# Nitrogen Fertility of Organic Vegetable Production Systems

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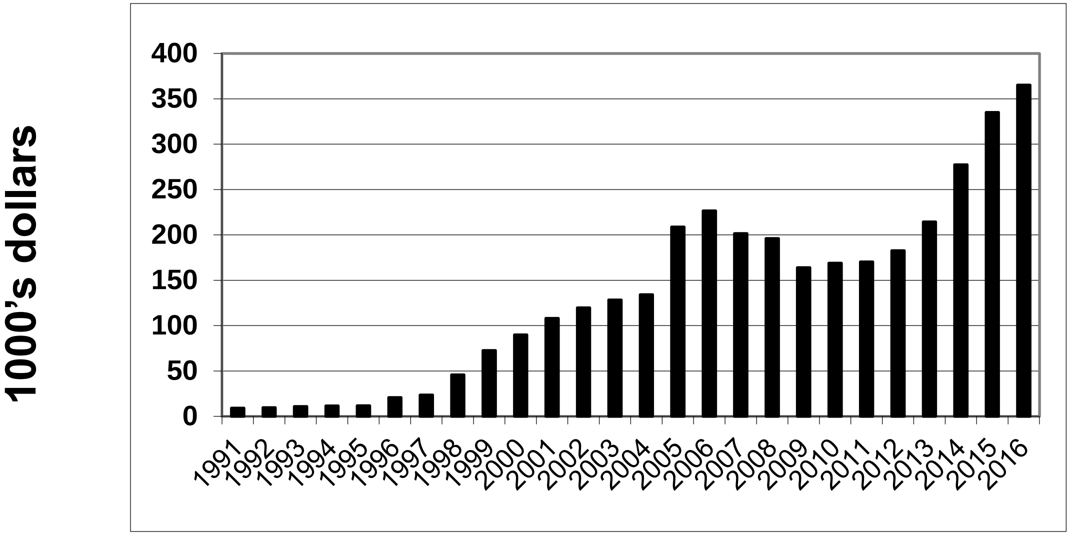
# Organic Fertilizer Evaluation

- **Evaluation nitrogen and phosphorus management in organic leafy green vegetables production on the Central Coast**
- **Funded by the Fertilizer Research and Education Program (FREP) of the California Department of Food and Agriculture**

# Why this Project?

- **Organic vegetable production in Monterey County is growing rapidly**




**Organic Agriculture: 8.6% of total ag value**

- **Nitrogen management in organic production systems is more complicated than conventional systems and is in need of greater understanding**

# Organic Fertilizer Evaluation

## Primary Objectives

- Determine the magnitude of mineralization by soil organic matter and its role in providing the N needs of leafy green vegetables
- Evaluate mineralization behavior of commonly used dry and liquid organic fertilizers

# In-field Soil Organic Matter Mineralization Evaluations

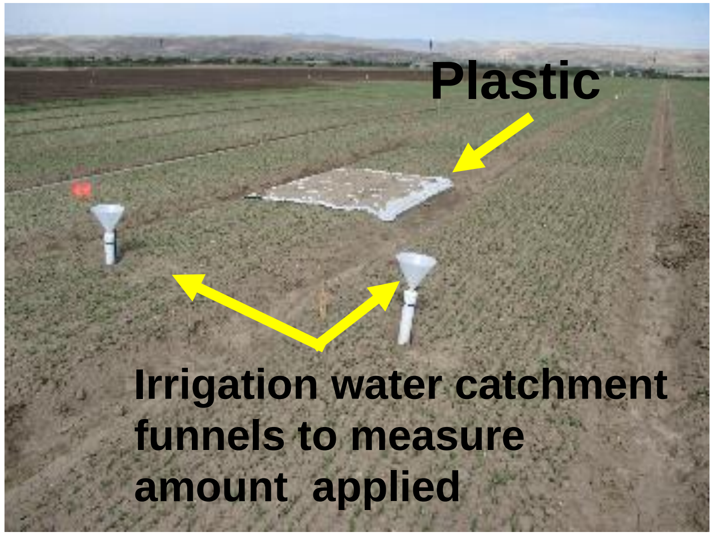
- **A survey of 20 sites in the Salinas Valley was conducted in 2016 & 17 with cooperating growers in commercial vegetable production fields**
  - **Crops included baby lettuce & chard, spinach, full term romaine and broccoli**
- **Replicated fertilized and non-fertilized plots were established in each field**

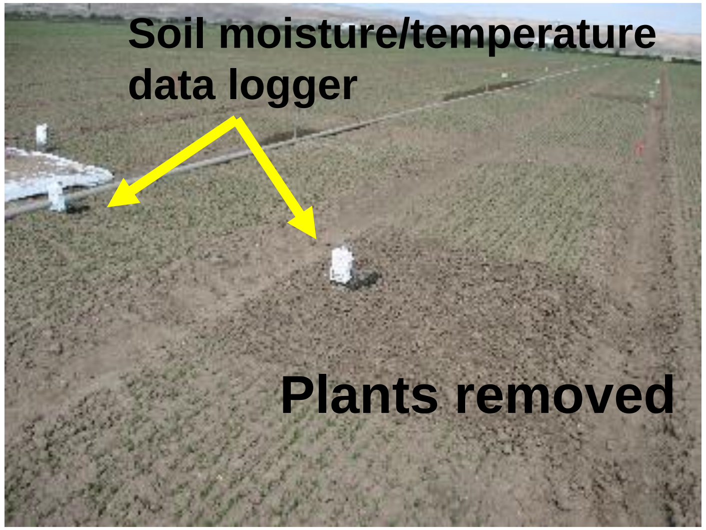
# Range of Soil Characteristics of Survey Sites

| | |
|---|---|
| pH | 7.28 – 8.17 |
| 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

