Nitrogen Fertility Management in Organic Production

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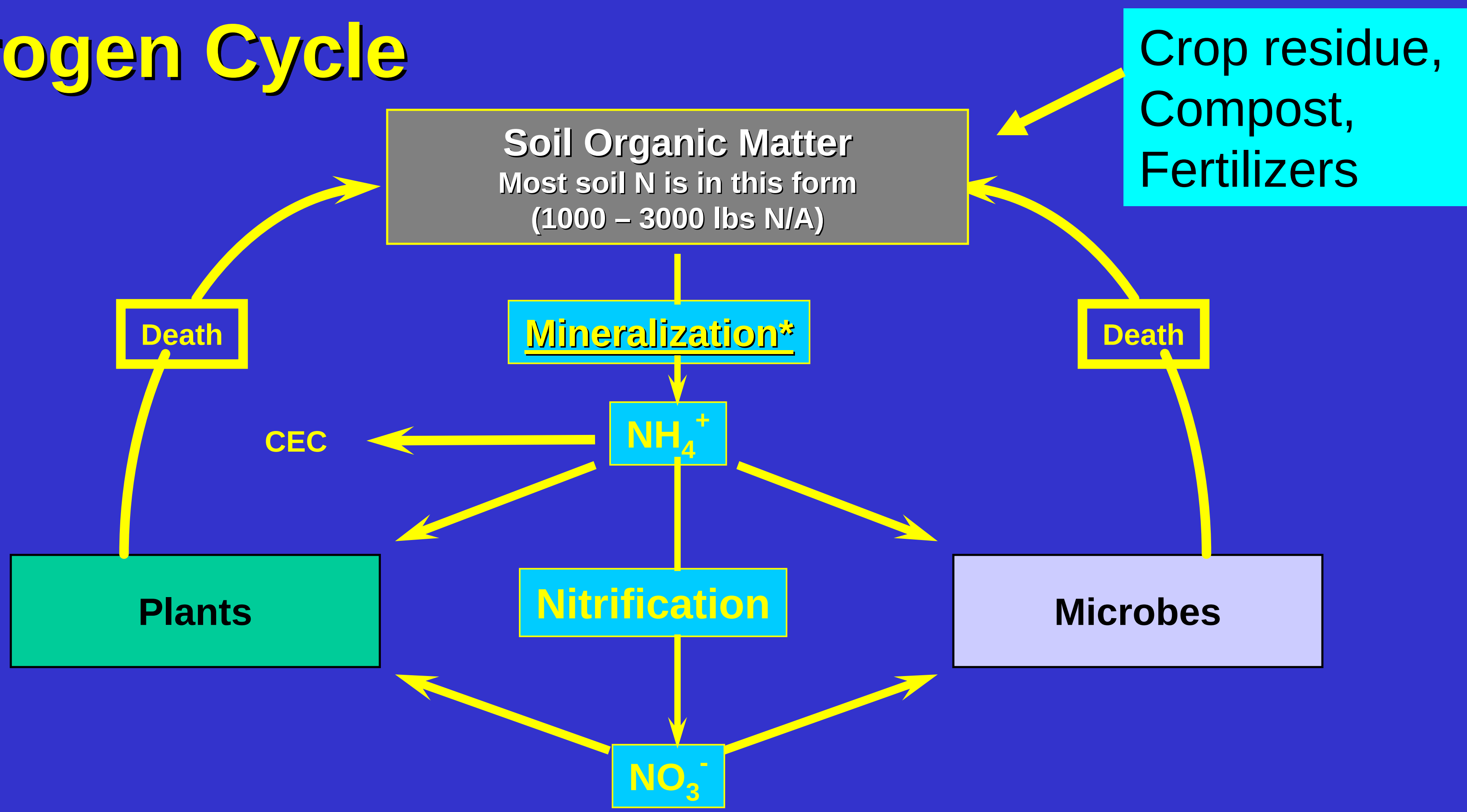
Characteristics of the Organic Production System

- 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)

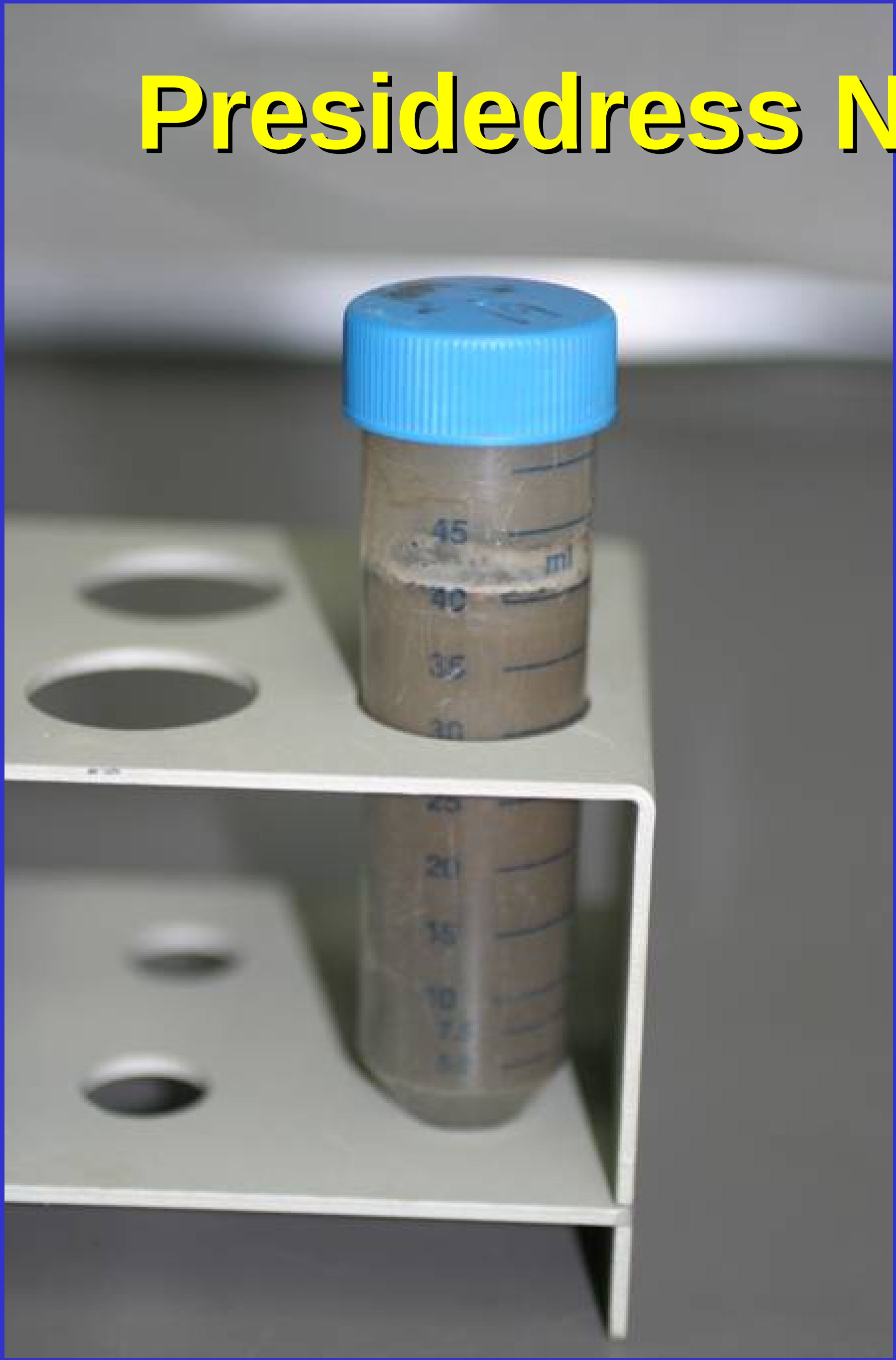
Sources of Nitrogen for Crop Growth

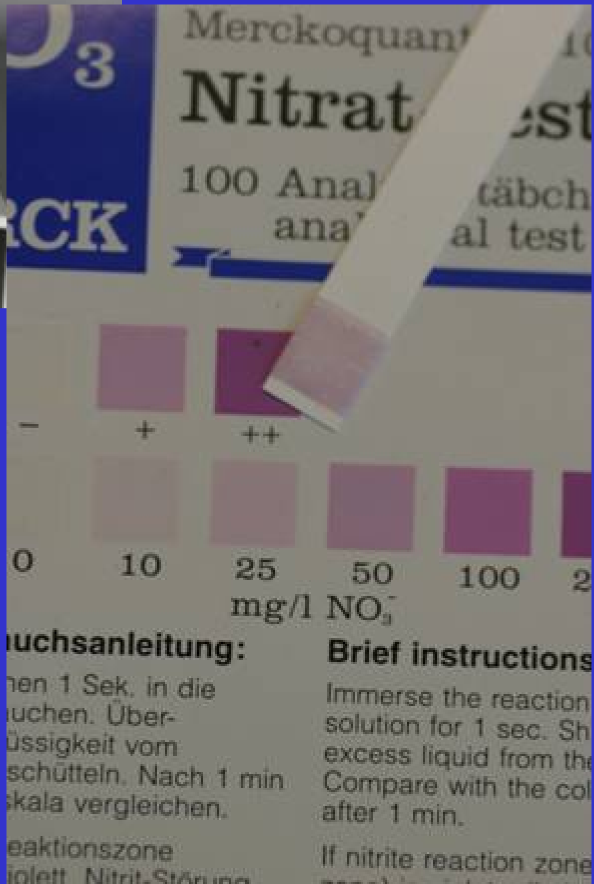
1. Residual mineral N (NO_3-N and NH_4-N)
2. In season mineralization of N from soil organic matter
3. N availability from prior crops & cover crops
4. Organic Fertilizer

