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Wednesday February 12, 2014

# Managing P and Zn

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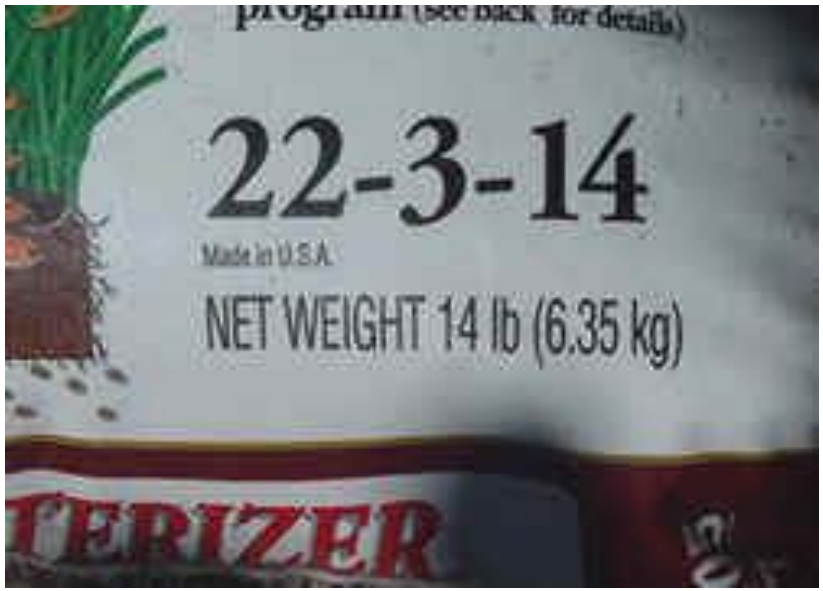
# Clear as mud…




P = the element Phosphorus

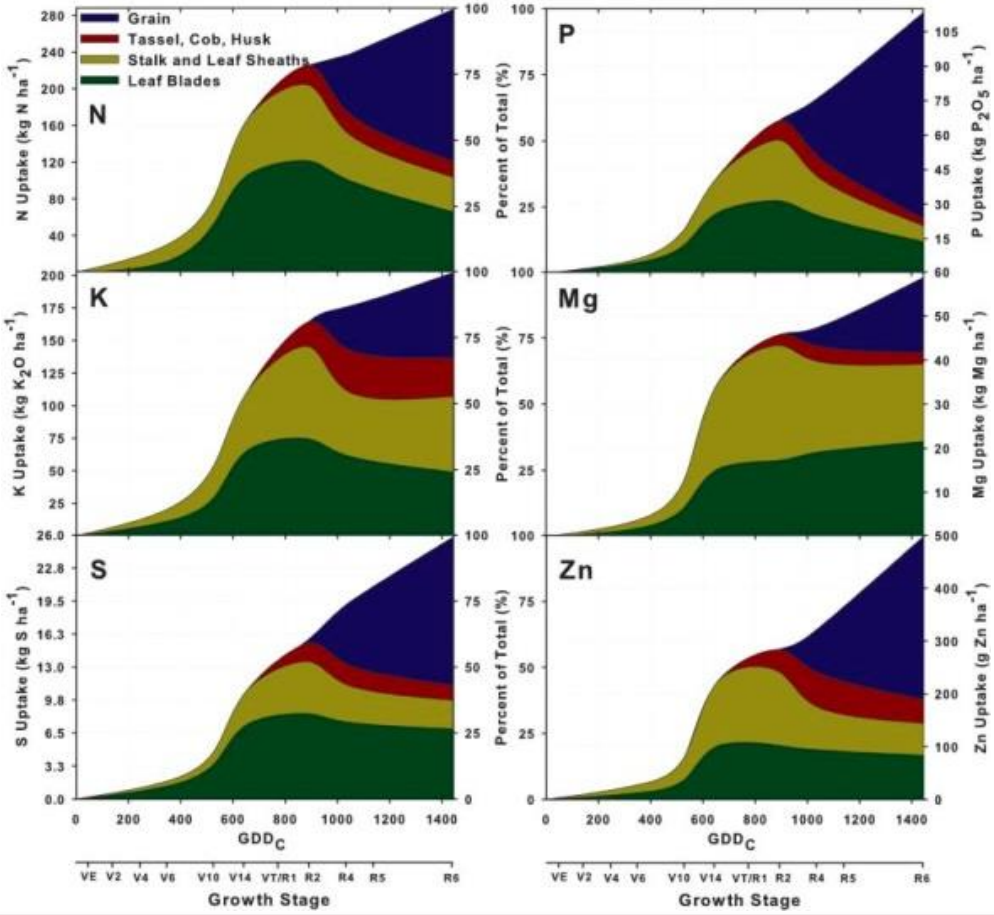
$P_2O_5$ = fertilizer standard (an expression) ~ 44% P

$H_2PO_4^-$ = orthophosphate (form of plant uptake)

Soil test reports usually make recommendations in terms of $P_2O_5$

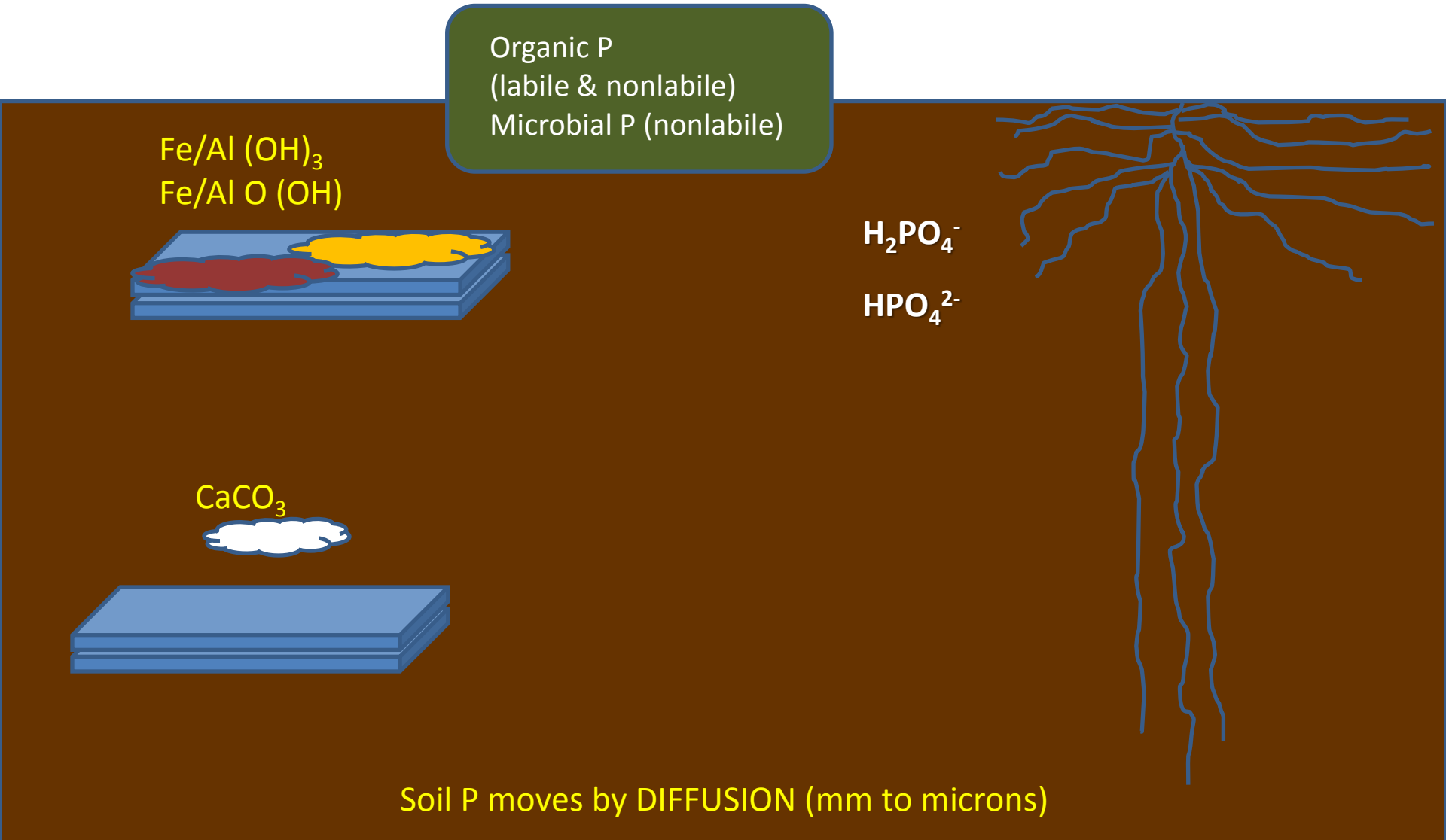
# Plant Use and Uptake

- Energy (ATP)
- DNA and RNA (cell division and protein synthesis)
- Phospholipids (cellular membranes)
- Seedling and root growth
- Substantial grain accumulation
- Manure implications (feed)

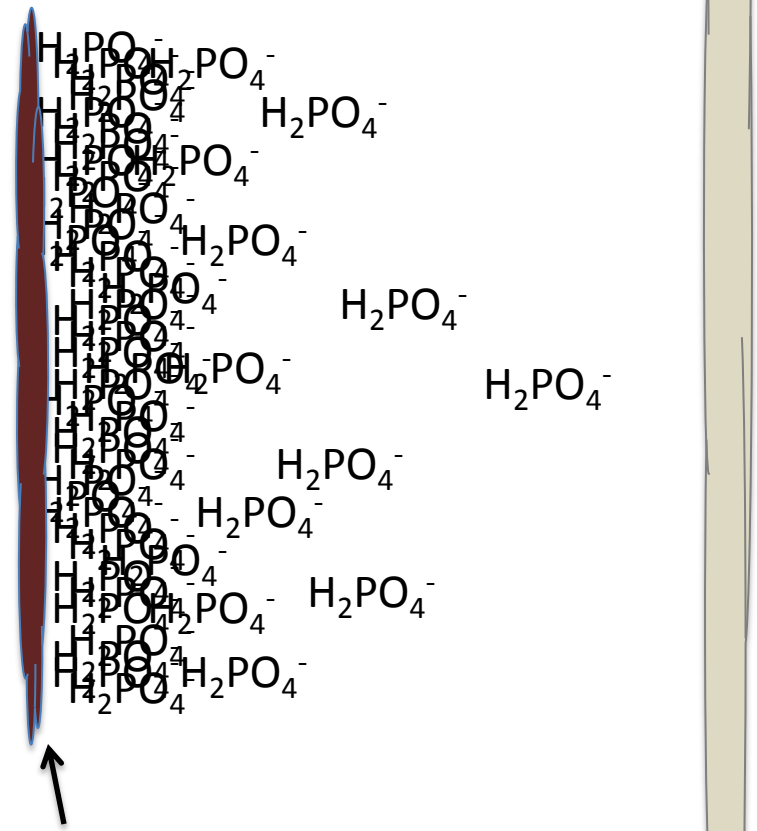


| Crop | $P_2O_5$ | Total crop removal (lbs/a) |
|---|---|---|
| Corn uptake (bu-1) | 0.54 | 108 (200 bu) |
| Corn removal (bu-1) | 0.35 | 70 |
| % removed | 65% | |
| | | |
| Soybean uptake (bu-1) | 1.1 | 66 (60 bu) |
| Soybean removal | 0.73 | 44 |
| % removed | 66% | |
| | | |
| Cotton uptake (bale-1) | 22 | 66 (3 bale) |
| Cotton removal | 14 | 42 |
| % removed | 64% | |
| | | |
| Wheat-wtr. Uptake (bu-1) | 0.68 | 41 (60 bu) |
| Wheat-wtr. Removal | 0.48 | 29 |
| % removed | 71% | |

