2019 Irrigation and Nutrient Management Meeting

- Certified Crop Advisor Program Continuing Education Credits:
  - CA 56570 3.0 (1.5 NM & 1.5 SW)
- Thank you Fresh Leaf Farms for the salad for lunch
- Please put phone on silent mode

Full-Season Nitrogen Management of Vegetables

Richard Smith
UC Cooperative Extension, Monterey County

- **At different times during the year there are different challenges and opportunities to reduce the leakiness of the vegetable production system**
  - **Management is focused on the pool of residual soil nitrate-N[1]**
    - **Build it up to an optimum level for crop growth**
    - **Optimizing fertilizer applications to keep the nitrate pool from getting excessively large**
    - **Keep it from leaching beyond the reach of the root zone**
    - **Scavenge nitrate that has moved deeper in the soil profile**
    - **Make use of the scavenged nitrate**

1 - For the most part we ignore ammonium-N because levels only range around 1-2 ppm during the warmer times of the season

First Crop – Late Winter Early Spring

- Residual soil nitrate pools can vary depending how much winter rain fell
  - In dry years, there may be sufficient residual nitrate-N to adjust fertilizer programs
  - In wet years (like this one) that may not be possible
- Fertilizer program may be adjusted based on levels of nitrate-N in the irrigation water

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

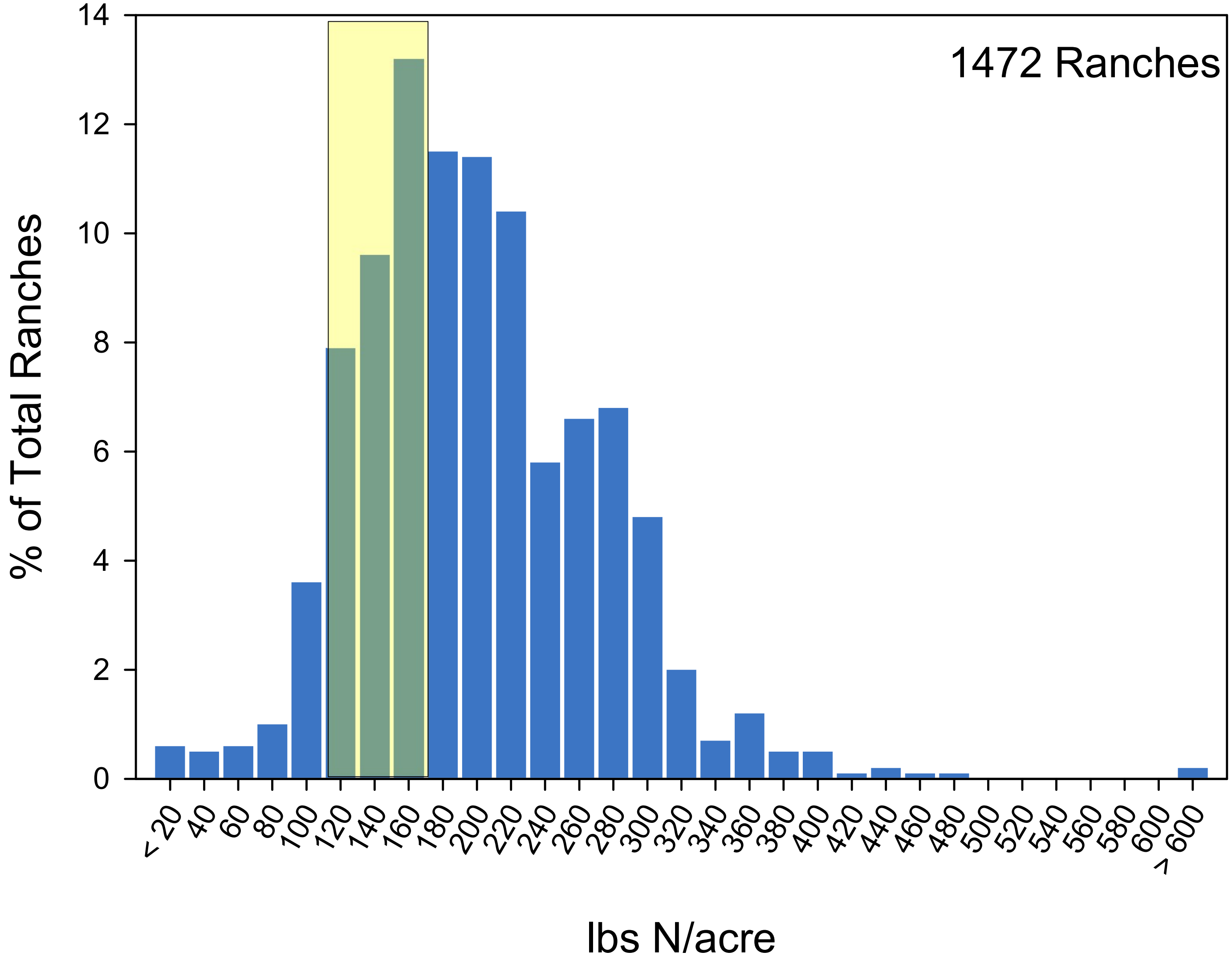
Crop	Crop Uptake lbs N/A	Percent removed in the harvested portion
Bell pepper	240-350	65-75
Broccoli	250-350	25-35
Brussels sprouts	350-500	30-50
Cabbage	280-380	50-60
Cauliflower	250-300	25-35
Celery	200-300	50-65
Lettuces	120-160	50-60
Baby lettuces	60-70	65-75
Onion	150-180	60-75
Spinach	90-130	65-75

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

https://vric.ucdavis.edu/pdf/fertilization/fertilization_UsingthePre-SidedressingSoilNitrateQuickTesttoGuideNFertilizerManagement.pdf

http://cemonterey.ucdavis.edu/files/153199.pdf

2017 Lettuce



CC Regional Water Quality Control Board Report; Cahn and Qin

Is your N application program reasonable ?

In more than 100 lettuce fields monitored over the past decade ...

	Seasonal N application (lb /acre)	
	Spring planting	Summer planting
High	392	306
Low	70	27
Average	215	152
Average of lowest 50% of fields	149	106
Average of highest 50% of fields	281	198

Tim Hartz

Calculating N applied from irrigation water:

ppm NO_3-N x 0.23 = lbs N/acre inch

Example:

- **Water nitrate-N concentration = 40 ppm**
- **40 x 0.23 = 9 lbs N/acre inch**

- **If 1.5 inches of water applied:**
- **1.5 x 9 lbs = 14 lbs N**

Residual Soil N and Water N

Trial No	Soil NO_3-N ppm	Water NO_3-N ppm	Drip Water Inches*	N in Water lbs/A
Trial 1	8	32	5.0	36
Trial 2	29	84	5.3	101
Trial 3	7	26	4.4	26
Trial 4	35	80	5.0	89
Trial 5	20	42	6.8	65
Trial 6	43	66	7.7	115

* N from irrigation water only includes applications post thinning when plants are big enough to utilize applied N

N fertilizer treatments (strip plots)

