# Tecnologias emergentes para os fertilizantes fosfatados

Terry A. Tindall Ph.D.
J.R. Simplot Company
Boise ID USA

# NEW METHODS FOR INFLUENCING PHOSPHATE AVAILABILITY TO PLANTS

## Common Objective…

### Treat Microenvironments, Not Entire Soil Mass, to Improve Effectiveness

# Phosphate becomes tied-up, or fixed

**On low pH soils**

- **Aluminum**
- **Iron**

**On high pH soils**

- **Calcium**
- **Magnesium**

# PHOSPHORUS FERTILIZERS THE PROBLEM

- Crop recovery limited to 5 – 25% of applied P fertilizer during the season of application (Mortvedt, 1994).
- At high pH, P is fixed by Ca and Mg.
- At low pH, P is fixed by Fe and Al.

# MODIFICATION OF MICROENVIRONMENTS RELATIVE TO P AVAILABILITY

- Banding of P
- Dual banding of ammonium N and P
- Injection of P fertilizers--fertigation

# WE'VE UNDERSTOOD THE VALUE OF PREPLANT BANDING OF N AND P FOR OVER 30 YEARS

# PRODUCT:

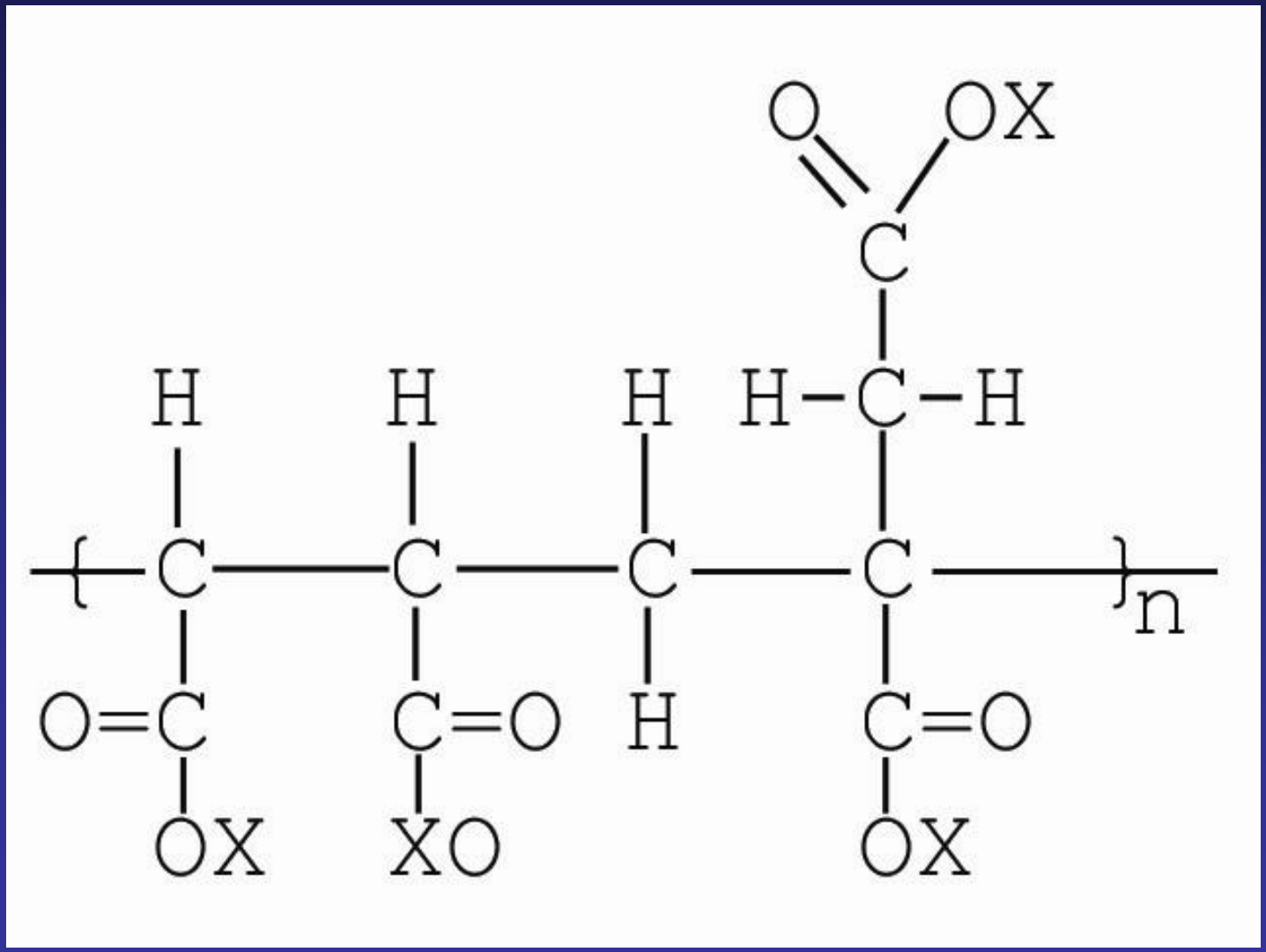
# *AVAIL*

## Specialty Fertilizer Products and J.R. Simplot

# WHAT IS AVAIL?

- **One of a patented family of dicarboxylic copolymers.**
- **Used as a coating on granular phosphates or mixed into fluid P fertilizers to enhance P availability.**

# AVAIL Polymer Chain

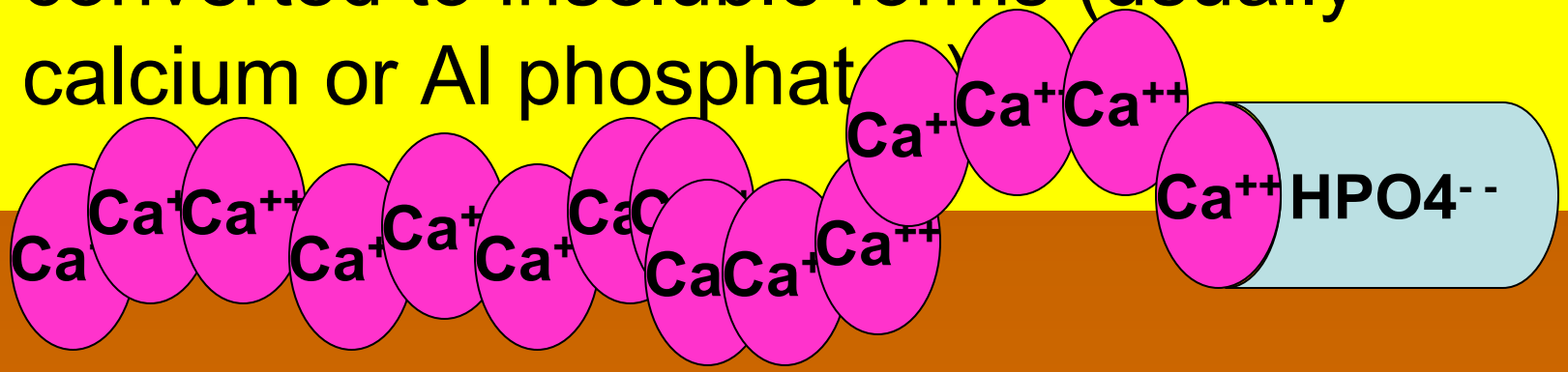


# **AVAIL** CHARACTERISTICS

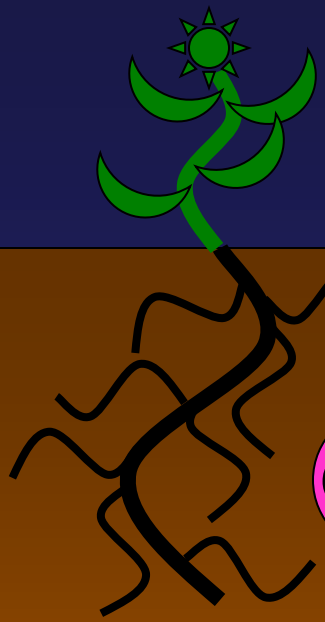
- **An extremely high cation exchange capacity – approximately 1800 milliequivalents /100 gms.**
- **Polymeric structure is very specific to attracting and adsorbing multivalent cations.**
- **Functionality is not affected by pH, temperature ranges.**
- **Biodegradable and water soluble.**

# Soil Phosphate

- 95% of the phosphorus in the soil is tied up as insoluble compounds and is unavailable for use by the plant.
- Added fertilizer phosphate is quickly converted to insoluble forms (usually calcium or Al phosphat



# Regular Phosphate



$Ca^{++}HPO4^{--}$ $Ca^{++}$ $HPO4^{-}$ $HPO4^{--}$

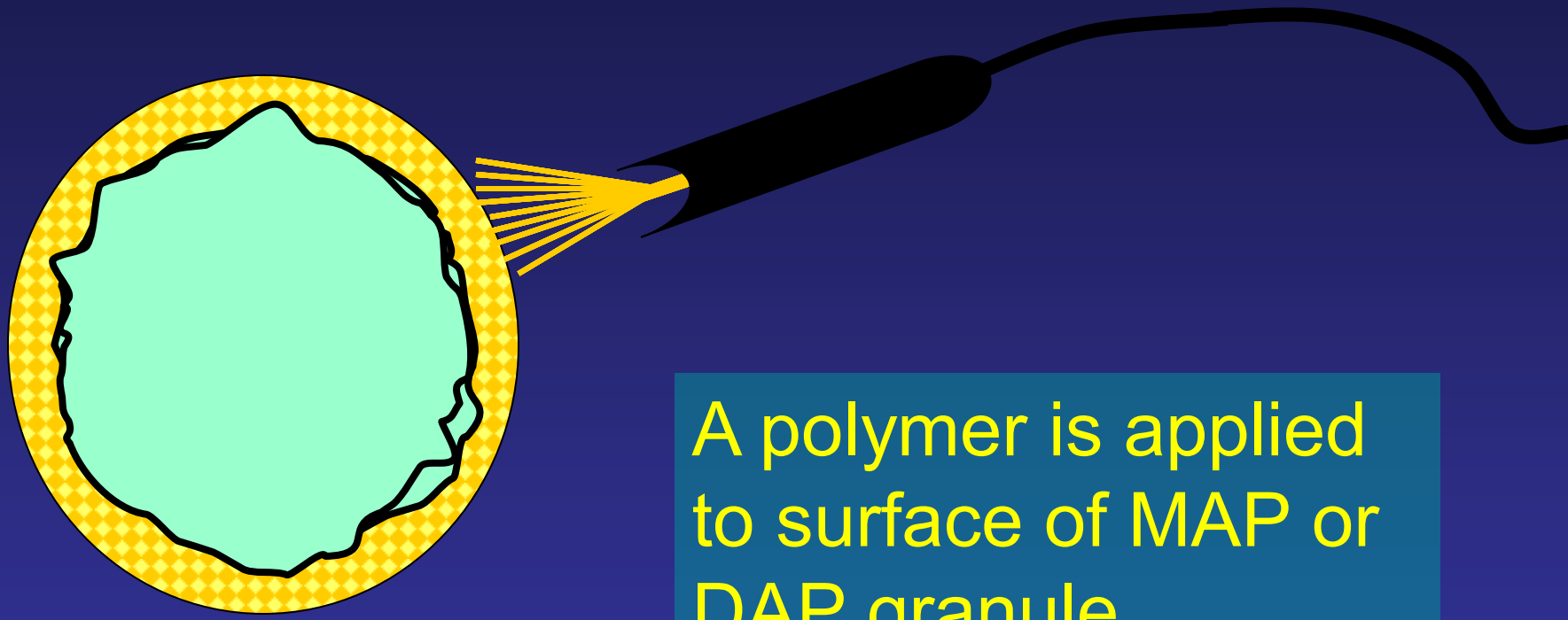
$Ca^{++}$ $HPO4^{--}$ $HPO4^{-}$ $HPO4^{--}$ $HPO4^{--}$