# Phosphorus in the soil

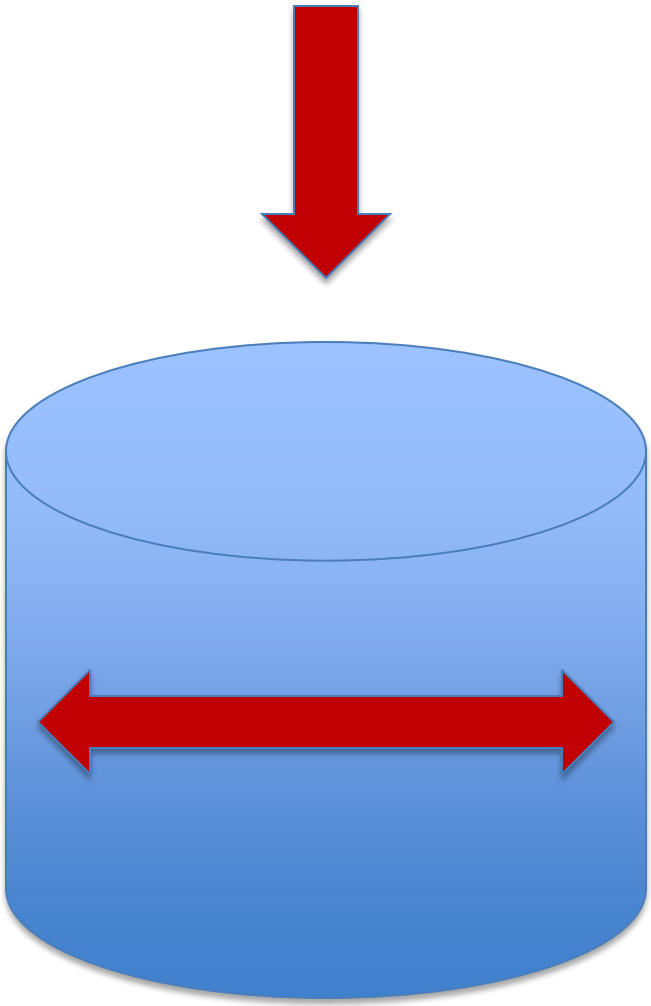


# Phosphorus in the soil

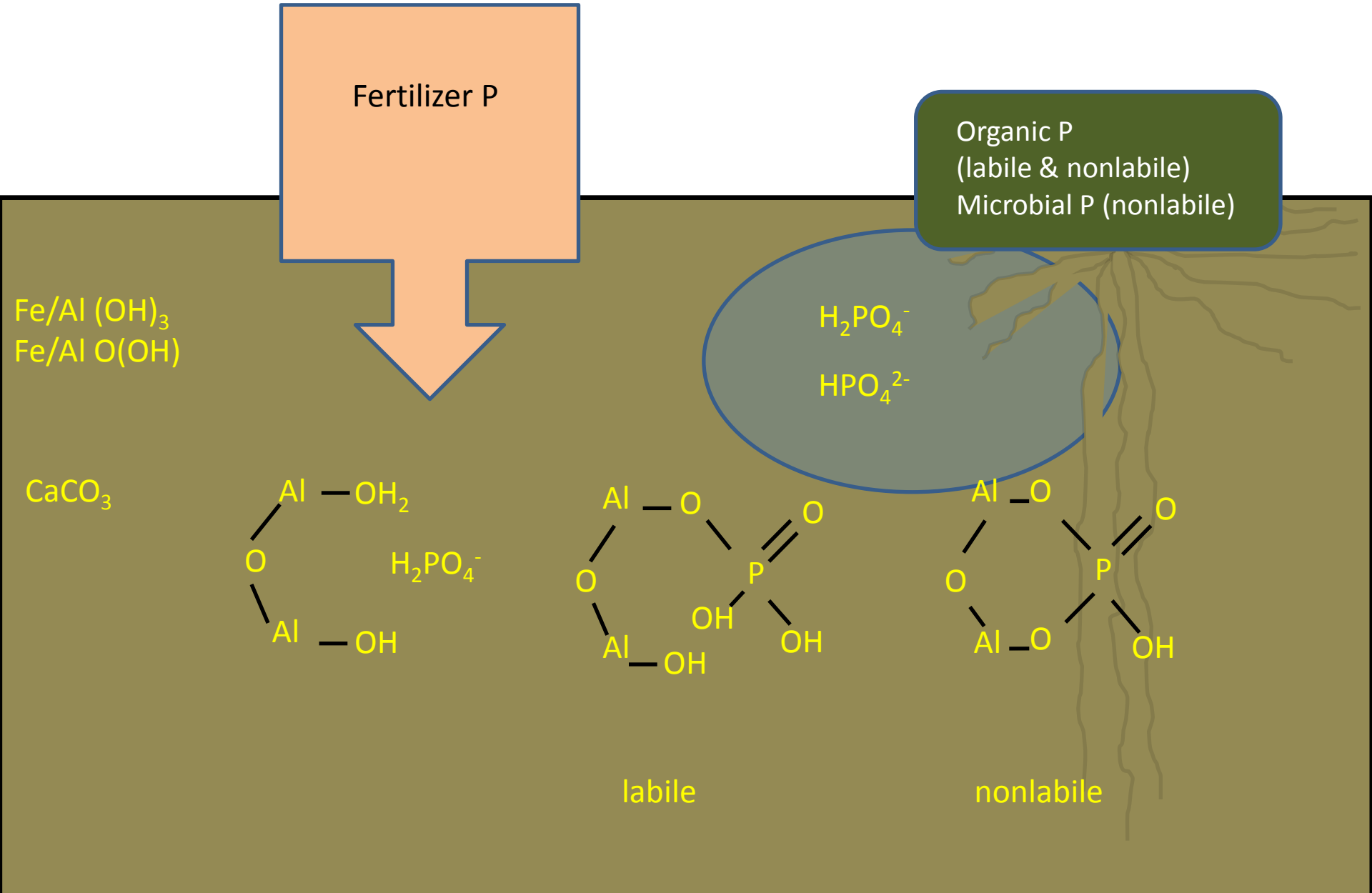



Iron and aluminum hydroxides and oxy-hydroxides (or $CaCO_3$)