# In-field Soil Organic Matter Mineralization Evaluations



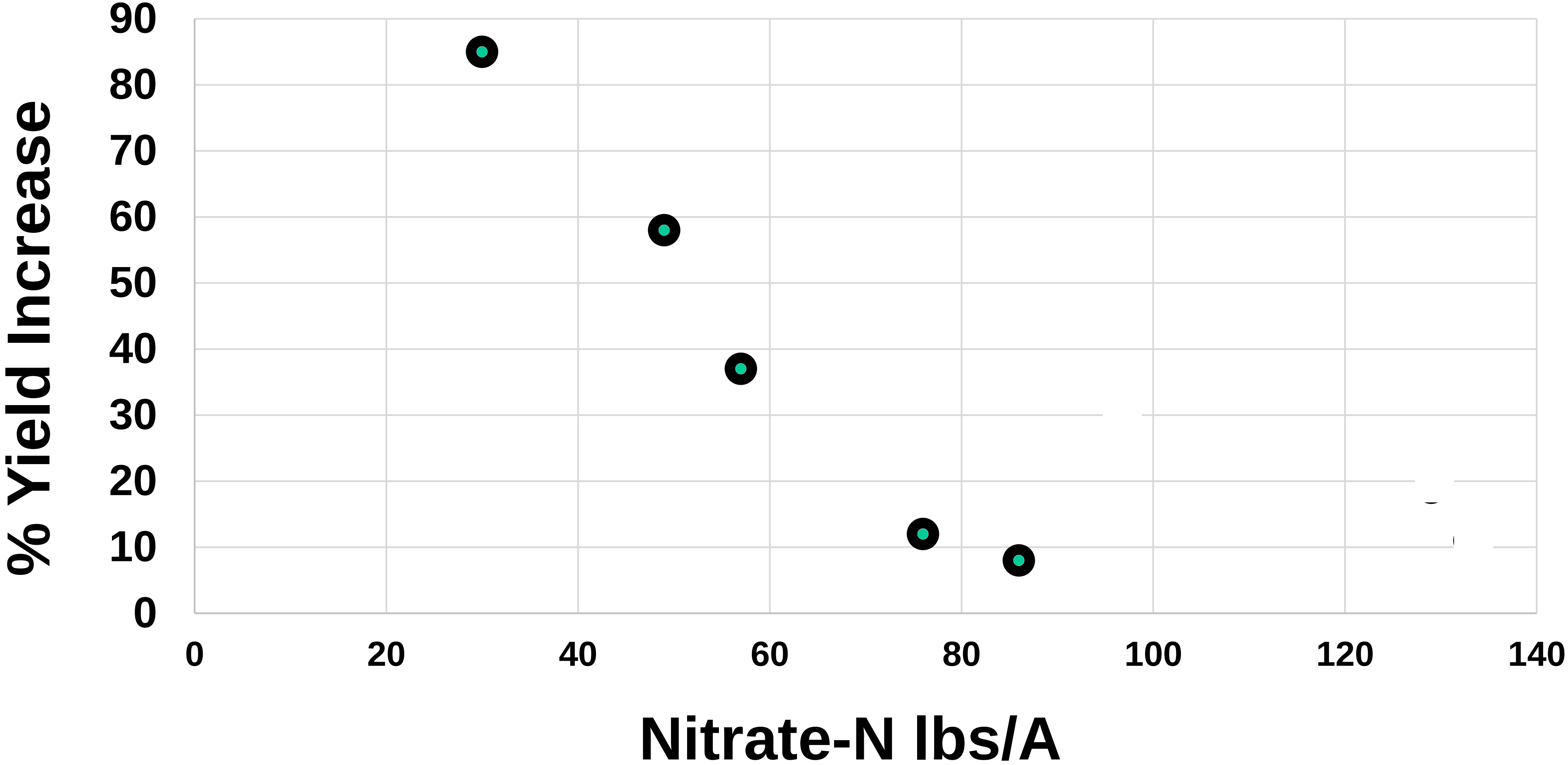

- **In each unfertilized plot subplots included:**
  1. **Plants present**
     - **Estimate of soil N mineralized, plant removal, leaching**
  2. **No plants**
     - **Estimate of soil N mineralized, no plant removal, leaching**
  3. **No plants, covered with plastic**
     - **Estimate of soil N mineralized,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

# In-field Soil Organic Matter Mineralization Evaluations

# Sources of N for 30-day Vegetables

| Crop | Initial nitrate-N lbs N/A | Fertilizer N applied lbs N/A | mineralized over crop cycle lbs N/A |
|---|---|---|---|
| Spinach | 49 | 210 | 58 |
| Spinach | 129 | 120 | --- |
| Baby lettuce | 30 | 90 | 16 |
| Baby lettuce | 57 | 120 | 33 |
| Baby lettuce | 86 | 160 | 73 |
| Baby chard | 97 | 160 | 82 |

