

Cover Crop Contributions to Nitrogen Fertility

Richard Smith

Vegetable Crop and Weed Science Farm Advisor

University of California Cooperative Extension

Monterey County

Cover Crops: Background

- **Cover crops are an important agricultural production practice**
- **In modern agriculture their use is common in permanent crops but is more problematic in annual crops**
- **They are mostly grown in the winter, but can “get in the way” of preparing the ground for early spring planting if wet weather prevents soil incorporation**

Cover Crops: Background

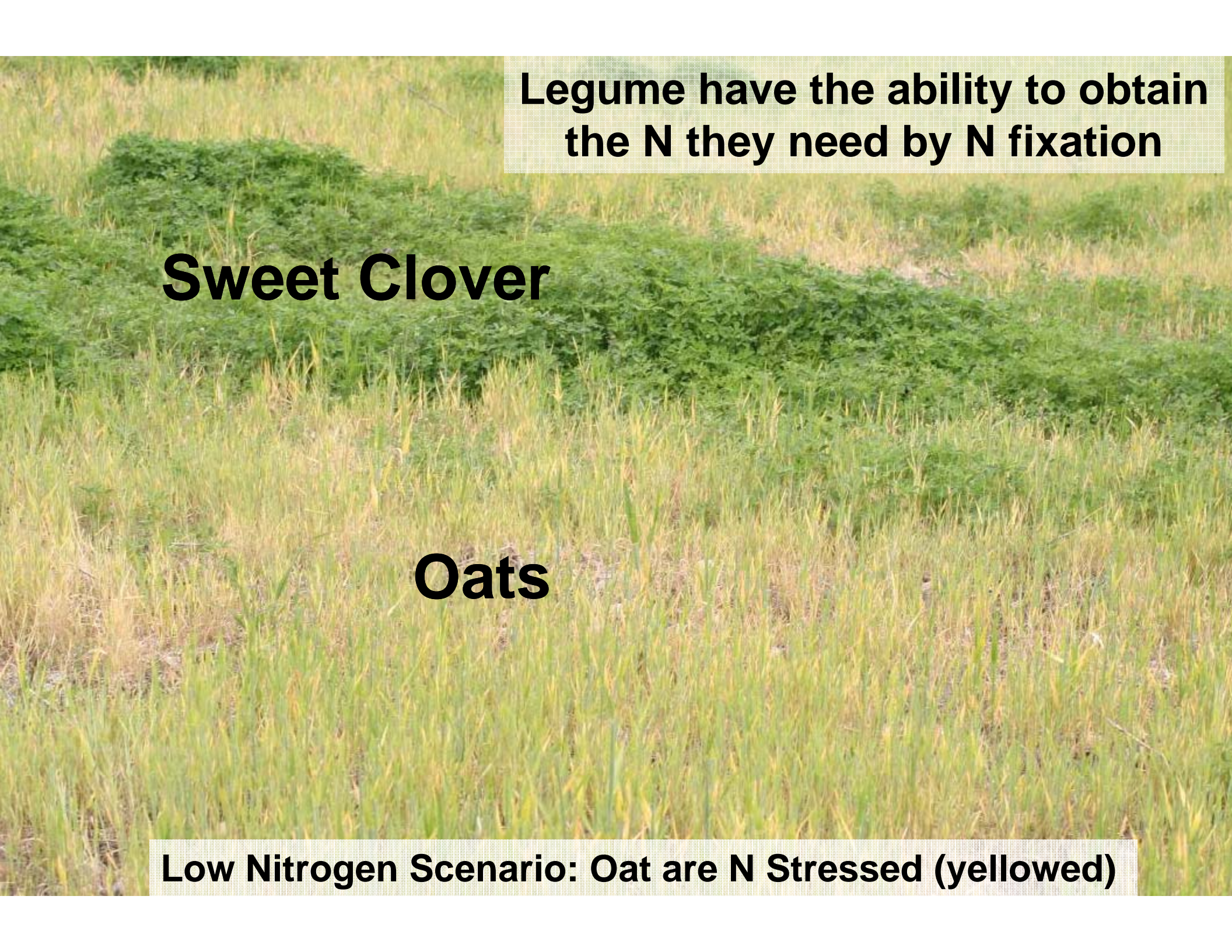
- **Cover crops can be a source of nitrogen for subsequent cash crops**
- **However, regarding N availability, there are important agronomic details that need to be discussed to better understand the role that cover crops can play in providing nitrogen to subsequent crops**

**Cereals, Mustards, Others:
Scavenge & recycle residual N from soil**



**Legumes: Fix N from the
air and provide a net
input of N to the soil**





**Legume have the ability to obtain
the N they need by N fixation**

Sweet Clover

Oats

Low Nitrogen Scenario: Oat are N Stressed (yellowed)

Legumes can leak some of their nitrogen to plants growing in their immediate vicinity



Compare the color of these two oat plants

**Legume and cereal mixes
take advantage of the N fixing ability of
legumes and the N scavenging ability of cereals**



How Much N do Cover Crops Contain?

Nitrogen Content of Cover Crops

Organic Farm in San Benito County

Six year Average

Cover Crop	Lbs N/A
Cereals	131.5
Legumes	145.7*
Cereal/Legume Mix	177.1

*** How much is net fixation is not known**

Scavenging of Nitrogen by Cover Crops

Following Conventional Lettuce Production

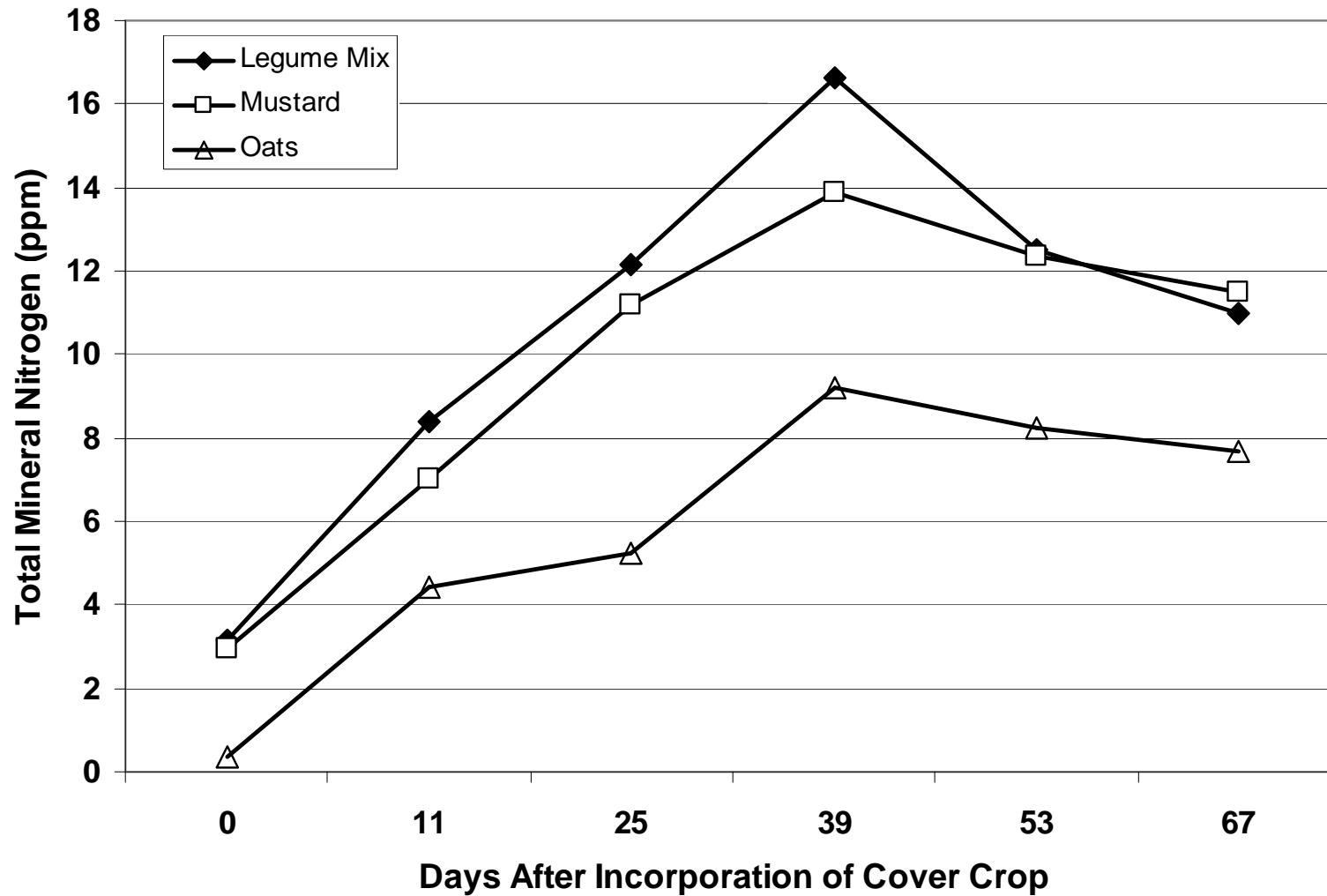
Chualar, 2003

Cover Crops	Biomass T/A	% N in Tops	lbs N/acre in Tops
White Mustard	2.5	3.9	194.8
Indian Mustard	2.2	4.5	199.7
Cereal Rye	3.1	3.3	203.7

