# Nitrogen Fertility Management in Organic Production

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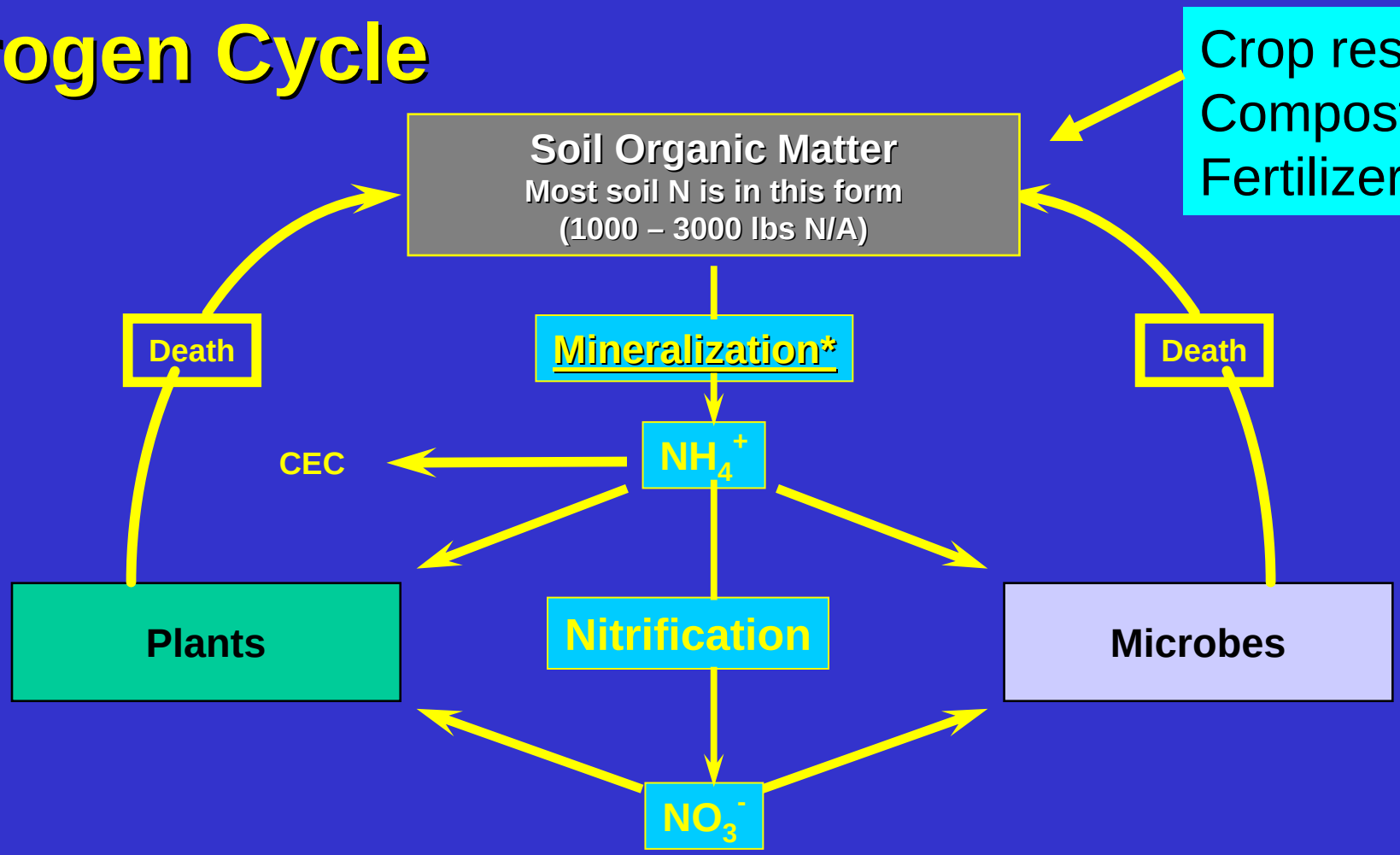
**Monterey, Santa Cruz and San Benito Counties**

# Characteristics of the Organic Production System

- Nearly all N is provided by organic sources
- Mineralization needs to occur to produce nitrate and ammonium for plant growth
- There is a need to build up levels of soil organic matter which is used as source of N for crop growth
- Cover crops, crop residues and fertilizers also contribute N for crop growth

# Nitrogen Cycle




*** Mineralization is a key step in making N available for plant growth**
**It is dependent upon adequate soil temperatures (i.e. > 50 F)**

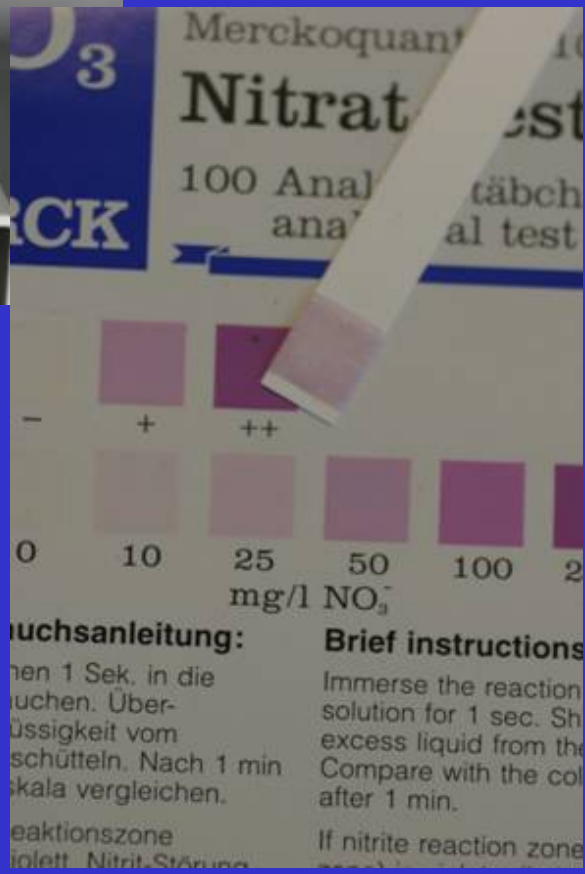
# Sources of Nitrogen for Crop Growth

1. Residual mineral N ($NO_3$-N and $NH_4$-N)
2. In season mineralization of N from soil organic matter
3. N availability from prior crops & cover crops
4. Organic Fertilizer

# 1. Residual Soil Mineral N (nitrate and ammonium pool)

- **Can be measured with the Presidedress Nitrate Quick Test**

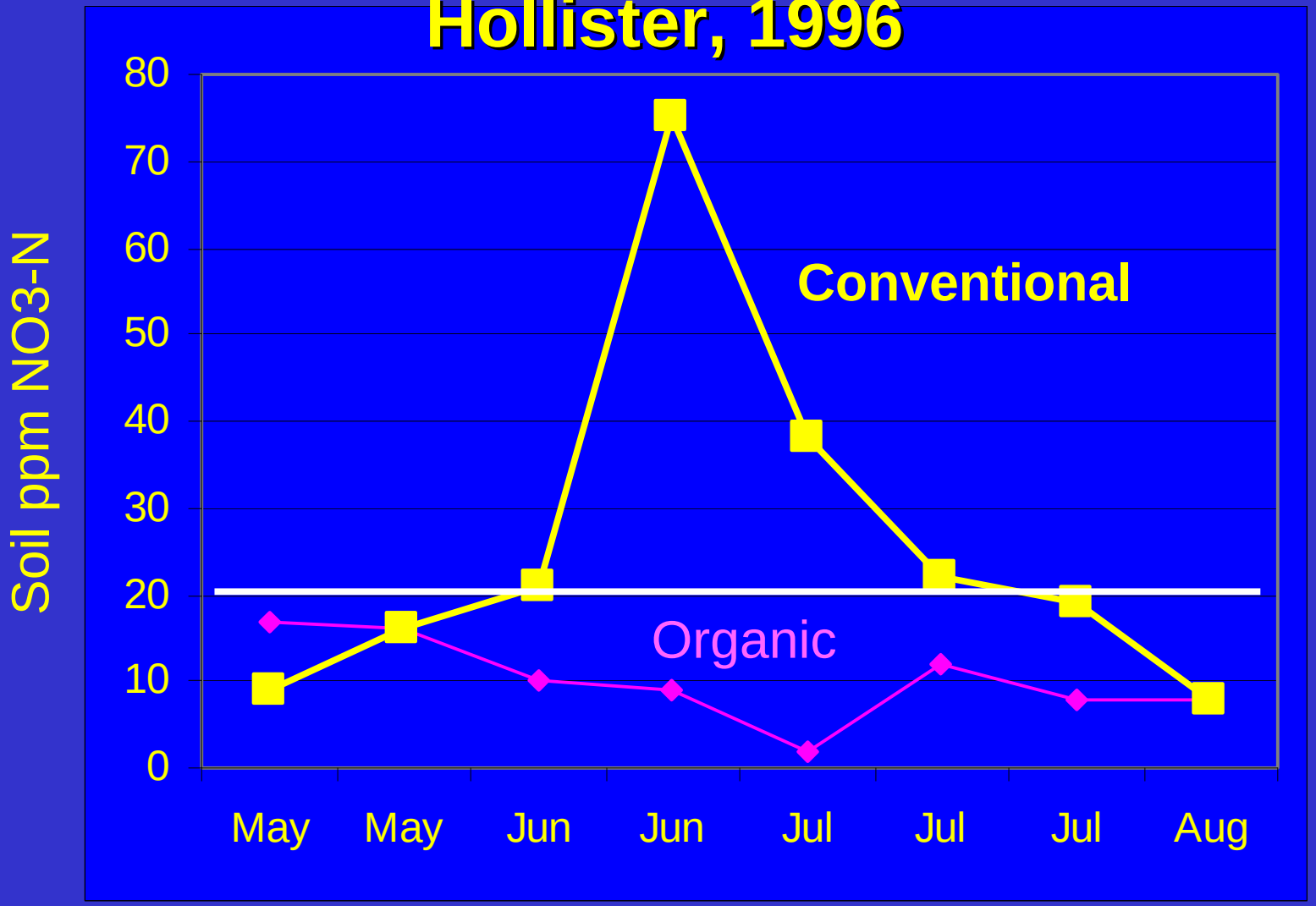
# Presidedress Nitrate Quick Test



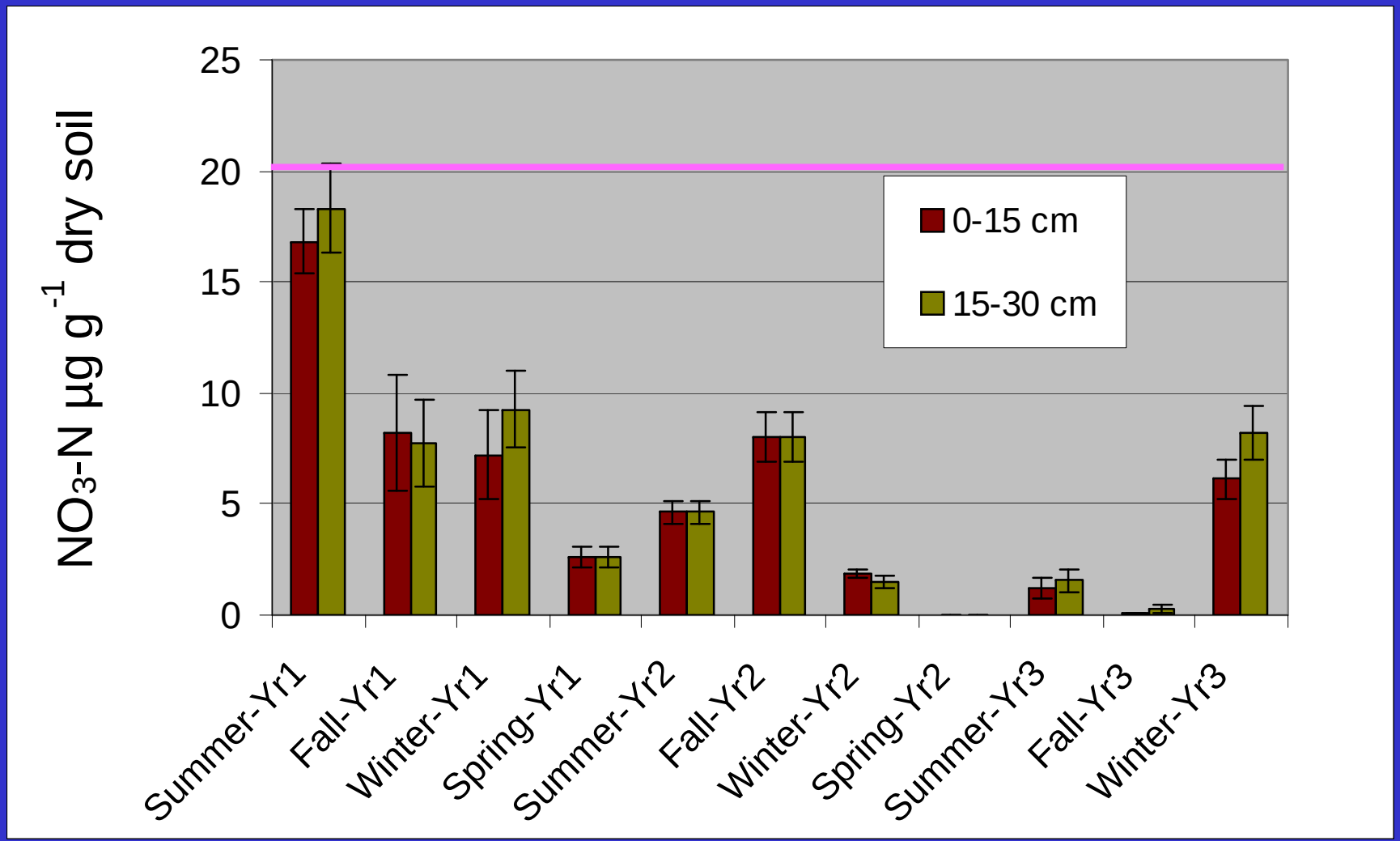
# Residual Soil Mineral N

- Nitrate is typically low in organic production systems
- Organic systems differ from conventional systems in that N management cannot typically be based on measuring a large pool of mineral N in the soil
- This can vary however, depending upon fertilization practices

# Comparison of Organic and Conventional Onions
## Hollister, 1996



# Soil Nitrate in Organic Vegetable Production 2001 - 2003




Jackson, 2005

# 2. In season mineralization of N from soil organic matter

- 2 to 5 % of soil organic matter decomposes annually
- As the organic matter decomposes $NH4^+$ and nitrate $NO3^-$ are released

# In season mineralization of N from soil organic matter

- A rough estimate of mineralization from soil organic matter can be made based on the amount of organic N present in the soil and the percent of that N likely to mineralize over a given period of time.