# Initial Nitrate-N and Percent Yield Increase with Fertilization



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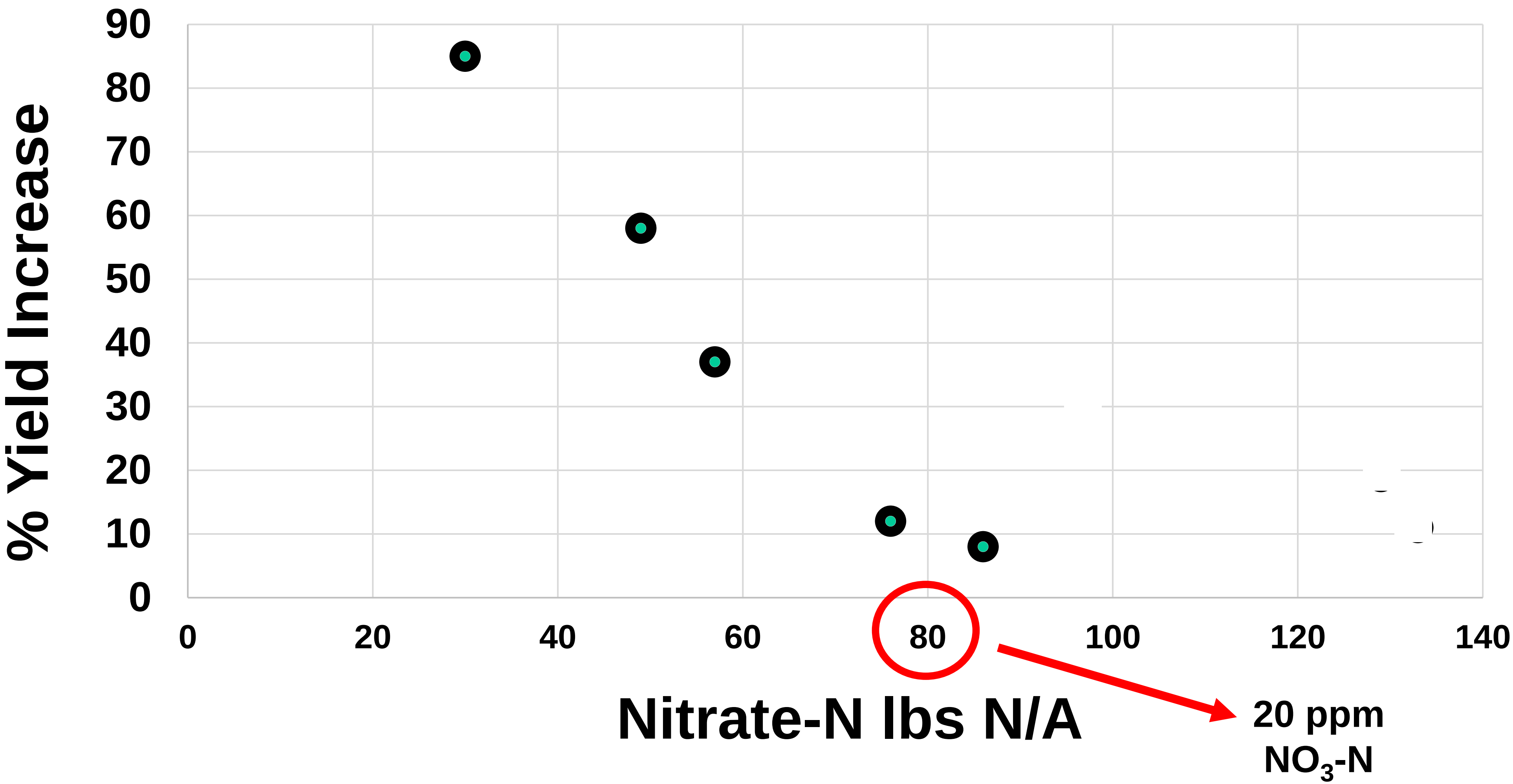
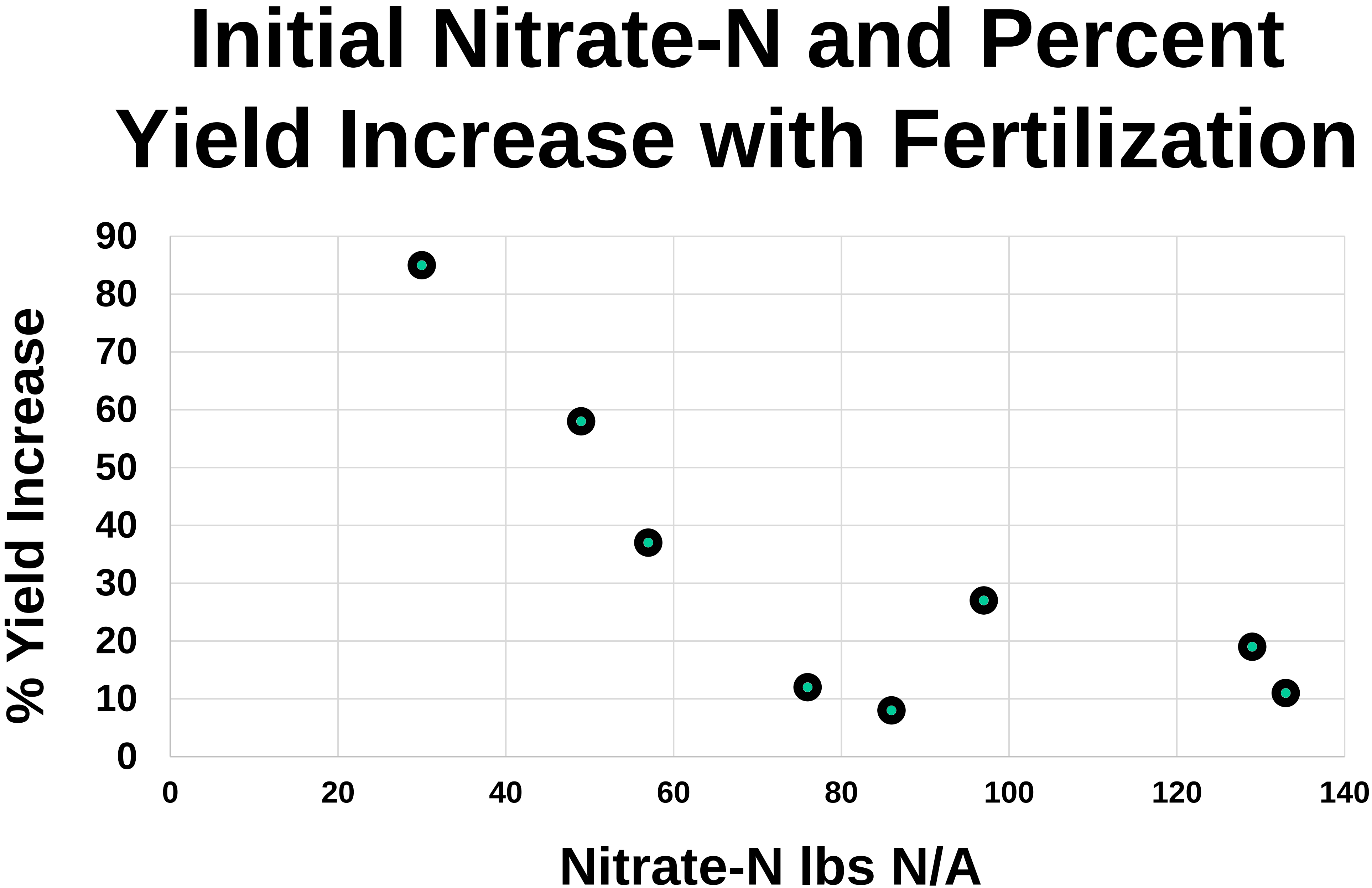
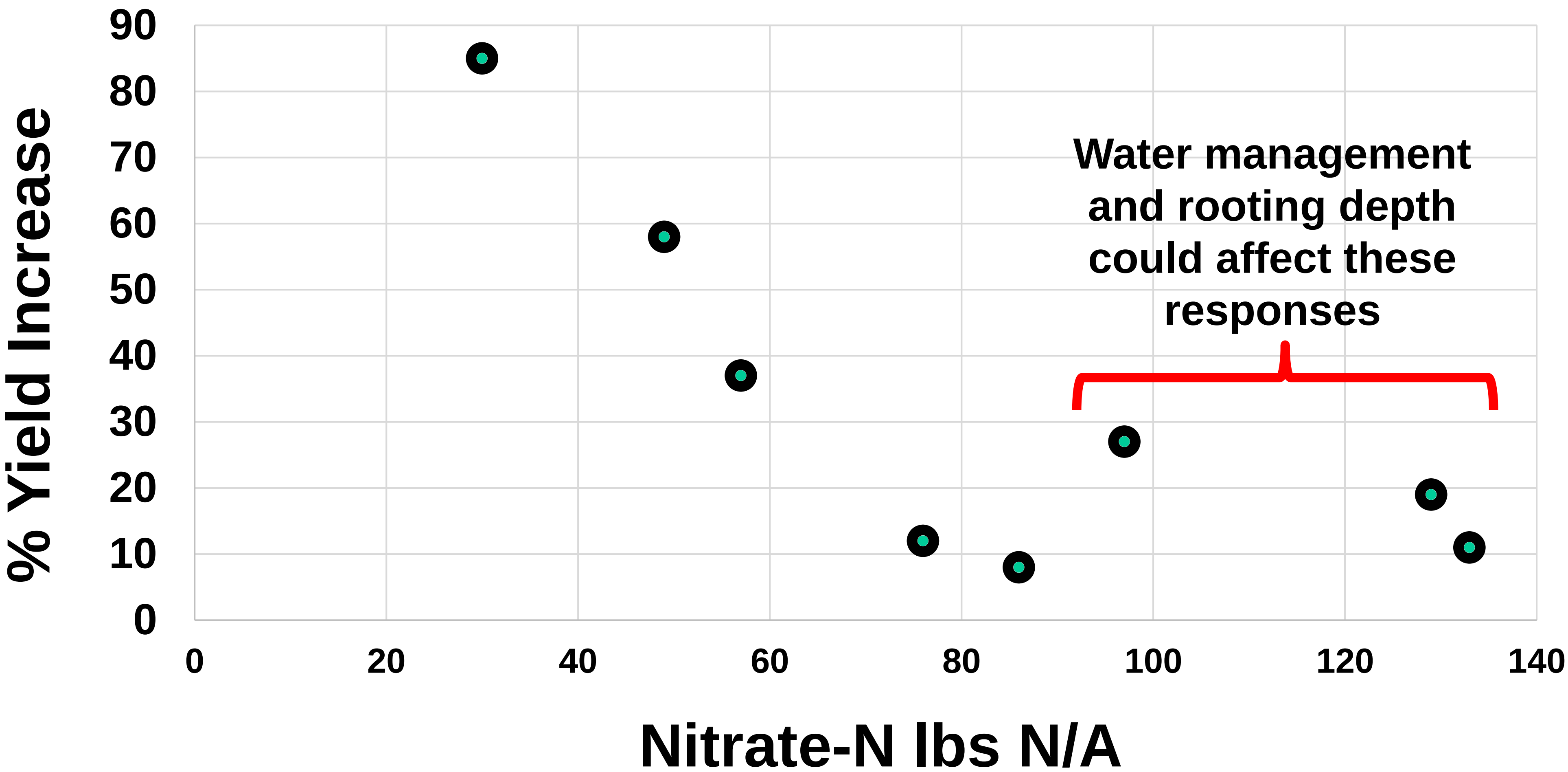