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

- Can be measured with the Presidedress Nitrate Quick Test

Presidedress Nitrate Quick Test

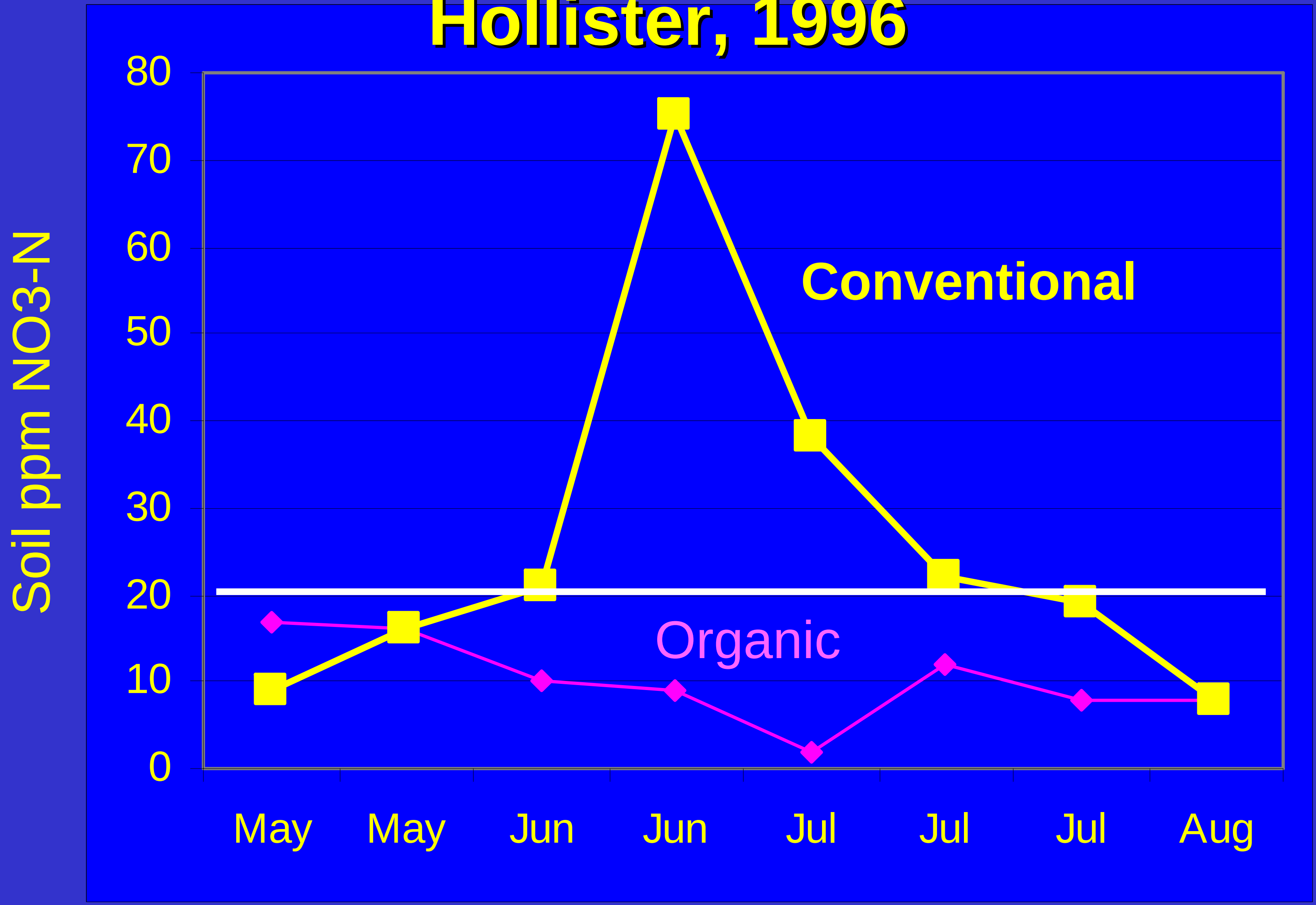




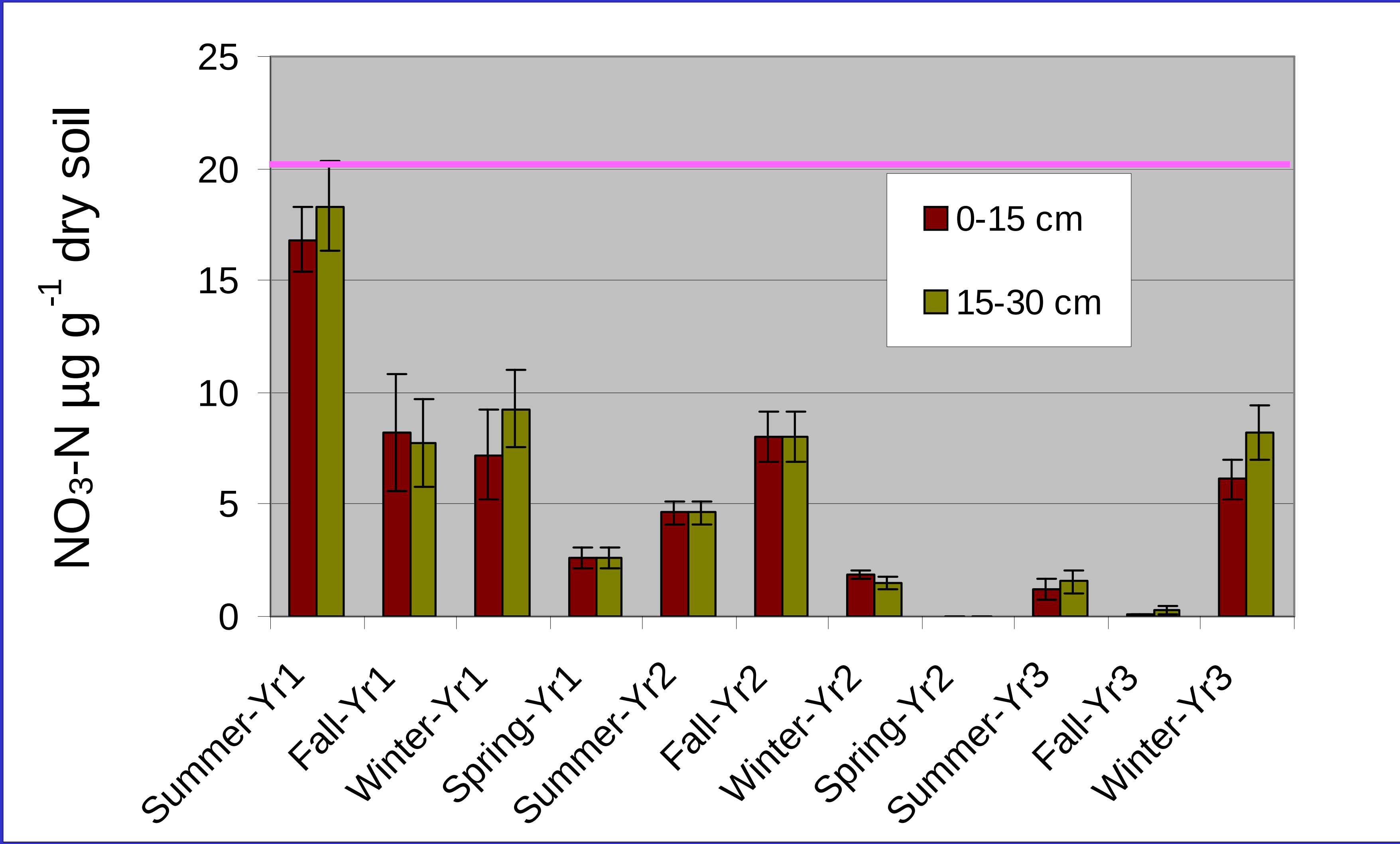
Residual Soil Mineral N

- 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.

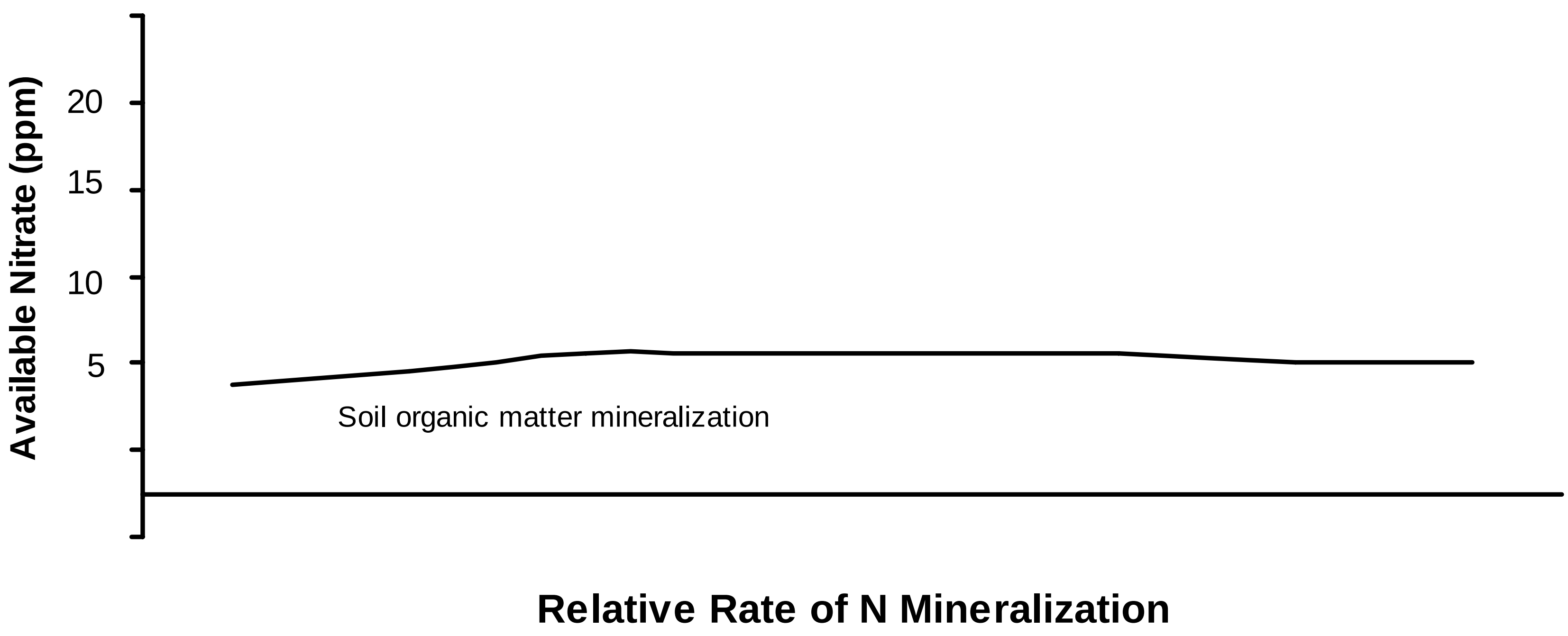
In season mineralization of N from soil organic matter

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

Microbes

Microbes

Depends upon C:N; lignin and Polyphenols

Available Mineral Nitrogen

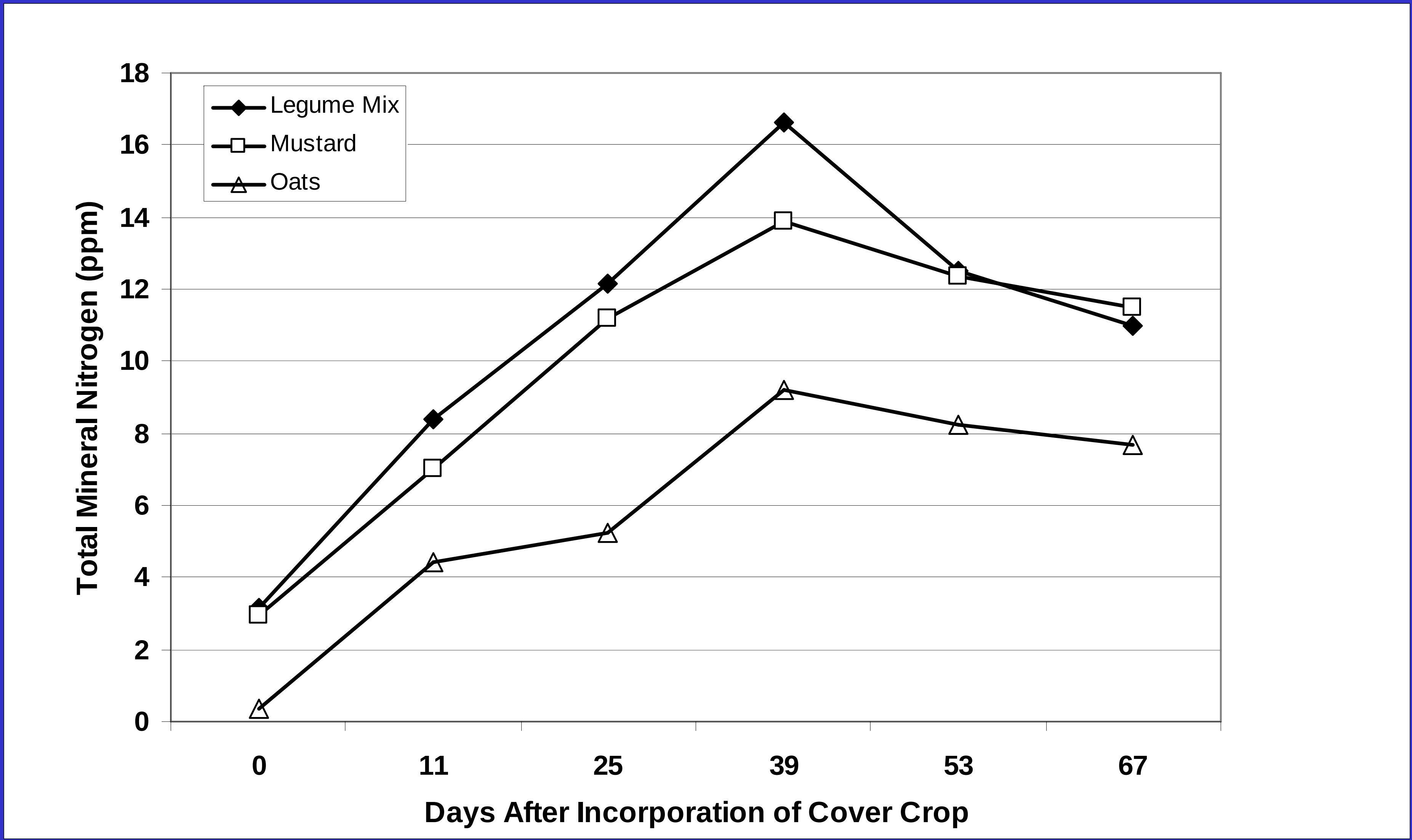
Typically <10-30% of cover crop N is taken up by the first subsequent Crop*

*** 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

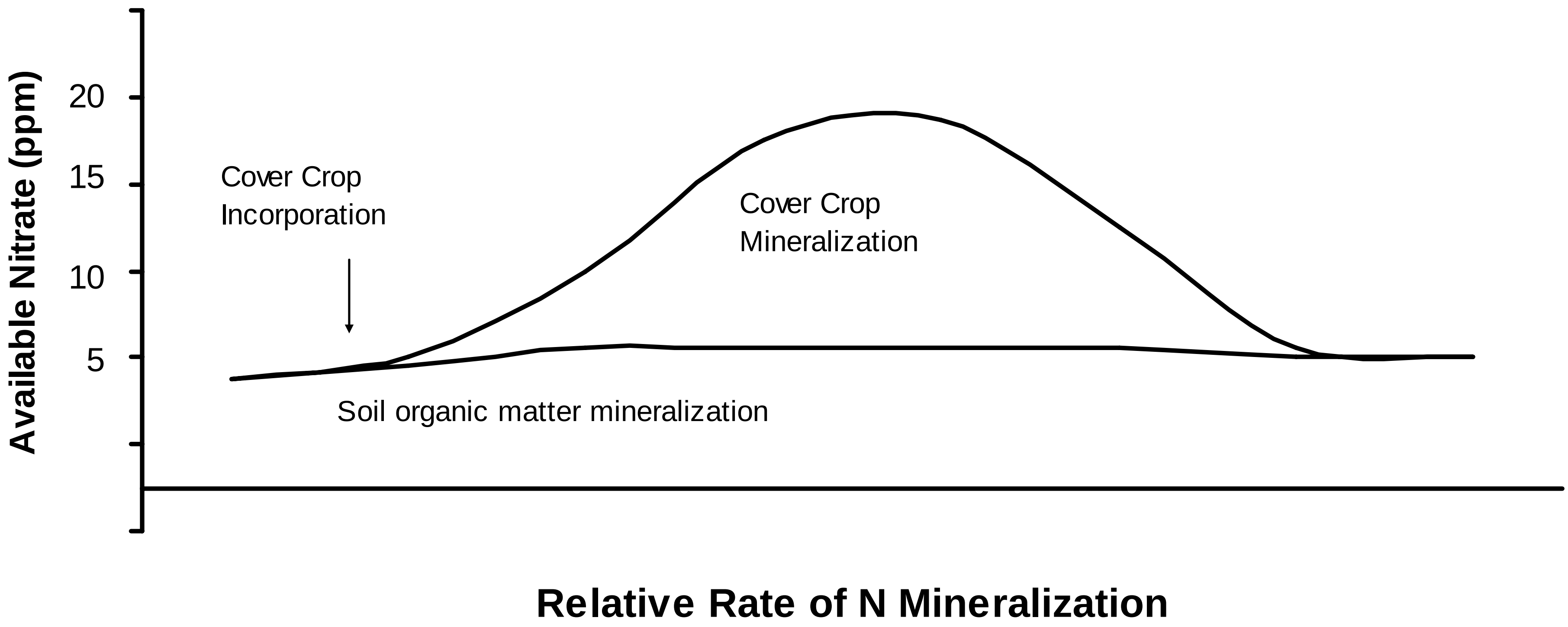
- The rate of mineralization of available N from a low C:N (<20) cover crop increases over a three- to six-week period following incorporation
- Soil N levels return to pre-incorporation levels by week 6-10