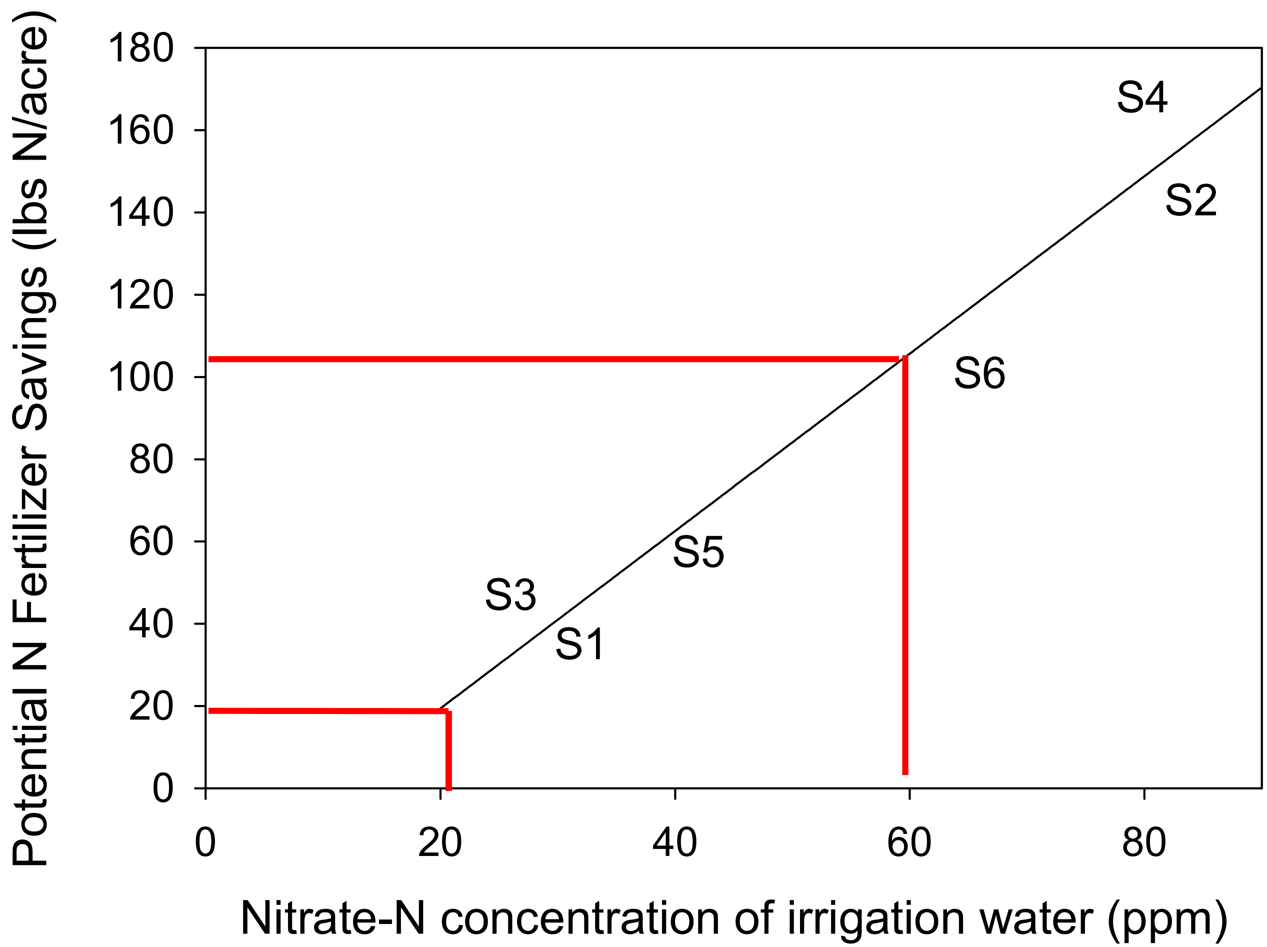
Trial No	Crop	Grower	BMP
		------lbs N/A------	
Trial 1	Iceberg	154	140
Trial 2	Iceberg	62	32
Trial 3	Romaine	120	128
Trial 4	Iceberg	63	7
Trial 5	Iceberg	155	118
Trial 6	Iceberg	155	92
Ave.		118	86

Marketable Yield

Commercial Strip Plots

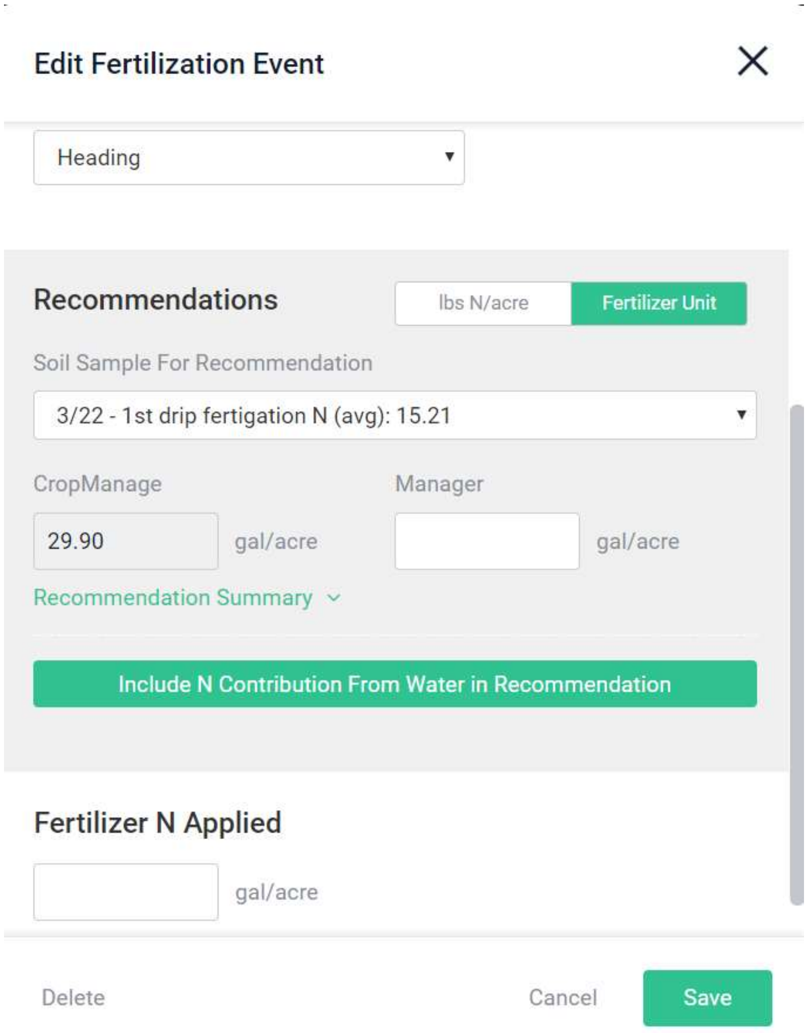
Trial No	Grower	BMP % change
Trial 1	53,573	2
Trial 2	42,387	-1
Trial 3	36,832	10
Trial 4	41,526	8
Trial 5	22,511	21
Trial 6	42,289	-8
Ave.	39,778	5

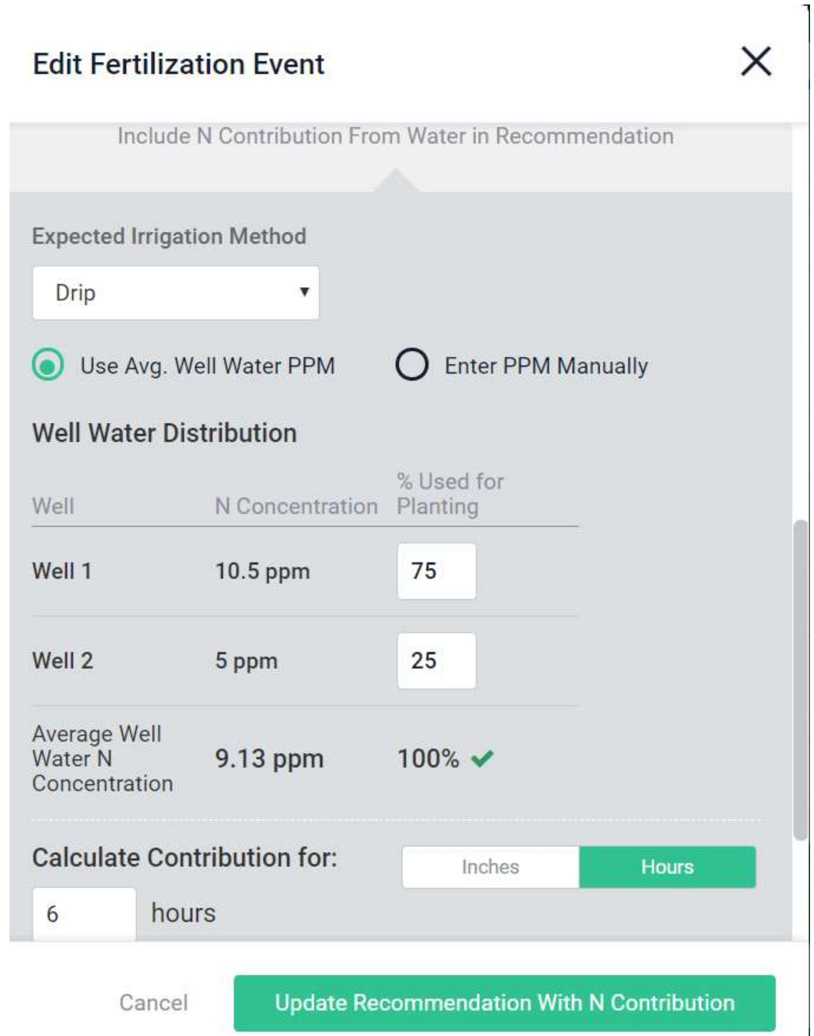
How much fertilizer* could potentially be saved by crediting N in water?