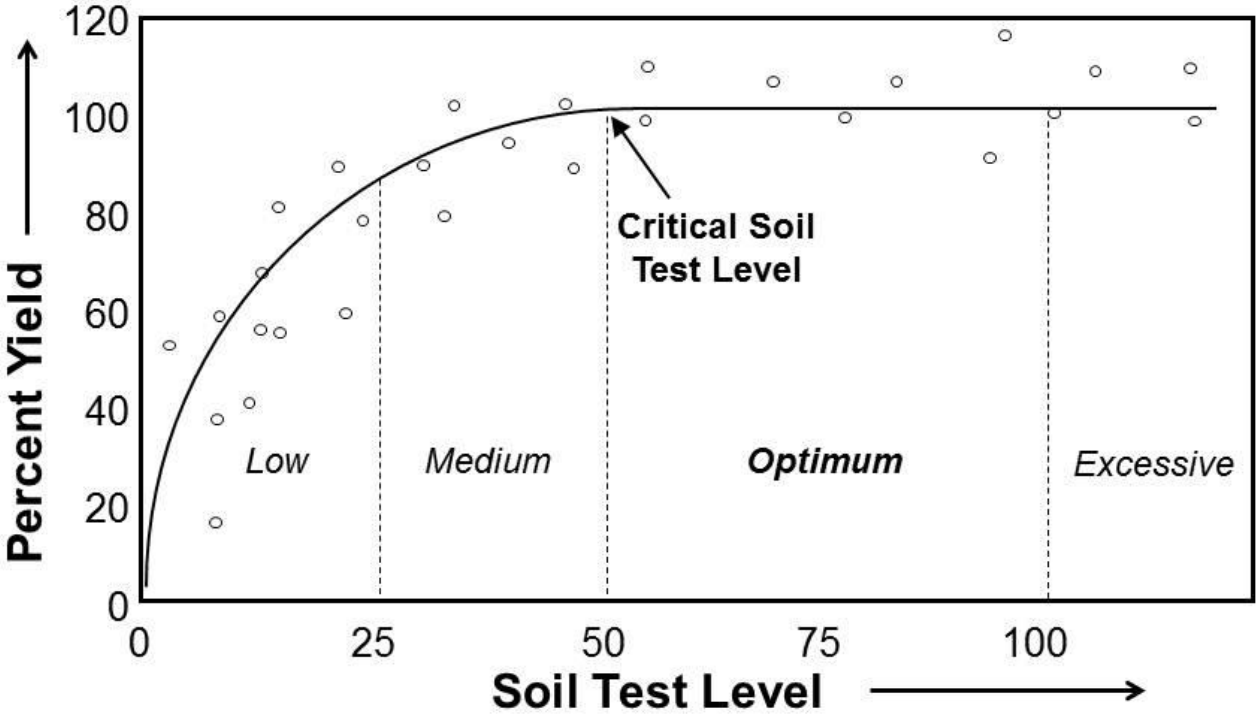
Plant root



# Phosphorus in the soil



# Soil Test P – probability of response

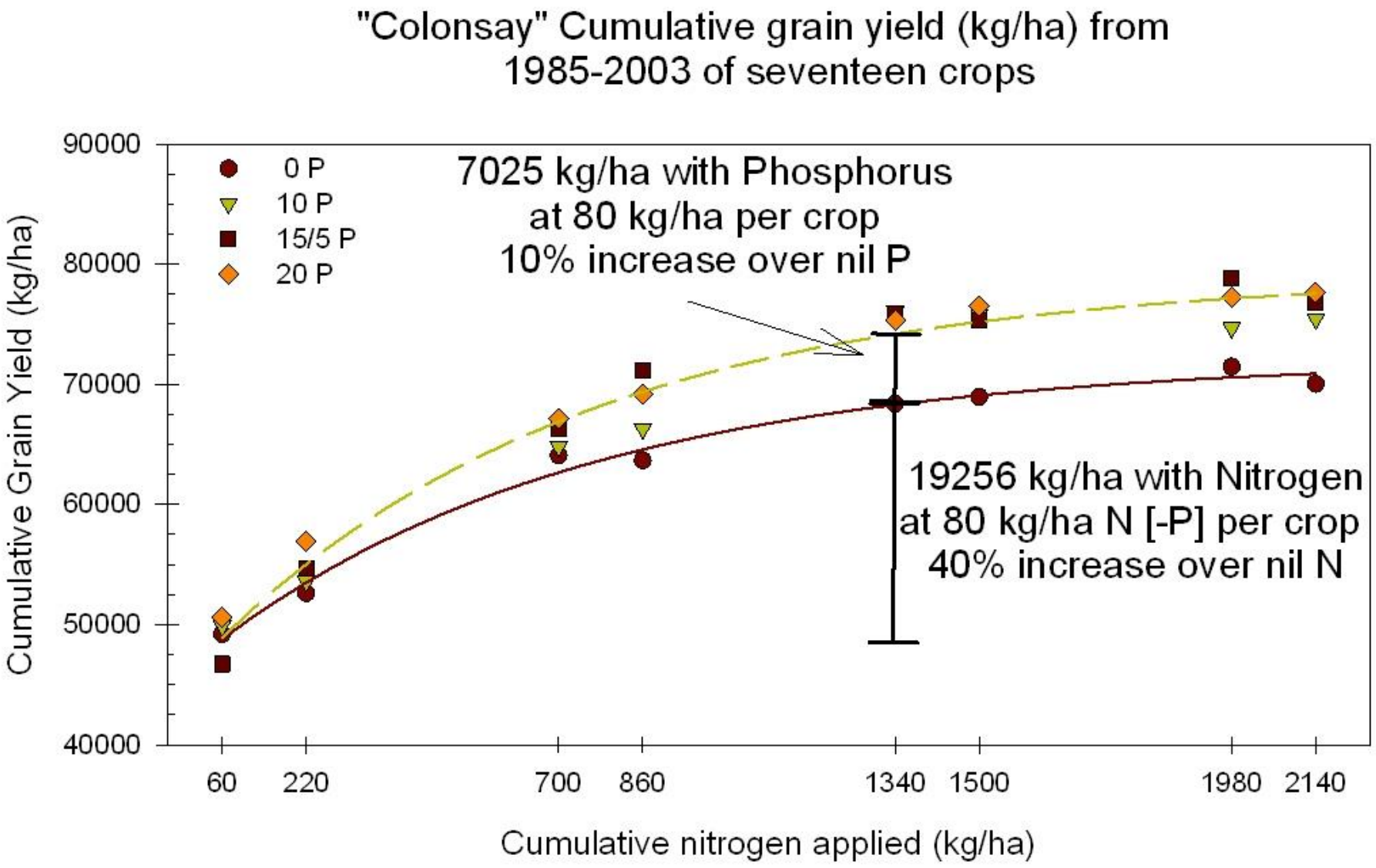



*"LOW (0-25 FertIndexValue).* The nutrient concentration in the soil is inadequate for the growth of most plants and will very likely limit plant growth and yield. *There is a high probability of a favorable economic response to additions of the nutrient*."

**Dr. Tubana: critical soil test P value: ~30 ppm (M3)**

Credit: extension.udel.edu

# N & P interaction




http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/~/media/E00EFC0A38FD4E99BDFD83899D4544FE.jpg

# Corn production research on low vs. high to very high P-testing soils

- Location:  SROC, Waseca
- Soils:  Webster clay loam, tiled 75'
- Soil Test Bray P: 7 ppm (L) vs. 25 ppm (VH)
- Low P site mined with no P or K applied for previous 6 years
- Corn: 2005, 2006, 2007
- Soybean: 2006, 2007, 2008
- Potassium applied at 120-200 lb $K_2O$/A/yr
- Hybrids, varieties, planting dates, etc same for both L & VH sites each year
- Strip-till corn, No-till soybean

# Corn yield as affected by soil P test and P placement

| P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A - - - - | |
| 0 | -- | | |
| 50/40 | Deep-band[1/] | | |
| 50/40 | Pop-up | | |
| 50/40 | Broadcast | | |
| 50/40 | DB + Pop-up | | |

[1/] 6-7” below soil surface under row.

# Corn yield as affected by soil P test and P placement

| P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A - - - - | |
| 0 | -- | 148 | |
| 50/40 | Deep-band[1/] | 166 | |
| 50/40 | Pop-up | 166 | |
| 50/40 | Broadcast | 167 | |
| 50/40 | DB + Pop-up | 172 | |

[1/] 6-7” below soil surface under row.

# Corn yield as affected by soil P test and P placement

| P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A - - - - | |
| 0 | -- | 148 | 193 |
| 50/40 | Deep-band[1/] | 166 | 186 |
| 50/40 | Pop-up | 166 | 194 |
| 50/40 | Broadcast | 167 | 190 |
| 50/40 | DB + Pop-up | 172 | 189 |

[1/] 6-7” below soil surface under row.

# Soybean yield as affected by soil P test and P placement for previous corn crop

| Residual P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A/yr - - - - | |
| 0 | -- | | |
| 50/40 | Deep-band | | |
| 50/40 | Pop-up | | |
| 50/40 | Broadcast | | |
| 50/40 | BD + Pop-up | | |

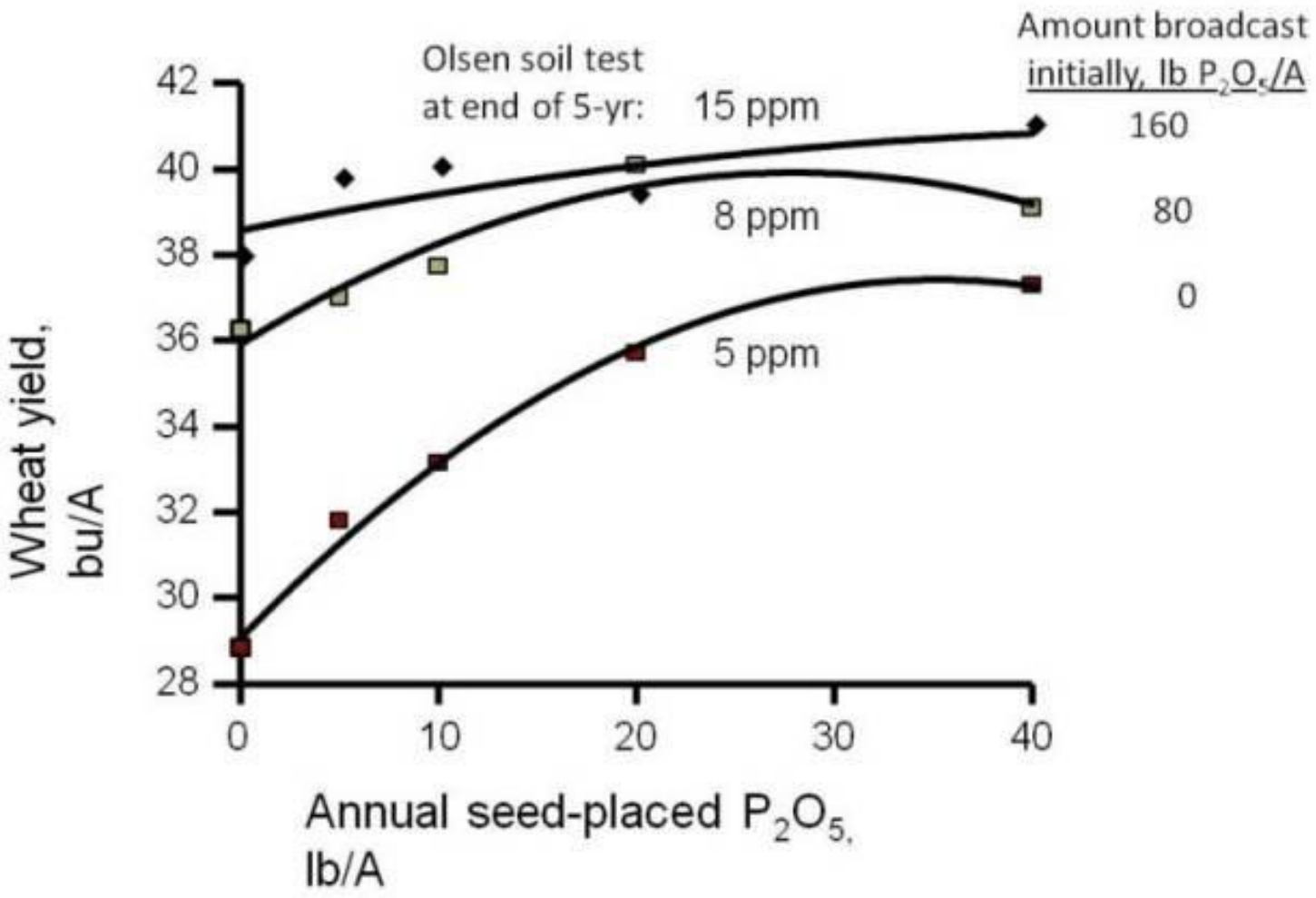
# Soybean yield as affected by soil P test and P placement for previous corn crop

| Residual P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A/yr - - - - | |
| 0 | -- | 34.5 | |
| 50/40 | Deep-band | 38.5 | |
| 50/40 | Pop-up | 38.2 | |
| 50/40 | Broadcast | 37.1 | |
| 50/40 | BD + Pop-up | 40.8 | |

