# Organic Soil Fertility Management


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# Organic Soil Fertility

- Ideally, relies on biological processes, recycling of nutrients and active soil microbial activity to supply crops with the nutrients they need
- Processes may include nitrogen fixation by legumes, mycorrhizae, microbial decomposition, scavenging and cycling of nutrients by crops and cover crops, etc
- Recycling of nutrients includes use of composts, manures, other amendments

# Phosphorus

- The need for phosphorus can be determined from soil tests which are a reliable indicator of the quantity of P available for crop growth
- The amount does not change rapidly over the cropping season and a yearly soil test is sufficient to keep track of the amount available
- Olsen (bicarbonate) extraction use for soils > pH 6.0 (most soils here on the Central Coast

# Phosphorus Soil Test Values and Yield Response to Phosphorus Fertilization

## Bicarbonate-extractable soil P*

| Crop | Yield improvement likely | Possible yield Improvement* | Yield improvement unlikely |
|---|---|---|---|
| Lettuce/Celery | < 40 | 40 - 60 | > 60 |
| Other Cool Season Vegetables | < 25 | 25 - 35 | > 35 |
| Warm season vegetables | < 15 | 15 - 25 | > 25 |

* Particularly in cold soil temperatures

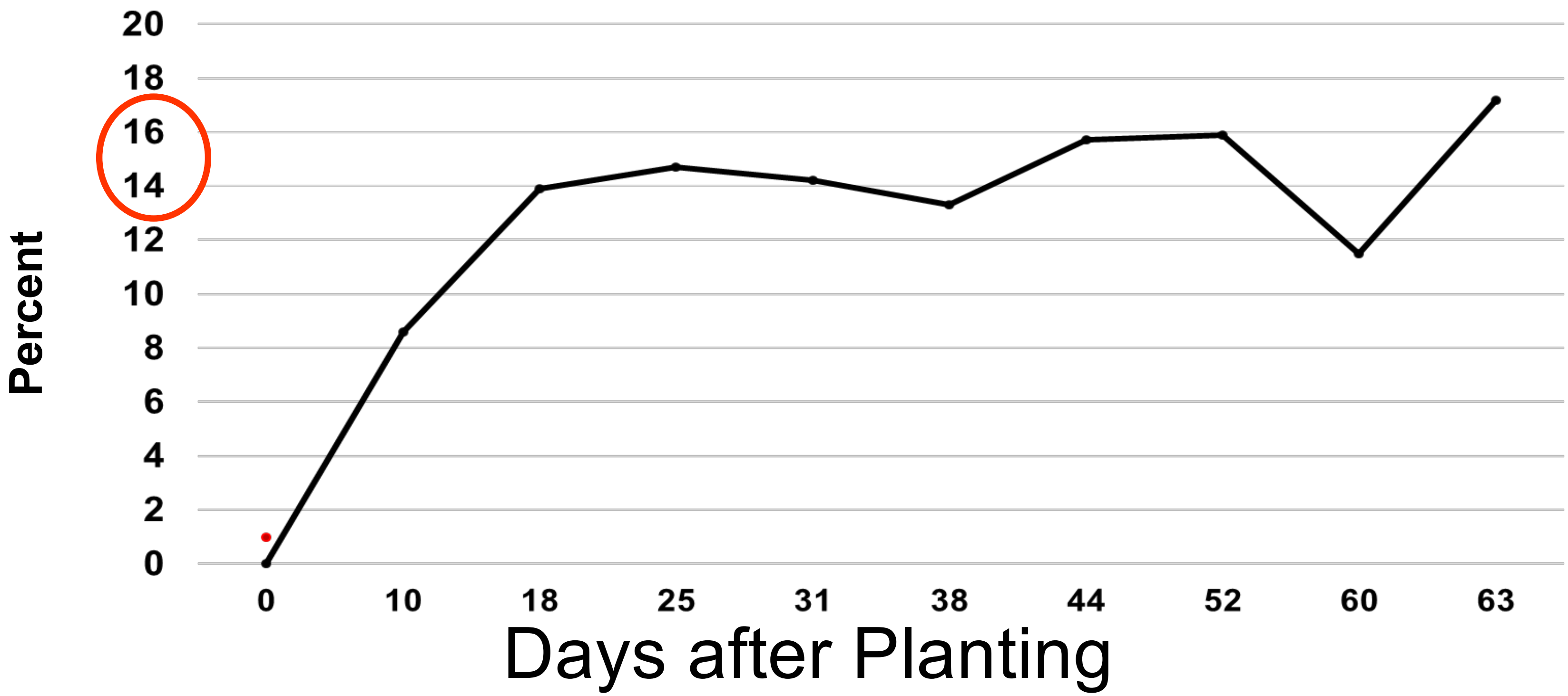
# Availability of P in animal manures and composts

| | % P in | |
|---|---|---|
| Material | organic form | phosphate form |
| Feedlot manure | 25 | 75 |
| Composted manure | 16 | 84 |
| Dairy manure | 25 | 75 |
| Poultry litter | 10 | 90 |
| Swine manure | 9 | 91 |

- phosphorus in manure (fresh or composted) is equal in availability to synthetic fertilizer
- rock phosphate and bone meal are slowly available in acid soils and are unavailable in alkaline soils

