

# High Yield Systems: Role of Placement and Timing

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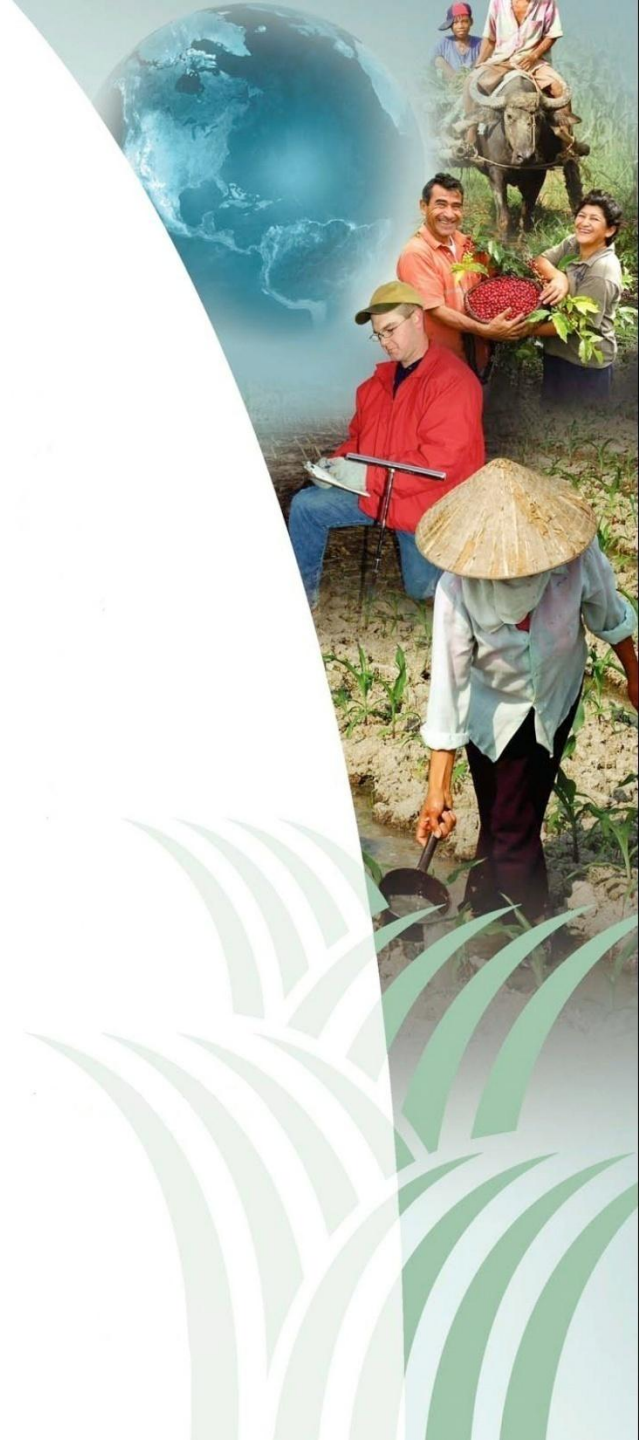


**IPNI**  
Better Crops, Better Environment  
...through Science

# Outline

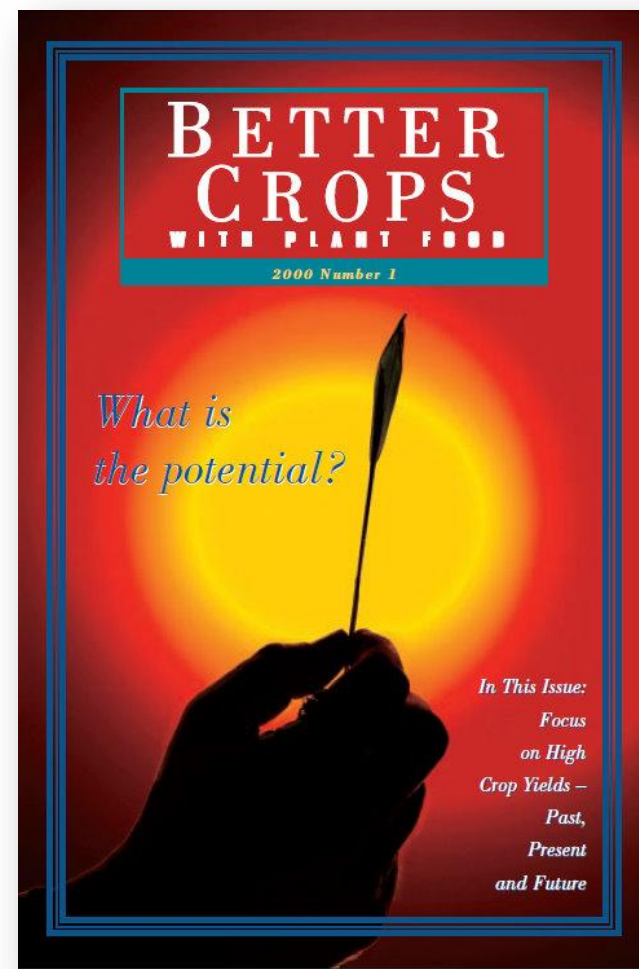
- How close are yields to those that are possible?
- Concepts to carry with you when working in high-yield systems
  - Short-term efficiency vs. long-term soil fertility management
  - Characteristics of young root systems
  - Root-nutrient interactions in bands
  - Spatial variability introduced by bands
  - Redistribution of nutrients in the soil caused by crop growth
  - Using banding to address economic constraints

# Yields: Determining the potential



# Yield goal vs. potential yield

- Farmers want to know how close their yields are to what is possible
- Yield goal:
  - Average of historical yields + \_\_\_\_\_%
  - “What has been done plus a little more”
  - Estimates for the coming season are used to determine “maintenance rates”
- Potential yield:
  - “...the maximum yield that could be reached by a crop in given environments” (Evans and Fischer. 1999. Crop Sci. 39:1544)
  - Estimated through crop growth models





## Hybrid-Maize plant growth simulation software

Settings

Save Results

Print

Utilities

Help

Hybrid-Maize

UNIVERSITY OF

Nebraska

Lincoln

Input

Results

Chart

Growth

Weather

Water

General Input

Weather file...

NASAGrissomJacoby1997

Available data

1/1/1997 - 12/31/2008

Simulation mode

Current season prediction

Include yield trend

Long-term runs

from: 1997

to: 2008

Single year

with long-term runs

Start from

Emergence

Planting

Seed depth (cm)

4.1

Seed brand

Generic

Maturity

GDD10C

1468

Date (m/d)

Relative maturity (days)

110

Optional:

Date of silking (m/d)

GDD10C to silking

\* Generic estimate

98.8

Population (x1000/ha)

98.8

Water

Optimal

Estimate irrigation water requirement

Rainfed / Irrigated

Assume no water stress in prediction phase

Irrigation schedule

Month

Day

Amount (mm)

Reset entries

Soil

Max rooting depth (cm)

102

Texture

Silt loam

Initial moisture status

Moist (75% FC)

Bulk density

1.3 (g/cm3)

Top-soil (30 cm)

Sub-soil

Silt loam

Wet (100% FC)

Nitrogen

Optimal

Last season residues incorporation

Type

Quantity (Mg/ha)

Date

Soil Nmin at planting (kg/ha)

Soil organic C (%)

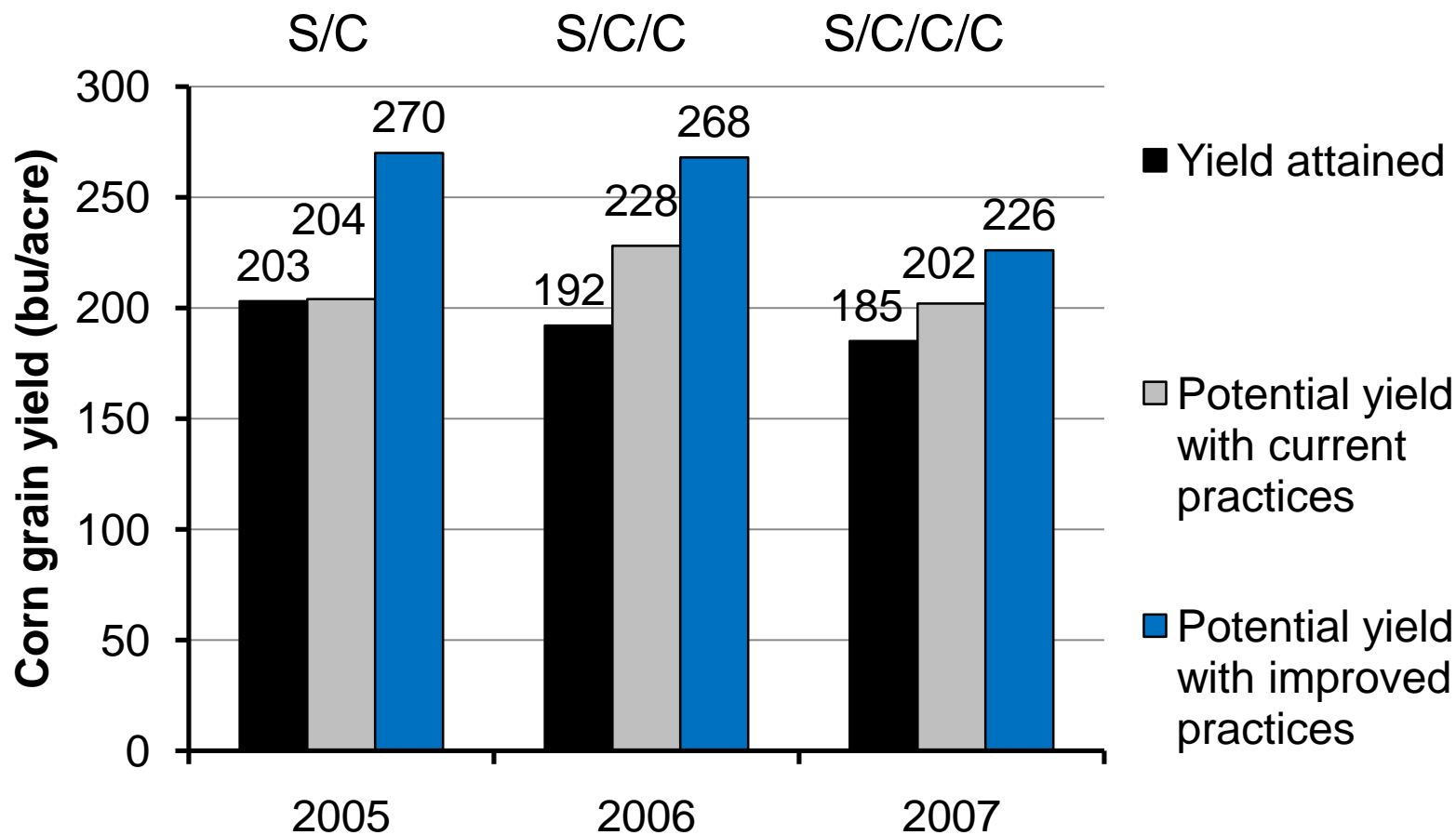
Fertilizer N (kg N/ha)

Metric units

Run...

