Effective Manganese Management for Corn and Soybean in Glyphosate-Dominant Cropping Systems

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Conditions Resulting in Mn Deficiency

- Low Mn supply
  - poorly drained soils
  - sandy soils
  - organic soils

Low Mn^{2+} availability:

- **high pH**
- **bacterial oxidation**

Soybean leaf Mn levels

Def.	Low	Suff.	High
<15	15-20	21-100	101-250

Most recently mature trifoliate at early flower. Shulte and Kelling, 1999.

Soybean Mn Research (2007-2008)

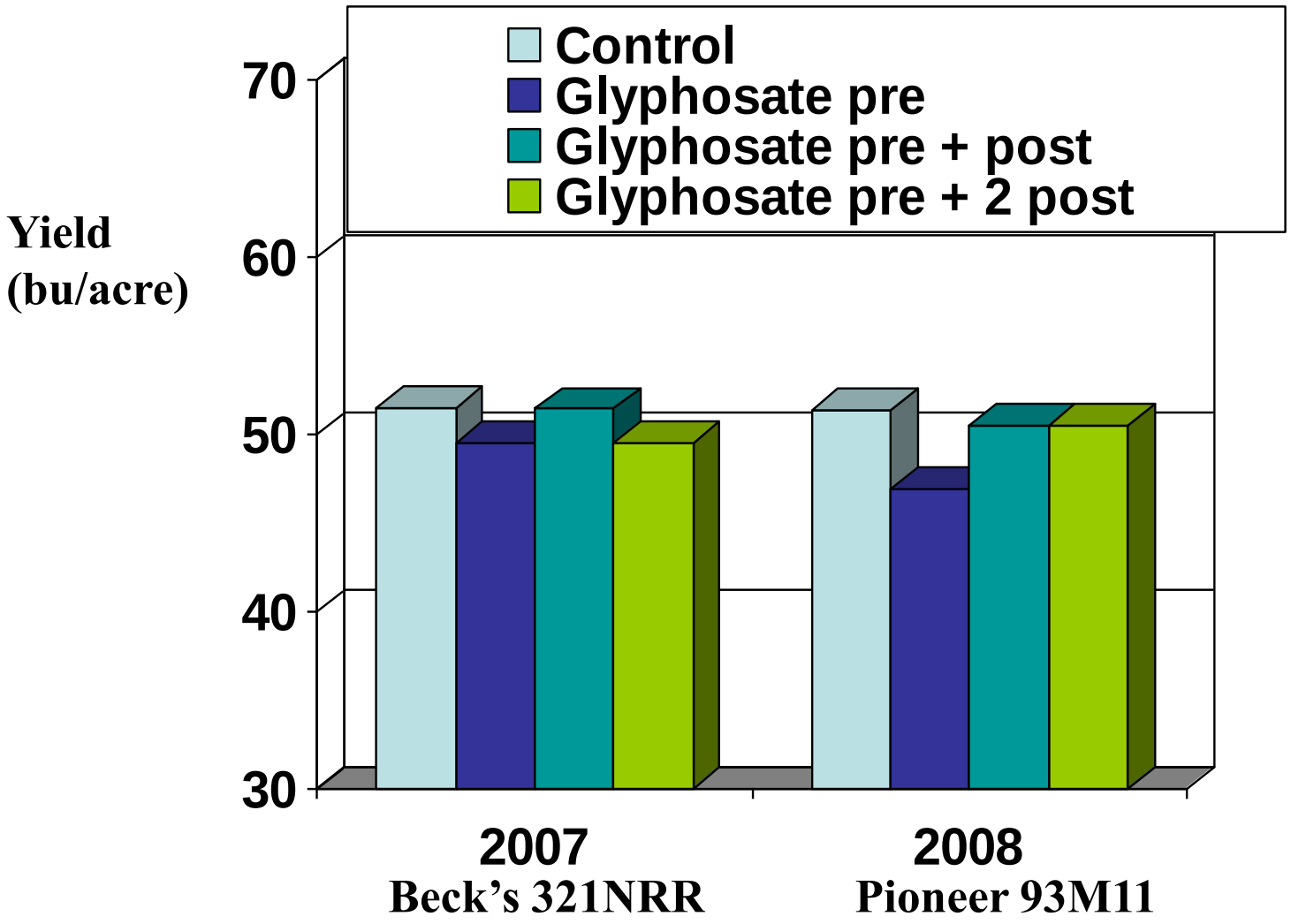
- **3 locations: Wanatah (PPAC) , La Crosse (J. Danford), Reynolds (M. Lehe)**
- **History of at least temporary Mn deficiency symptoms following glyphosate application to soybean**
- **Main Treatments for No-till Soybean:**
  1. **No Glyphosate**
  2. **Pre-plant Glyphosate only**
  3. **Pre plus one Post application of Glyphosate**
  4. **Pre plus two Post applications of Glyphosate at V3 and V6-V7**
- **Sub-treatments (Mn application)**
  1. **Control. Zero Banded $MnSO_4$**
  2. **Banded $MnSO_4$ at 3 pounds/acre**
  3. **Banded $MnSO_4$ at 6 pounds/acre**
  4. **Foliar Tank-mix Mn EDTA to #3 above**

