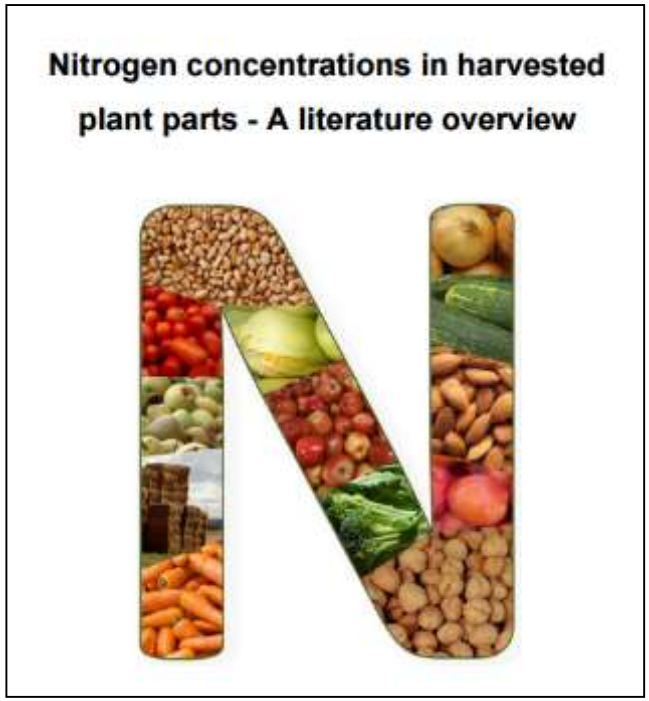
2018 Irrigation and Nutrient Management Meeting

- **CCA meeting: CA 55564**
  - **2.0 nutrient management**
  - **1.5 soil and water management**
- **No pest management continuing education credits were awarded**

Soil Nitrogen Dynamics of Long-Season Vegetable Crops

Richard Smith and Michael Cahn
UC Cooperative Extension, Monterey County

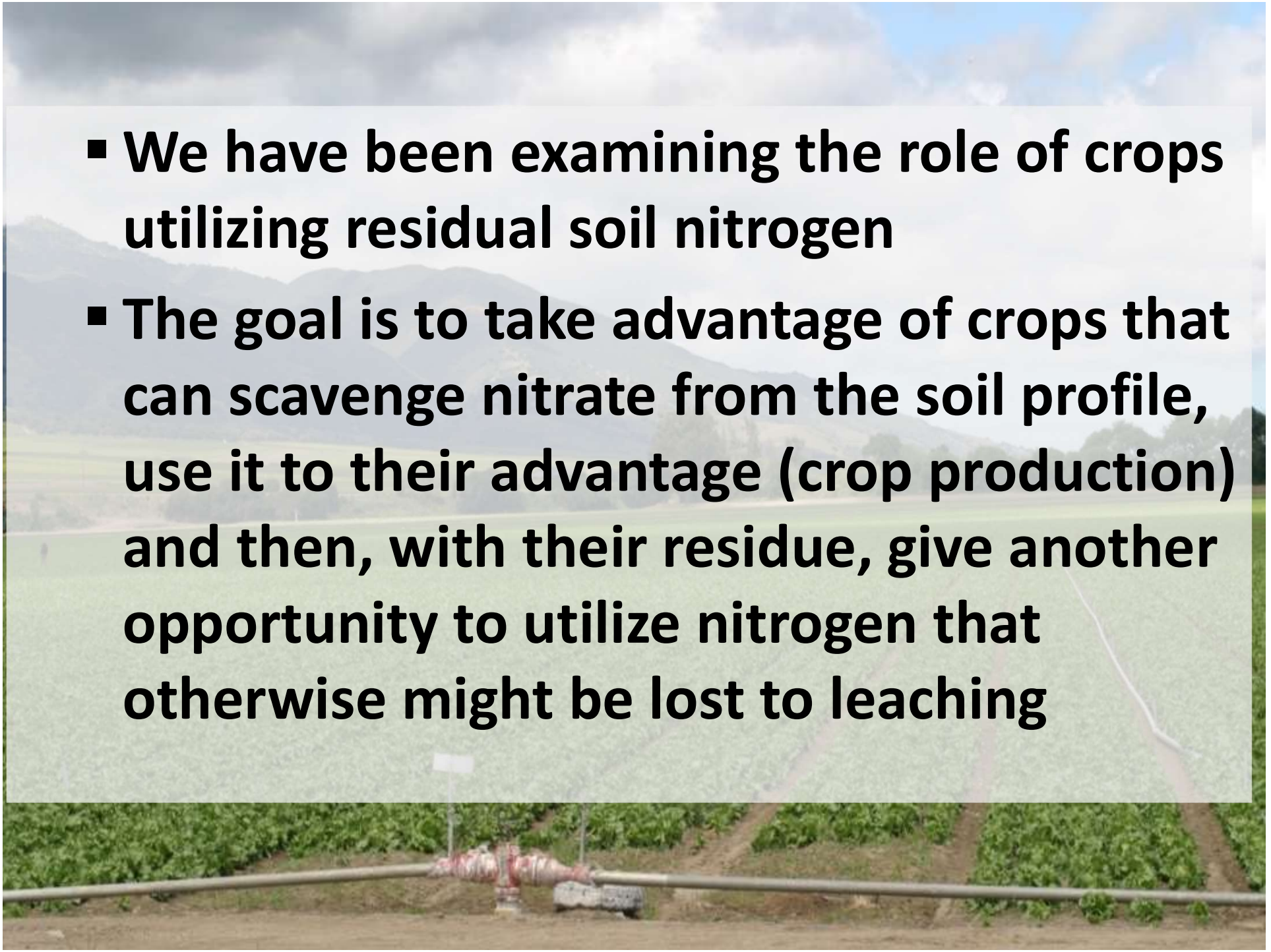
2016 report to the Region 5 (Central Valley) Water Board:



The intent is to establish defensible calculations for 'N balance':

- **N application vs. *harvest removal***
  - **A/R**
  - **A-R**

- **Nitrogen management in vegetable production systems is made more efficient in the following ways:**
  - **Applying quantities of N only to supplement residual N already present in the soil to meet crop needs**
  - **Carefully managing irrigation water**
  - **Account for NO_3-N in irrigation water**
  - **Manage in-season inputs to draw down soil NO_3-N at harvest**
  - **Take advantage of scavenging crops**
  - **End of season practices to sequester NO_3-N**



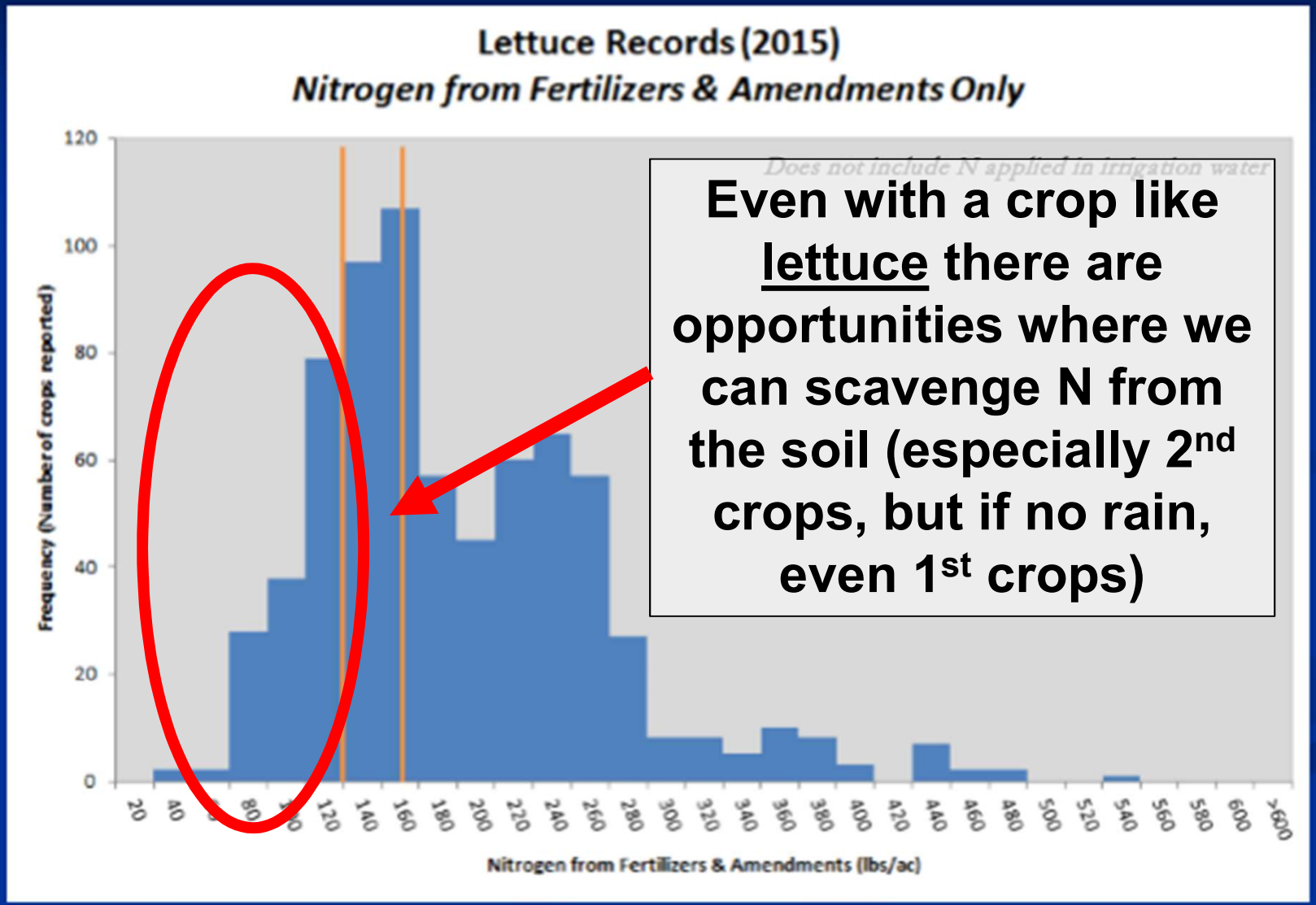
- We have been examining the role of crops utilizing residual soil nitrogen
- The goal is to take advantage of crops that can scavenge nitrate from the soil profile, use it to their advantage (crop production) and then, with their residue, give another opportunity to utilize nitrogen that otherwise might be lost to leaching