# Organic Fertilizer Trials Salinas Valley

## Phosphate released from 4-4-2 Fertilizer




**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**

## Potassium

- The need for potassium can be determined from soil tests (ammonium acetate extraction) which is a reliable indicator of the  quantity of K available for crop growth
- The tests usually range from 50-400 ppm (higher on clay soils and lower on sandy soils)
- Potassium is often taken up by many vegetables in greater quantities than nitrogen
- The amount does not change rapidly over the cropping season and a yearly soil test can be a good way to keep track of the amount of these nutrients that are neede

# Sources of Potassium

- **Mined minerals:**
  - **Potassium sulfate (40% actual potassium), potassium chloride (17%)**
  - **Greensand (1- 5%) – low solubility**
- **Wood ash (4%)**
- **Seaweed (up to 2%)**
- **Compost (depending on feedstock, generally no more than 2%)**
- **Manures**
  - **Chicken (2.5%)**
  - **Cow (15-20%)**

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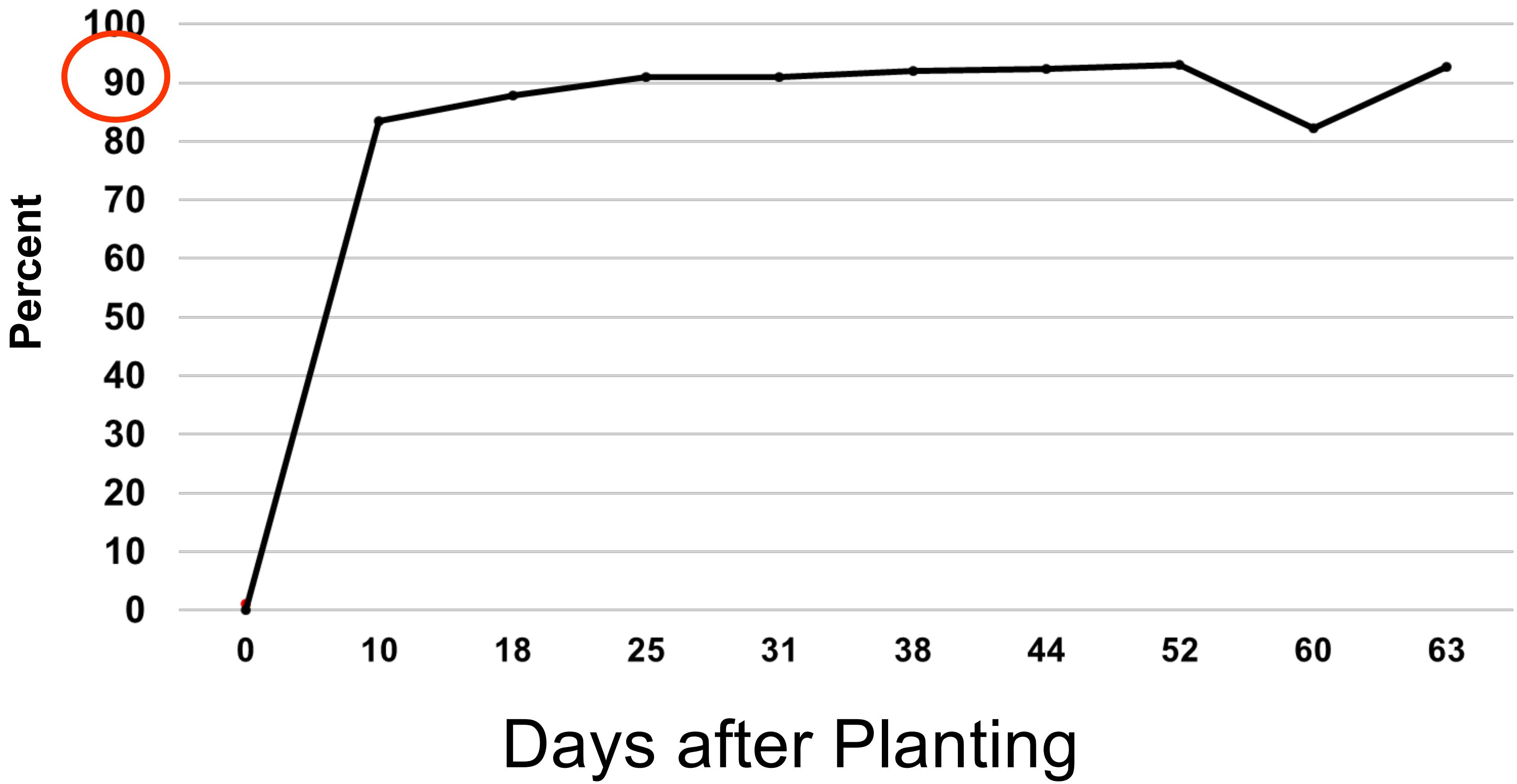
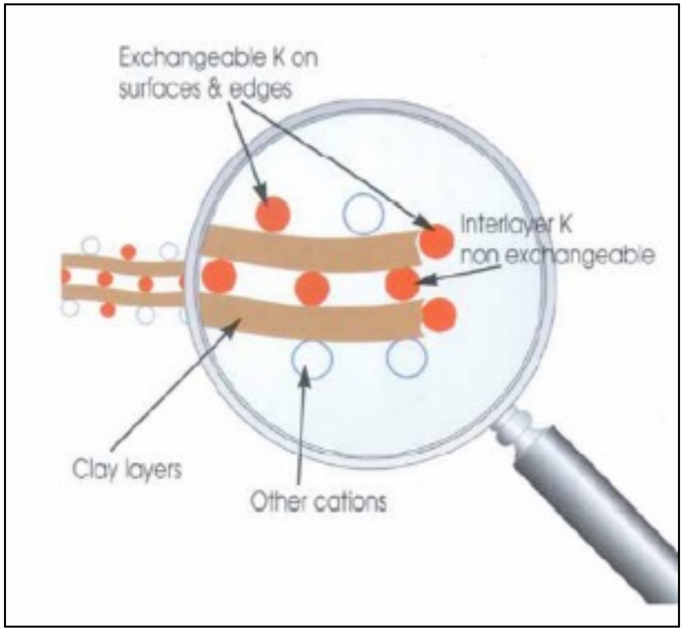