Soil pH and Mn Status at Test Sites

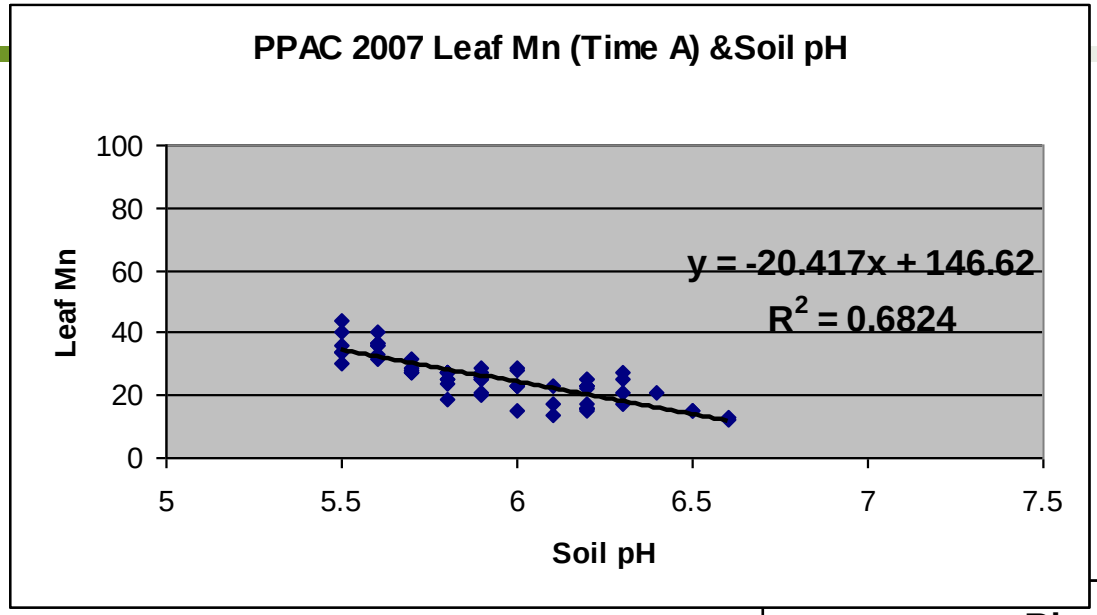
Year	Location	Soil pH Mean	Soil pH Range	Soil Mn Mean (ppm)	Soil Mn Range (ppm)
2007	PPAC	5.9	5.5~6.6	8	4~21
	Rice	5.9	5.2~6.6	3	2~6
	White	7.0	6.5~7.3	13	4~48
2008	PPAC	6.6	6.1~7.0	12	5~24
	Rice	6.7	5.9~7.2	6	4~10
	White	7.1	6.5~7.8	14	5~31