- Inefficiency in nitrogen management is unavoidable at times
- The causes of inefficiency in N utilization includes: leaching by irrigation/rain, excessive fertilization over what the crop can take up and what is already available
- The goal is to maximize residence time of nitrate N in the root zone to allow uptake
- Not always possible
  - Particularly challenging on very sandy soils

- Crops that scavenge nitrate give us a tool for cleaning up any inefficiency in N application and utilization
- Certain crops are particularly helpful in this regard
- Long-season vegetables such as kale, Brussels sprouts and others have interesting dynamics with regards to N use and cycling – can they help improve nitrogen use efficiency?

Grower Reported N from Fertilizers

(718 Crop Records) Compared to Specific Crop Nitrogen Uptake



Even with a crop like <u>lettuce</u> there are opportunities where we can scavenge N from the soil (especially 2nd crops, but if no rain, even 1st crops)

Cole Crops

Summer Production

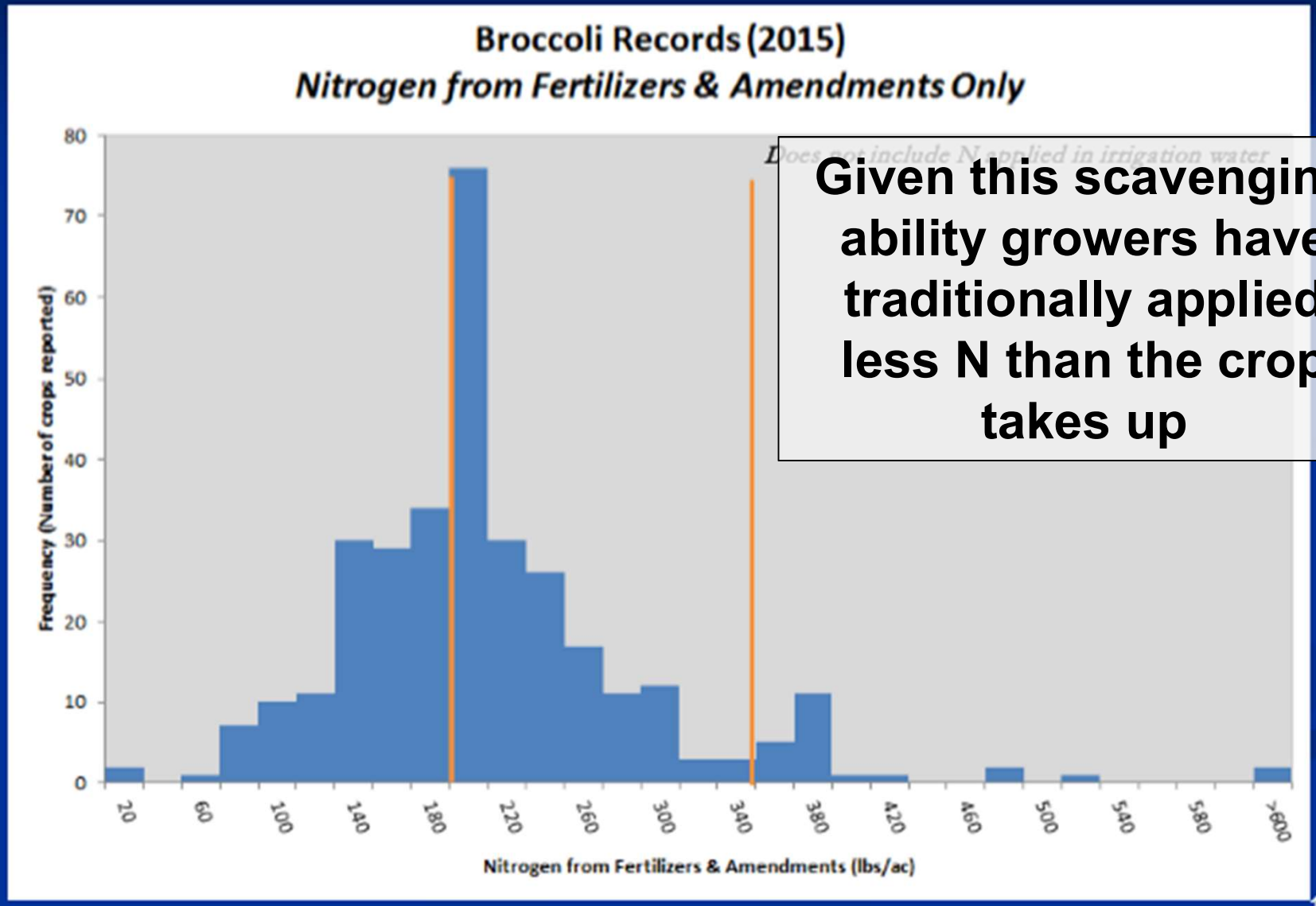
Crop	Fertilizer applied	Crop Uptake	Scavenged from soil
Broccoli	181	337	155
Cauliflower	260	285	21
Cabbage	215	337	97

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 (chase) nitrate-nitrogen deeper in the soil profile