# Potassium Nutrition

- Issues with potassium result from low levels of potassium in the soil
- Also, ‘fixation’ results from vermiculitic (2:1) minerals can trap K ions




Potassium deficiency on peppers

# Potassium crop nutrition

- Potassium is taken up by root interception
- Factors that reduce rooting or the amount of soil that the roots explore affect potassium nutrition
- For instance, in the early 1990's when peppers were being transitioned to drip irrigation, potassium deficiency began to show up (smaller root systems)
- Also, nematode issues can result in potassium deficiency symptoms on the plant

| | Exchangeable K (ppm) | | |
|---|---|---|---|
| Crop | crop response likely | response possible | response unlikely |
| celery | < 150 | 150-200 | > 200 |
| other cool-season vegetables | <100 | 100-150 | > 150 |
| potato, tomato, pepper | <150 | 150-200 | > 200 |
| cucurbits | < 80 | 80-120 | > 120 |

# Zinc and other nutrients

- Given the climate and geology of California we generally have sufficient calcium & magnesium
- Use of composts and manures generally supply the needs for many of the micronutrients

| Element | Response likely | Response possible | Response unlikely |
|---|---|---|---|
| Zinc* | <0.5 | 0.5-1.5 | >1.5 |
| Iron** | <5.0 | 5.0-10.0 | >10.0 |
| Boron | <0.2 | 0.2-1.0 | >1.0 |

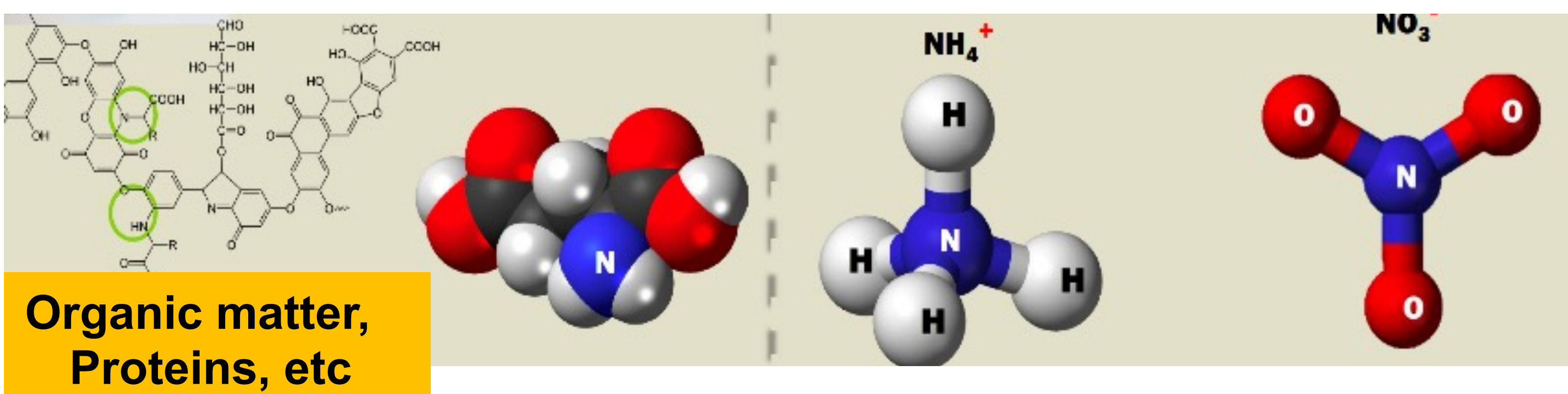
3 tons of compost (4,500 lbs dry weight) may contain 0.1 – 0.7 lbs of zinc or boron

## Nitrogen

- Organic N management is complicated due to the different forms that nitrogen can occur
- We rely on the mineralization of nitrogen from soil organic matter, fertilizers and soil amendments to produce the plant available forms of nitrogen, nitrate and ammonium
- The mineralization of nitrogen depends upon several factors: 1) C:N ratio of the material; 2) temperature; 3) placement of the material
- Once the material is mineralized to nitrate, its availability is affected by its mobility in irrigation or rain water which can cause it to leach below the root zone

# Nitrogen Soil Fertility

- In organic production it is the most complicated and expensive nutrient to supply to crops
- It is made available by the decomposition of organic materials: soil organic matter, plant residues (crop & cover crop), manures, compost, slaughterhouse and fish residues & seed meals



# Nitrogen Content of Various Organic Fertilizers

| Fertilizer | Source |
| --- | --- |
| Dry | |
| 2.5 | Poultry |
| 3 – 4 | Seed meals |
| 4 | Poultry Manure + Meat and Bone Meals |
| 12 – 13 | Feather and blood meals |
| 8 | Meat and Bone |
| 9 – 12 | Guanos |
| Liquid | |
| 2 – 5 | Fish waste |
| 14 | Hydrolyzed soybean (solutionized) |