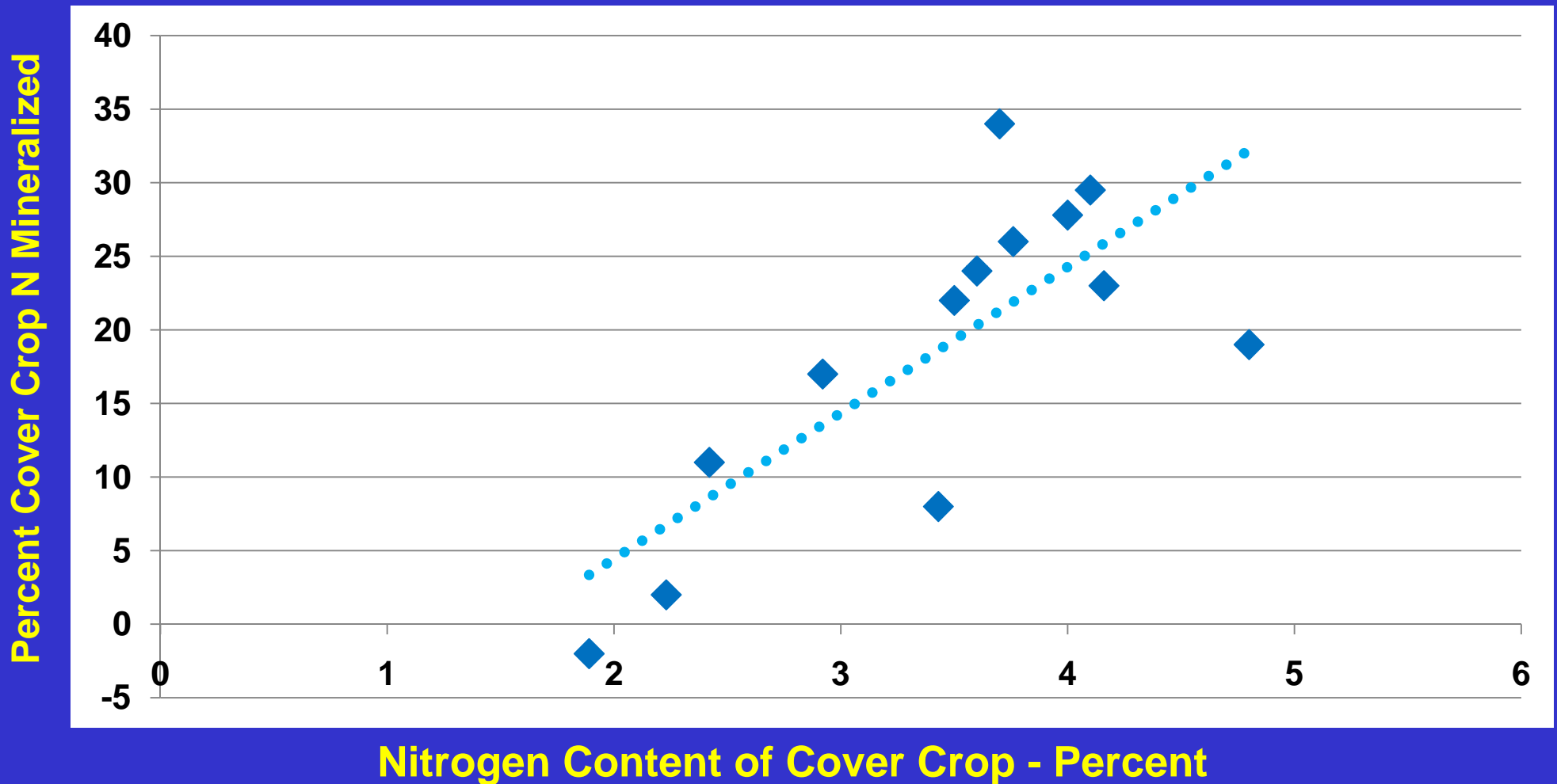
How much and at what rate is the nitrogen contained in cover crops made available to the subsequent cash crop?

- The release of nitrogen by cover crops is dependent on soil moisture and temperature**
- The nitrogen concentration of the cover crop is important**

N Release Pattern from Cover Crops



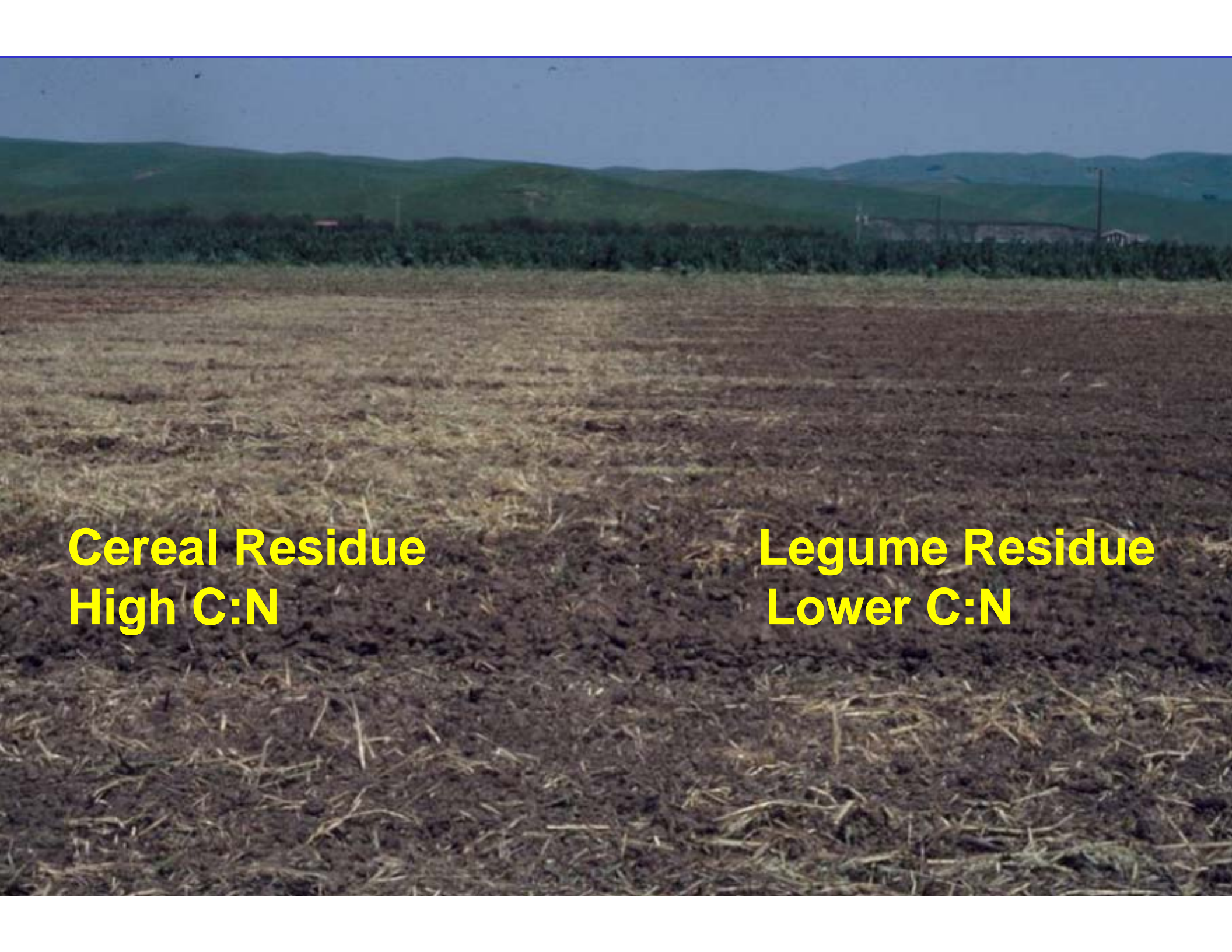
Percent of Cover Crop Nitrogen Mineralized at 8 Weeks