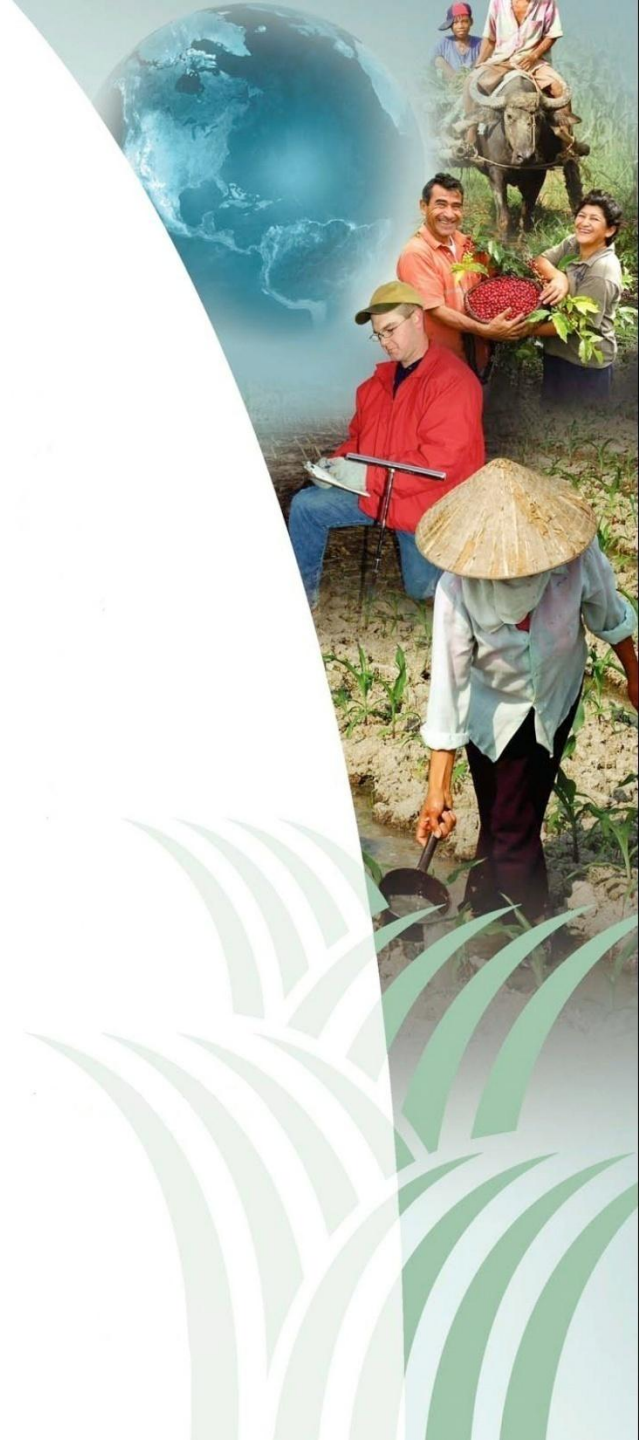
Weather folder = C:\Documents and Settings\Scott Murrell\Mu Documents\SDo

# Yield attained vs. potential yield



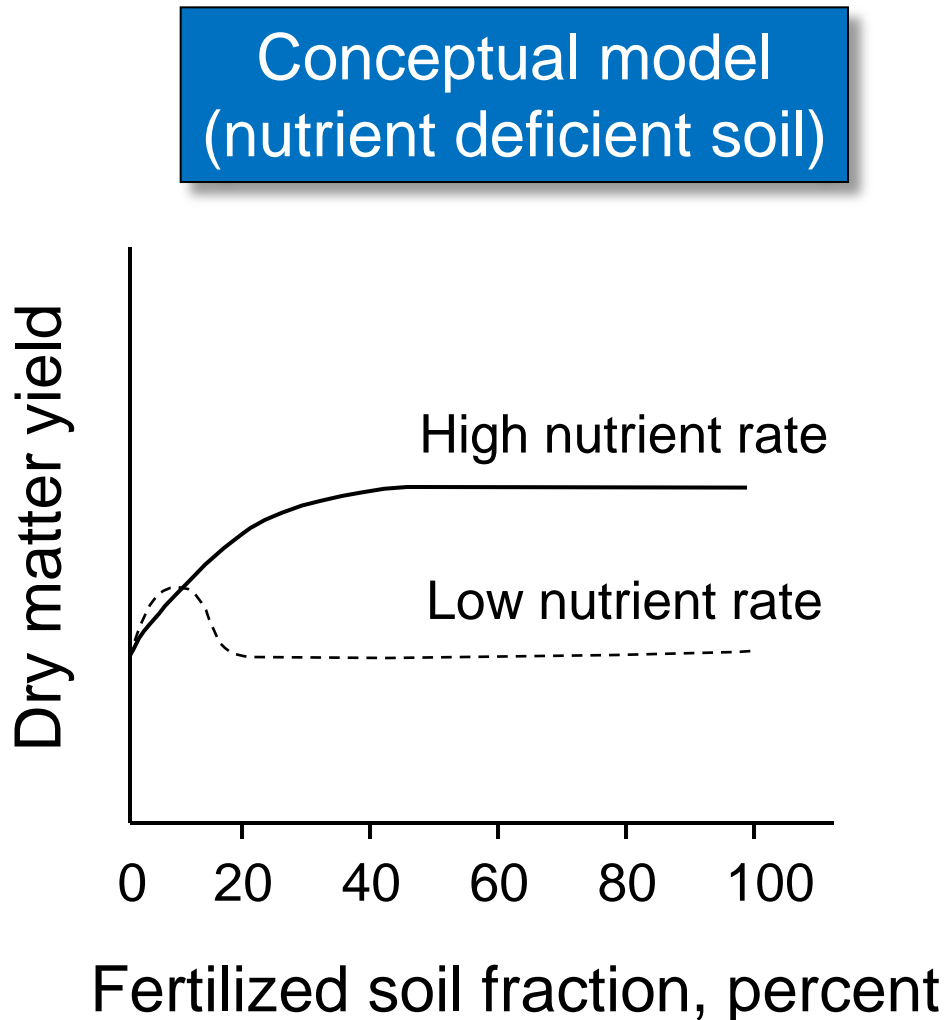
# **Banded applications:**

## ***Efficiency and soil tests***



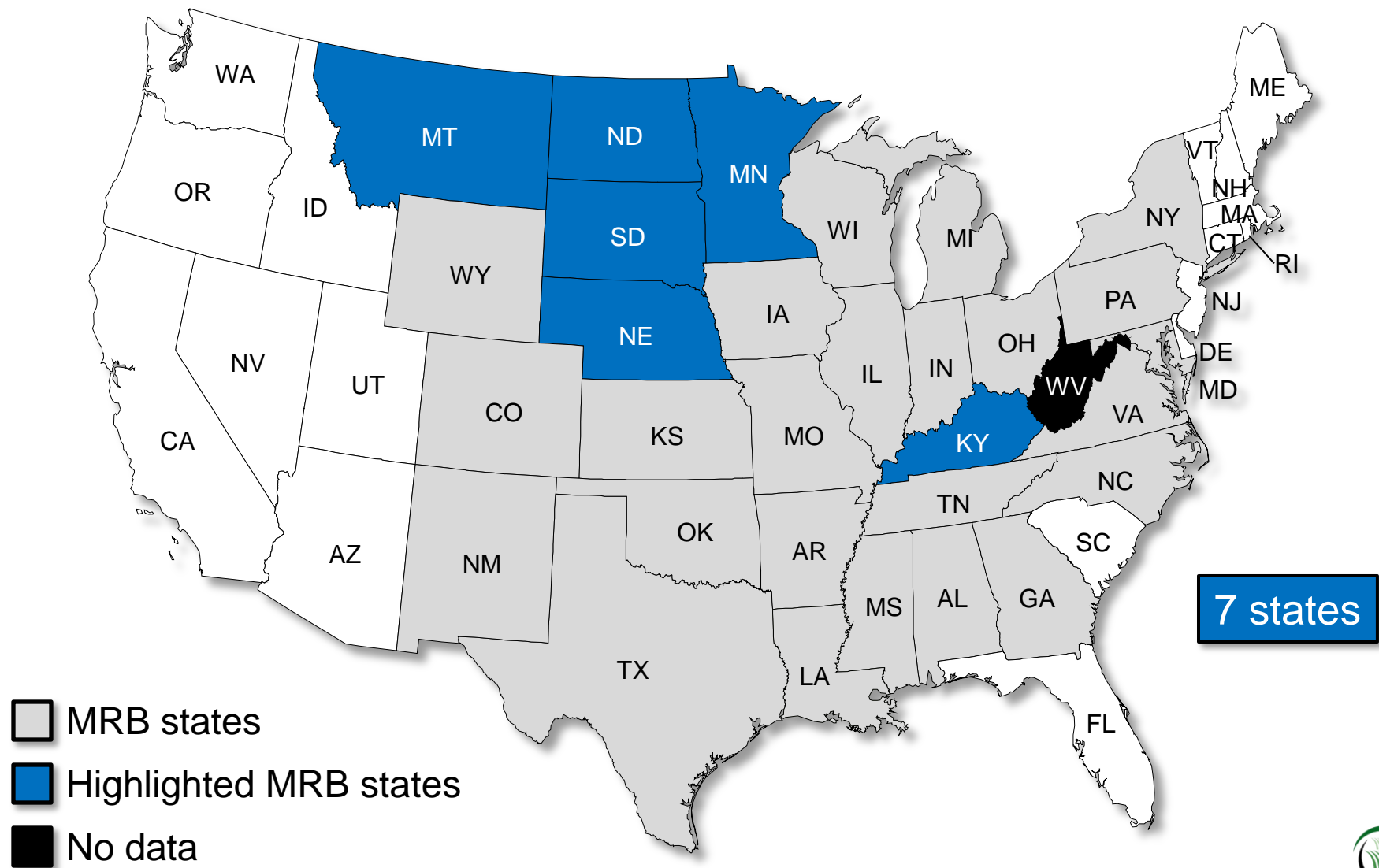
# Nutrient placement considerations

- Banding:
  - Less soil volume fertilized
  - Smaller portion of fertilizer is “tied up”
  - Roots proliferate where N and P are found
  - Rate may be too low to maximize yield
    - Fewer roots exposed to supply
    - Increase in influx rate by roots may not compensate for fewer total number of roots near P supplies