# Soybean yield as affected by soil P test and P placement for previous corn crop

| Residual P Treatment | | P Test | |
|---|---|---|---|
| Rate | Placement | Low | VH |
| lb $P_2O_5$/A | | - - - - bu/A/yr - - - - | |
| 0 | -- | 34.5 | 49.1 |
| 50/40 | Deep-band | 38.5 | 49.1 |
| 50/40 | Pop-up | 38.2 | 48.9 |
| 50/40 | Broadcast | 37.1 | 48.4 |
| 50/40 | BD + Pop-up | 40.8 | 49.3 |

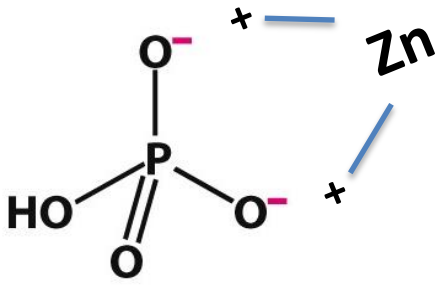
# Wheat response to added P

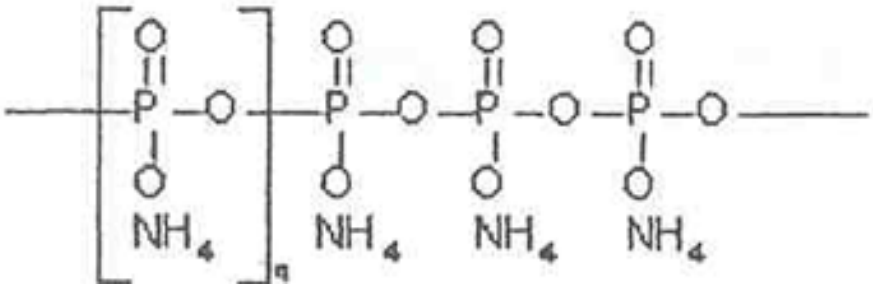


# Phosphate Fertilizers

- SSP (0-20-0)
- TSP (0-46-0)
- MAP (11-52-0)
- DAP (18-46-0)
- APP (10-34-0)
- OP (6-24-6)
- Source: Rock Phosphate ($Ca_{10}(PO_4)_6(X)_2$ where $X=F^-$, $OH^-$, or $Cl^-$ (apatites)
- Florida, Morocco, Russia, South Africa, China

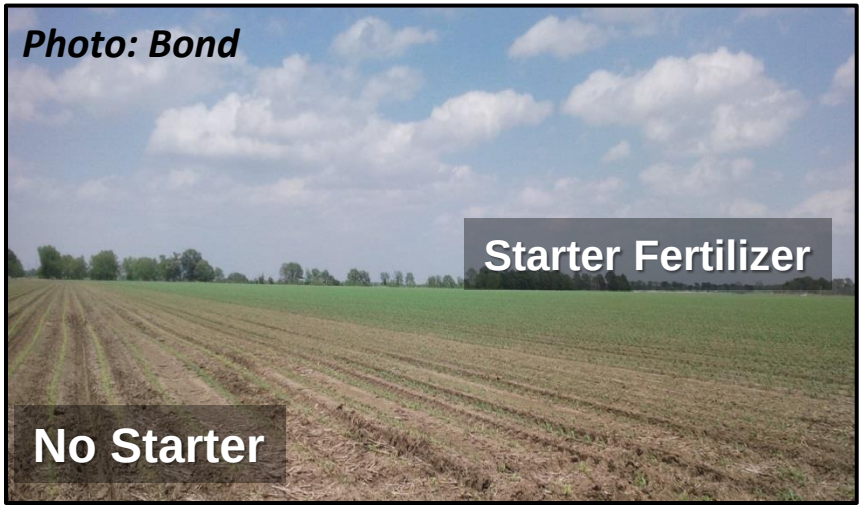
# Orthophosphate and Ammonium Polyphosphate



# Corn Response to in-furrow starter

- Beneficial when soils are cold and wet.
- Use 4 gal (max) APP/acre for wide rows.
- Provides a concentrated nutrient supply directly in the root zone of young plants
- Sequesters P from $CaCO_3$ in calcareous soils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# Corn Response to in-furrow starter

Yield Increases most likely to occur:

- Planting reduced till
- Coarse textured; low O.M. soils
- Cold, poorly drained soils
- Fields with low soil test P
- High pH (calcareous) soil

| *Salt Index comparisons for commonly used starters, (expressed as lbs salt effect/gal)* | | | |
|---|---|---|---|
| **Product** | **Analysis** | **Salt Index, (lb/gal)** | **Value Relative to 10-34-0** |
| **APP** | **10-34-0** | **2.28** | **1.0** |
| **OP** | **6-24-6** | **3.04** | **1.3** |
| **UAN** | **32-0-0** | **7.78** | **3.1** |
| **ATS** | **12-0-0-26S** | **30.9** | **13.6** |

***Salt index adapted from Pioneer***

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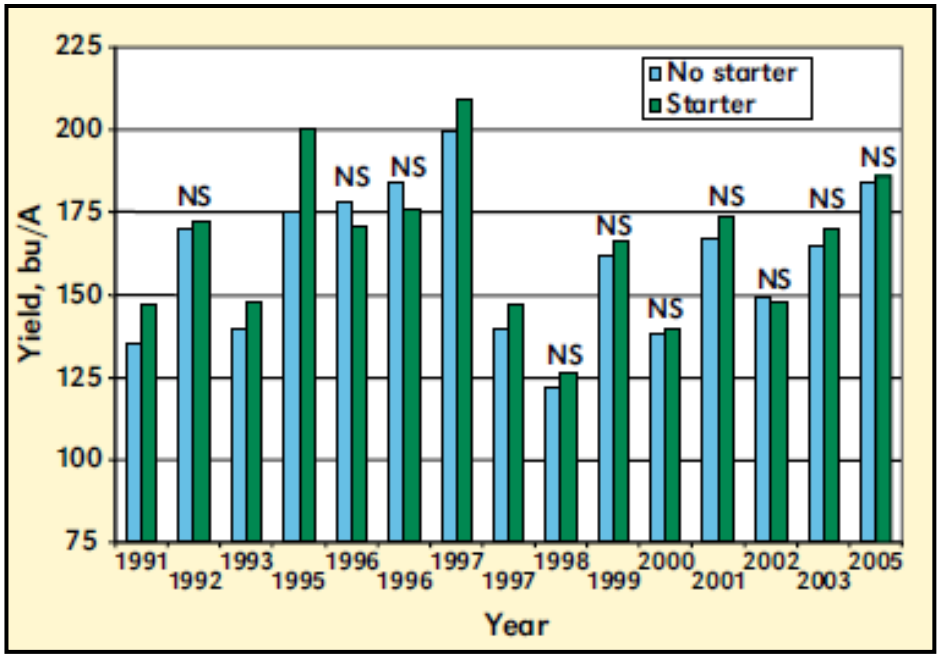
# Corn Response to in-furrow starter

- **Early season plant growth increased in all trials.**
- **Plant height increase remains until tassel.**
- **Authors attributed growth increase to $P_2O_5$ content of starter.**




***Source: Mascagni et al., Better Crops 91:2 (2007)***

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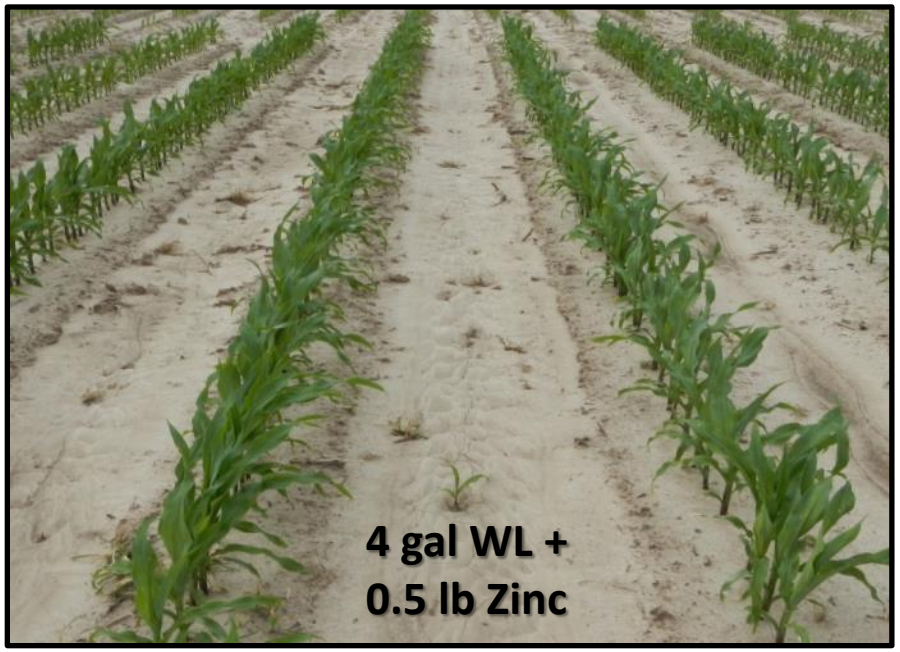
# Corn Response to in-furrow starter


**Inconsistent with respect to increases in grain yield**

**Lower harvest moisture and earlier Mid silk dates when no yield response observation**

**Consistently enhances plant growth and maturity**

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# Phosphorus Summary

- P is very immobile
- Moves by diffusion
- Apply P to “sufficiency level” (30 ppm M3)
- If low soil test P, use a starter fertilizer at planting
- If sufficient soil test P, utilize crop replacement levels at a minimum
- Own-land versus rent-land strategies

# Zinc Agronomics


# Zinc in Soil and Plant Tissue

- Immobile Nutrient (plant & soil)
- Soil CEC (mostly SOM)
- Challenge: High pH and high soil test P
- A key Micronutrient for Corn
  - Relatively high demand by the plant
  - **Enzyme synthesis**
  - Necessary for chlorophyll formation
  - Involved in growth hormone and auxin production
  - Co Factor for alcohol dehydrogenase pathway

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# Zinc Promotes Earlier Tassel

recall the importance of cool temperatures during pollination



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# Herbicide Injury or Nutrient Deficiency ?