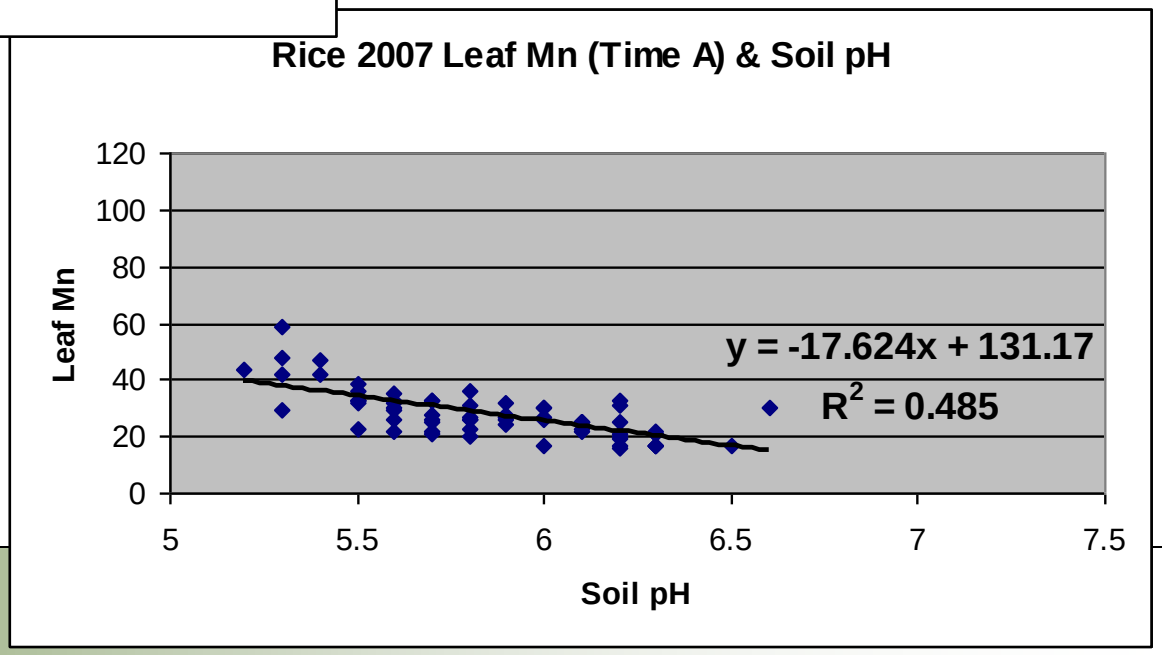
Leaf Symptoms and Sampling 4 Times/year

Glyphosate Influence on Mean Soybean Yield without Mn