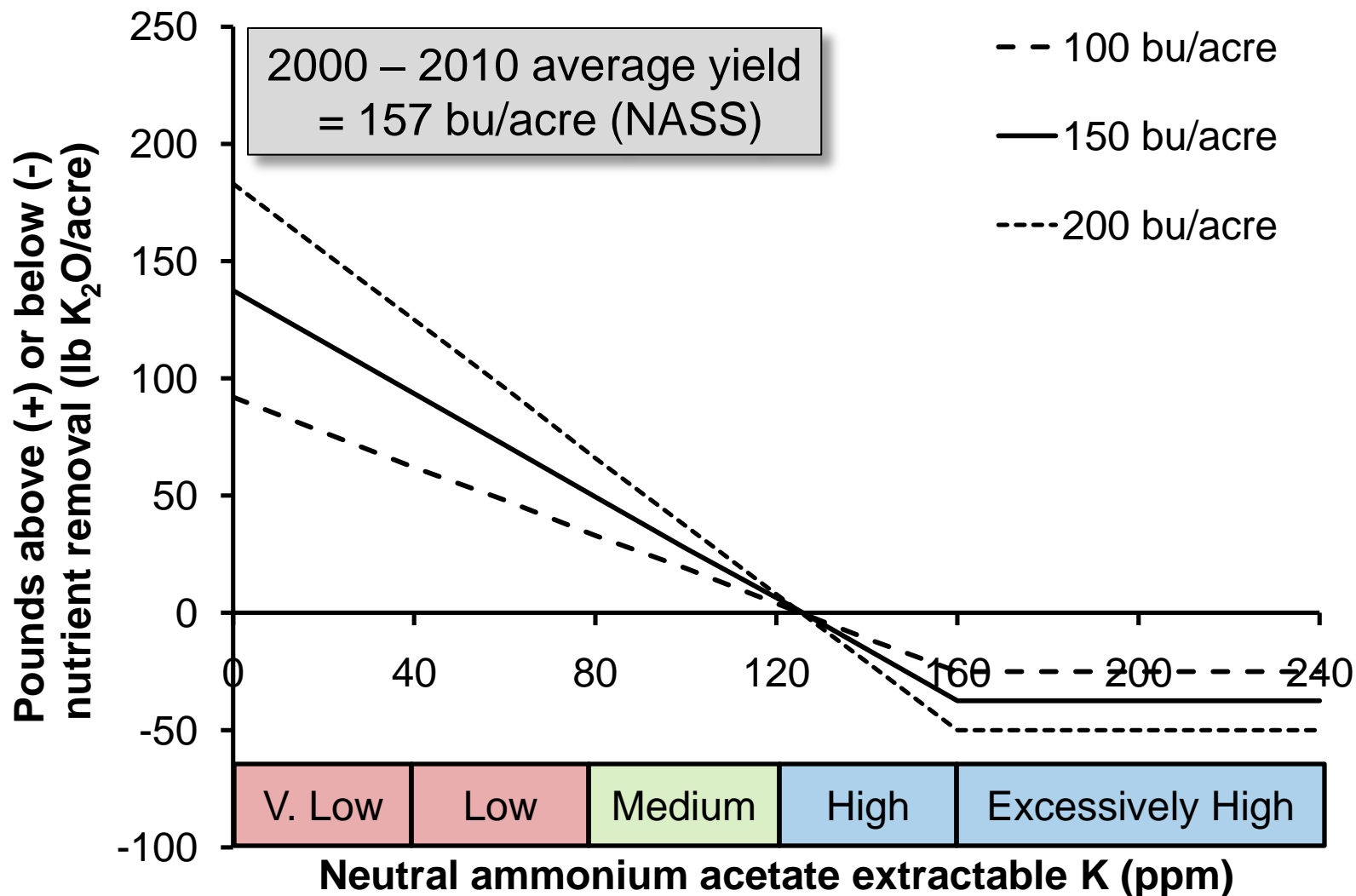




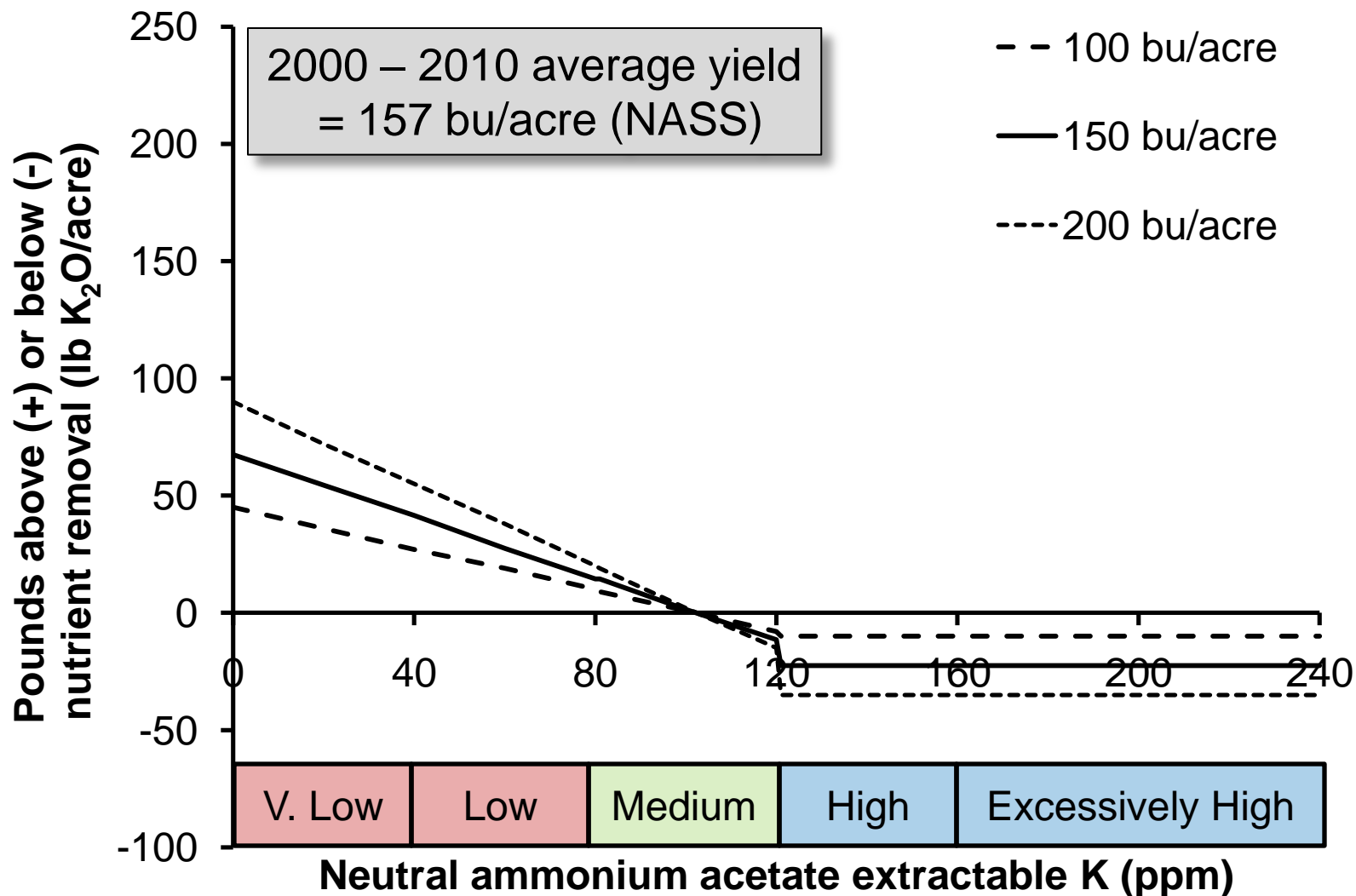
# Mississippi River Basin (MRB) states recommending rate reductions with banded applications



## A K recommendation that does consider yield goal: *Example: MN – broadcast application*

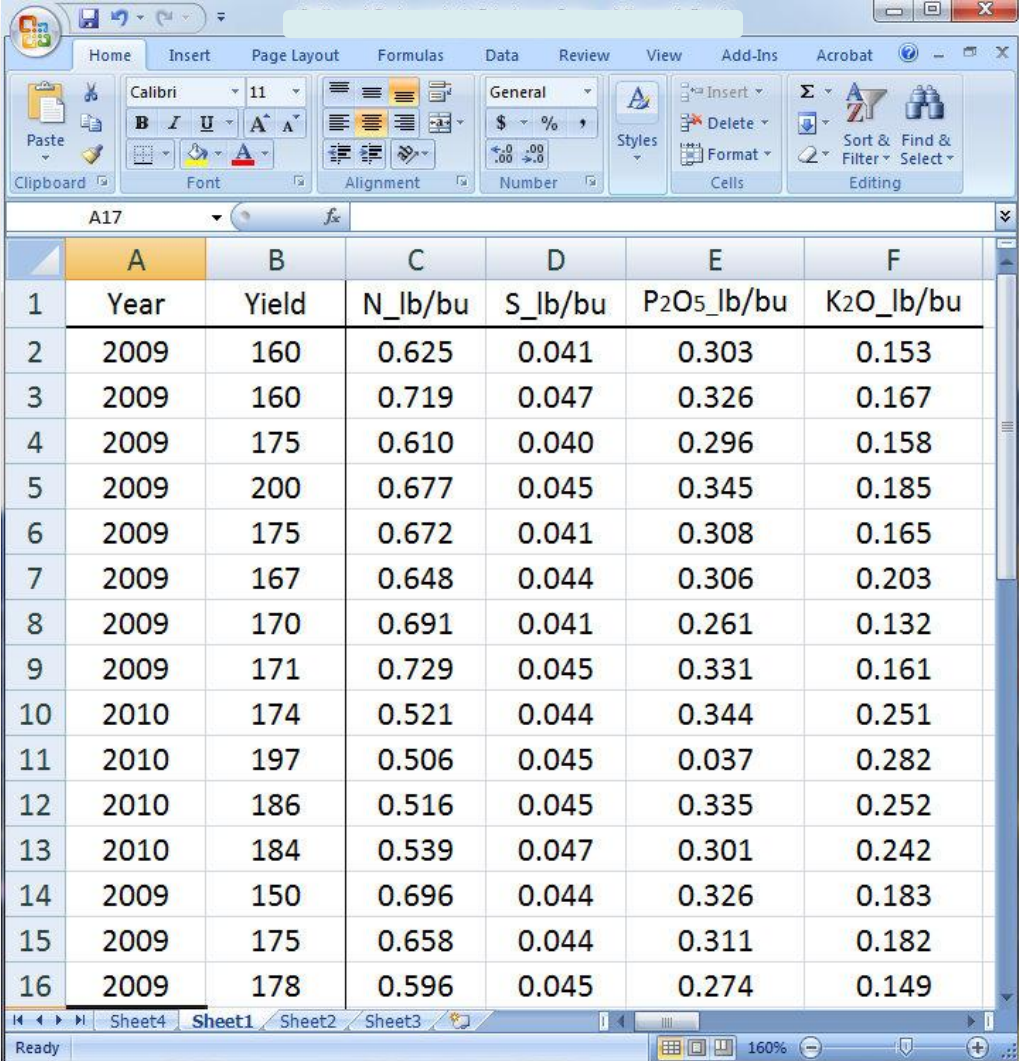


## A K recommendation that does consider yield goal: *Example: MN – banded application (40% reduction)*



# Monitoring nutrient removal

- Short-term improvements in efficiency must be weighed against long-term impacts on soil fertility
- Consider creating a local database of crop removal rates for crops in your area



The screenshot shows a Microsoft Excel spreadsheet with a data table. The table has 7 columns: Year, Yield, N\_lb/bu, S\_lb/bu, P2O5\_lb/bu, and K2O\_lb/bu. The data spans from 2009 to 2010. The spreadsheet interface includes the ribbon (Home, Insert, Page Layout, Formulas, Data, Review, View, Add-Ins, Acrobat), the formula bar (A17), and the status bar (Ready, 160%).