***based on average fertilizer rate of 175 lb N/acre for lettuce**

CropManage can calculate N contribution from irrigation water



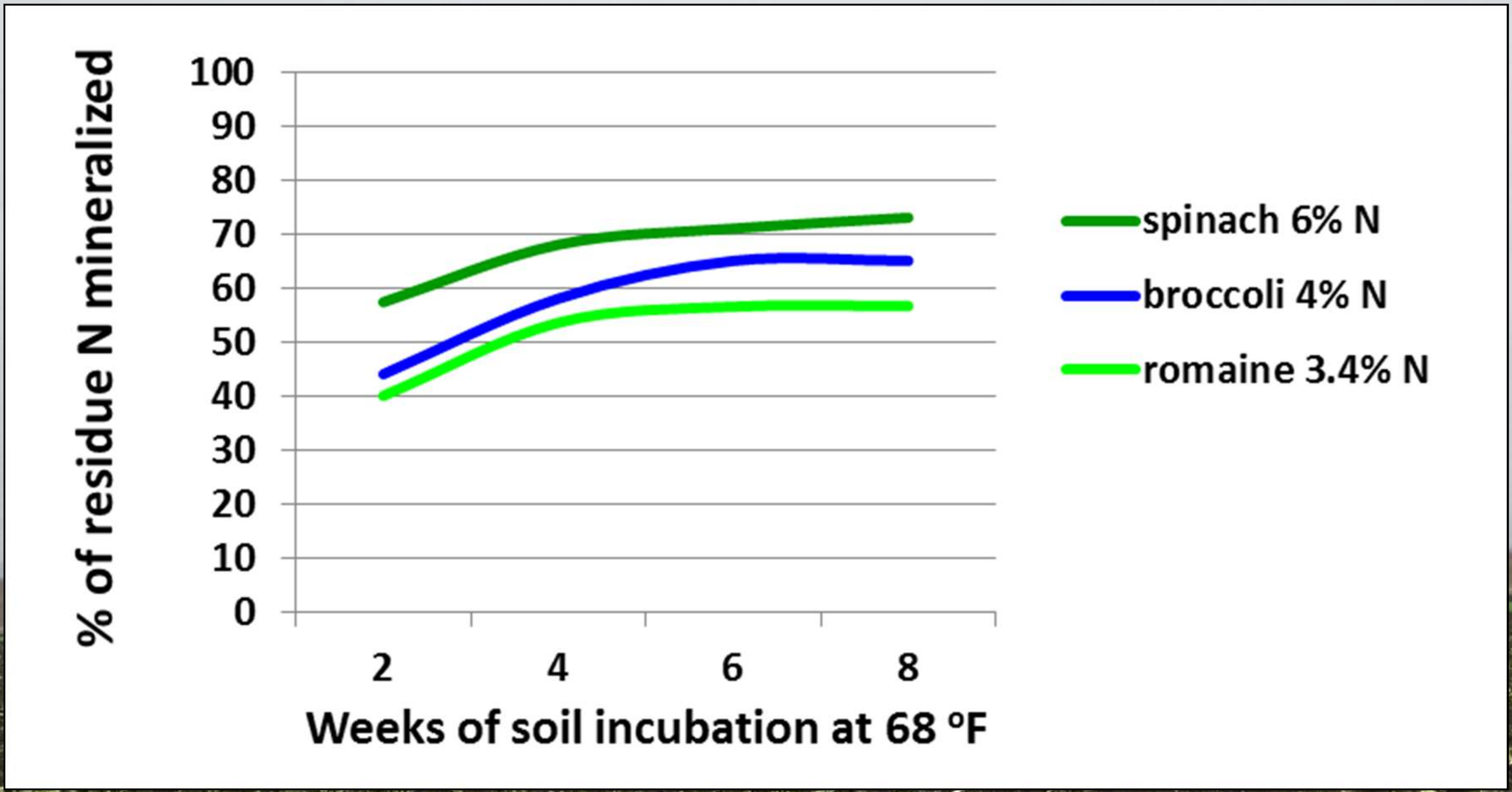


Second Crop – Spring through Fall

- **Substantial residual soil nitrate builds up following the first crop from mineralization of soil organic matter, unused fertilizer N, mineralization of crop residues**
- **As discussed, the residual soil nitrate can be accounted for in fertilizer programs**
- **Scavenging crops capture the pools of nitrate that have moved deeper into the soil profile**

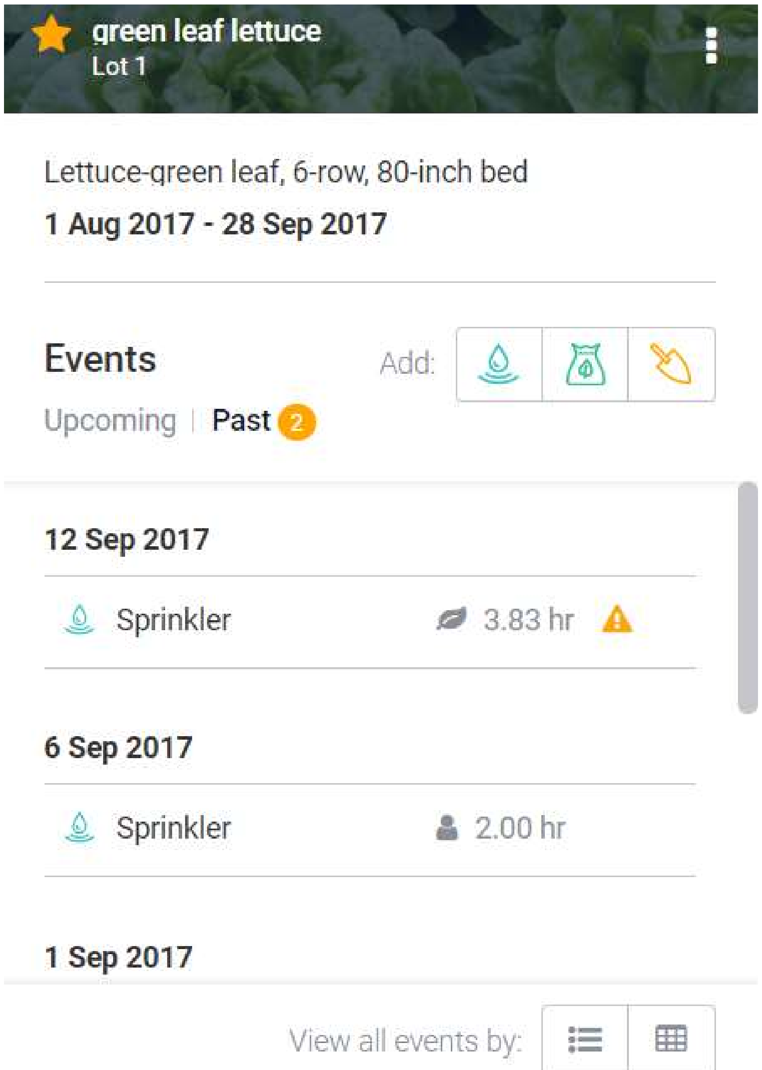
Nitrogen in Crop Residue

Contribution of prior crop residue:



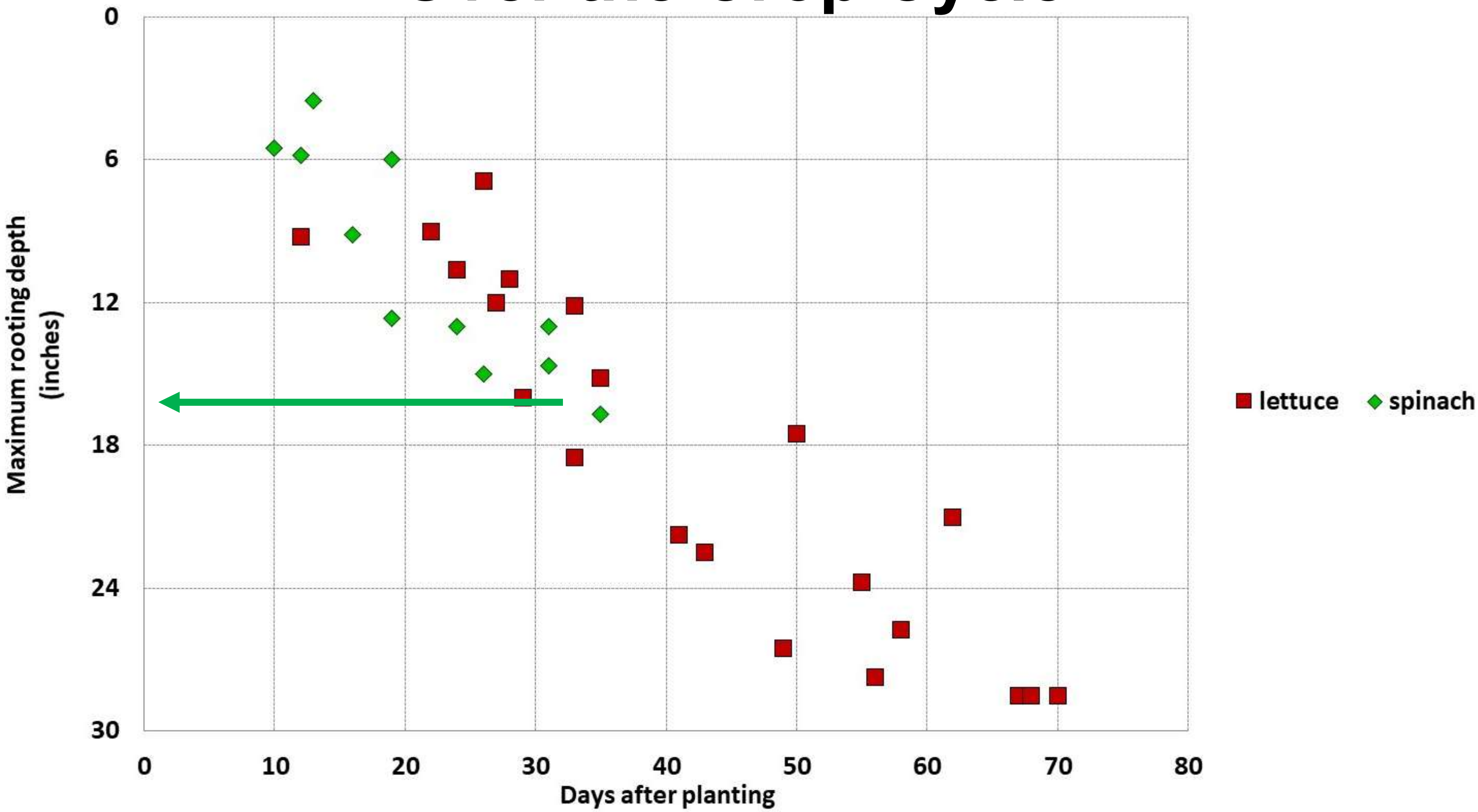
- **Within 4-6 weeks after incorporation, crop residue N mineralization slows down**
- **The contribution of residue to soil N availability can be measured in the soil nitrate test taken before the first fertilization event**

