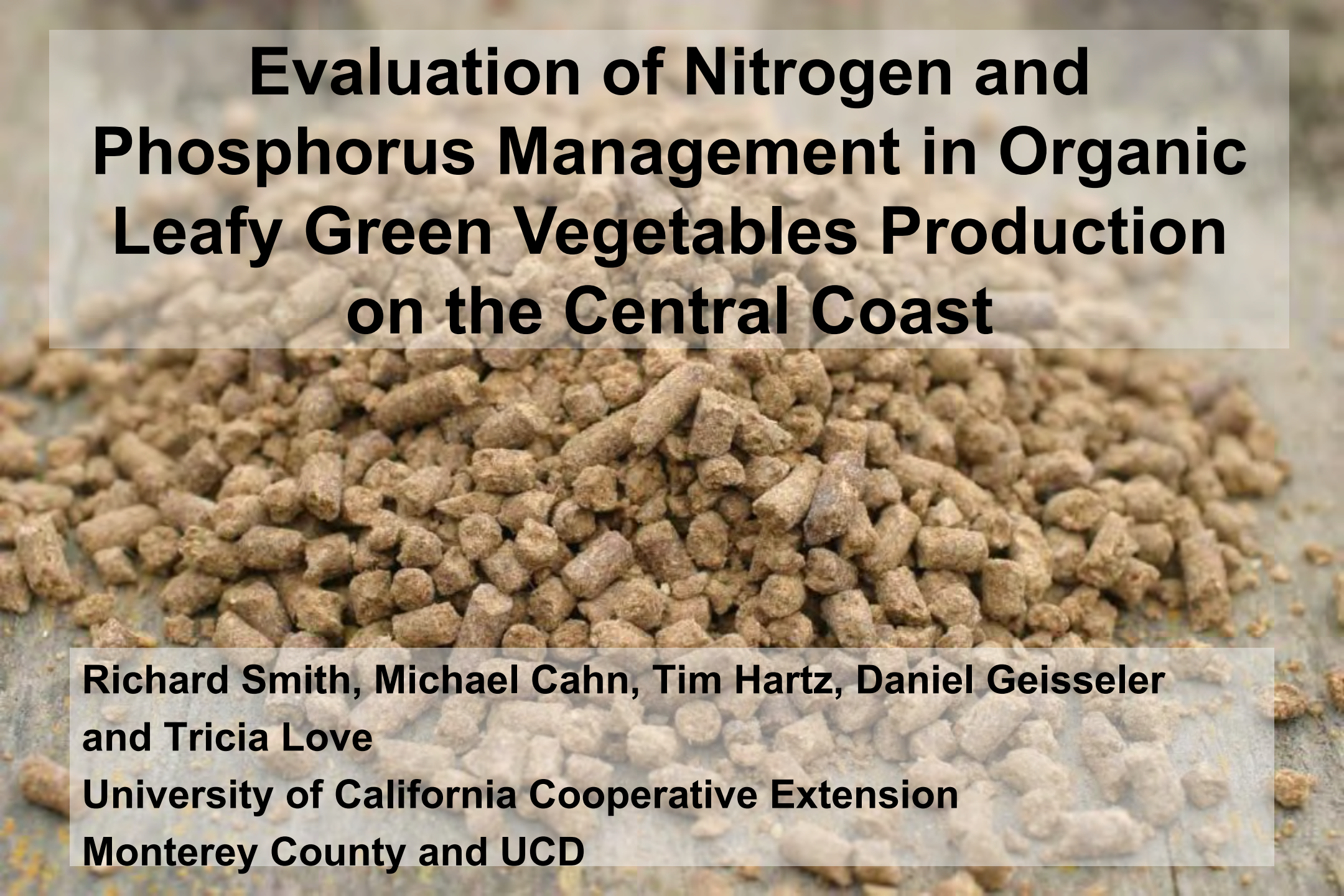
Evaluation of Nitrogen and Phosphorus Management in Organic Leafy Green Vegetables Production on the Central Coast



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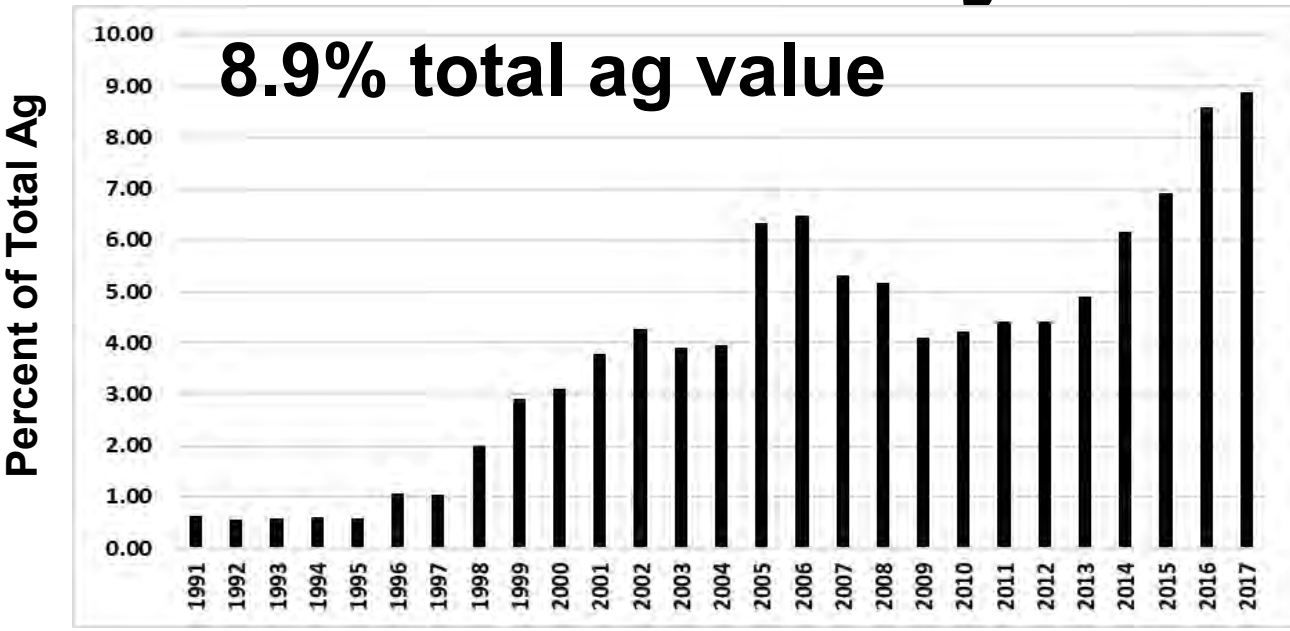
Organic vegetable Production in Monterey County