	A	B	C	D	E	F
1	Year	Yield	N_lb/bu	S_lb/bu	P2O5_lb/bu	K2O_lb/bu
2	2009	160	0.625	0.041	0.303	0.153
3	2009	160	0.719	0.047	0.326	0.167
4	2009	175	0.610	0.040	0.296	0.158
5	2009	200	0.677	0.045	0.345	0.185
6	2009	175	0.672	0.041	0.308	0.165
7	2009	167	0.648	0.044	0.306	0.203
8	2009	170	0.691	0.041	0.261	0.132
9	2009	171	0.729	0.045	0.331	0.161
10	2010	174	0.521	0.044	0.344	0.251
11	2010	197	0.506	0.045	0.037	0.282
12	2010	186	0.516	0.045	0.335	0.252
13	2010	184	0.539	0.047	0.301	0.242
14	2009	150	0.696	0.044	0.326	0.183
15	2009	175	0.658	0.044	0.311	0.182
16	2009	178	0.596	0.045	0.274	0.149

# Banded applications near the seed at planting

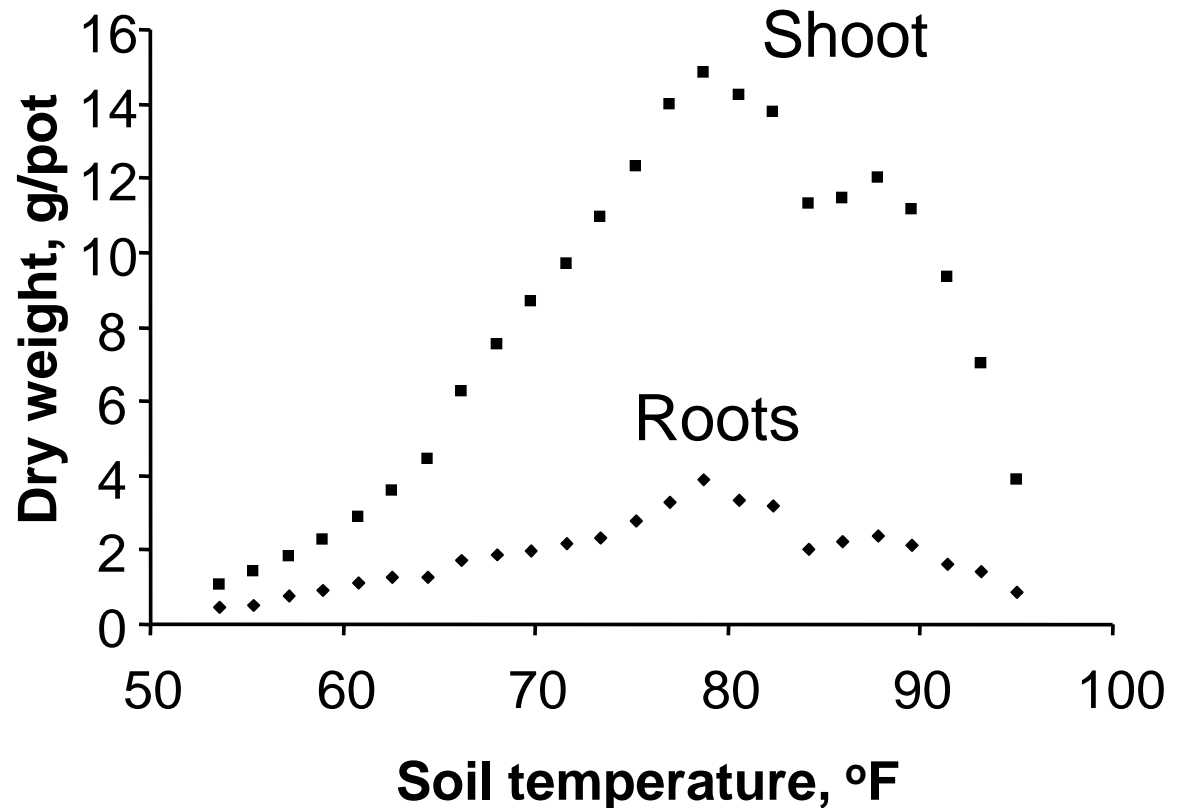
## *Theoretical principles*



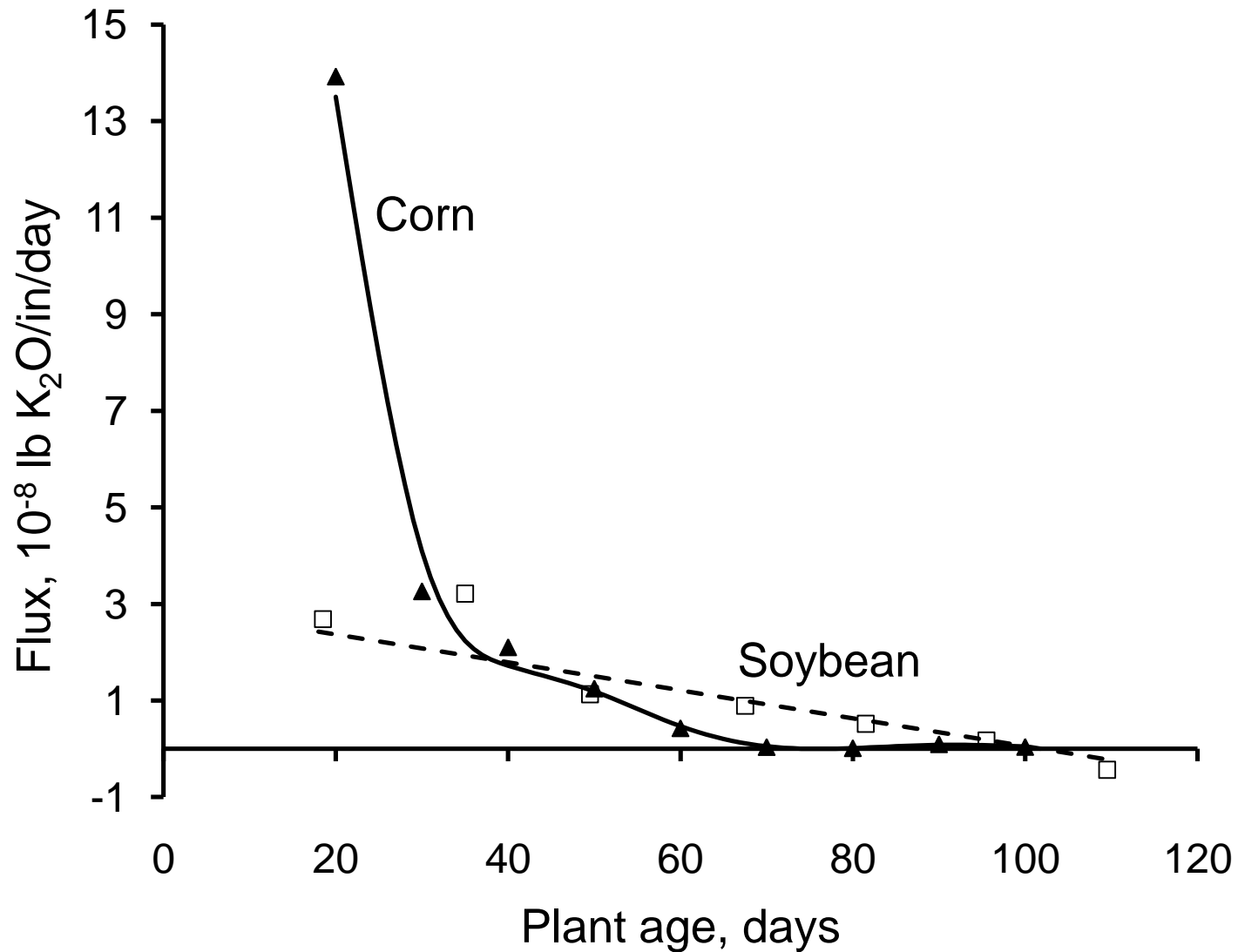


# Environmental effects: soil temperature

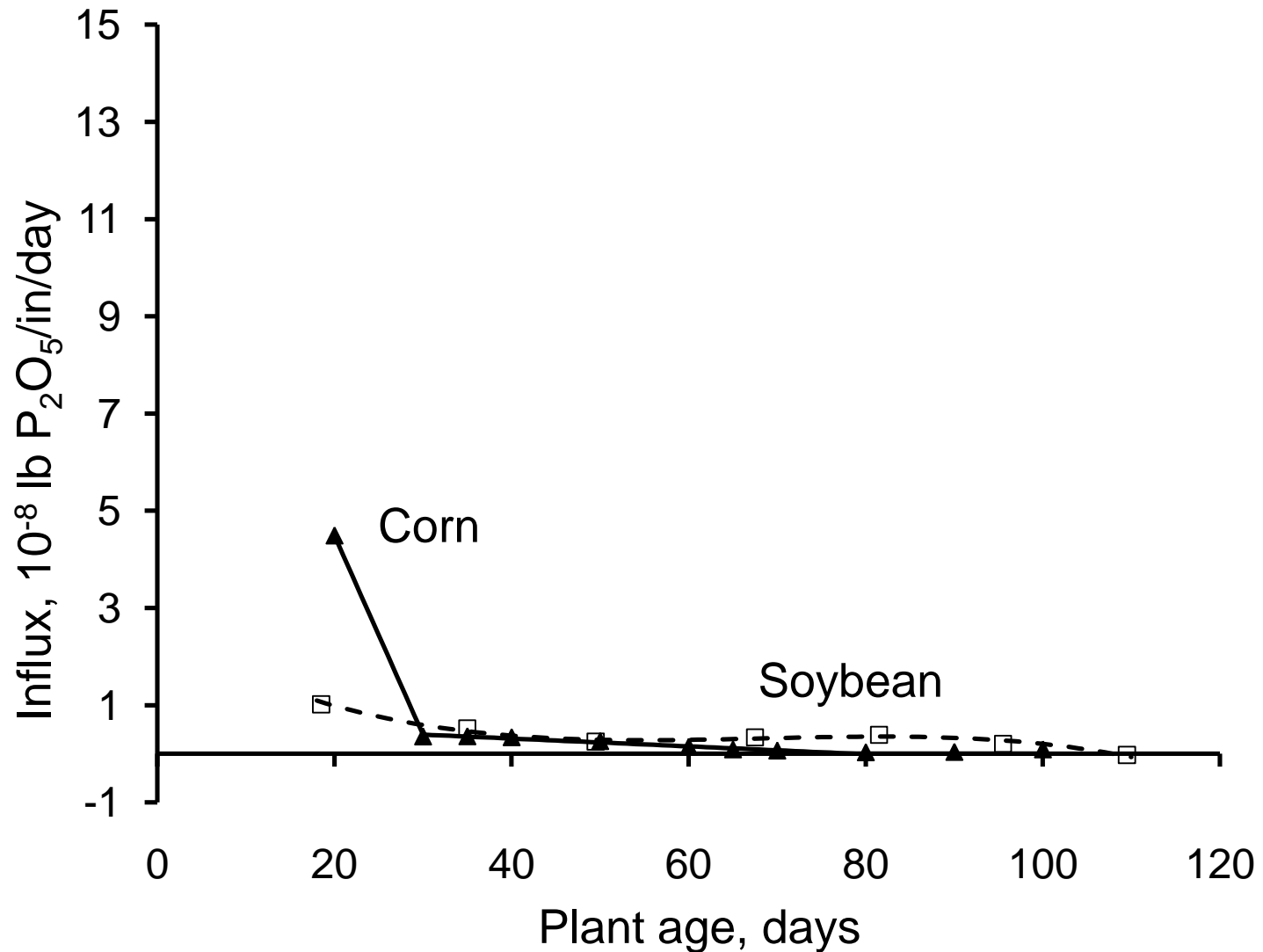
- Air temperature held constant at 77°F
- 23 day old corn seedlings measured