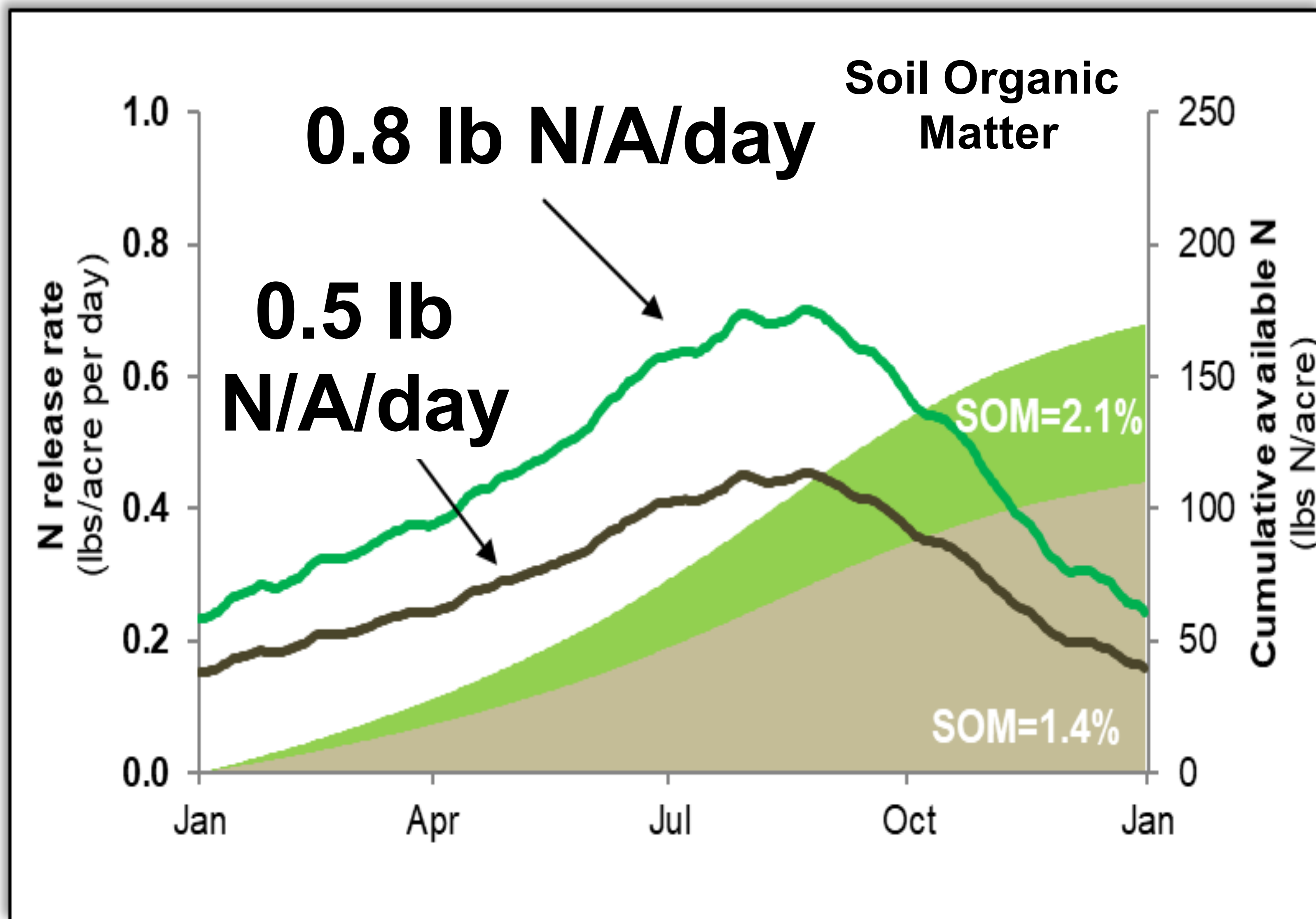
# Analysis and Carbon Content of Various Fertilizers

| Fertilizer | % Carbon | C:N | Source |
|---|---|---|---|
| 4-1-1 | 40 | 10 | Seed meals |
| 14-0-0 | 43 | 3 | Hydrolyzed soybean meal |
| 2.5-2-2.5 | 25 | 10 | Poultry |
| 4-4-2 | 28 | 7 | Poultry Manure<br>+ Meat and Bone Meals |
| 9 to 12 | --- | --- | Guano |
| 12-0-0 | 46 | 4 | Feather |
| 8-5-1 | 37 | 5 | Meat and Bone |

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

| Crop | Crop Uptake lbs N/A |
|---|---|
| Bell pepper | 240-350 |
| Broccoli | 250-350 |
| Brussels sprouts | 350-500 |
| Cabbage | 280-380 |
| Cauliflower | 250-300 |
| Celery | 200-300 |
| Lettuces | 120-160 |
| Baby lettuces | 60-70 |
| Onion | 150-180 |
| Spinach | 90-130 |