Grower Reported N from Fertilizers

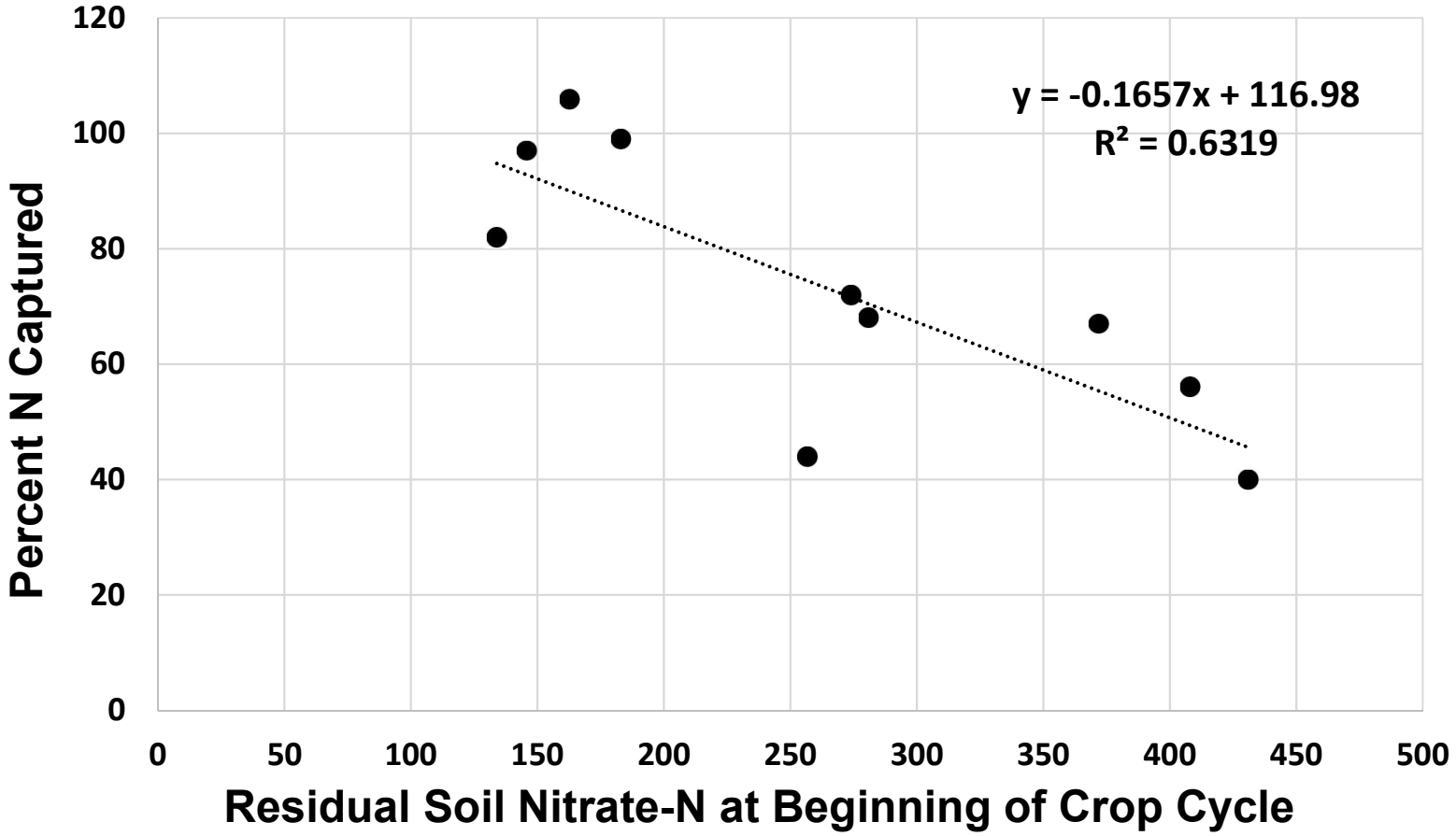
Central Coast Regional Water Quality Control Board



Given this scavenging ability growers have traditionally applied less N than the crop takes up

Ability of Broccoli to Scavenge Residual Soil Nitrate from Prior Lettuce Crop

(residual N in top 3' of soil; fertilizer rates: 160 – 200 lbs N/A)



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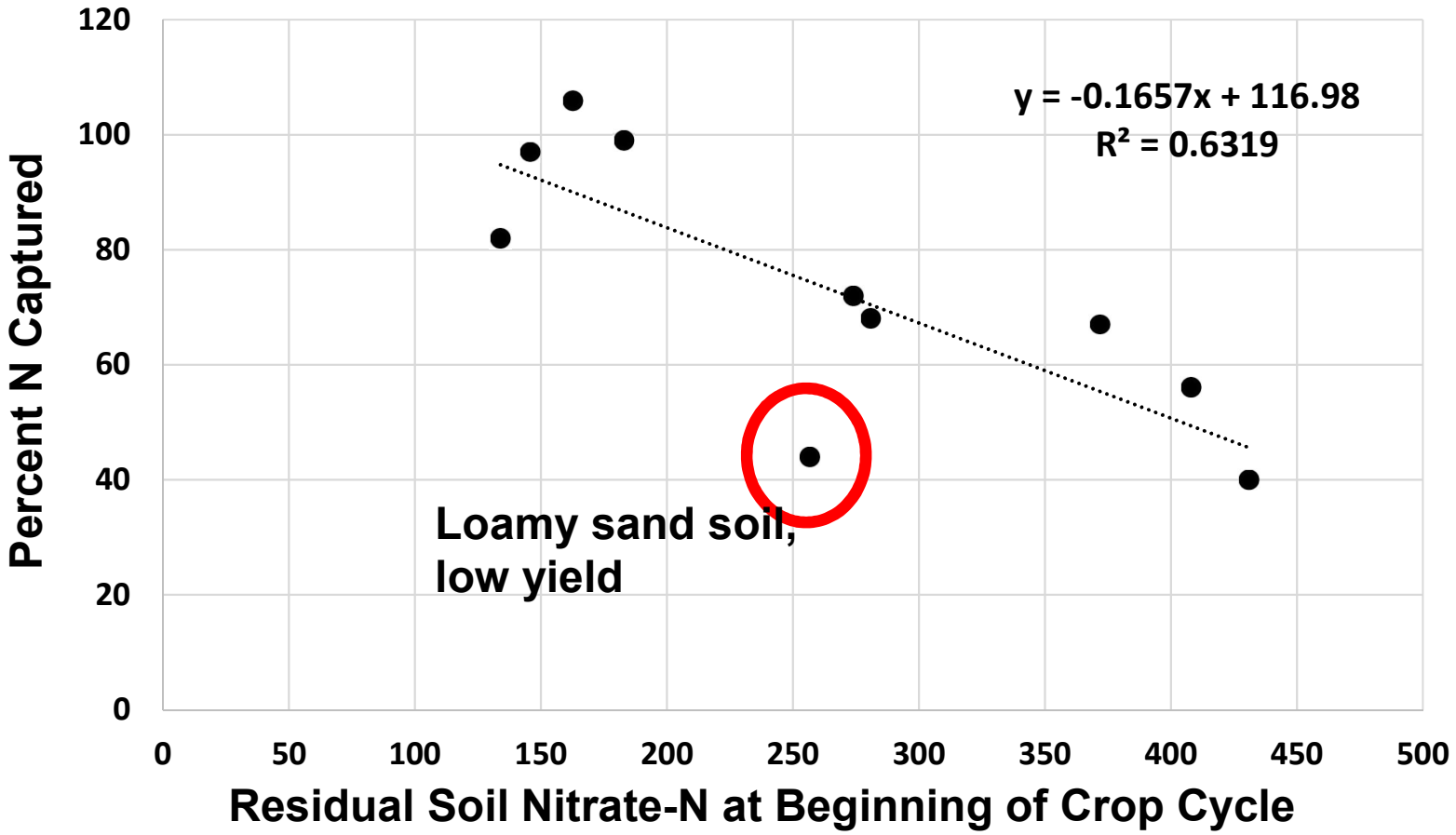
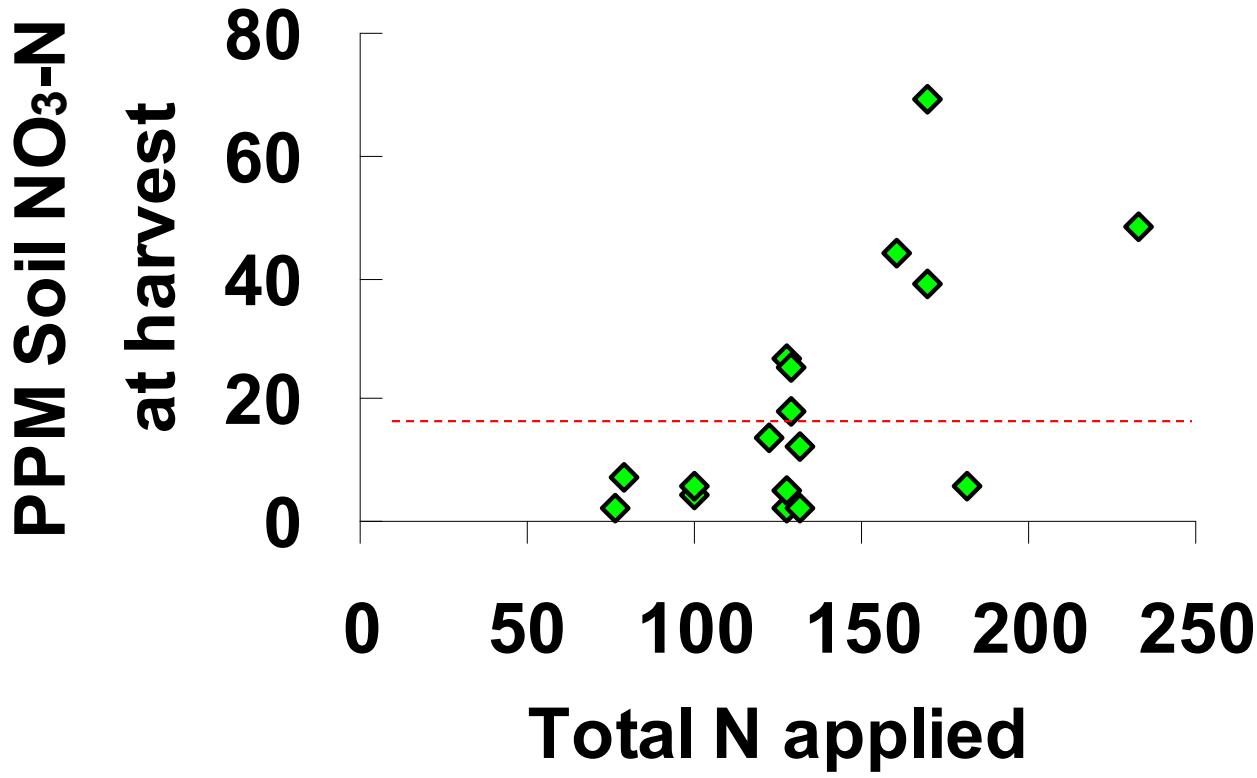
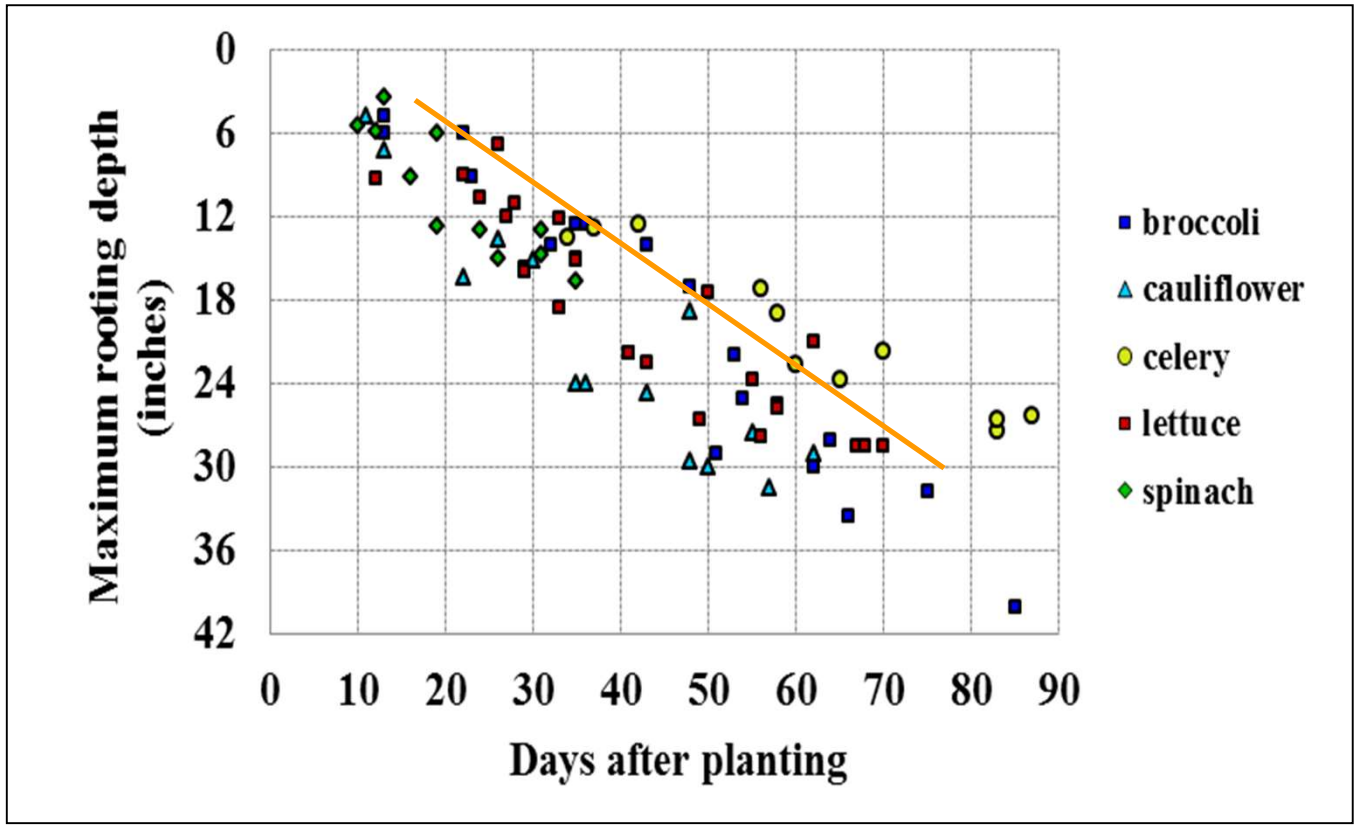


