Data



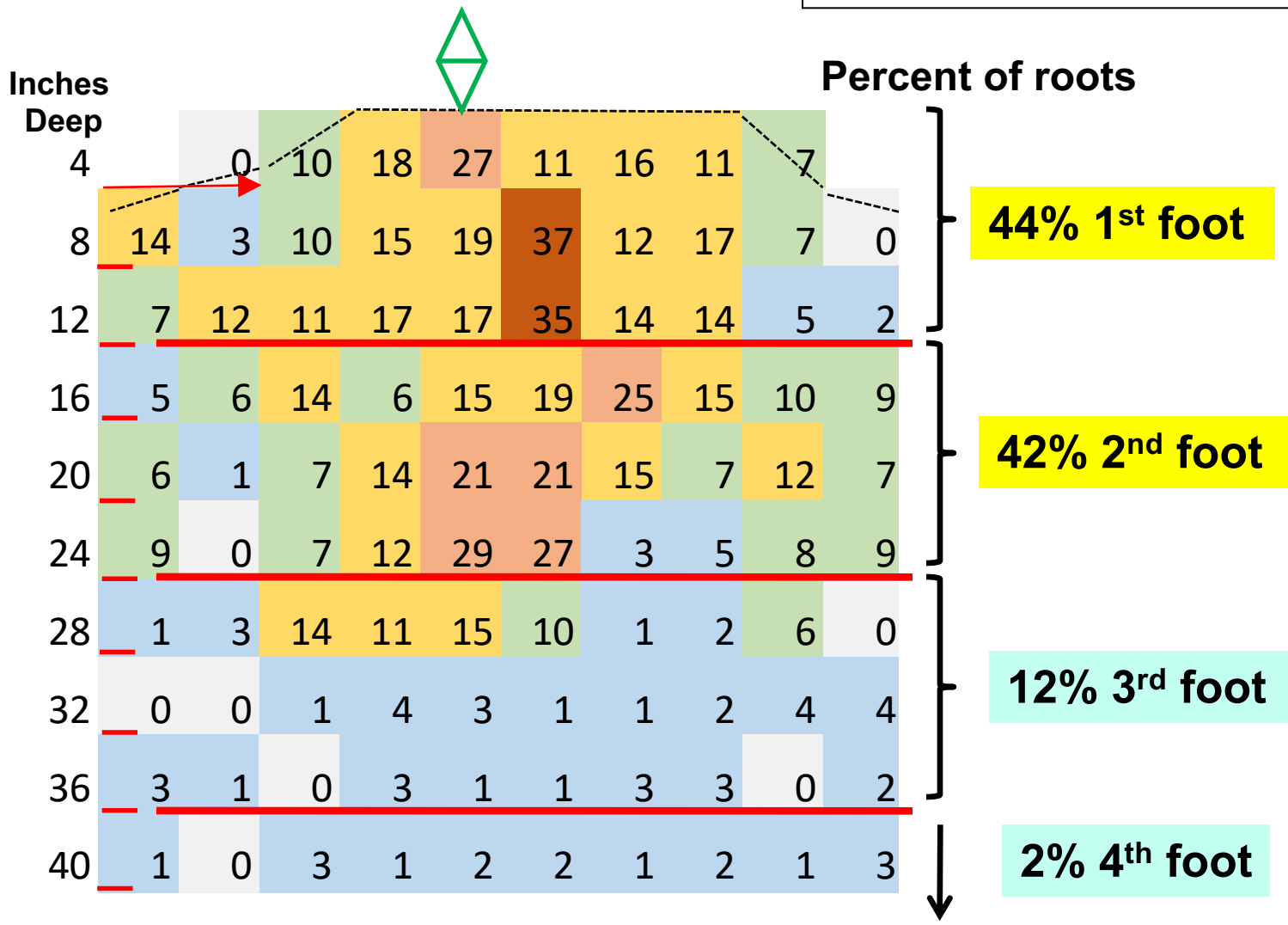
CC Regional Water Quality Control Board Report

Rooting Depth of Broccoli and Other Crops Over the Crop Cycle



Cauliflower
113 days after planting

Later in the crop cycle a greater portion of roots occur deeper in the soil profile