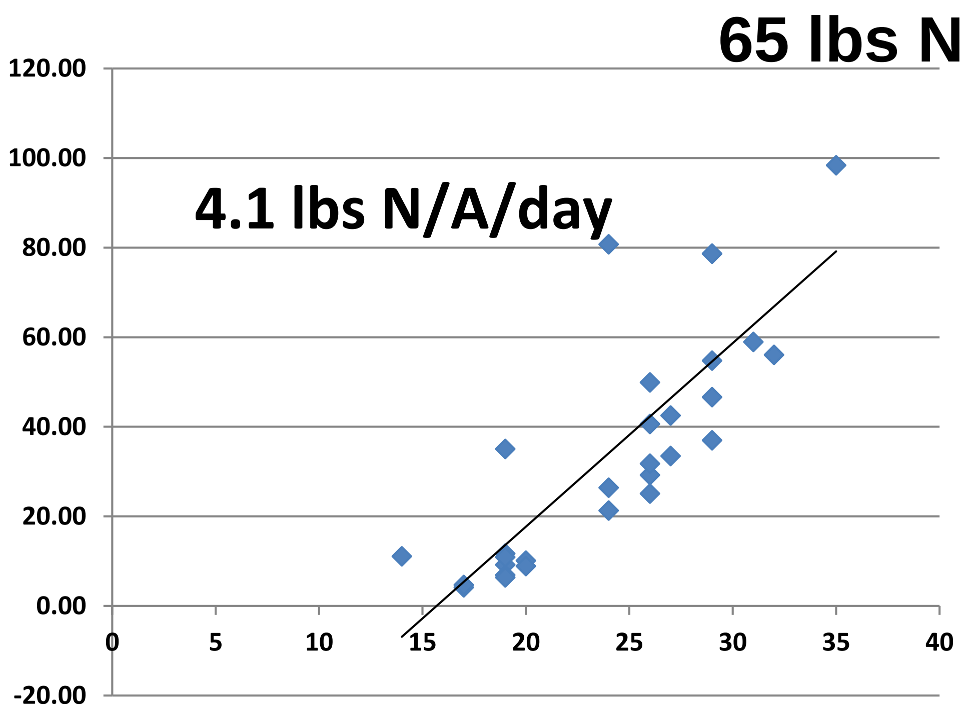
Initial Nitrate-N and Percent Yield Increase with Fertilization
% Yield Increase
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Nitrate-N lbs N/A