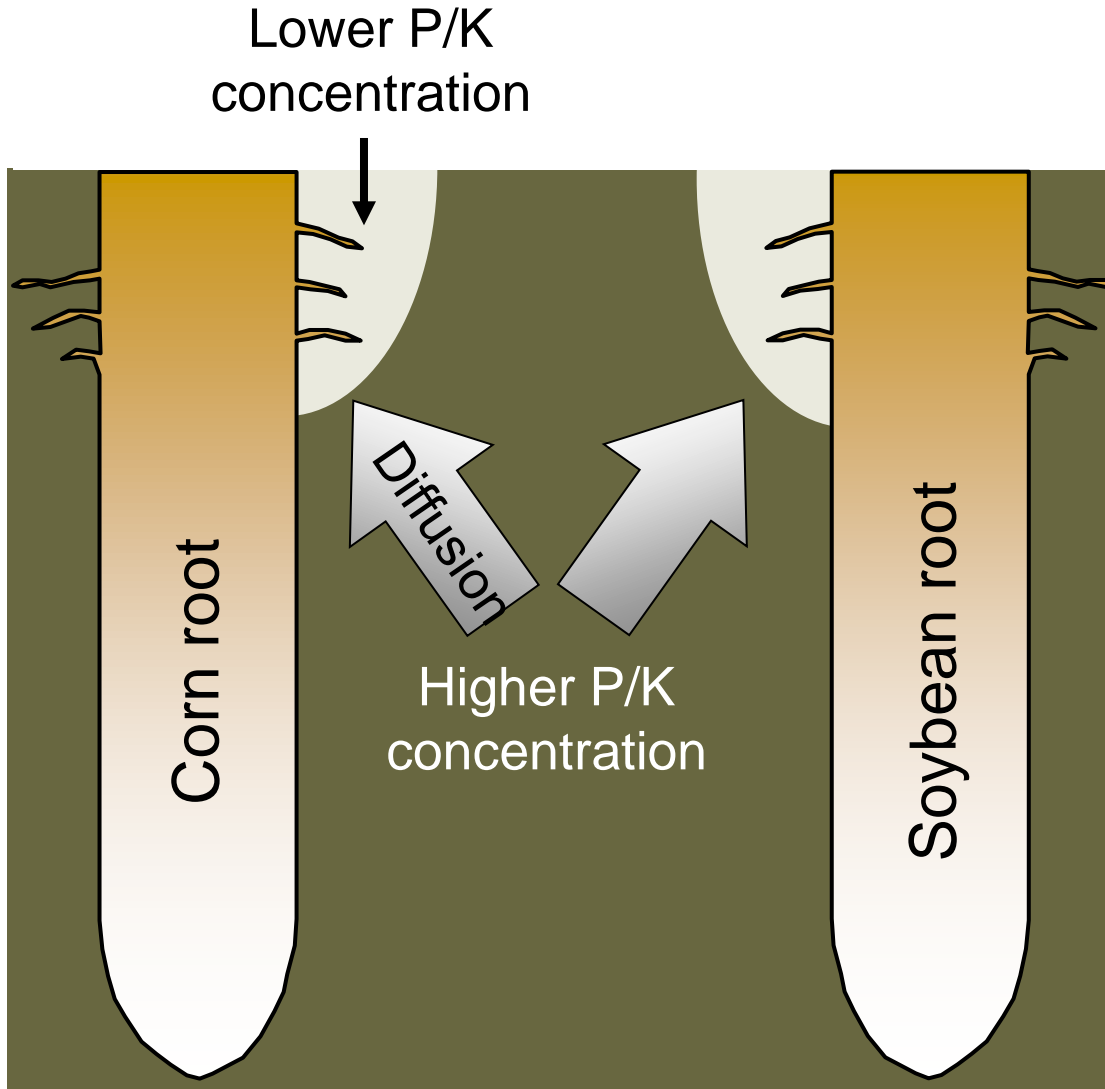
# Rate of K uptake by roots differs with plant age



# Rate of P uptake by roots differs with plant age

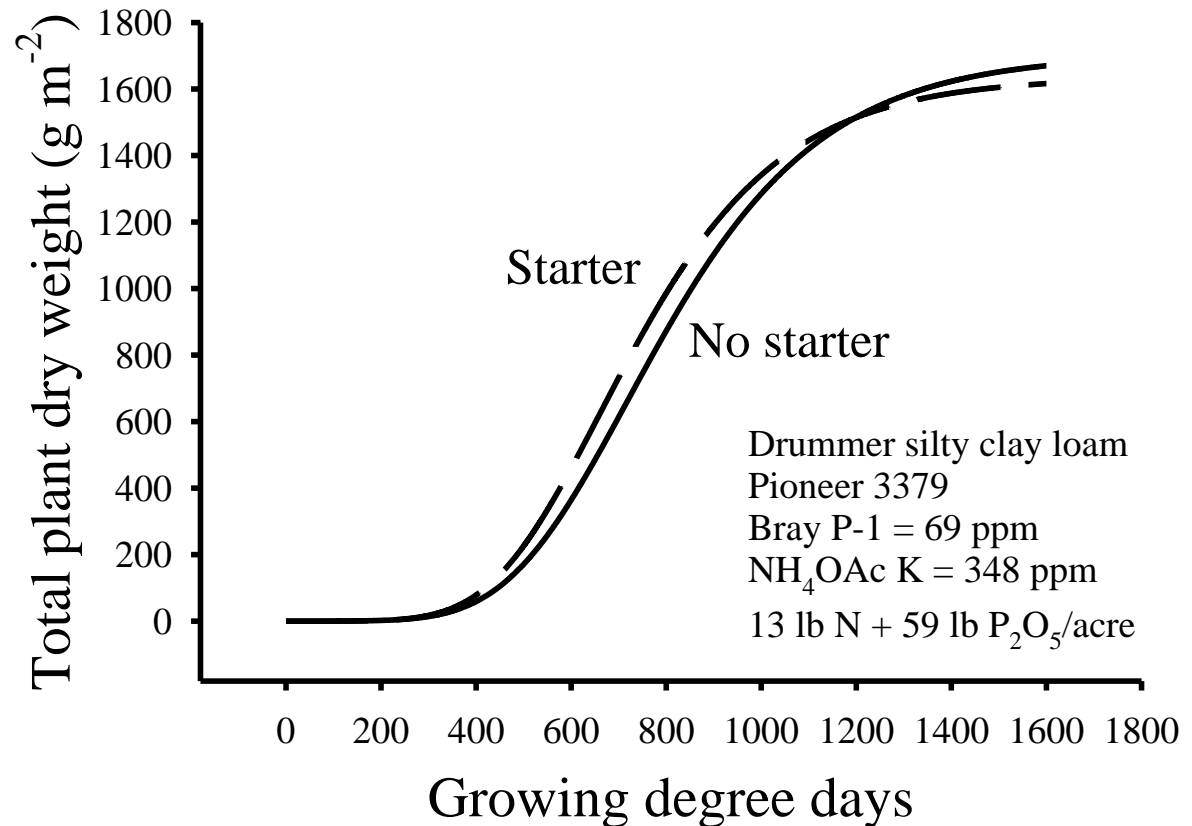


# Flux rate affects the rate of nutrient depletion



# Early growth response does not necessarily translate to increased yield

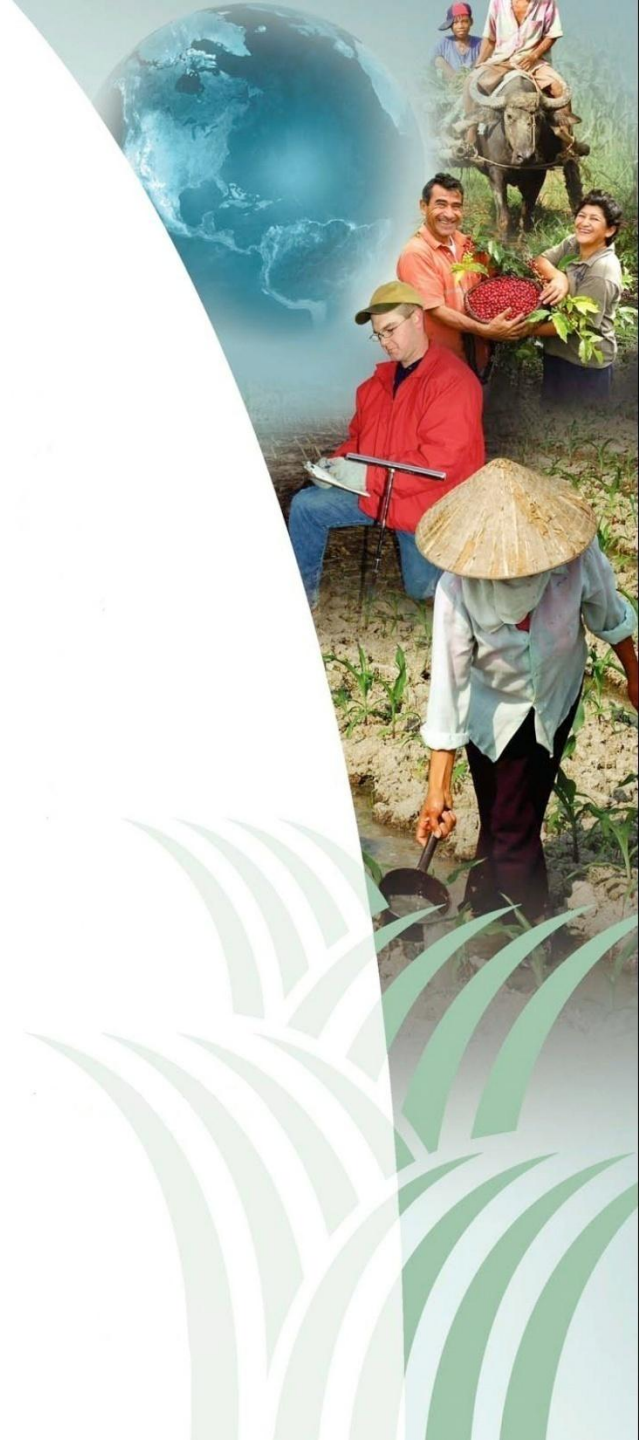
- Larger plant dry weight from 500 to 1200 GDD
- Final plant dry weight not affected by starter
- Starter hastened:
  - Development
  - Maturation
- No yield increase