# Sources of Nitrogen for Crop Growth




Patricia Lazicki

# Crop Residues and Residual Soil N




# Cover Crop Residues

# Nitrogen from Irrigation Water

**Calculation:**

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

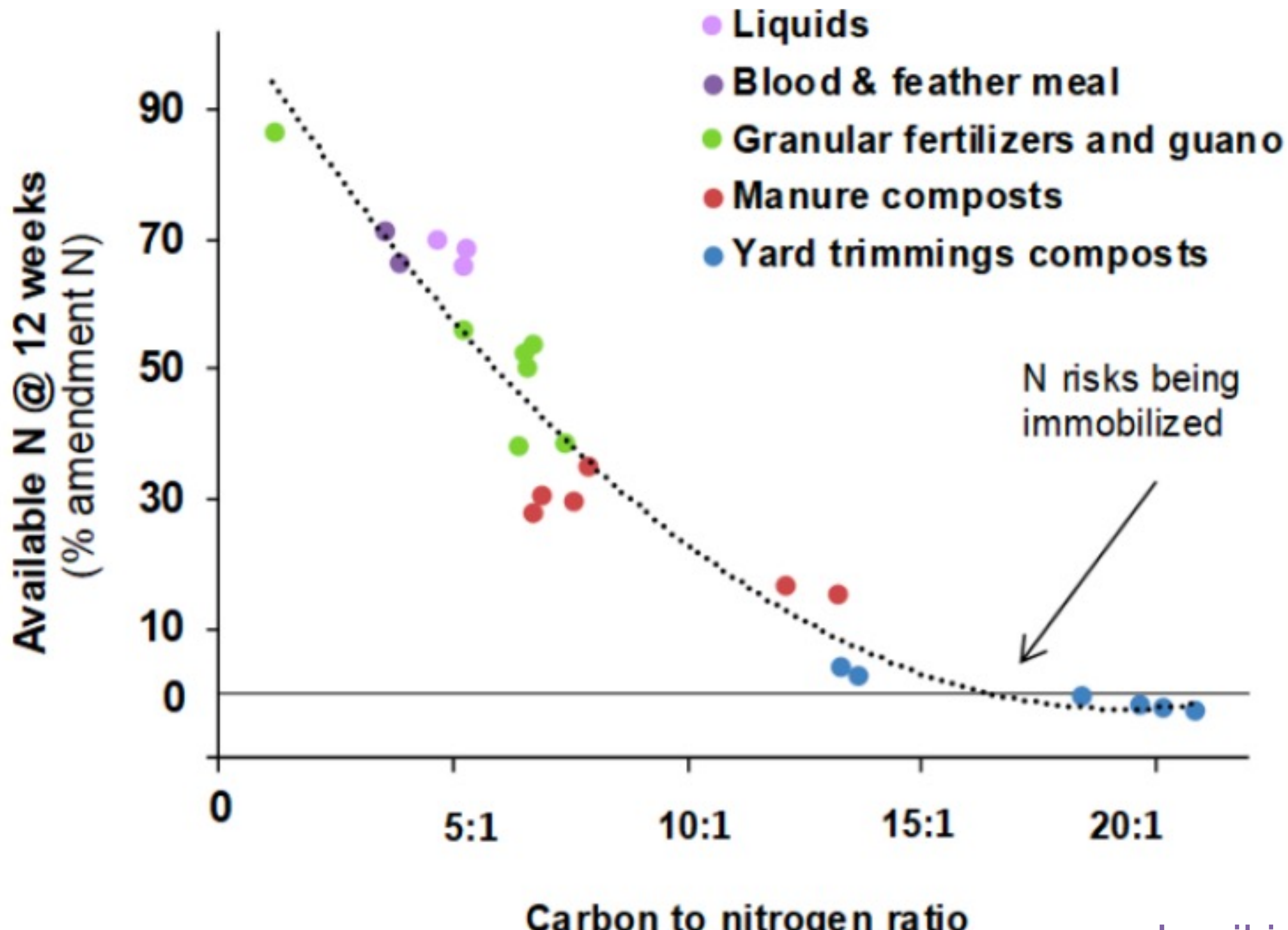
**Example:**

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

- If 10 inches of water applied:
- 10 x 9 lbs = 90 lbs N