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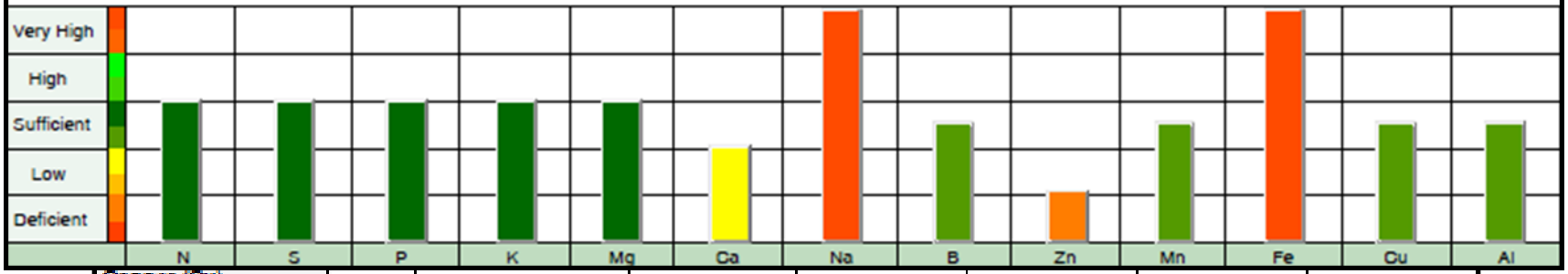
# Zinc Deficiency Symptomology

# Soil and tissue test Zn interpretation

| | Nitrogen % | Sulfur % | Phosphorus % | Potassium % | Magnesium % | Calcium % | Sodium % | Boron ppm | Zinc ppm | Manganese ppm | Iron ppm | Copper ppm | Aluminum ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analysis | 4.00 | 0.65 | 0.57 | 2.03 | 0.62 | 1.78 | 1.58 | 57 | 11 | 134 | 448 | 17 | 111 |
| Normal Range | 3.00<br>4.49 | 0.30<br>0.89 | 0.15<br>0.59 | 0.75<br>2.49 | 0.30<br>0.89 | 2.00<br>3.99 | 0.00<br>0.14 | 15<br>100 | 20<br>100 | 10<br>400 | 50<br>300 | 5<br>30 | 0<br>500 |

| | N/S | N/K | P/S | P/Zn | K/Mg | K/Mn | Ca/B | Fe/Mn |
|---|---|---|---|---|---|---|---|---|
| Actual Ratio | 6.2 | 2.0 | 0.9 | 518.2 | 3.3 | 151.5 | 312.3 | 3.3 |
| Expected Ratio | 6.3 | 2.3 | 0.6 | 61.7 | 2.7 | 79.0 | 520.9 | 0.9 |




| | | |
|---|---|---|
| Copper (Cu) | | |
| Iron (Fe) | | |
| Manganese (Mn) | | |
| Zinc (Zn) | M3 | 0.7 ppm |
| Sodium (Na) | | |
| Soluble Salts | | |
| Organic Matter | LOI | 2.1 % ENR 86 |
| Nitrate Nitrogen | | |

# Methods of Zn fertilization

- Soil Applied
  - 5-10 lb Zn/acre as a granular fertilizer
  - Adjust rates based on water solubility of Zn sources (oxides, sulfates and oxysulfates)
- Foliar Applied
  - Apply 1-2 lb Zn/acre after emergence
  - Chelated for soil application (Little foliage for interception)
  - Sulfate for foliar application (larger plants)

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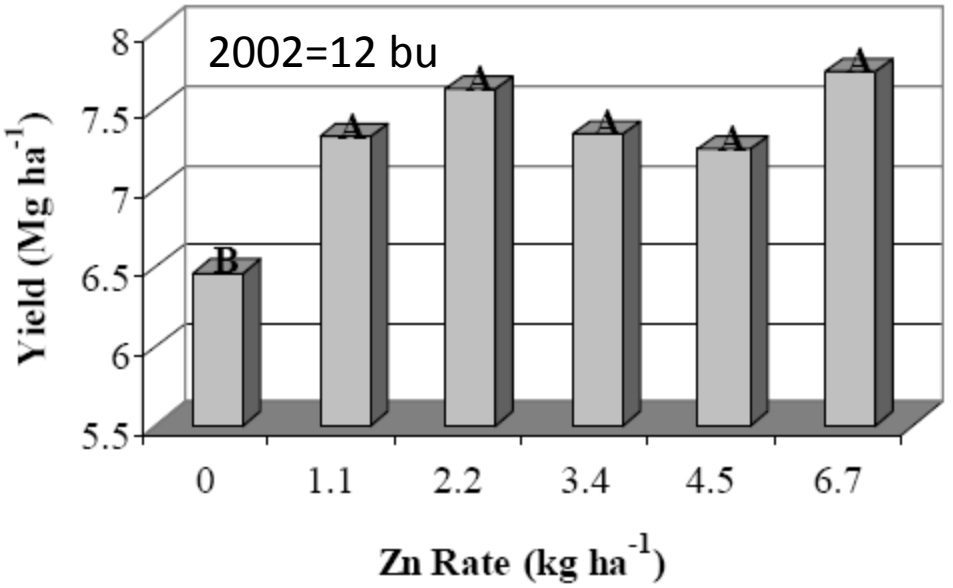
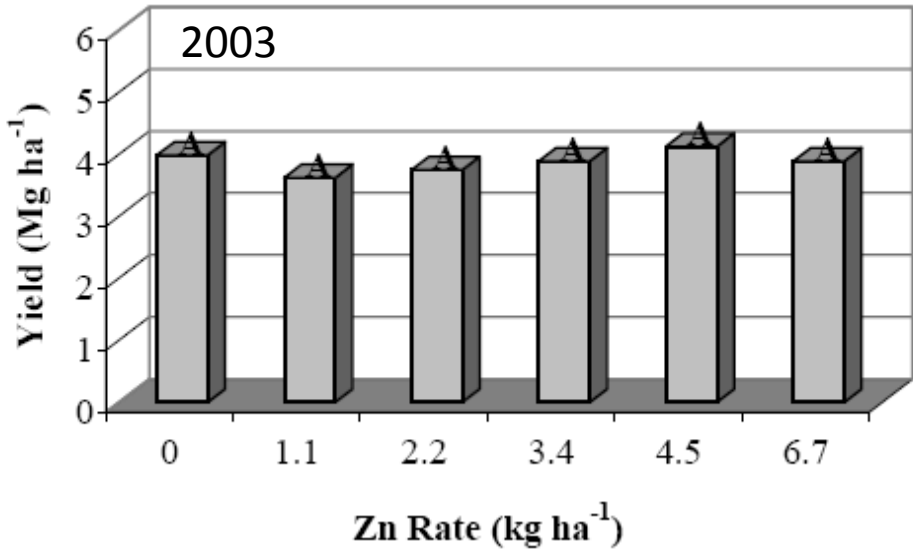
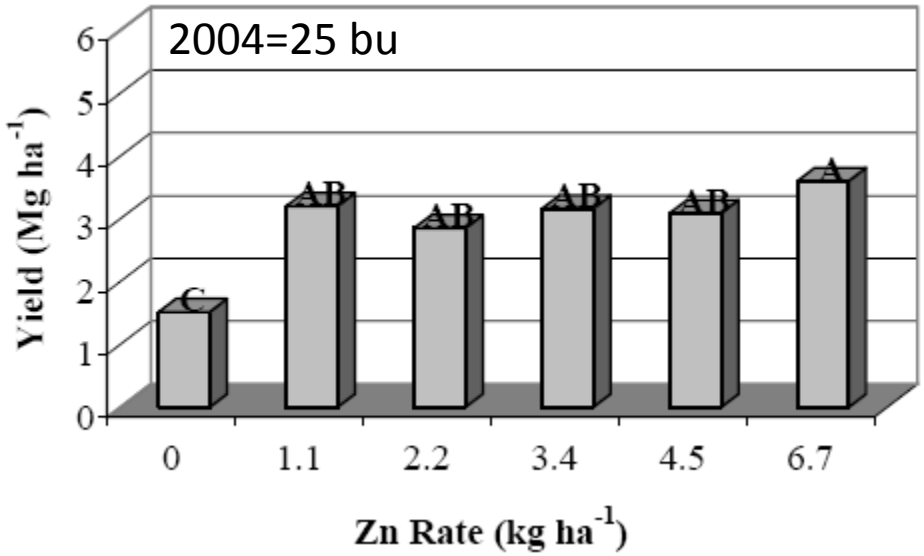
# Zinc research in corn (Dr. Dustin Harrell, 2002-2004)

| Year | P | Zn |
|---|---|---|
| | Mehlich III | |
| 2002 | 53 | 1.32 |
| 2003 | 14 | 0.81 |
| 2004 | 54 | 1.44 |

$ZnSO_4$ banded in furrow at planting



# Zinc Research in Corn (Red River alluvial soils)

Cheneyville, 2011

| Source | Rate, lbs/A | Soil Test Zn, ppm | V3 leaf stage | | V8 leaf stage | | Grain Yield, bu/A |
|---|---|---|---|---|---|---|---|
| | | | Zn, ppm | P/Zn | Zn, ppm | P/Zn | |
| $ZnSO_4$ | 0 | 1.21 | 22 | 147 | 18 | 116 | 115 |
| | 2.5 | 1.72 | 21 | 152 | 20 | 116 | 142 |
| | 5 | 2.43 | 21 | 141 | 20 | 115 | **159** |
| | 10 | 4.00 | 26 | 124 | 18 | 124 | 139 |
| | | | | | | | |
| ZnEDTA | 0 | 1.28 | 18 | 167 | 19 | 121 | 129 |
| | 2.5 | 1.99 | 20 | 153 | 19 | 113 | **155** |
| | 5 | 2.39 | 21 | 145 | 18 | 115 | 143 |
| | 10 | 2.11 | 23 | 129 | 20 | 110 | 139 |