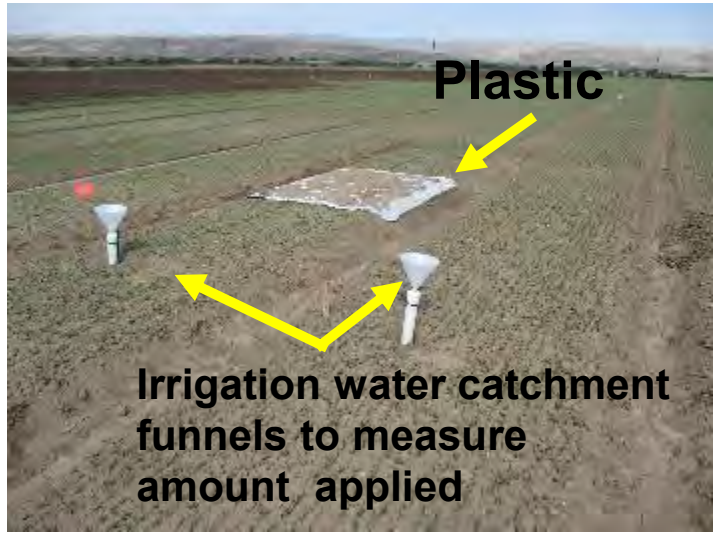
Objectives

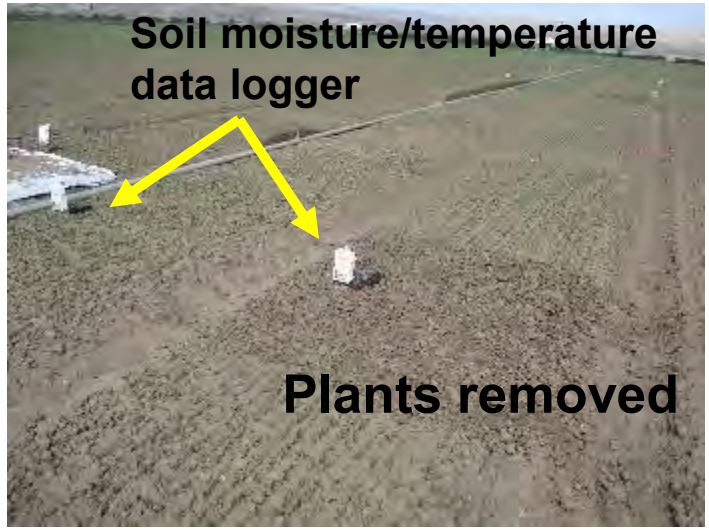
- **Demonstrate and evaluate the proportion of crop N needs that are provided by soil organic matter mineralization in organic leafy vegetable production under coastal climate conditions**
- **Demonstrate and evaluate mineralization behavior of a group of commonly used dry and liquid organic fertilizers under field conditions on the Central Coast**
- **Demonstrate and evaluate the N and P balance of organic production fields (N and P inputs, mineralization and removal)**
- **Refine and update algorithms of nitrate mineralization from soil organic matter in CropManage**

In-field Soil Organic Matter Mineralization Evaluations

- 20 evaluations were conducted with cooperating growers in commercial vegetable production fields
  - High density:
    - baby lettuce and spinach
  - Full term:
    - romaine and broccoli
- Replicated fertilized and non-fertilized plots were established in each field

In-field Soil Organic Matter Mineralization Evaluations





- **In each unfertilized plot subplots included:**
  1. **Plants present**
     - **Estimate of soil N mineralized, plant removal, leaching**
  2. **No plants**
     - **Estimate of soil N mineralized, no plant removal, leaching**
  3. **No plants, covered with plastic**
     - **Estimate of soil N mineralized, no plant removal, no leaching**

Range of Soil Characteristics of Survey Sites

pH	7.3 – 8.2
Total N	0.05 – 0.18*
Organic Matter	0.64 – 4.13
Olsen P	10.2 – 111.8
Clay percent	5.6 - 53.3