addition in 2007 and 2008

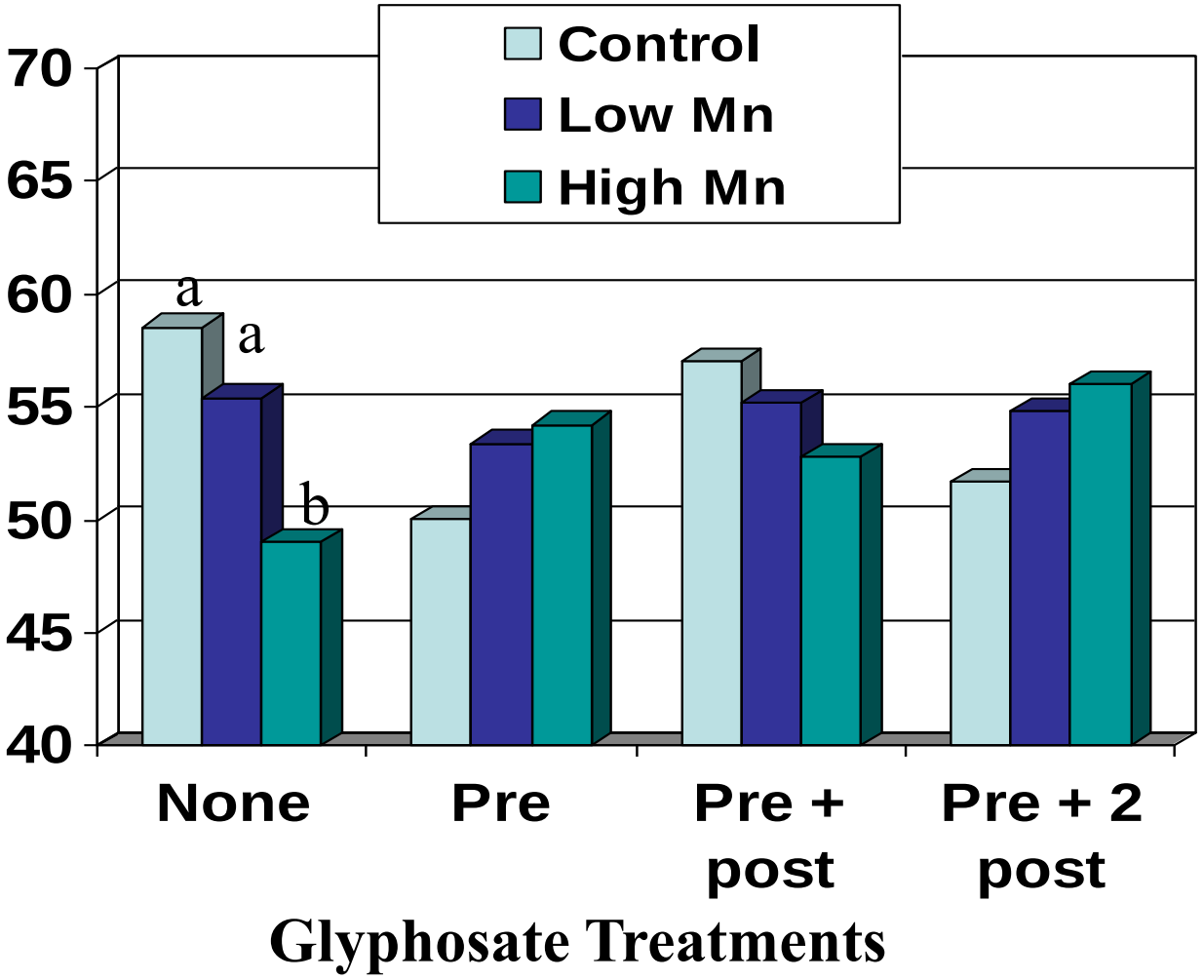


Relationship of Leaf Mn to Soil pH in 2007

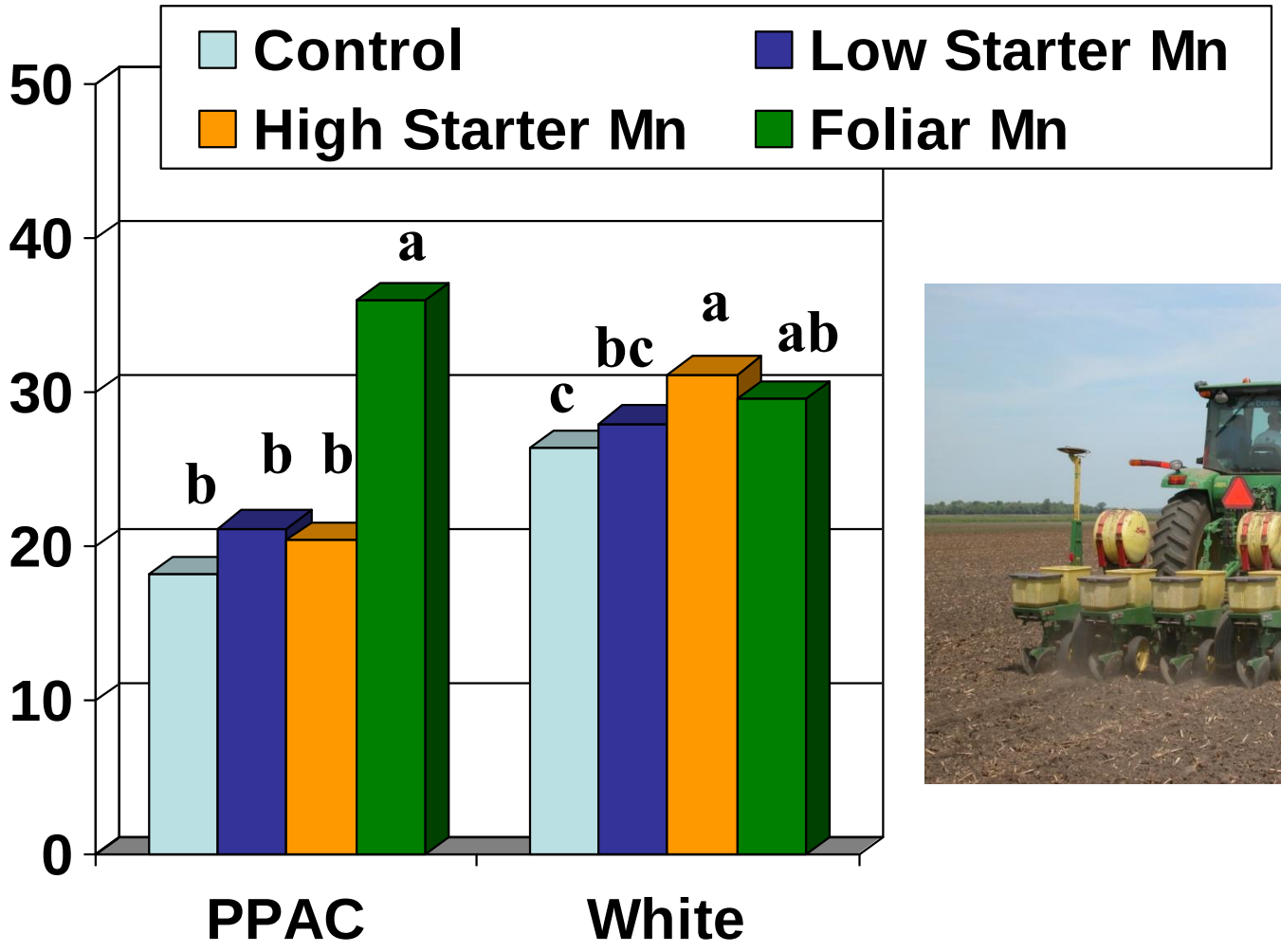