Residual Soil Nitrate At Harvest
18 Successful Lettuce Production Fields



Made possible by utilizing residual and not over loading the soil

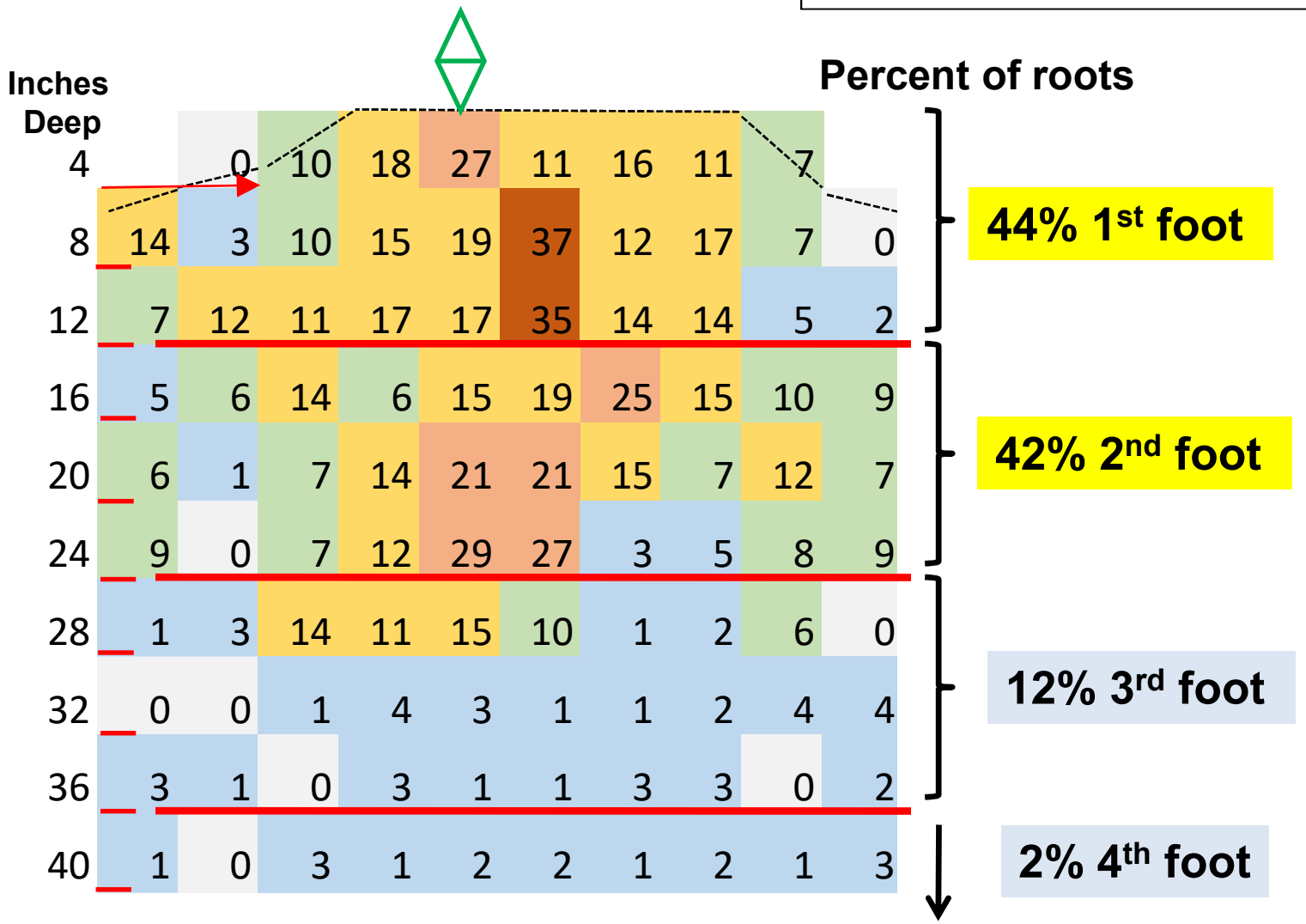
Rooting Depth of Five Common Salinas Valley Vegetables