$Ca^{++}$ $Mg^{++}$ $Ca^{++}$ $HPO4^{--}$ $HPO4^{--}$ $HPO4^{--}$

$Mg^{++}HPO4^{--}$ $Mg^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Mg^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Mg^{++}HPO4^{--}$ $Ca^{++}$ $HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$ $Mg^{++}HPO4^{--}$ $Ca^{++}HPO4^{--}$

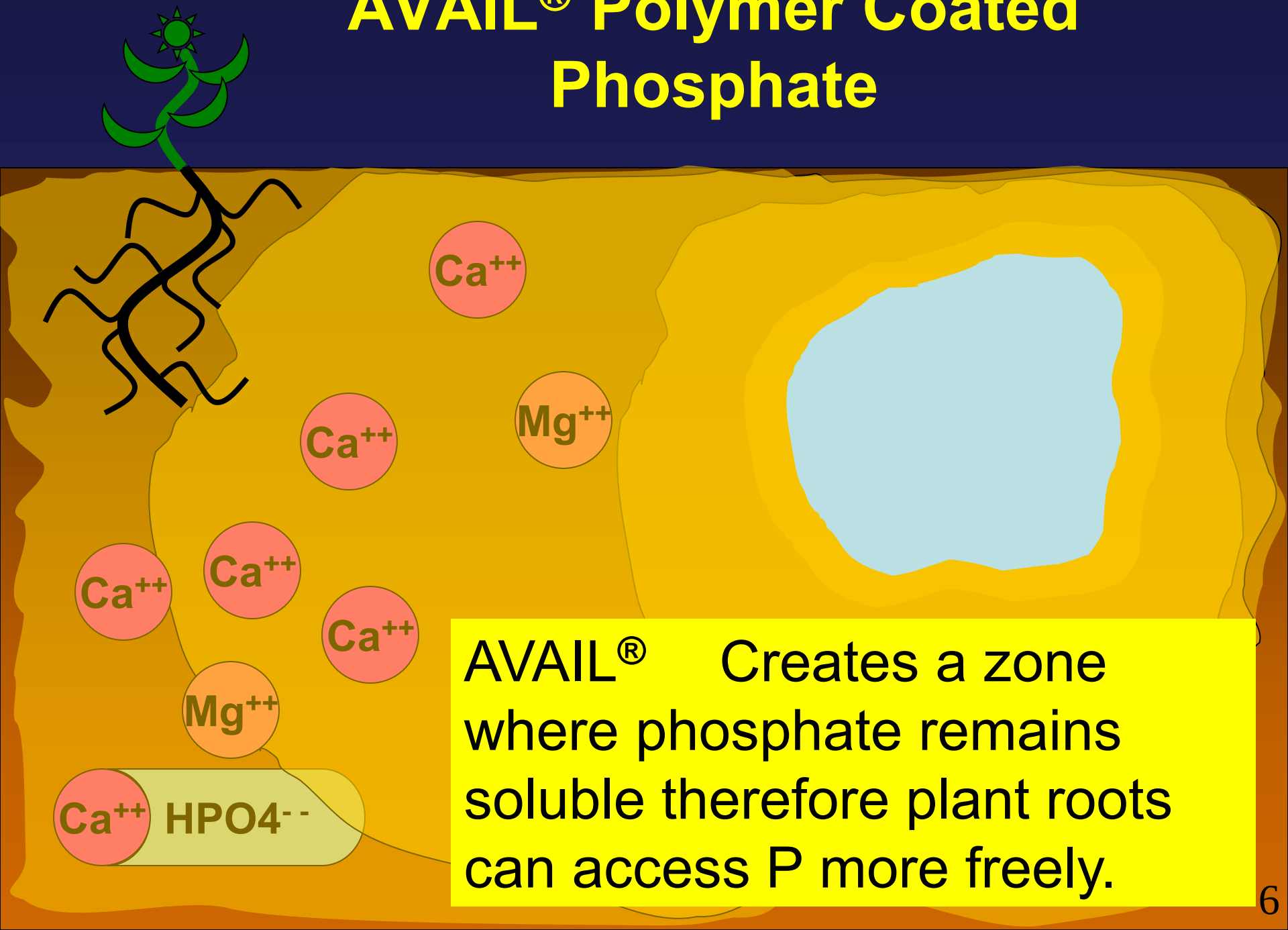
**Most of the phosphate combines with calcium or magnesium in the soil and is unavailable for plant uptake.**

# AVAIL® Phosphate Enhancer



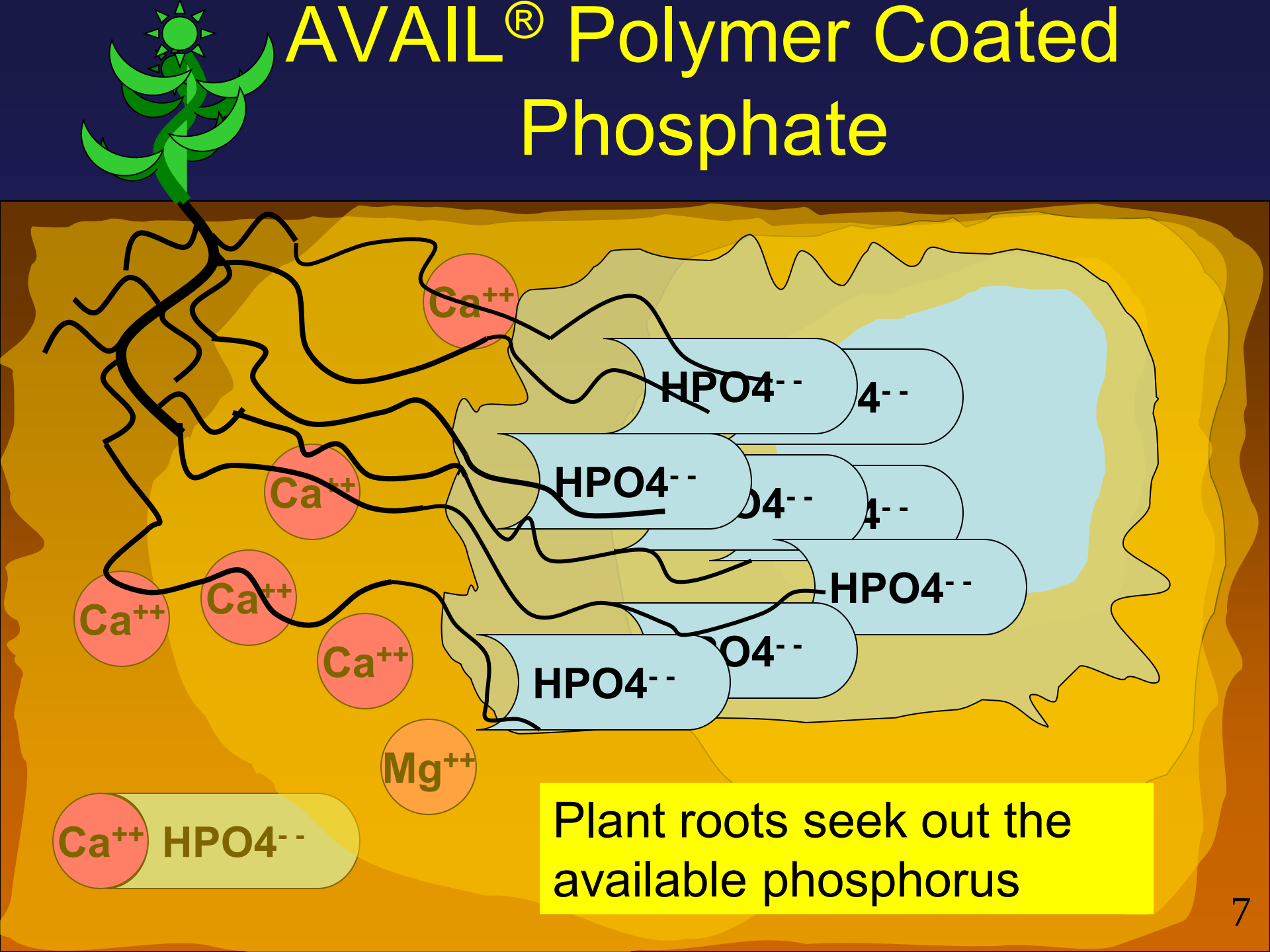
A polymer is applied to surface of MAP or DAP granule

# AVAIL® Polymer Coated Phosphate




AVAIL® Creates a zone where phosphate remains soluble therefore plant roots can access P more freely.