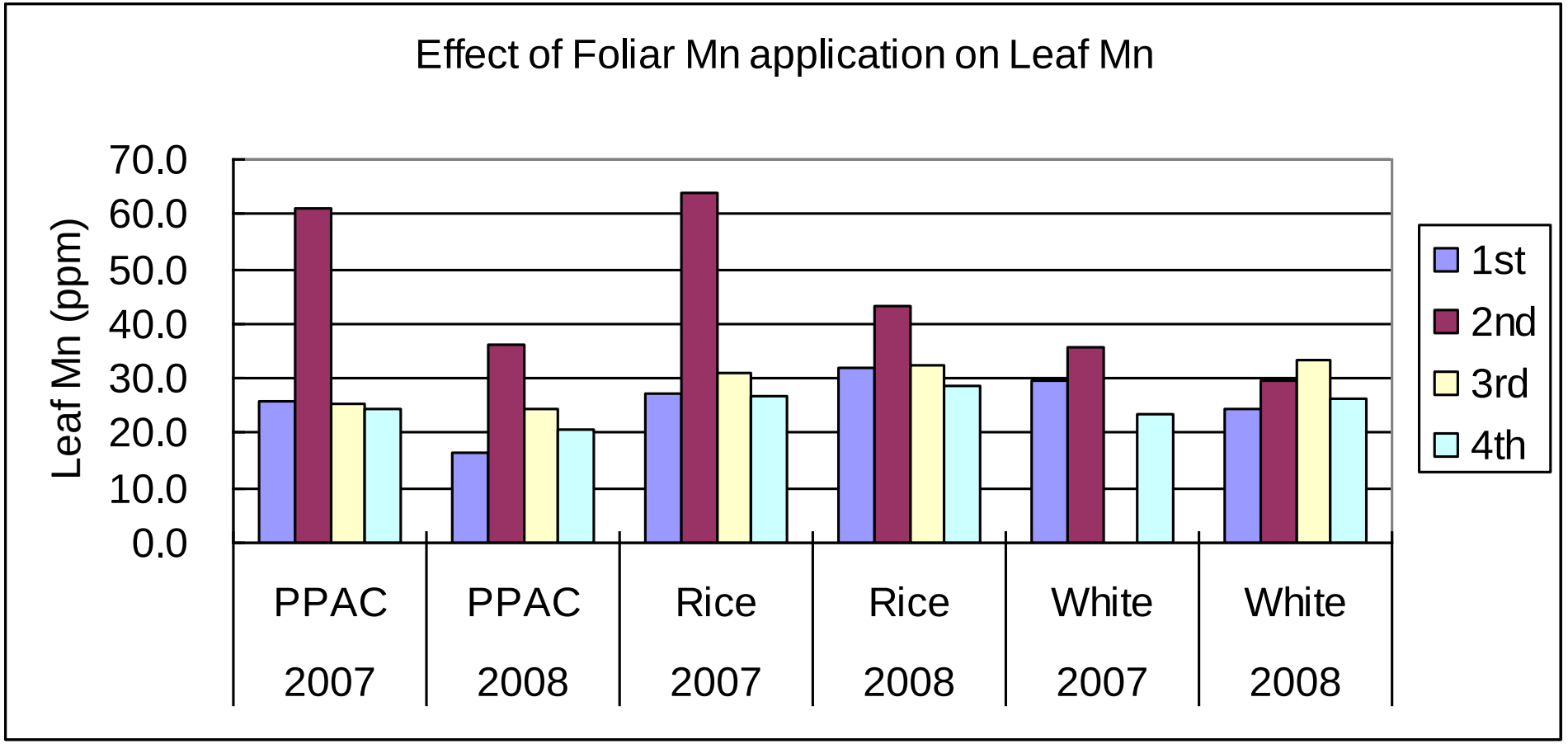
Variable Soybean Yield Response to Starter Banded Mn at White, 2008