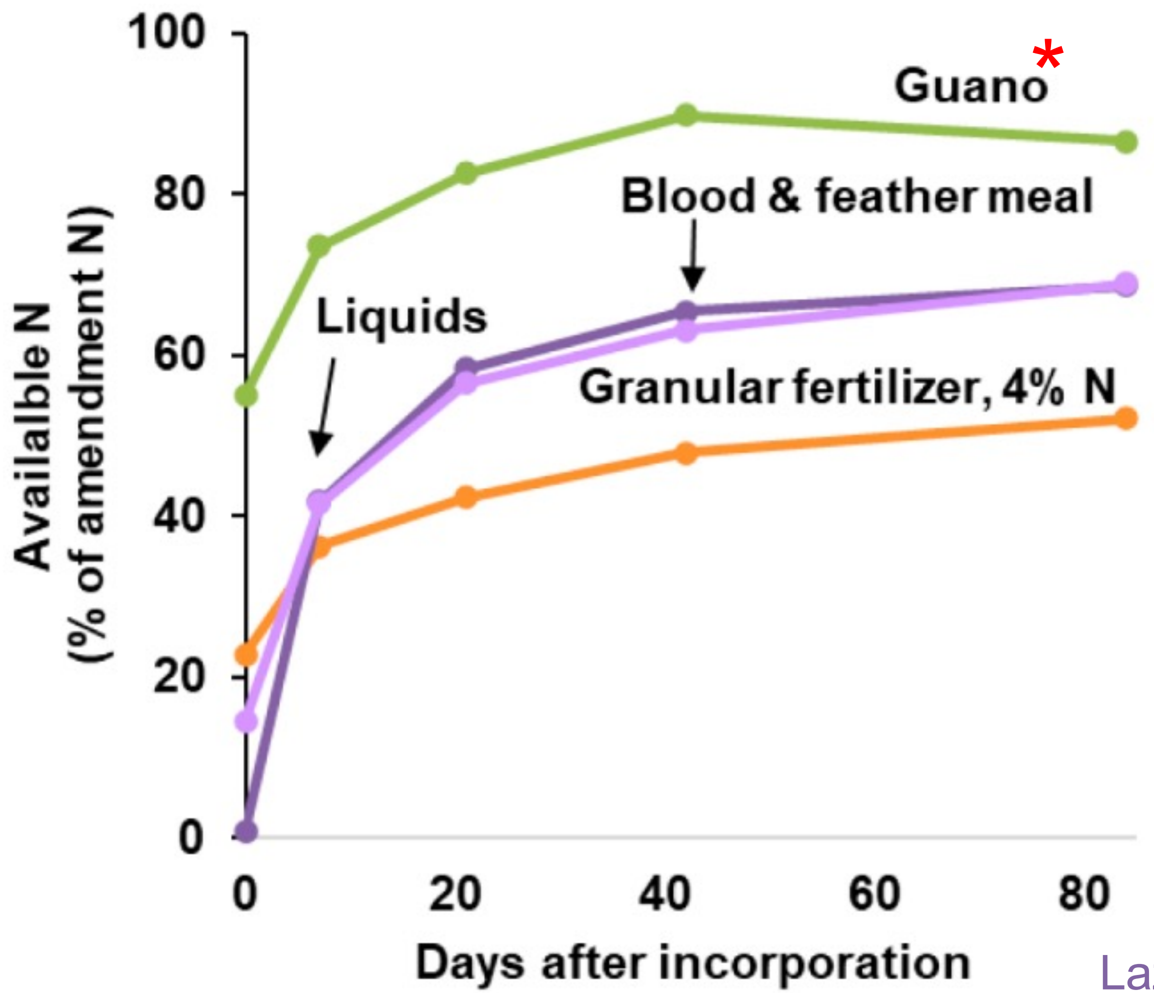
# Nitrogen Availability from Organic Fertilizers

# Nitrogen Availability in Organic: C:N Ratio of the Material is the Driver




Laziki et al, 2020

# Availability of N from Common Fertilizers

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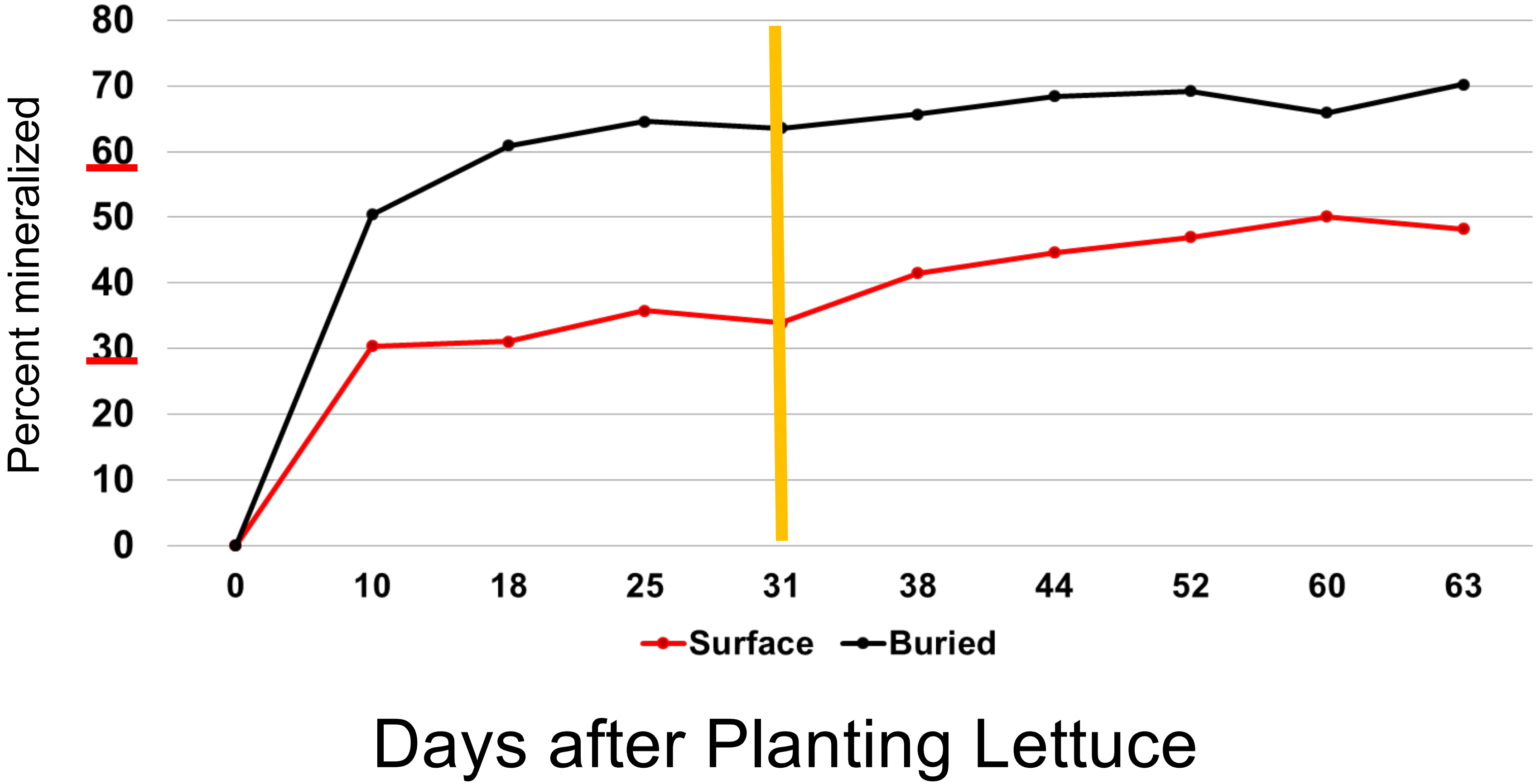
# In-field Fertilizer Mineralization Studies