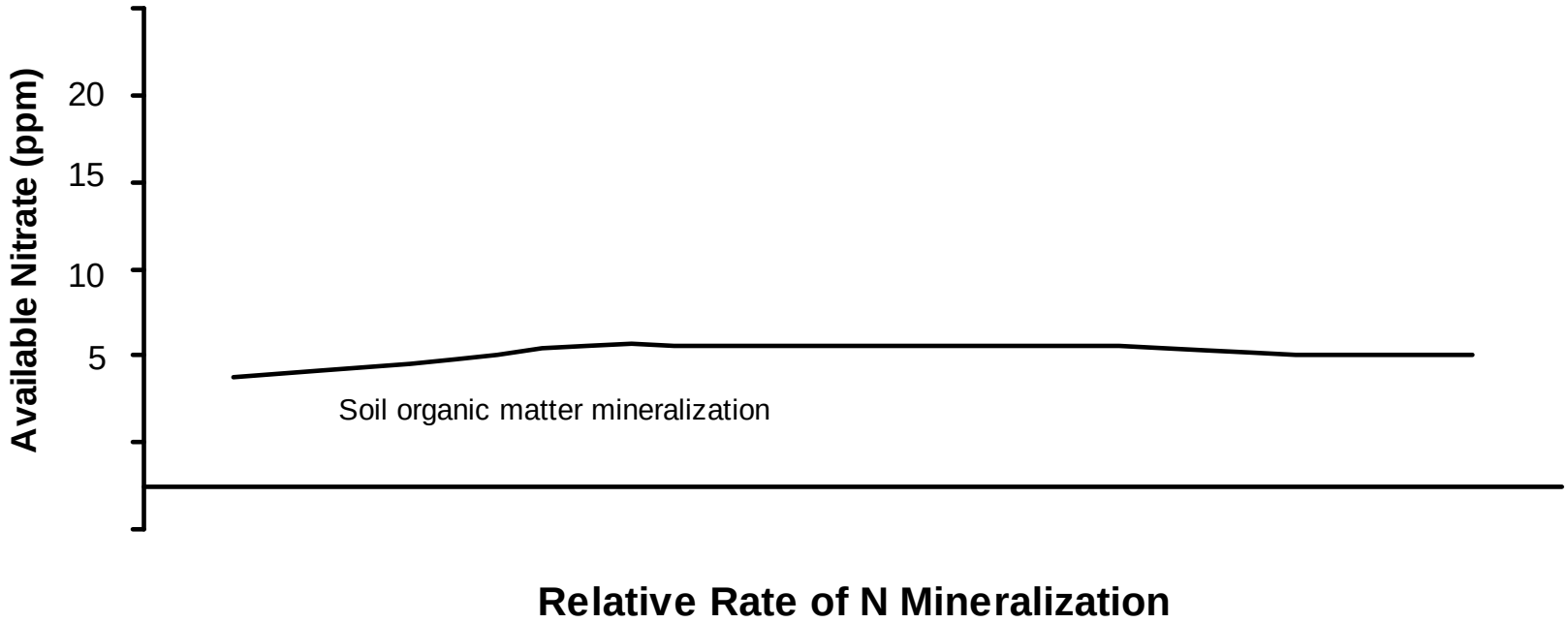
# In season mineralization of N from soil organic matter

**For a soil with 1% organic matter:**

- **2,800 lb organic N / acre x 0.02 (percent of organic N that mineralizes in 60 days) =**

**56 lb plant available N / acre over two months**

# Nitrogen Release Characteristics of N Soil Organic Matter



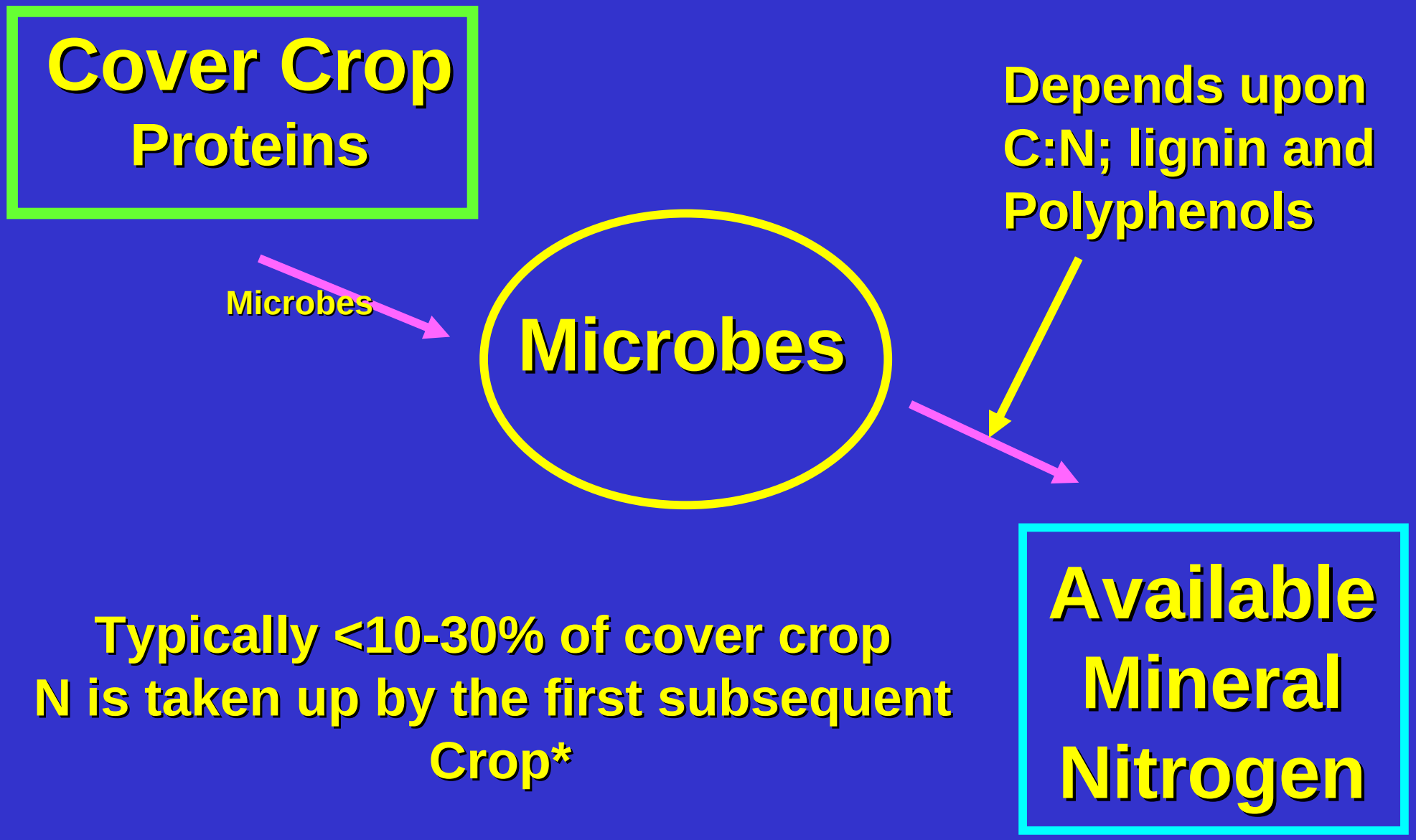
# 3. N availability from cover crops

- Cover crops typically take up or fix between 100-200 lbs N/ acre
- Cover crops are often tilled into the soil when the C:N ratio <20 to achieve a net release of N to the soil to feed subsequent vegetable crops
- Cover crops with a low N content such as mature cereals (i.e. C:N ratio > 20) temporarily tie up nitrogen*

* soil microbes utilize available soil N to break down the cover crop residue

# Nitrogen release from cover crop residue based on the N content

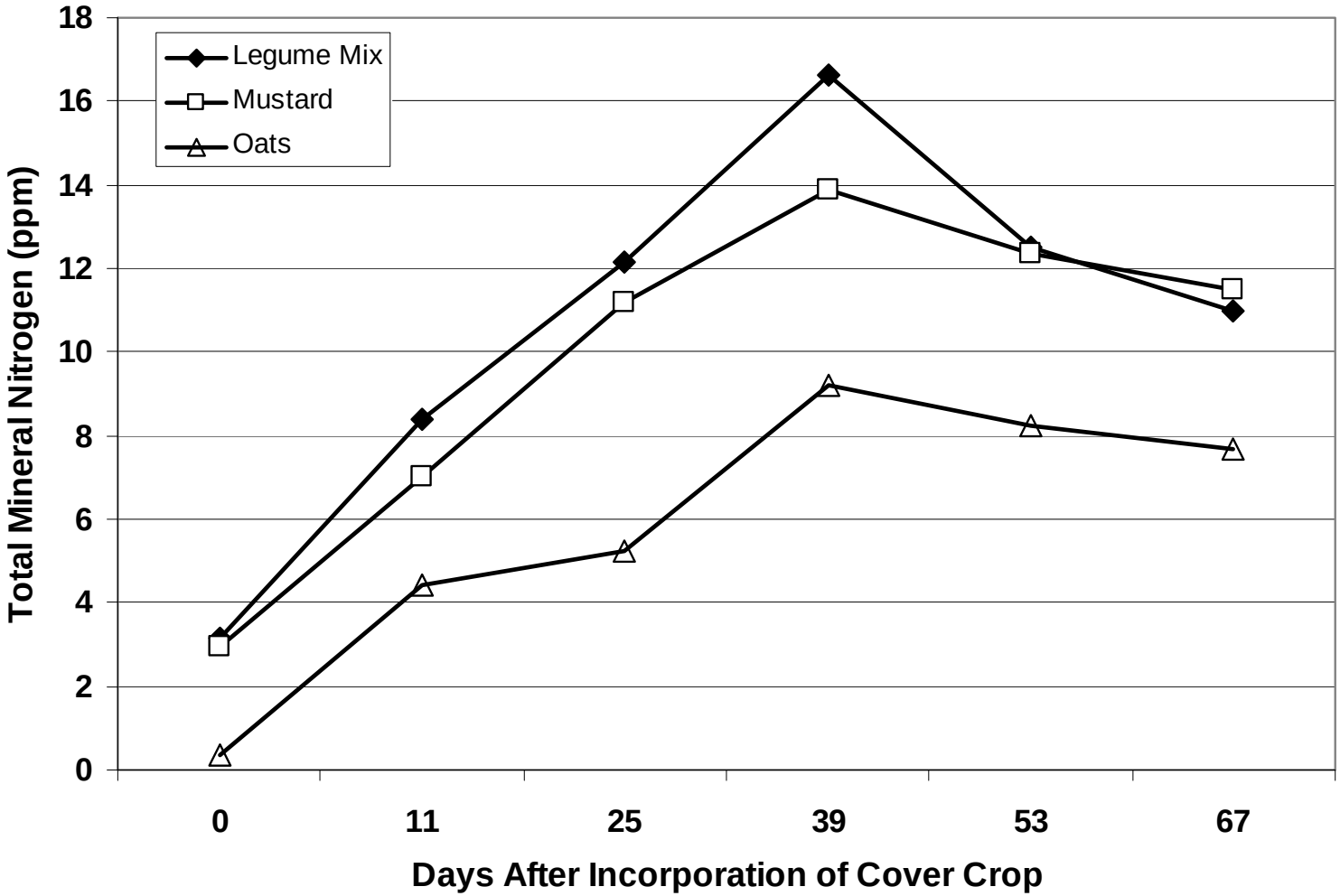
| Nitrogen Release | Percent N in Cover Crop | Examples of Cover Crops |
|---|---|---|
| Will Tie up N | 0.5 | Cereal Straw |
| Will Tie up N | 1.0 | Cereal Straw |
| Will Tie up N | 1.5 | Cereal at heading |
| May Tie up N* | 2.0 | Cereal pre heading |
| May Tie up N* | 2.5 | Mustards at heading and Imm. cereal |
| Will Release N | 3.0 | Mustards, legumes and juvenile cereal |
| Will Release N | 3.5 | Legumes and immature mustards |
| Will Release N | 4.0 | Legumes |


Cover Crop
Proteins
Depends upon
C:N; lignin and
Polyphenols
Microbes
Microbes
Available
Mineral
Nitrogen
Typically <10-30% of cover crop
N is taken up by the first subsequent
Crop*
* A good deal of cover crop N remains in the system and can
can be taken up in later years (i.e. 73%)