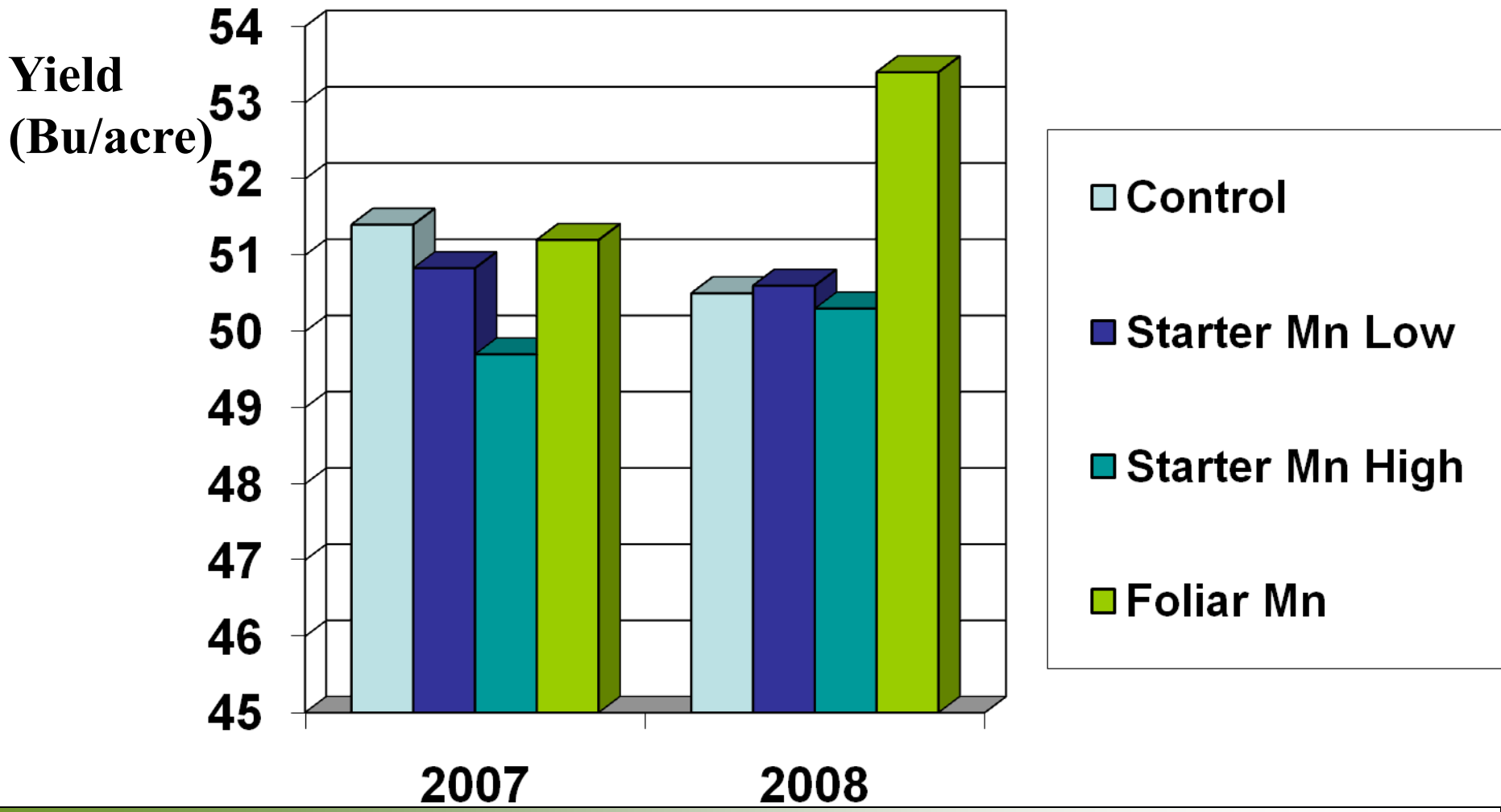
Leaf Mn Concentrations after Mn applications in 2008



Temporary Soybean Leaf Mn Response to Foliar Application (Time 2 = 8-16 days later)