N Release Pattern from Cover Crops



Smith & Brennan, 2003

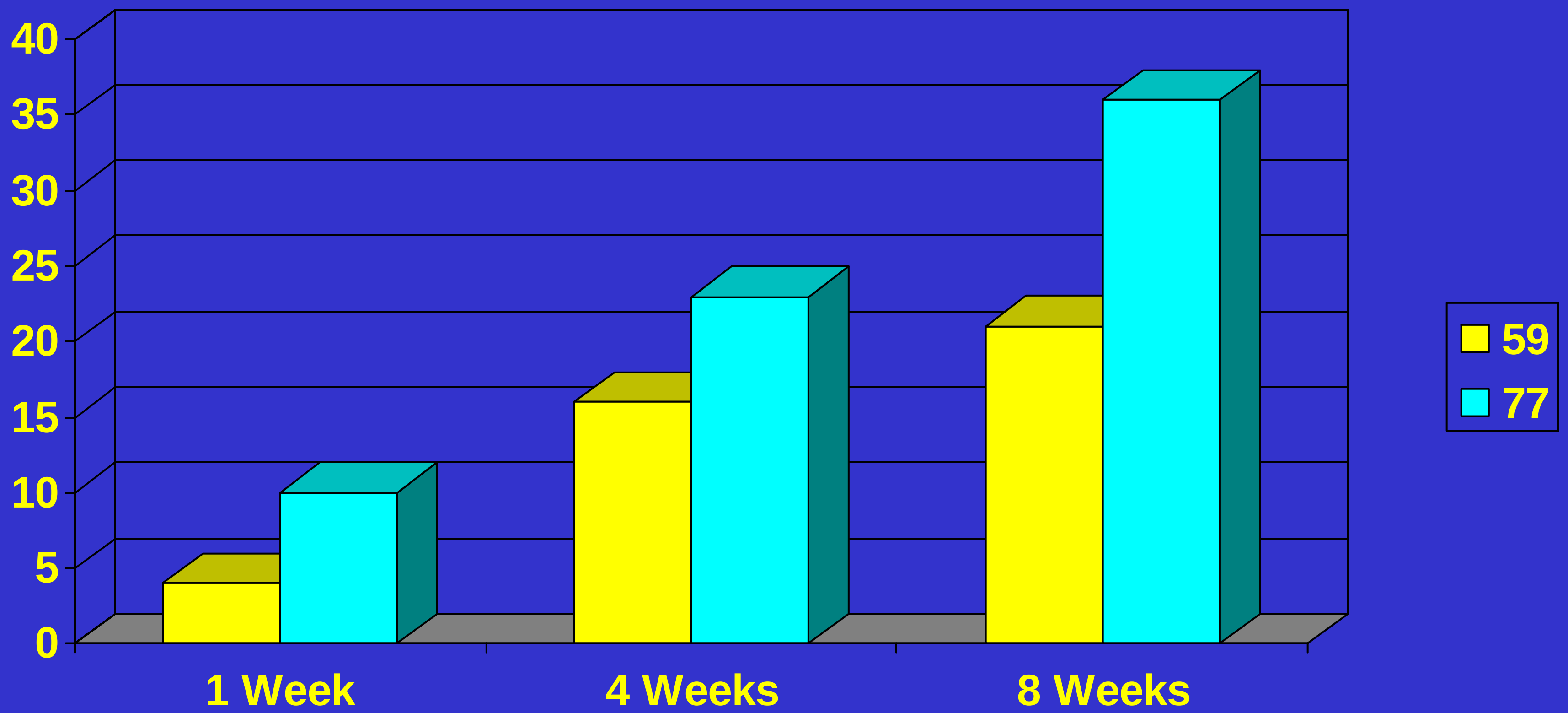
Nitrogen Release Characteristics of N From Cover Crop



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

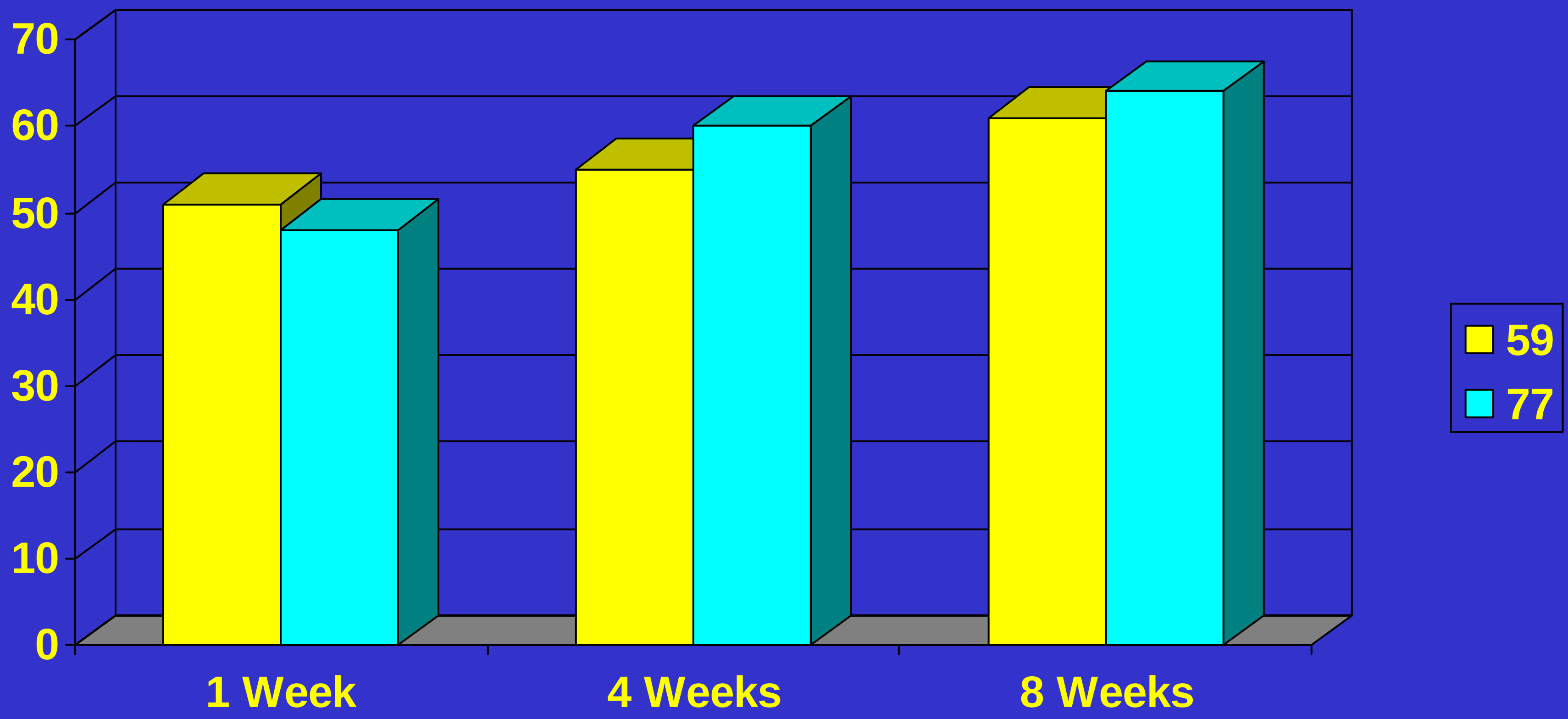
Pelleted Poultry Manure
Net N Mineralization