Rooting depth increases:
≈ ½” per day, across crops

Cauliflower
113 days after planting

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

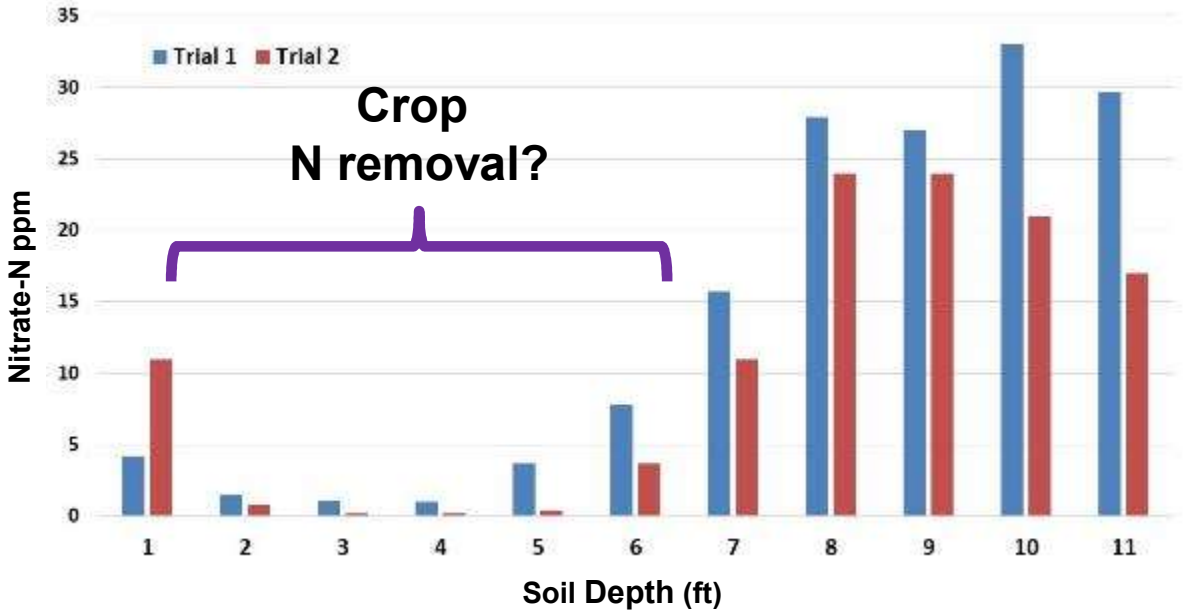


Evaluations of Long-Season Vegetables: Brussels Sprouts and Kale

- Six evaluations done on Brussels sprouts
- Sites ranged from valley bottom soil with no impeding layers to soils with impeding at about 3 feet deep
- Length of the crops varied from 150 to 190 days after transplanting

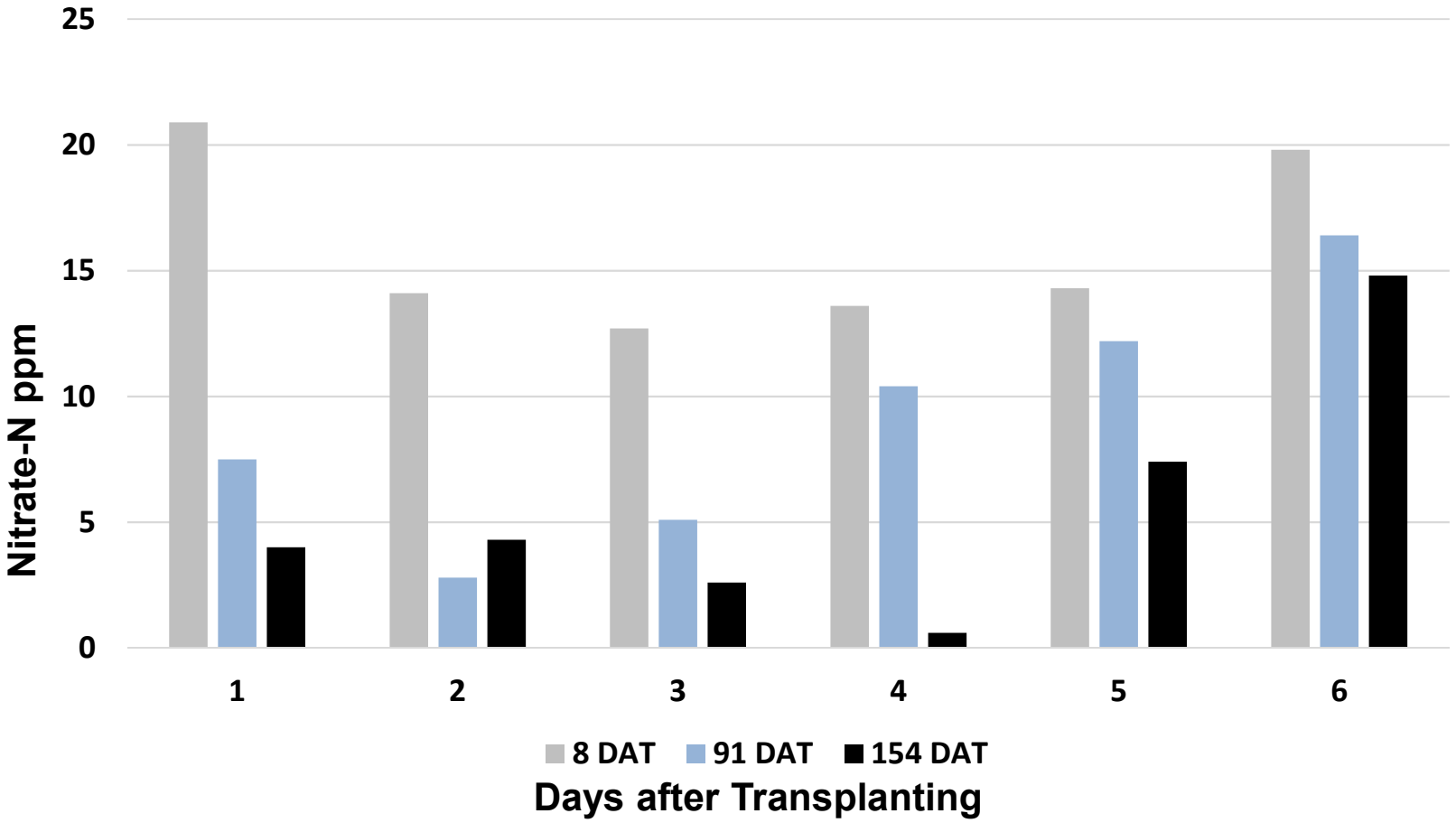
Brussels Sprouts 2016

Trial	Crop biomass Tons/A	Crop uptake lbs N/A	Fruit uptake lbs N/A	Fertilizer lbs N/A	Scavenging lbs N/A
1	58	456	170	217	239
2	49	375	159	217	158
3	30	271	174	385	No