The challenge is to keep the nitrate in the rootzone

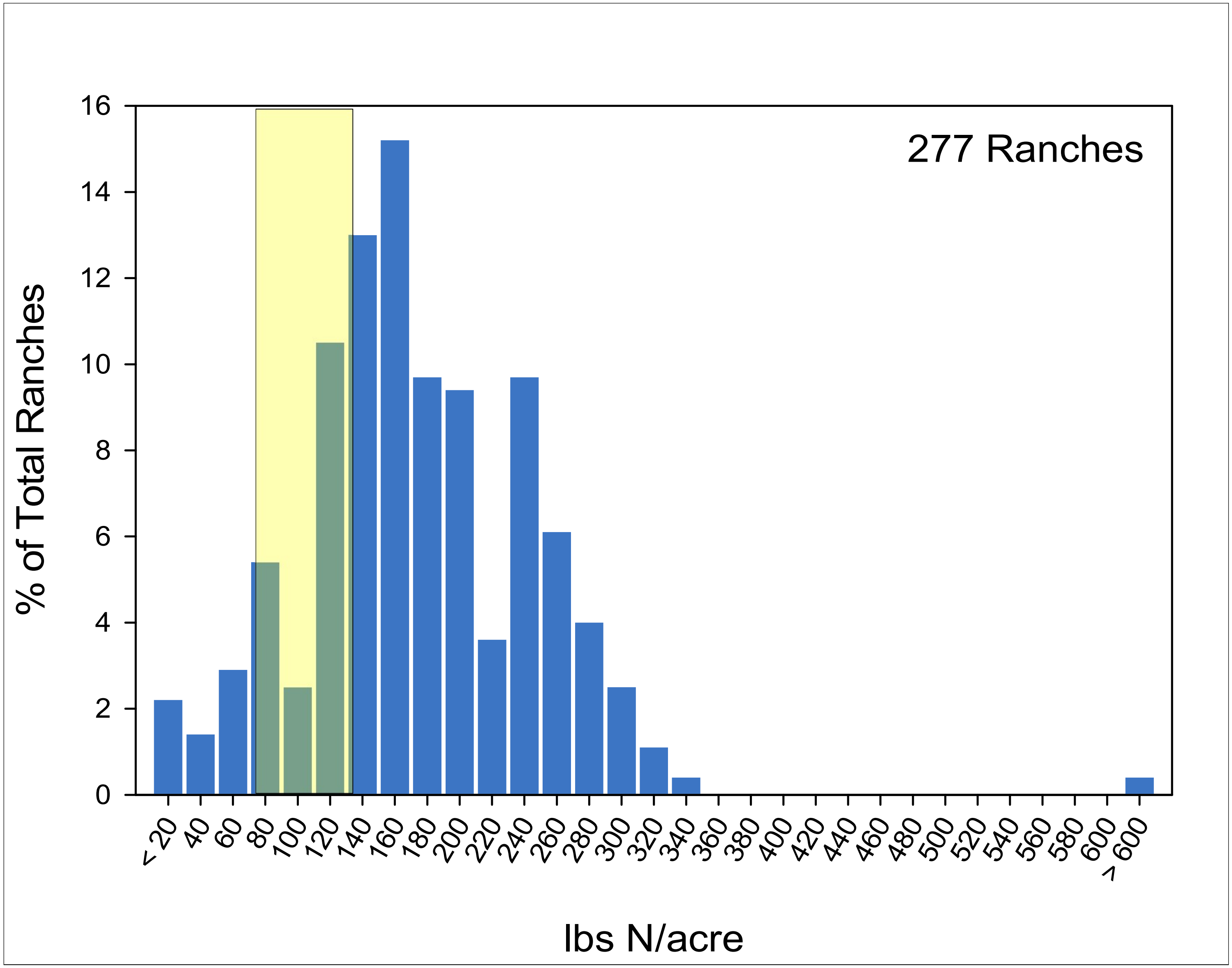


CropManage Uses Weather Based Info to Determine Irrigation Needs

Rooting Depth of Lettuce and Spinach Over the Crop Cycle



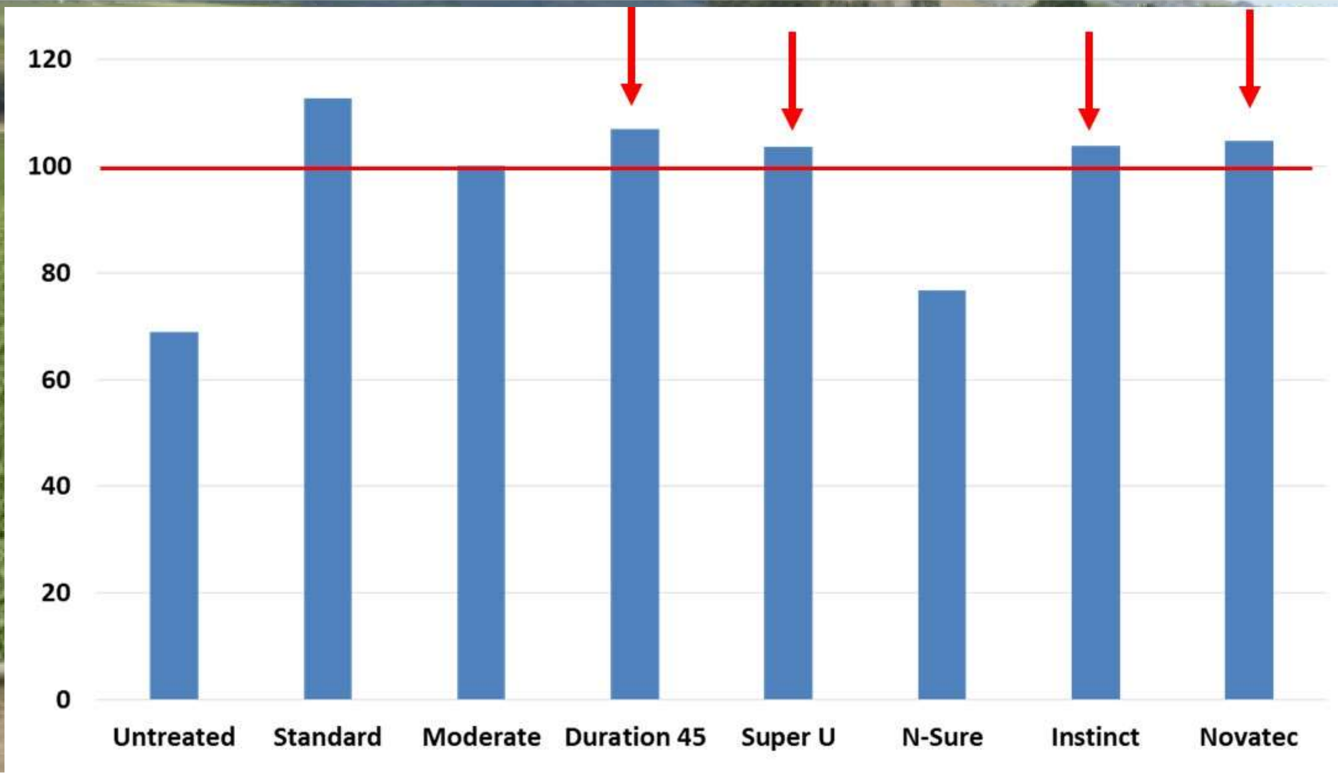
2017 Clipped Spinach