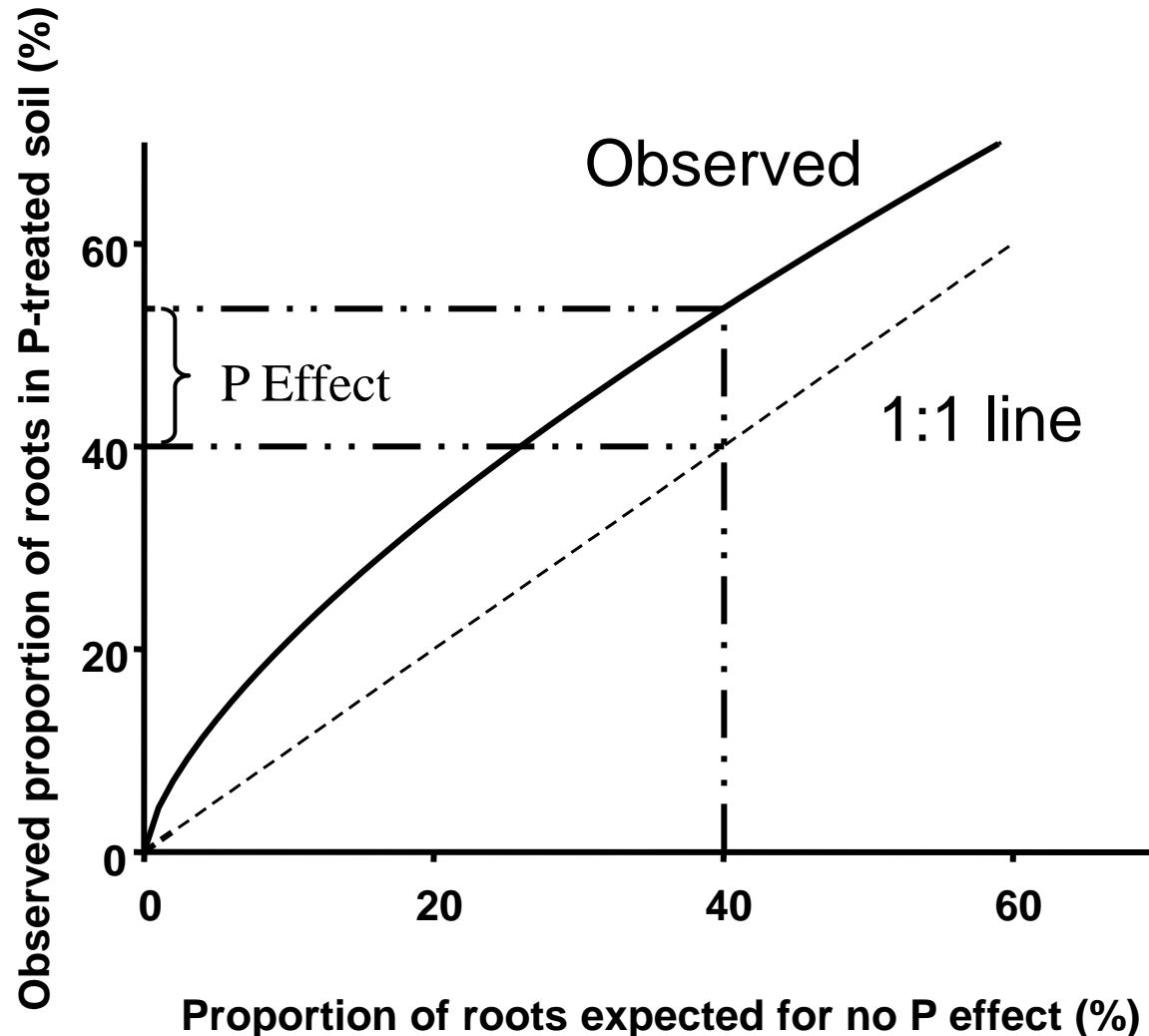
# Banding nutrients together

## *Theoretical principles*

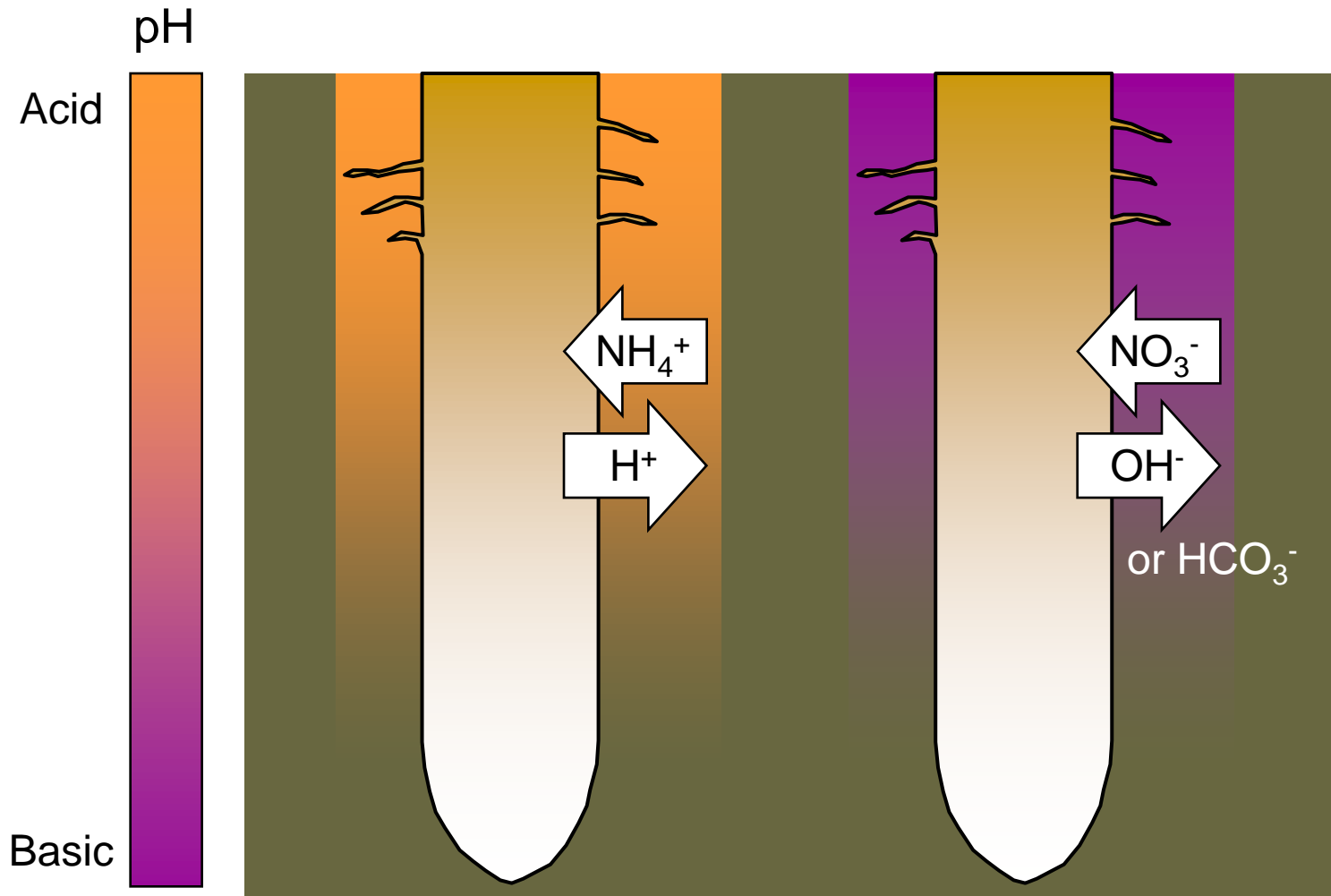


# N and P cause roots to “proliferate”

- Split-root experiment
- Percent of the total root system on the side with P was greater than that on the side without P