Brussels Sprouts 2017

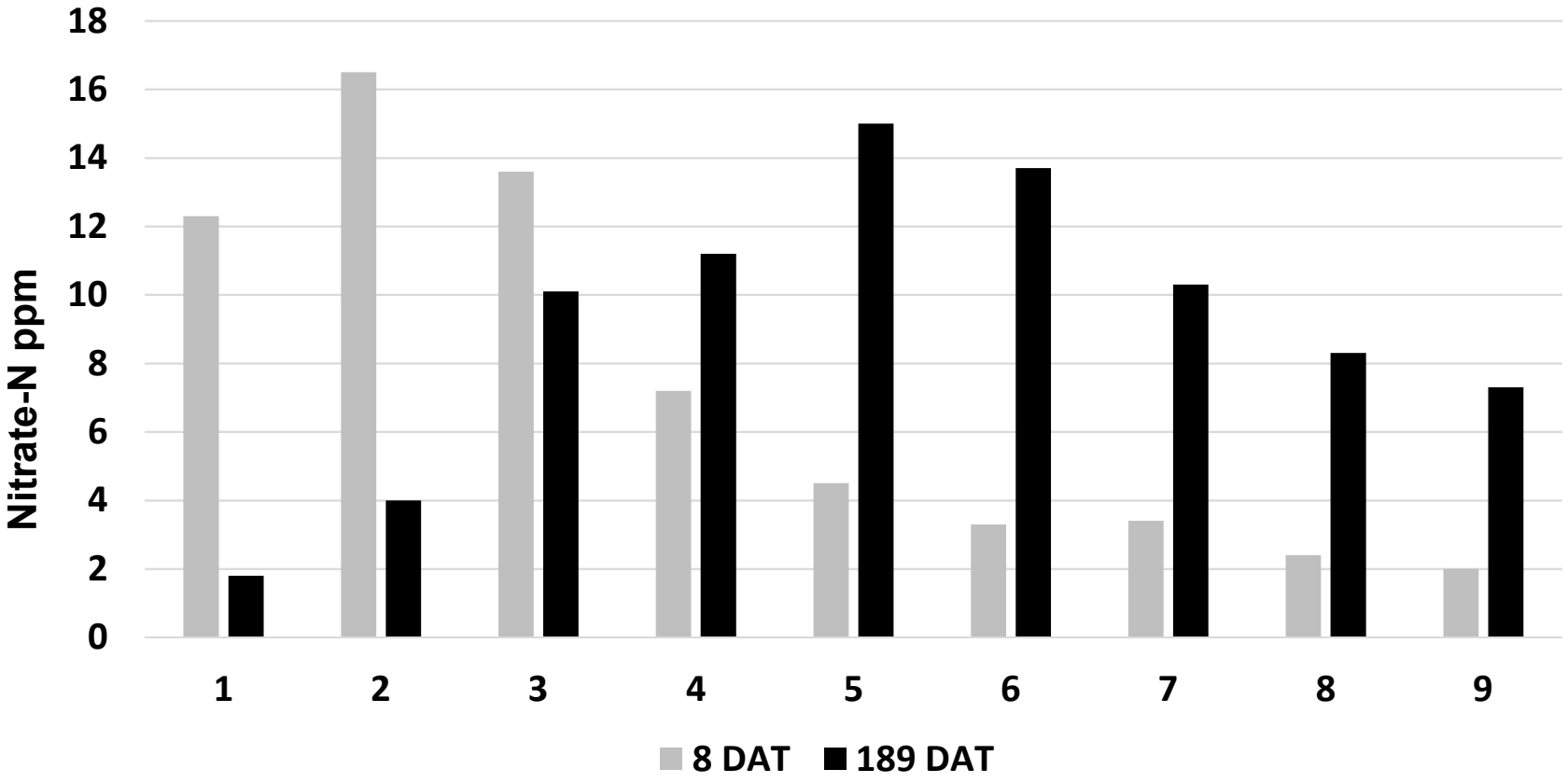
Loamy Soil, Deep Rooted



Similar to 2016: evidence of N removal down to 5 – 6 feet

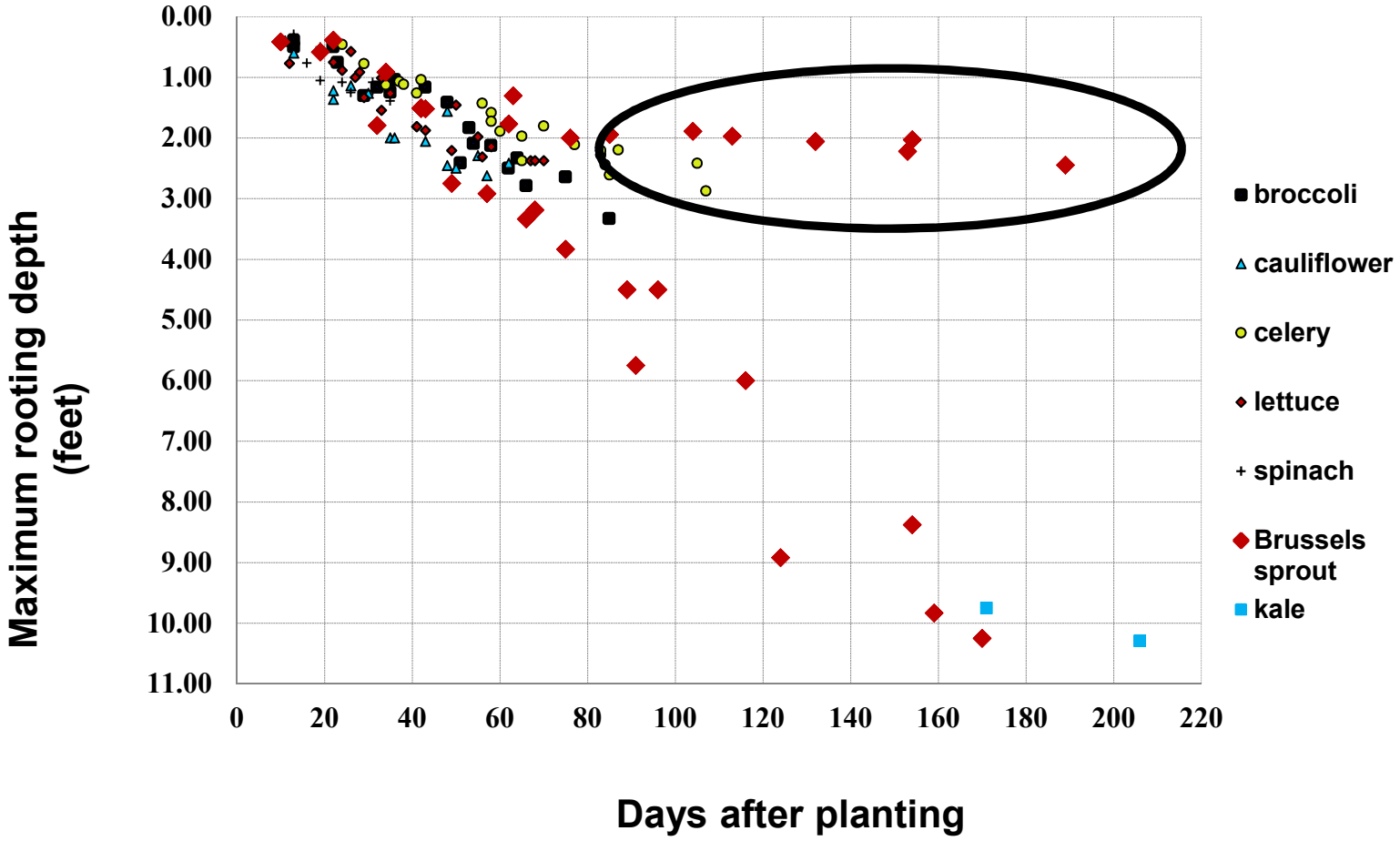
Brussels Sprouts 2017

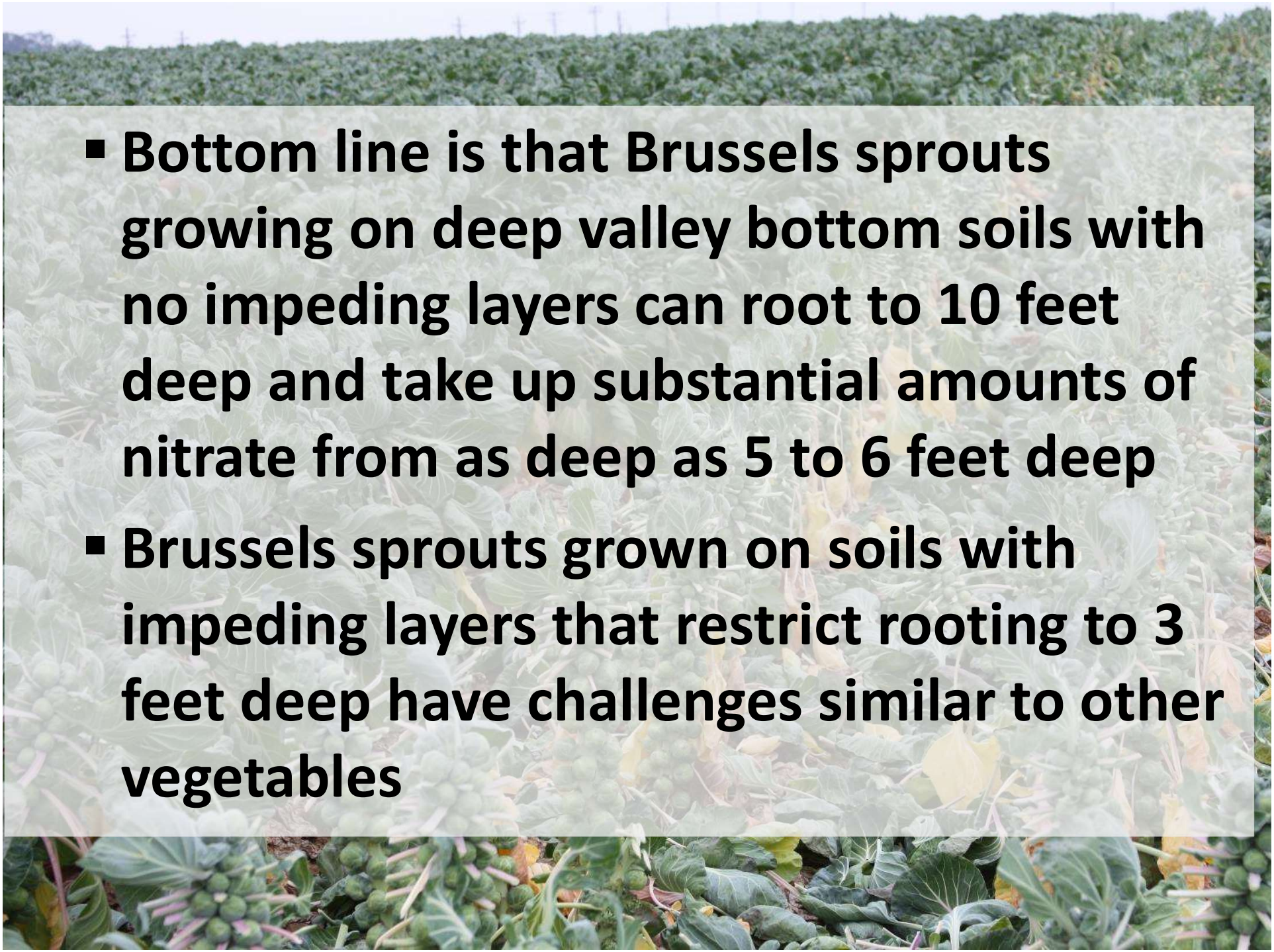
Sandy Soil, Shallow Rooted



Rooting depth impeded and evidence of enrichment of deeper soil levels

Affect of Impeding Layer on Rooting Depth of Brussels Sprouts





- Bottom line is that Brussels sprouts growing on deep valley bottom soils with no impeding layers can root to 10 feet deep and take up substantial amounts of nitrate from as deep as 5 to 6 feet deep