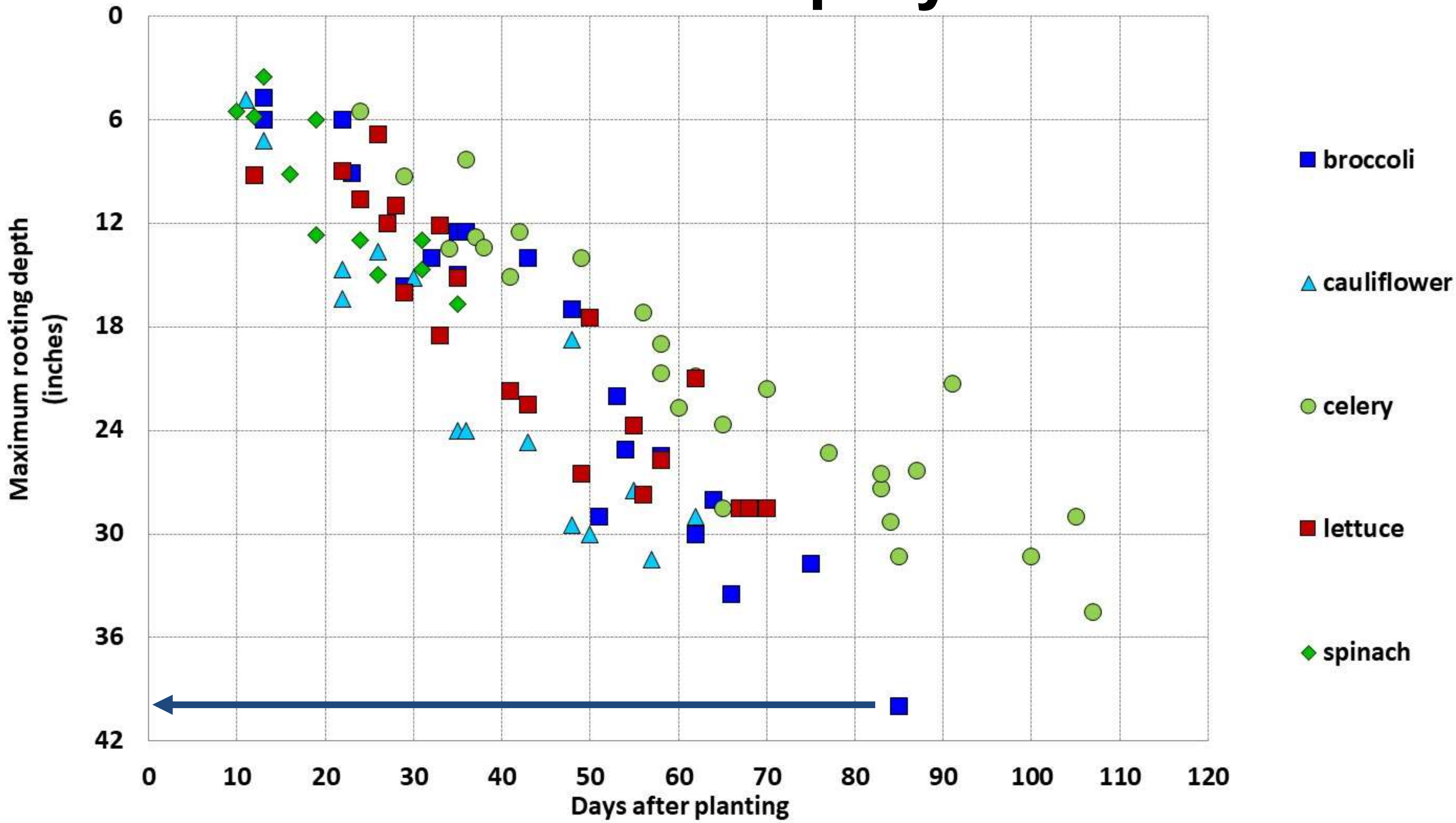
CC Regional Water Quality Control Board Report; Cahn and Qin

High Density Crops with Sprinkler Irrigation

- **Irrigation management is key to improving nitrogen use efficiency**
- **Nitrogen technology can help improve nitrogen use efficiency in spinach**