Various legume, and non-legume, cover crops, Hartz, unpublished

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



Cereal Residue
High C:N

Legume Residue
Lower C:N

**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*

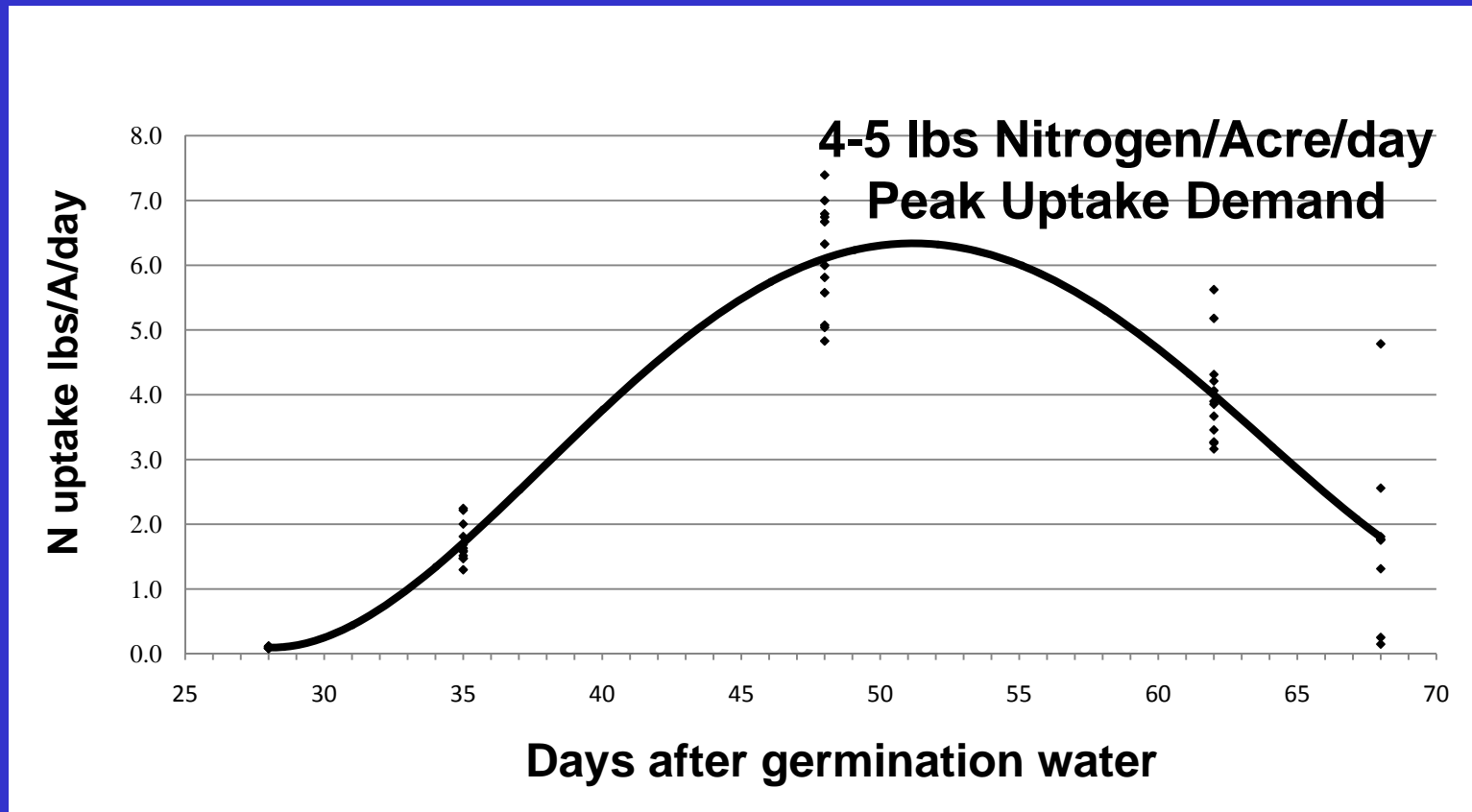
* A good deal of cover crop N remains in the system and can
be taken up in later years (i.e. 73% - Jackson, 2000)

Nitrogen Release by Cover Crops

- The nitrogen concentration of the cover crop is critical
- It determines the ability of cover crops to provide nitrogen for subsequent cash crop growth
- The synchrony of N release from cover crops with the uptake demand of crops is a more difficult issue to understand

Biomass Accumulation and Nitrogen Demand of Lettuce

- Rapid growth from 30 to 60 days following planting
- High Peak Demand for N

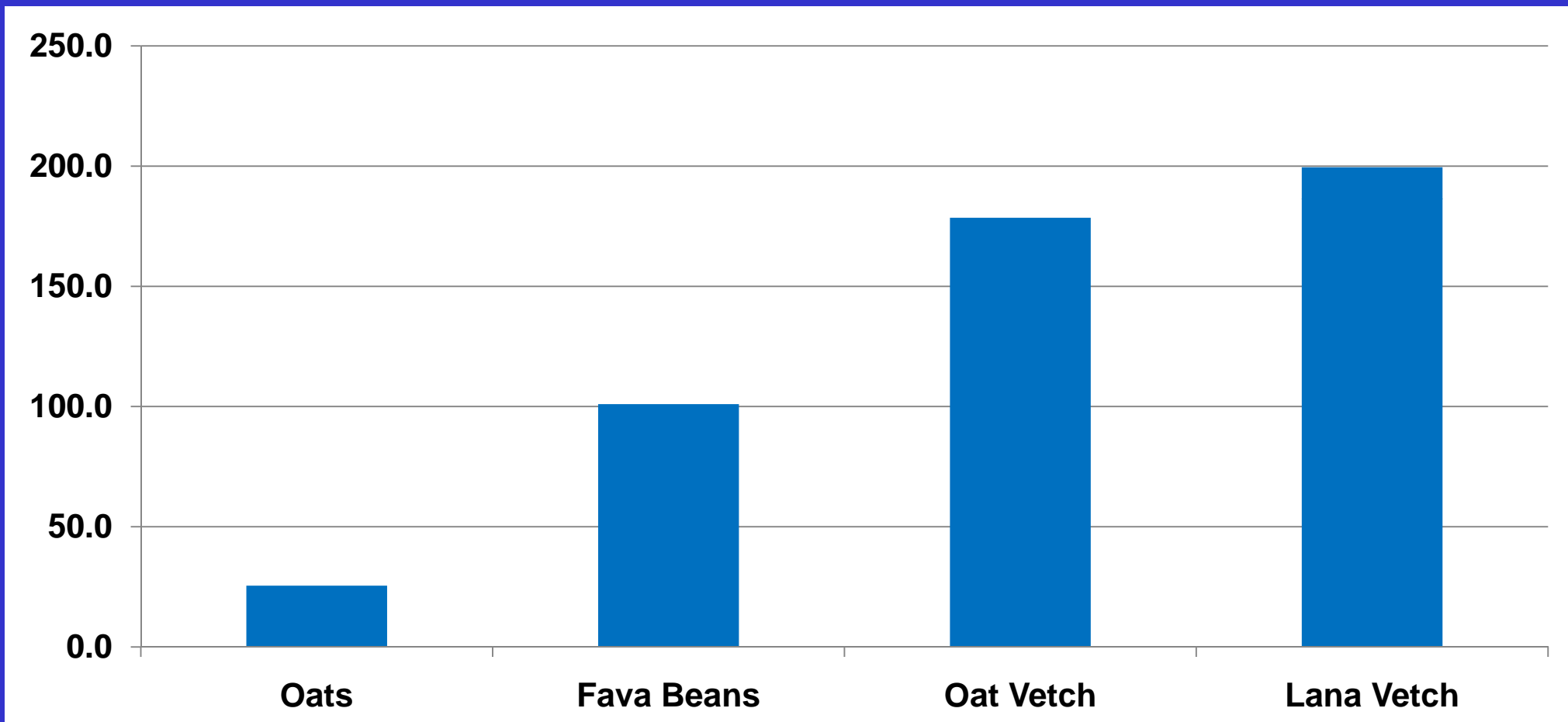


Field Trial on Nitrogen Release and Crop Response

- A field study conducted by Rick Miller (1987-1988), conducted on the UCD farm, illustrates an optimal situation of a cover crop providing adequate amounts of N in synchrony with crop demand

Nitrogen Content of Cover Crop Tops

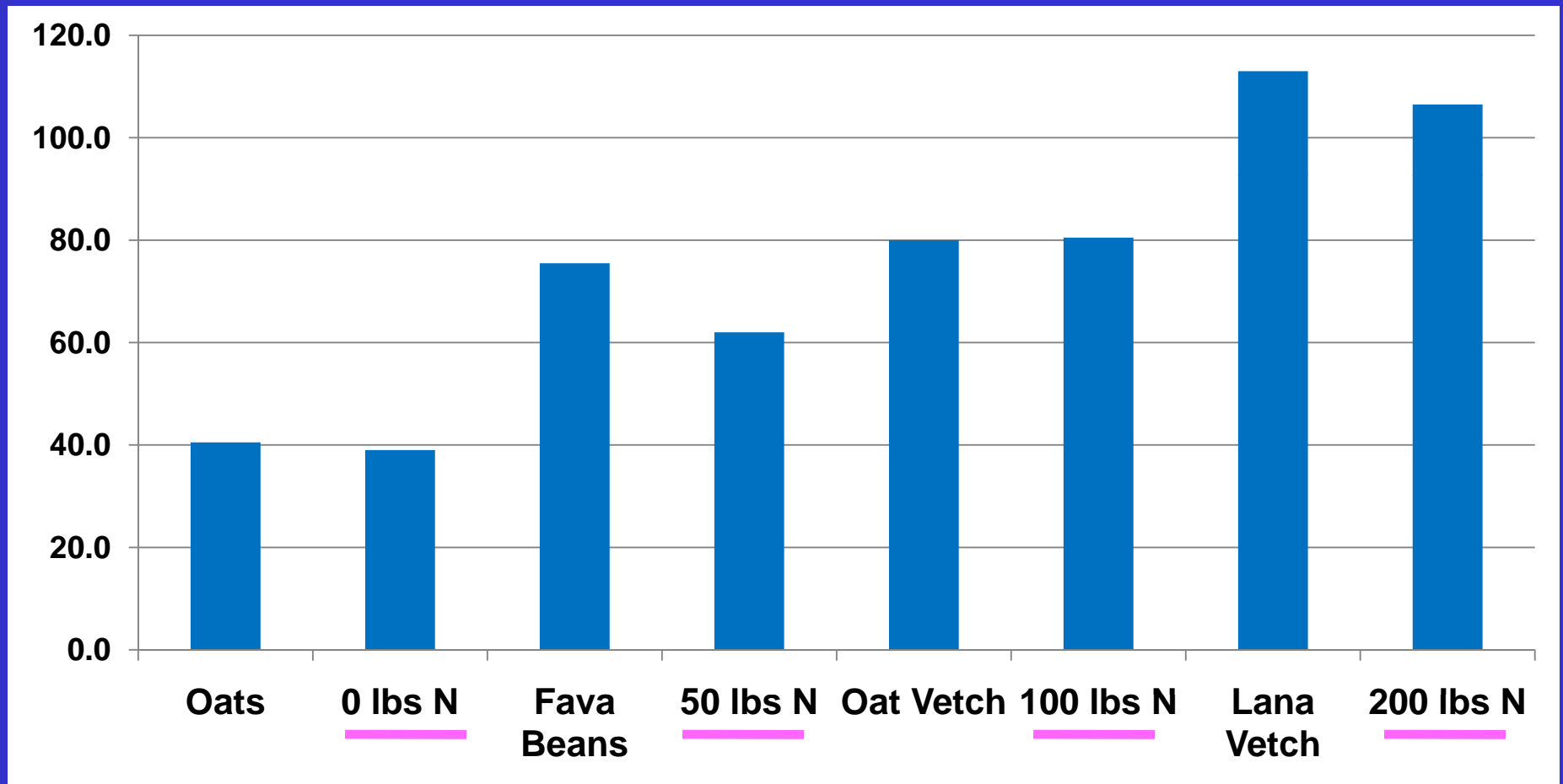
Two Year Average (1987/1988)