Starter versus Foliar Mn for Soybean with pre and post Glyphosate



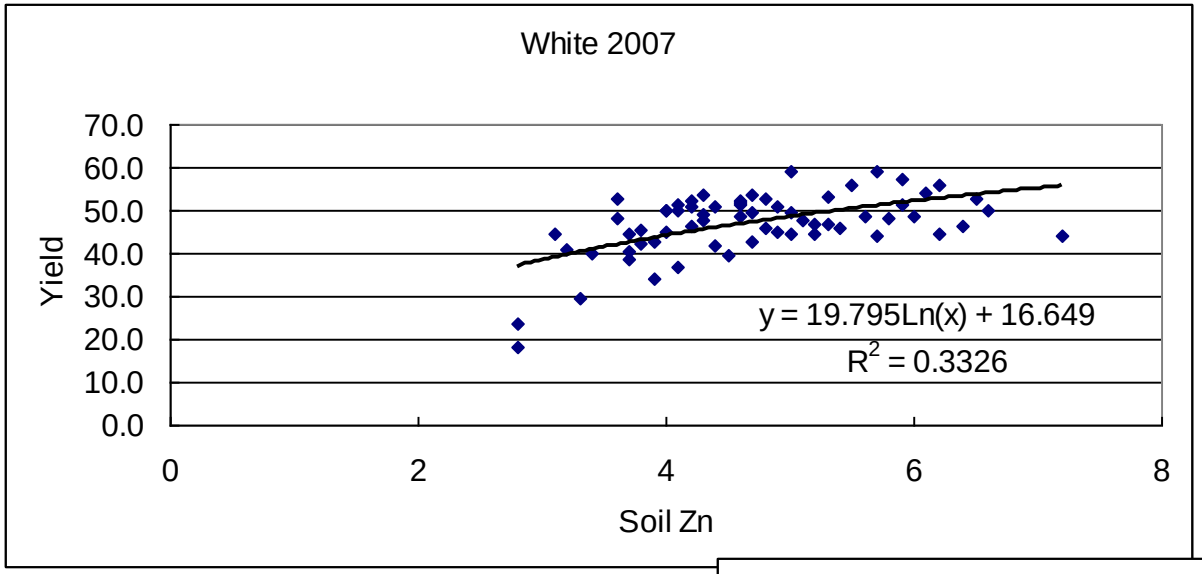
Control versus Second Foliar Mn 2008

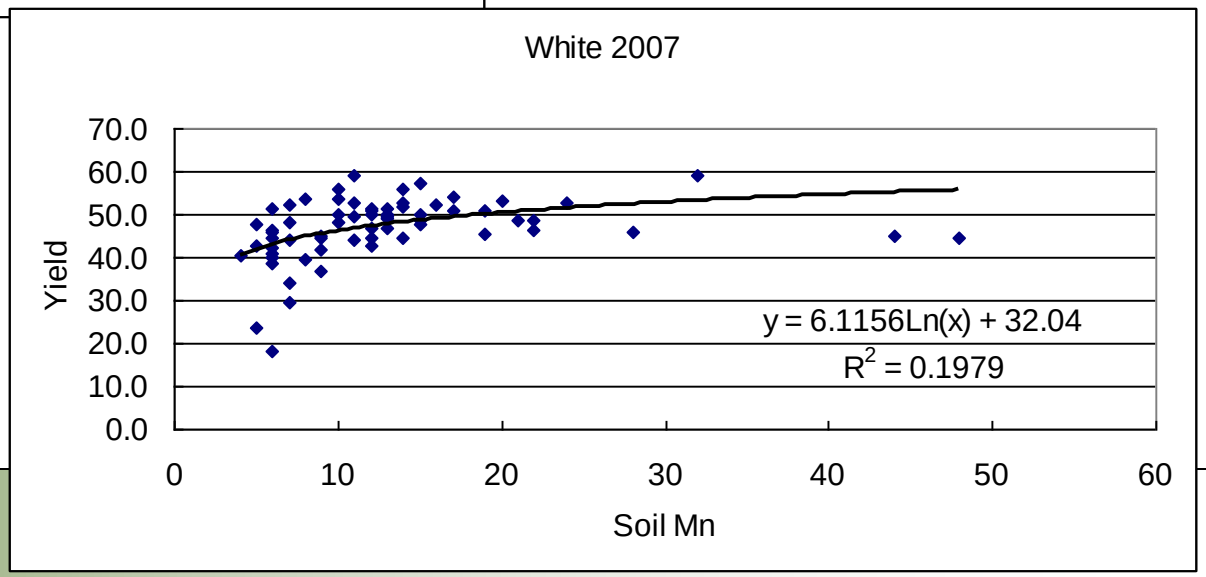
2008 Soybean Yield Response (bu/acre) to Single versus Double Foliar Mn Application after Glyphosate

Glyphosate Treatment	Single Foliar Mn	Double Foliar Mn
Control	2.6	3.1
Pre Glyphosate	1.7	3.5
Pre + Post Glyphosate	0	4.8
Pre + 2 Post Glyphosate	0	2.2

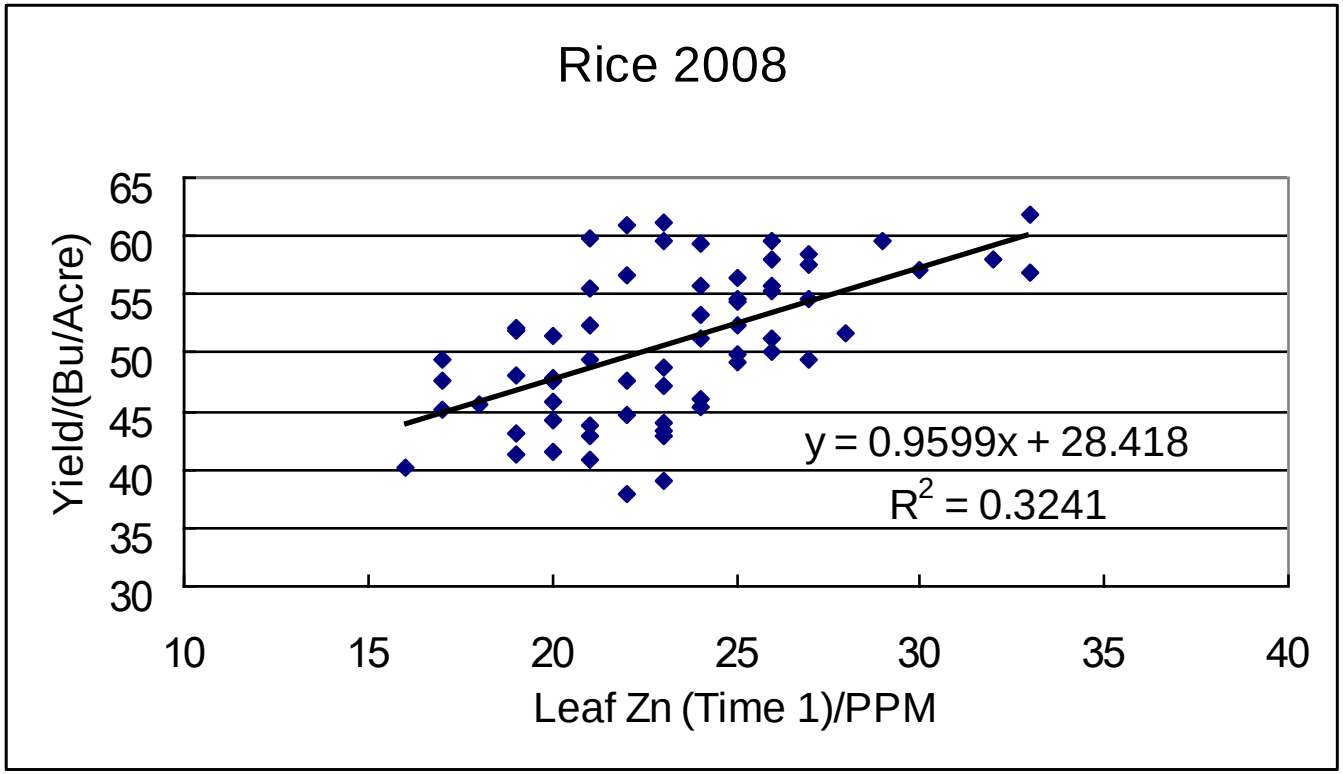
Note: All treatments had single post application of glyphosate to prior corn in 2007. Location is Wanatah, IN (PPAC)