# AVAIL® Polymer Coated Phosphate

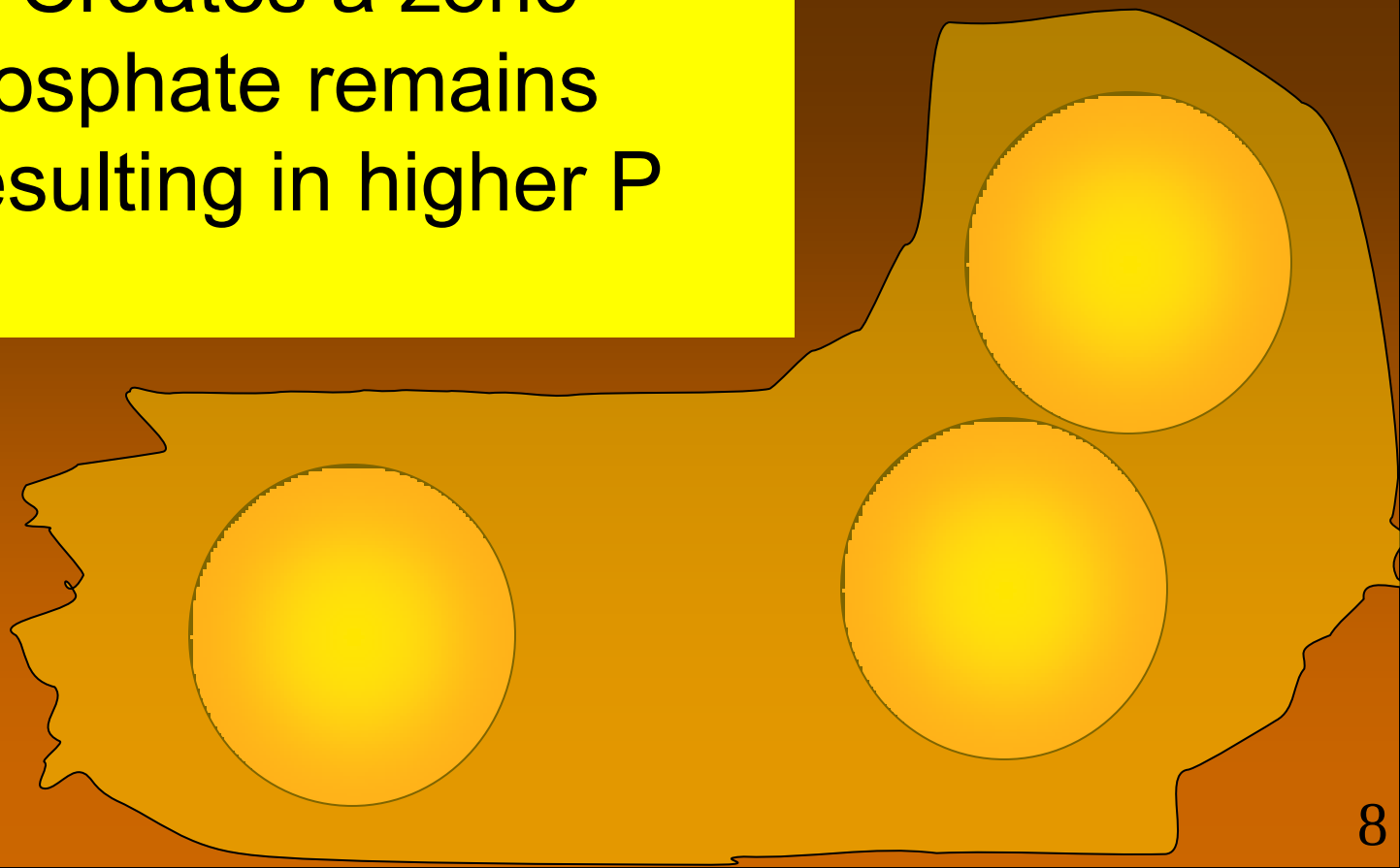



Plant roots seek out the available phosphorus

# AVAIL® Phosphate Enhancer

## Phosphate for the 21st Century

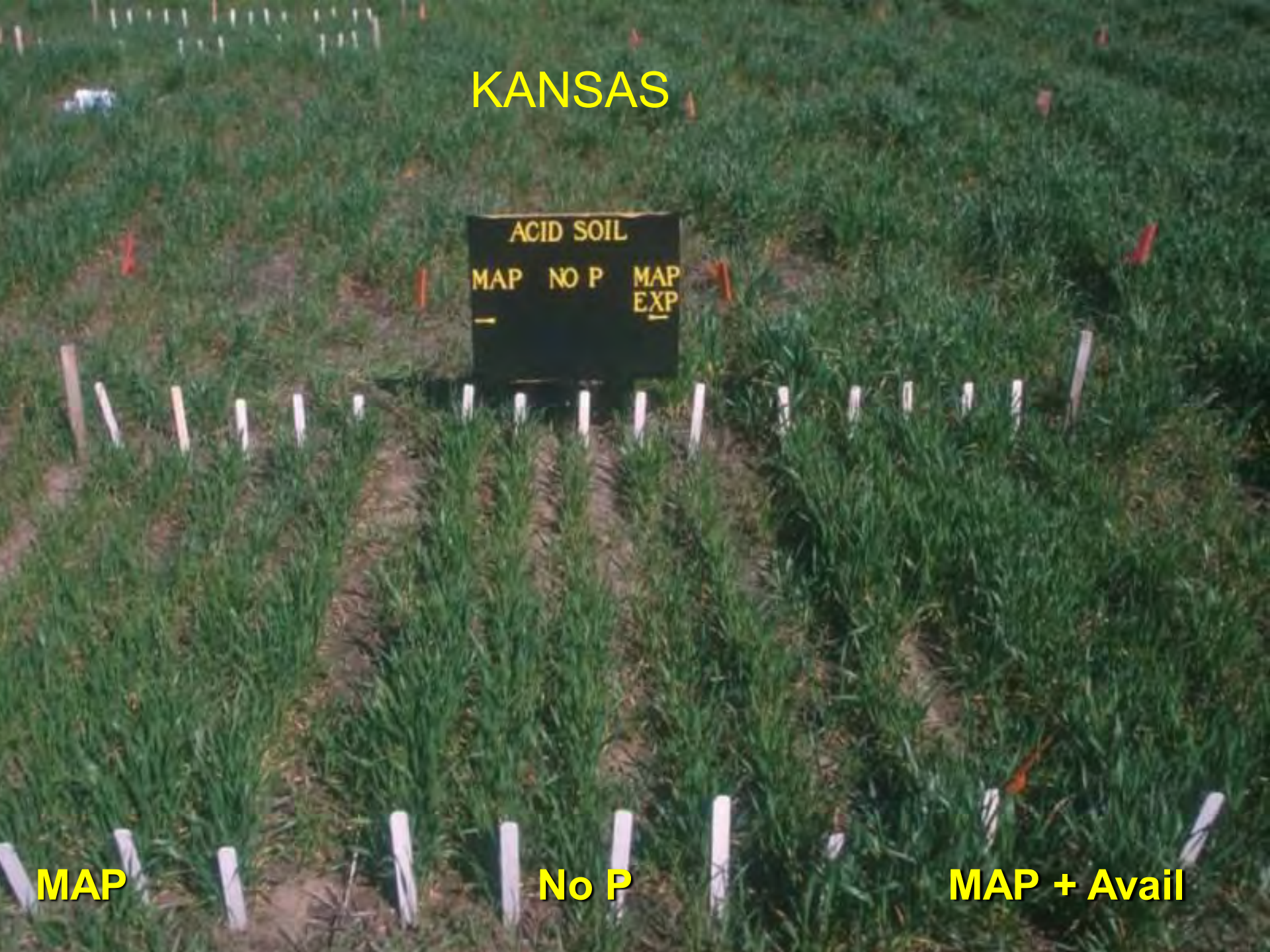
AVAIL® Creates a zone where phosphate remains soluble resulting in higher P uptake!



# WHAT IS THE MODE OF ACTION?

**Mode of Action Theory**

- **Polymer sequesters antagonistic cations out of soil solution around P fertilizer granule.**
- **P remains unfixed and available for plant uptake.**
- **Results in highly concentrated zones of available P for the plants (microenvironments).**


KANSAS
ACID SOIL
MAP NO P MAP
EXP
MAP
No P
MAP + Avail

# WHEAT RESPONSE TO ENHANCED P AVAILABILITY
## Kansas

| Treatment Applied | Grain Yield bu/A |
|---|---|
| Control | 31.6 |
| MAP | 34.2 |
| MAP + polymer | 39.5 |

1% polymer  Murphy Agro – Kansas State Univ.
20 lb $P_2O_5$/A banded at planting.  Soil pH 4.7

# POLYMER AND P APPLICATION METHOD EFFECTS ON WHEAT Arkansas

| Treatment | Yield bu/A |
|---|---|
| Control | 46.7 |
| MAP banded | 54.7 |
| MAP + polymer, banded | 76.9 |
| MAP broadcast | 58.2 |
| MAP + polymer, broadcast | 65.6 |
| MAP + seed, broadcast | 55.1 |
| Map + polymer + seed, broadcast | 68.3 |
| LSD (0.10) | 7.5 |

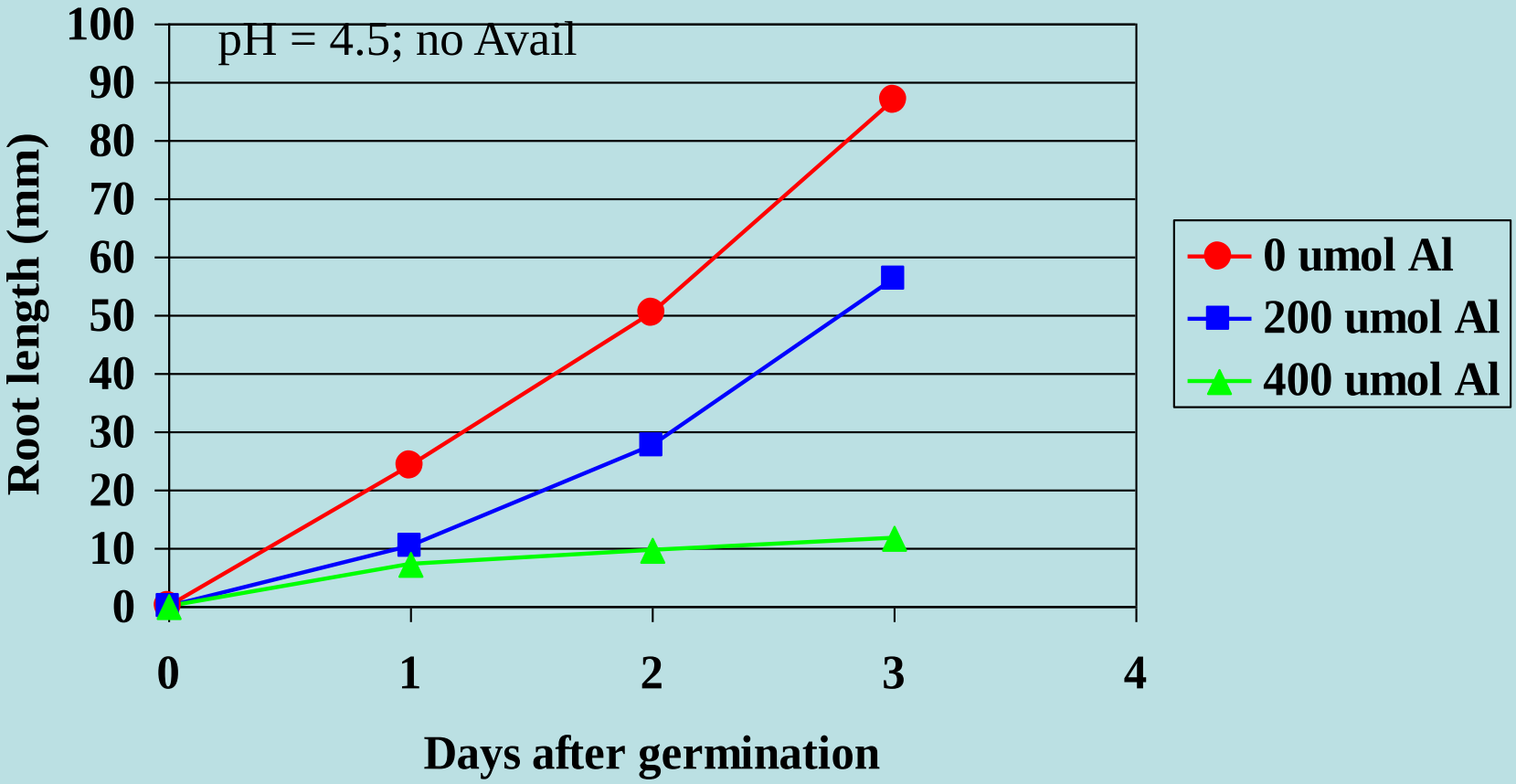
30 lb $P_2O_5$/A. Soil P test low. Soil pH=7.6. Palmer, Univ. of Arkansas

# AVAIL EFFECTS ON ALUMINUM TOXICITY TO WHEAT SEEDLINGS

Dr. Rich Koenig, Washington State Univ.