Miller, 1989

Nitrogen Uptake in Grain lbs/A

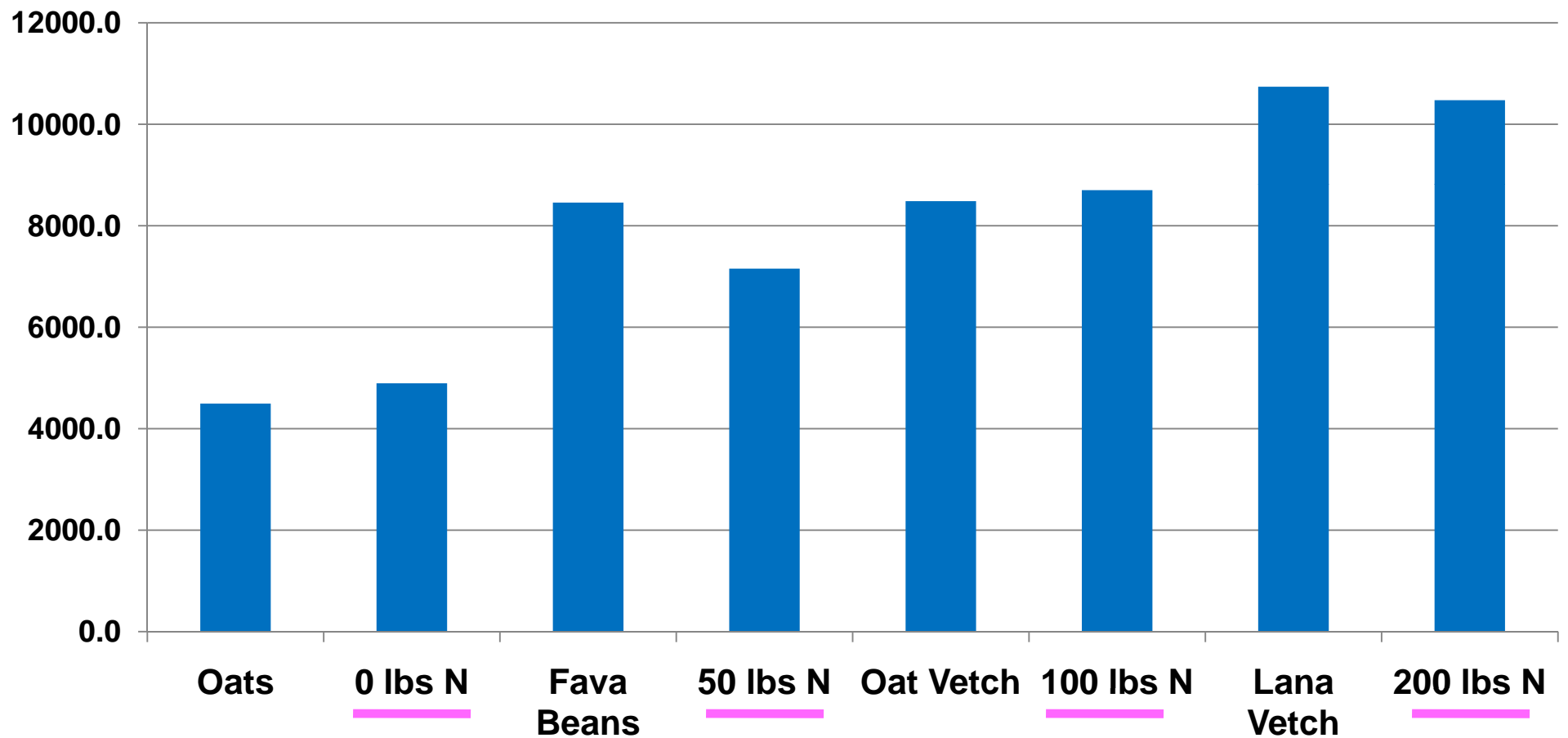
Two Year Average (1987/1988)



Miller, 1989

Grain Yield lbs/A

Two Year Average (1987/1988)



Conclusions of this Study

- Evidently, the synchrony of release of N from the cover crop and the quantity of N was optimal and gave equivalent yields to standard nitrogen fertilization practices
- This study showed optimal use of nitrogen from the cover crop by the subsequent cash crop

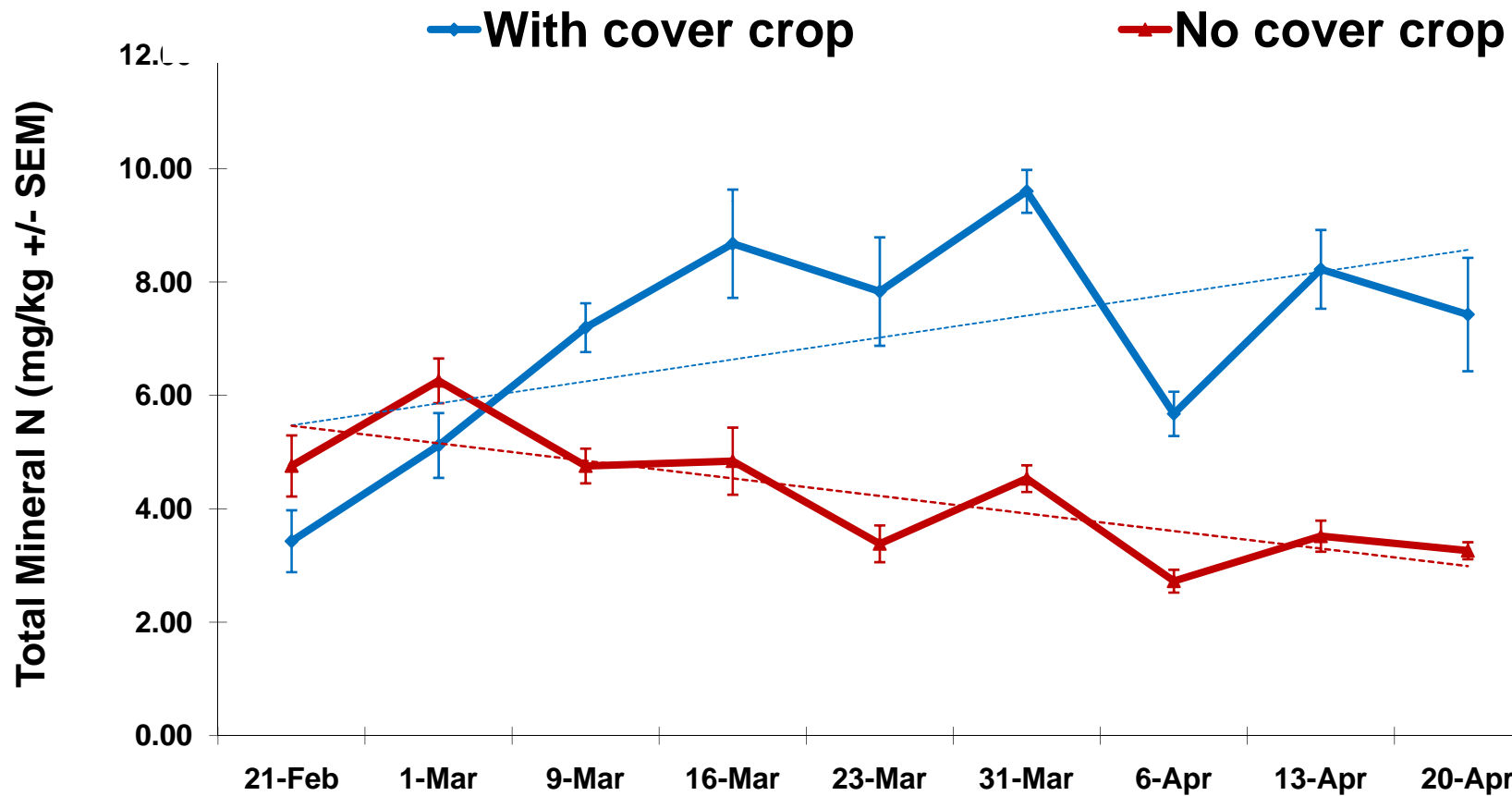
2006 & 2007 Cover Crop & Fertilizer Trial - Salinas

Year	Biomass T/A	N in Tops Percent	N in Tops lbs/A
2006	3.21	3.1	194.5
2007	3.71	2.1	153.4