Soybean Yield Response to Soil Zn versus Mn (White County, 2007)





Relationship of Soybean Yield to Leaf Zn (Rice, 2008)



Recommendations regarding Mn in Glyphosate-Resistant Soybean

1. Although soil Mn is important, starter-band Mn by itself is not effective. That could change with Mn formulation or with multi-nutrient starters (especially with acid-forming fertilizers).

2. Timing for foliar Mn applications is important (7-14 days after each?? post glyphosate), but positive yield response is not guaranteed due to soil nutrient and moisture fluctuations as soybean growth continues.

3. Maintain optimum leaf Mn and Zn concentrations post flowering. Aim for lower cost Mn sources if higher rates are required.

New Proposal (2009-2012)

- **Objective 1:** **To help farmers better understand soil, environment, and soybean management factors reducing micronutrient availability.**

- **Objective 2:** **To assist farmers in determining optimum mode for micronutrient supplementation in RR soybeans for Mn and Zn individually and combined, or when both are mixed with other micronutrients.**

Foliar micronutrient products applied to soybean in 2009

White County

Pinney (PPAC), Wanatah

Foliar micronutrients applied to corn

Soybean Response to Glyphosate and Foliar Nutrient Products (White County, 2009)

Treatment	Foliar Nutrient Rate/ac	Yield (bu/ac)	Δ Yield (%)
Main			
Glyphosate at V4	22 oz	37.3a	
Glyphosate at V4 and R1	22 oz	34.6b	
Sub-treatment			
Control (no micronutrient)	0	31.5c	0
Mn #1 (EDTA Mn)	32 oz	36.6ab	16.1
Zn #1 (super Tel Zn)	0.25 lb	30.4c	-3.5
Mn1Zn #1	32oz Mn + 0.25lb Zn	36.7ab	16.3
MnZnNBo #1 (Manni-Plex)	60 oz	39.8a	26.5
ProMn #1 (Tetra Pro Mn)	38 oz	36.3ab	15.3
MnZn #2 (applied twice)	32oz Mn + 0.25lb Zn	38.4ab	21.7
MnZnNBo #2 (applied twice)	60 oz	37.8ab	19.9
ProMn #2 (applied twice)	38 oz	35.7b	13.4

Soybean Yield Response to Foliar Nutrient Products and Rates (Wanatah, IN, 2009)

Treatment	Mn Rate (per acre)	Yield (bu/acre)	Δ Yield (%)
Control (no Mn)	----	14.5e	0
Mn powder at V4	0.25 lb	30.2c	108.3
Mn powder at V4	0.50 lb	30.5c	110.1
Mn powder at V4	1.0 lb	36.3ab	150.3
Mn powder at V4	2.0 lb	37.6a	159.3
Mn EDTA at V4	32 oz	27.5dc	89.5
Mn EDTA at V4	64 oz	23.1d	59.1
Manni-Plex for Beans at V4	60 oz	30.4c	109.6
Manni-Plex for Beans at V4	120 oz	31.7bc	118.6
Mn powder at V4 and R1	0.50 lb	29.2c	101.6
Mn powder at V4 and R1	1.0 lb	36.2ab	149.9
Mn powder at V4 and R1	2.0 lb	36.7ab	153.3
Mn powder at V4 and R1	4.0 lb	38.8a	167.4

Acknowledgments

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(b) Nutrients (Brandt Consolidated, Inc.,
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Equipment:

John Deere Cropping Systems Unit

Soybean Seed:

Pioneer Hi-Bred, Int.
Monsanto

Thanks!

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