* Screening test for wheat varieties
* Various concentrations of Al
* Included Avail polymer as a variable

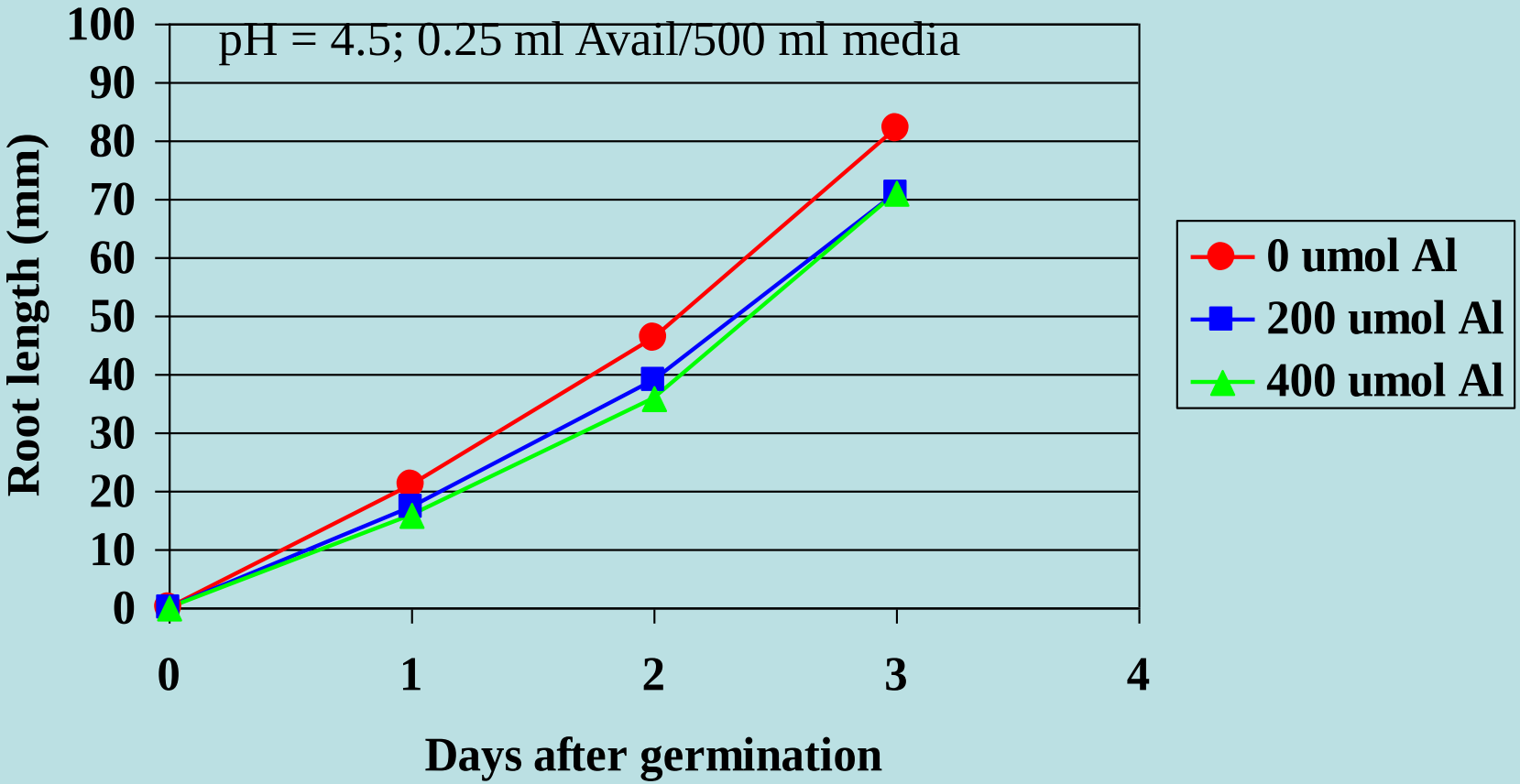
# ALUMINUM EFFECTS ON WHEAT GROWTH
## Low pH




Rich Koenig, WSU

# ALUMINUM EFFECTS ON WHEAT IN PRESENCE OF AVAIL POLYMER

## Low pH




Rich Koenig, WSU

# Dr. KOENIG'S **WORK SUPPORTS THEORY OF AVAIL EFFECTS ON P FIXING CATIONS**

- ***Polymer lowers the activity of multivalent cations in solution*.**

## Spring Wheat – University of Idaho ’06
## SSP/MAP - Preplant Broadcast
## S/E Idaho, Soil pH 8.1

| | Bu. / Acre* | Avail ROI/A |
|---|---|---|
| MAP – 40 | 91 | |
| +$4.00/A MAP + Avail | 97 | +$24.00 |
| | | |
| MAP - 80 | 96 | |
| +$8.00/A MAP + Avail | 102 | +$27.00 |
| | | |
| MAP - 160 | 94 | |
| +$16.00/A MAP + Avail | 98 | +$18.00 |

*$4.50/bu.

**Stark 2006**

CORN


UNIV. OF MISSOURI
pH 5.9, low P
MAP
EXP MAP
20 $P_2O_5$
Dale Blevins

# CORN RESPONSE TO ENHANCED P AVAILABILITY
## Missouri

| Treatment | Grain Yield bu/A |
|---|---|
| Control, no P | 135 |
| MAP broadcast | 132 |
| MAP + polymer broadcast | 151 |
| MAP banded | 132 |
| MAP + polymer banded | 157 |
| LSD (0.10) | 13 |

1% polymer coating — Dale Blevins, Univ. of Missouri

20 lb $P_2O_5$/A  Soil test Bray P-1: 7 ppm  pH: 5.9

# ENHANCING P AVAILABILITY FOR CORN
# Minnesota

| P Source<br>lb $P_2O_5$/A | P Uptake V-6<br>g/12 plants | Yield<br>bu/A |
|---|---|---|
| 0 | 1.85 | 136 |
| 25 DAP | 1.77 | 151 |
| 25 DAP + polymer | 2.72 | 172 |
| 50 DAP | 2.17 | 155 |
| 50 DAP + polymer | 2.47 | 175 |
| LSD (0.10) | 0.71 | 18 |

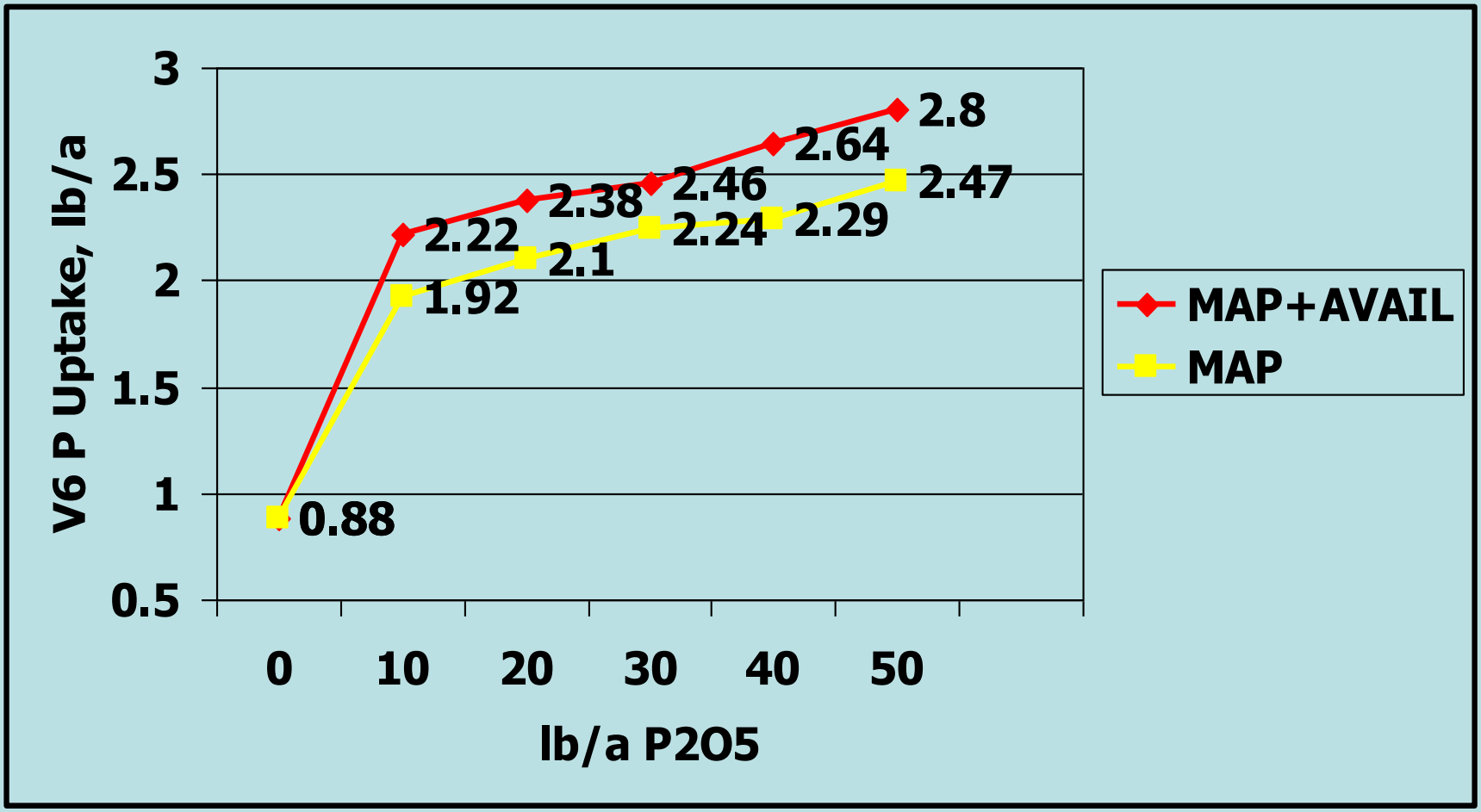
P broadcast, 0.25 % polymer coating. Randall, Univ. of Minnesota
Soil pH: 7.3 Soil test P: 7 ppm Olsen.