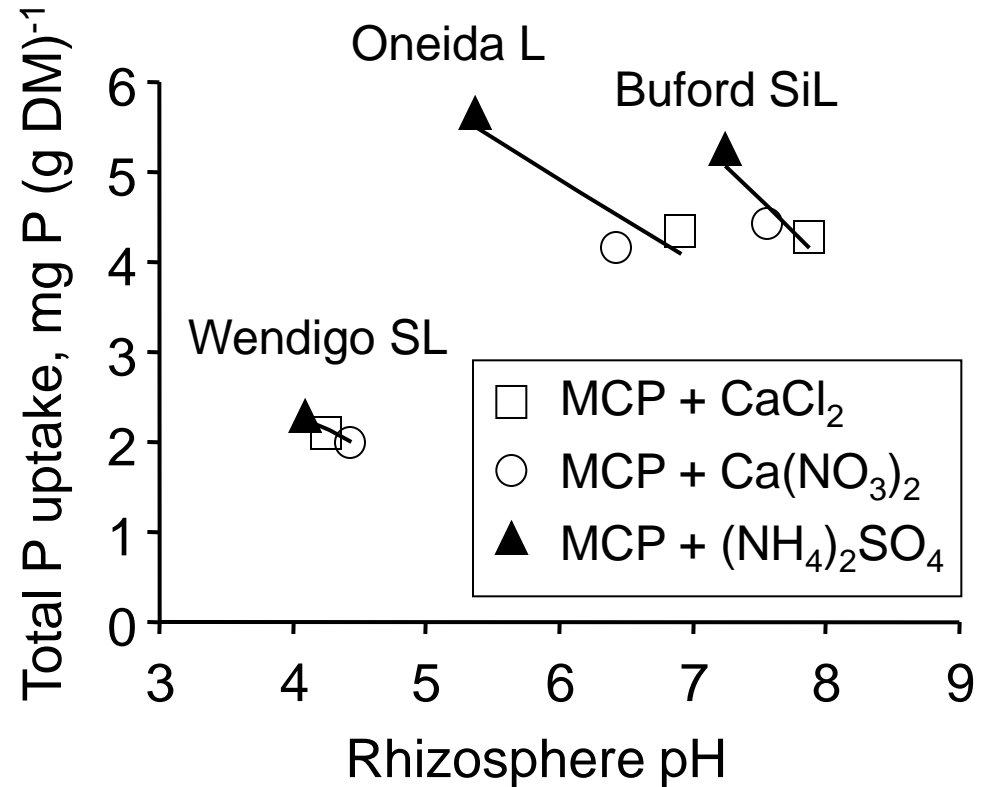


# Ammonium and nitrate: rhizosphere pH differences

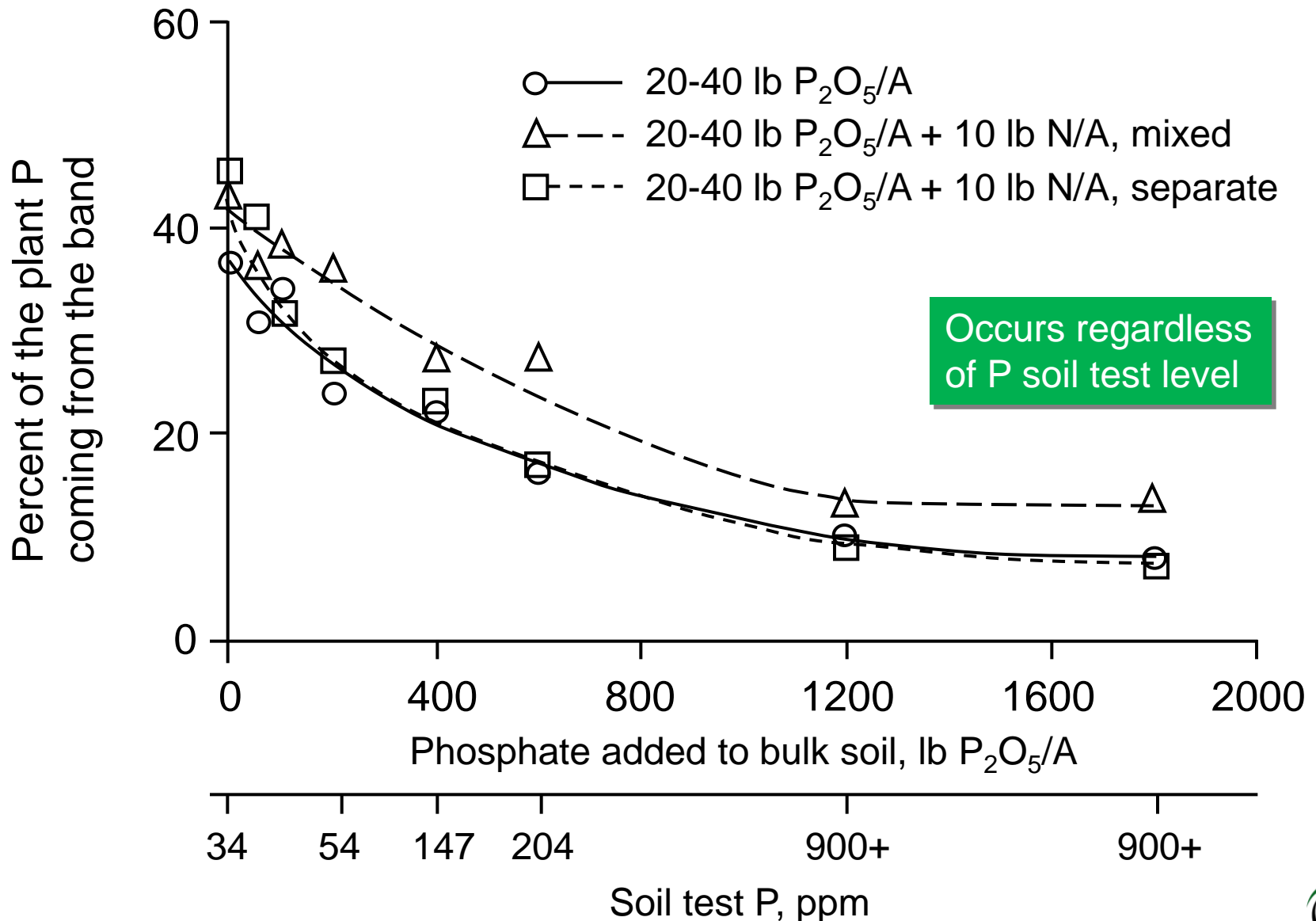


# Rhizosphere pH affects P uptake by corn

- 11 day old corn
- Ammonium source reduced rhizosphere pH and increased P uptake



## Starter fertilizer: $\text{NH}_4^+$ and P should be placed together





# Impact of banded applications on spatial variability

## *Theoretical principles*



## Months after initial application in the spring

6 mo.

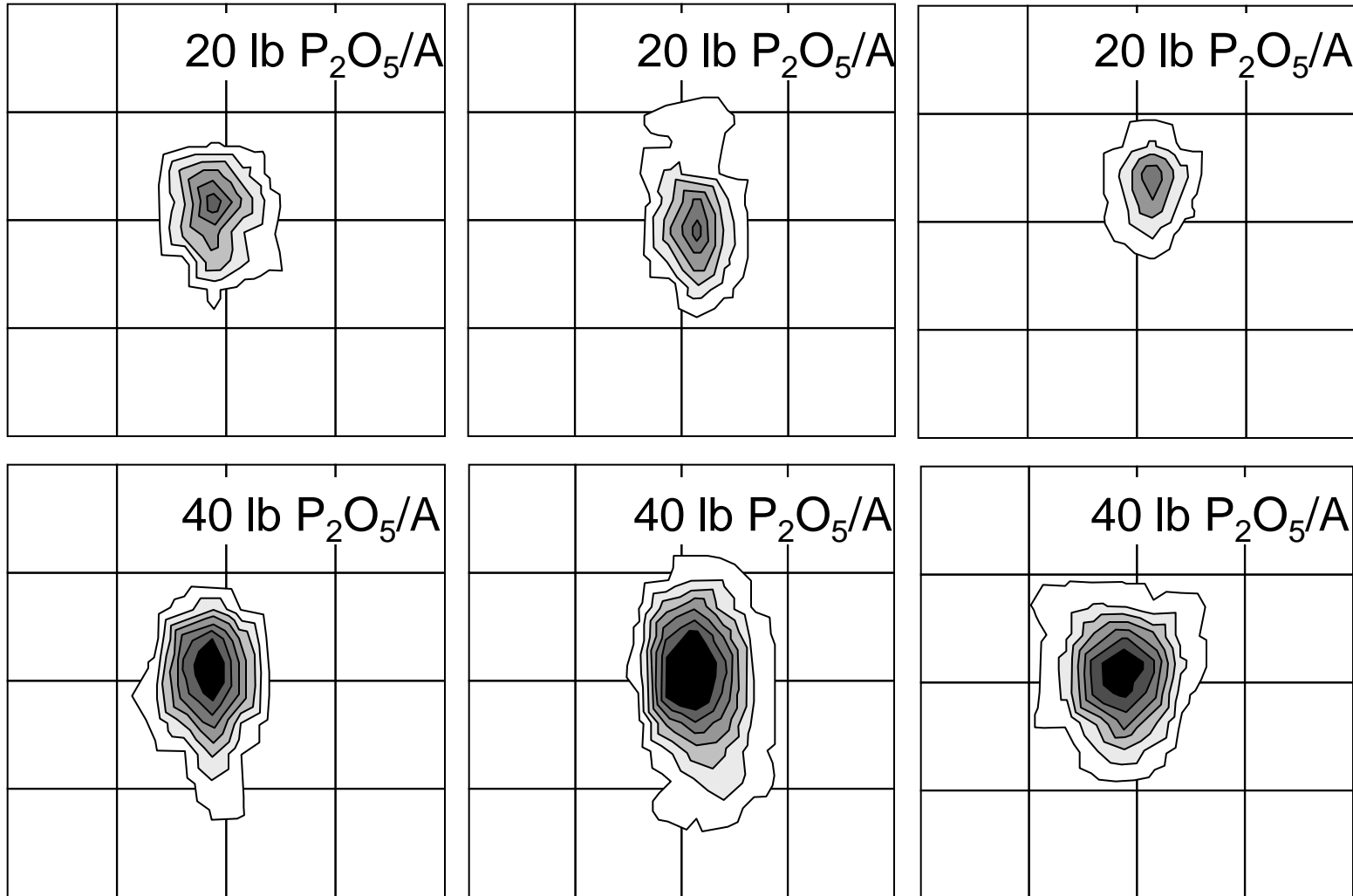
12 mo.

18 mo.

Multiple of  
background  
concentration

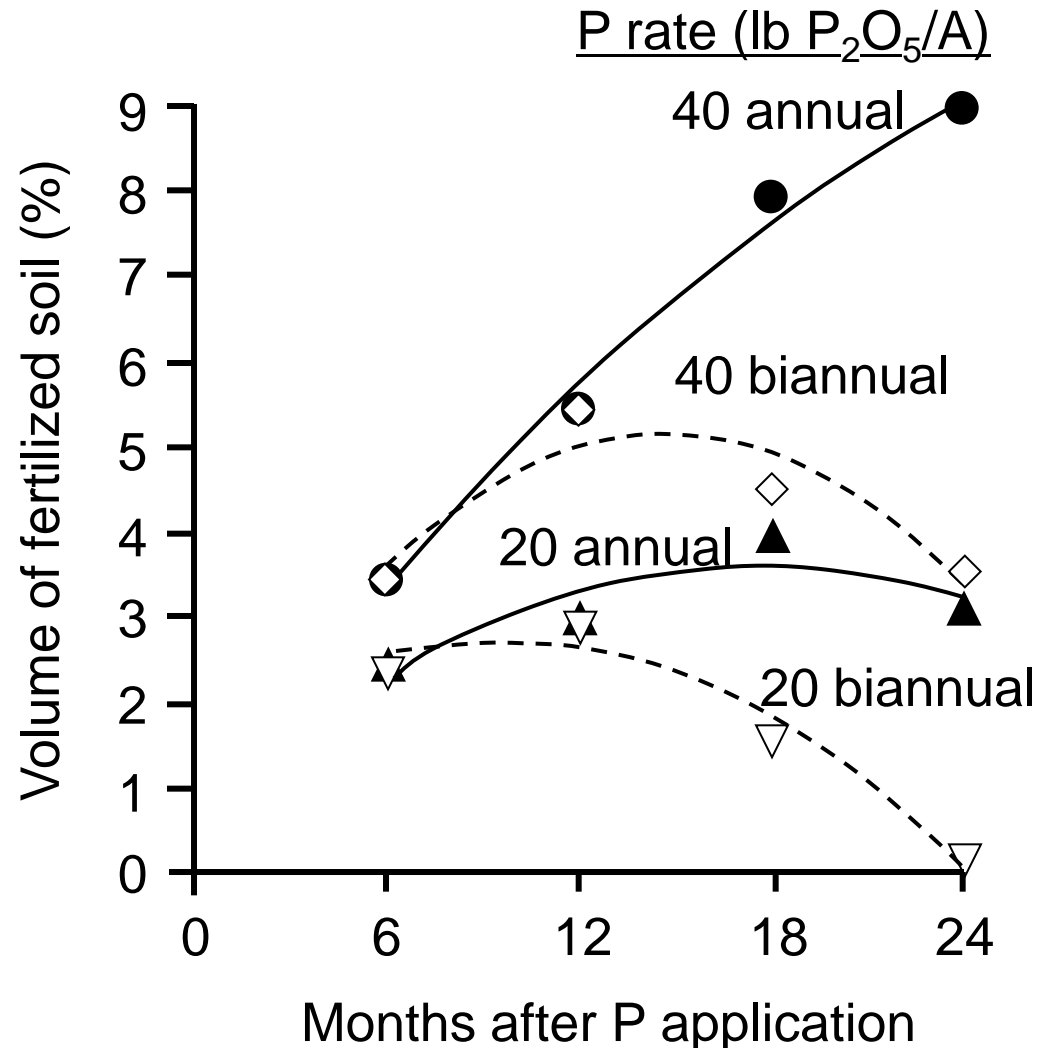


2 in.