Rooting Depth of Broccoli and Other Crops Over the Crop Cycle

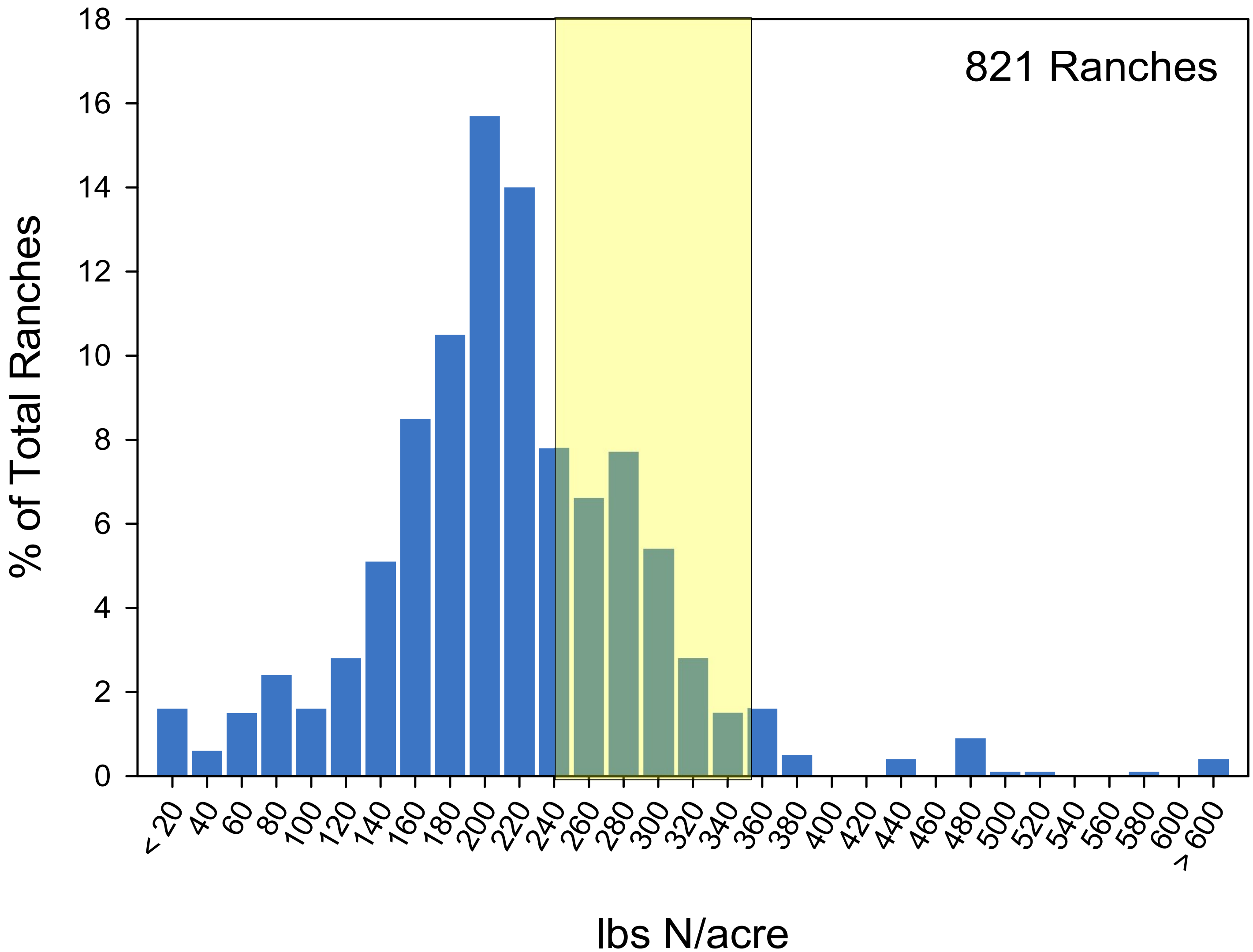


Cole Crops

Summer Production

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

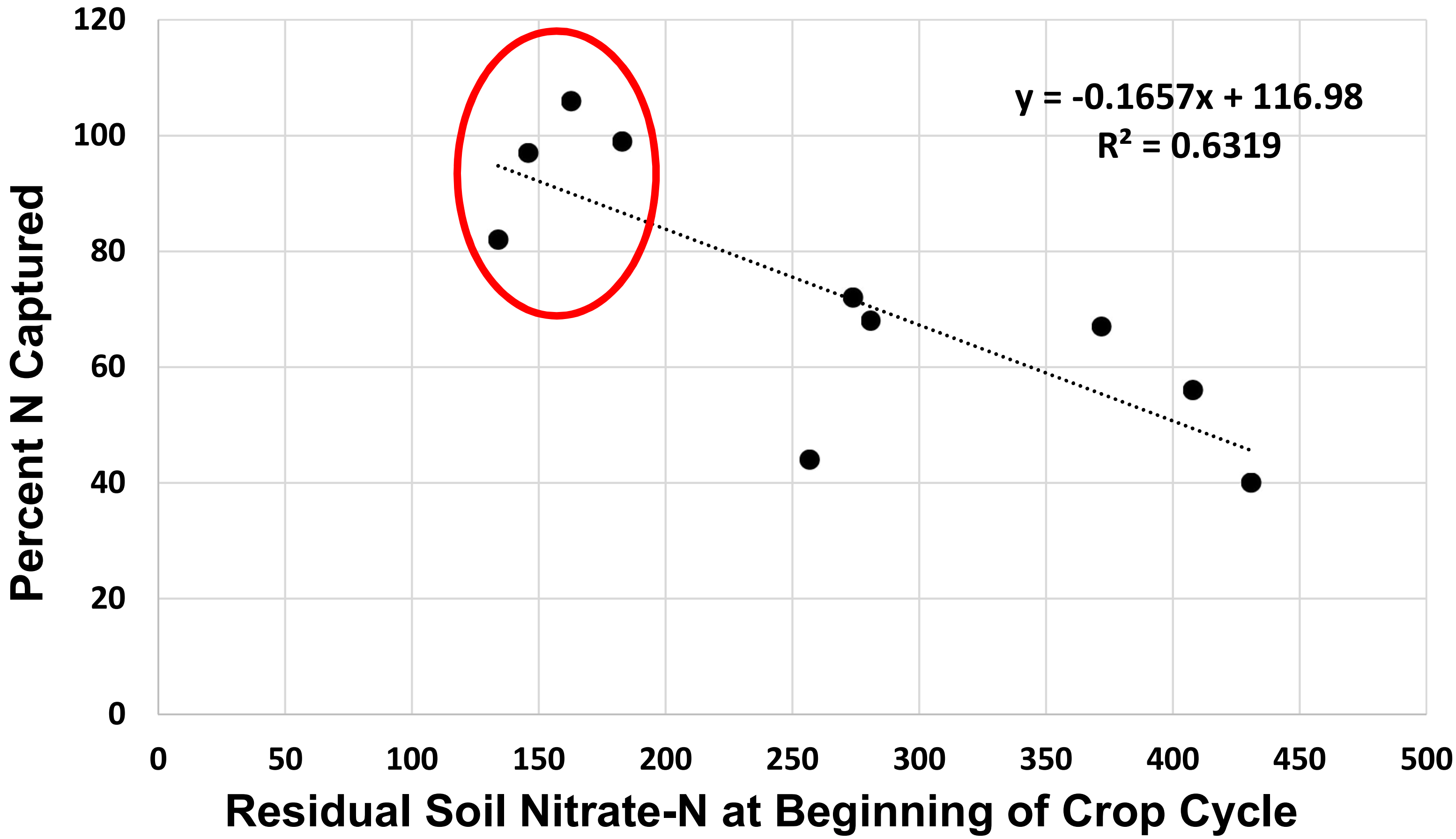
2017 Broccoli



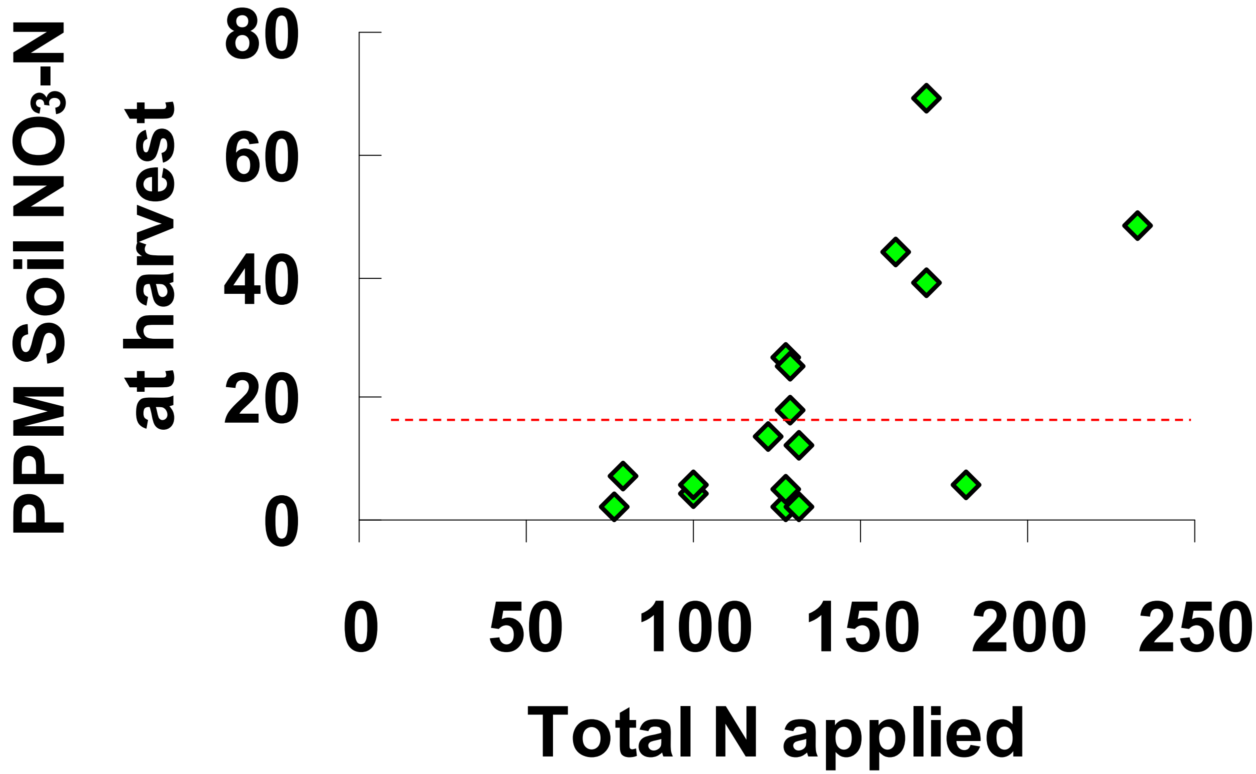
CC Regional Water Quality Control Board Report; Cahn and Qin

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)