Broccoli Nitrogen Evaluations
Sandy Soils

Field	Initial Min. N	Fert. N applied	Net from fertilizer	N from water	Soil N mineralized over cycle	Total available N	Crop N uptake
1	90	437	219	20	67	396	376
2	61	451	163	10	109	343	326

- Both fields used drop on top applications which reduced the amount of N released by the fertilizer

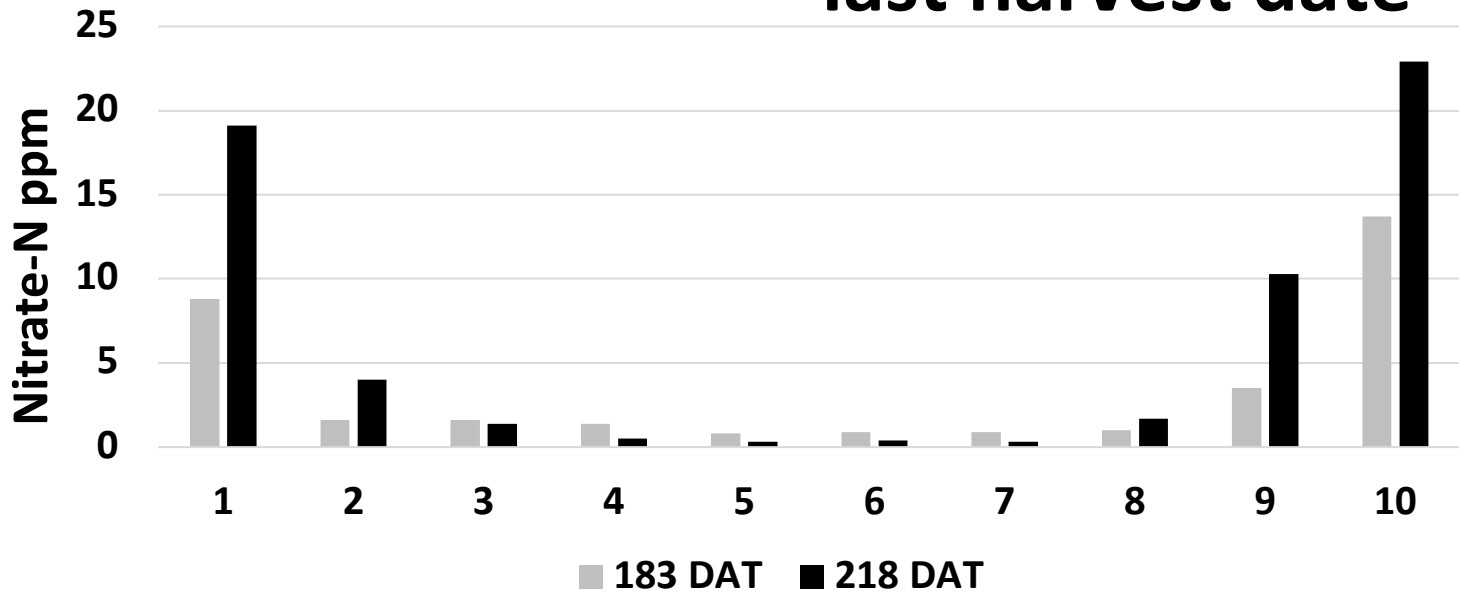
Broccoli Scavenging

Site	Initial residual soil nitrate[1] lbs N/A	Nitrogen applied lbs N/A	Total available lbs N/A	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[2]	257	240	497	44