# N availability from cover crops

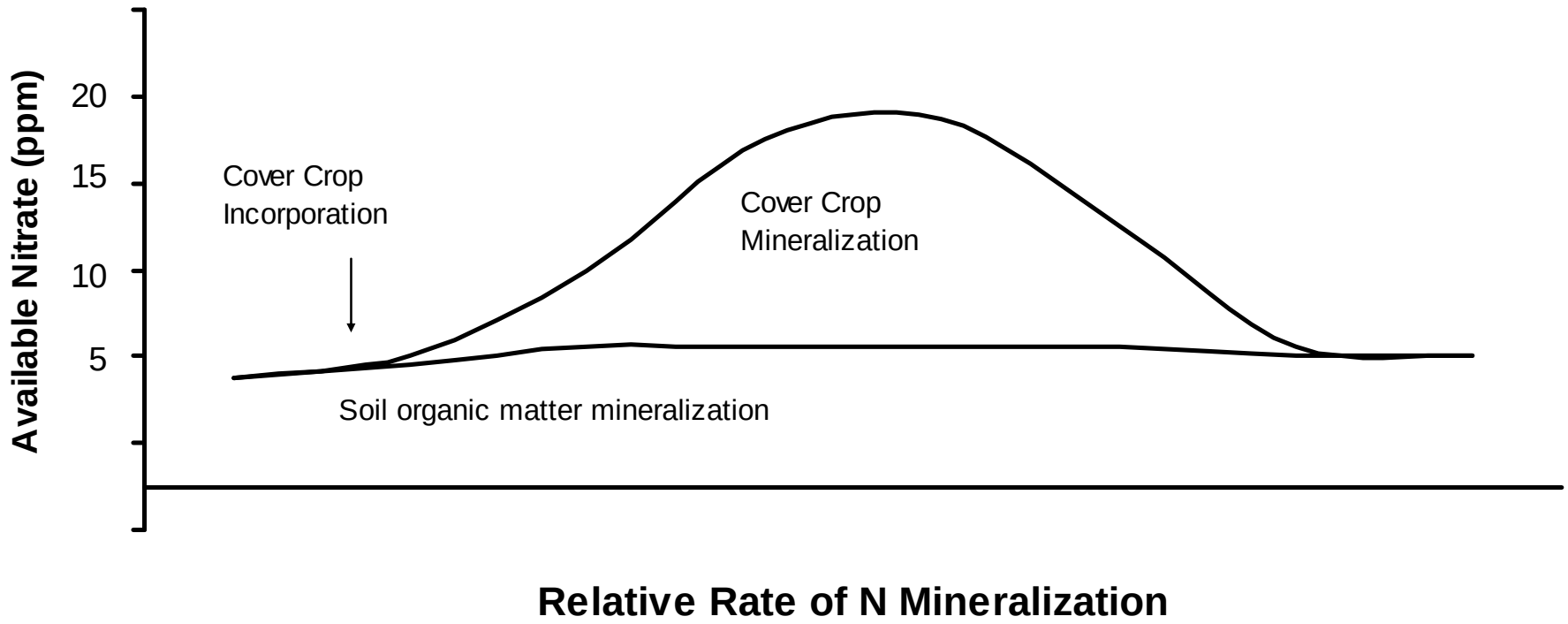
- The rate of mineralization of available N from a low C:N (<20) cover crop increases over a three- to six-week period following incorporation
- Soil N levels return to pre-incorporation levels by week 6-10

# N Release Pattern from Cover Crops




Smith & Brennan, 2003

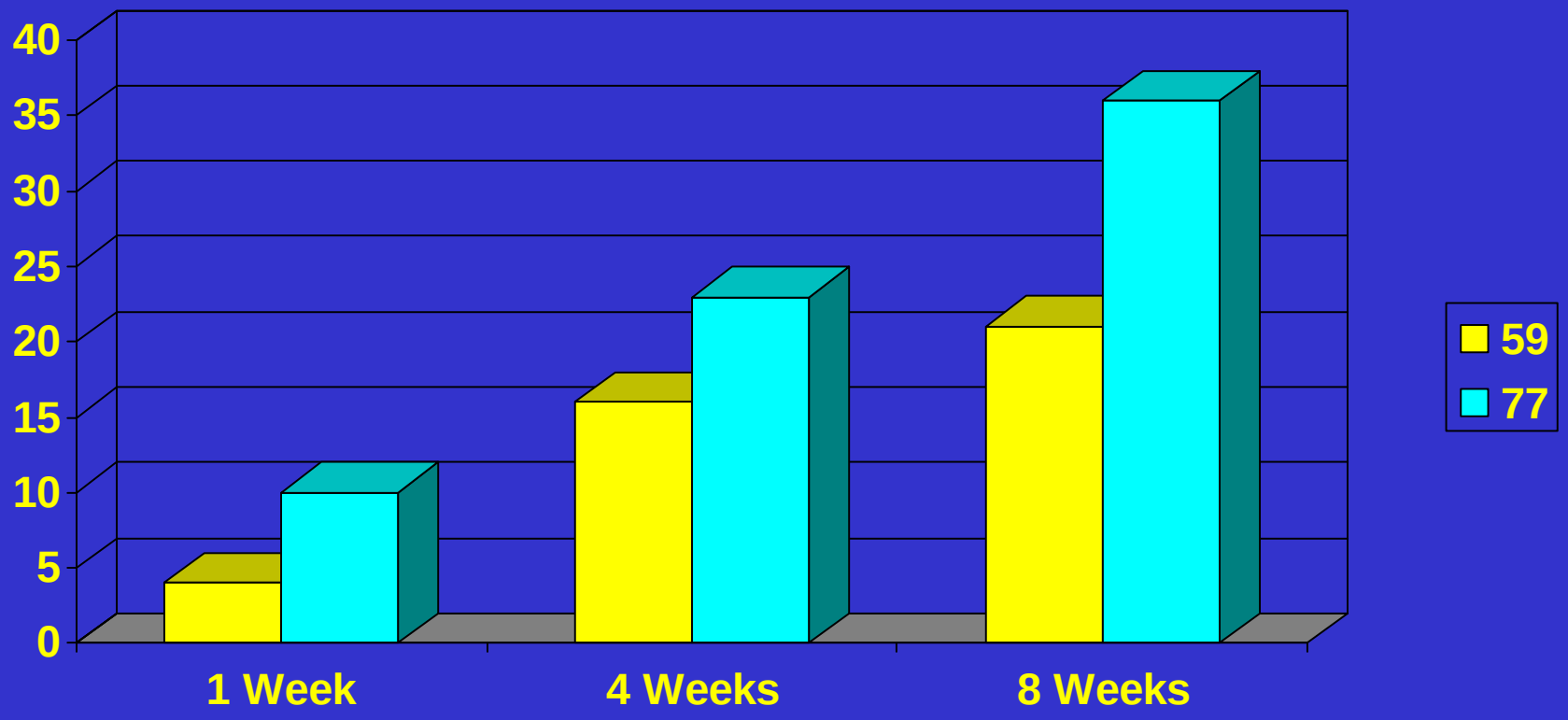
# Nitrogen Release Characteristics of N From Cover Crop



# 4. N Availability from Organic Fertilizers

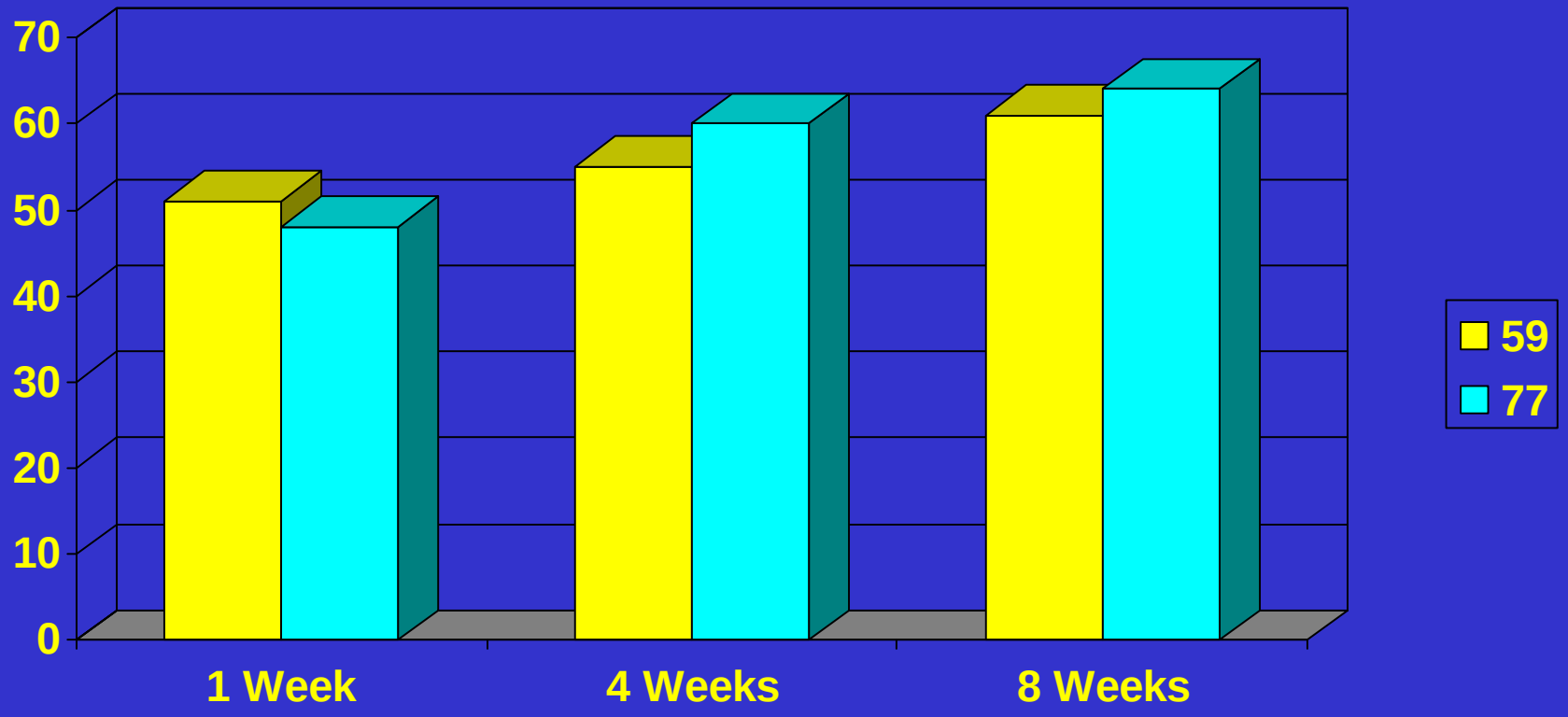
| Material | Nitrogen | Material | Nitrogen |
|---|---|---|---|
| Chilean nitrate | 16 | Soybean meal | 7 |
| Blood meal | 12 | Processed liquid fish | 4 |
| Feather meal | 12 | Alfalfa meal | 4 |
| Seabird and bat guano | 9-12 | Pelleted chicken manure | 2-4 |
| Fish meal or powder | 10-11 | Bone Meal | 2 |
| Meat and bone meal | 8 | Kelp | <1 |