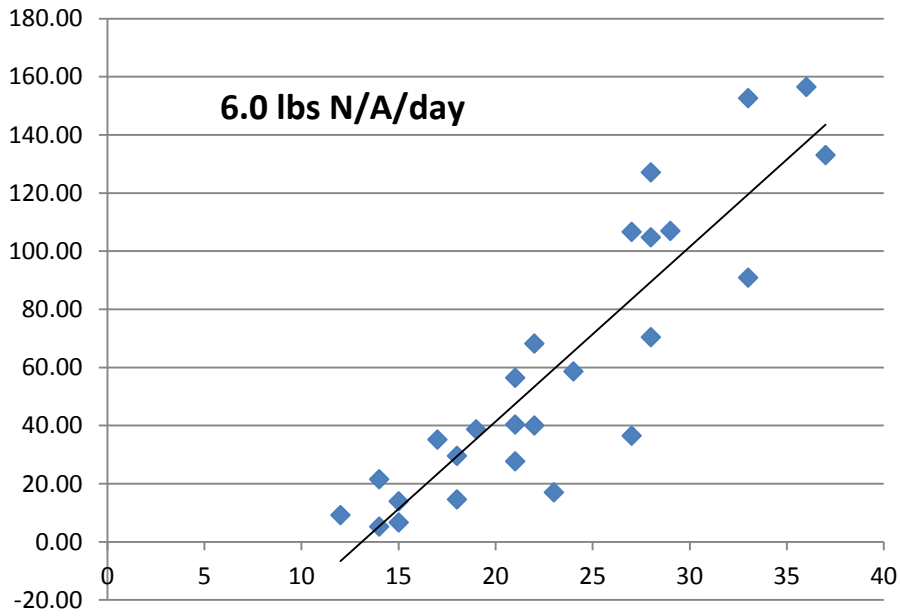
* a change of 0.01 = 380 lbs of N/A

Summary of In-Field Nitrogen Mineralization Evaluations

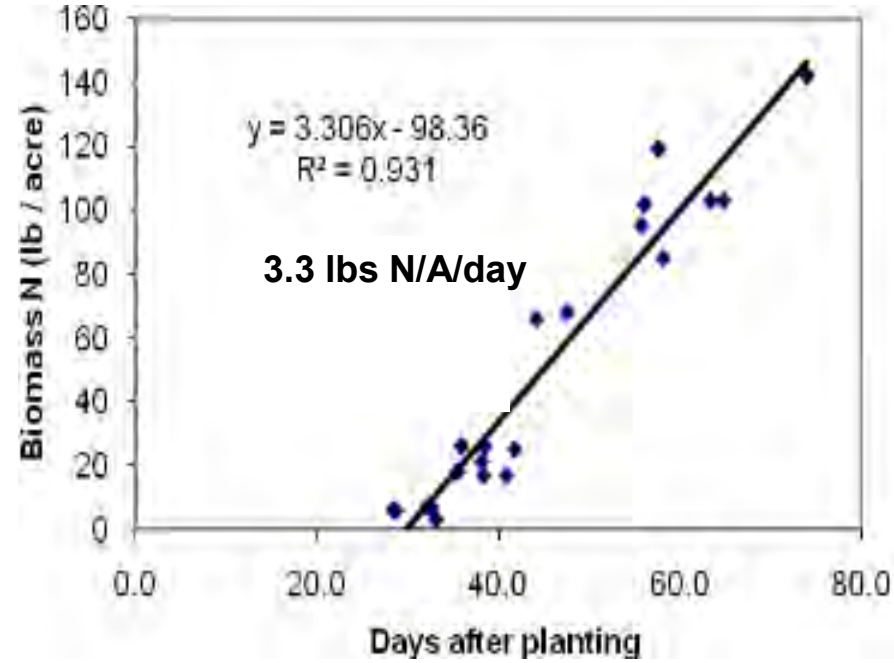
- Estimates of N mineralization from the soil over the cropping cycle ranged from 0.3 to 3.3 lbs N/A/day; average = 1.6 lbs N/A/day
- Laboratory estimates ranged from 0.3 to 1.9 lbs N/A/day; average = 0.5 lbs N/A/day
- R^2 = 0.08 between the two estimates
  - Core collection issues in 2016; moisture conditions between lab and field varied; incubation temperatures varied; difficulties avoiding crop residue in production fields

Effect of Nitrogen Fertilization

- **The yield of vegetables was improved by fertilization in 17 of the 20 field evaluations**