# Initial Nitrate-N and Percent Yield Increase with Fertilization

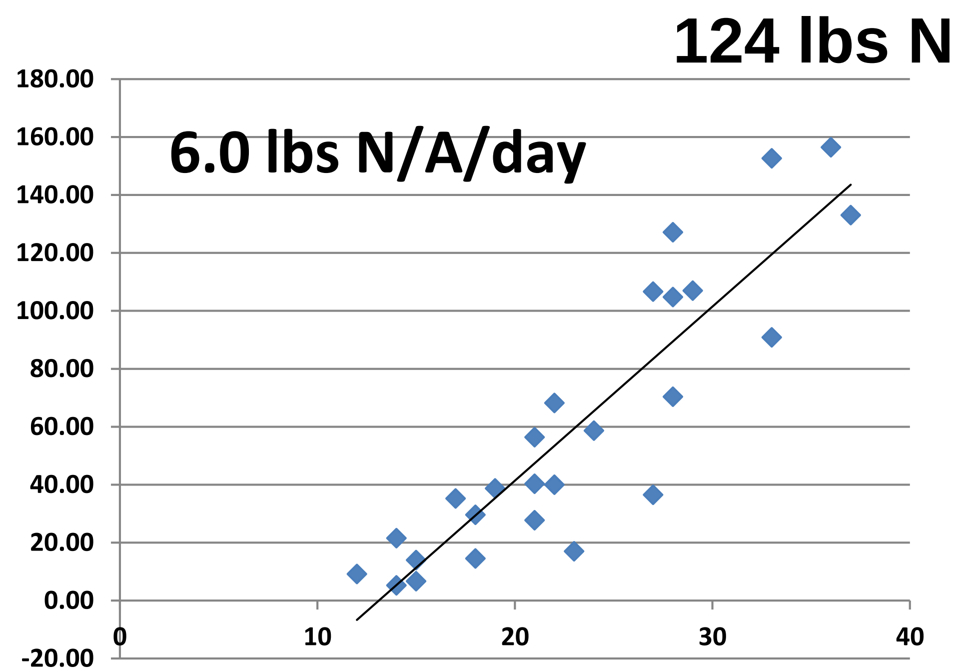


# Nitrogen Uptake

## Conventional Production

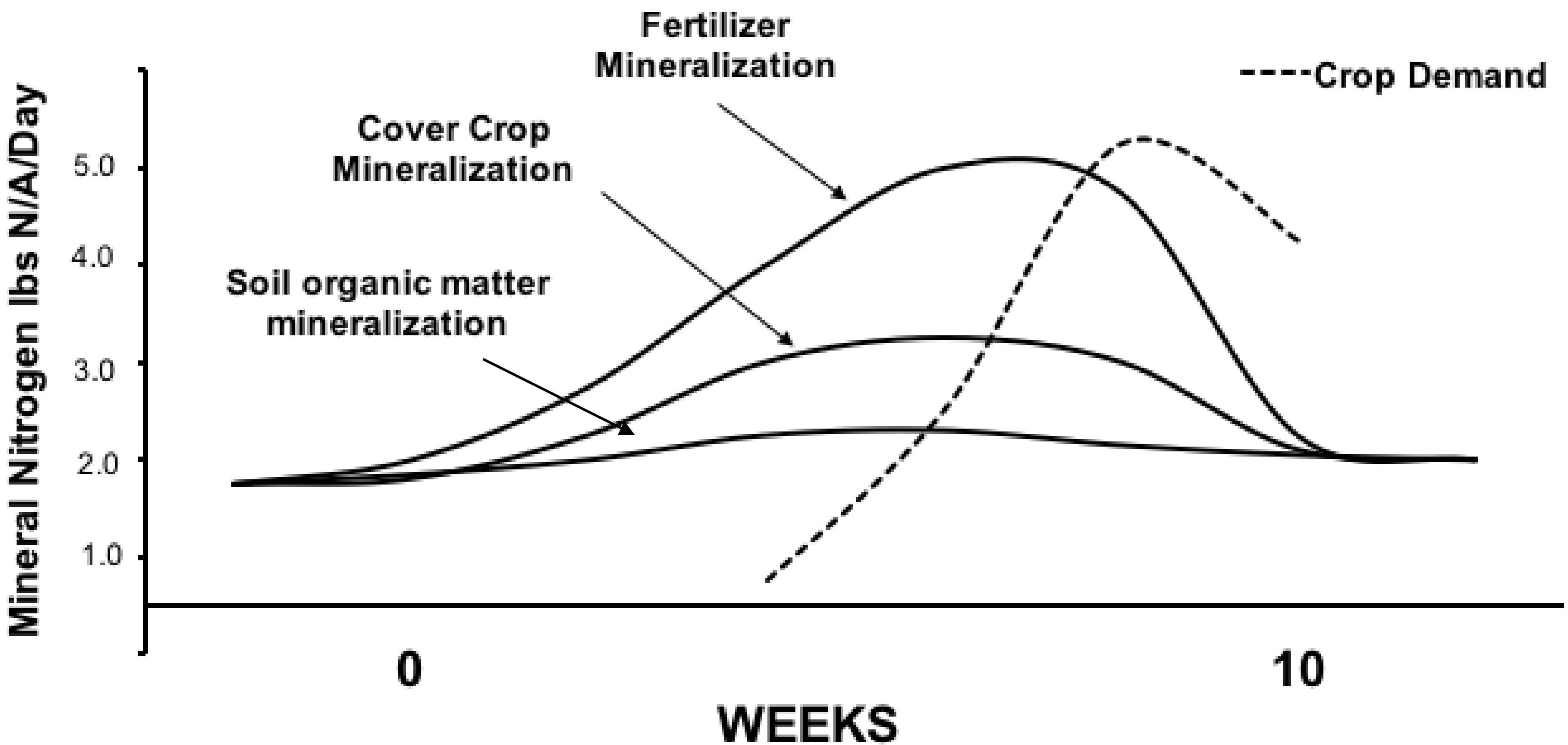



**Baby Lettuce**




**Spinach**

# Effective Synchrony Between Mineralization from the Various Sources and Crop Demand



# Nitrogen Management of Short-Season Organic Vegetables

- A soil test for residual soil nitrogen prior to planting is the only realistic opportunity to adjust fertilizer applications given the short cropping cycle and the lag time in the release of nitrogen from the organic fertilizer material
- Some growers use liquid materials during the crop cycle and this may have utility

# In-field Fertilizer Mineralization Studies

Polypropylene Pouches with Fertilizer

- Pouches with fertilizer were placed into the soil at the beginning of the crop cycle
- Two studies conducted:
- 4-4-2 (blend of chicken manure, bone and meat meals) buried and on soil surface (direct seeded romaine)
- 4-4-2 and feather meal buried in soil (broccolini)