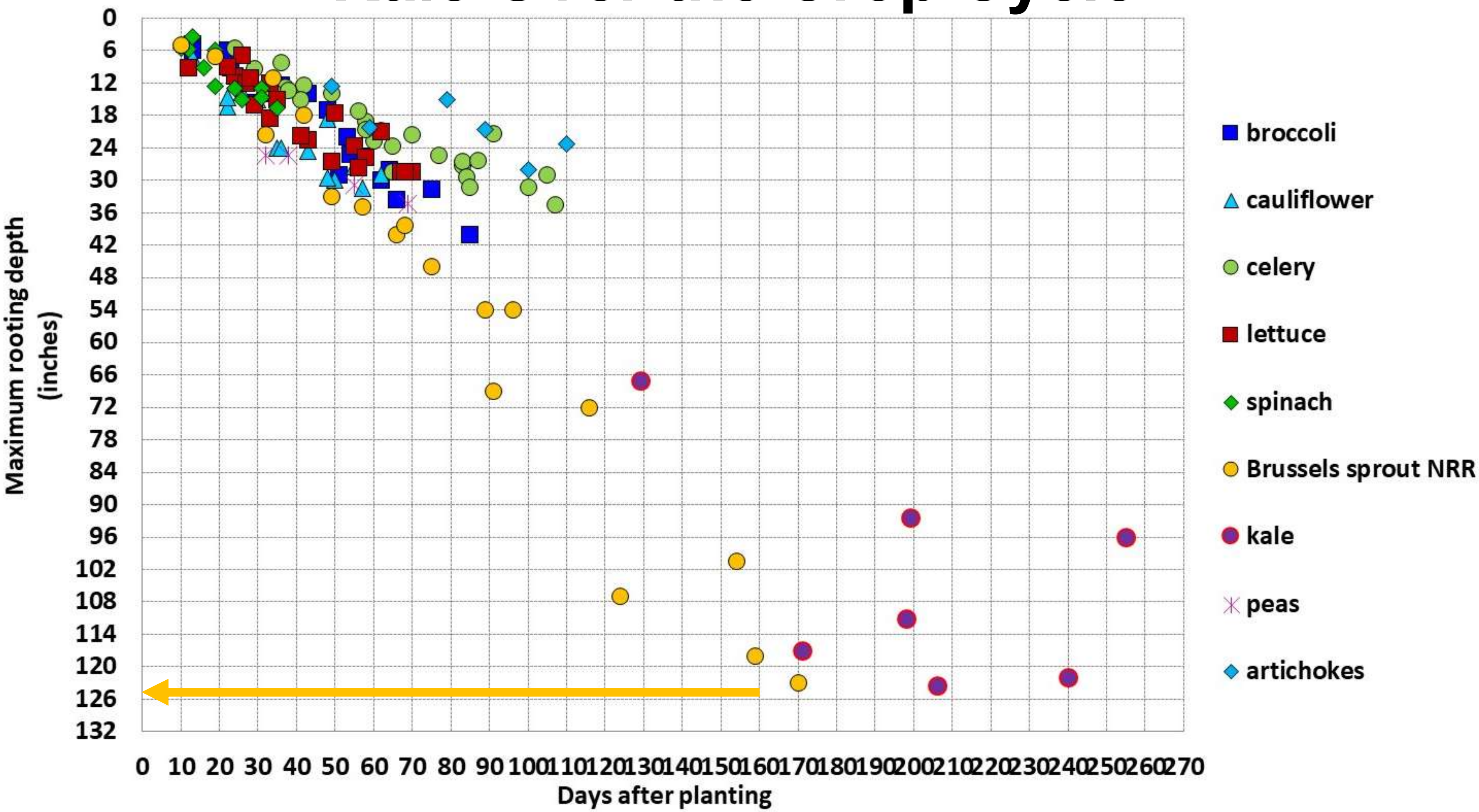


Residual Soil Nitrate At Harvest
18 Successful Lettuce Production Fields



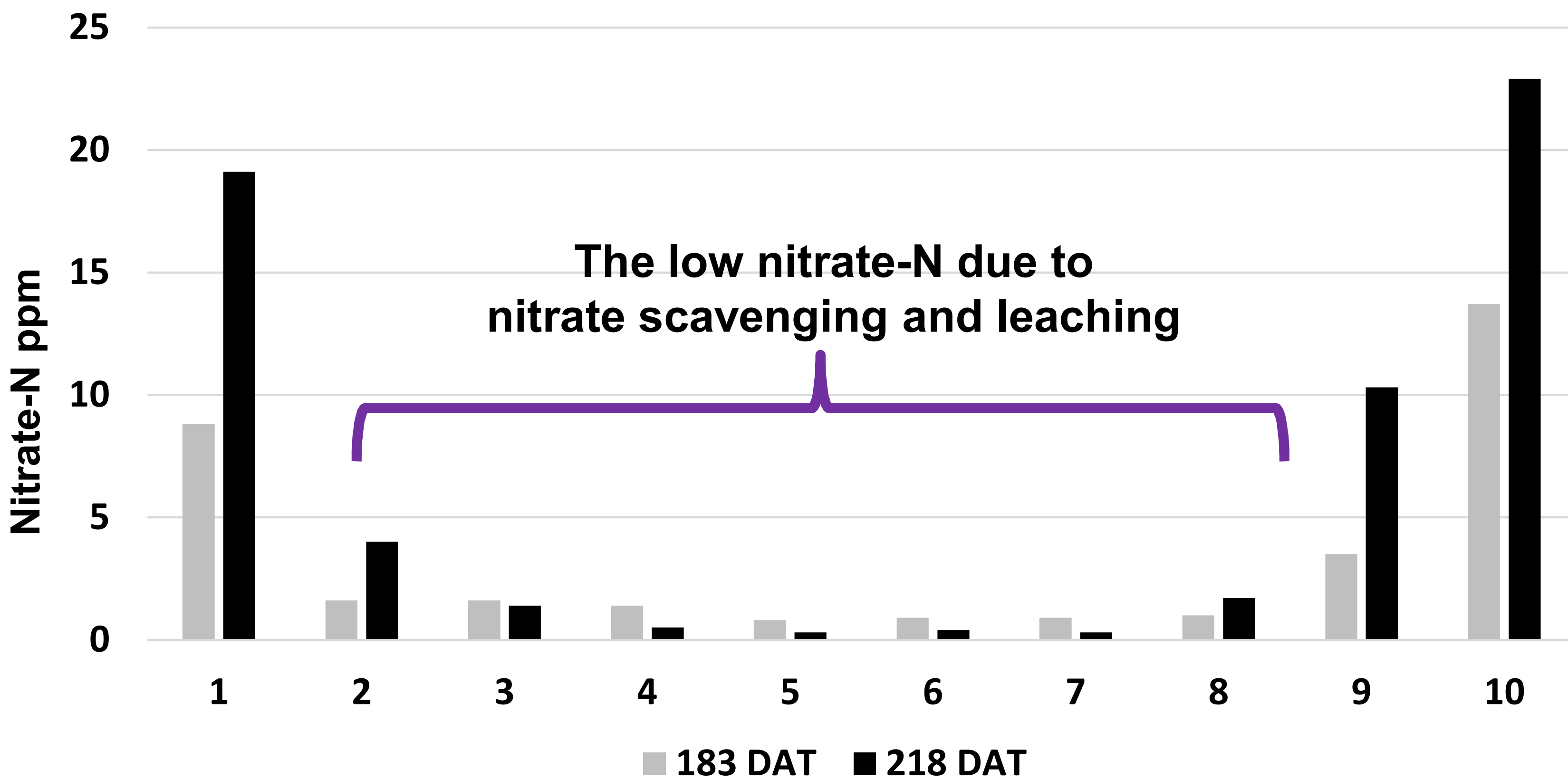
Made possible by utilizing residual and not over loading the soil

Rooting Depth of Brussels Sprouts and Kale Over the Crop Cycle



Curled Leaf Kale 2017

Fertilizer N = 384 lbs; Crop removal = 704 lbs; Scavenged = 320 lbs

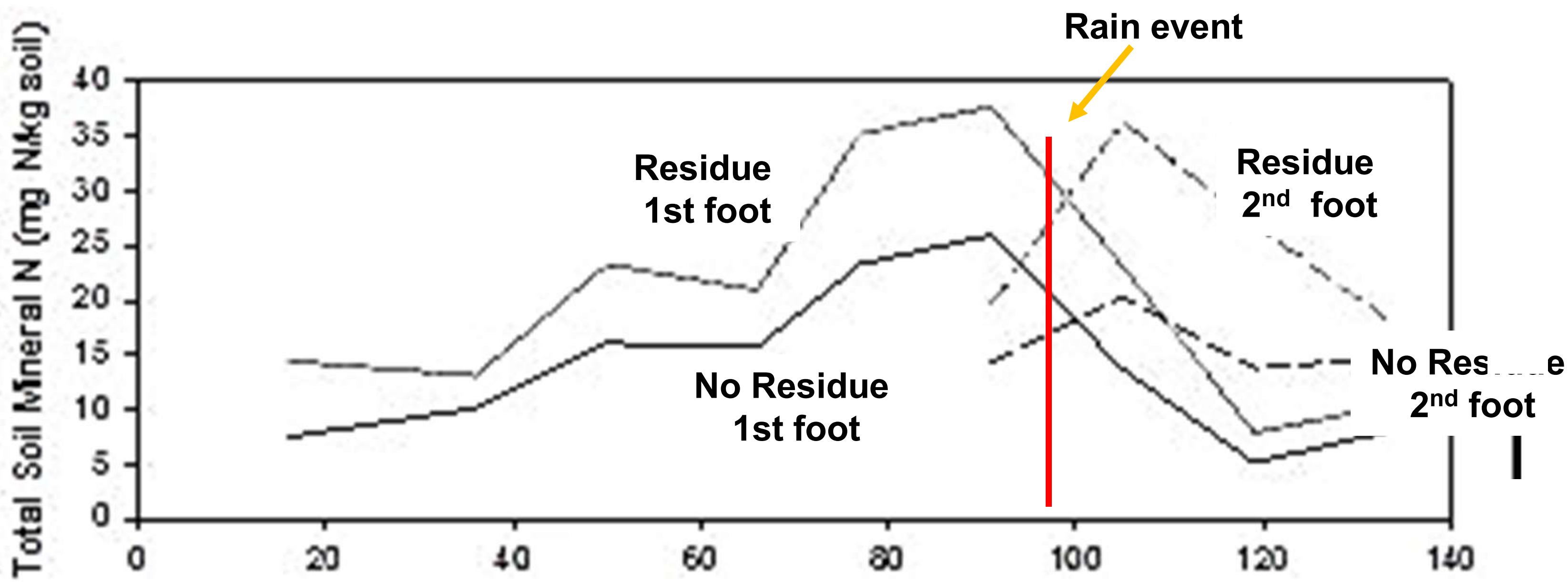


Fall Management of Soil Nitrate Pool

- High residual soil nitrates build up in the fall
- Limitations to the use of cover crops
  - According to CCRWQCB data: 0.5% of acreage is cover cropped
- Use of compost is common
- Can high C:N compost immobilize a useful quantity of N in the fall?