Incubation - Weeks

Hartz and Johnstone, 2006

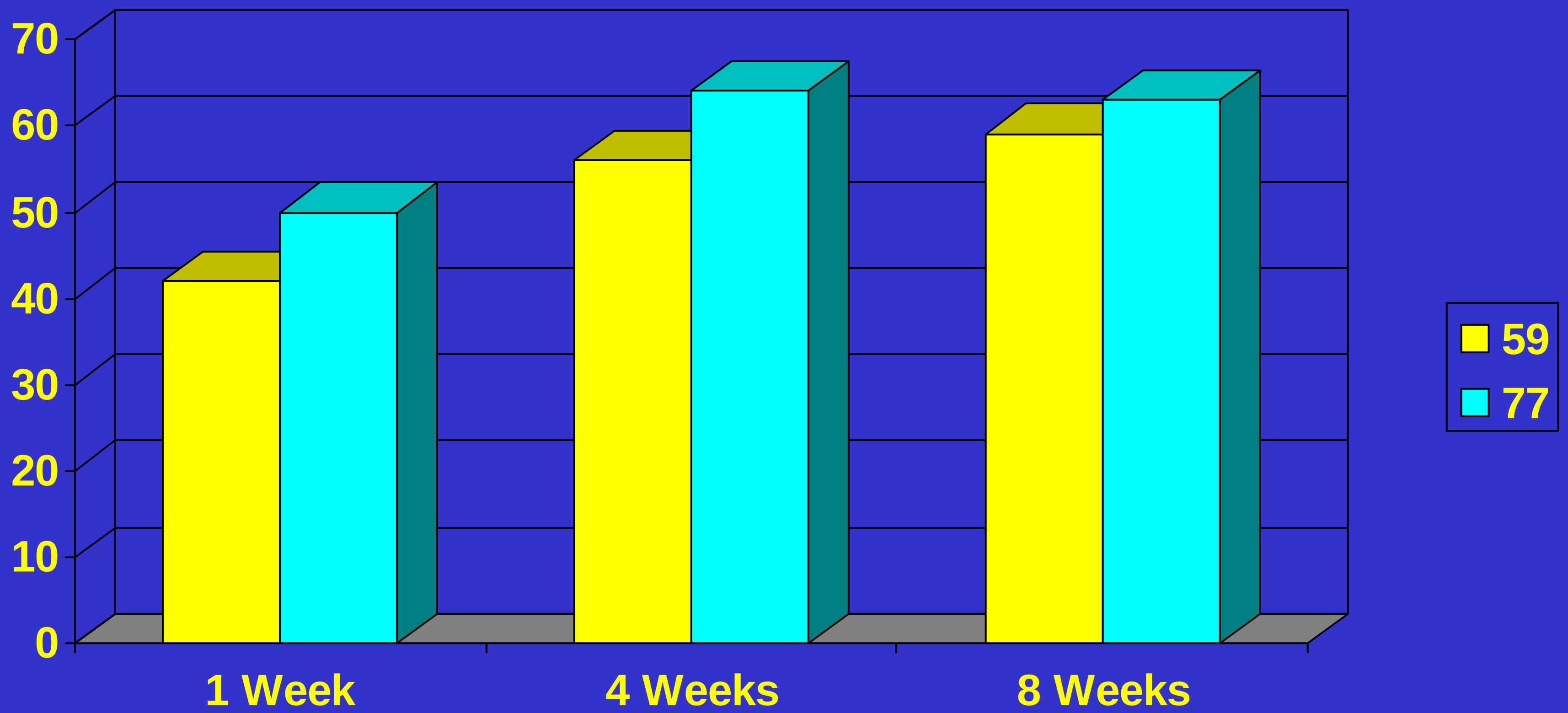
Fish Powder
Net N Mineralization



Incubation - Weeks

Hartz and Johnstone, 2006

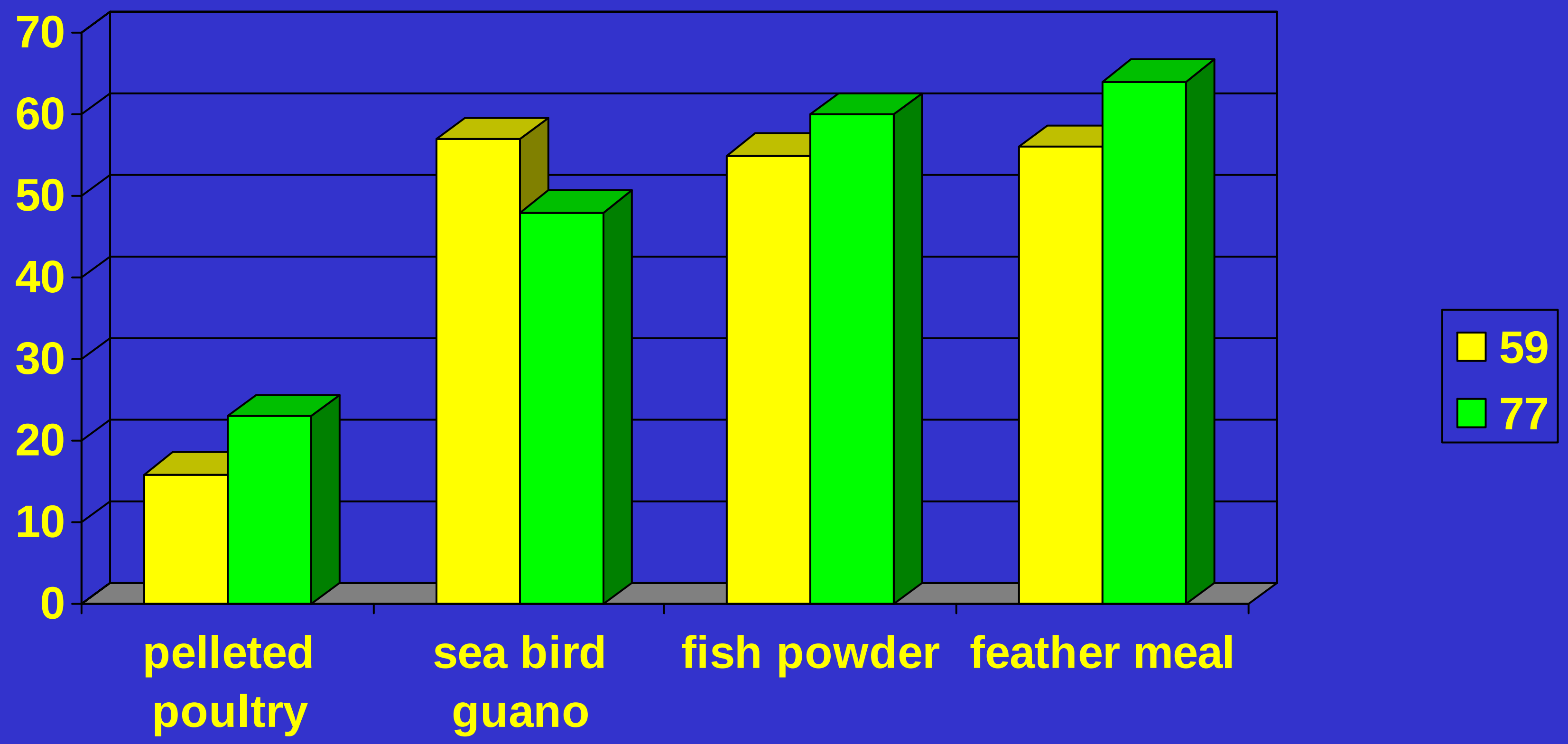
Feather Meal
Net N Mineralization



Incubation - Weeks

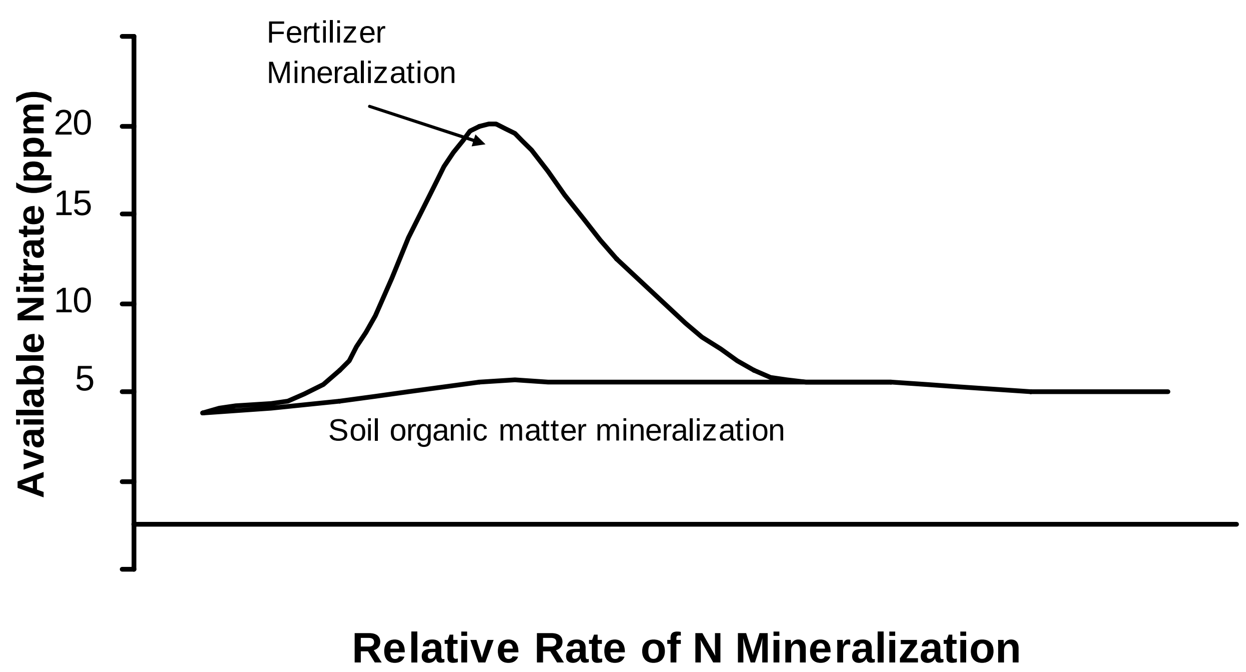
Hartz and Johnstone, 2006

Percent of Initial Organic N Mineralized – 4 Weeks Incubation



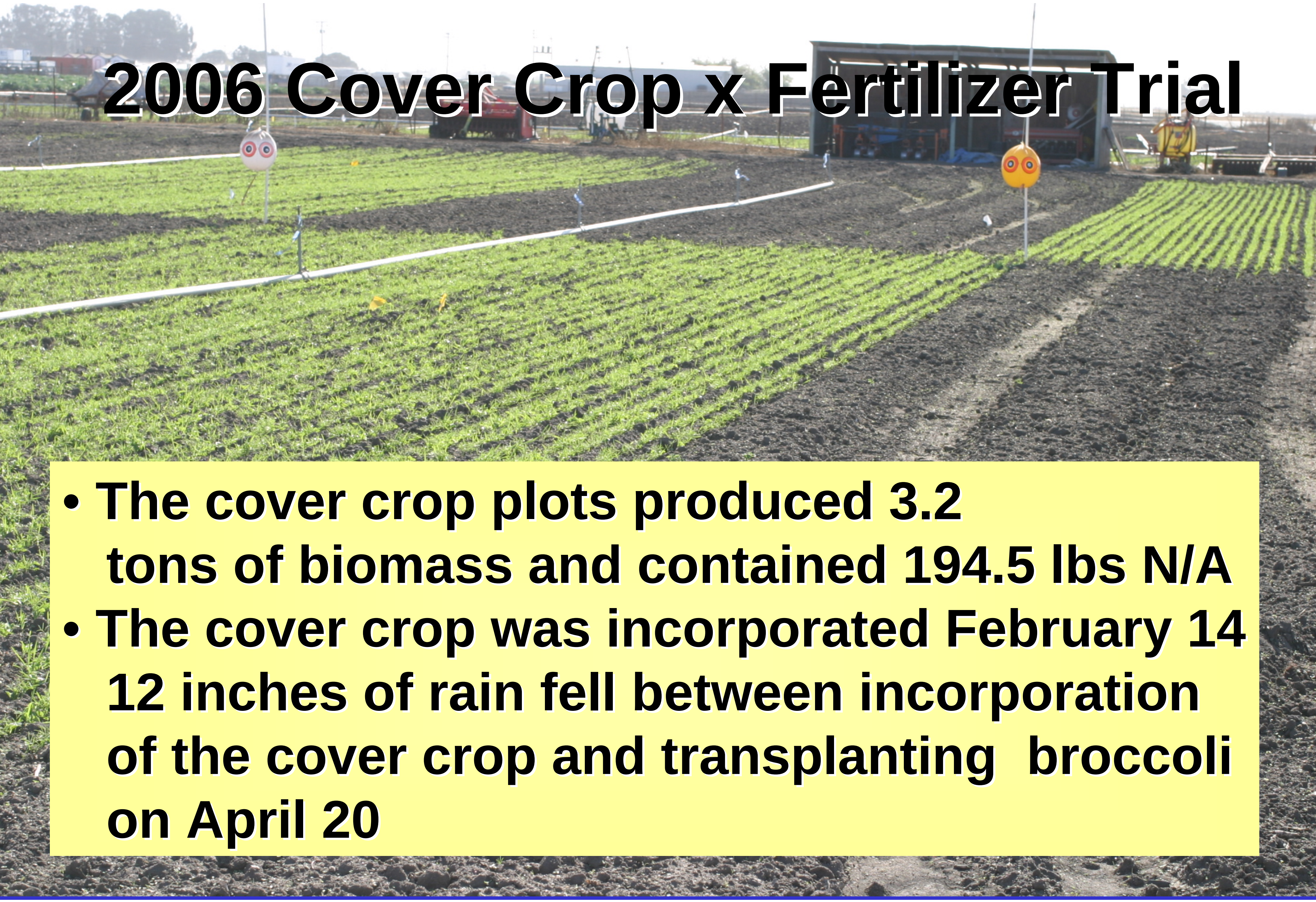
Hartz and Johnstone, 2006

Nitrogen Release Characteristics of N From Fertilizer



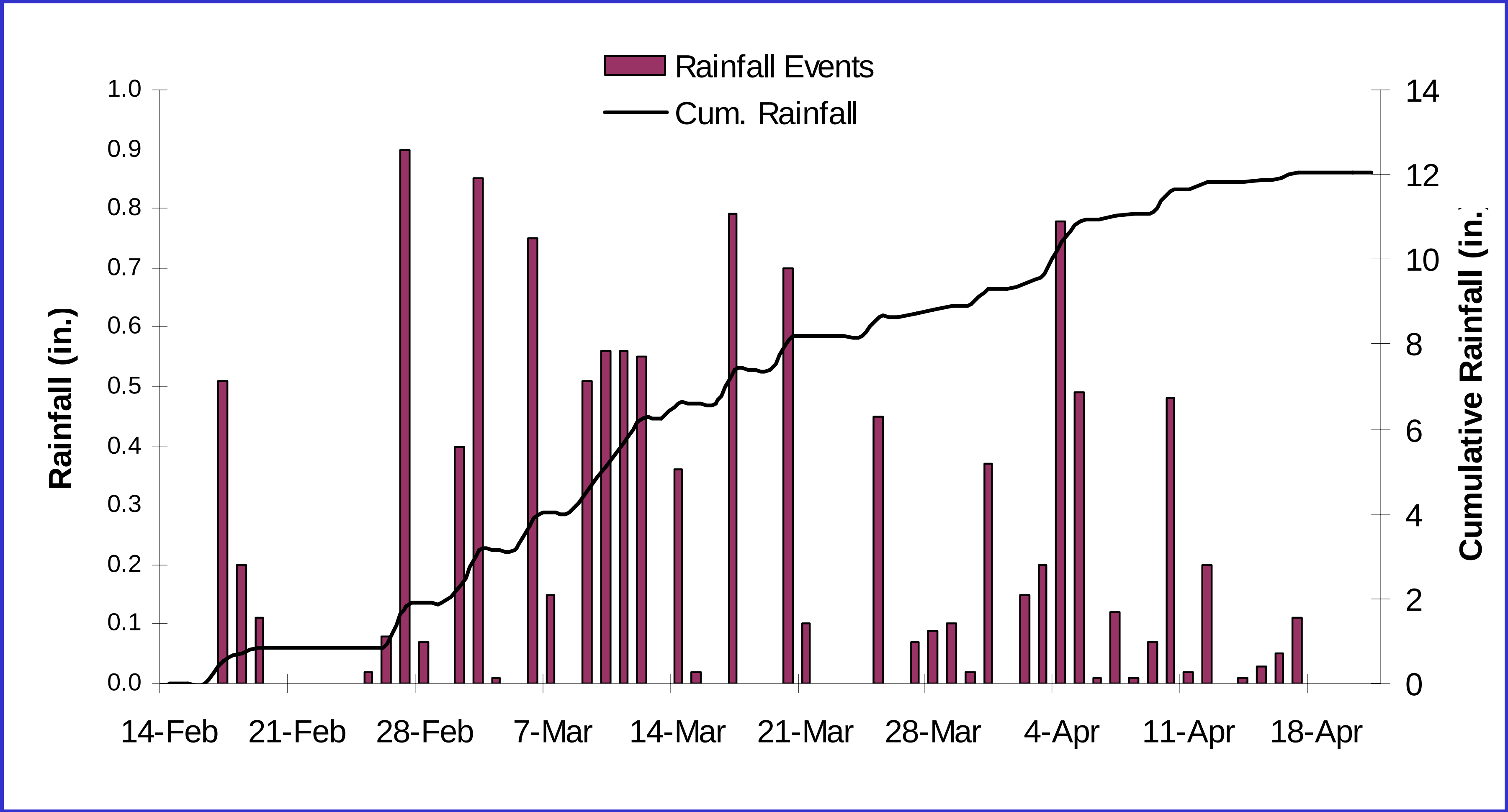
Integrating Sources of N for Organic Production