# In-field Fertilizer Mineralization Studies

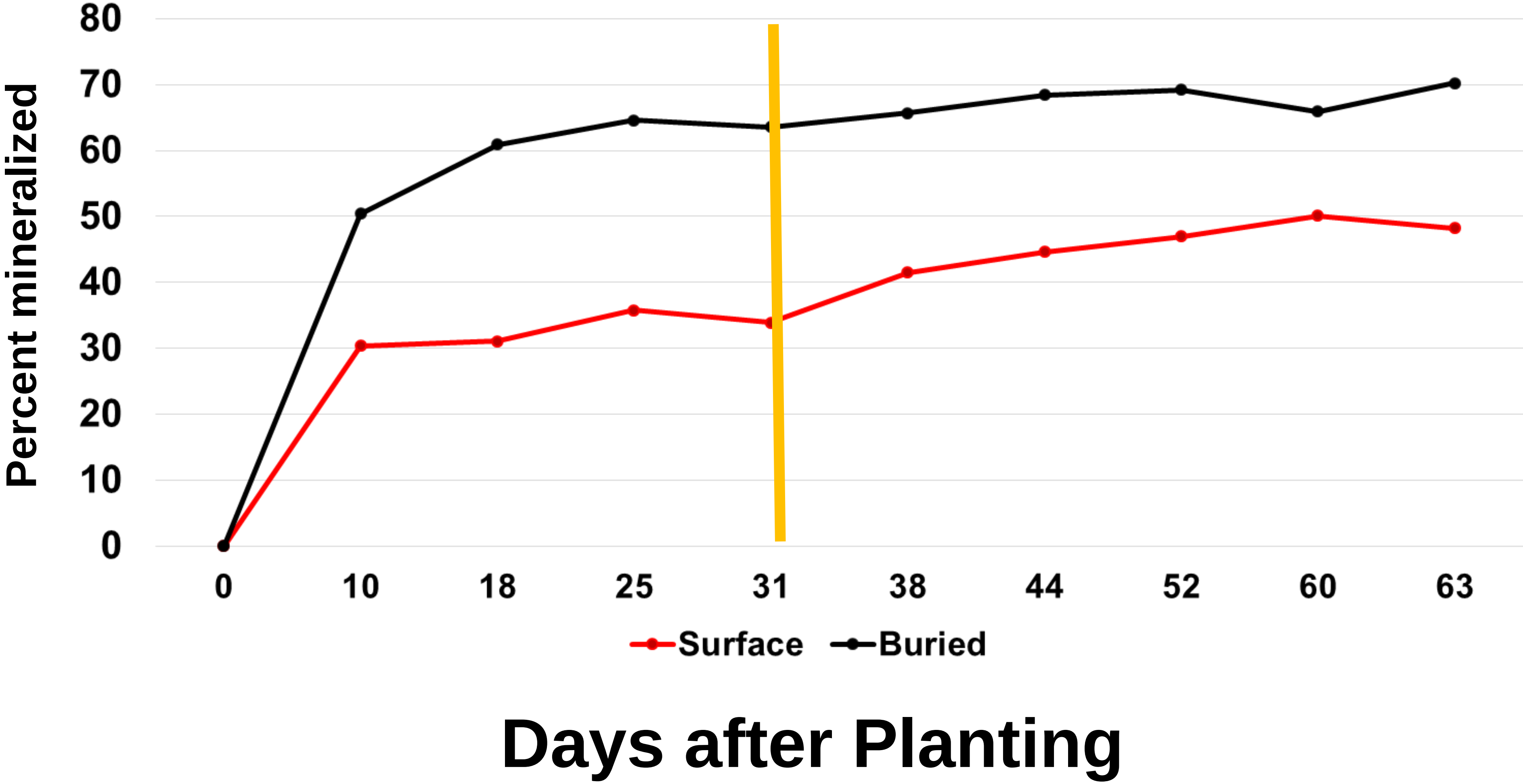
Buried in soil

Place on top of soil

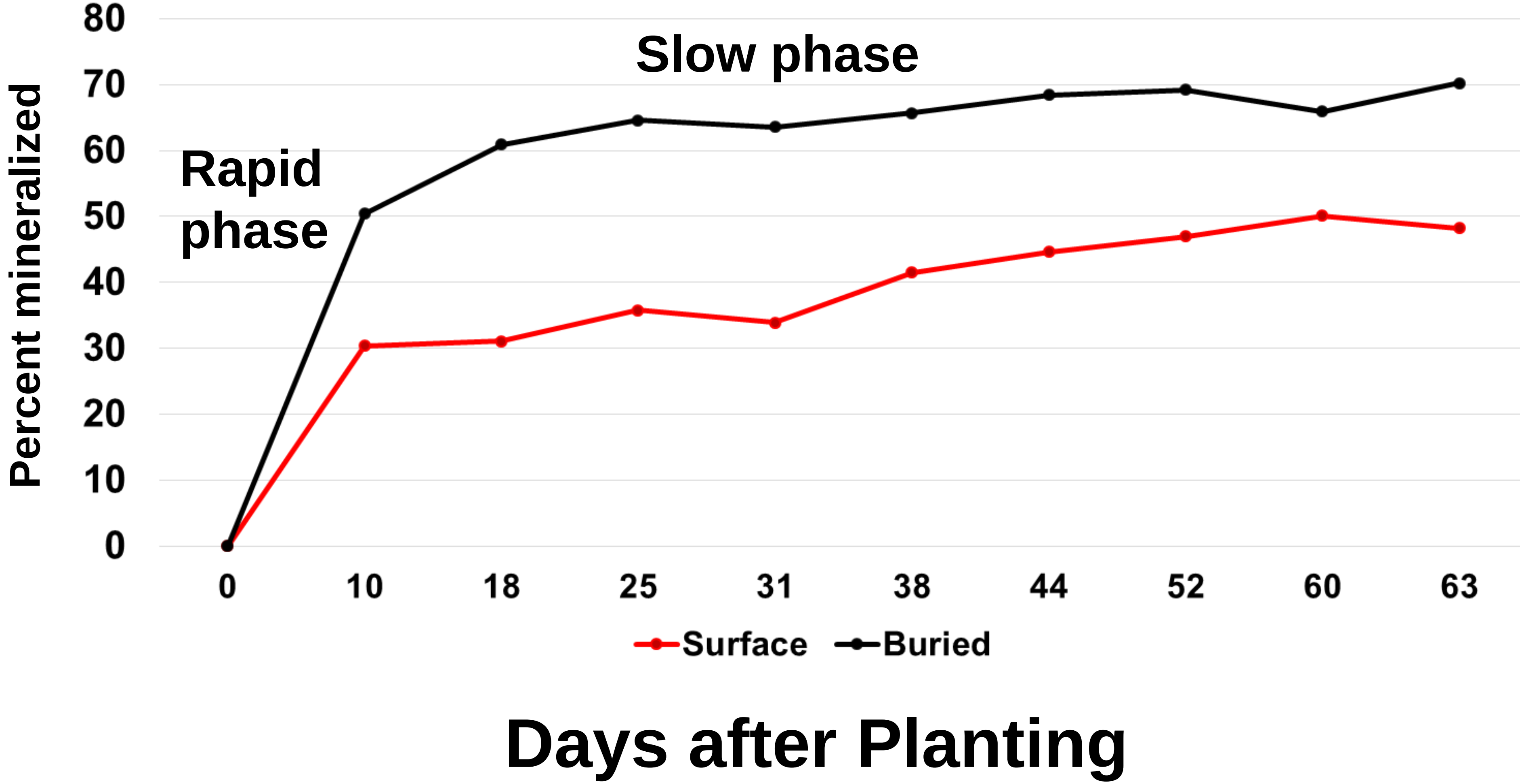
# In-field Fertilizer Mineralization Studies

- 3-4 pouches were collected each week and the contents were collected, weighed and analyzed for N, P and K
- This technique has limitations (e.g. loss of particulate matter)