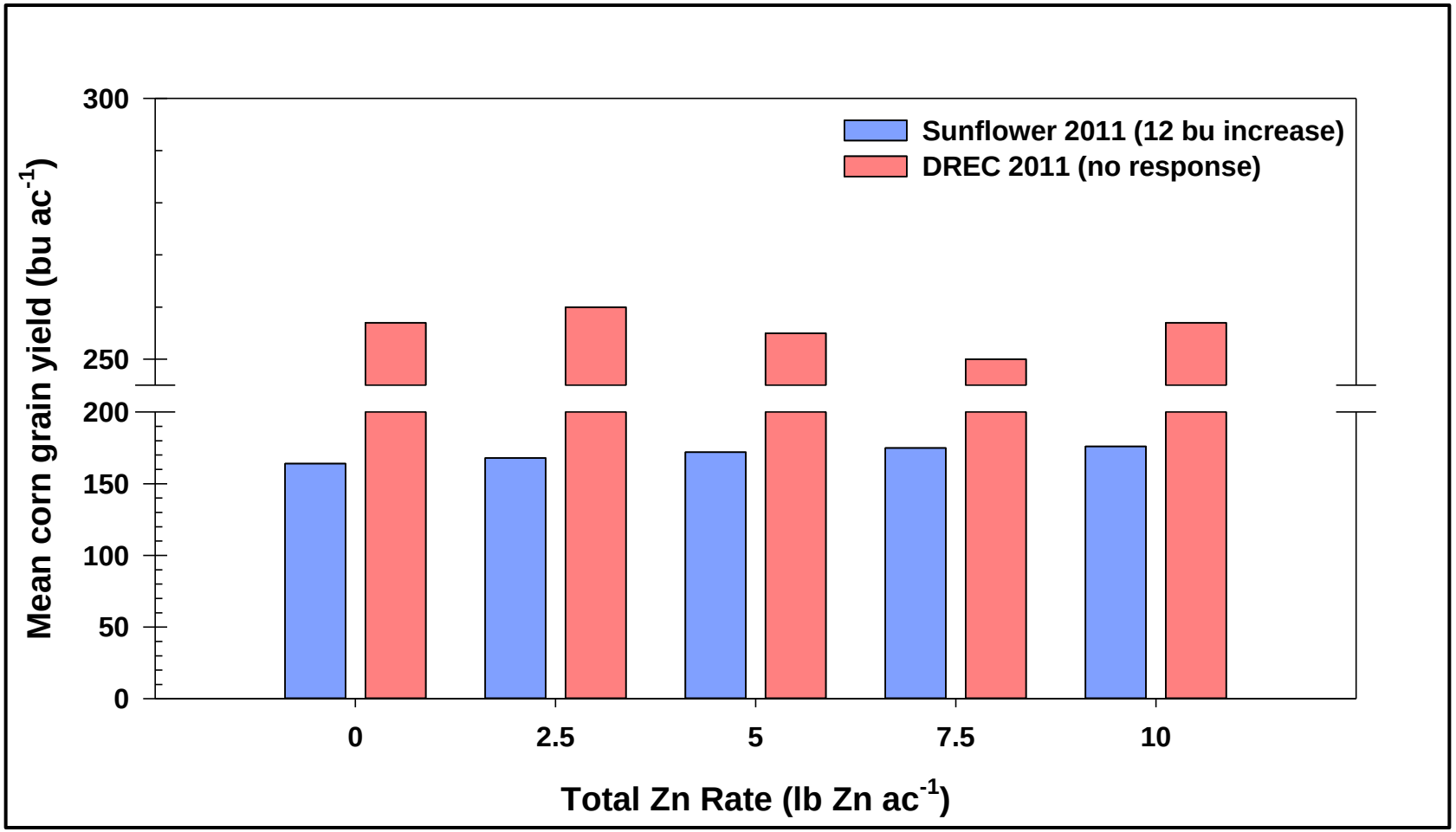
Soil test P = 50 ppm; pH = 7.5

# 2011 Red River alluvial Zn trial

- A Zn application rate of 5 lbs/A was required for soil testing <1.5 ppm  Zn.
  - An average of 35 bu/A increase in grain yield was obtained
  - Lower application rate was required if applied as ZnEDTA

- A marginal increase in grain yield was observed when 2.5 lbs Zn/A (regardless of source) was applied to corn grown on soil with Zn < 2.5 ppm.

# Corn Response to Zn Rate




*Golden unpublished data (2013)*

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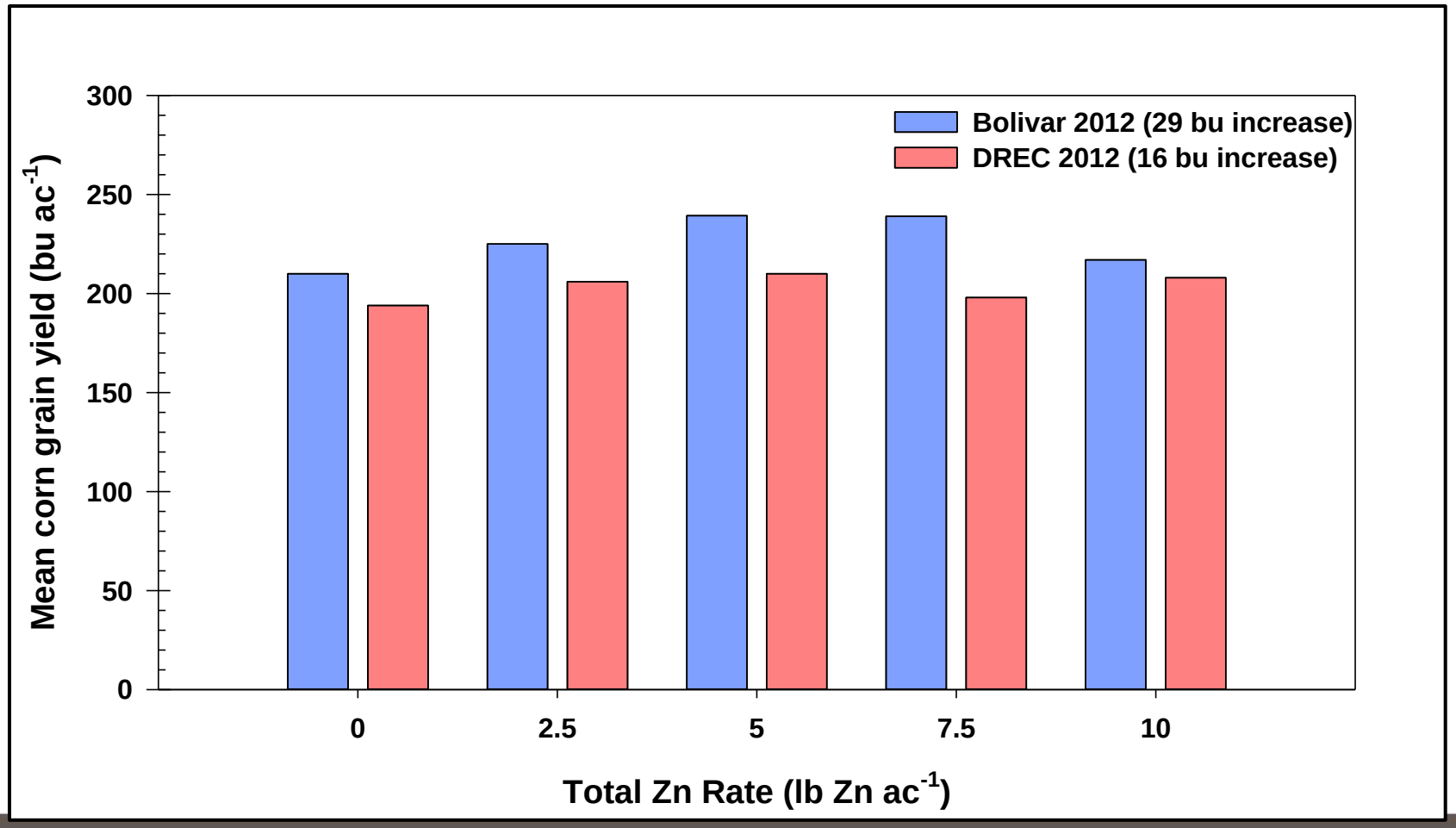