Tom Haigh—JRS Kansas and Dr. Barney Gordon KSU


Kansas State University NorthCentral R&D Center--2006

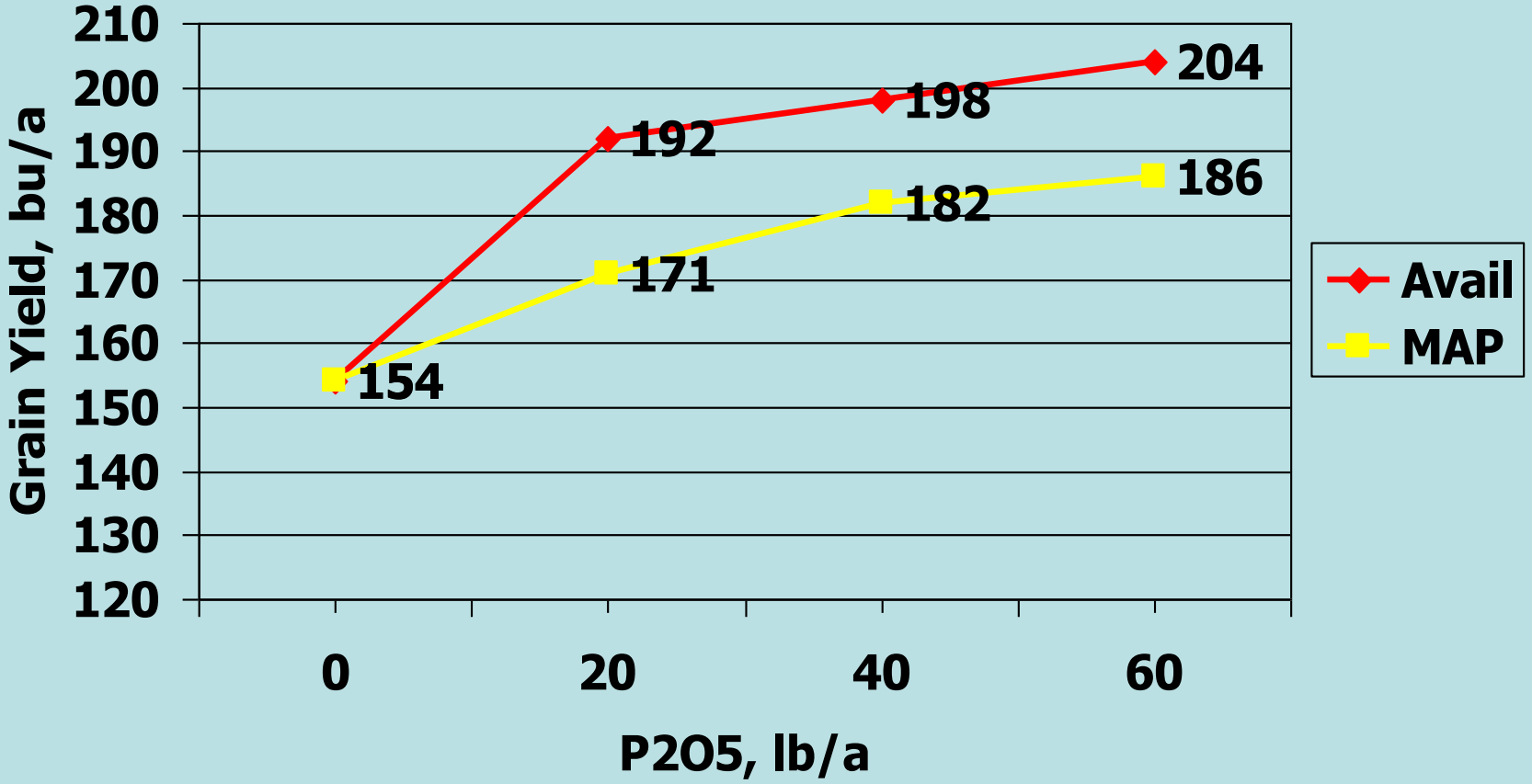

KSU, North Central Exp. Field
MAP
STARTER
60 $P_2O_5$
CK
SFP
NO Avail
Avail Polymer

# V6 Whole Plant P Uptake, 2004 Scandia, KS



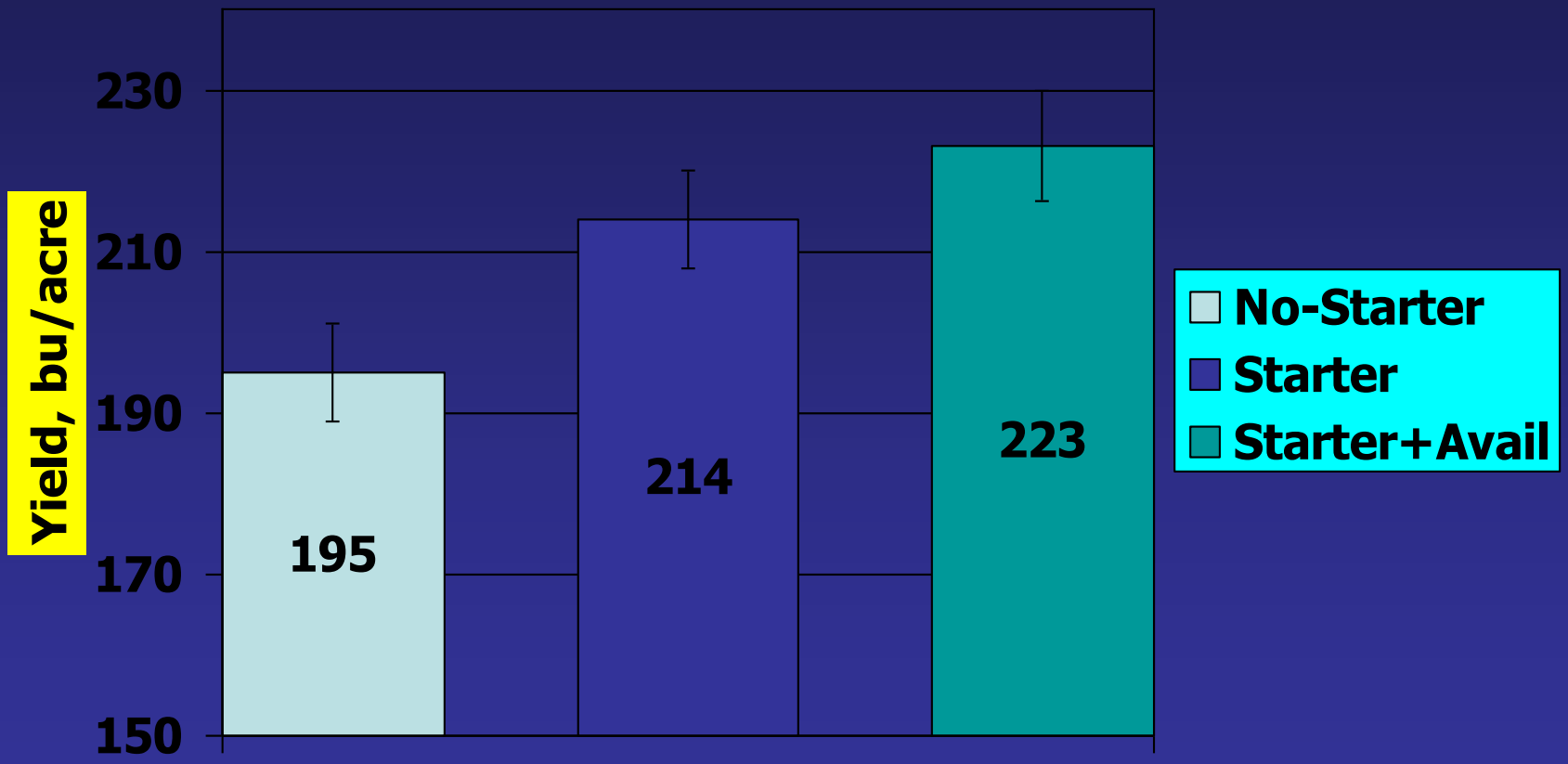

Barney Gordon, KSU

# Avail Effects on Corn Grain Yield 2001-2003 Kansas




Barney Gordon, KSU

# Corn Yield as affected by Avail in Liquid Starter Fertilizer 2003-2005




Gordon and Tindall 2006

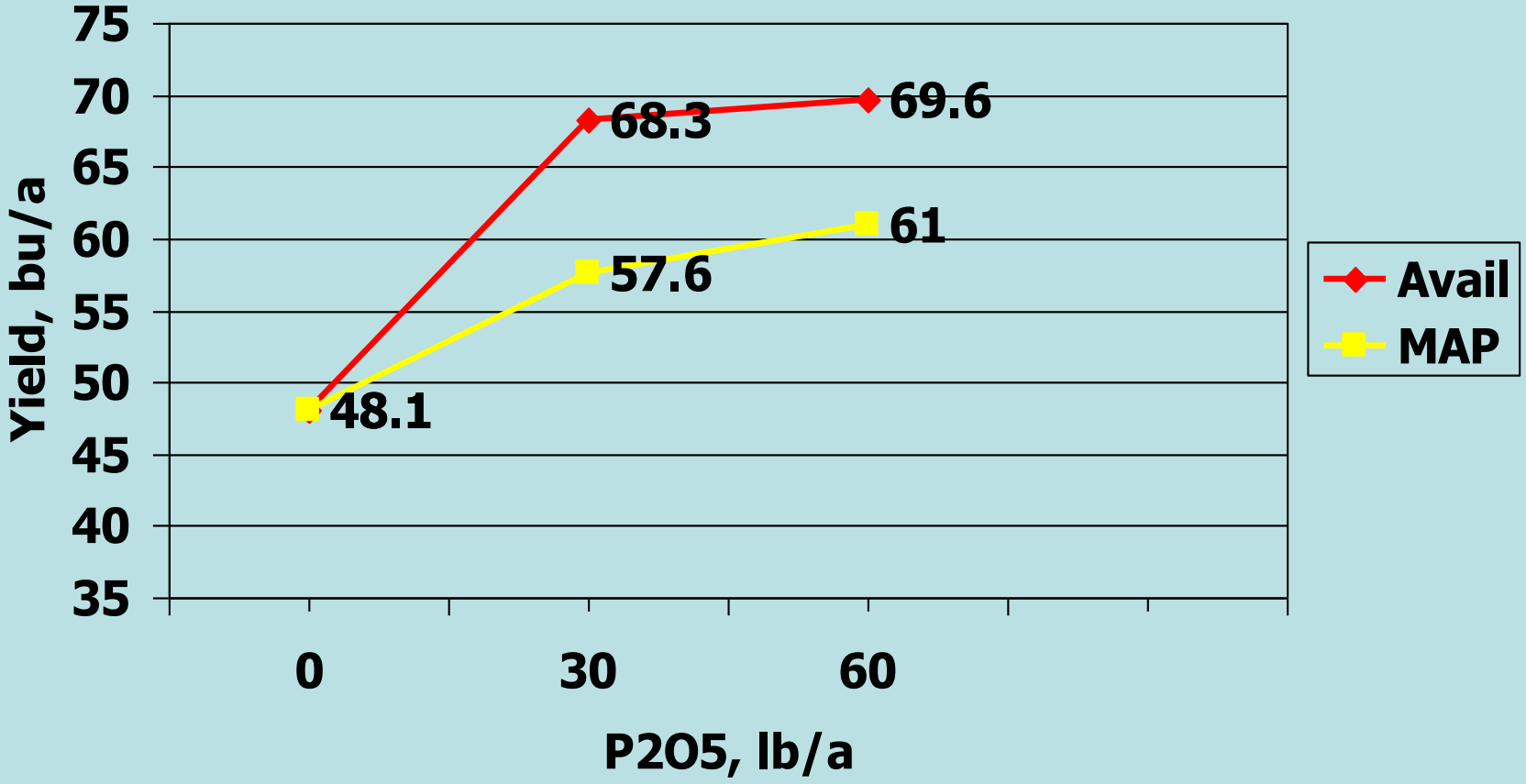
# STUDIES WITH SOYBEANS

# ENHANCING P AVAILABILITY FOR IRRIGATED SOYBEANS
## Kansas

| Treatments<br>lb $P_2O_5$/A | 2002 Grain Yield<br>bu/A | 2003 Grain Yield<br>bu/A |
|---|---|---|
| Control | 52d | 32d |
| 30 MAP | 62c | 41c |
| 30 MAP + polymer | 70b | 57a |
| 60 MAP | 62c | 47b |
| 60 MAP + polymer | 73a | 58a |

Duncan's multiple range test, 5%. Gordon, Kansas State Univ.
P broadcast preplant. Soil test P: 38 ppm Bray 1. Soil pH: 6.8.
0.25% polymer.