Buried in soil

Place on top of soil

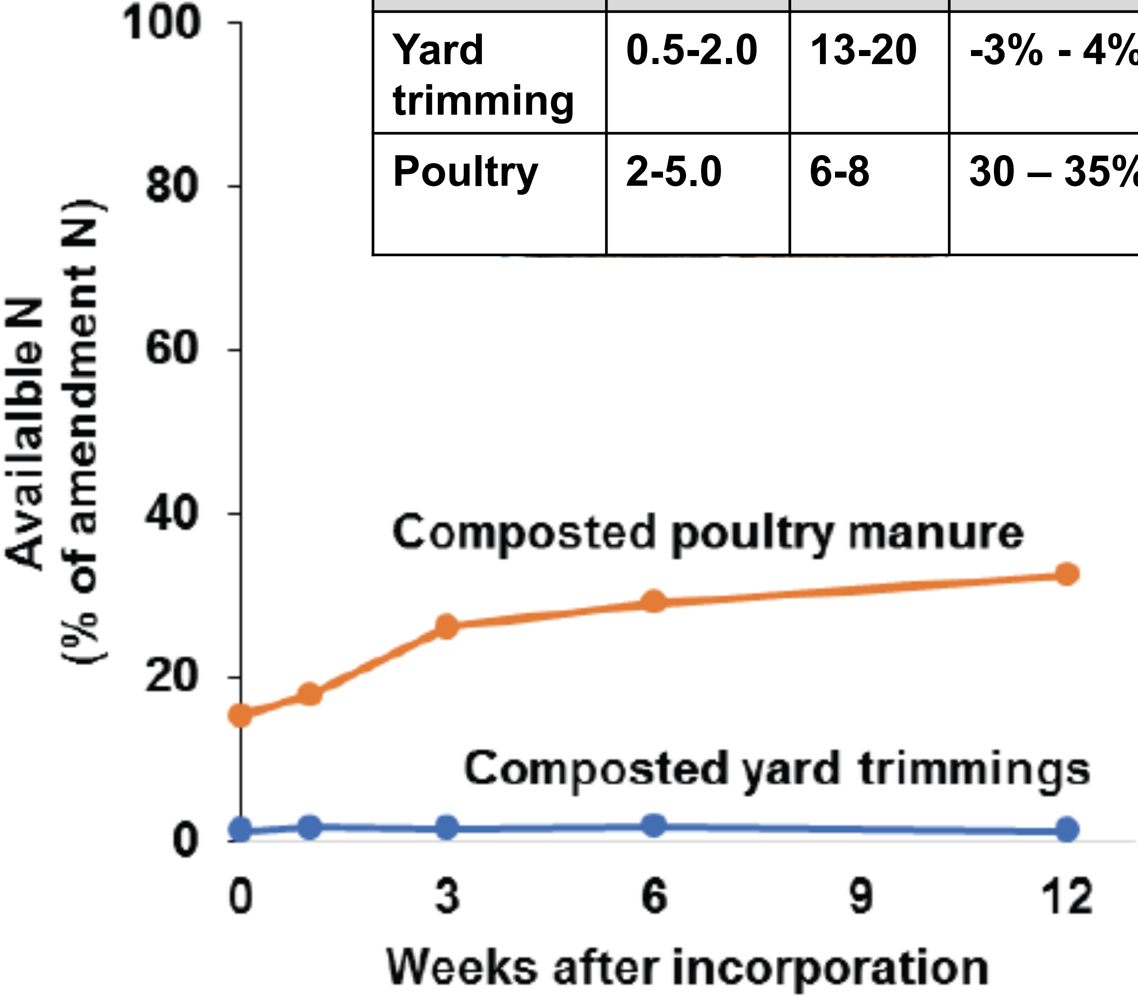
4 pouches collected weekly and analyzed for N, P & K over the crop cycle

# 4-4-2
# Percent N Mineralized from Pouches
## Buried vs Surface 2016



# Nitrogen Release from Compost

| Material | %N | C:N | Available in 12 weeks | Release time frame |
|---|---|---|---|---|
| Yard trimming | 0.5-2.0 | 13-20 | -3% - 4% | years |
| Poultry | 2-5.0 | 6-8 | 30 – 35% | Weeks - months |