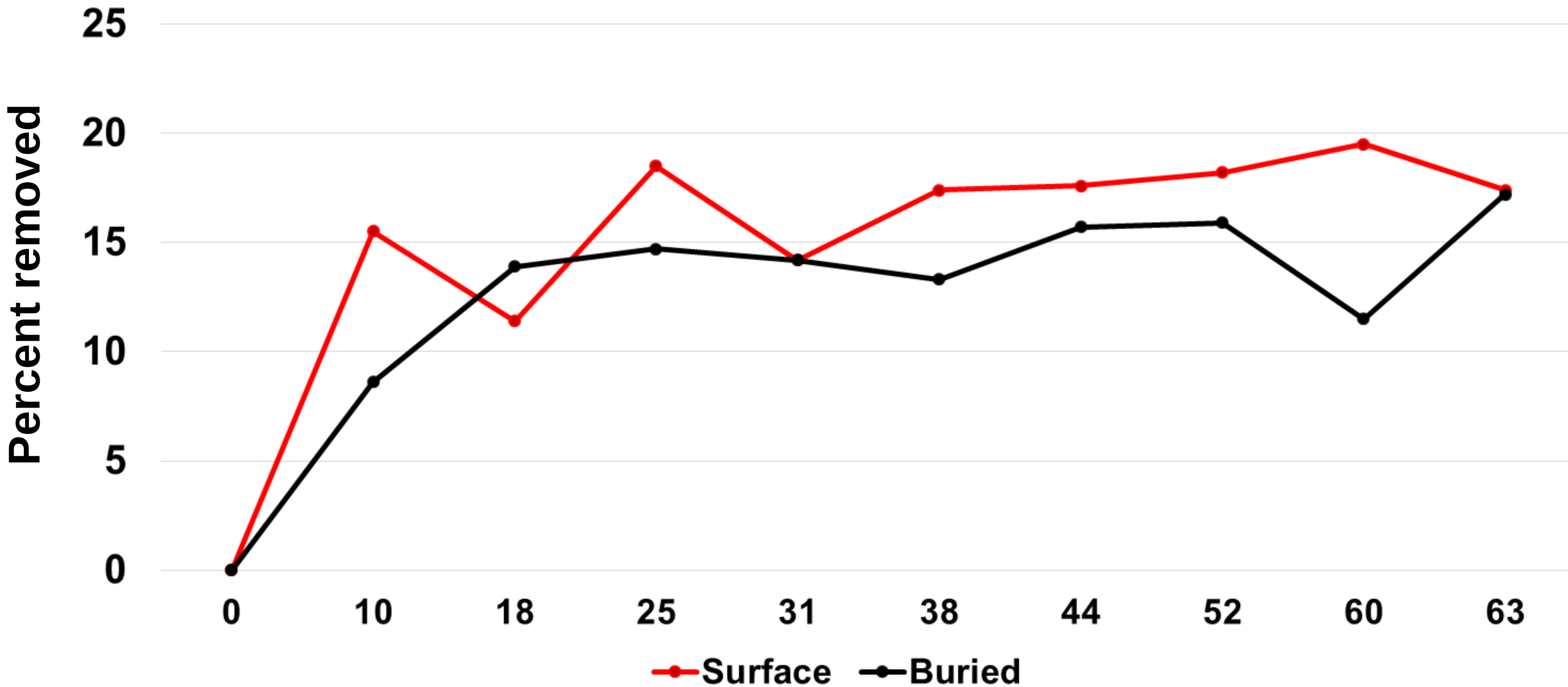
# 4-4-2
# Percent N Mineralized from Pouches
## Buried vs Surface