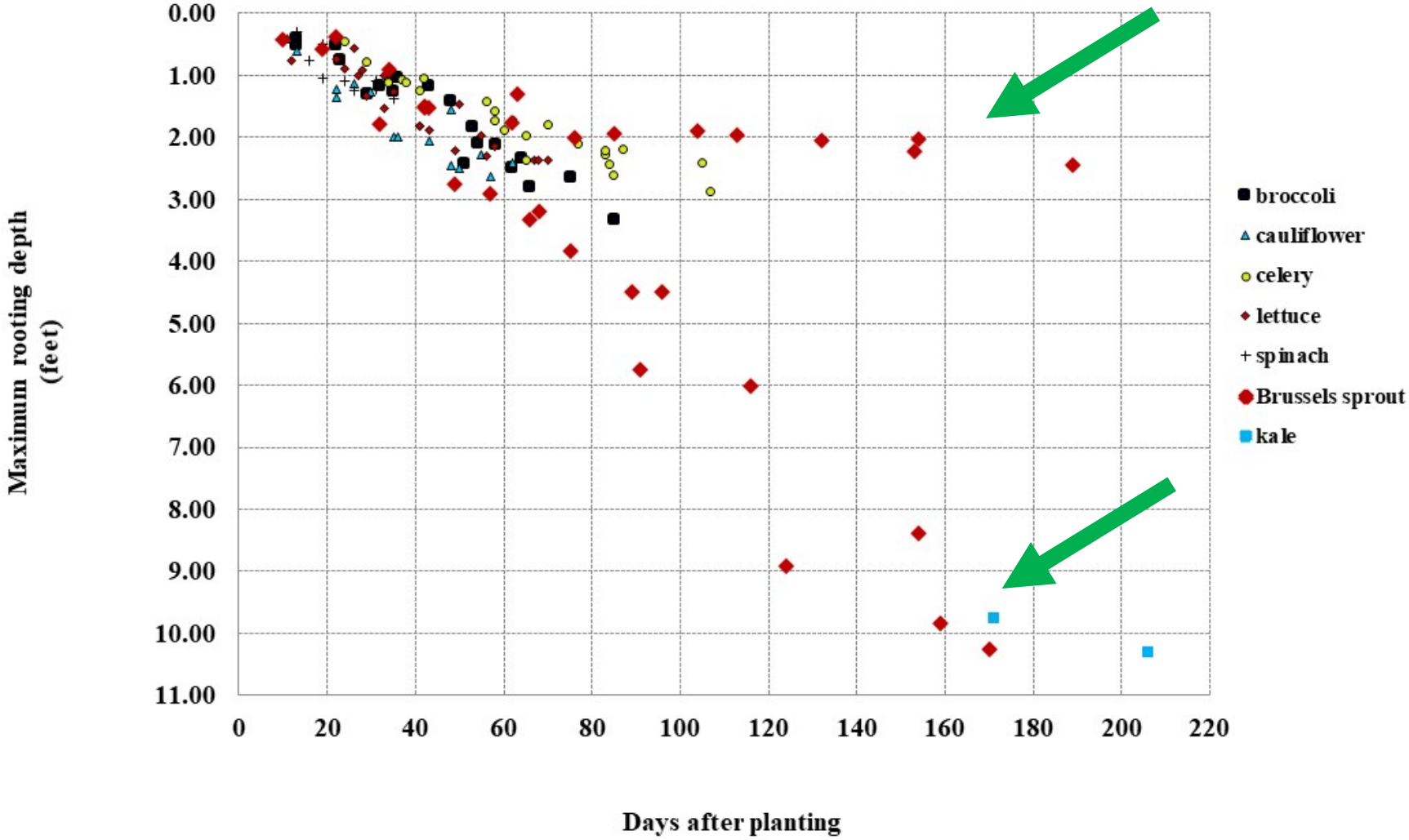
1 - In the top three feet of soil; 2 – loamy sand soil

Multi-Pick Kale – 220 days

Crop was harvested 4 times; 704 lbs N/A was in the harvested leaves; a total of 320 lbs N/A was scavenged; roots reached 11 feet deep by last harvest date