# Pelleted Poultry Manure
# Net N Mineralization



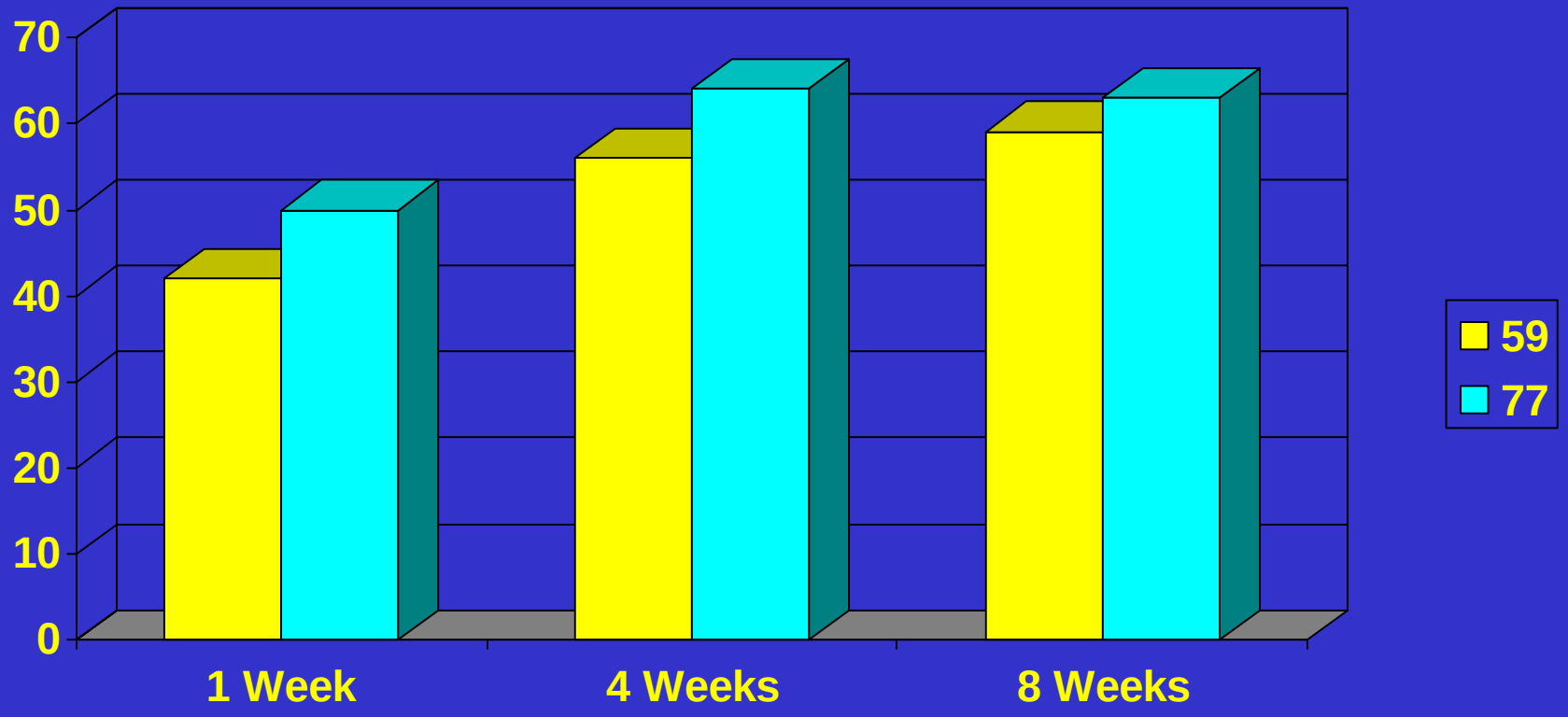

Hartz and Johnstone, 2006

# Fish Powder
# Net N Mineralization




Hartz and Johnstone, 2006

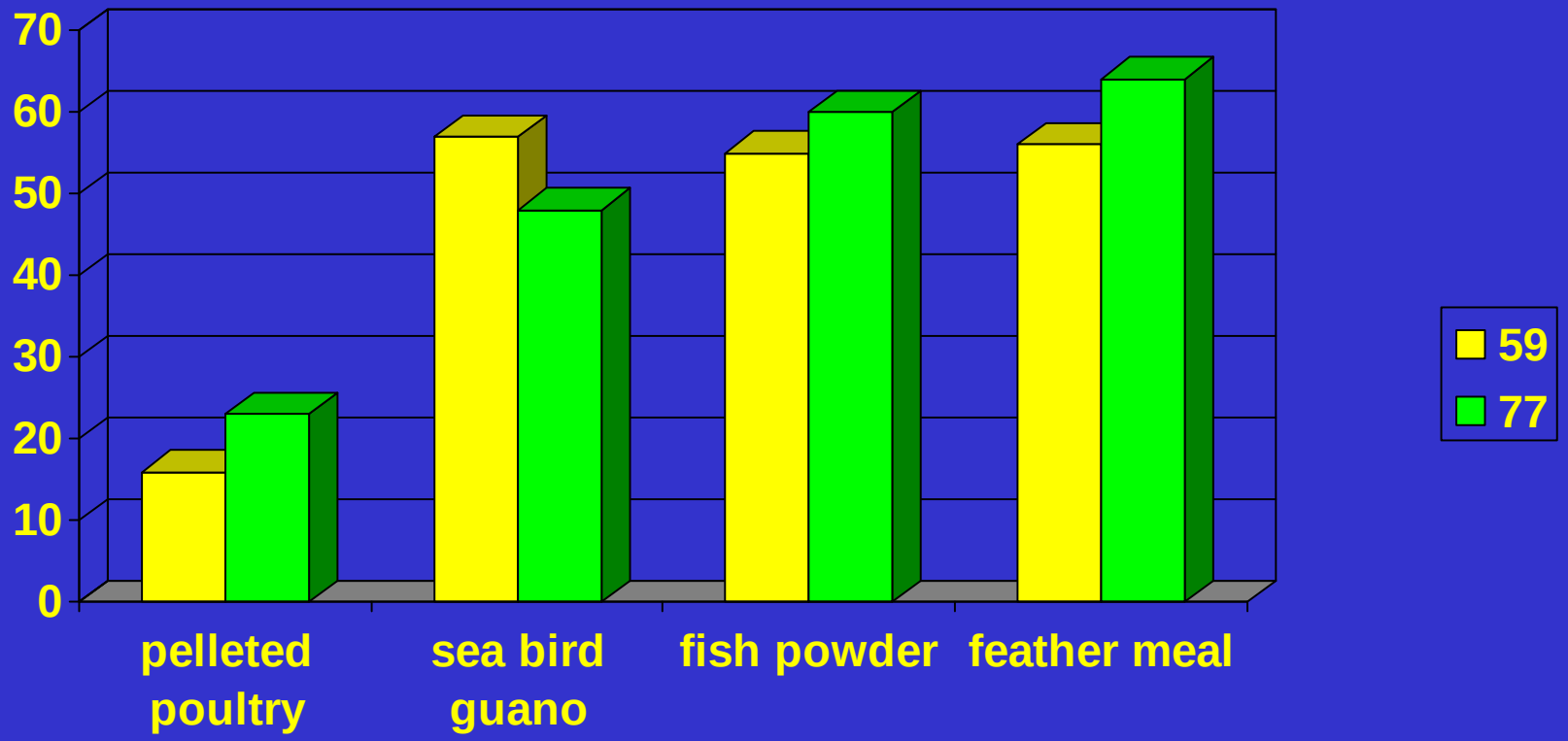
# Feather Meal
# Net N Mineralization




## Incubation - Weeks

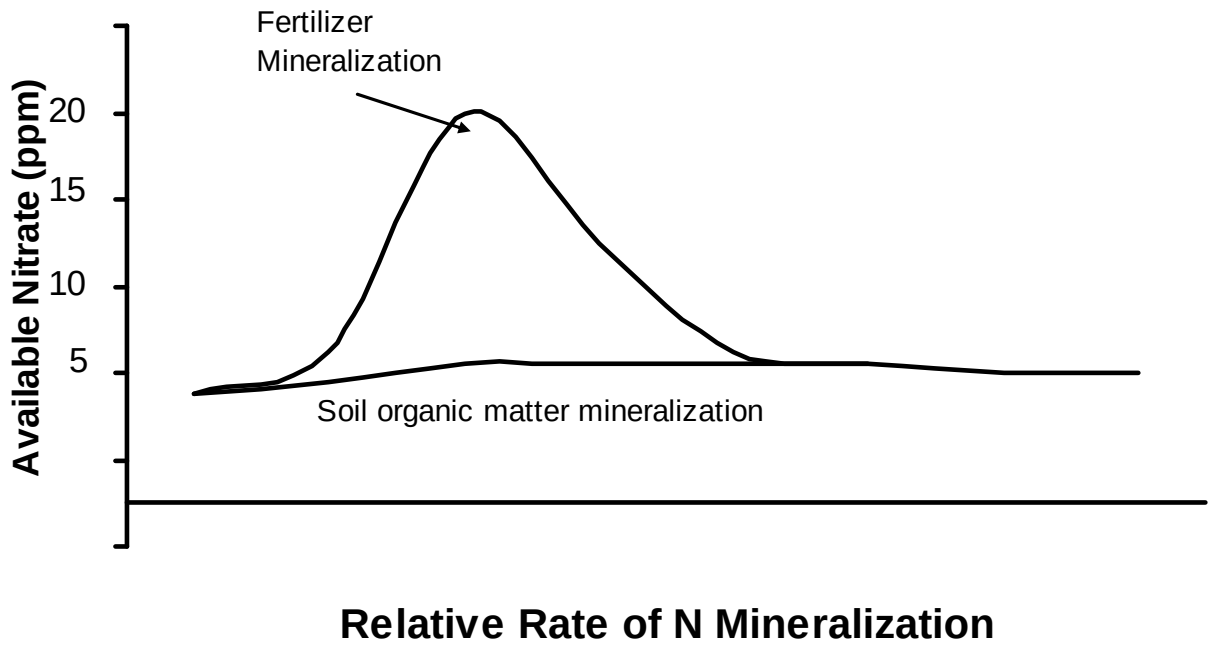
Hartz and Johnstone, 2006

# Percent of Initial Organic N Mineralized – 4 Weeks Incubation



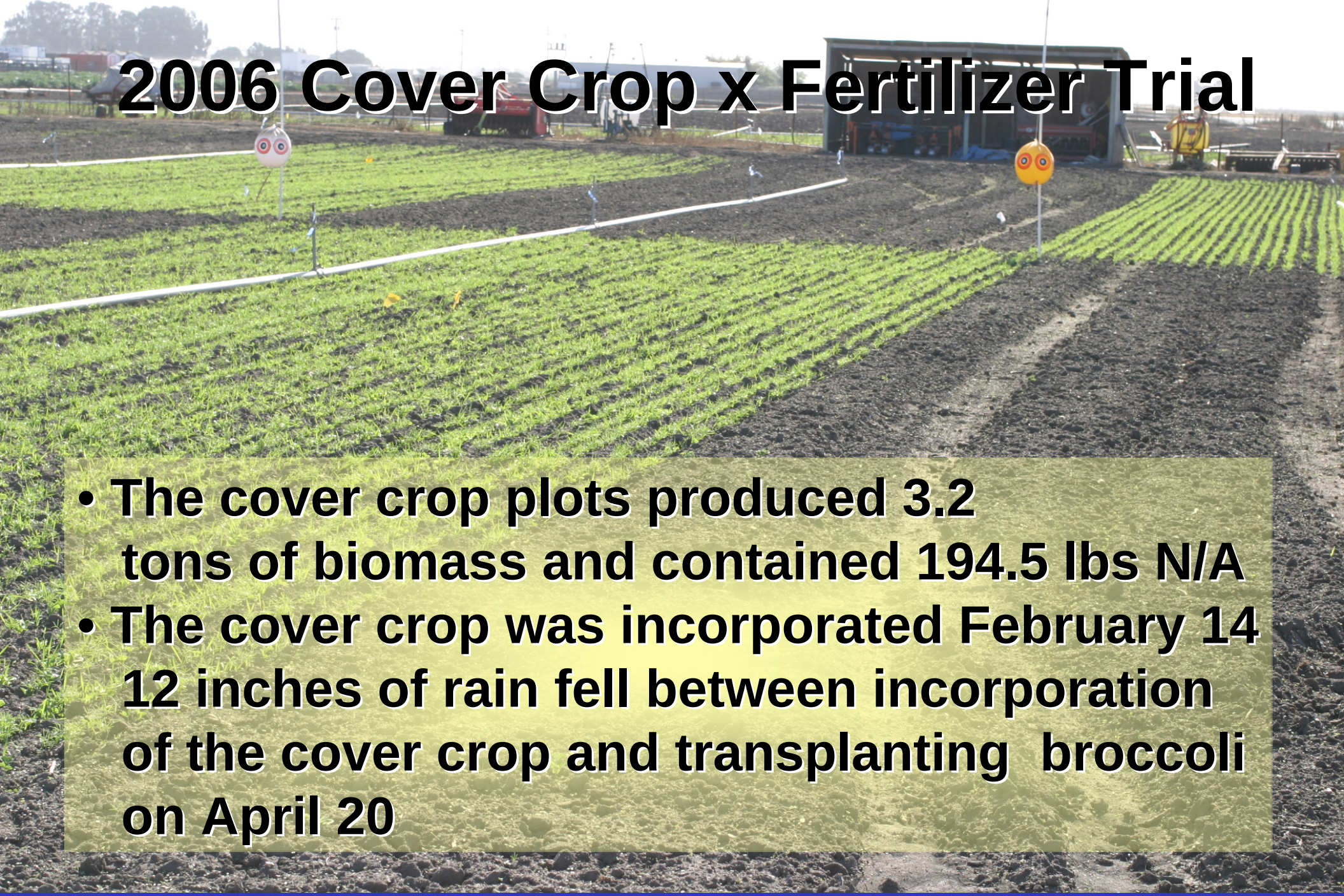

Hartz and Johnstone, 2006

# Nitrogen Release Characteristics of N From Fertilizer



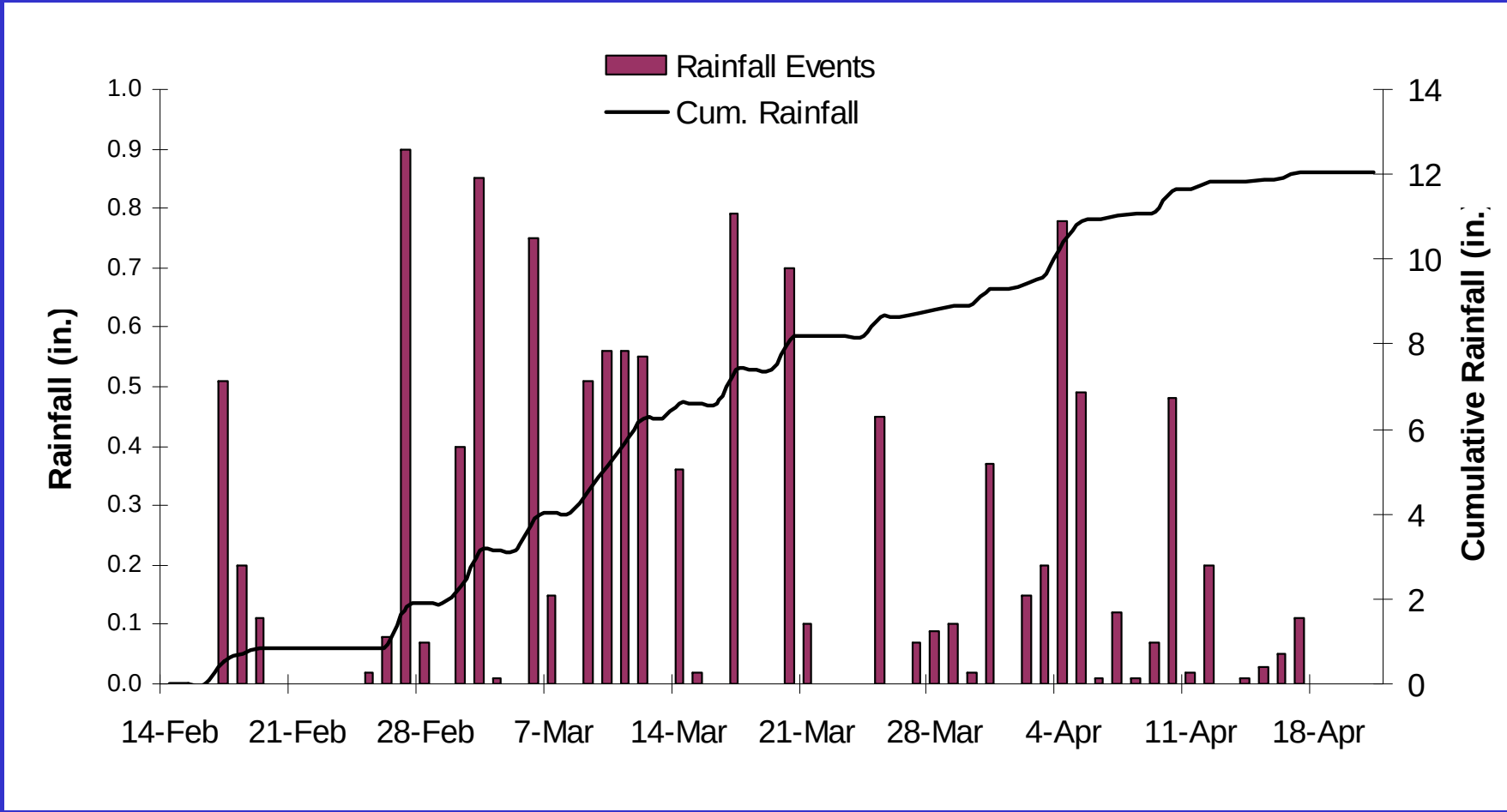
# Integrating Sources of N for Organic Production