Spinach

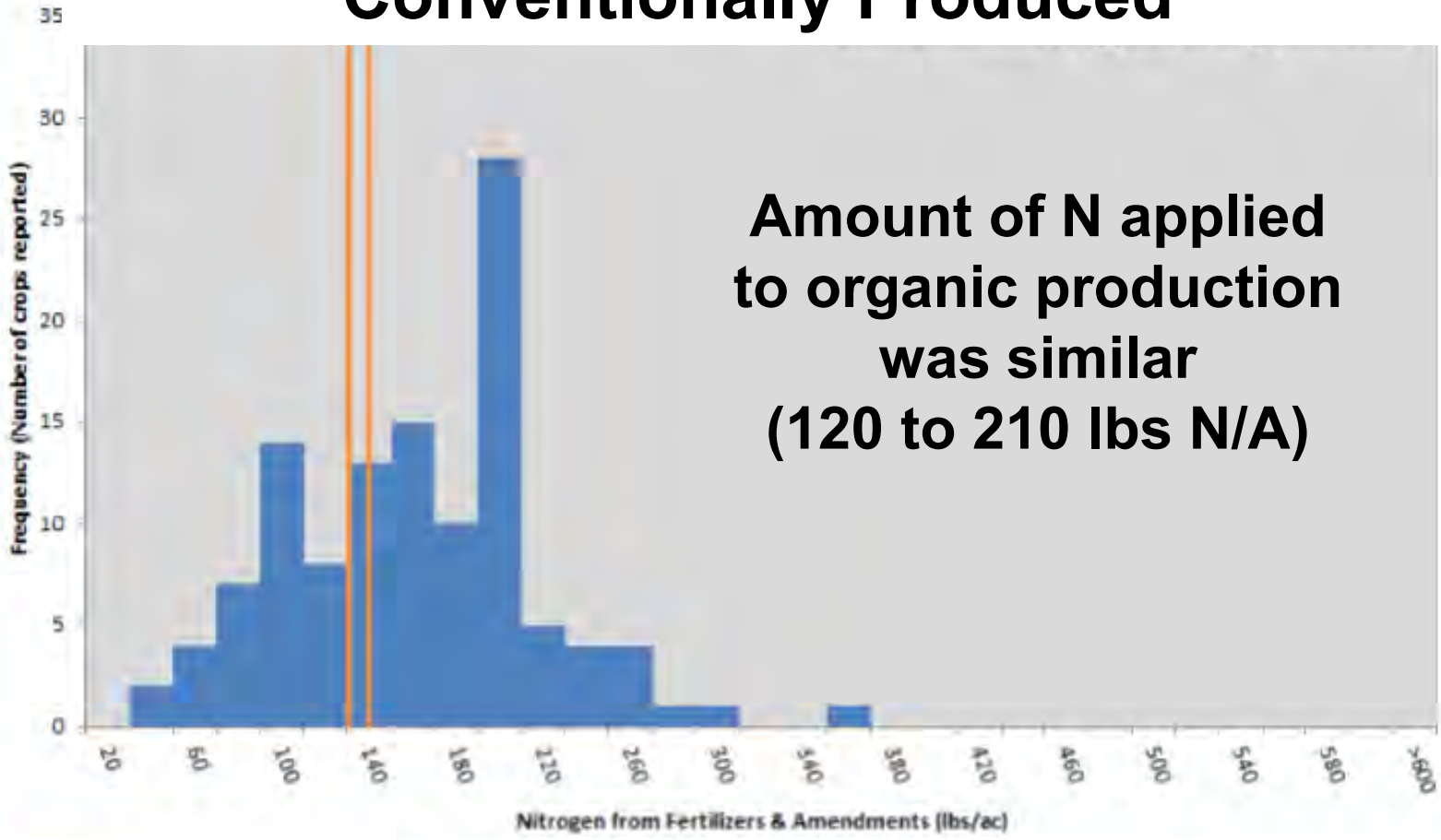


Lettuce

Grower Reported N from Fertilizers

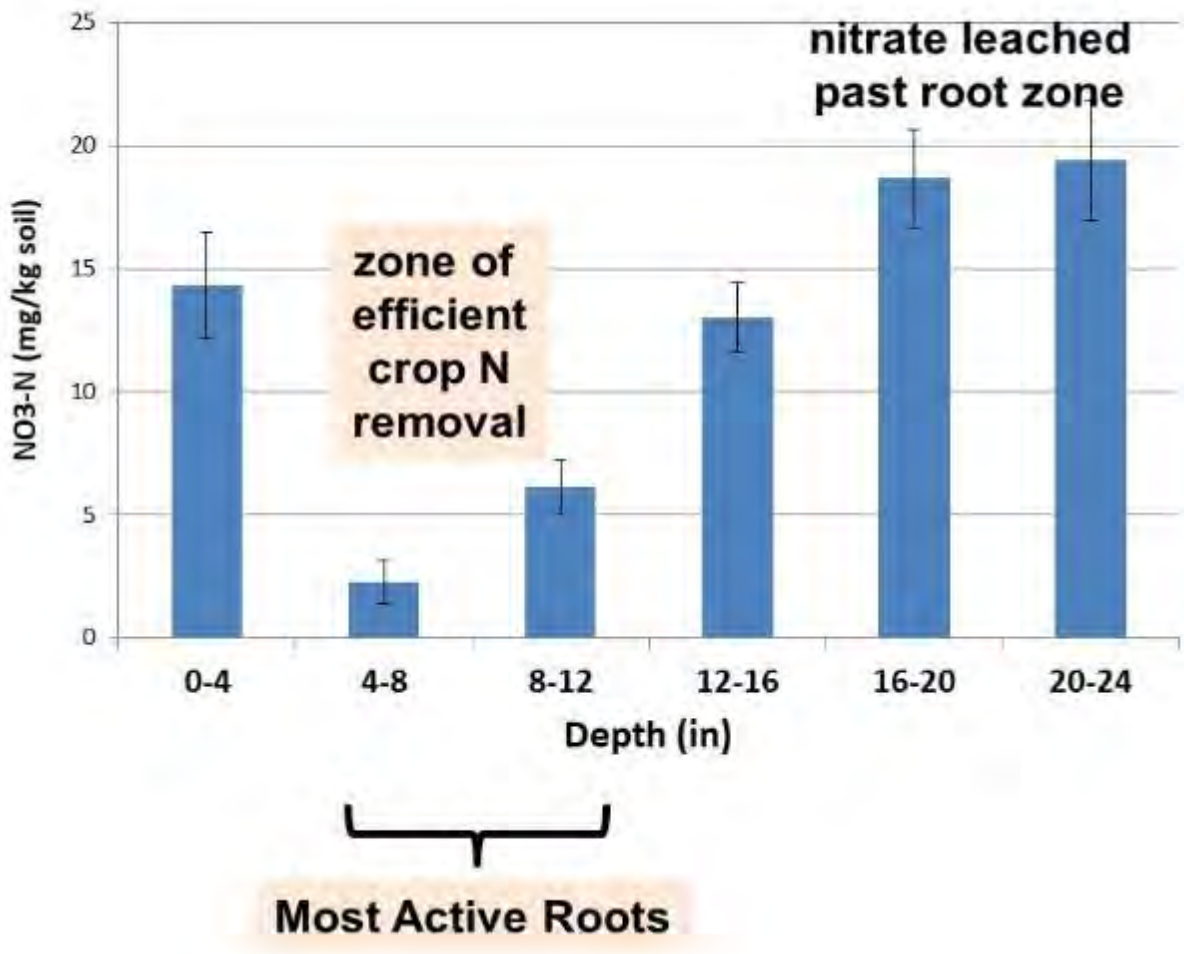
(117 Crop Records) Compared to Specific Crop Nitrogen Uptake

Spinach Fertilizer N Applications 2015 Conventionally Produced



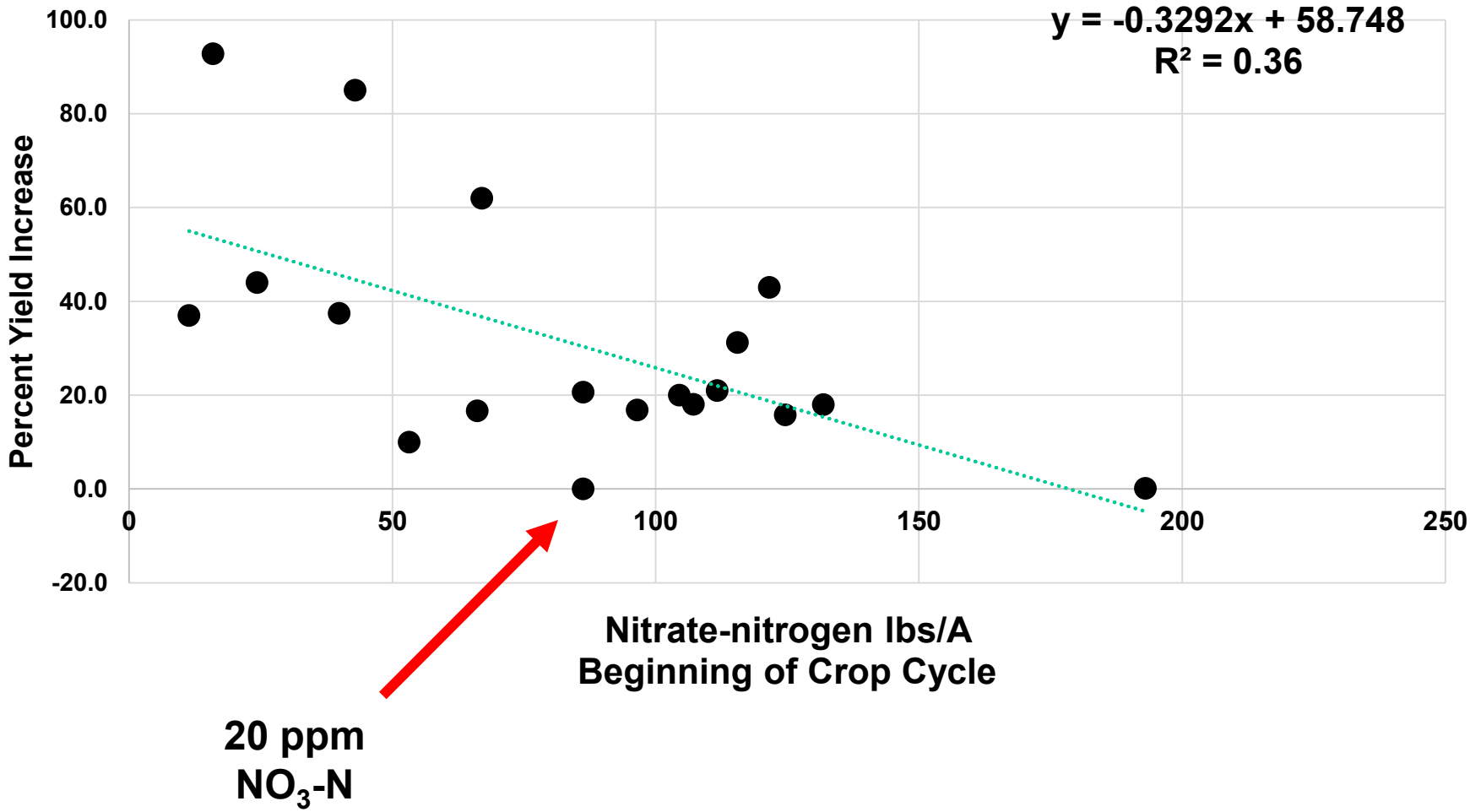
Amount of N applied to organic production was similar (120 to 210 lbs N/A)