# Need to Update

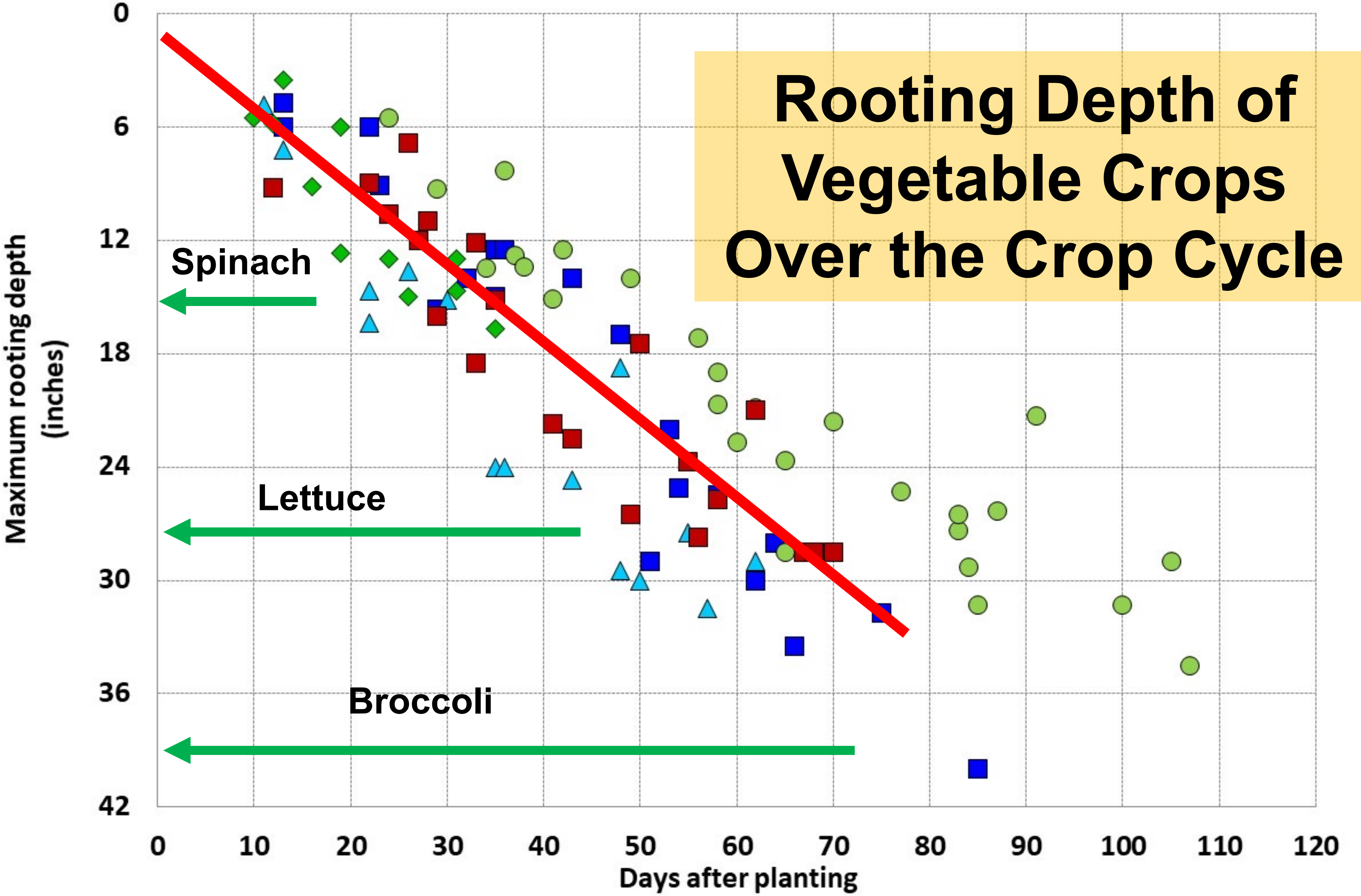
# Costs of Liquid Organic Fertilizers

| Material | Type | Cost/lb of Nitrogen |
|---|---|---|
| 5-1-2 | Liquid – Fish, corn | $12.10 |
| 4-1-3 | Liquid – Fish | $13.30 |
| 14-0-0 | Dry (soluble) – hydrolyzed soy protein | $18.50 – 35.70 |
| 4-4-2 | Dry – Poultry manure, feather and meat & bone | $4.20 |

# Crop Maturity and Fertilizer

- Fast maturing crops like spinach takes up 5-6 lbs N/A/day for the final two weeks (of a four week crop)
- The soil only supplied 0.5-0.8 lbs N/A/day
- Fertilizers and residual soil nitrate play a large role in supplying  the N needs of a crop like this
- Longer season crops like broccoli takes up 3-4 lbs N/A/day
- It needs adequate N early in the crop cycle to build a plant capable of developing a good root system that can scavenge N from deeper in the soil profile; soil organic matter can play a larger role in its N needs

# Rooting Depth, Soil Type and Irrigation Management affect NUE



## Summary:

- Organic soil fertility is more complex than conventional
- It takes careful observation to develop skills and expertise to manage nitrogen fertilization
- In our experience, growers often applied less N than the crop took up
    - Residual soil N, nitrate-N in irrigation water and mineralization from soil organic matter probably made up the difference in the N demand of the crop
- There is a great deal of research going on to better understand mineralization of N from organic materials and from soil organic matter