# 2006 Cover Crop x Fertilizer Trial

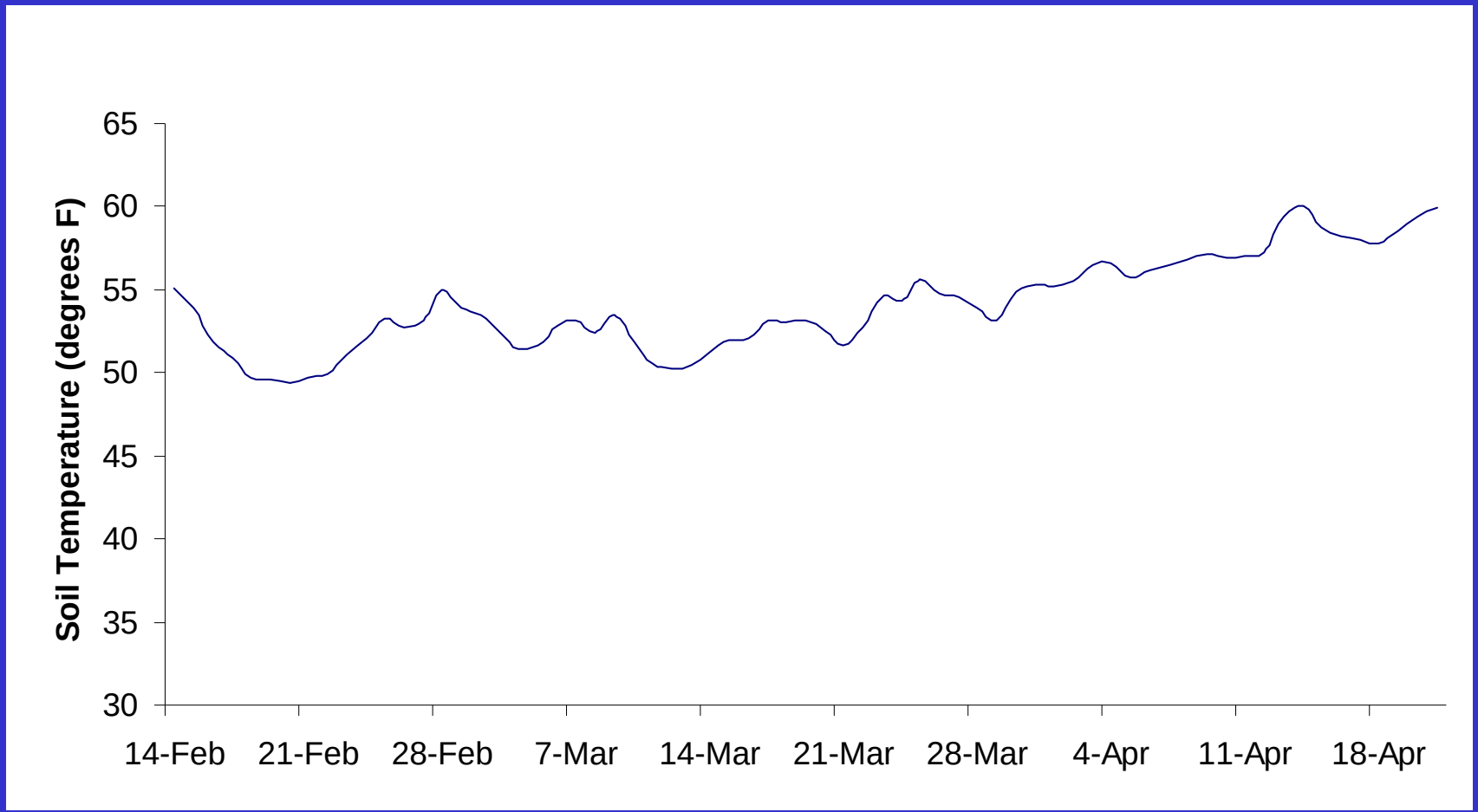


- The cover crop plots produced 3.2 tons of biomass and contained 194.5 lbs N/A
- The cover crop was incorporated February 14 12 inches of rain fell between incorporation of the cover crop and transplanting broccoli on April 20

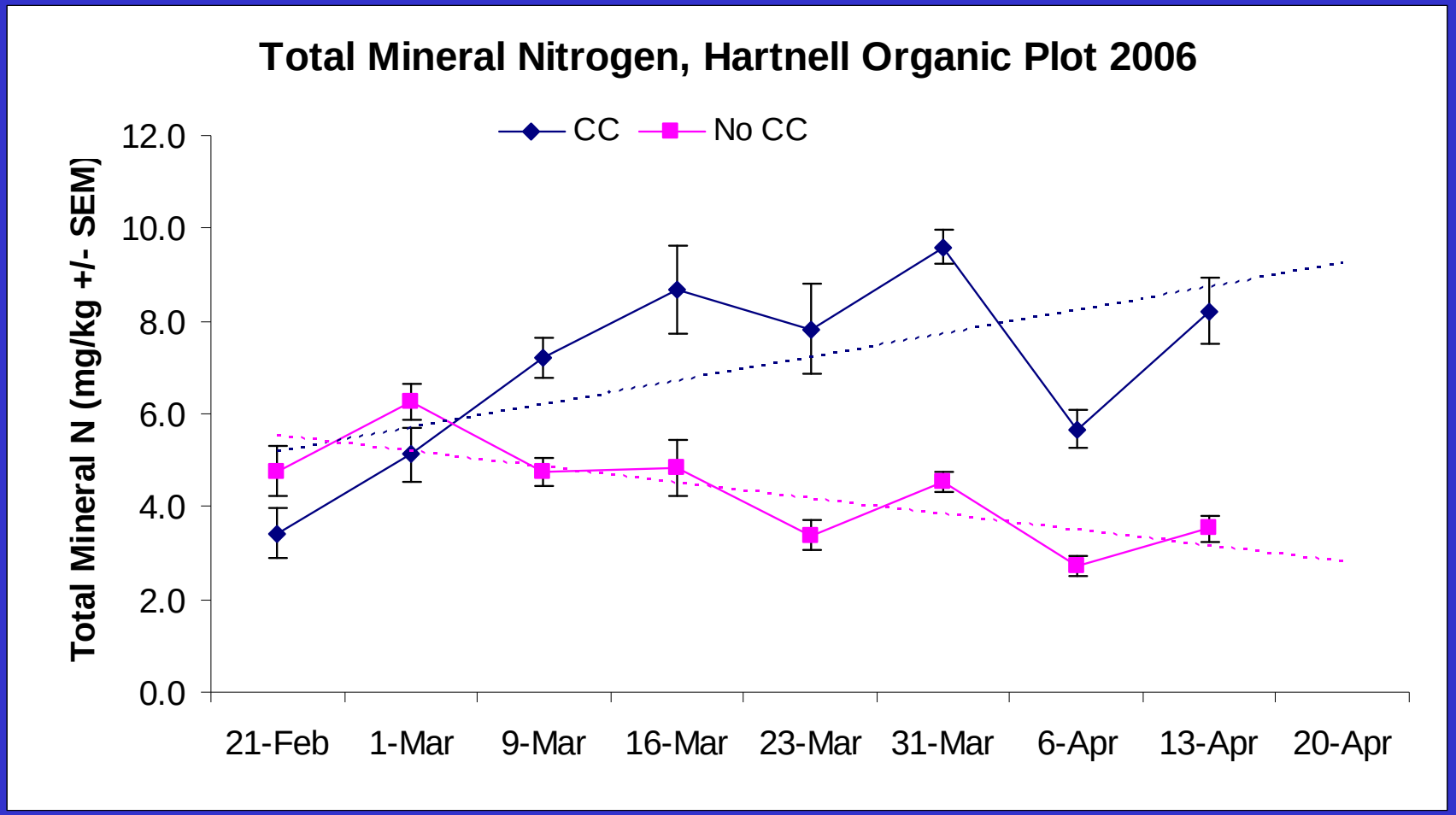
# Rain Events Between Cover Crop Incorporation and Transplanting Broccoli



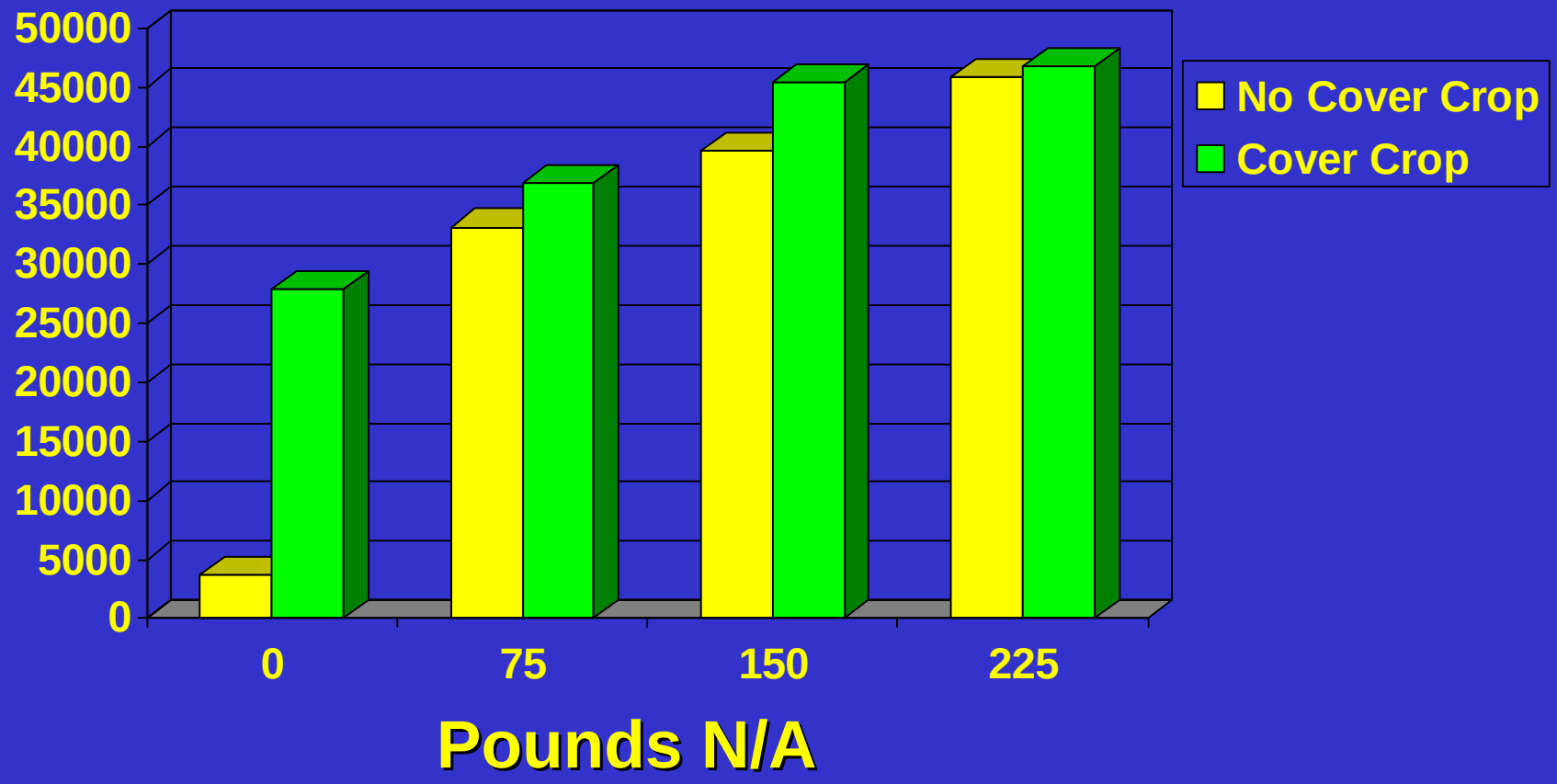
# Soil Temperatures Between Cover Crop Incorporation and Transplanting Broccoli