Rooting Depth and Impact on Nitrogen Uptake

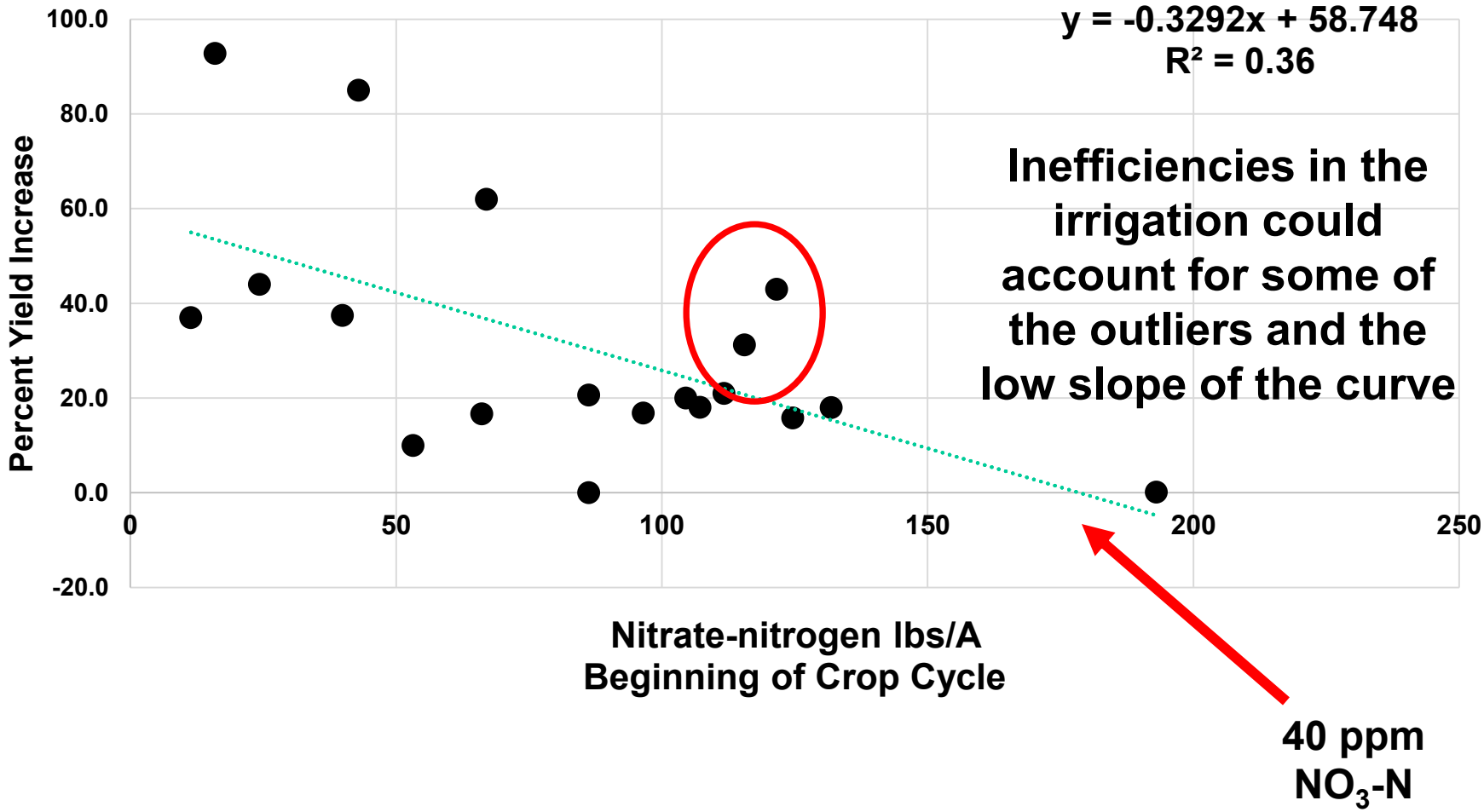


The shallow nature of the rooting zone makes irrigation management very important for keeping nitrate at the depth in the soil where roots can reach it

Residual Soil Nitrate-N and Percent Yield Increase with Fertilization



Residual Soil Nitrate-N and Percent Yield Increase with Fertilization



Soil Mineralization Summary

- Nitrate mineralization from soil organic matter generally cannot provide sufficient N for fast-growing leafy greens
- Measurements of residual soil nitrate-N at the beginning of the crop cycle can give an indication of the need for fertilization of the crop
- Because of the lag in the release of N from organic fertilizer, the beginning of the crop cycle is the best time for adjusting fertilizer applications for crops like spinach