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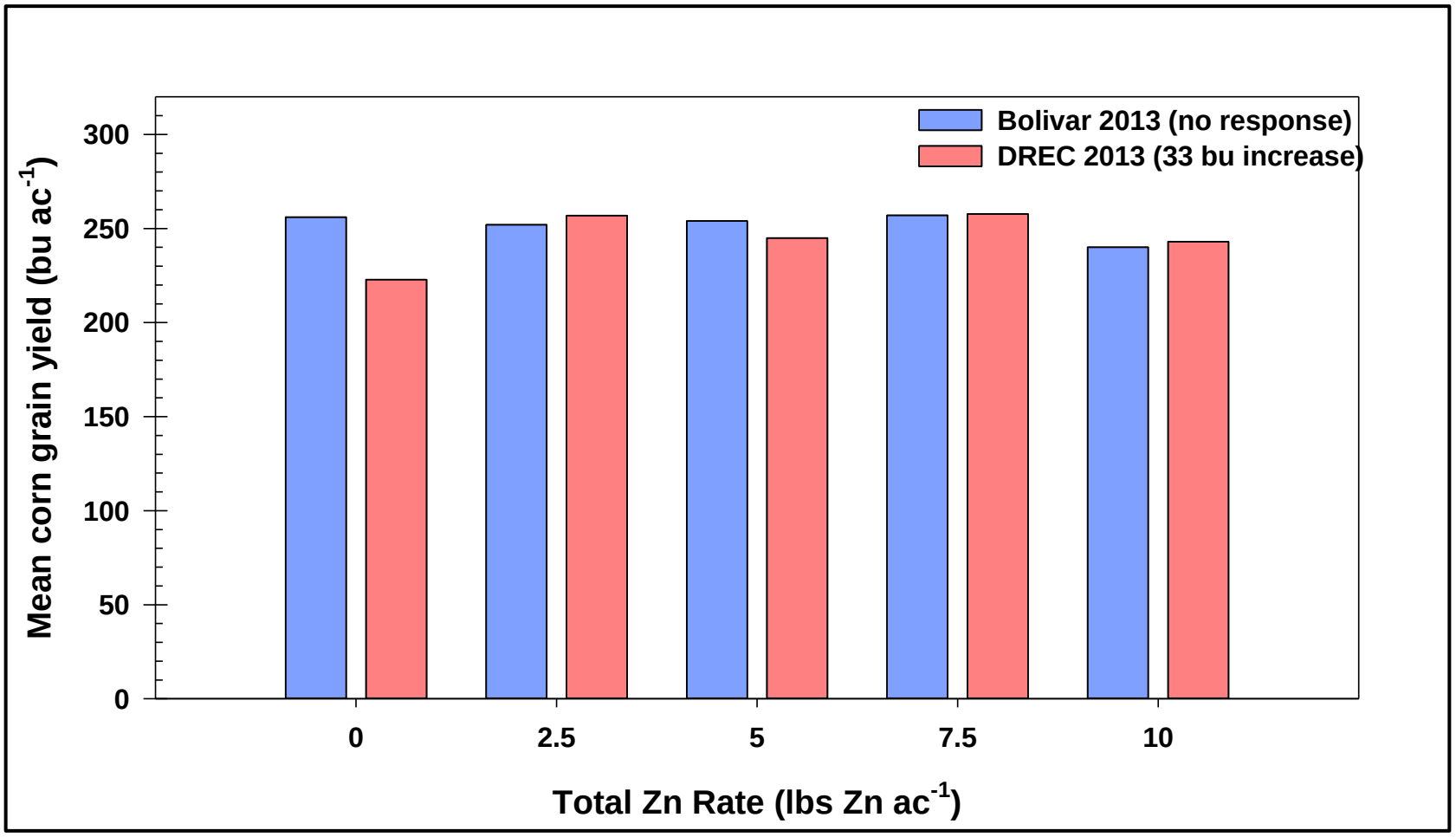
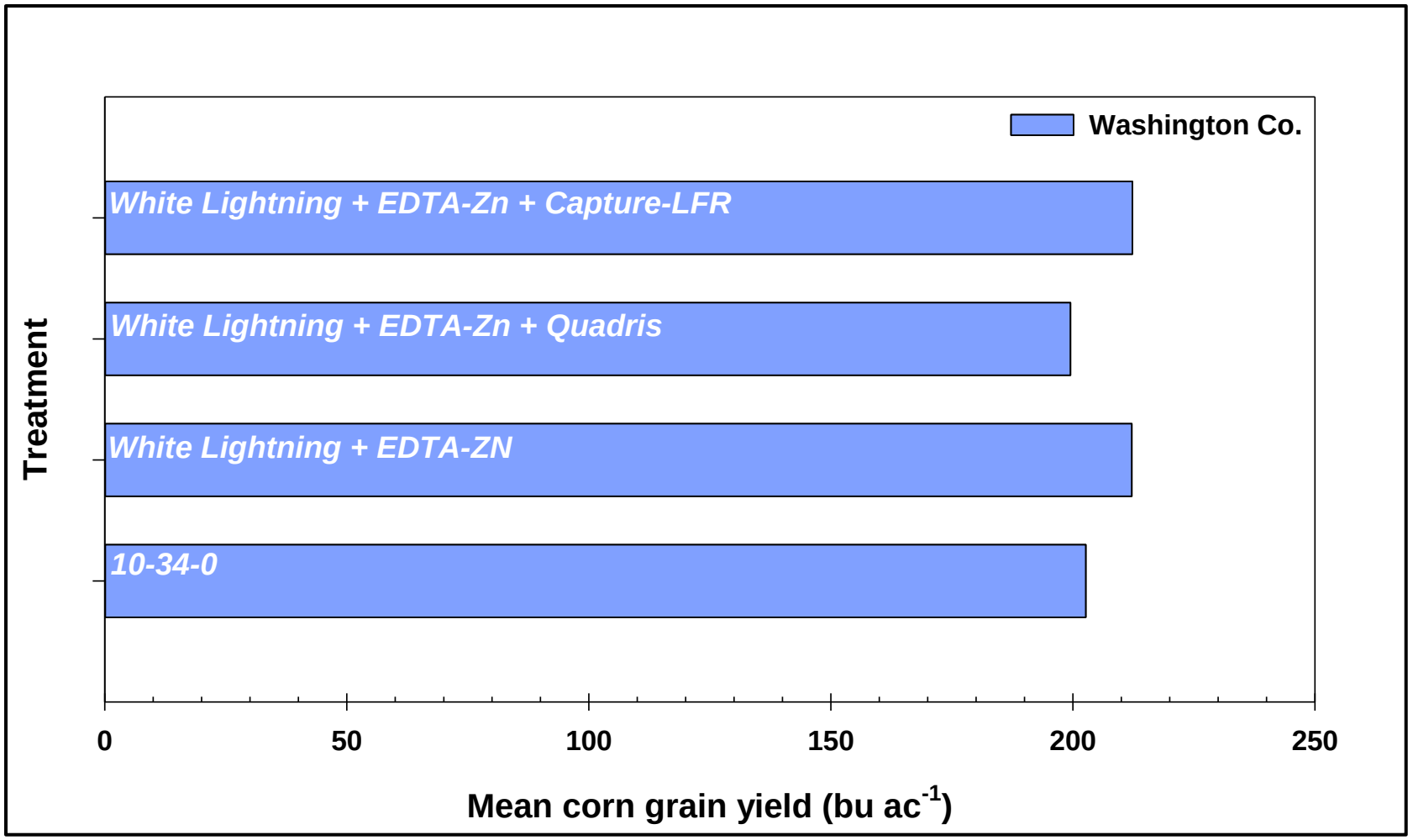



*Golden unpublished data (2013)*

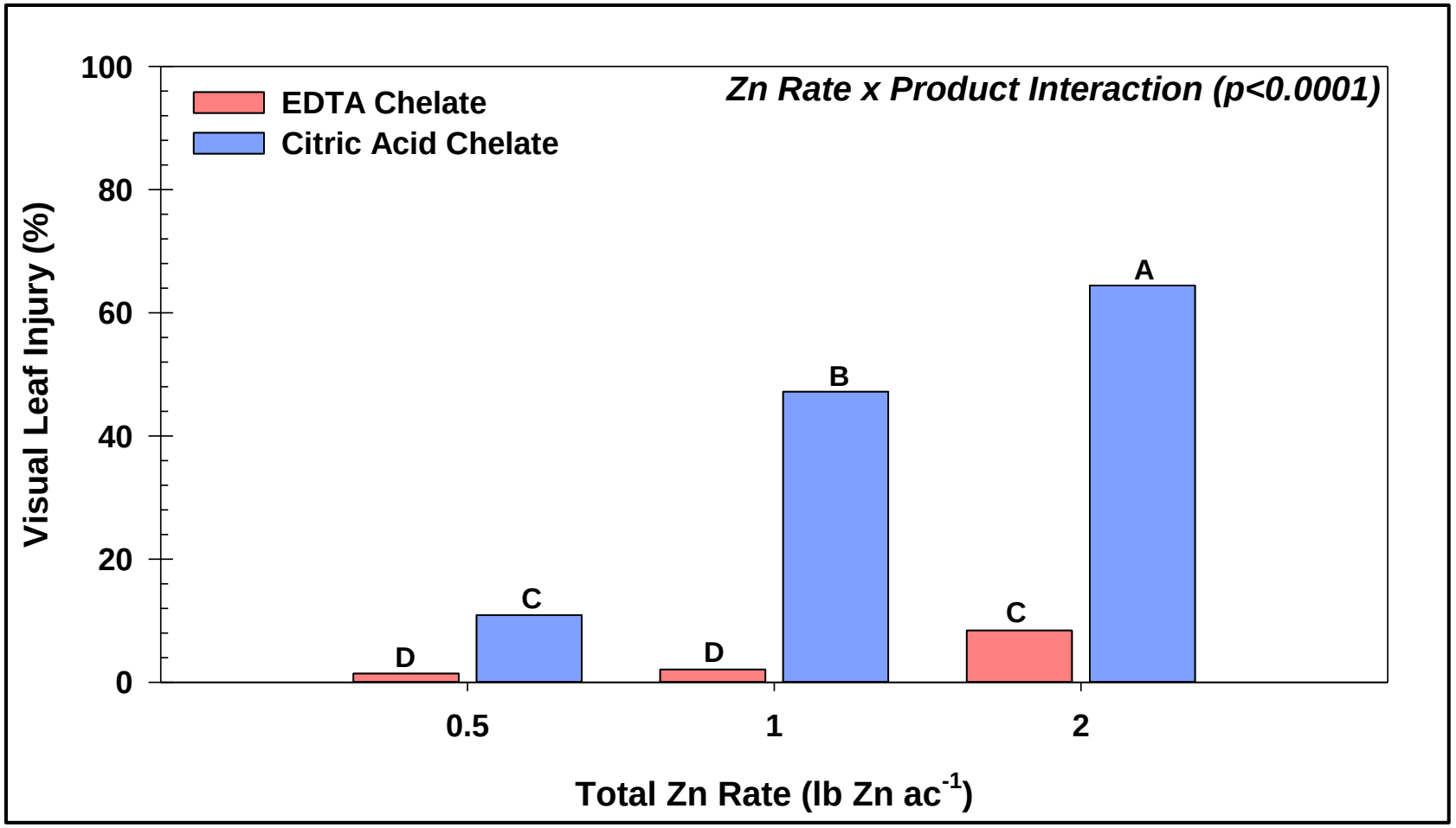
# Corn response to in-furrow starters




***Source: Scott; unpublished data (2013)***

# Zn Product Foliar Burn

# Zinc Product Foliar Injury at 9d after Application




Golden unpublished data (2013)