# Typical Two Phase Breakdown of Organic Fertilizer (and other Organic Materials)



# 4-4-2
# Percent Phosphorus Removed from Pouches
## Buried vs Surface



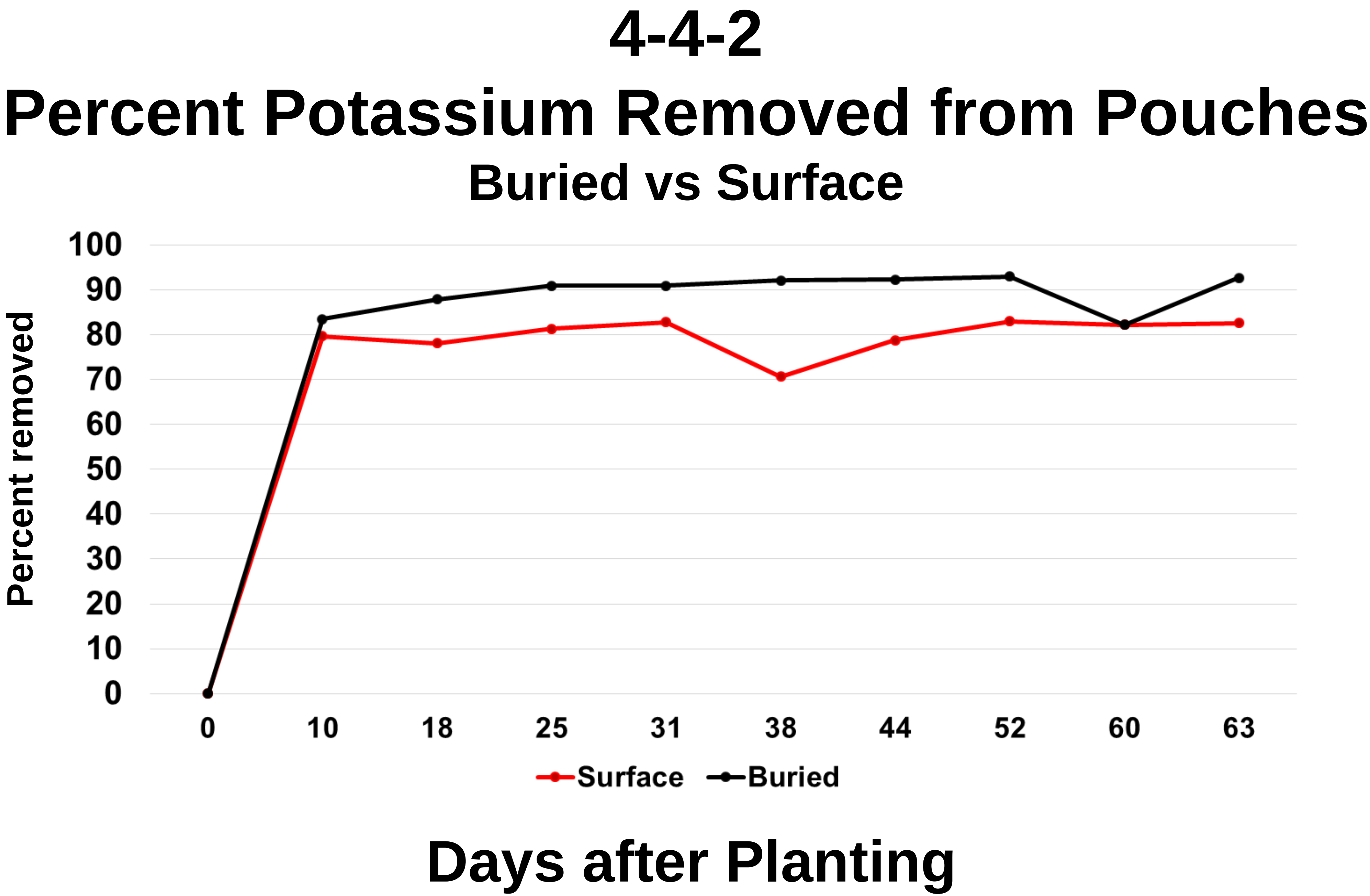

Days after Planting

# Organic Management Impact on Soil Phosphorus

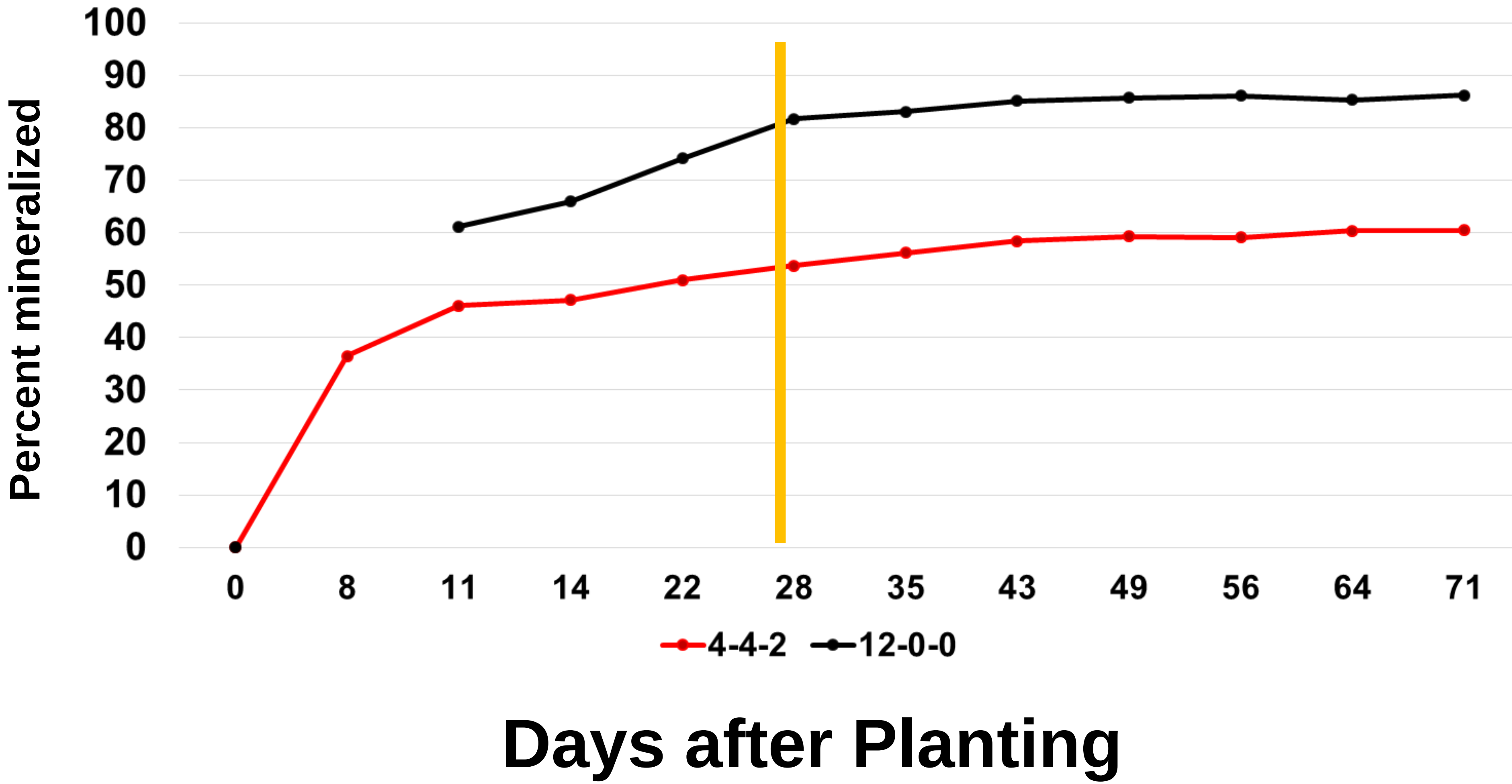
| 4-4-2 lbs/A | Phosphorus lbs/A | Net Available P lbs/A* |
|---|---|---|
| 2000 | 31 | 4.6 |
| 3000 | 46 | 7.0 |
| 4000 | 62 | 9.3 |

* 15% released

**A large percent of the P in 4-4-2 is insoluble at soil pH values > 7.0. Soil P values in our survey ranged from 10.2 to 111.8 ppm (Olsen P) with an average = 36.0 ppm, which is not elevated in comparison with conventional fields. We are evaluating to see if total soil P is increasing in organic fields.**


4-4-2
Percent Potassium Removed from Pouches
Buried vs Surface
100
90
80
70
60
50
40
30
20
10
0
Percent removed
0
10
18
25
31
38
44
52
60
63
Surface
Buried
Days after Planting

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



# 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 |

**Higher N content fertilizers released N more rapidly**

# Overview of Organic Soil Fertility in Large-Scale Organic Vegetable Production

- Many of the operations do not have the ability to routinely cover crop and some have also gotten away from the use of composts
- Do double or triple crops using organic fertilizers may substitute to some degree for cover crops and compost?

# Input of Carbon to the Soil System from the Organic Fertilizer 4-4-2

| 4-4-2 lbs/A | Net lbs/A | Carbon lbs/A |
|---|---|---|
| 2000 | 1800 | 504 |
| 3000 | 2700 | 756 |
| 4000 | 3600 | 1008 |

**Amount of carbon from other sources:**

**Cover crop (2-4 tons/A): 1600 to 3200 lbs carbon/A**

**Compost (3-5 tons/A): 1340 to 2240 lbs carbon/A**

# Overview of Organic Soil Fertility in Large-Scale Organic Vegetable Production

- Carbon inputs can be significant from organic fertilizers
- It appears that the organic fertilizers are also leaving significant amounts of residual N from the fertilizer in the soil
- What is the fate of this N?
- Is it continuing to slowly mineralize or is it recalcitrant and building up total N in the soil?

# Management Considerations

- Higher N content fertilizers released available N more rapidly
- The efficiency of soil surface applications is lower than incorporated applications

# Management Considerations

- The need to apply the organic fertilizer N early in the crop cycle makes an early season evaluation of soil N necessary in order to adjust fertilizer N application rates
- A nitrate quick test following the germ water may be the best tool for getting an understanding of N available for the crop

# Acknowledgements

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