2006 Cover Crop x Fertilizer Trial

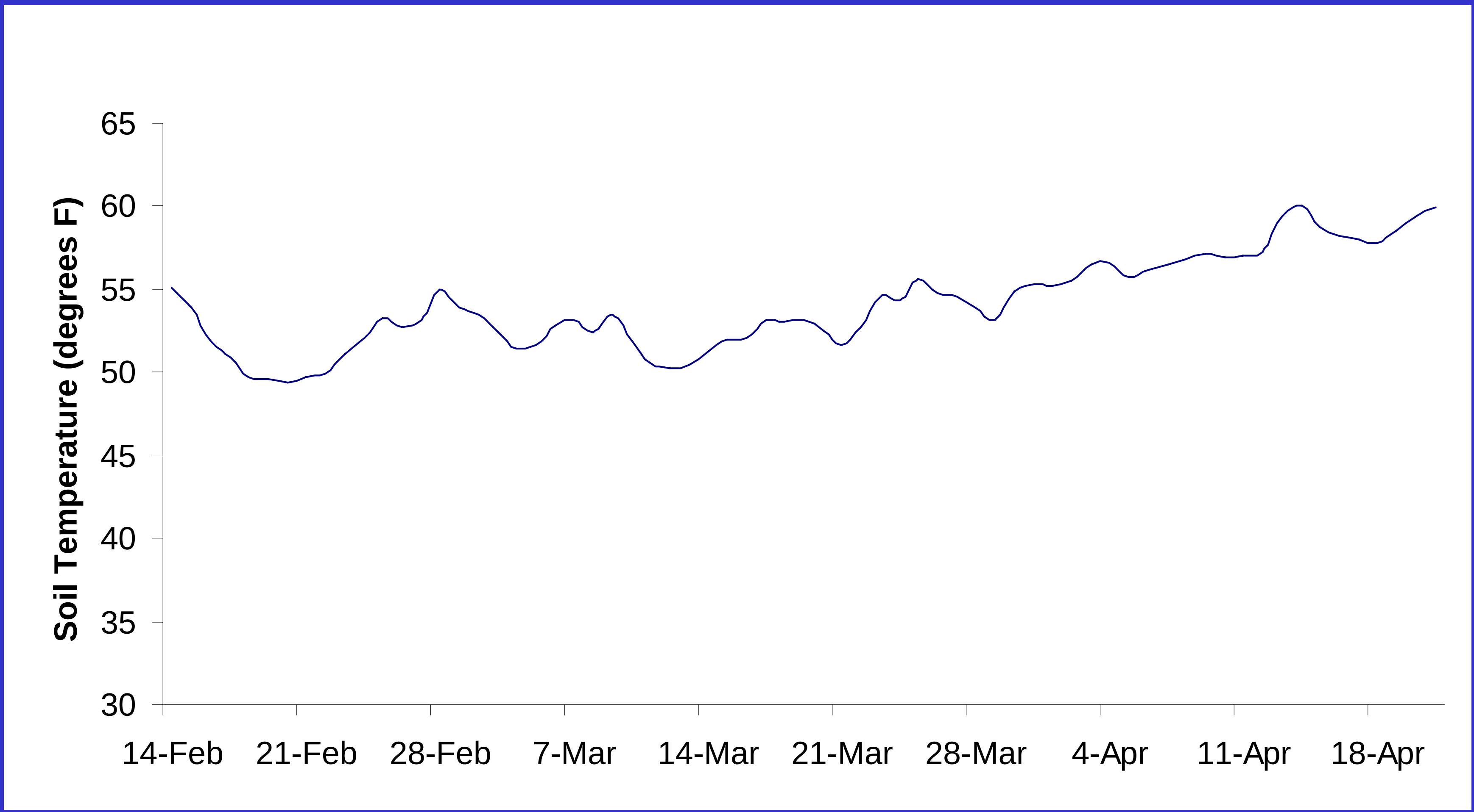


- The cover crop plots produced 3.2 tons of biomass and contained 194.5 lbs N/A
- The cover crop was incorporated February 14 12 inches of rain fell between incorporation of the cover crop and transplanting broccoli on April 20

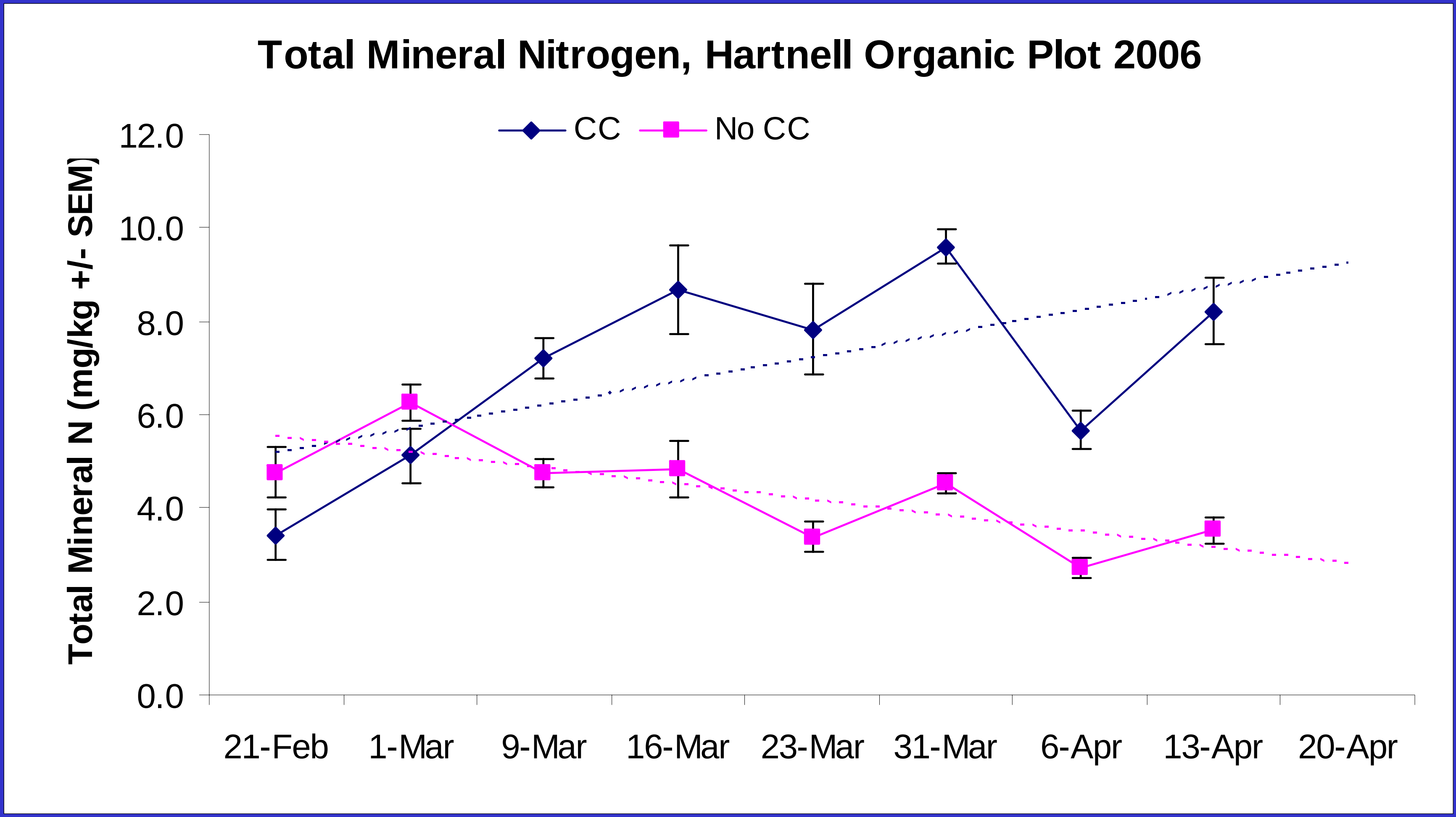
Rain Events Between Cover Crop Incorporation and Transplanting Broccoli



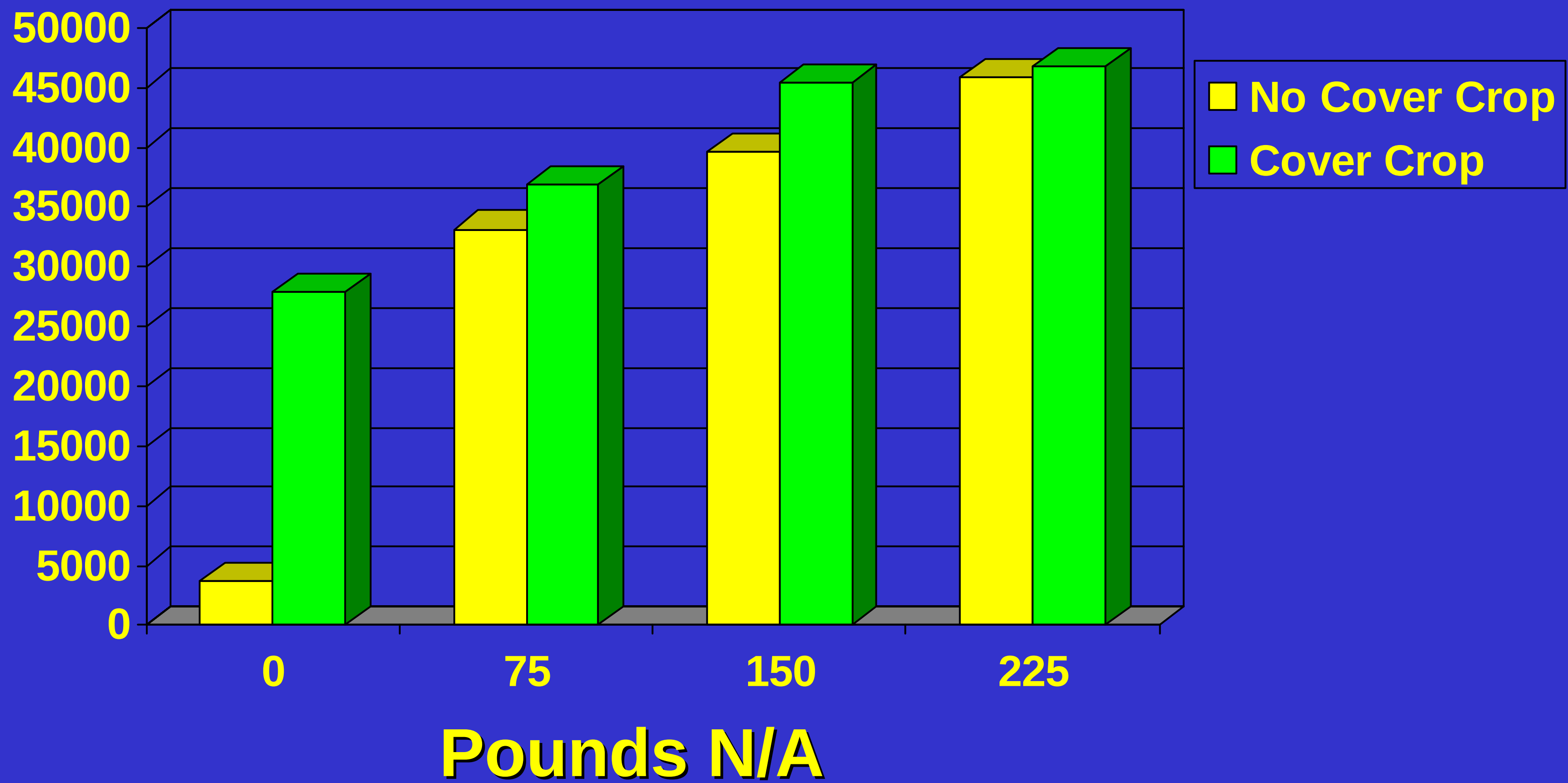
Soil Temperatures Between Cover Crop Incorporation and Transplanting Broccoli