- Brussels sprouts grown on soils with impeding layers that restrict rooting to 3 feet deep have challenges similar to other vegetables

- One evaluation conducted in 2017 on a site that was harvested four times
- The crop cycle was 252 days

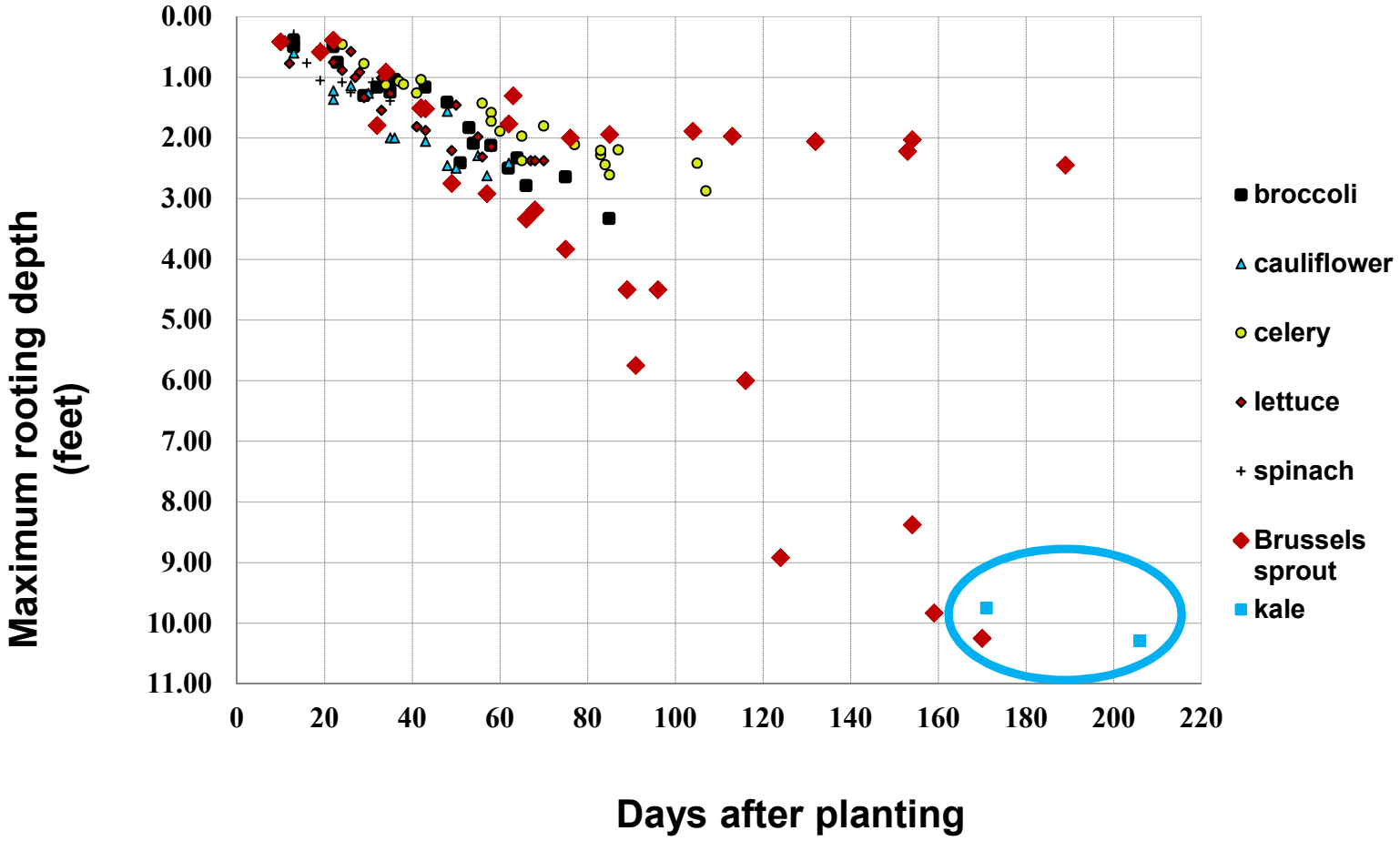
Kale Biomass and N Uptake

Four Harvests - 2017

DAT	Component	Fresh tons/A	N uptake lbs/A
72	Total	28	276
	Harvested	14	164
127	Total	45	380
	Harvested	24	208
181	Total	49	341
	Harvested	19	160
252	Total	33	281
	Harvested	15	171
	Total Harvested	73	704