# Avail Soybean Grain Yield 2002-2004



# AVAIL POLYMER EFFECTS ON SOYBEANS
## Missouri – 2005

| Treatments<br>lb $P_2O_5$/A<br>bu/A | P<br>% | P Uptake<br>lb/A | Yield |
|---|---|---|---|
| 0 | 0.250 | 2.62 | 51 |
| 50 | 0.265 | 3.75 | 52 |
| 50 + Avail | 0.315 | 4.95 | 56 |
| $LSD_{.10}$ | 0.048 | 0.78 | 2 |

P applied pre-plant.
Soil pH = 6.0

D. Dunn, Univ. of Missouri

# AVAIL EFFECTS ON SOIL TEST P

## Missouri - 2005

| Treatment lb $P_2O_5$/A | Bray P-1 lb/A |
|---|---|
| 0 | 29.5 |
| 50 | 54.0 |
| 50 + Avail | 73.2 |
| $LSD_{.10}$ | 6.7 |

Soybeans. pH = 6.0 D. Dunn, U. of Missouri

# *POTATOES and ONIONS*


Avail
No Avail
EXP
MAP
MAP
120 $P_2O_5$
Dr. Jeff Stark, Univ. of Idaho

# Potato Yield and Return Responses to Enhanced P Availability

## Idaho

| Treatment Applied | Yield CWT/A | Petiole P% | Gross Return |
|---|---|---|---|
| Control | 311a | .225d | 1456 |
| MAP 60 lb P205/Ac | 330ab | .253cd | 1546 |
| MAP 120 lb P205/Ac | 344bc | .275bc | 1591 |
| MAP + Exp 60 lb P2O5/A | 339ab | .288ab | 1575 |
| MAP + Exp 120 lb P2O5/A | 369c | .308a | 1791 |

Calcareous soil, Aberdeen, ID  Jeff Stark, University of Idaho

# Russet Burbank Potatoes –'06
# University of Idaho, SE Idaho
# Soil pH 8.1 - Preplant Broadcast – SSP/MAP
# Fall / Spring Applications (Stark)

| | Yield /Acre (cwt)** | U.S. # 1 | Grower ROI/A (Avail Benefit) |
|---|---|---|---|
| MAP-100-F | 409 | 281 | |
| SSP/MAP | 449 | 335 | +$281 |
| | | | |
| MAP- 200-F | 431 | 318 | |
| SSP/MAP | 445 | 343 | +$101 |
| | | | |
| MAP- 100-S | 407 | 283 | |
| SSP/MAP | 438 | 328 | +$218 |
| | | | |
| MAP- 200-S | 417 | 284 | |
| SSP/MAP | 414 | 309 | +$33 |

**Avail Upcharge**

+$10.00/A

+$20.00/A

**$6.00/cwt

+$10.00/A

+$20.00/A


Avail SD 10 gal/ac plant band
GSP 10-34-0 banded

We continue to see positive responses over multiple years for Avail applications with P fertilizers used on potatoes. Avail consistently provides positive yield and improvements in quality.

Dr. Jeff Stark—Univ. of ID--2007

# ONIONS

- Avail SD applications on furrow irrigated onions
- Avail SD applications on drip irrigated onions
- Avail works extremely well to improve P uptake and improves quality and yield!


**Crop Advisor Introduction of Avail SD to Growers-2006**


**Avail SD 1 % 40 lbs/ac** **Growers Standard Practice**

10-34-0—Grower Standard Practice

Avail SD w/10-34-0


Grower Standard Practice
Avail SD w/10-34-0

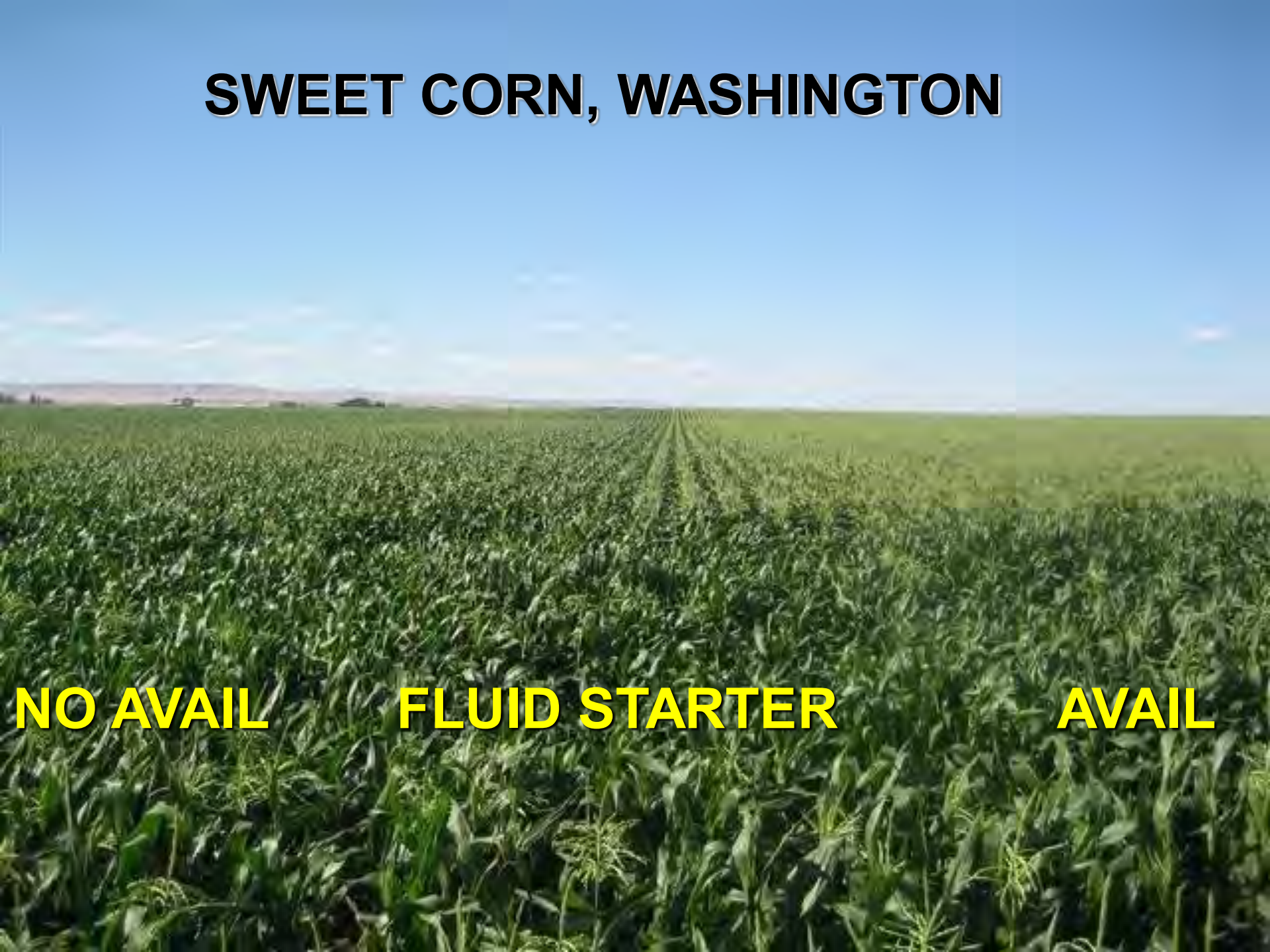
I needed to prove Avail Technology would work for “my growers”. I started slow with no sales in 04 or 05, but had such good results using Avail SD at 1% by volume in 06--that I now recommend Avail on 100% of my grower fields.

Andy Serpa—SGS CCA Treasure Valley ID--2007

“We began to use Avail OS and SD on our onions in 2005—50 acres at the beginning to over 800 acres in 2006, we owe the production increases and improved quality to the Avail applications”

Larry Bouman—L & L Farms
Othello Washington

Avail allows P to be taken up in the plant more rapidly and at higher concentrations speeding up maturity in many plants


SWEET CORN, WASHINGTON
NO AVAIL
FLUID STARTER
AVAIL


AVAIL FOR ALFALFA
Enhancing yield and quality

# AVAIL FOR ALFALFA

## Scottsbluff, NE

| | MAP | MAP + Avail |
|---|---|---|
| | Tons/A | |
| Phillips | 6.09 | 7.87 |
| Stricker | 5.06 | 6.60 |

50 lb $P_2O_5$/A  Olsen P  16-18 ppm
0.25% coating  Simplot


Avail SD with 10-34-0 new planting alfalfa in beds


Avail 1%
40P
Control
1
2
3
4
5
6


NO AVAIL
AVAIL

# VEGETABLES


Avail Treated
Harvested 6/8/2006 3pm


GSP Control
Harvested 6/8/2006 3pm

I was able to measure an increase in my established alfalfa by using Avail treated MAP in the spring of 06. I was impressed and am now using Avail on sugarbeets, corn, garlic (300 ac) seed alfalfa and wheat (1000 acres)—I am sold on the technology!