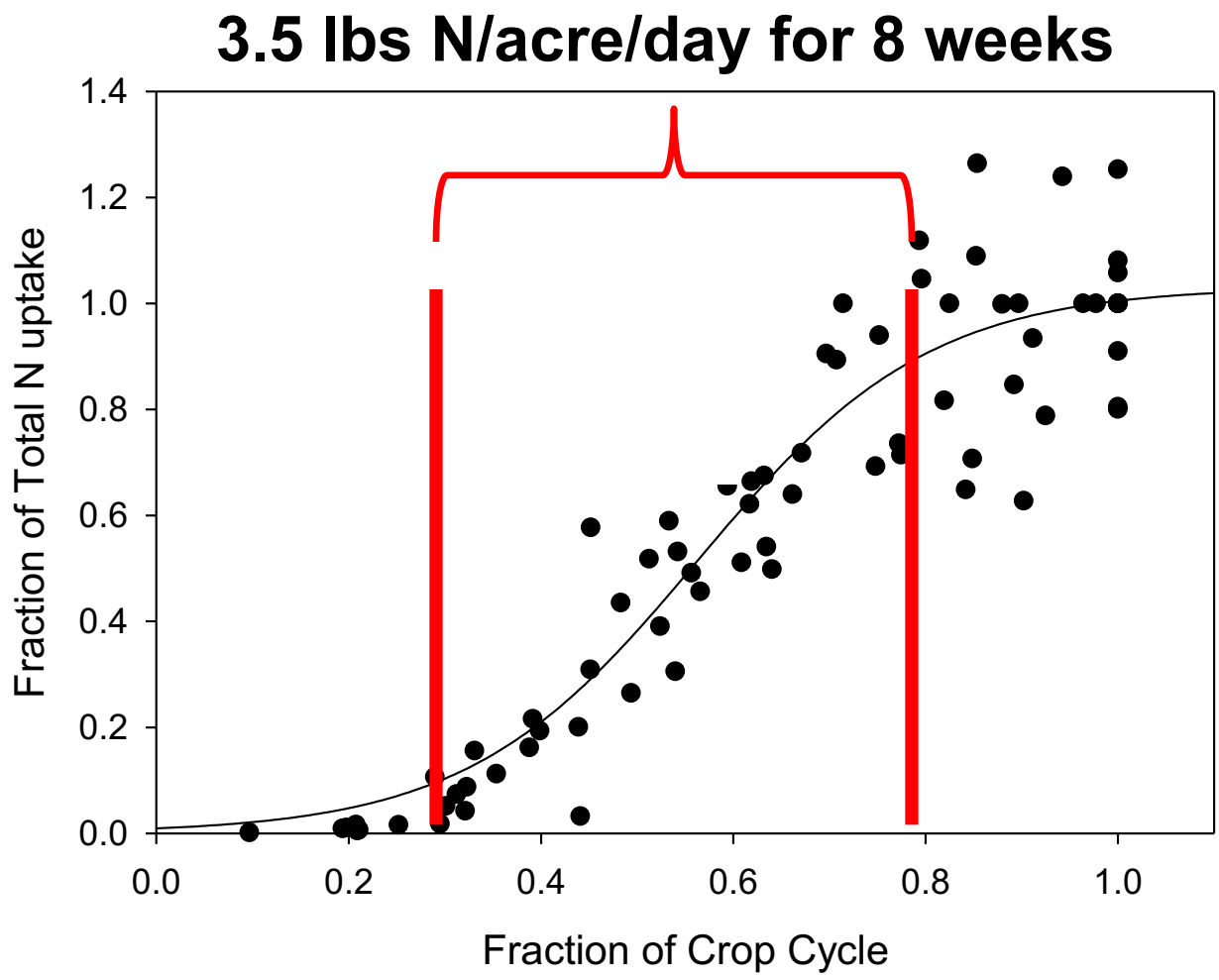


Vegetable Crop Rooting Depth



Roots grew about ½ inch per day

Pepper N uptake



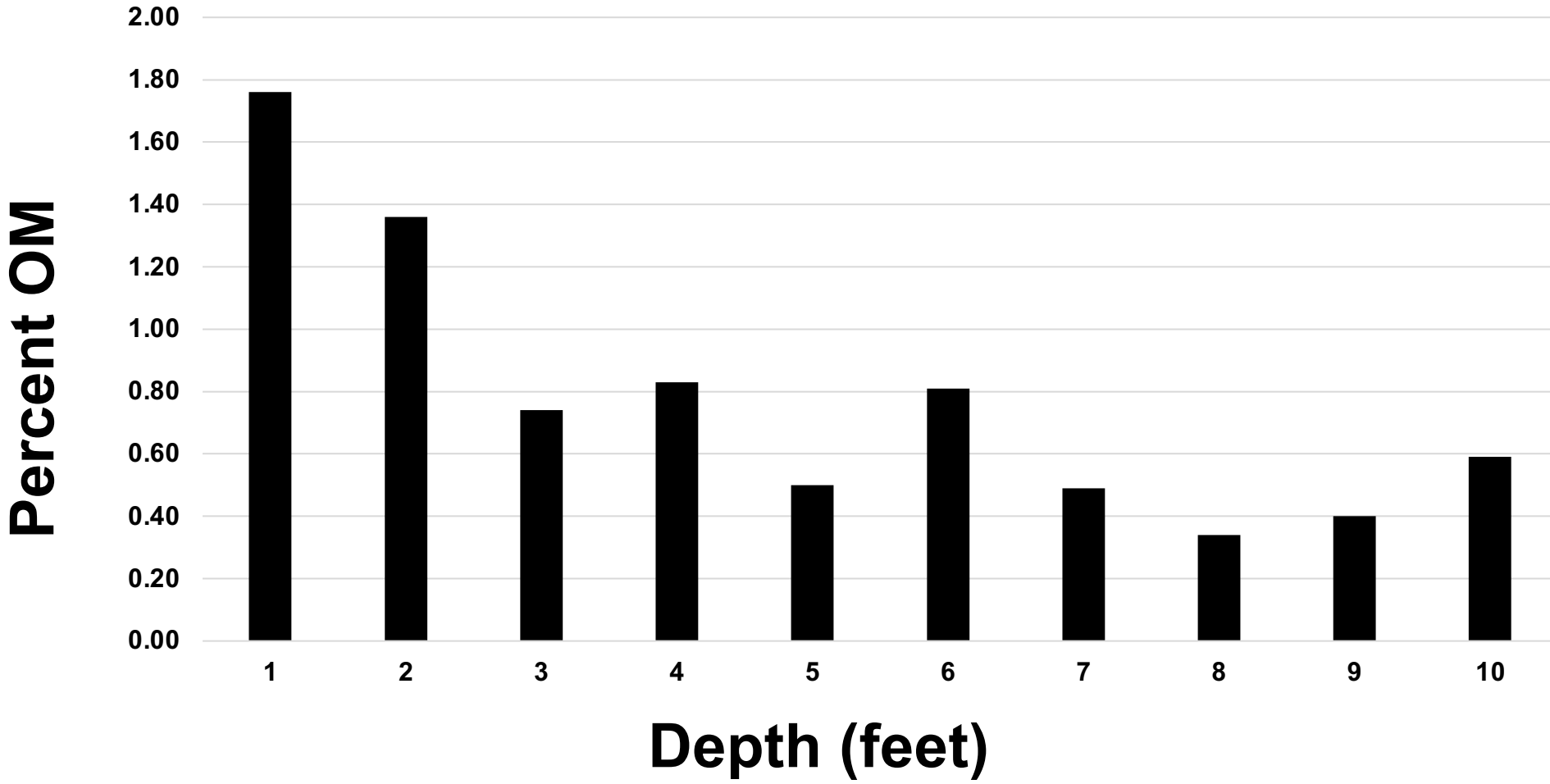
Processing Tomato Evaluations

Bustamante and Hartz, 2015

- **Evaluations of 37 organic processing tomato fields:**
- **Average total N uptake 180 lbs/A**
- **Early season mineral N levels were equal to 50-100% of crop needs**
- **Soil mineral N threshold 10-15 ppm**
- **Early-season soil nitrate-N tests predicted N fertilizer (feather meal) requirement**
- **Early season tissue N tests showed crop status**