Smith and Muramoto, 2007

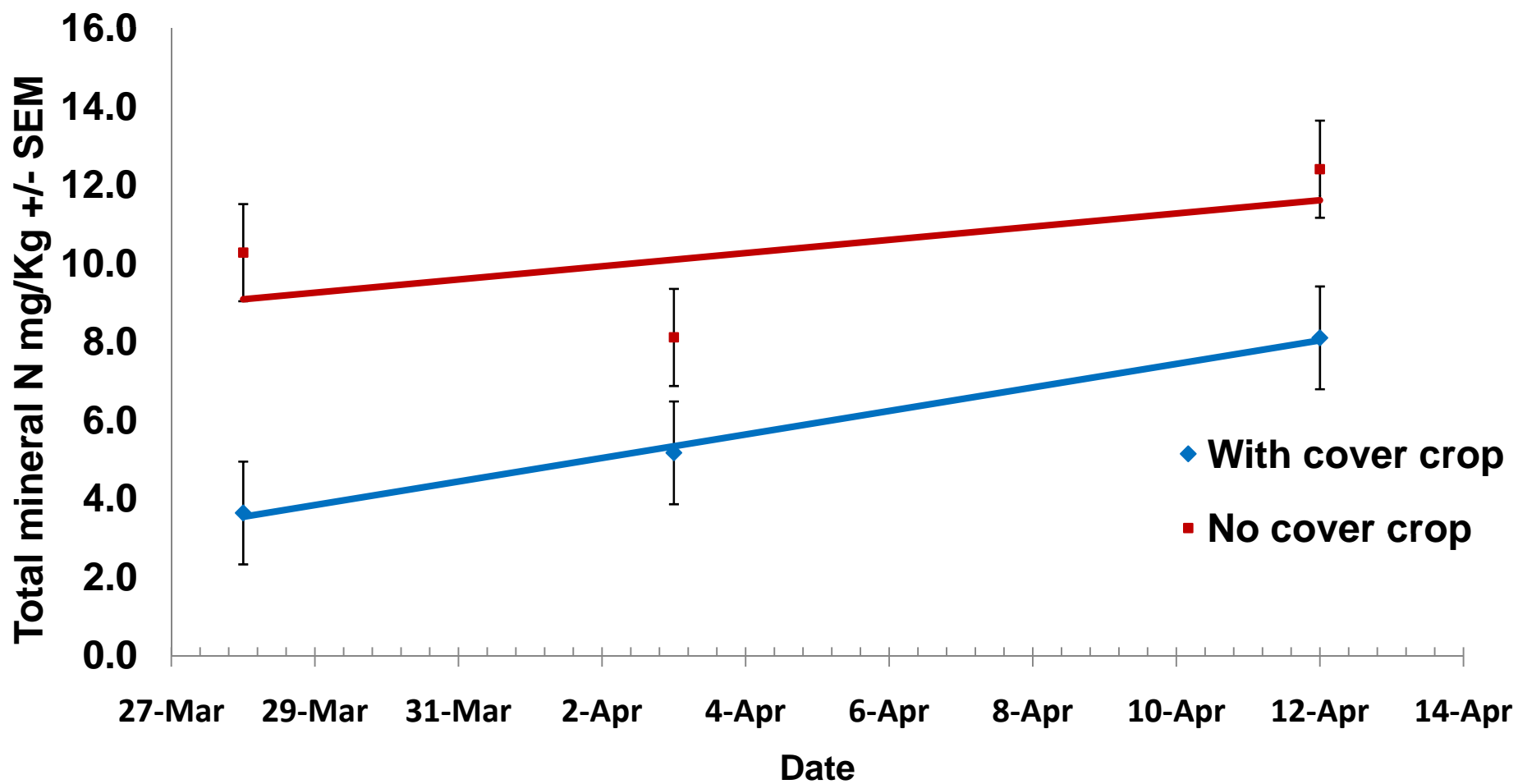
2006 Soil Mineral Nitrogen

Cover Crop Incorporation to Planting Broccoli

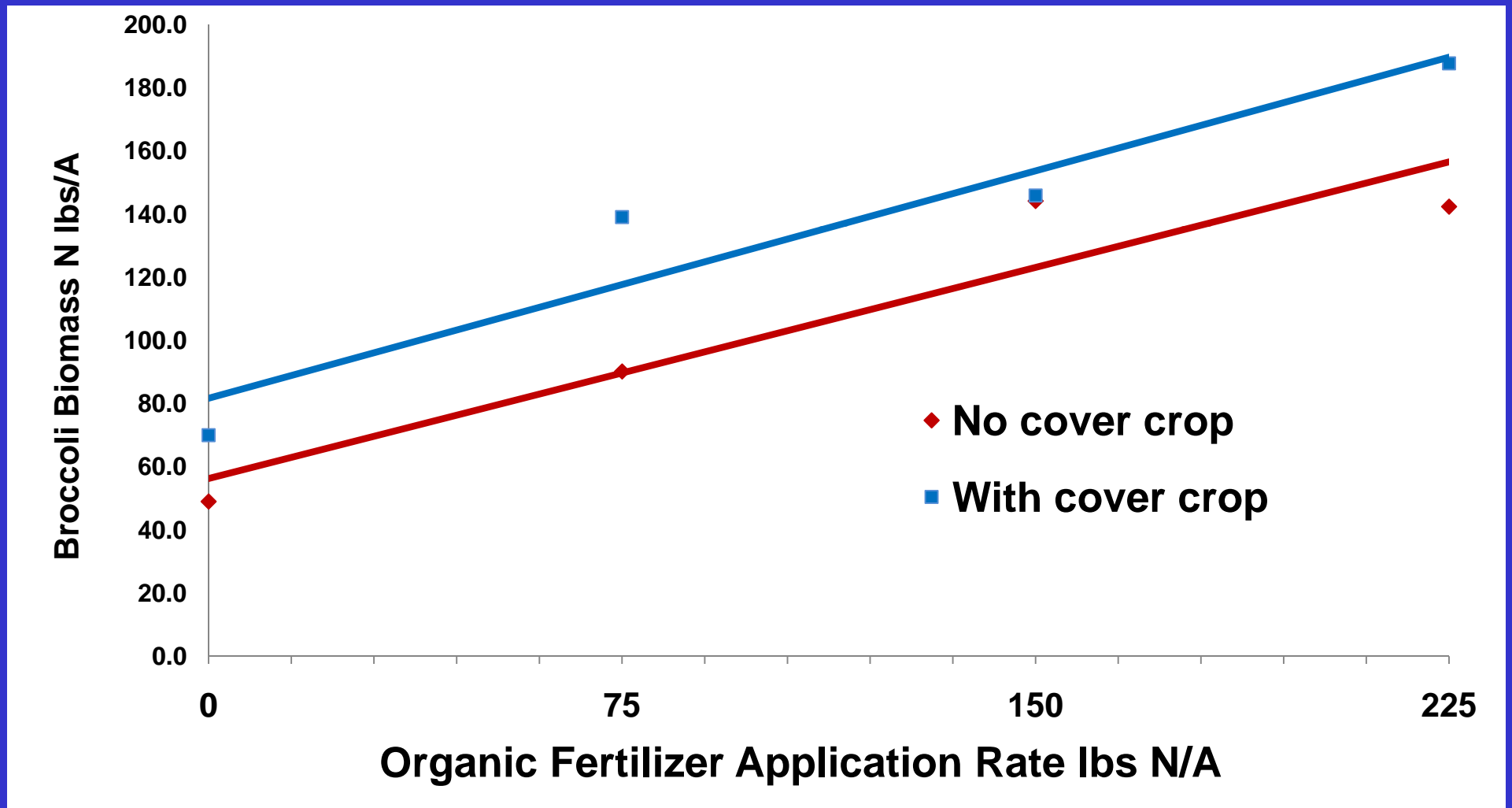


2007 Soil Mineral Nitrogen

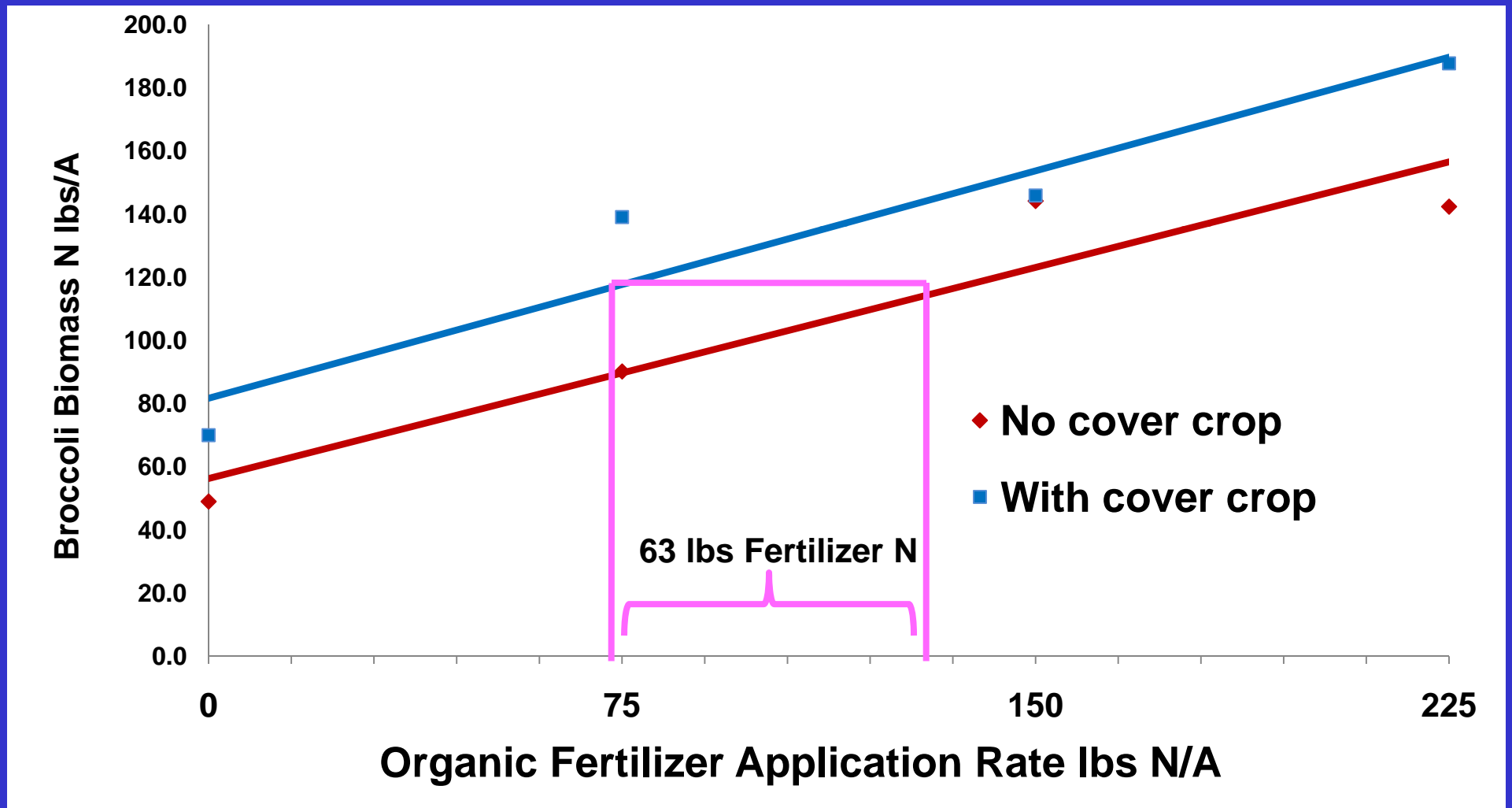