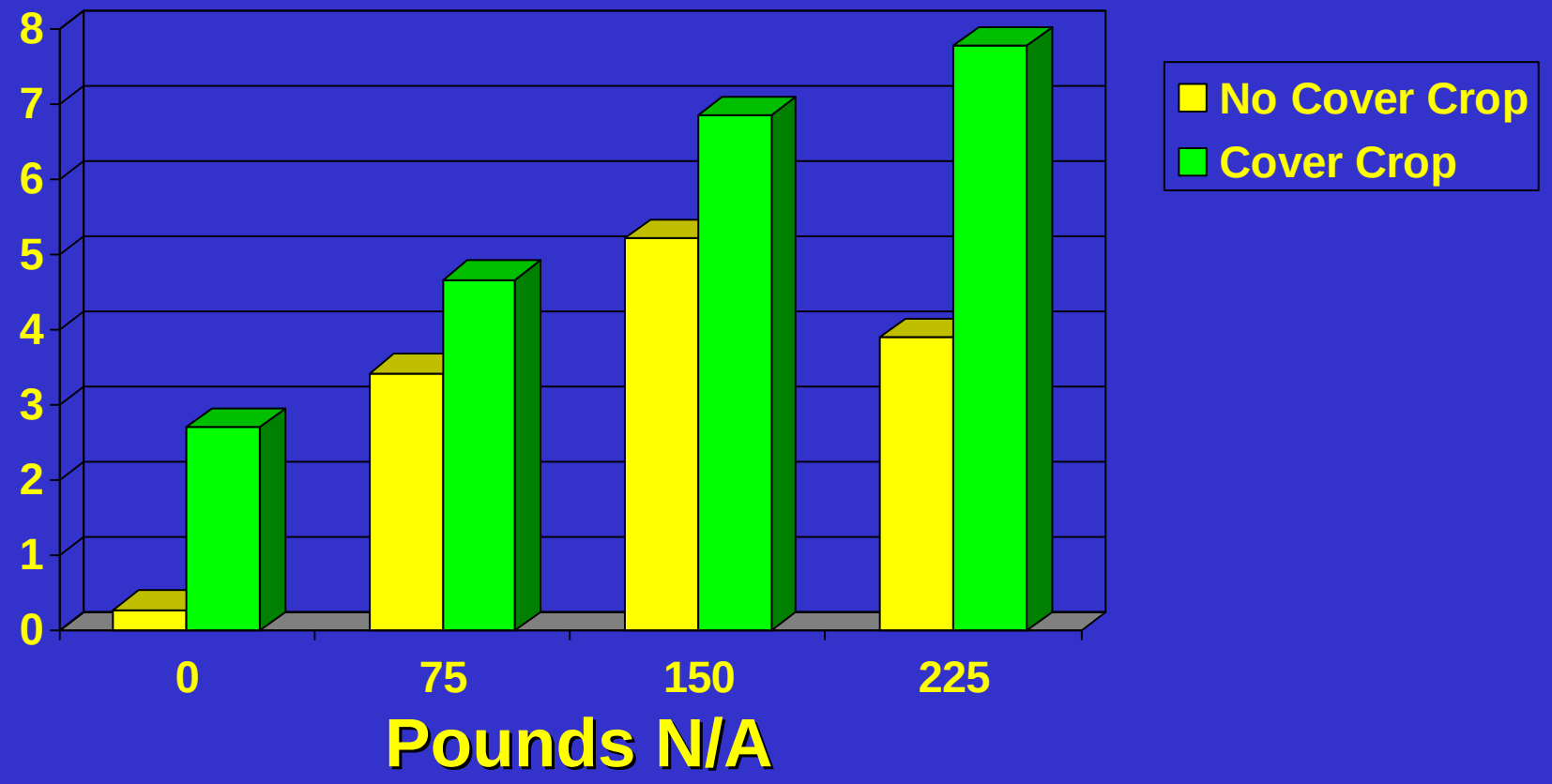
# Total Mineral Nitrogen in Soil Between Cover Crop Incorporation and Transplanting Broccoli



# Harvest – Number of Heads Number/A



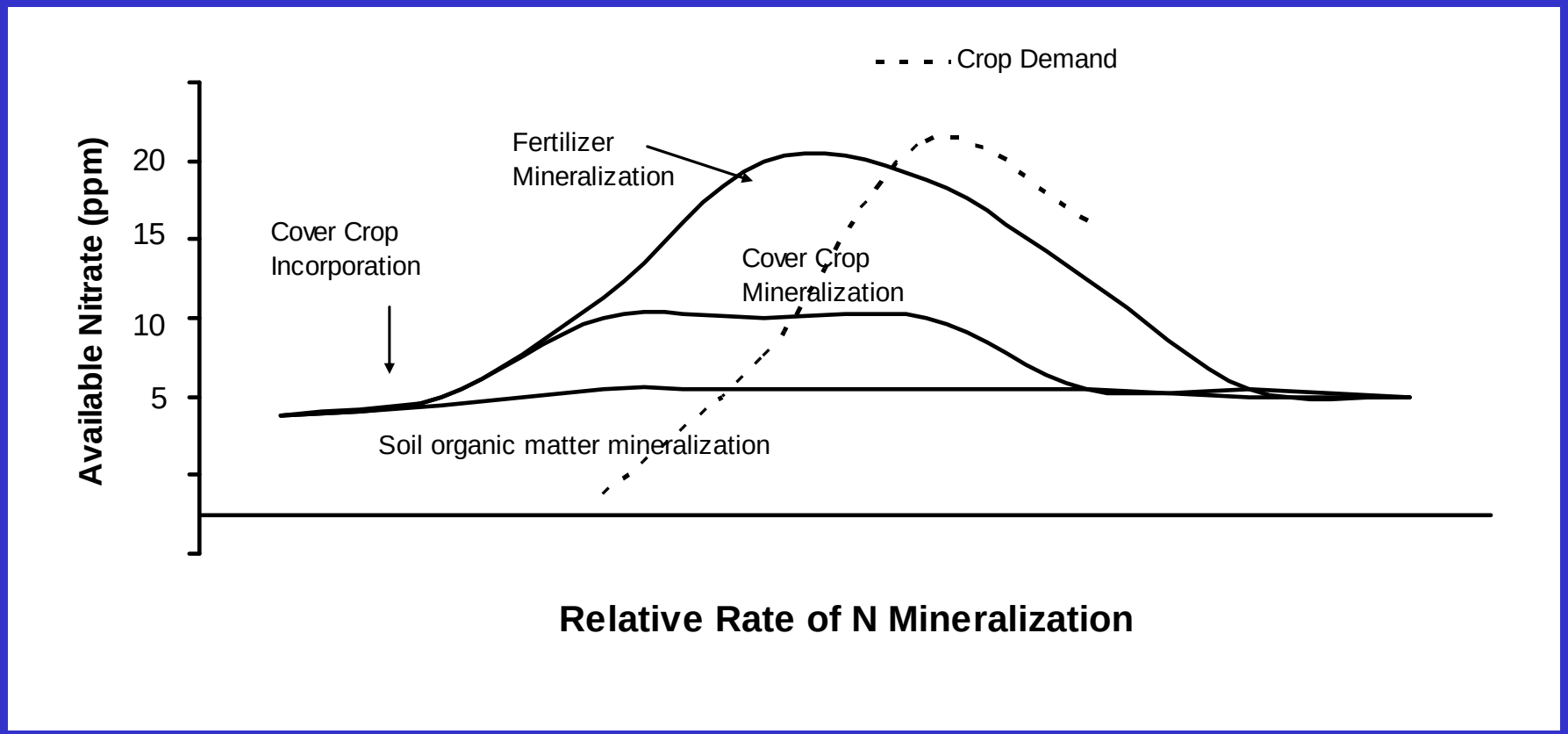
# Harvest – Weight of Heads Tons/A



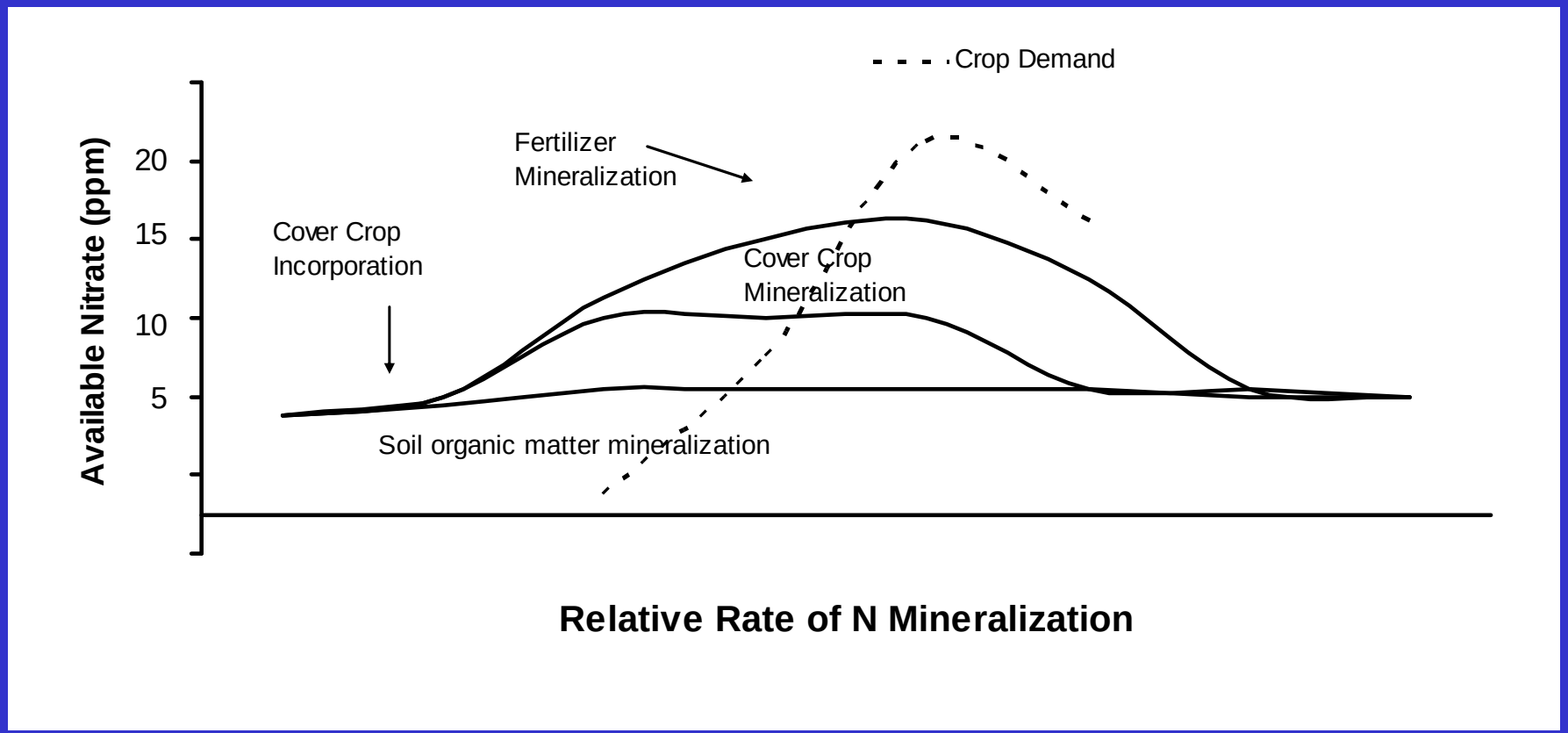
# N availability from cover crops

- It is likely that a substantial portion of the nitrogen contained in the cover crop was lost to leaching prior to planting the broccoli
- In spite of these conditions, there was an increase of 25 lbs of N/A in the biomass of broccoli in cover cropped plots vs non-cover cropped plots at the end of the growing season.
- Mark Gaskell has typically seen cover crops to contribute 100 lbs of N/A in studies on peppers and cabbage

# High Yielding Treatments Low Synchrony form Cover Crop but Good Synchrony of N Release from Fertilizer



# Low Yielding Treatments had Poor Synchrony between N Availability from Cover Crop and Fertilizer Rates that were too Low

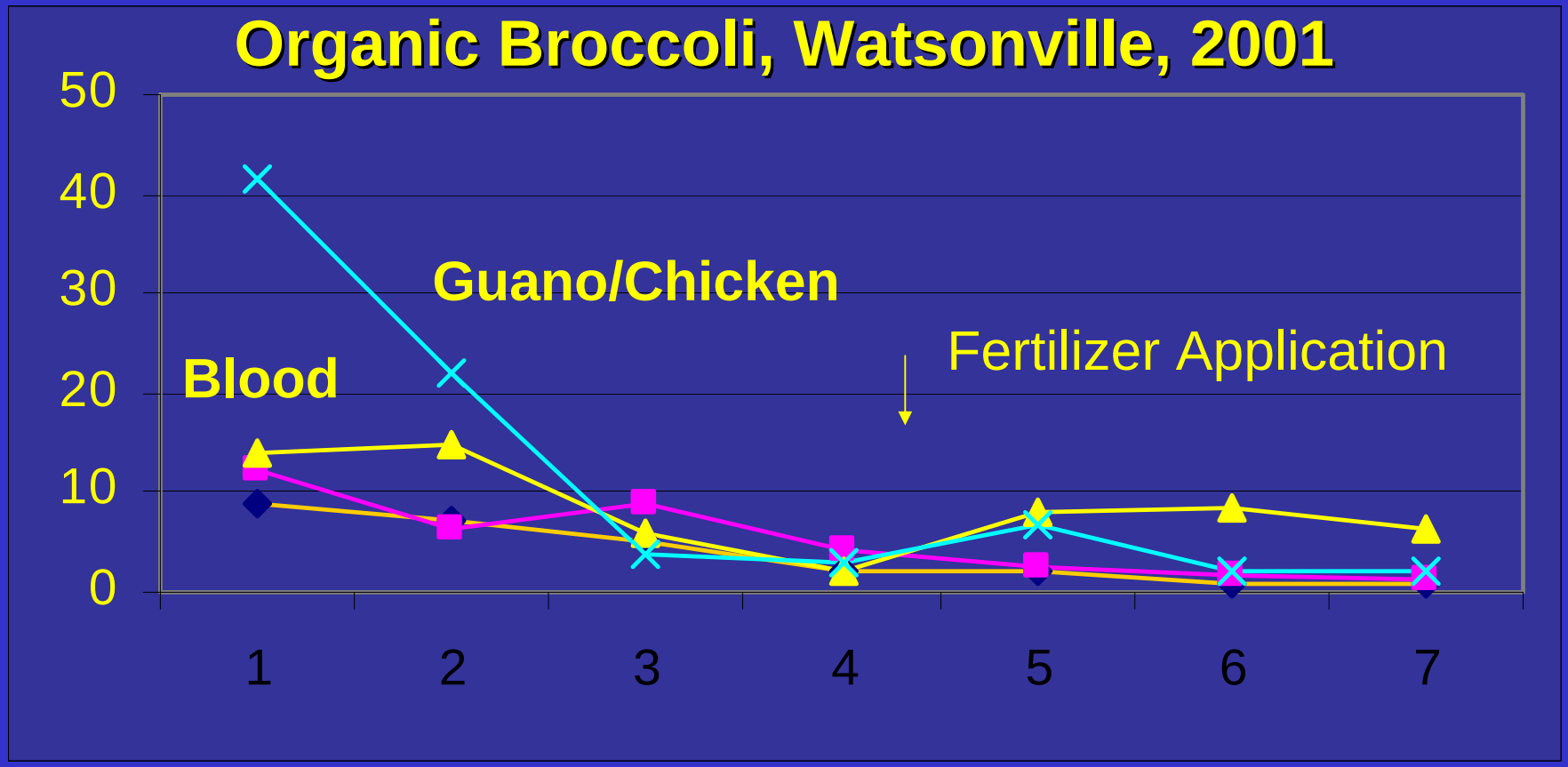


# Organic Fertilizer Form and Timing Trial Watsonville, 2001

| Treatment | Preplant May 8 | Top dress May 31 | Top dress June 7 | Top dress June 14 | Total |
|---|---|---|---|---|---|
| Untreated | 0 | 0 | 0 | 0 | 0 |
| Fert Treat No. 1 | 45 | 45 | 45 | 45 | 180 |
| Fert Treat No. 2 | 90 | 0 | 45 | 45 | 180 |
| Fert Treat No. 3 | 135 | 0 | 0 | 45 | 180 |