John Deaner Red Rock Ranch—Fresno Co. CA

# Avail Technology—Bright Hope for Western Growers


Nutrisphere-N for Nitrogen

# Nutrisphere-N
## Improving N Use Efficiency and Profits

# *Nutrisphere-N POLYMER*

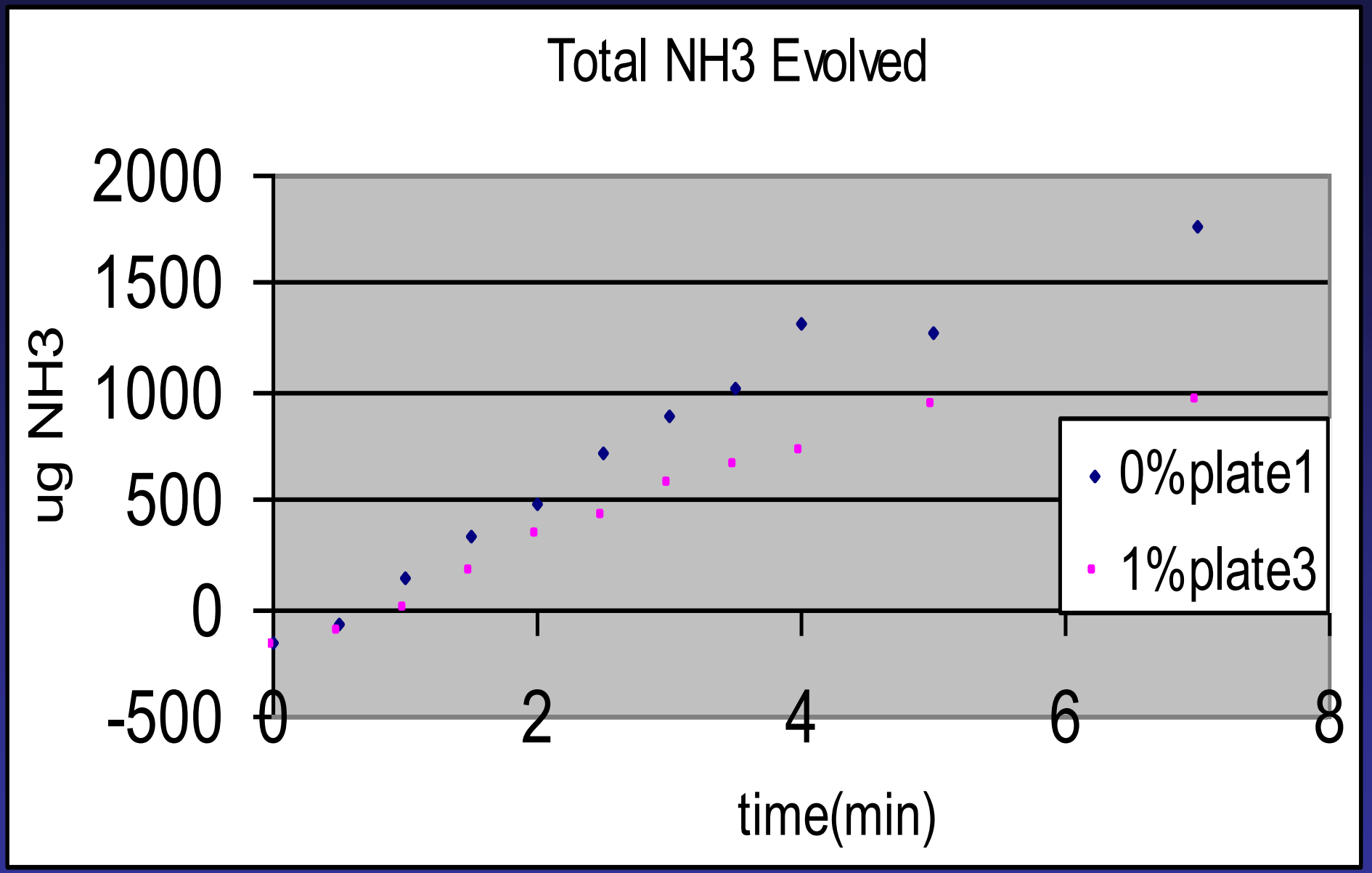
- High charge density like AVAIL
- Not same formulation as AVAIL
- Initial studies looked at effects on ammonia volatilization under lab conditions…successful (Univ. of GA)
- First field study in 2004 in Kansas with coated urea on no-till corn..KSU
- Studies continuing at 15 universities

# *NutriSphere N*

- **Suggested mode of action:**

  **Sequestration of bio-available Ni ions in soil around urea particle decreases volatilization.**

- **Bacterial synthesis involves Cu and Fe for nitrification and appears to be suppressed with NutriSphere N**




**NutriSphere N EFFECTS ON UREASE**

Univ. of Kentucky

# NSN and Nitrification

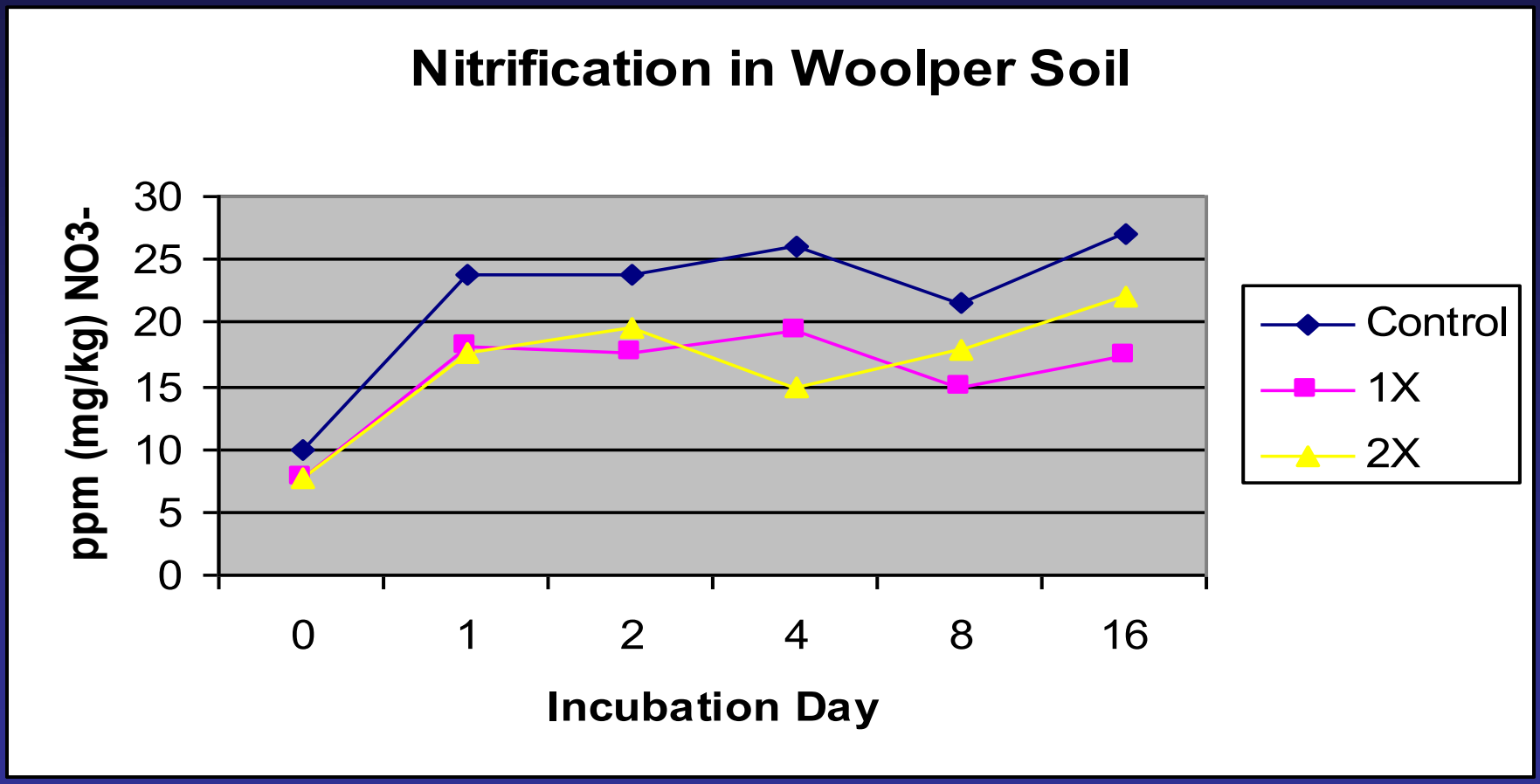



Figure 1. 16-day net nitrification in Woolper soil amended with N-Guard polymer--2006

# NUTRISPHERE-N EFFECTS ON UREA PERFORMANCE
## No-Till Corn---Kansas 2004

| Treatment lb N/A | % N | Corn Yield bu/A |
|---|---|---|
| 0 | 1.77 | 154 |
| 80 Urea | 2.00 | 176 |
| 80 + N-GUARD | 2.20 | 198 |
| 160 Urea | 2.08 | 192 |
| 160 + N-GUARD | 2.32 | 210 |
| 240 Urea | 2.22 | 230 |
| 240 + N-GUARD | 2.46 | 254 |

Sidedressed N, 0.5% N-GUARD
2004 Gordon, KSU

# *HIGH CHARGE DENSITY POLYMER EFFECTS ON UREA*

## *2005-- No-Till Corn,Kansas*

| N Rate lb/A | | Ear Leaf N % | Corn Yield bu/A |
|---|---|---|---|
| 0 | | 1.78 | 139 |
| 80 | Urea | 2.79 | 167 |
| 80 | Urea + N-GUARD | 2.90 | 184 |
| 160 | Urea | 2.90 | 183 |
| 160 | Urea + N-GUARD | 3.07 | 216 |
| 240 | Urea | 2.95 | 192 |
| 240 | Urea + N-GUARD | 3.09 | 215 |
| LSD .05 | | 0.09 | 6 |

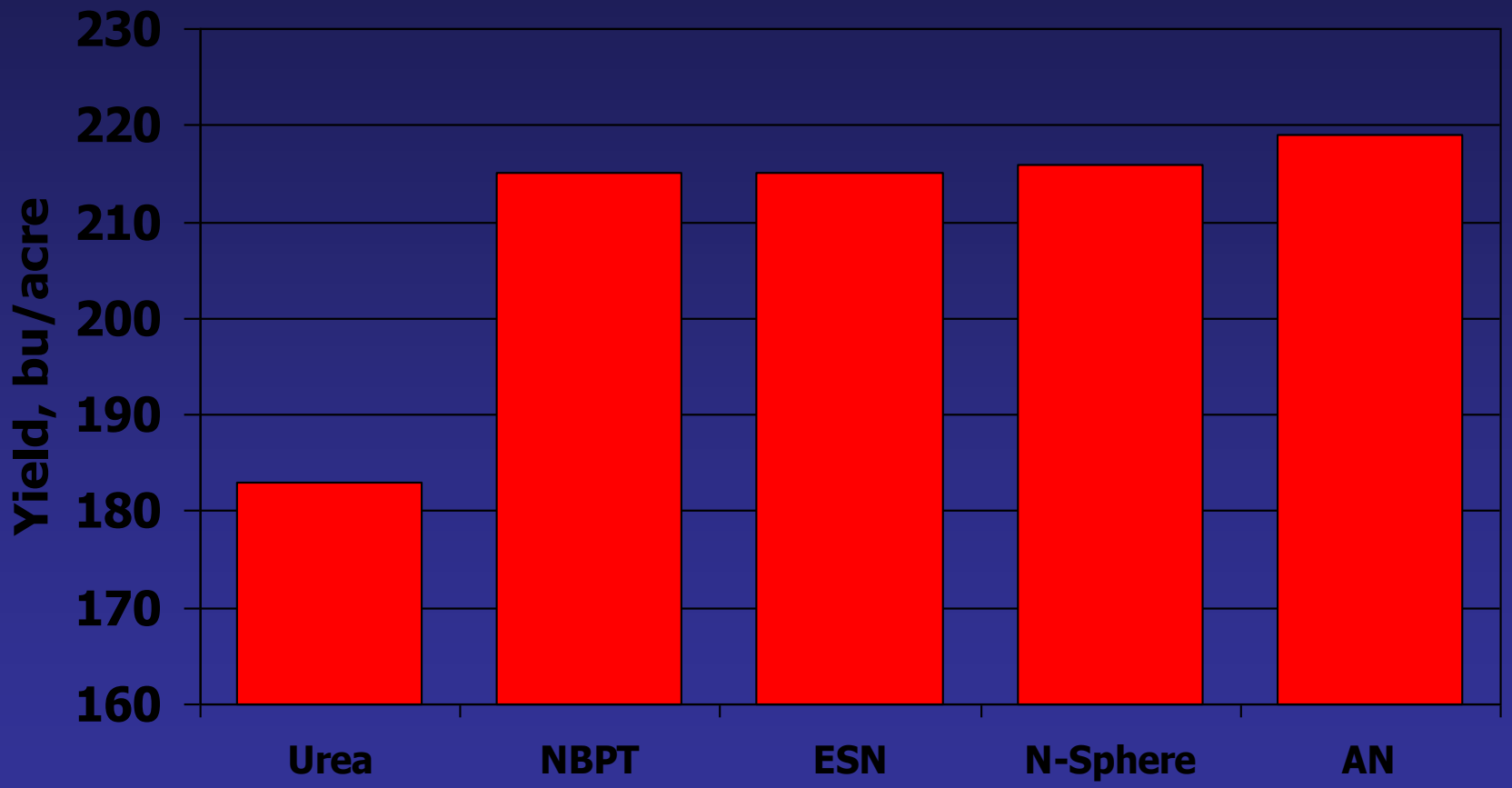
Soil pH = 7.0 Gordon, Kansas State Univ.