Cover Crop Incorporation to Planting Broccoli



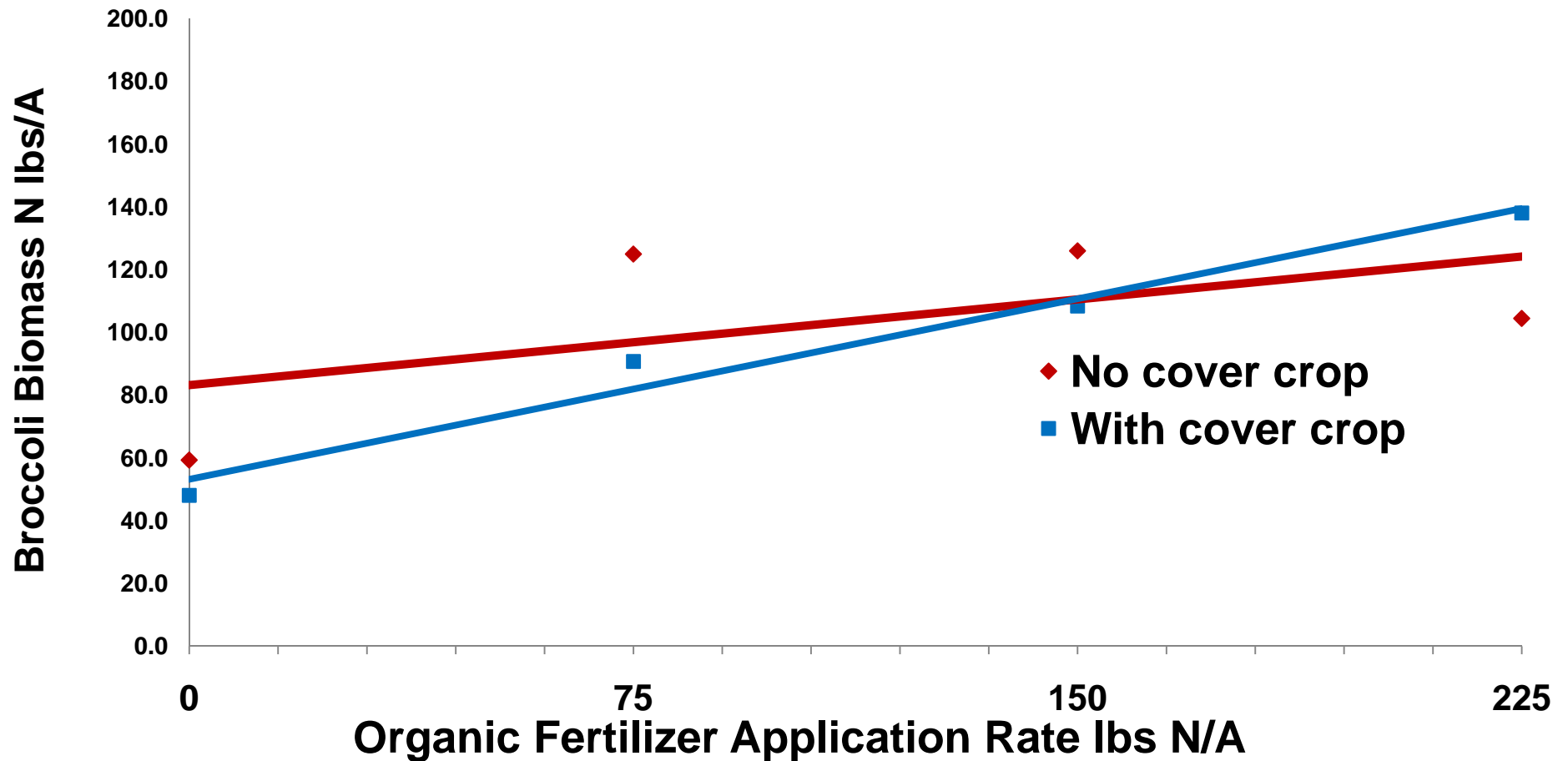
2006 Nitrogen in Broccoli Biomass lbs/A At Harvest



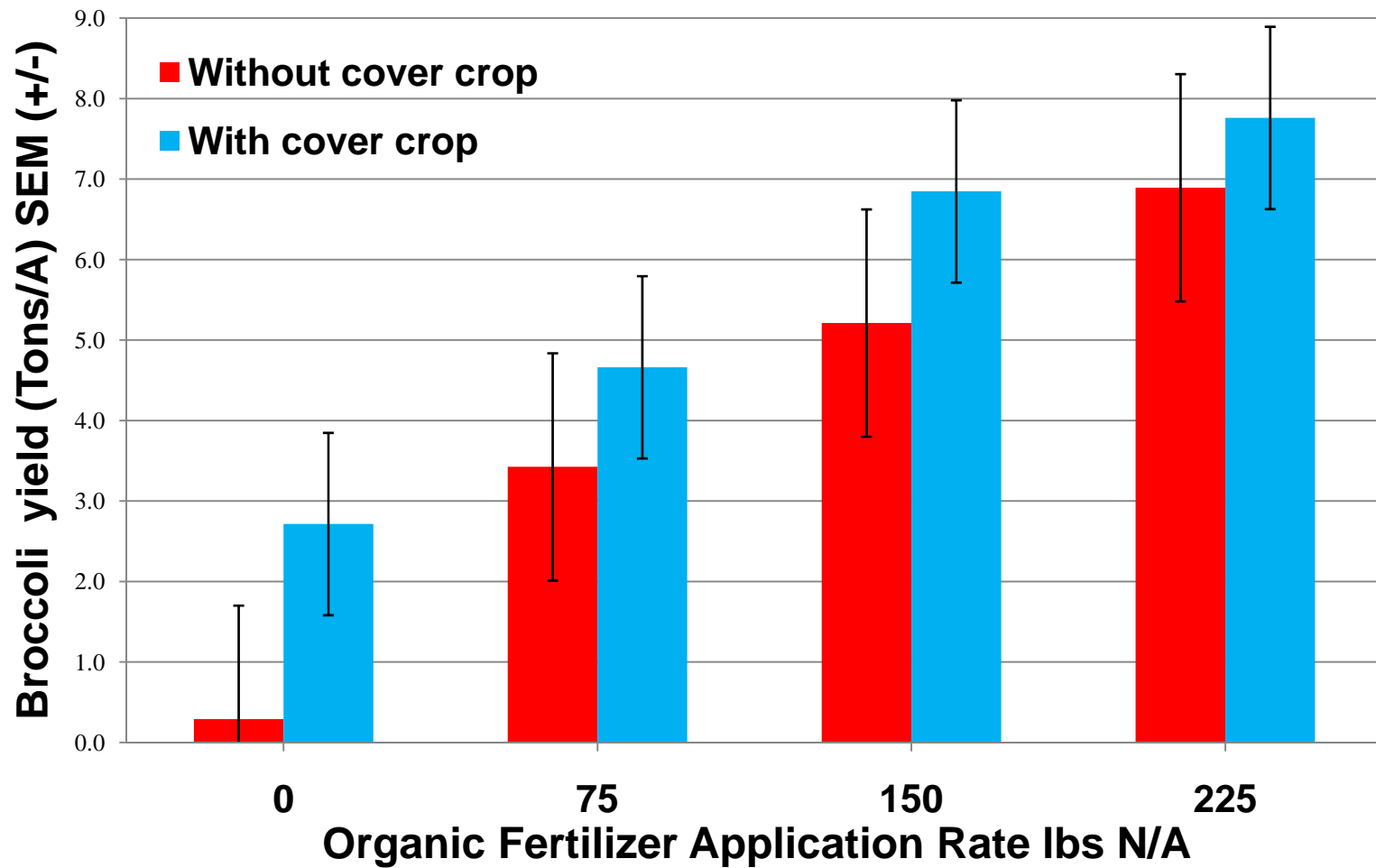
2006 Nitrogen in Broccoli Biomass lbs/A At Harvest