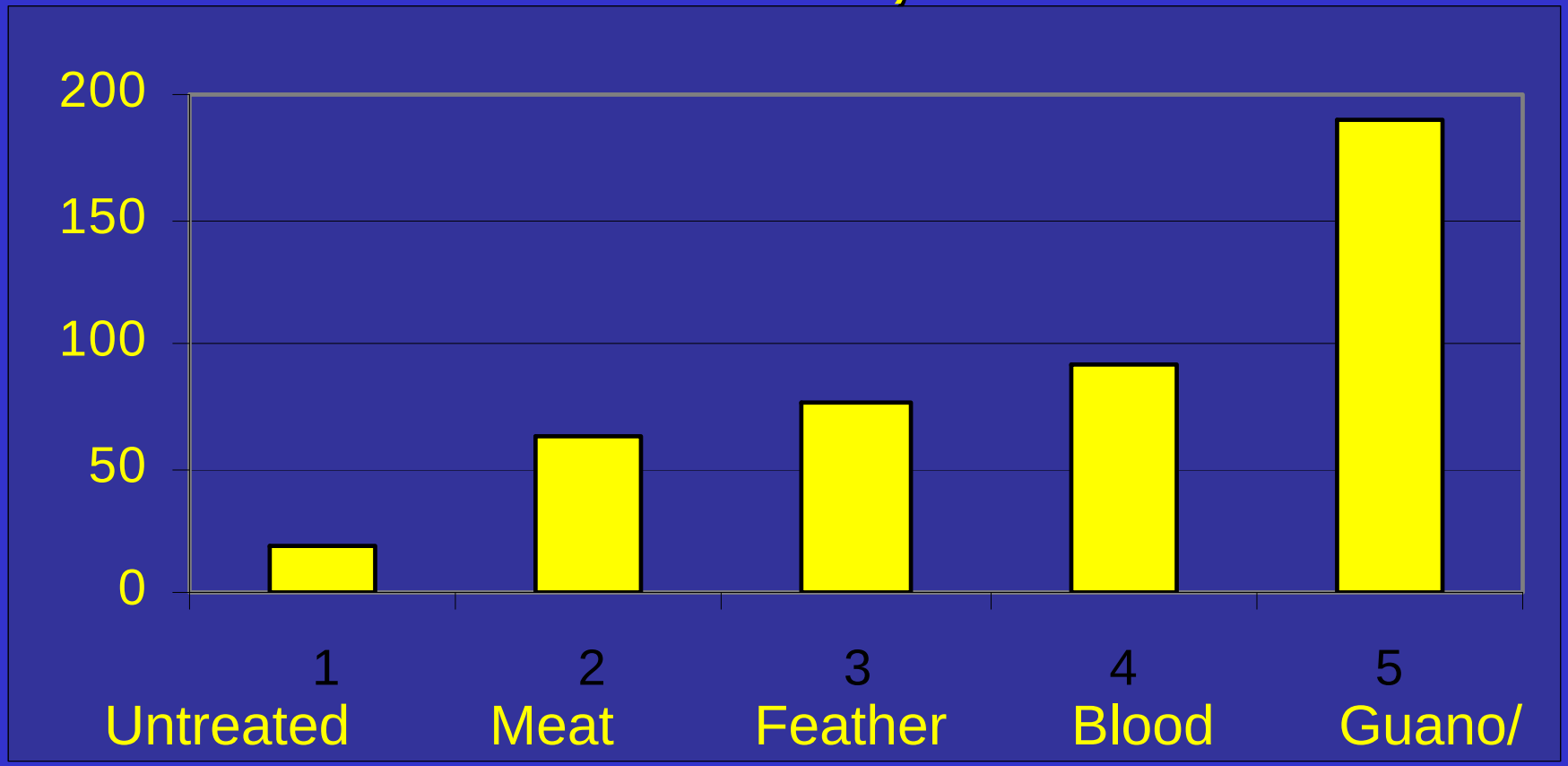
1) Meat Meal 8-5-1; 2) Feather Meal 12-0-0
3) Blood Meal 13-0-0; 4) Guano/Chicken 7-0-0