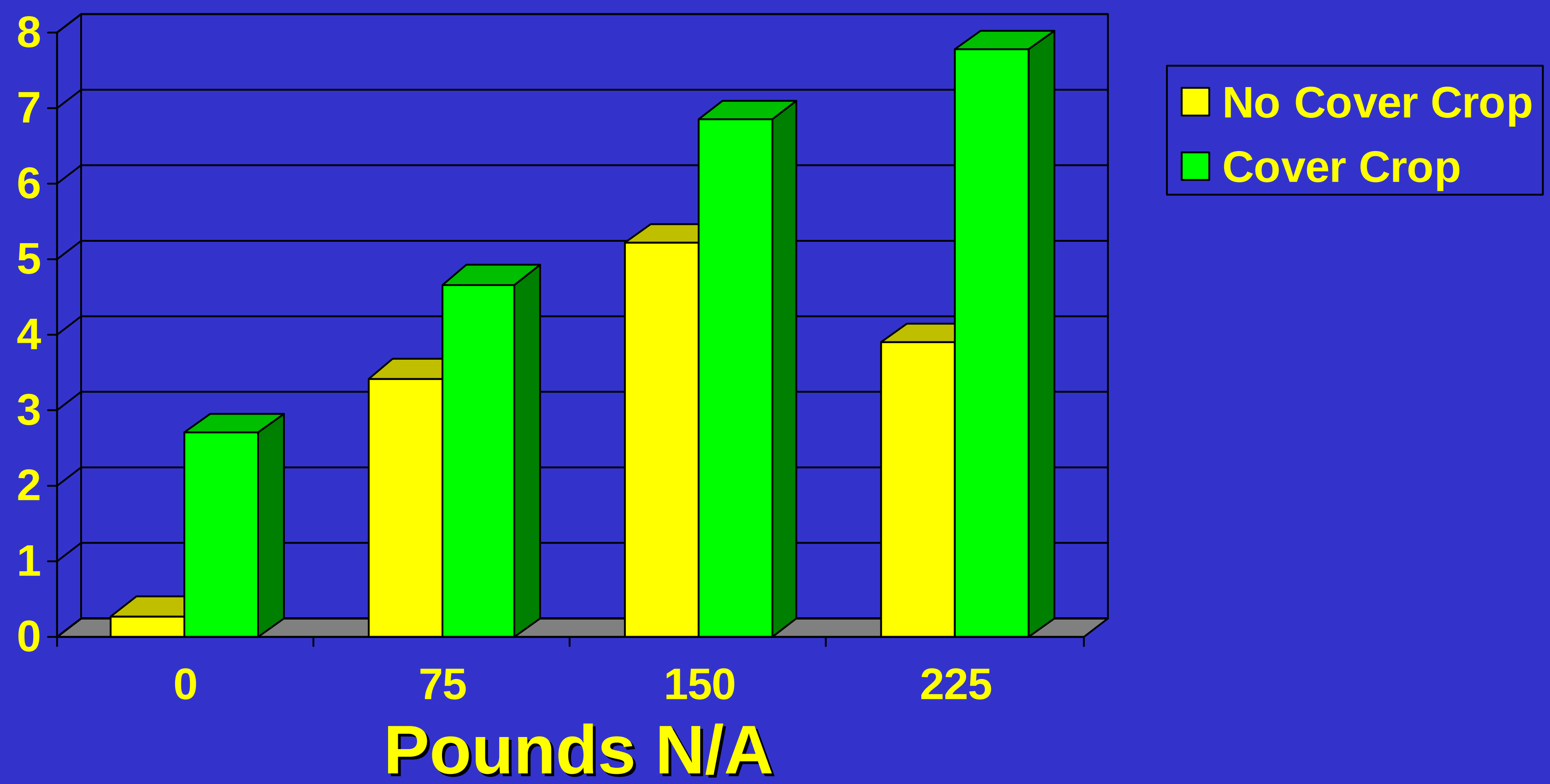
Total Mineral Nitrogen in Soil Between Cover Crop Incorporation and Transplanting Broccoli