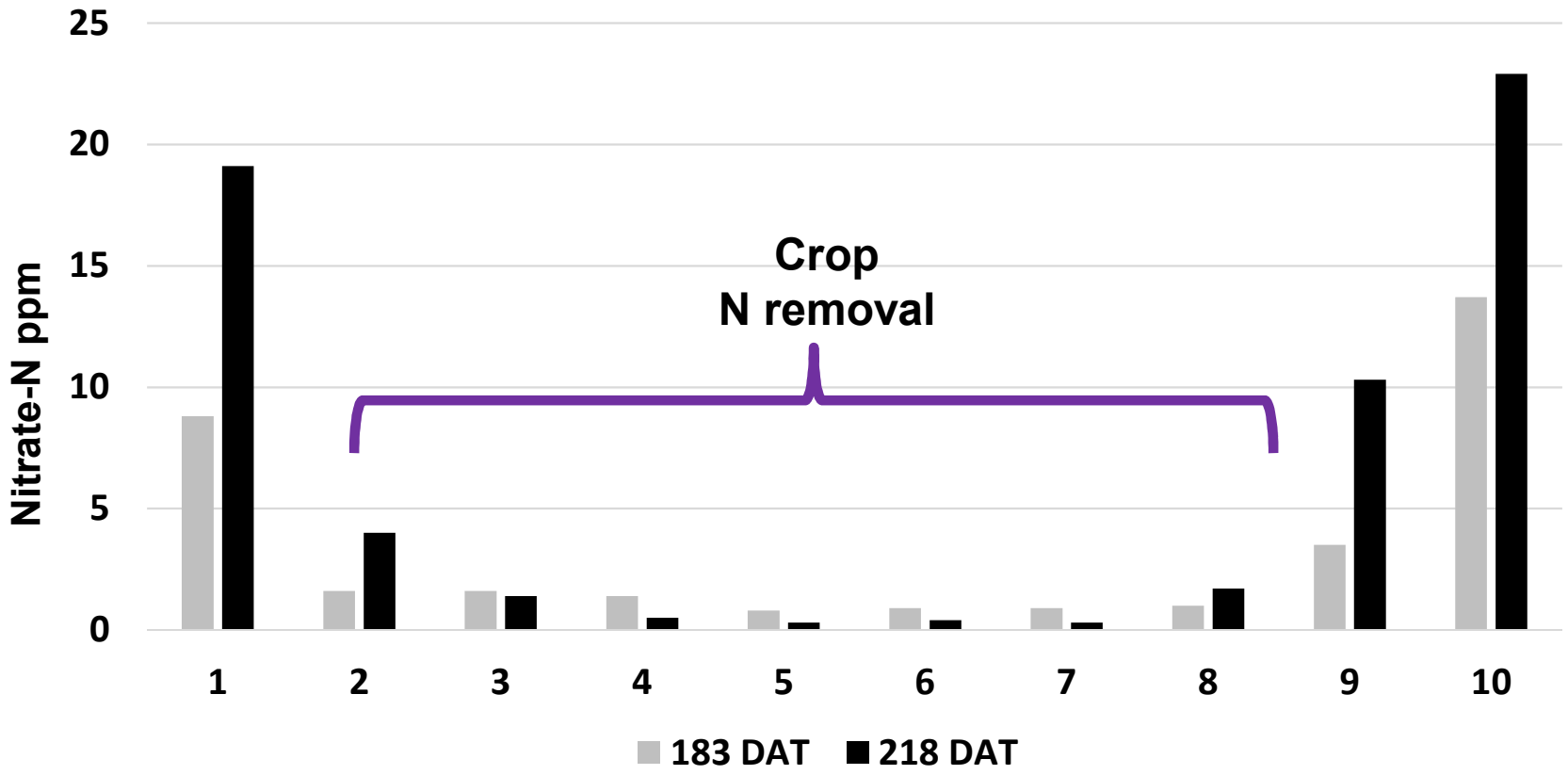
67 lbs P & 654 lbs K

Kale Rooting Depth at End of Season



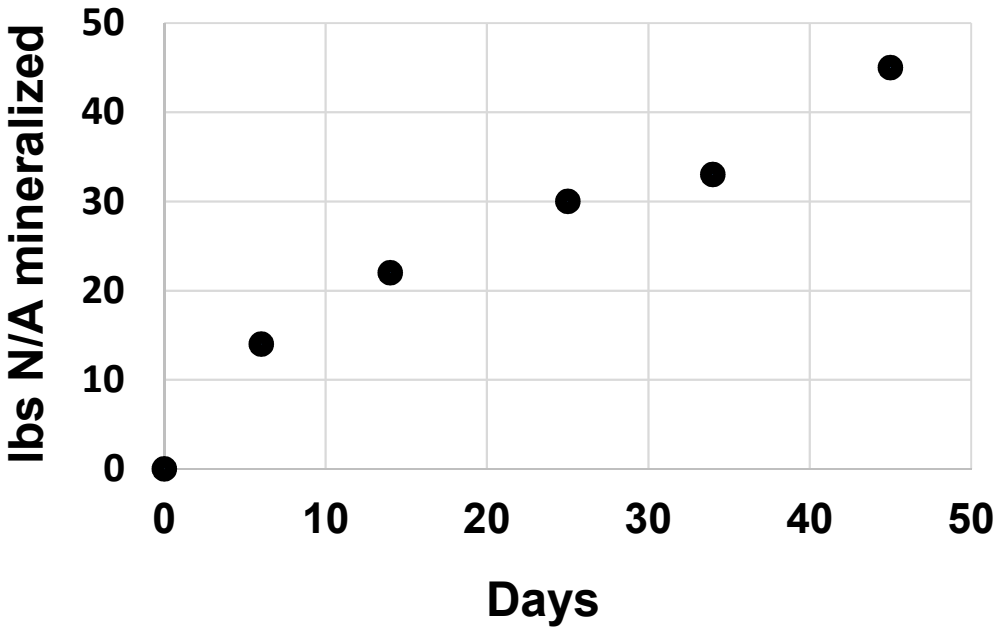
Curled Leaf Kale 2017

Silty Clay Loamy Soil, Deep Rooted



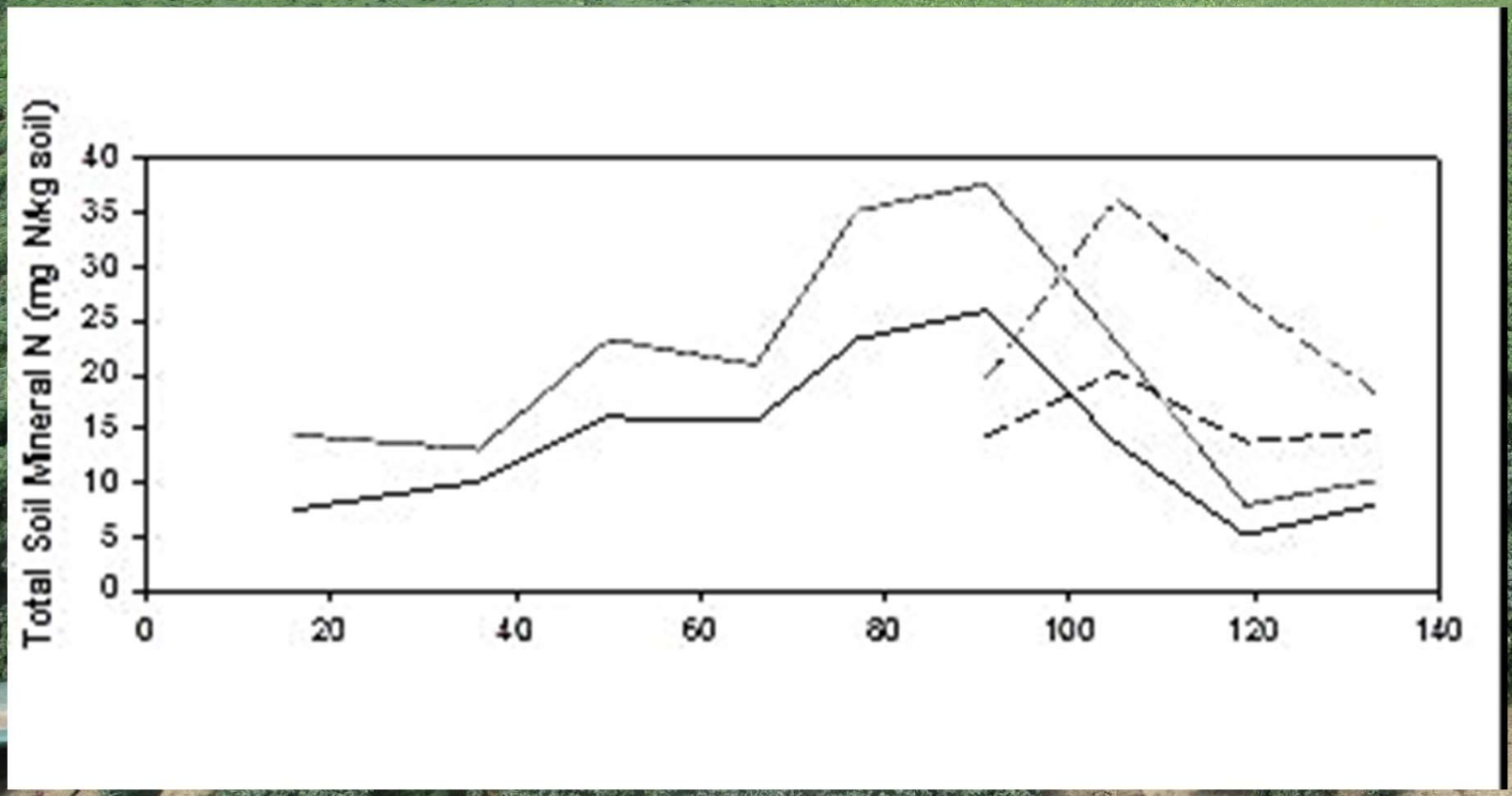
N in Crop Residue

Cut	Lbs N/A
First	163
Second	256



- High yielding field
- 384 lbs N/A applied as fertilizer
- 320 lbs N/A scavenged
- 704 lbs N/A; 67 lbs P/A; and 654 lbs K/A uptake
- At harvest: 111 lbs N/A standing biomass, unknown how much biomass in the leaf litter already on the soil

- **The N left over following these deep rooted crops can be substantial and can be utilized by subsequent crops**
- **Going into the winter fallow they are at risk for leaching in wet years**



Other Scavenging Crops*

Peppers

Year	Crop biomass Tons/A	Crop uptake lbs N/A	Fruit uptake lbs N/A	Fertilizer lbs N/A
2014	62	329	201	277
2015	67	344	203	200
2016	72	334	220	383

- Scavenging crops have a good A/R ratios
- But they also have a role to play in reducing nitrate leaching
- A key aspect of reducing leaching is due to their deep rooting and high N uptake
- However, on sites with an impeding layer, they are less effective and may not scavenge effectively
- The N that they scavenge is brought back to the soil surface and is available for a subsequent crop to utilize, thereby improving N use efficiency in the vegetable cropping system
- Even in-season N cycling from sloughed off leaves

- **Sites with very sandy soils are very difficult to effectively manage soil nitrate**
- **On shallow soils, even these deep rooting, high N uptake crops do not act any different than many other more shallow rooted crops and careful N management is necessary**

- **Acknowledgements**
  - **Patricia Love, Laura Murphy, Bibiana Urbina, Jose Delgado, Carlos Lopez Rodriguez**
  - **Cooperating Growers**
  - **Specialty Crop Block Grant Program**