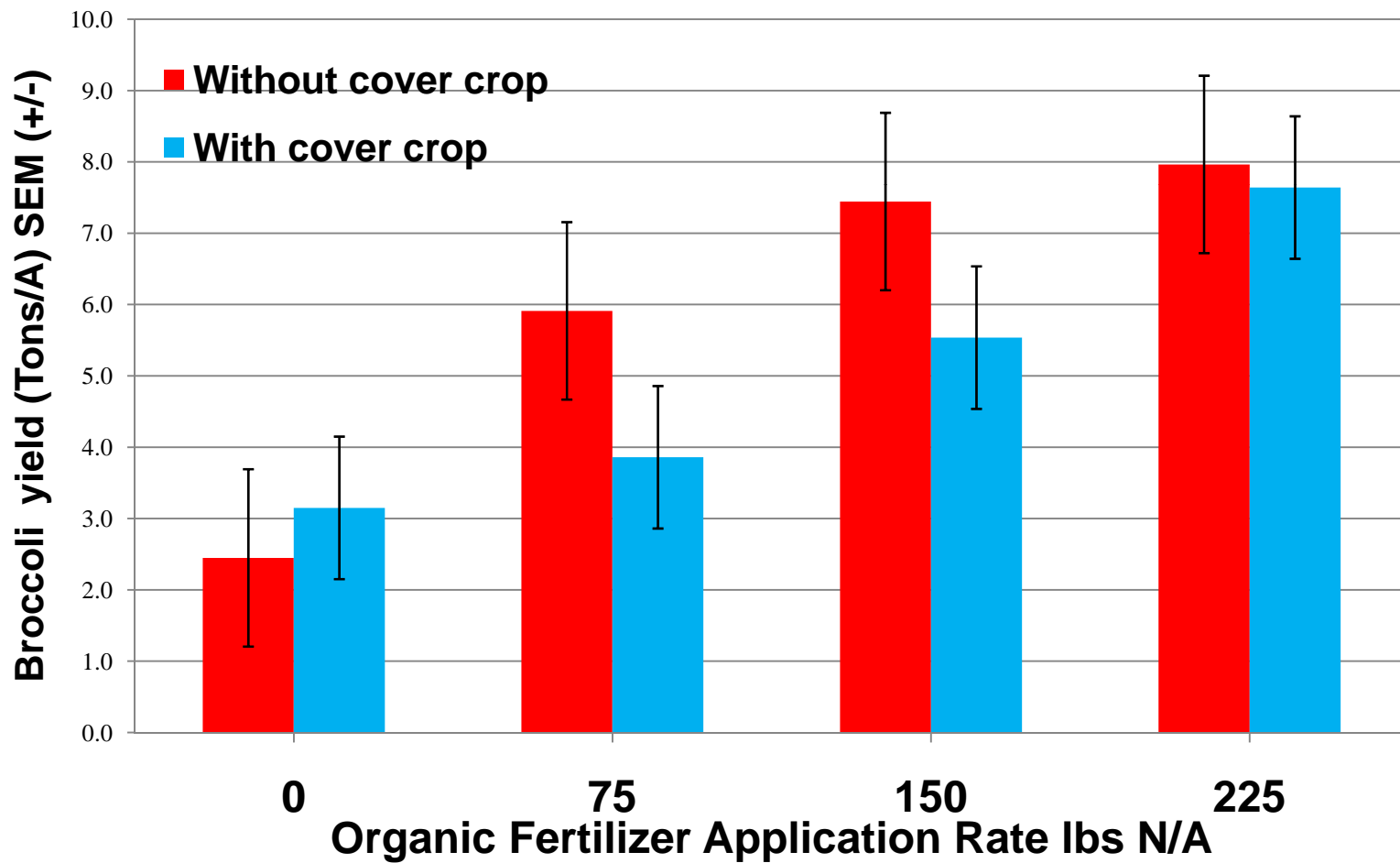
2007 Nitrogen in Broccoli Biomass lbs/A At Harvest



Broccoli Yield 2006 Trial



Broccoli Yield 2007 Trial





Summary of Cover Crop and Nitrogen Fertility Trial

When the nitrogen levels in the cover crop were sufficient, the cover crop was able to provide the equivalent of 63 lbs of fertilizer N to the broccoli

Supplemental N fertilizer improved yield up to 150 lbs N/A both with and without cover crop



Summary of Cover Crop and Nitrogen Fertility Trial

When the nitrogen levels in the cover crop were close to 2%, the cover crop tied up nitrogen and it took 225 lbs of fertilizer N to over come this effect

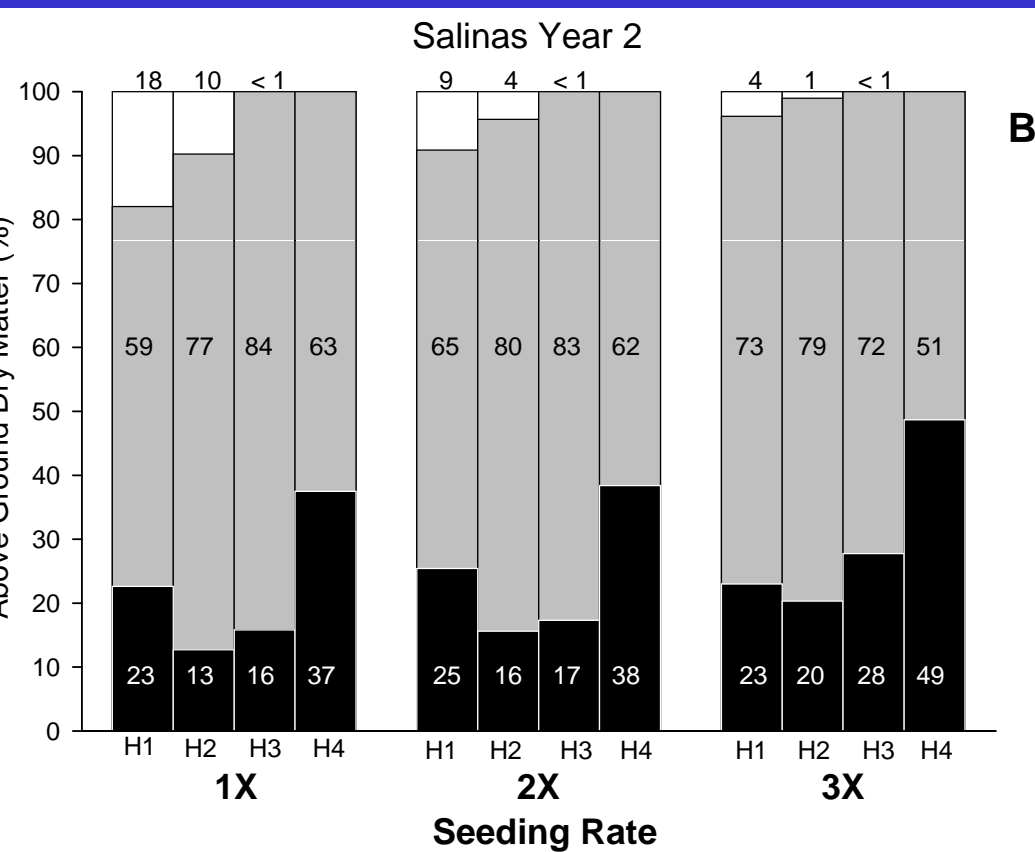
Cover crops can provide useful amounts of nitrogen, but can also make soil nitrogen unavailable for subsequent crop growth