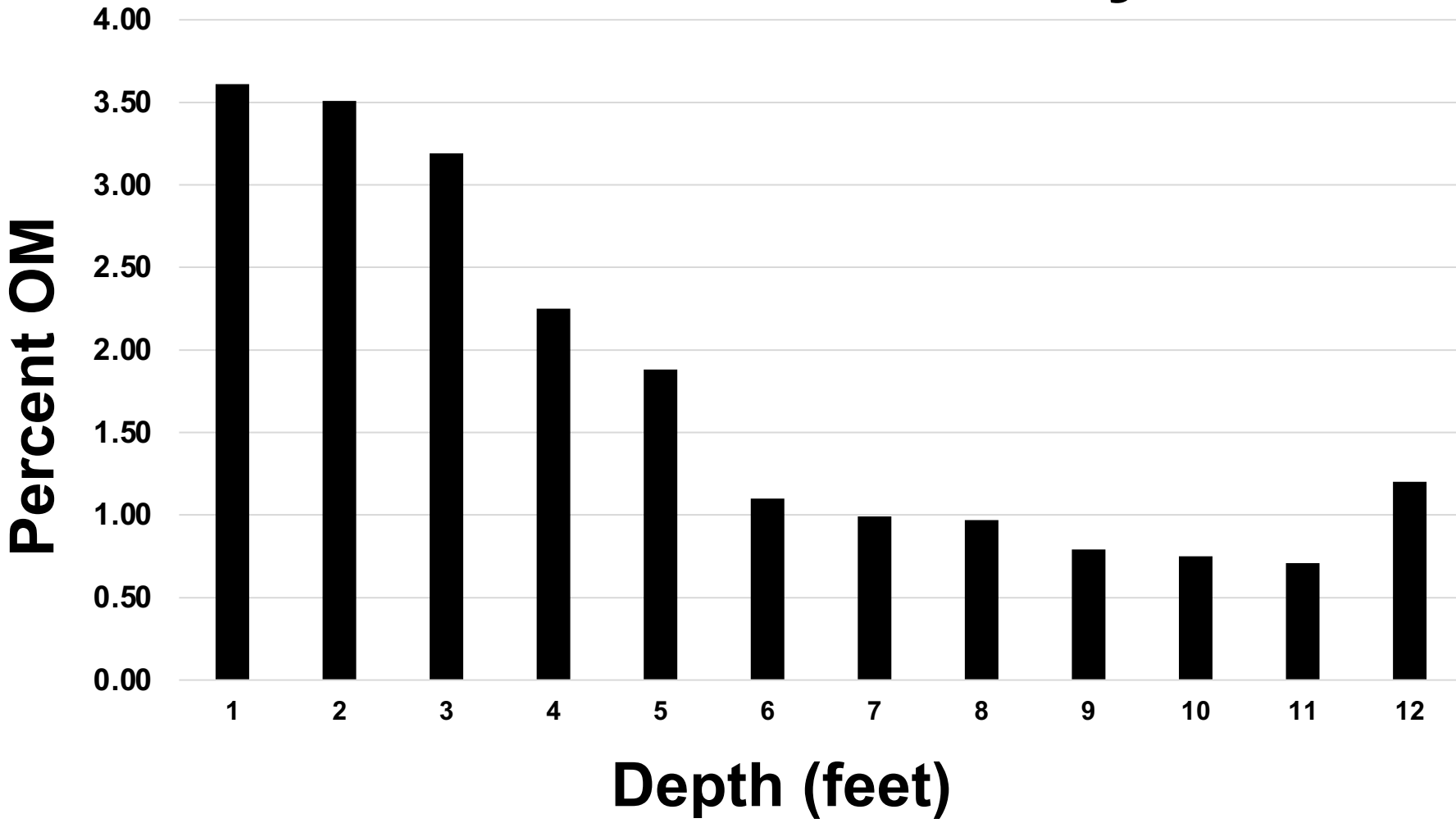
Soil Organic Matter by Depth

Organic Farm 28 Years

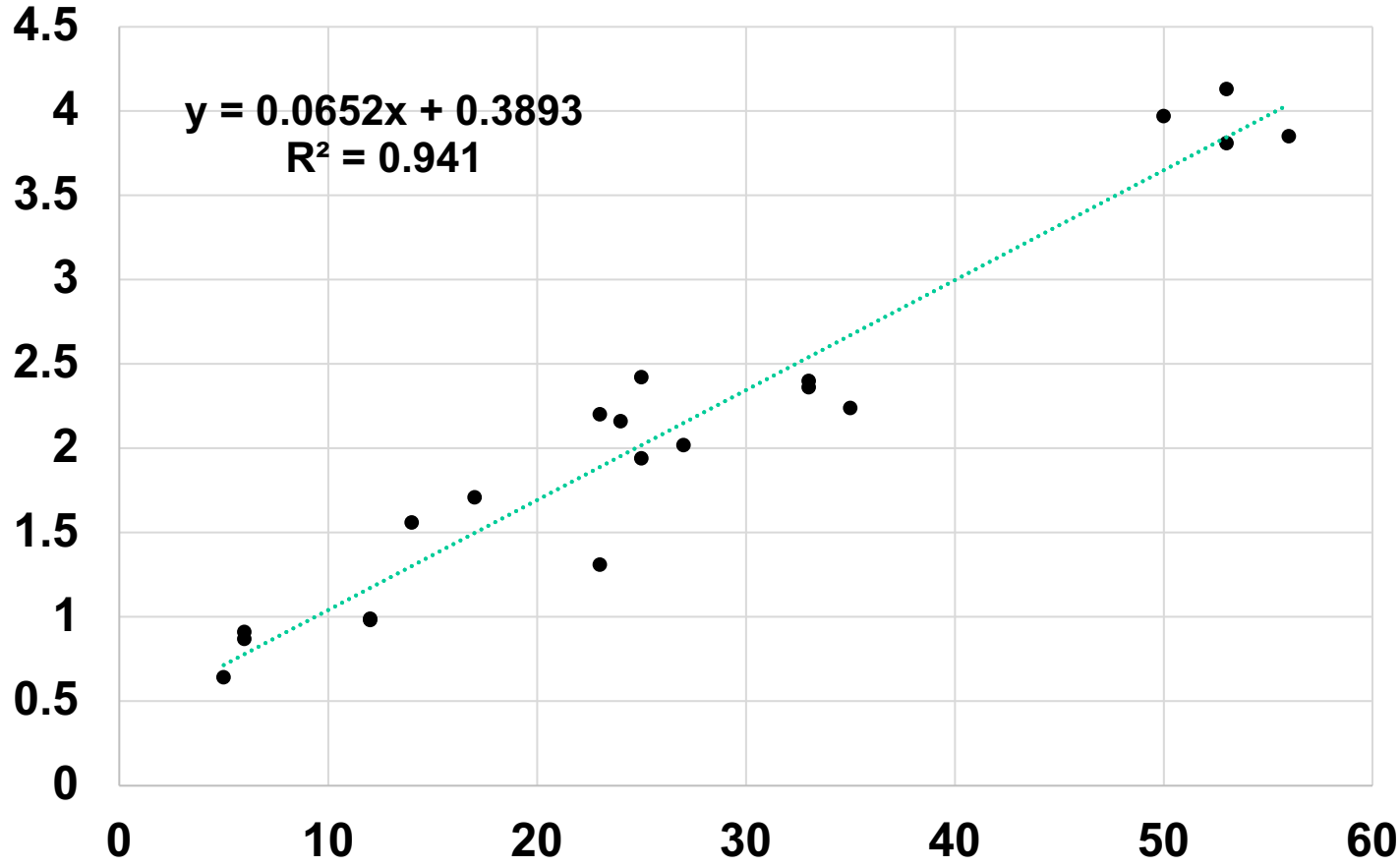


Soil Organic Matter by Depth

Conventional Farm - Clay Loam

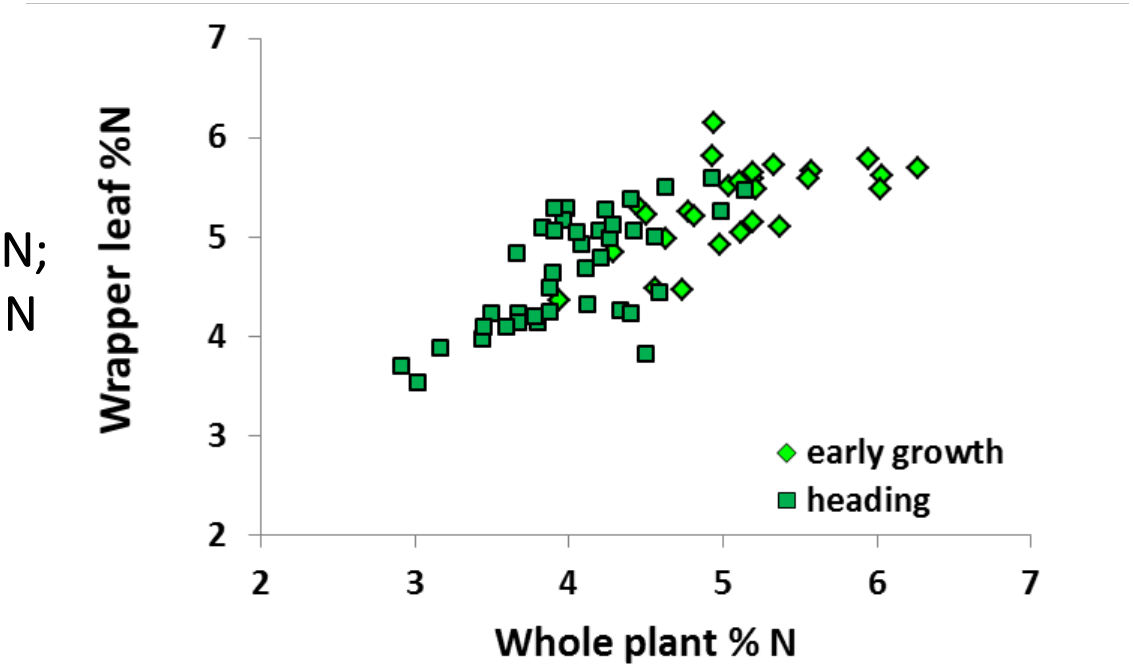


Organic Matter vs Clay Content

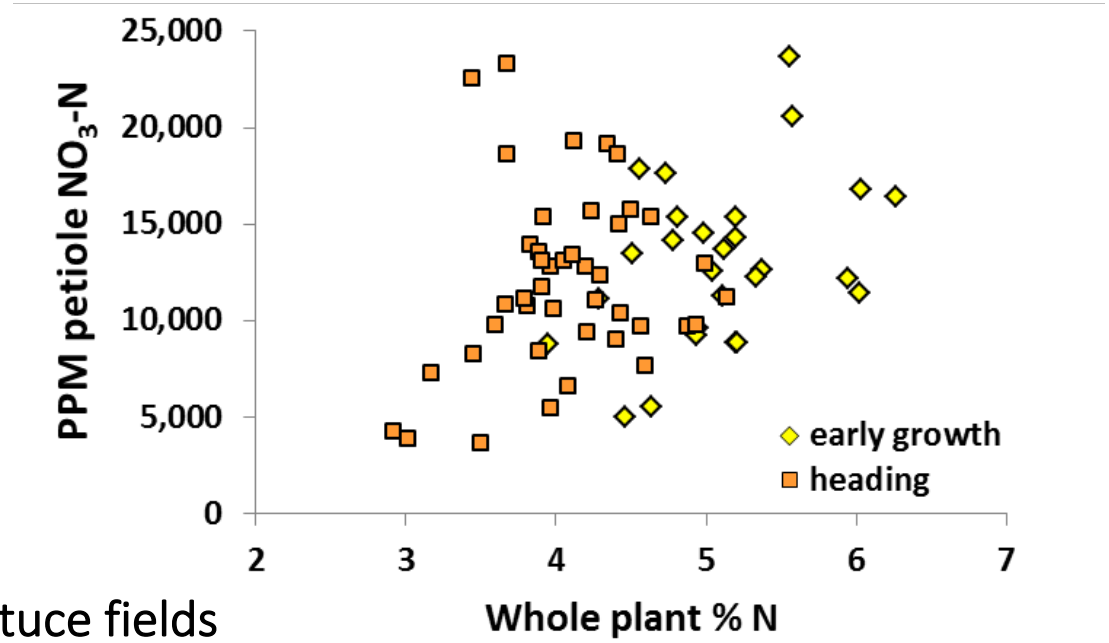


Tissue diagnostics:

- Leaf N correlated to whole plant N; critical values approximately 4% N early season, 3.5% N preharvest



- Petiole NO_3-N highly variable, not correlated to either leaf N or whole plant N



Data from 24 N-sufficient coastal lettuce fields

Bottom line on plant tissue testing :

- whole leaf sampling gives a good snapshot of current crop N status, but it is a poor indicator of current soil NO_3-N supply, and therefore a poor indicator of future need for N fertilization
- Petiole NO_3-N testing is a flawed technique. Maintaining high petiole NO_3-N helps ensure crop nitrogen sufficiency; however, *this often leads to unnecessary fertilization*


Thank you for your attention