In-field Fertilizer Mineralization Studies

Polypropylene Pouches with Fertilizer

- Pouches with fertilizer were placed into the soil at the beginning of the crop cycle
- 4-4-2 (blend of chicken manure, bone and meat meals) & 12-0-0 (feather meal)
- Pouches were buried & placed on soil surface to simulate application methods

In-field Fertilizer Mineralization Studies

Buried in soil

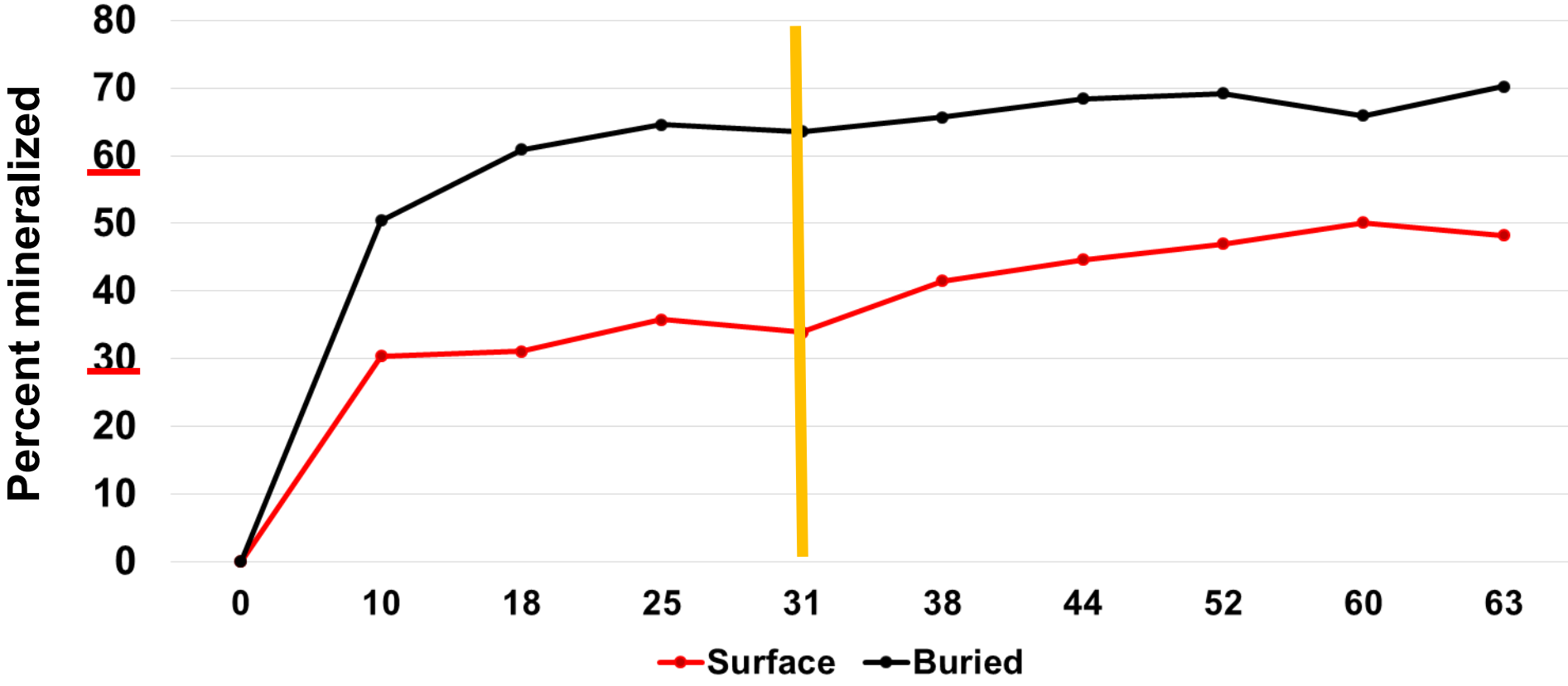
Place on top of soil

4 pouches collected weekly and analyzed for N, P & K over the crop cycle of lettuce or spinach