Harvest – Number of Heads Number/A



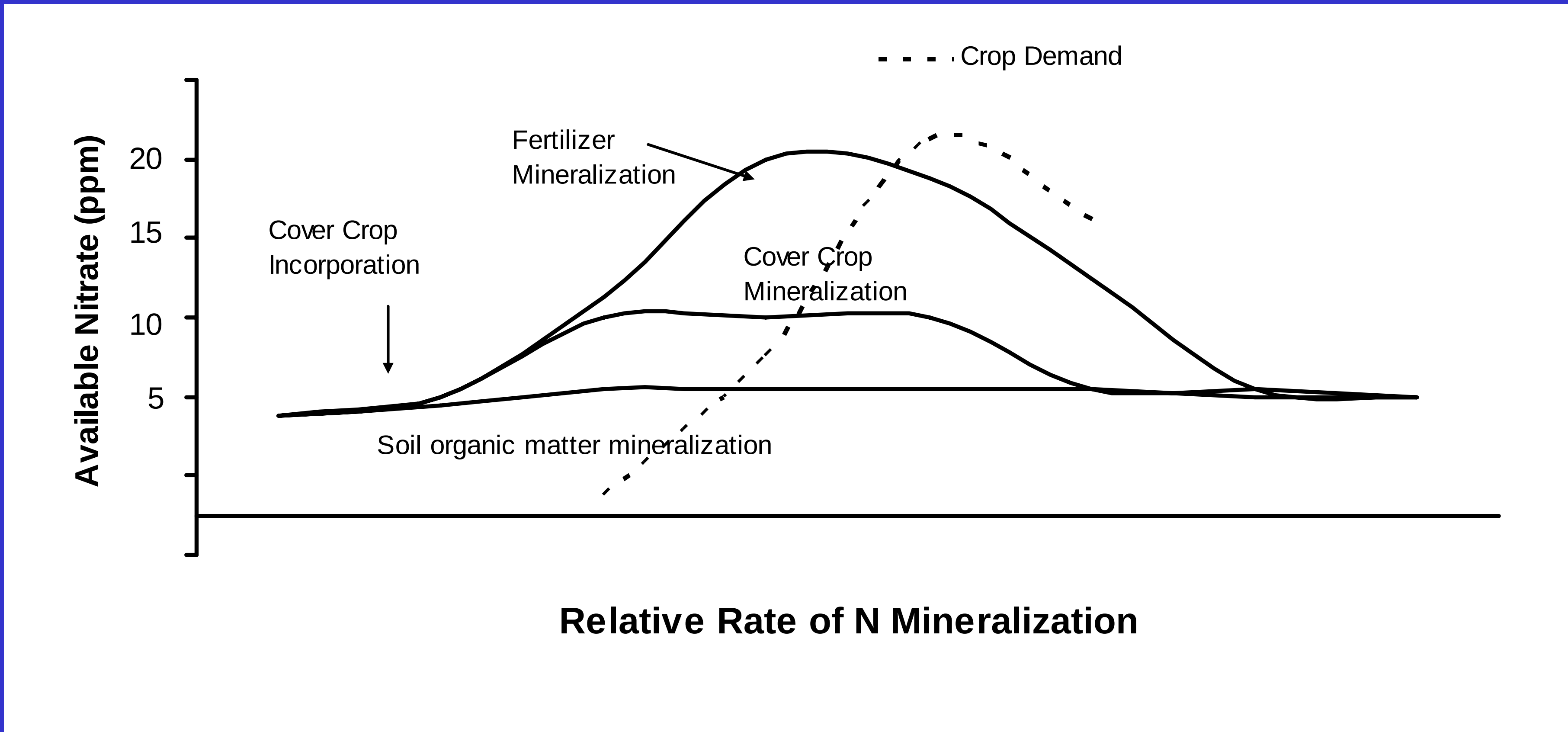
Harvest – Weight of Heads Tons/A



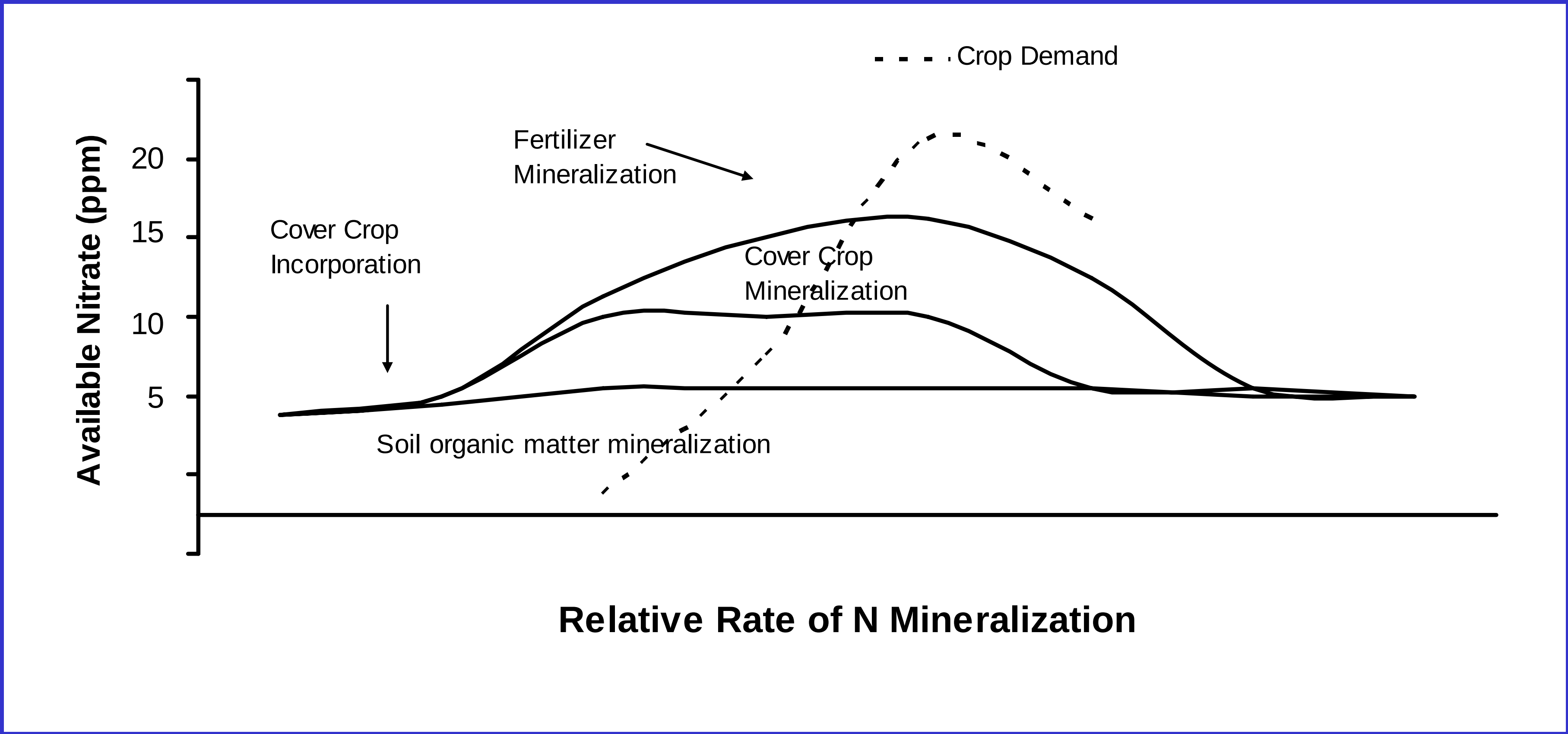
N availability from cover crops

- 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

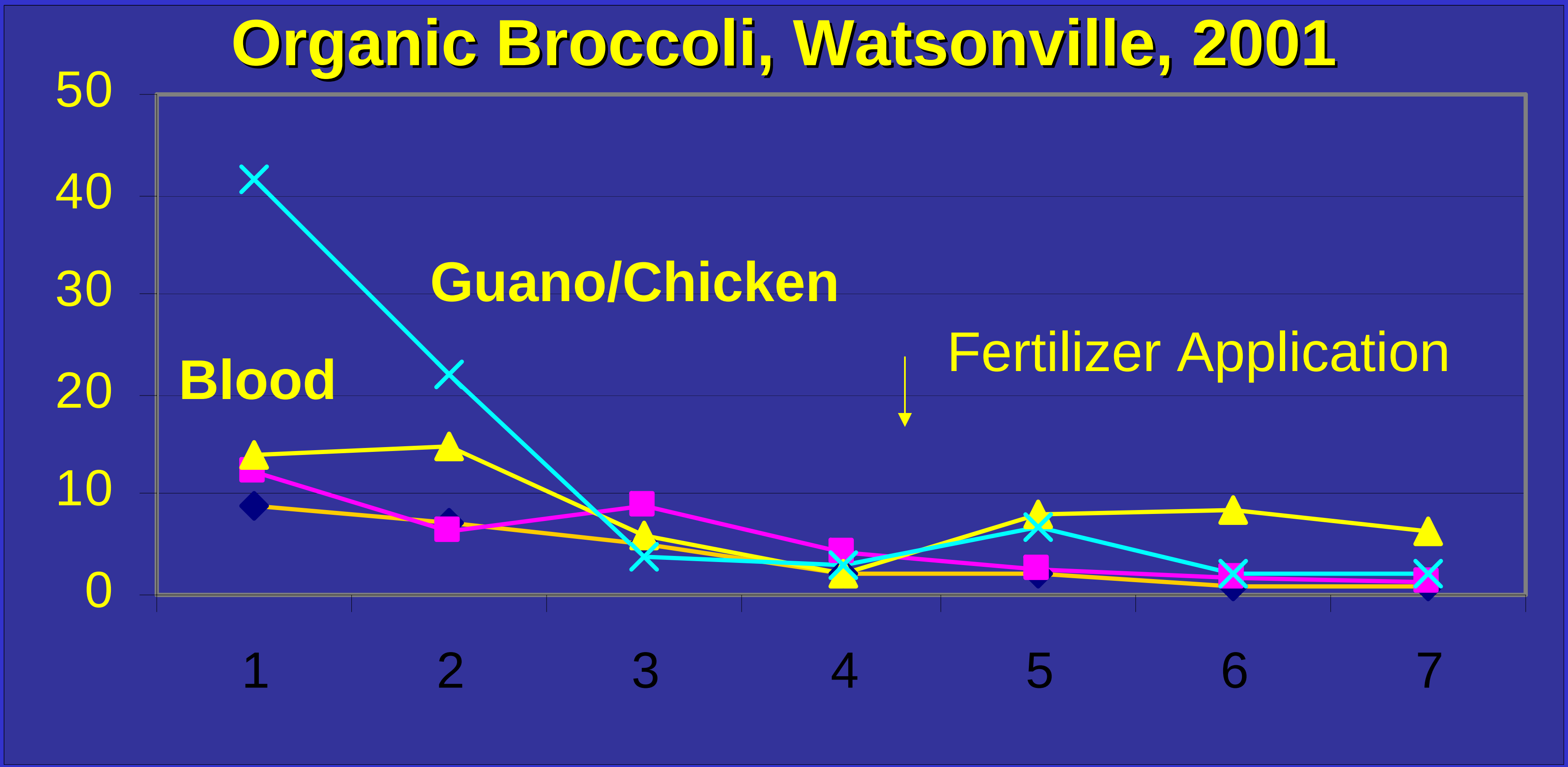


Organic Fertilizer Form and Timing Trial
Watsonville, 2001

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

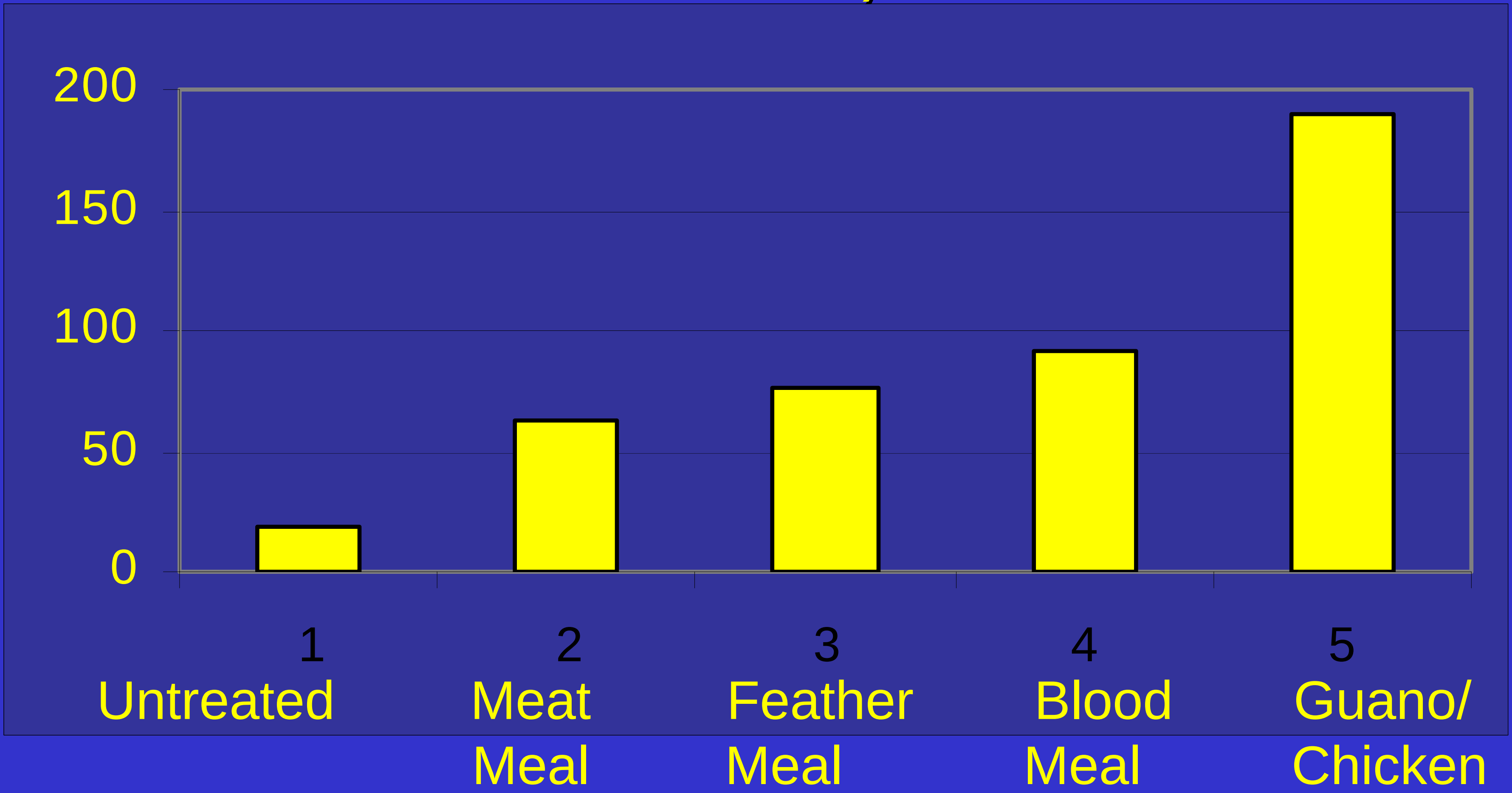
1) Meat Meal 8-5-1; 2) Feather Meal 12-0-0
3) Blood Meal 13-0-0; 4) Guano/Chicken 7-0-0