# Nitrate-Nitrogen in the Soil of 135-45 Fertilizer Treatments

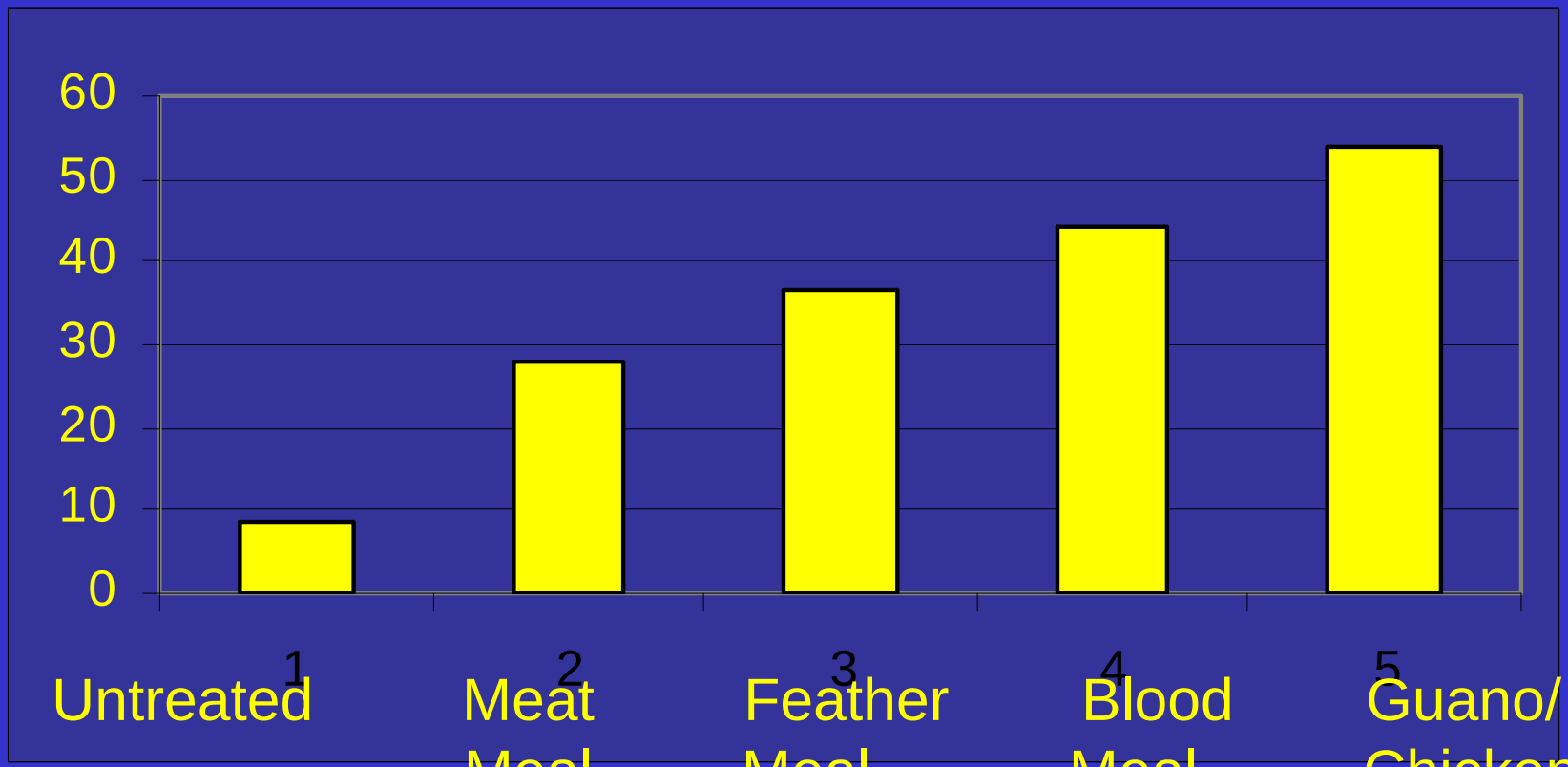


# Total Number of Heads, Organic Broccoli

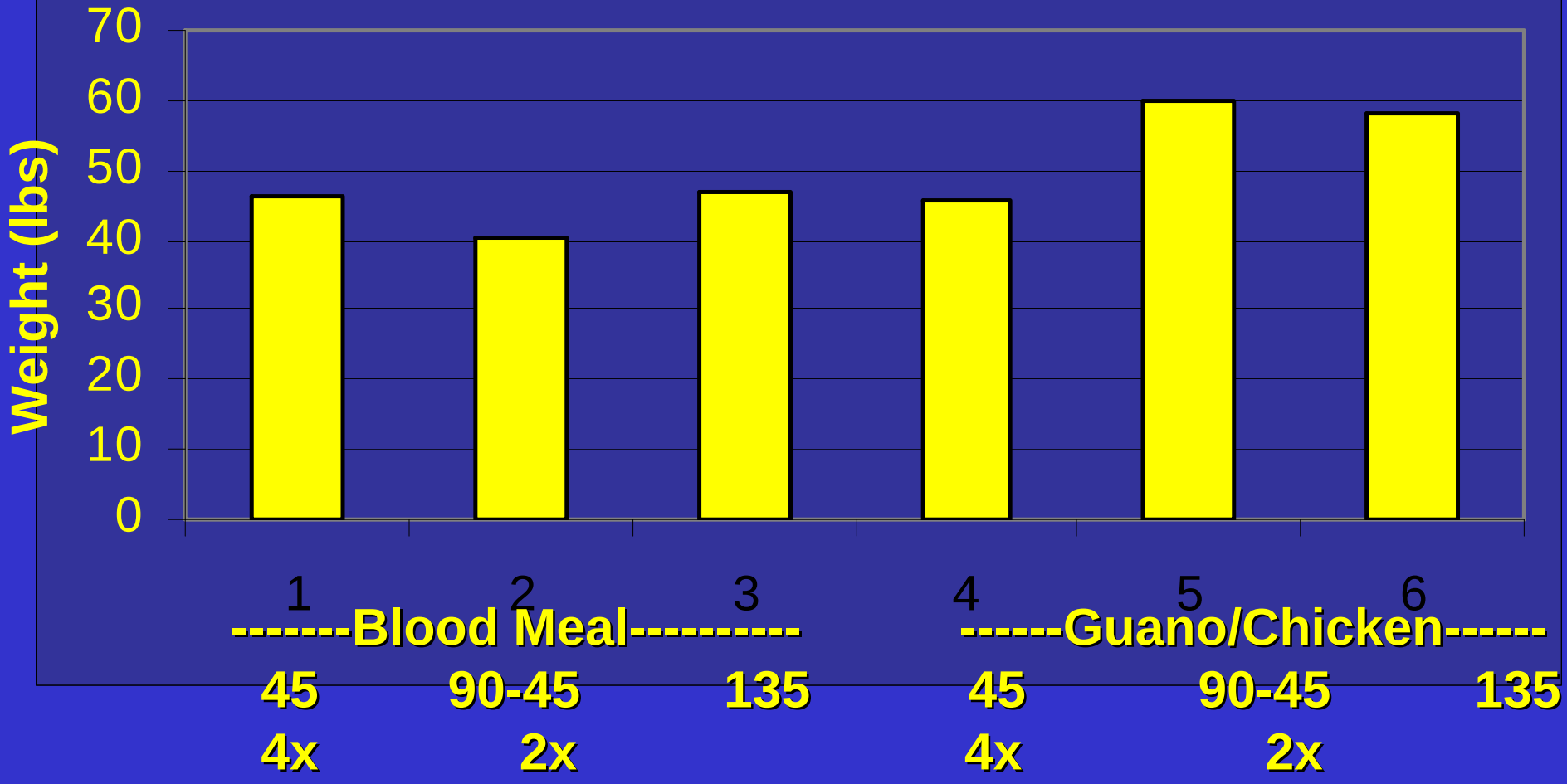
## Watsonville, 2001



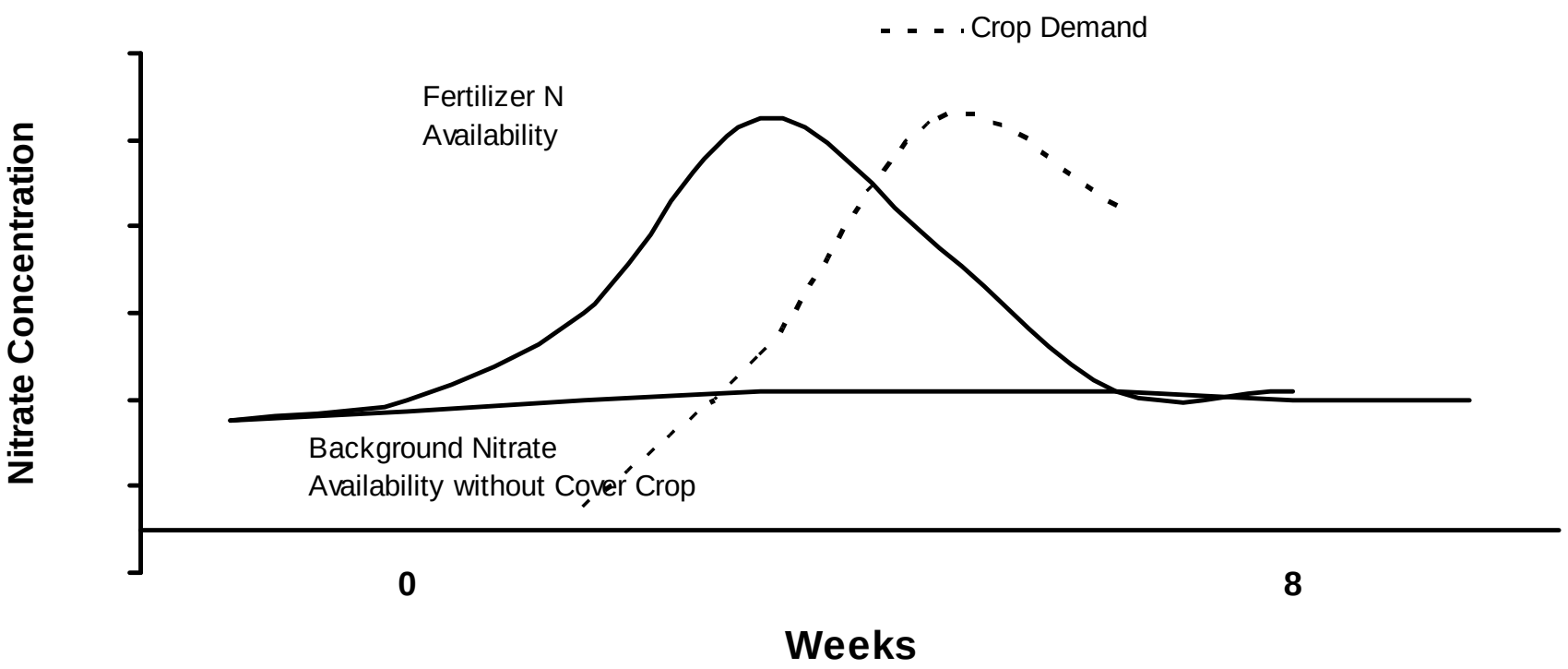
# Total Weight of Heads, Organic Broccoli
## Watsonville, 2001



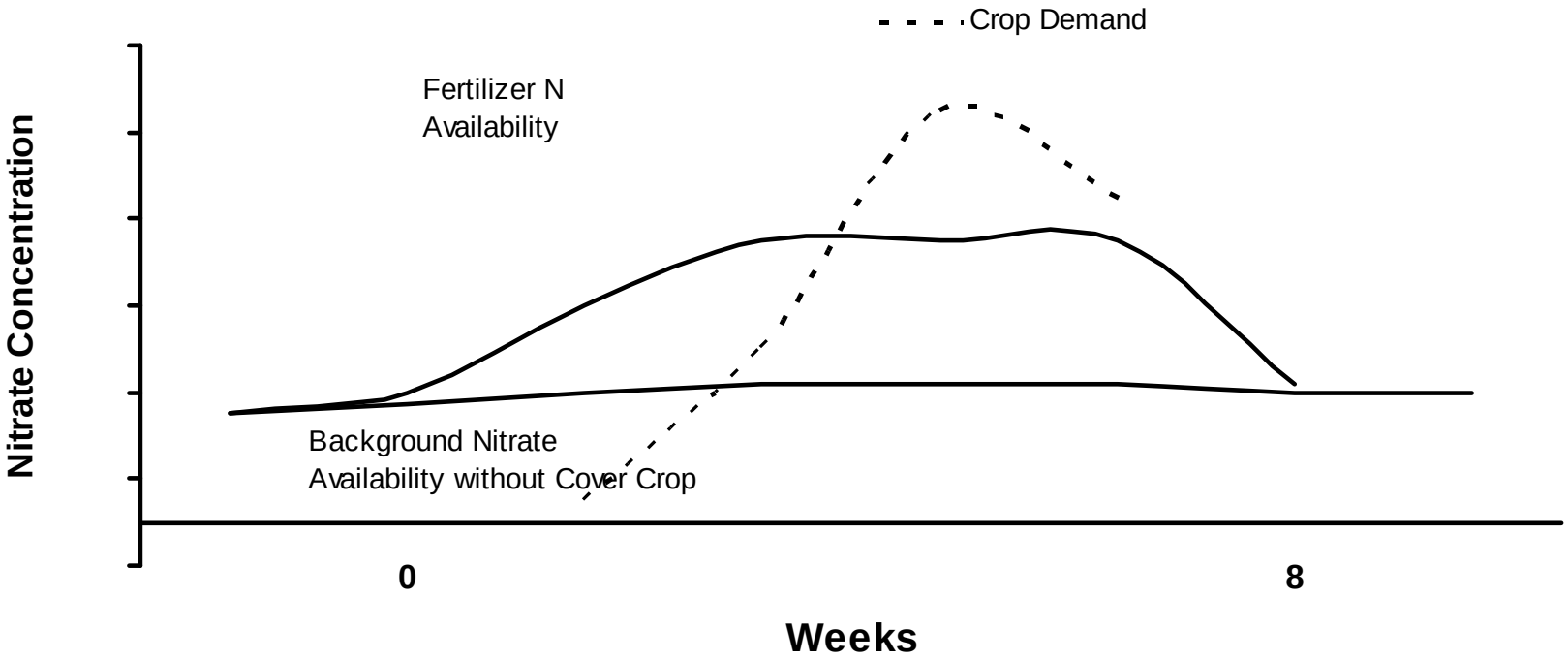
# Comparison of Materials and Timing Organic Broccoli, Watsonville, 2001



# Chicken/Guano Rate and Timing in Good Synchrony with Crop Demand



# Fertilizers Rate is Adequate, but Timing and Mineralization Rate Out of Synch with Crop Demand (i.e. 4x rate of 45 lbs N/A)



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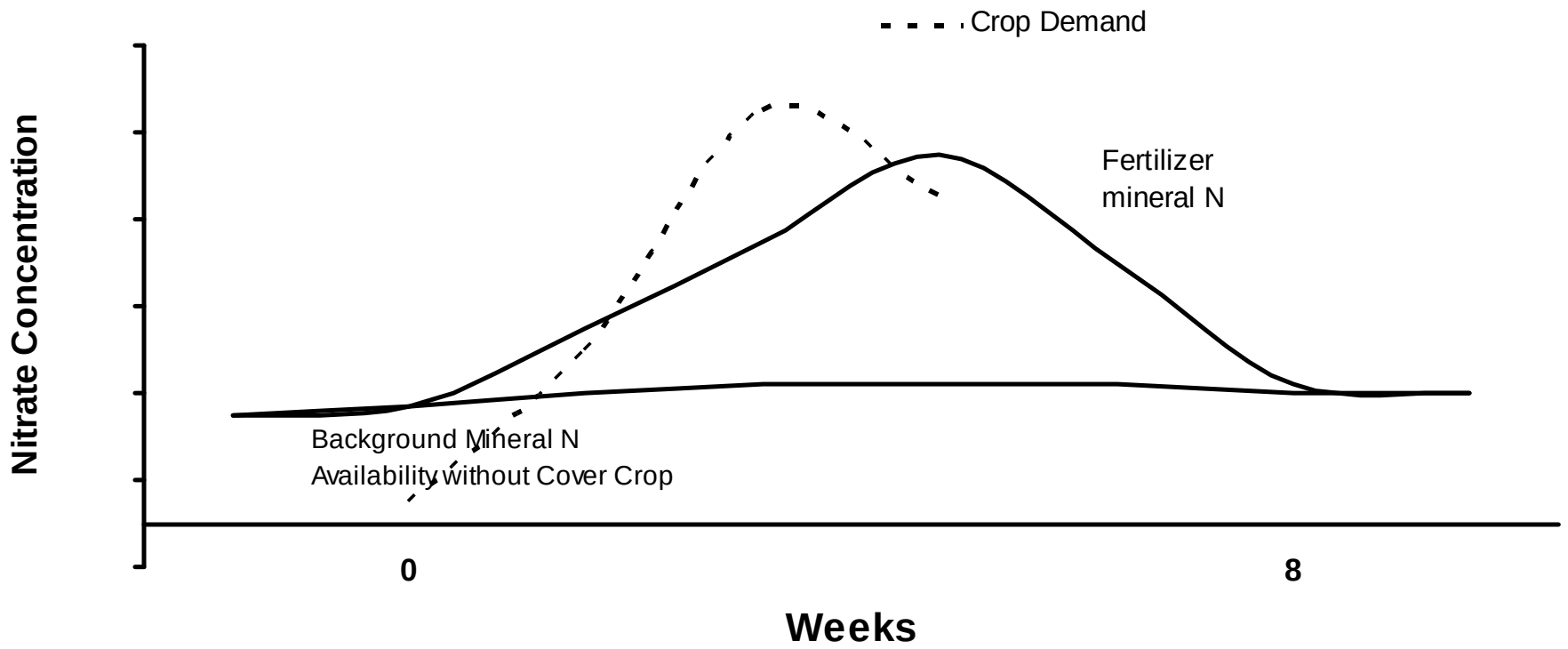
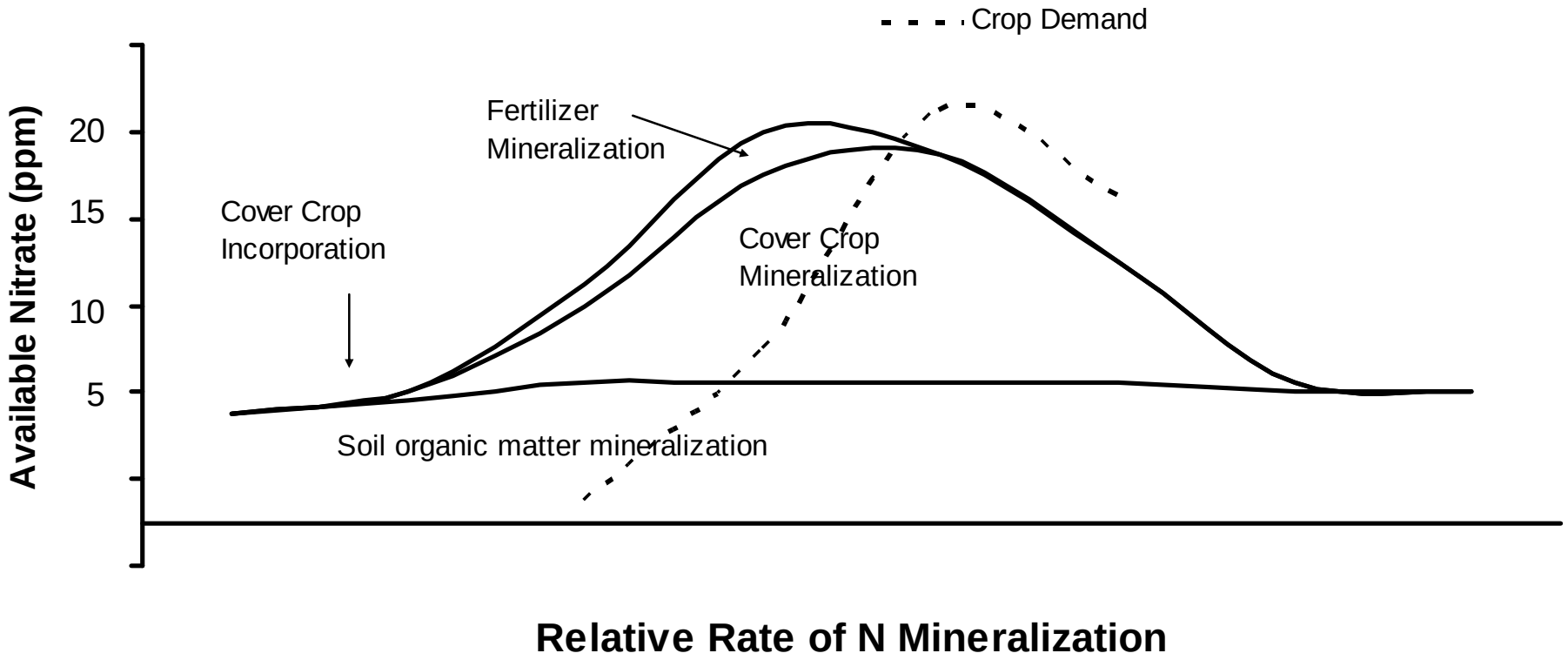


# Integrating All Sources of Nitrogen

- Achieving effective synchrony between crop uptake and N supplied by mineralization from soil organic matter, cover crop residues and fertilizers is the challenge for managing N fertility of vegetables in organic systems

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



# Summary

- Nitrogen fertilization in organic systems is trickier than in conventional systems where applications of readily available N can be applied in a timely manner
- There are typically large pools of organic N in soils, but the availability of this N and the synchrony of release and availability for crop production are difficult to predict

# Summary

- As a result, organic growers have to develop excellent skills and knowledge to work with this system
- There may be a tendency to over fertilize, especially in cold soils to make sure there is adequate material available for mineralization