4-4-2

Percent N Mineralized from Pouches

Buried vs Surface 2016

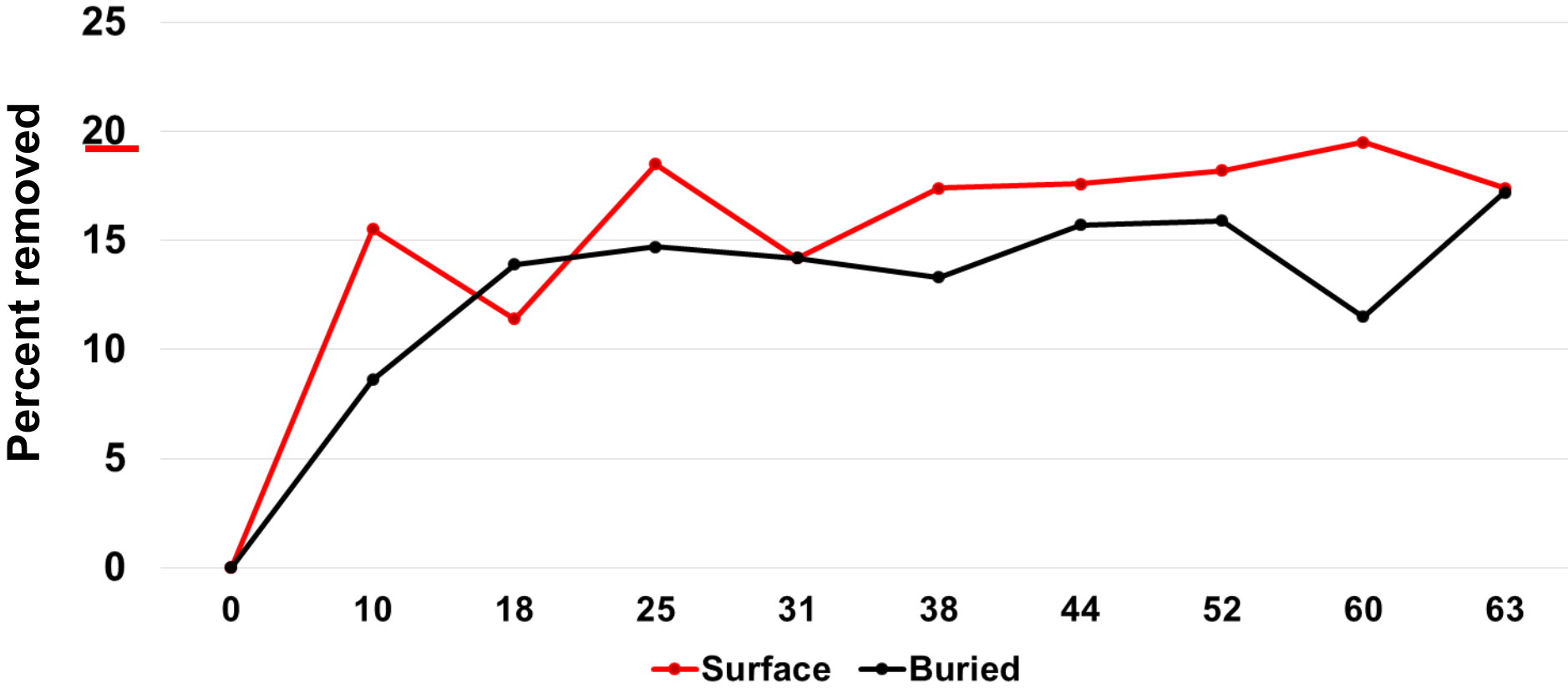


Days after Planting Lettuce

4-4-2

Percent Phosphorus Removed from Pouches

Buried vs Surface 2016

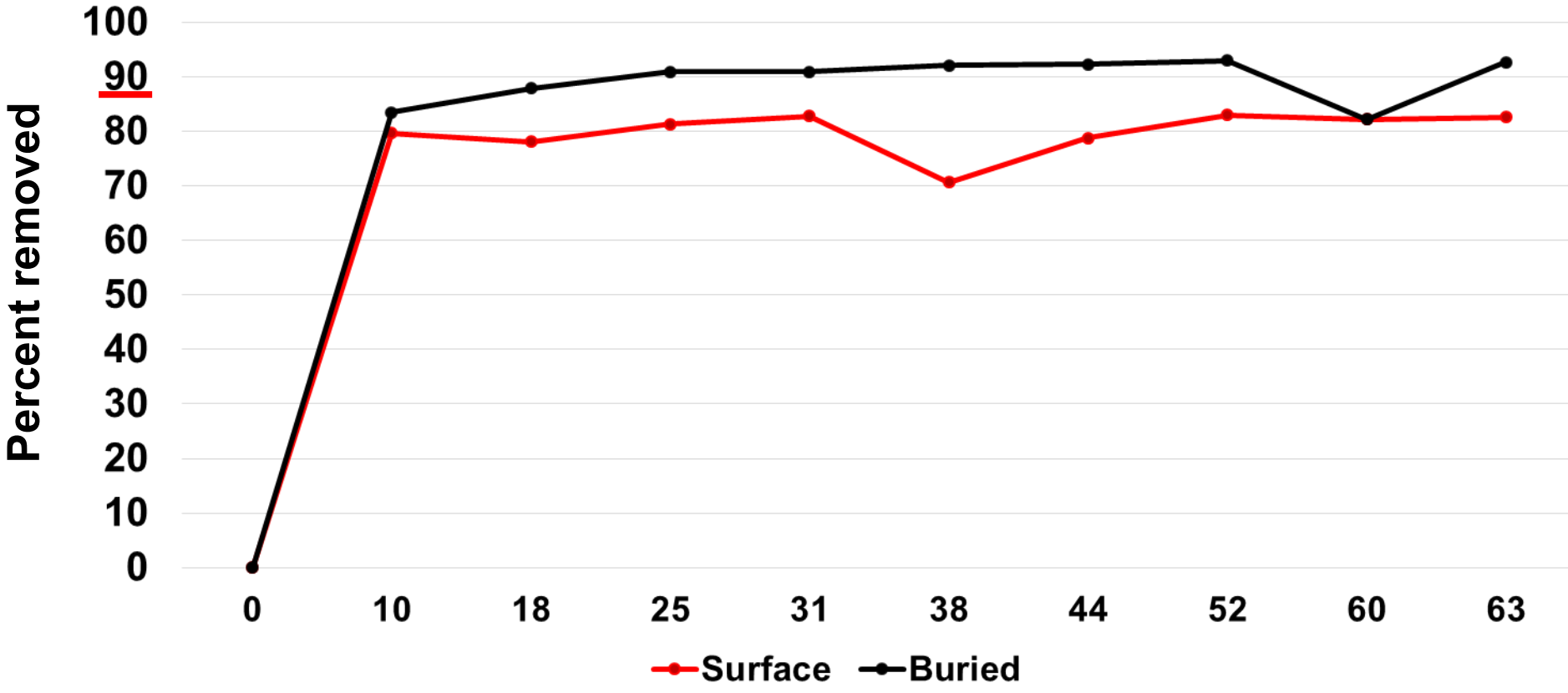


Days after Planting Lettuce

4-4-2

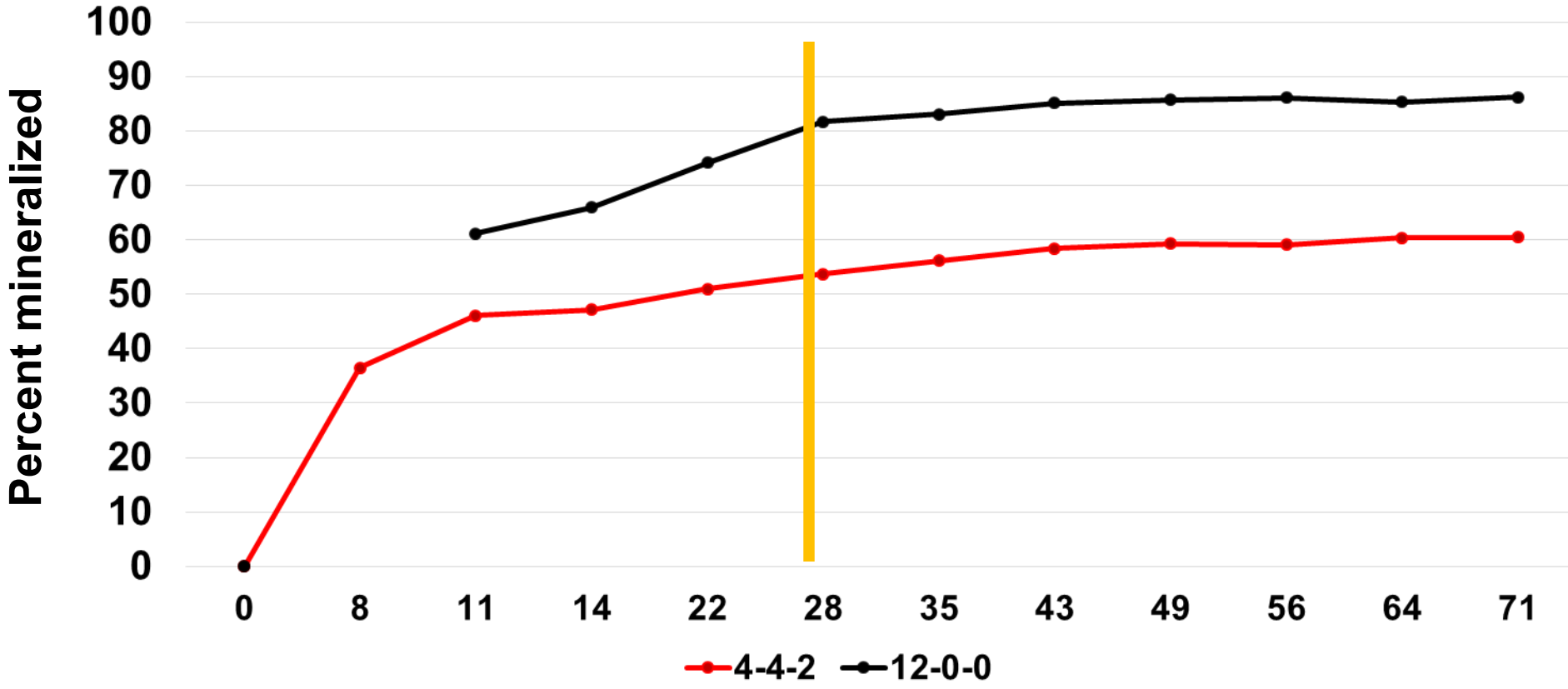
Percent Potassium Removed from Pouches

Buried vs Surface 2016



Days after Planting Lettuce

Buried 4-4-2 vs 12-0-0
Percent N Mineralized from Pouches



Days after Planting Lettuce

Summary of Pouch Evaluations Buried vs Surface

- **Placement of the material affects the speed of mineralization of N and may affect the rate of material needed for optimal growth**
- **Given soil pH's in these evaluations (7.3-8.2), the phosphorus in 4-4-2 that comes from bone meal, is not available to the crop and remains in the soil as an insoluble mineral**

Laboratory Incubations of Fertilizer Materials

Percent N Mineralized

Material	2 weeks	4 weeks	8 weeks
2.5-2.0-2.5	4.0	5.8	13.6
4-4-2	28.8	30.5	37.5
8-5-1	47.2	43.5	58.5
10-5-2	43.8	49.3	58.8
12-0-0	48.7	56.5	59.3

Lab evaluations generally had lower levels of N mineralization and it may be because they don't have issues with loss of material from the pouches

Fate of Unused Applied N

- Double or triple cropping may be leaving a significant amount of N from the unmineralized fertilizer in the soil
- What is the fate of this N?
- It is recalcitrant and adds to total N in the soil and probably continues to slowly mineralize
- In a survey of 20 pairs of organic and conventional fields we did not detect a build up of total N in organically managed fields
- However, soil microbial activity was higher in organic fields

Comparison of 20 Pairs of Conventional and Organic Fields

Soil Constituent	Conventional	Organic
Organic Matter %	2.0	2.1
Total Nitrogen %	0.12	0.12
Total Carbon %	1.01	1.03
Phosphorous (Olsen) ppm	37	42
Phosphorous (Total) ppm	0.10	0.09

Organic Fertilizer Programs

- **The amount of N applied to the crops ranged from 1.2 to 5.7 times N uptake**
  - **A:U (crop uptake, not R – removal)**
- **54 – 70% of N in 4-4-2 mineralized over 60 days (2016 and 2017, respectively)**
- **Taking into account N mineralized from organic fertilizer over the crop cycle, the amount applied to crop uptake ranged from 0.4 to 2.8 times N uptake**

Water Quality Implications For Organic Fertilizer