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



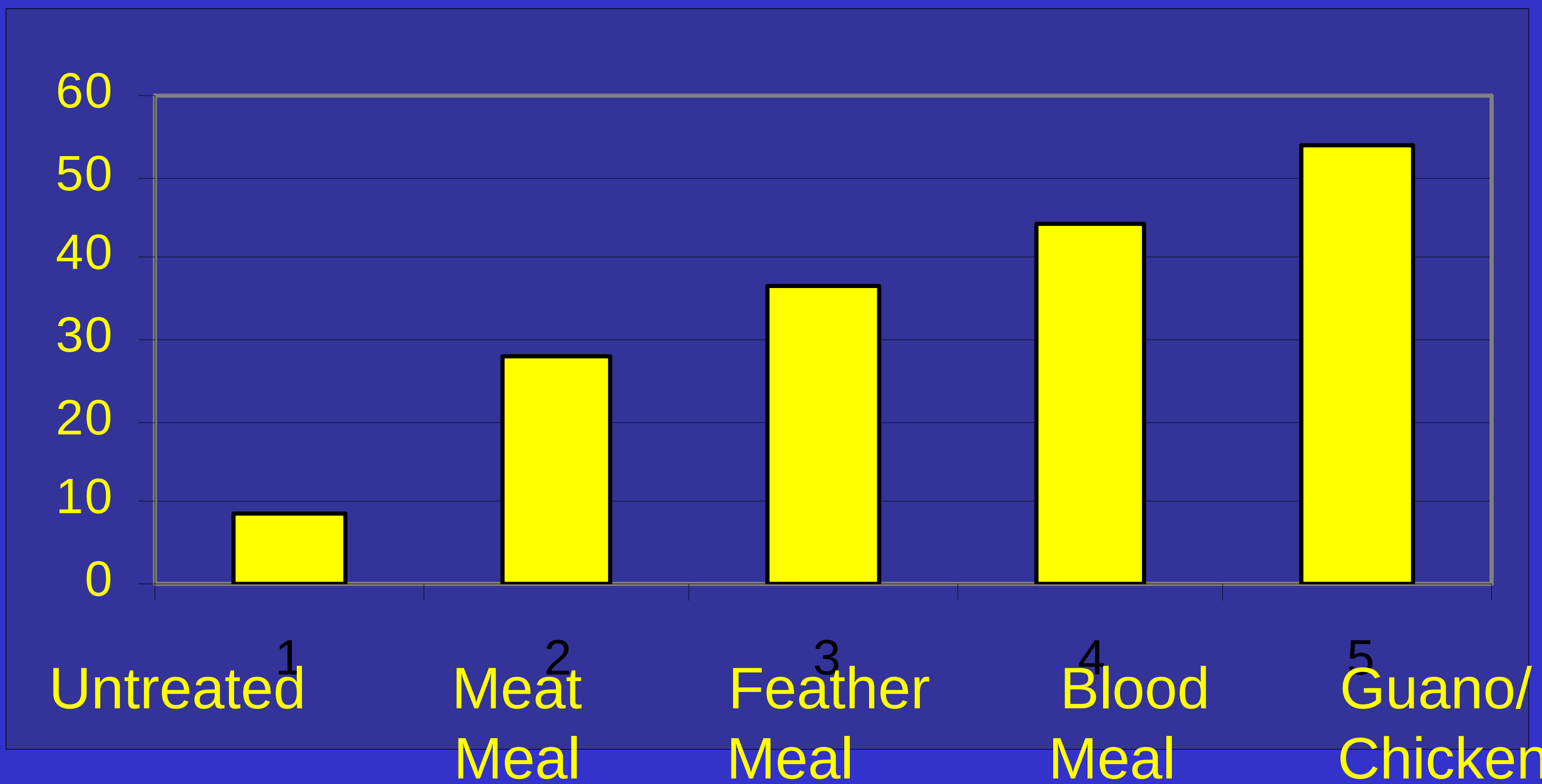
Total Number of Heads, Organic Broccoli

Watsonville, 2001

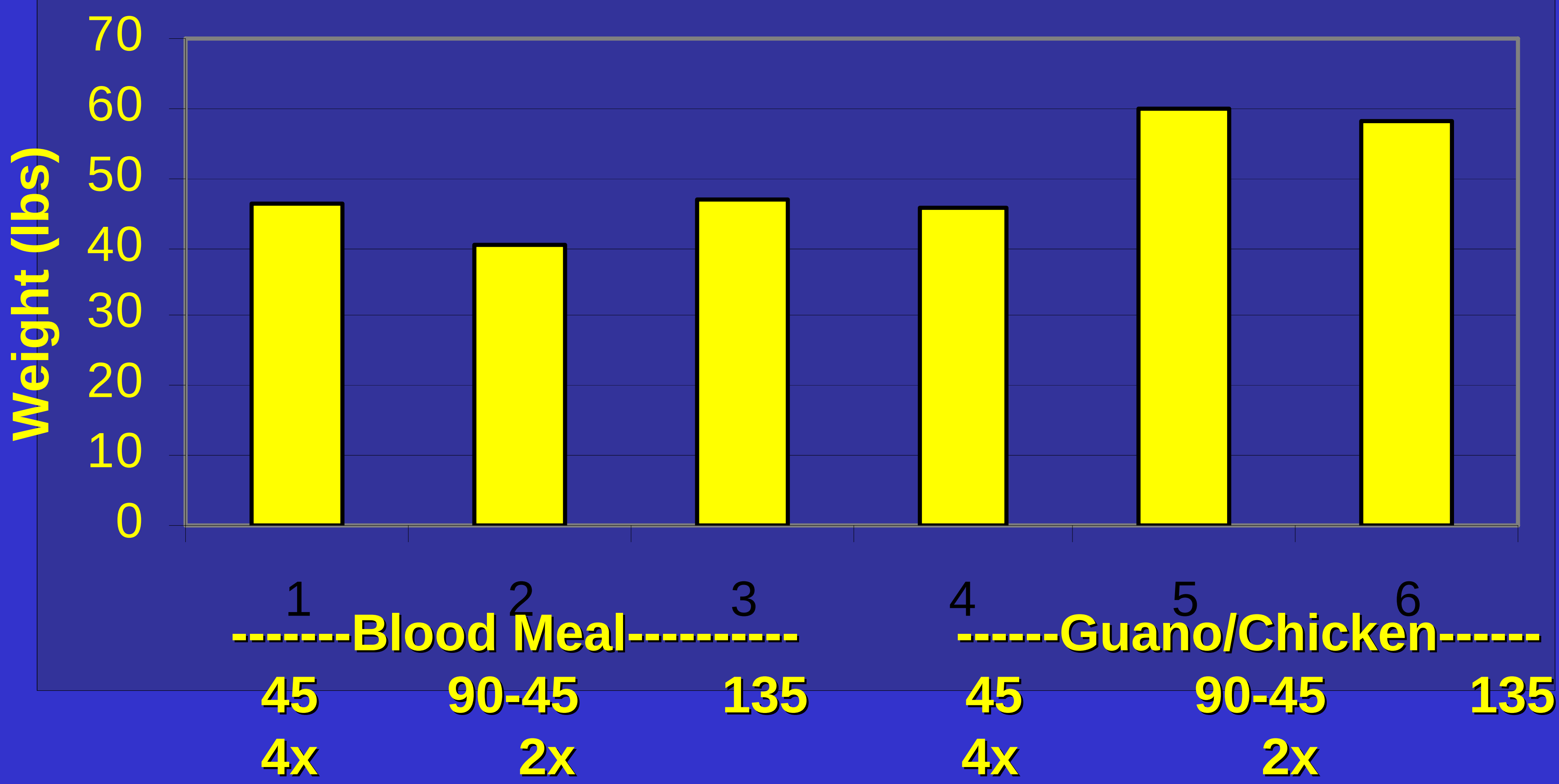


Total Weight of Heads, Organic Broccoli

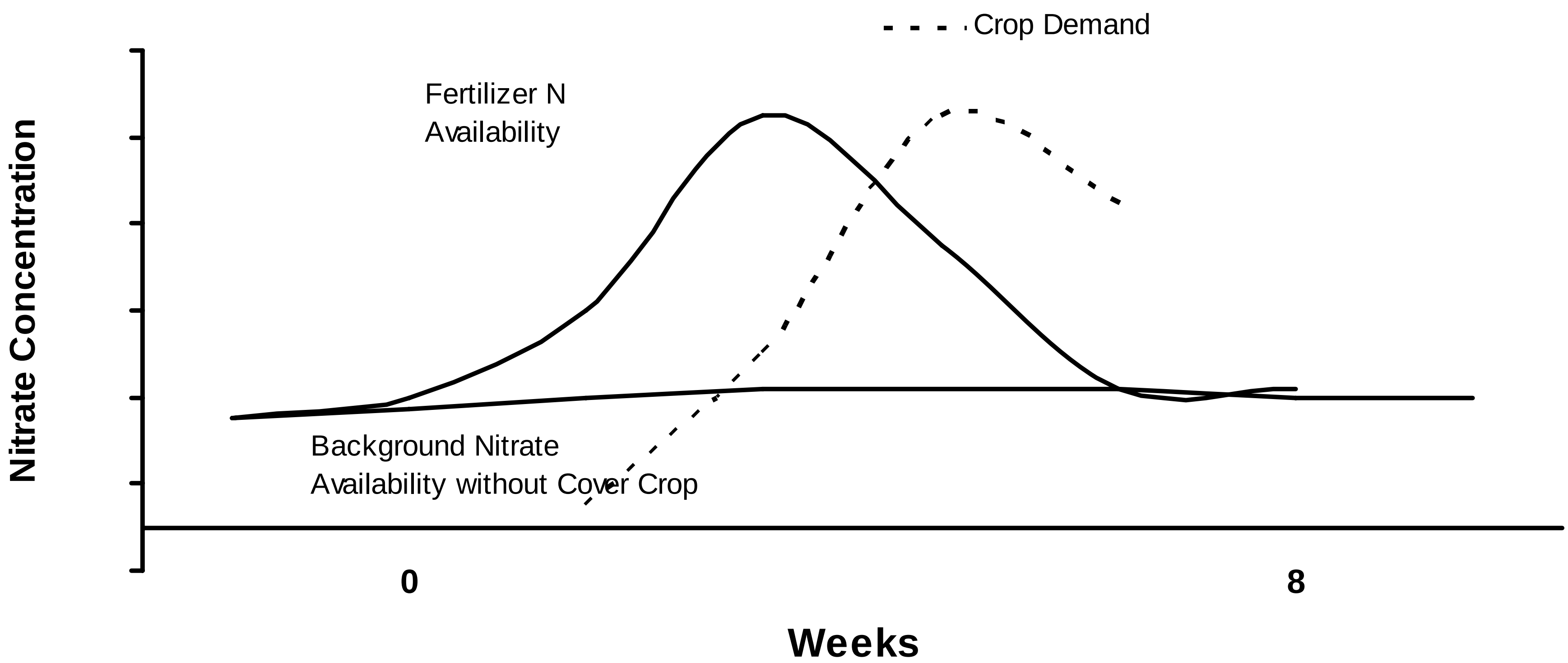
Watsonville, 2001



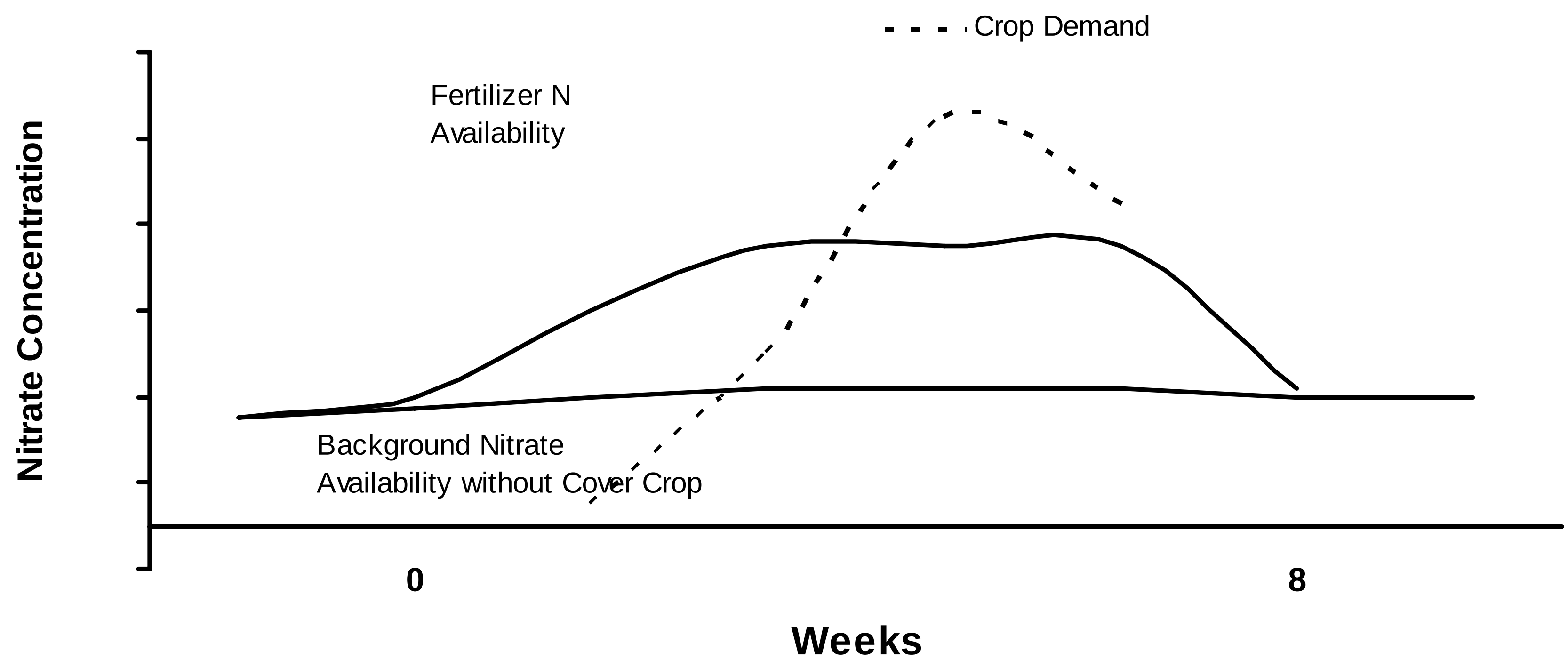
Comparison of Materials and Timing Organic Broccoli, Watsonville, 2001



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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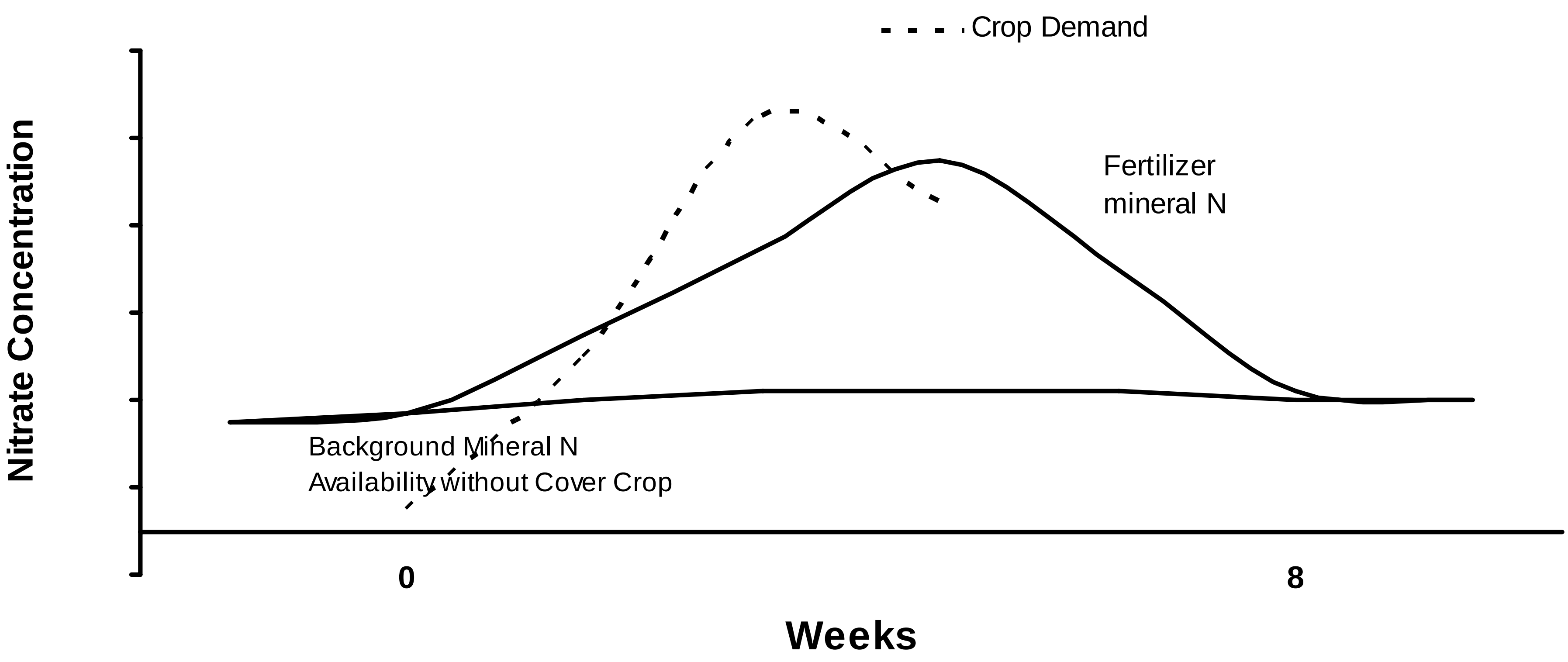
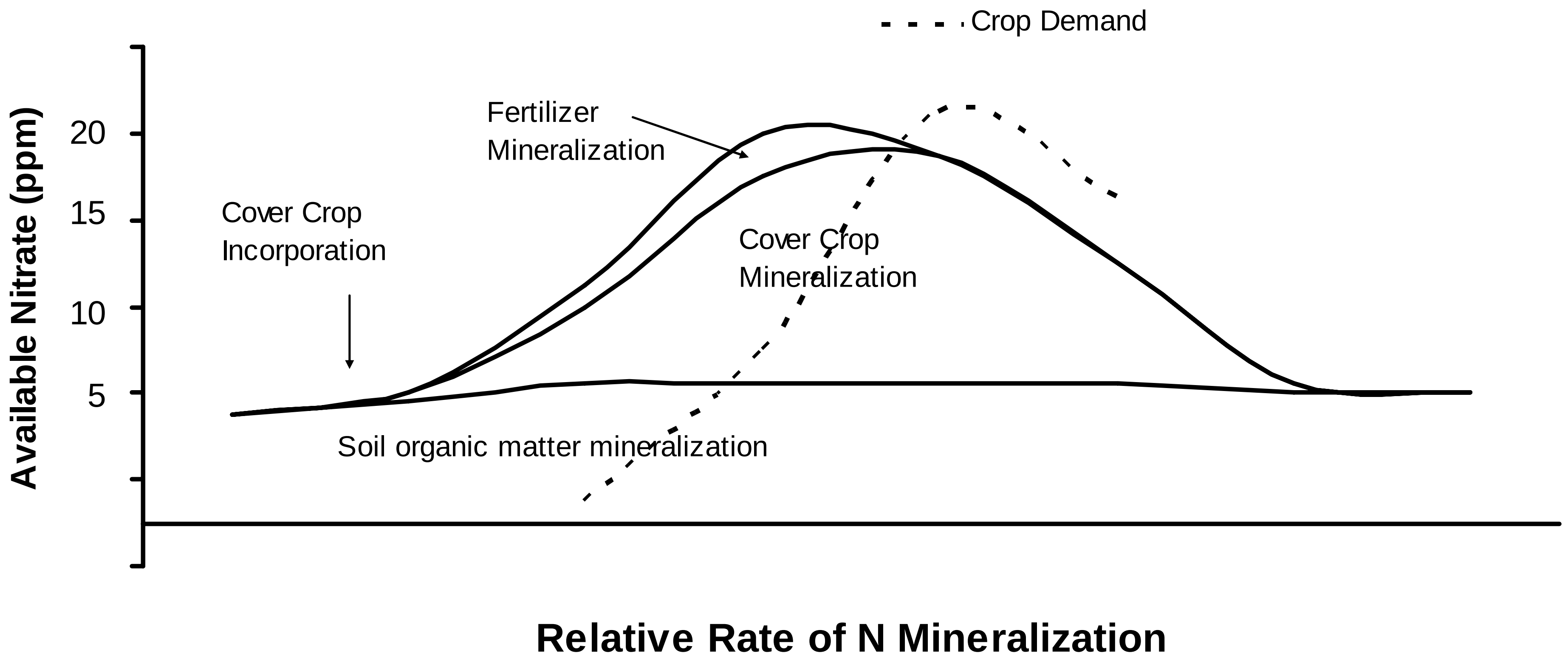


Integrating All Sources of Nitrogen

- 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