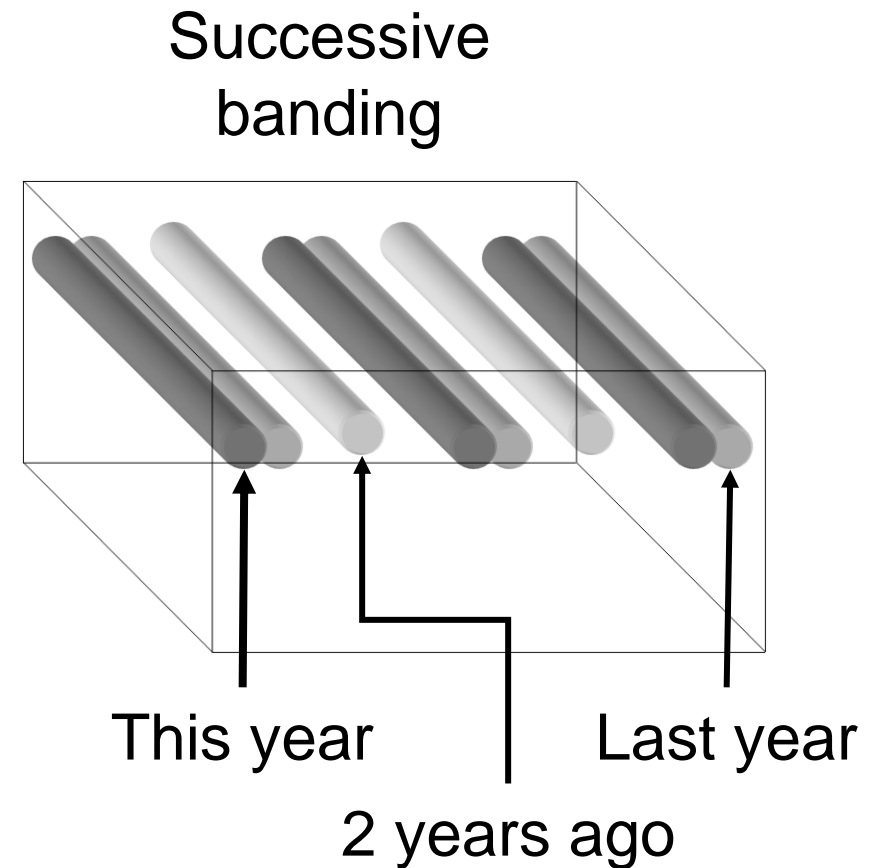
# Impact of successive banding

- Mexico silty clay loam soil
- Single 20 lb/A band fertilizes 2.6% of soil volume
- Volume assumed to be additive
- Annual applications stay ahead of volumetric reductions of specific bands over time



# Successive banding in different places creates concentrated zone that decay over time

- Placing bands in different places over time can lead to a greater volume of fertilized soil over time



# Impact of crop uptake and on spatial variability

## *Theoretical principles*

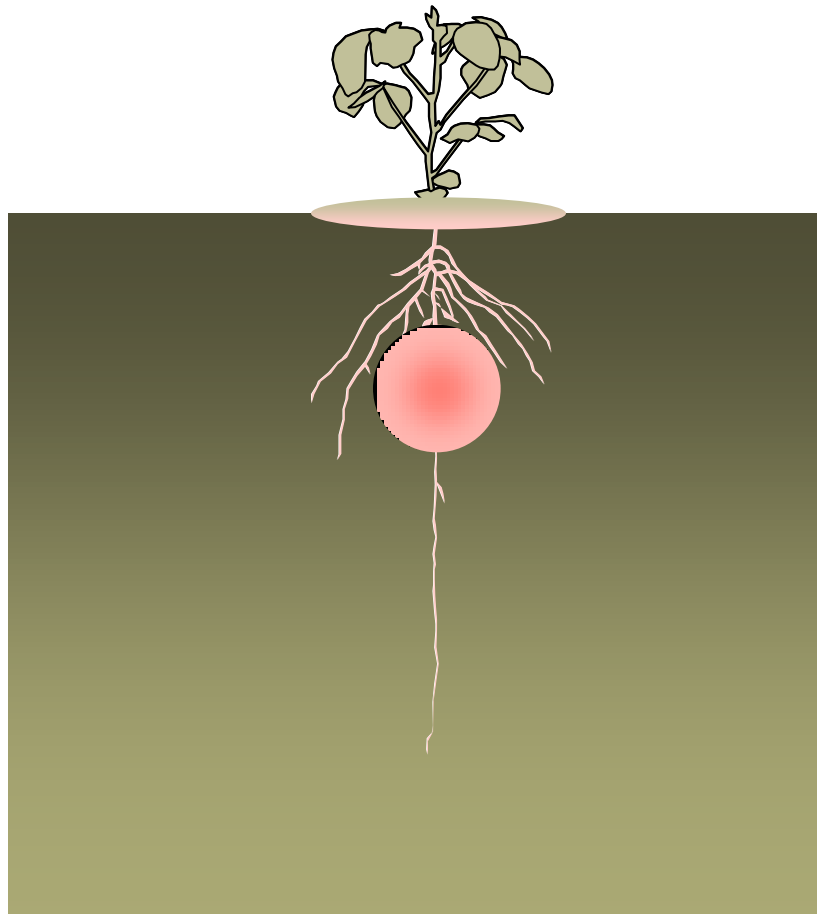


# Transport of banded K

Nutrient uptake

Deposition and  
leaching

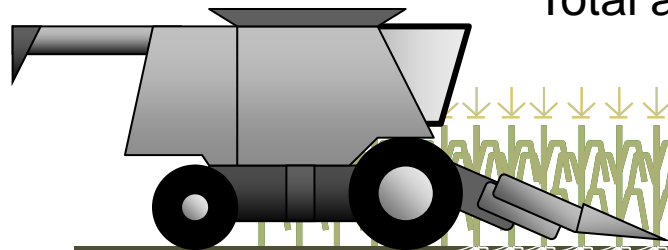
Diffusion



# K uptake and leaching by a corn crop: Estimated quantities

K removal in 200 bu/A grain  
(54 lb  $K_2O/A$ )

Total above-ground K uptake  
(274 lb  $K_2O/A$ )



K leached from stover  
(220 lb  $K_2O/A$ )



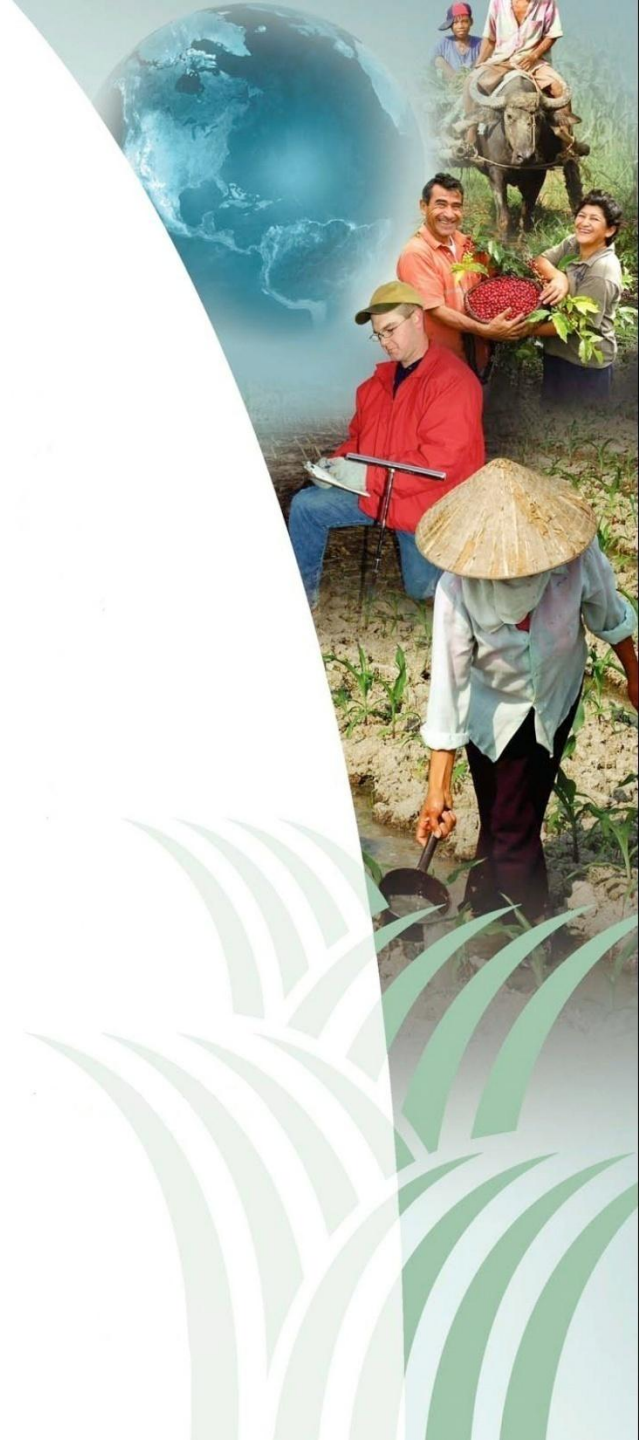
K leached from roots  
(39 lb  $K_2O/A$ )





# The role of starter fertilizer under economic constraints

## *Theoretical principles*



# Combination for maximum profit:

Wheat response to N and P