NSN: 0.25% coating

# Tools to Manage N-Losses with Surface Applied N.

- Urease-Inhibitors (NBPT)
- Controlled Release N. Urea granule is coated, but allows water to diffuse across membrane. N-release is then temperature controlled. (ESN).
- Long-Chain liquid Polymer coating of Urea (NutriSphere N).

# Corn Yield as Affected by N Source (2-year Average)




**N-Rate= 160 lb/acre**

**No-Till Corn**

# N-GUARD EFFECTS IN NITROGEN SOLUTION
## No-Till Corn--2005

| Treatments<br>lb N/A | Grain Yield<br>bu/A |
|---|---|
| 0 | 71 |
| 90 Banded | 104 |
| 90 Banded + 1% N-GUARD | 131 |
| 130 Banded | 130 |
| 130 Banded + 1% N-GUARD | 158 |

Loam soil

Ron Mulford, Univ. of Maryland

# N RATES AND N-GUARD

## *No-Till Corn, Kansas--2006*

| N Rates | Urea | | UAN | |
|---|---|---|---|---|
| lb/A | N-Guard | None | N-Guard | None |
| 0 | | 138 bu/A | | |
| 80 | 166 | 152 | 170 | 157 |
| 160 | 188 | 169 | 192 | 167 |
| 240 | 197 | 188 | 196 | 181 |

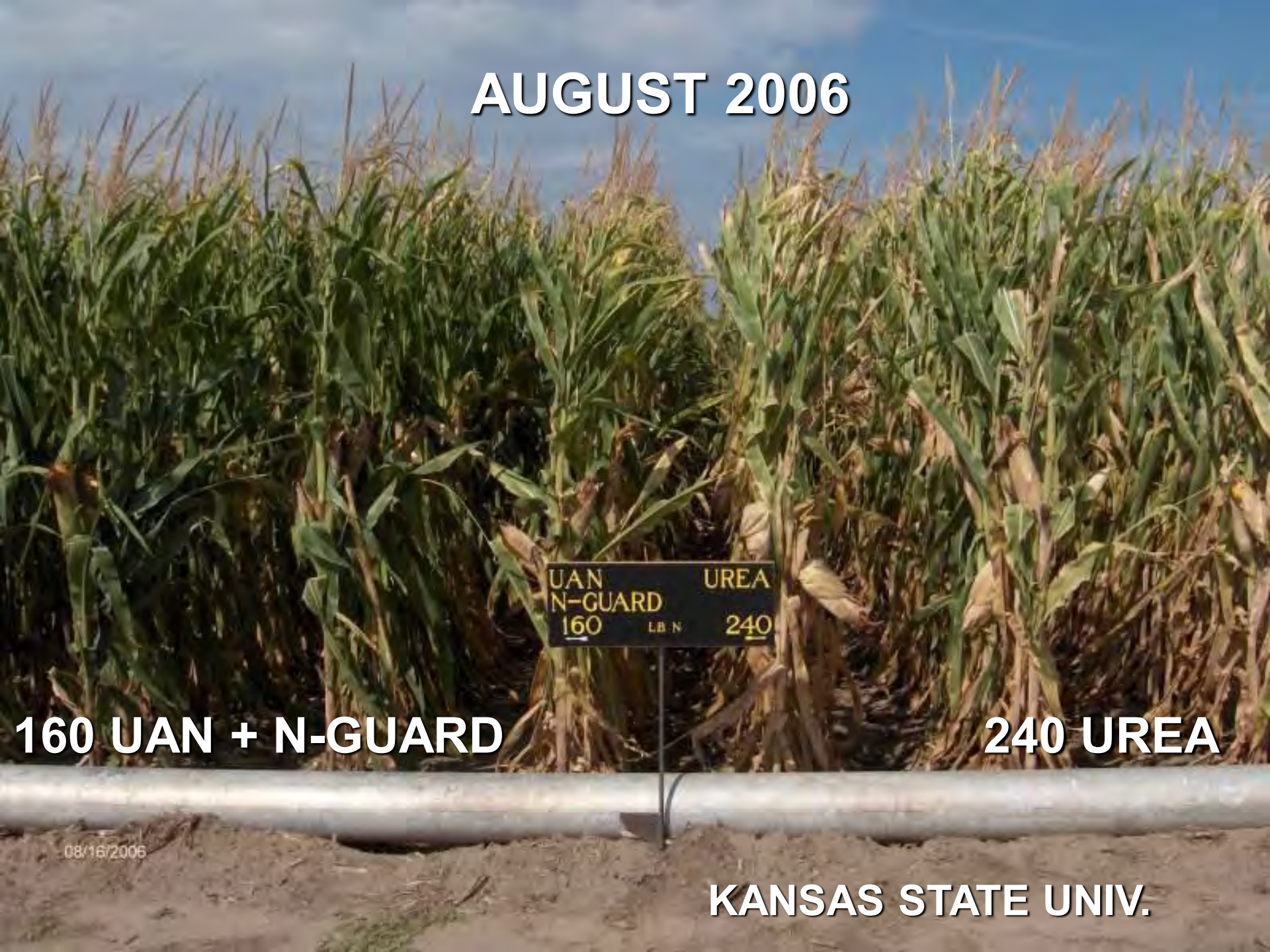
All N broadcast

Gordon, KSU

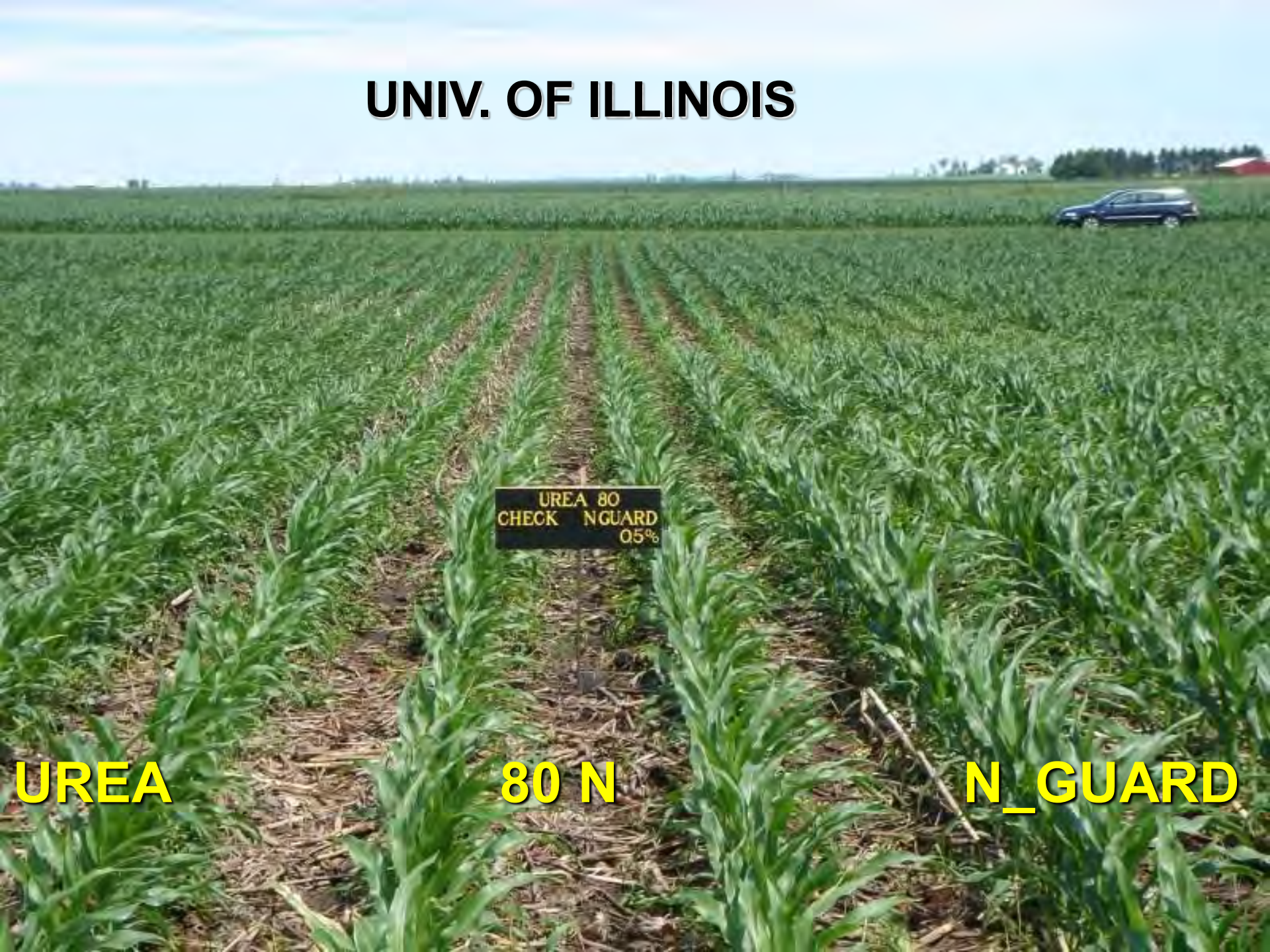
Soil pH: 7.0

# *CURRENT STUDIES*

- Kansas State (2)….no-till corn
- Univ. of Kentucky (3)…no-till corn
- Texas A&M….hybrid bermudagrass
- Univ. of Arkansas… bermuda, rice (2)
- Univ. of Missouri…rice, corn
- Univ. of Illinois…no-till corn
- Univ. of Maryland (2)…no-till corn
- Mississippi State…rice
- Ohio State…..corn


AUGUST 2006
UAN
N-GUARD
160
LB N
UREA
240
160 UAN + N-GUARD
240 UREA
08/16/2006
KANSAS STATE UNIV.

# UNIV. OF ILLINOIS




UNIV. OF KENTUCKY
UREA
120
160
NGUARD

# N-GUARD POLYMER EFFECTS ON NO-TILL CORN YIELDS

## Maryland – 2006

| Treatments<br>lb N/A | Corn Yields<br>bu/A |
|---|---|
| 80 UAN | 138 |
| 80 UAN + 1% N-Guard | 147 |
| 120 UAN | 156 |
| 120 UAN + 1% N-Guard | 166 |

Mattapeake loam
DeKalb DKC 63-74

Mulford, Univ. of MD

# Economics

- Grower costs of Avail is about .08/lb of P2O5
- Grower costs of Avail SD or Avail OS is about $150.00/gallon and applied at either .5 % or 1.5% by volume.

- Grower cost of NutriSphere is about .08/lb of N above cost of urea.

# SUMMARY

- Polymer coatings of P materials have been and continue to be effective
- Slowed solubility a factor in lessening germination damage in sensitive crops
- Delayed P fixation reactions improve P use efficiency
- Cost effective

# Opportunities for Brazil

- Develop a better understanding of Avail and NutriSphere responses across Brazilian agriculture production systems.
- Work with industry partners to be successful in Brazil
- Provide Brazilian growers with more efficient nutrient management programs.


Obrigado
terry.tindall@simplot.com