Composition of Cover Crop Mixes

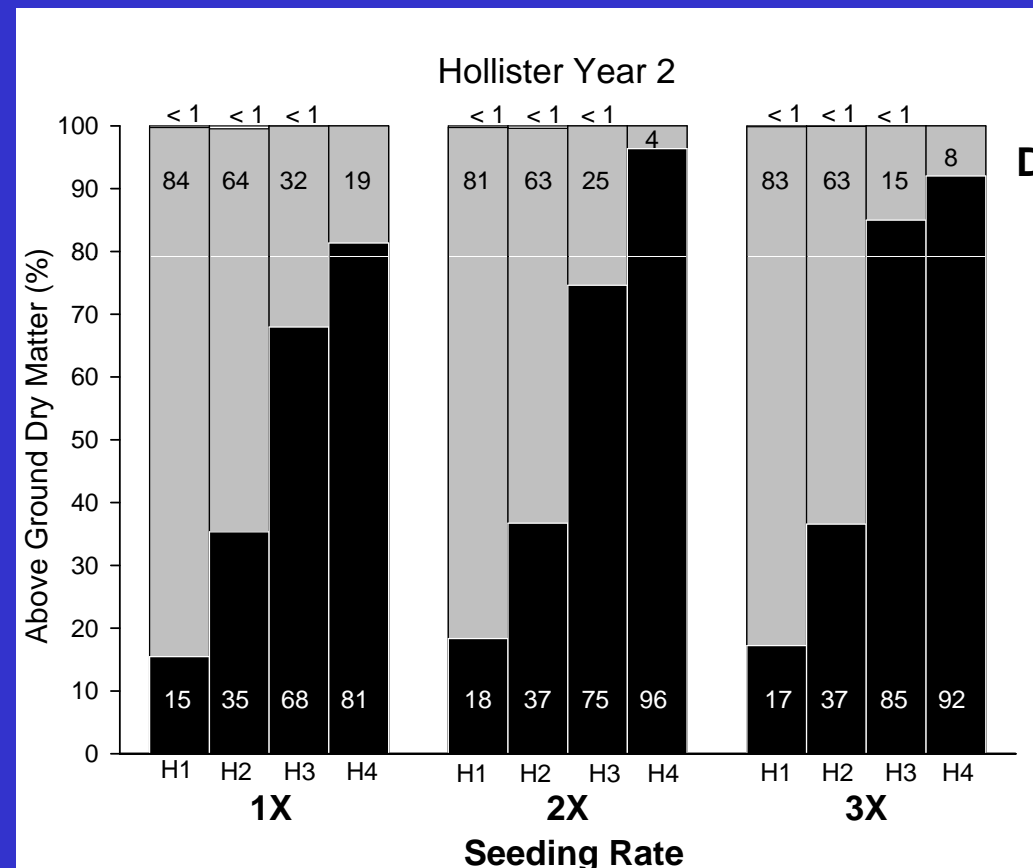
- **Planting Date, weather conditions and soil fertility can affect the composition of cover crop mixes and can impact their nitrogen concentration at incorporation**

Comparison of Cover Crop Composition on Two Soil Types

black = cereal; gray = legume



Sandy loam, low fertility

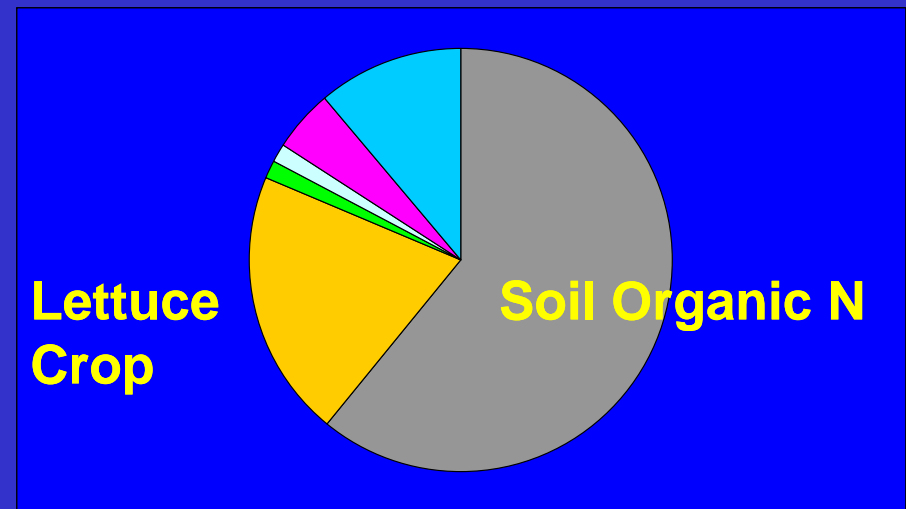


Clay loam, high soil fertility

How Much Cover Crop N is Made Available for Crop Growth

- **Cover crops can contain 100 – 200 lbs N but typically less than half of this is made available to the subsequent crop**

**Cover Crop in Lettuce
Four months after incorporation**



Jackson, 2000

Mineralization of Mineral Nitrogen from Cover Crops

- Cover crops also play a larger role in soil building and provide a long-term source of N that contributes to total soil nitrogen content and that behaves the same as soil organic matter**

Impacts of Organic Soil Building on Nitrogen Storage in Soil

Soil Type	Management	Total Soil N %
Clay Loam	Organic	0.17
Clay Loam	Conventional	0.14
Loam	Organic	0.14
Loam	Conventional	0.11
Fine Sandy Loam	Organic	0.12
Fine Sandy Loam	Conventional	0.06

Smith, 2003

Impacts of Organic Soil Building on Nitrogen Storage in Soil

Soil Type	Management	Total Soil N %
Clay Loam	Organic	0.17
Clay Loam	Conventional	0.14
Loam	Organic	0.14
Loam	Conventional	0.11
Fine Sandy Loam	Organic	0.12
Fine Sandy Loam	Conventional	0.06

Smith, 2003

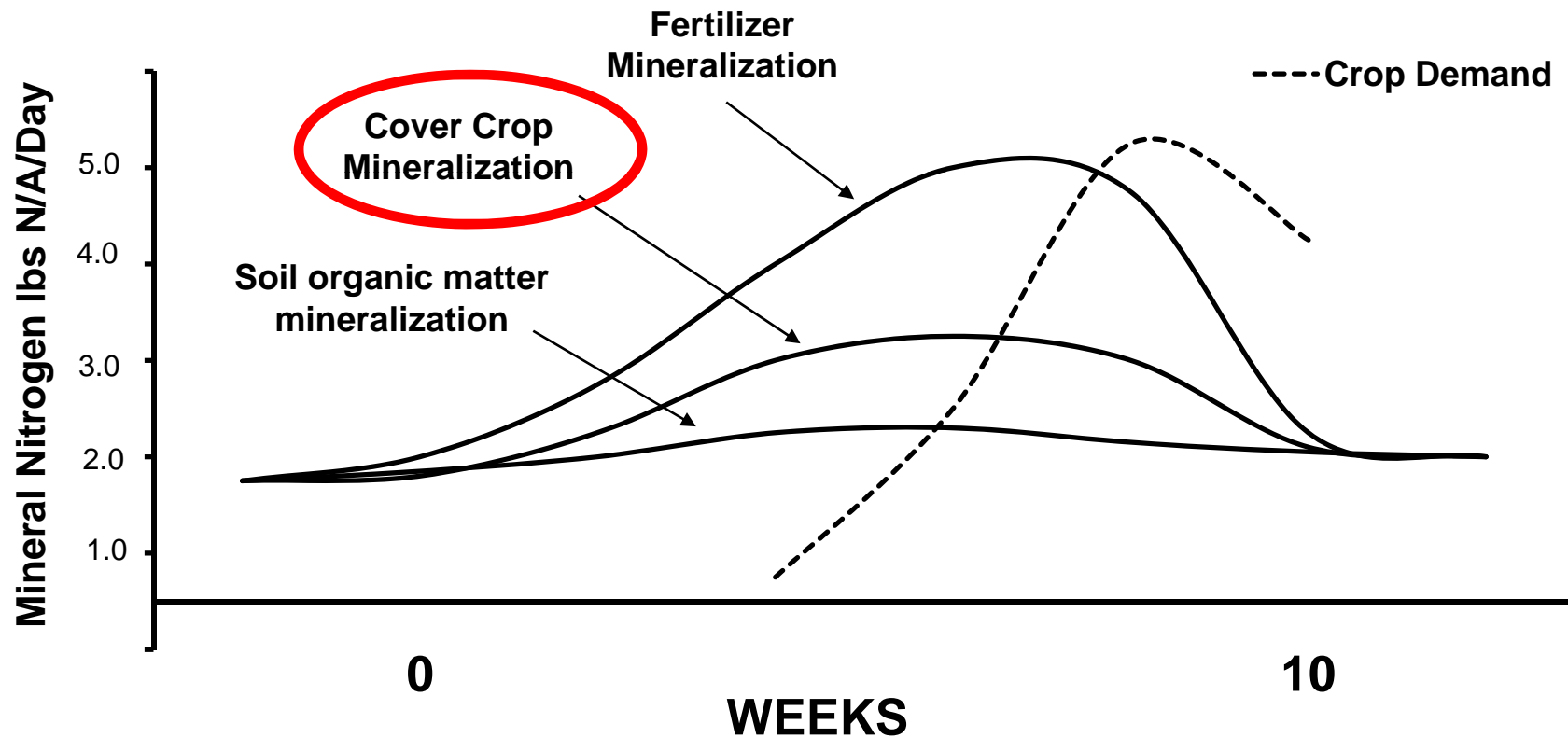
Summary of Nitrogen Fertilization of Organic Horticultural Crops

- **Some crops may be able to achieve economically acceptable yield from mineralization of soil organic matter and crop residues from cover crops**
- **Most of our key crops will generally need greater quantities of available mineral nitrogen to achieve economically viable yields**

Nitrogen Fertilization of Organic Horticultural Crops

- **The key is for organic sources of N to mineralize in sufficient quantities and quick enough to meet crop demand**
- **Synchrony of supply and demand**

Effective Synchrony Between Mineralization from the Various Sources and Crop Demand



Management of Cover Crops to Provide Nitrogen to Subsequent Cash Crops

- Cover crops should be incorporated in a juvenile enough stage to prevent immobilization of N:
- Nitrogen content of the tops $> 2.5\%$
 - Legumes at flowering or before
 - Cereals well before heading

Management of Cover Crops to Provide Nitrogen to Subsequent Cash Crops

- Allow sufficient time for the cover crops to decompose and release nitrate and ammonium**
- Manage water carefully to not leach available N below the root zone**

Thank you for your attention