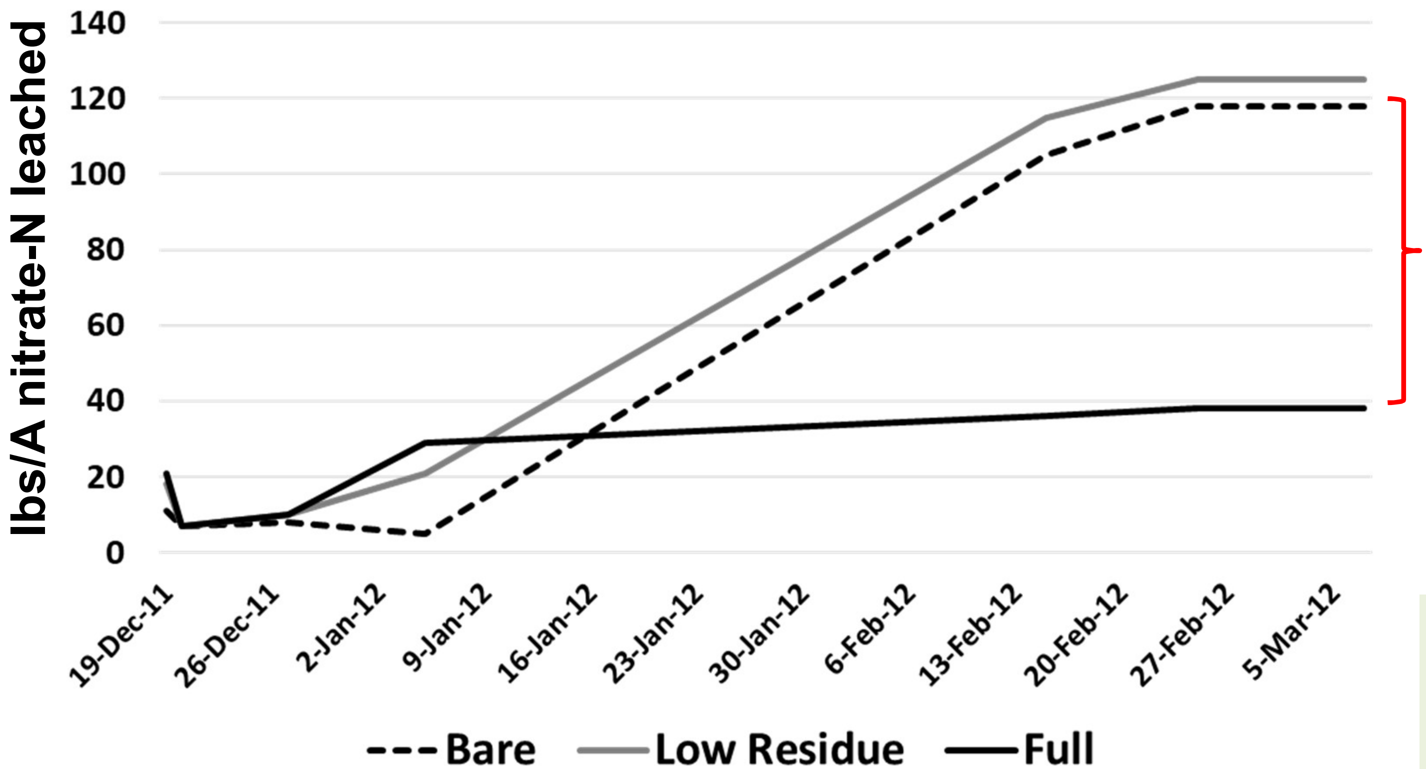
Fate of Nitrogen Mineralized from Broccoli Residue

2014-15 Field Evaluations



Even where there was no broccoli residue, there was significant mineralization of soil organic matter resulting in high levels of soil nitrate-N (25 ppm)

Nitrate Leaching Over Winter
Three Cover Crop Strategies:
Bare Fallow, Low Residue and Full-Term



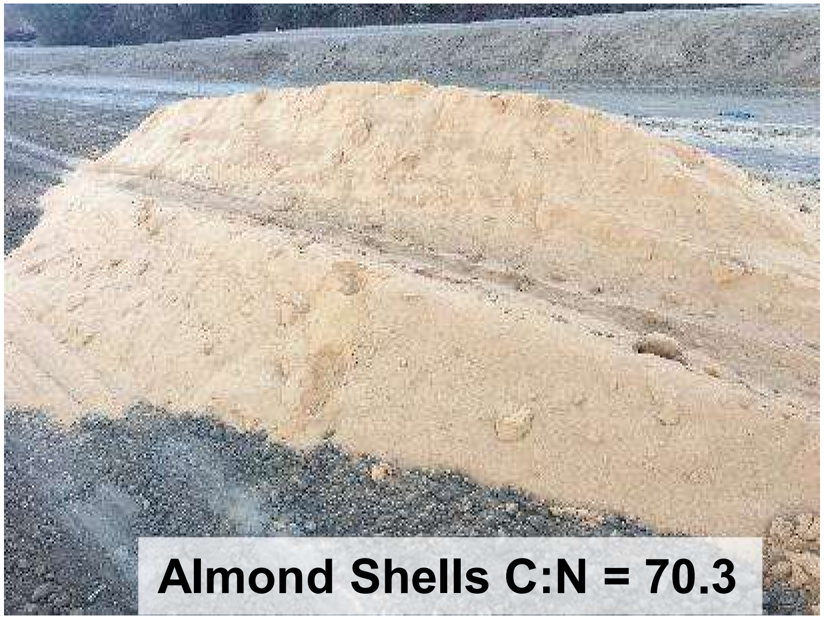
Difference between no cover crop and full term cover crop

Even with a cover crop there was some nitrate loss

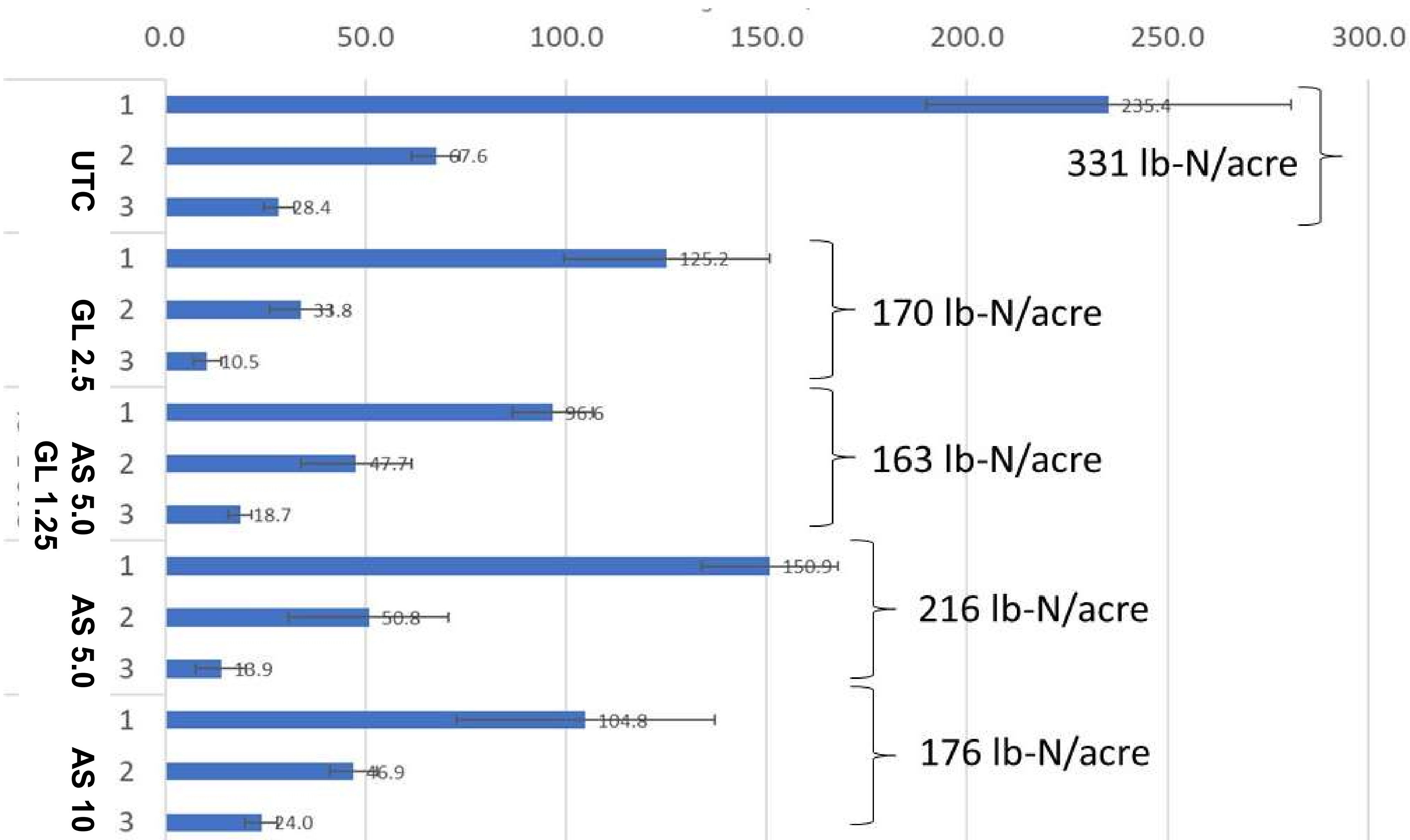
Immobilization of Nitrate

- **The addition of high carbon containing materials such as green waste, straw, sawdust, almond shells, etc can result in the immobilization of nitrate in the soil**
- **Microbes utilize the availability of the labile (available) carbon and use available nitrate for their growth, thereby sequestering the N in their biomass, making it temporarily unavailable for leaching**

2017-18 Trial with Ground Almond Shells



Total Load of Nitrate in Top 3 Feet of Soil



Treatment	Yield Tons/A	Biomass N Lbs/A
Untreated	23.4a	121
5.0 T/A Almond	22.9ab	132
10.0 T/A Almond	14.7c	104
2.5 T/A Glycerol	24.2a	130
5.0 T/A Almond 1.25 T/A Glycerol	21.3b	128

Next Step in Nitrate Immobilization

- Ground almond shells and glycerol work, but are too expensive
- We are looking at using locally source, high C:N compost that might be able to sequester nitrate in the same way
- The challenge will be grinding it effectively

Acknowledgements

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- Keith Day Trucking