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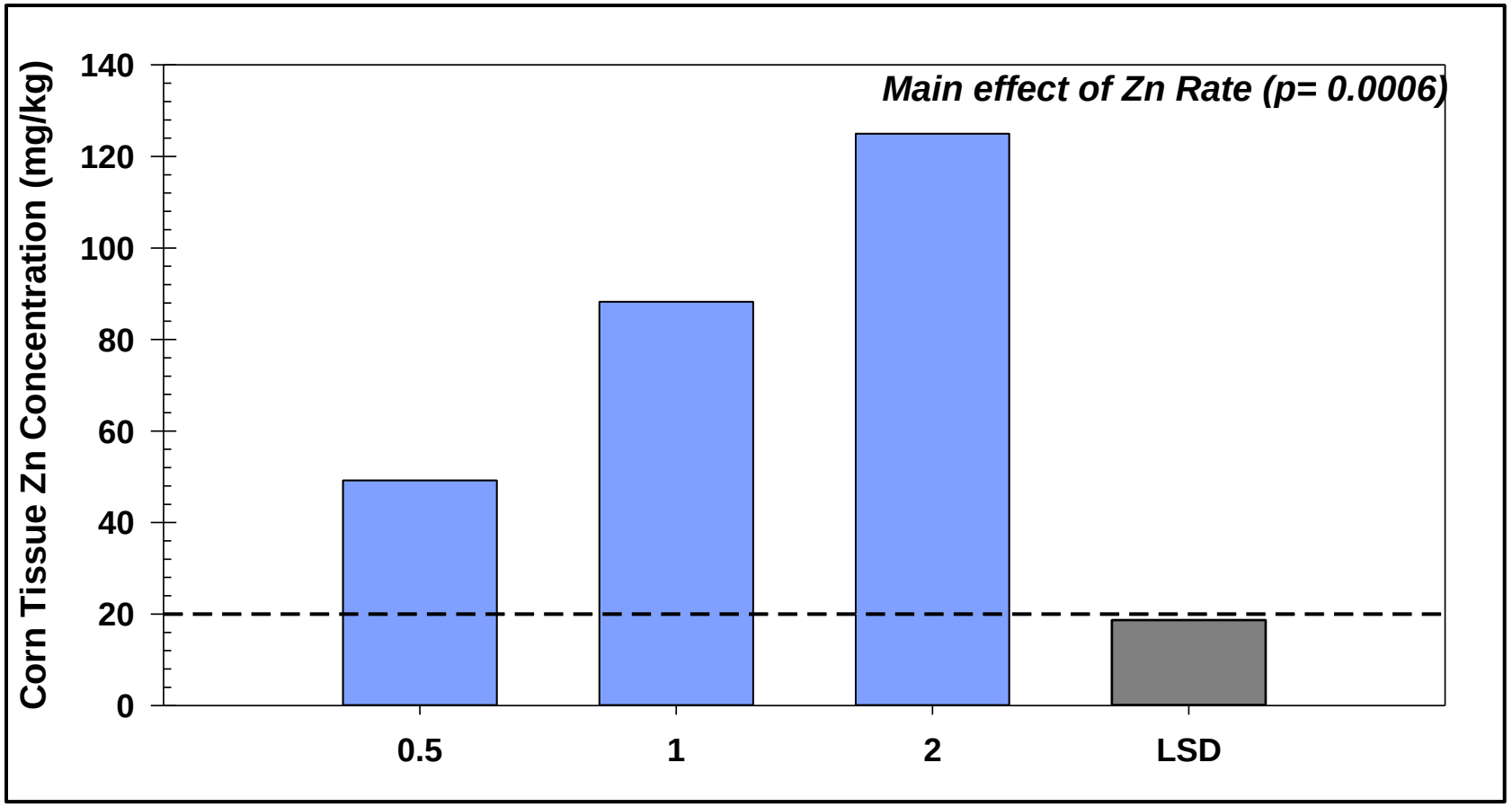
# Zinc Product Tissue Concentration at 2w after Application

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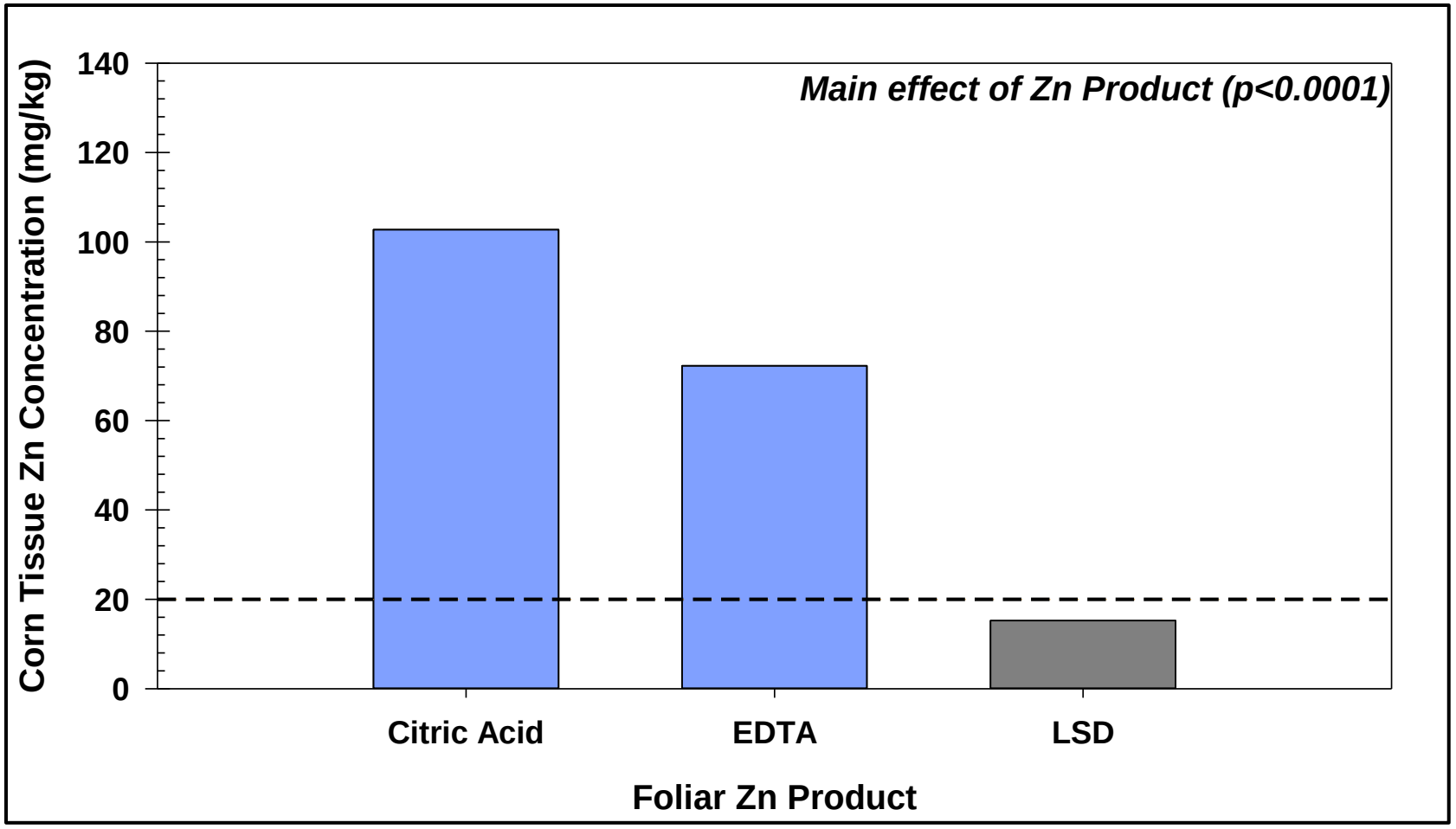


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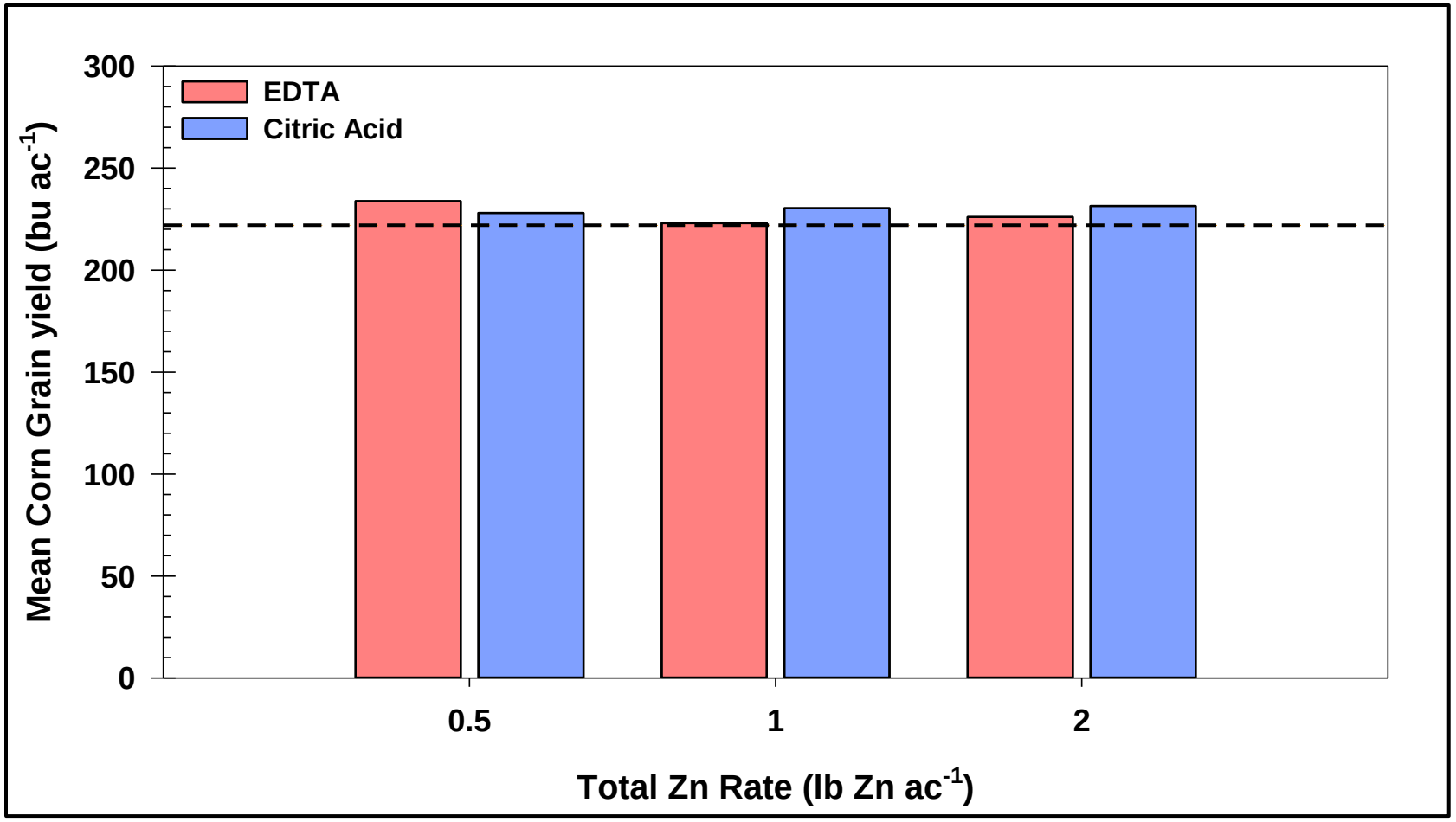


*Golden unpublished data (2013)*

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# Zinc Source Foliar Burn




# Zinc program basics

- Soil test Zn coupled with pH is a good indicator of need
- Not all Zn fertilizers are created equal
  - Must take into account water solubility
  - Supply Zn early

- Soil test Zn should be above 1.5 ppm
- Broadcast at a rate of 5-10 lbs Zn/acre
- Higher applications may provide enough Zn to remain effective for multiple years
- Zn can be banded or added to APP starter at rate of 0.5 – 1.0 lbs Zn/acre as chelate or 2-4 lbs Zn/acre as sulfate
- 0.5 – 2.0 lbs Zn/acre as a foliar
- Less residual effect, so repeat annually
- Zn is immobile in soil so subsurface banding is best for no-till

# Thank You



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