- In Ag Order 4.0, the A/R regulations may have implications for organic production, if a percent of the applied fertilizer N is recalcitrant and not a leaching hazard
- Data from this project indicates that water quality regulations affecting organic production will need to take into account actual mineralization

Management Considerations

- **Incorporated applications of organic fertilizers released a higher percentage of N and faster than top dress applications**
- **Higher analysis fertilizers released a higher percentage of N and faster than lower analysis materials**

Management Considerations

- High density, baby vegetables only have two opportunities for applying N (preplant at 2 weeks after the first germ water)
- Preplant tests of nitrate can be useful prior to planting and that is a key time to adjust fertilizer applications
- Adjustments would probably be rather coarse given the issues of inertia, lag times in N release, etc.

Management Considerations

- **Currently, the use of preplant testing for nitrate is not common in organic production**
- **There is a need for further fertilizer rate trials to fine tune the knowledge base on supplemental N applications and to apply the use of nitrate testing in organic production**

Organic Soil Fertility Short-Course
February 12, 2019

UNIVERISTY OF CALIFORNIA

Organic Soil Fertility for Vegetables and Strawberries

University of California Short Course
Tuesday, February 12, 2019 - 8 AM - 4:30 PM
Agricultural Center Conference Room, Salinas, CA

This short course will focus on the practical aspects of organic soil fertility management for fast-maturing leafy green vegetables and long-season strawberry production .

TOPICS covered include - understanding the contribution of the various sources of nitrogen for crop production including mineralization from soil organic matter, release of inorganic nitrogen from organic fertilizers and composts, and the contribution of prior crop residues, cover crops, and irrigation water.

The focus will be on nutrient management in cool season vegetables grown in multiple rotations, as well as strawberries grown in a year-long production cycle. The content will be geared toward commercial-scale production.

Acknowledgements

- Cooperating growers
- Crop consultants (PCA's and CCA's)
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