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Micronutrient management for soybean production

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Outline

- Field research on micronutrient in soybean:
  - Micronutrients with starter fertilizer
  - Broadcast pre-plant
  - Iron chlorosis in soybean
- Soil test and tissue testing as diagnostic tools.

Essential micronutrients

- Increased interest in micronutrients
  - Higher crop yields and micronutrient removal rates
  - Declining soil organic matter, a major source of most micronutrients
  - N, P and K fertilizers contain lower amounts of micronutrient impurities
- In the Midwest: Fe, Zn, Mn and Cl.
- Other micronutrients: B, Mg, and Cu.

Application method

- Micronutrients are needed in small amounts.
- Broadcast application.
  - Higher rates are needed
  - Benefit of soil build-up and fix low soil test
- Band application with the starter fertilizer.
- Foliar application to plant leaves.

Study on micronutrients as starter and foliar

- Fields with high soybean yields may benefit from micronutrients?
- Typically low micronutrient requirements can be combined with a starter program.
- The use of foliar micronutrient application in combination with soil-applied program.
- Evaluate if nutrient is sufficient or potential “hidden hunger”.

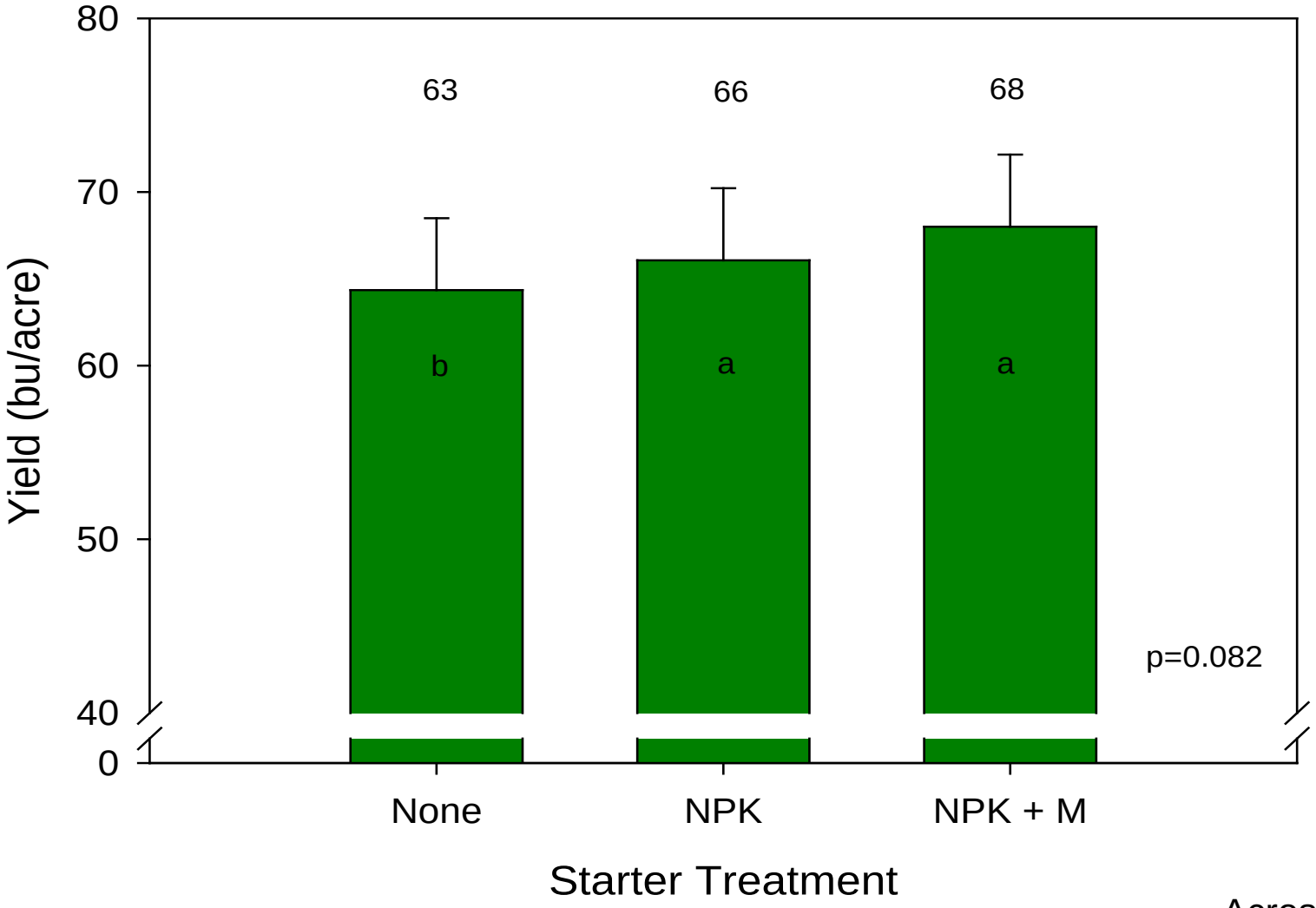
Fertilizer treatments

Nutrient application rates, 9 locations

	N	P2O5	K2O	Fe	Mn	Zn	Cu	B
Starter	- - - - - - - - - - - - - - - lbs/acre - - - - - - - - - - - - - - -							
NPK	4	10	10	-	-	-	-	-
NPK + micros	4	10	10	0.5	0.5	0.5	0.5	0.5
Foliar								
NPK	2	2	2	-	-	-	-	-
NPK + micros	2	2	2	0.2	0.2	0.2	0.2	0.2

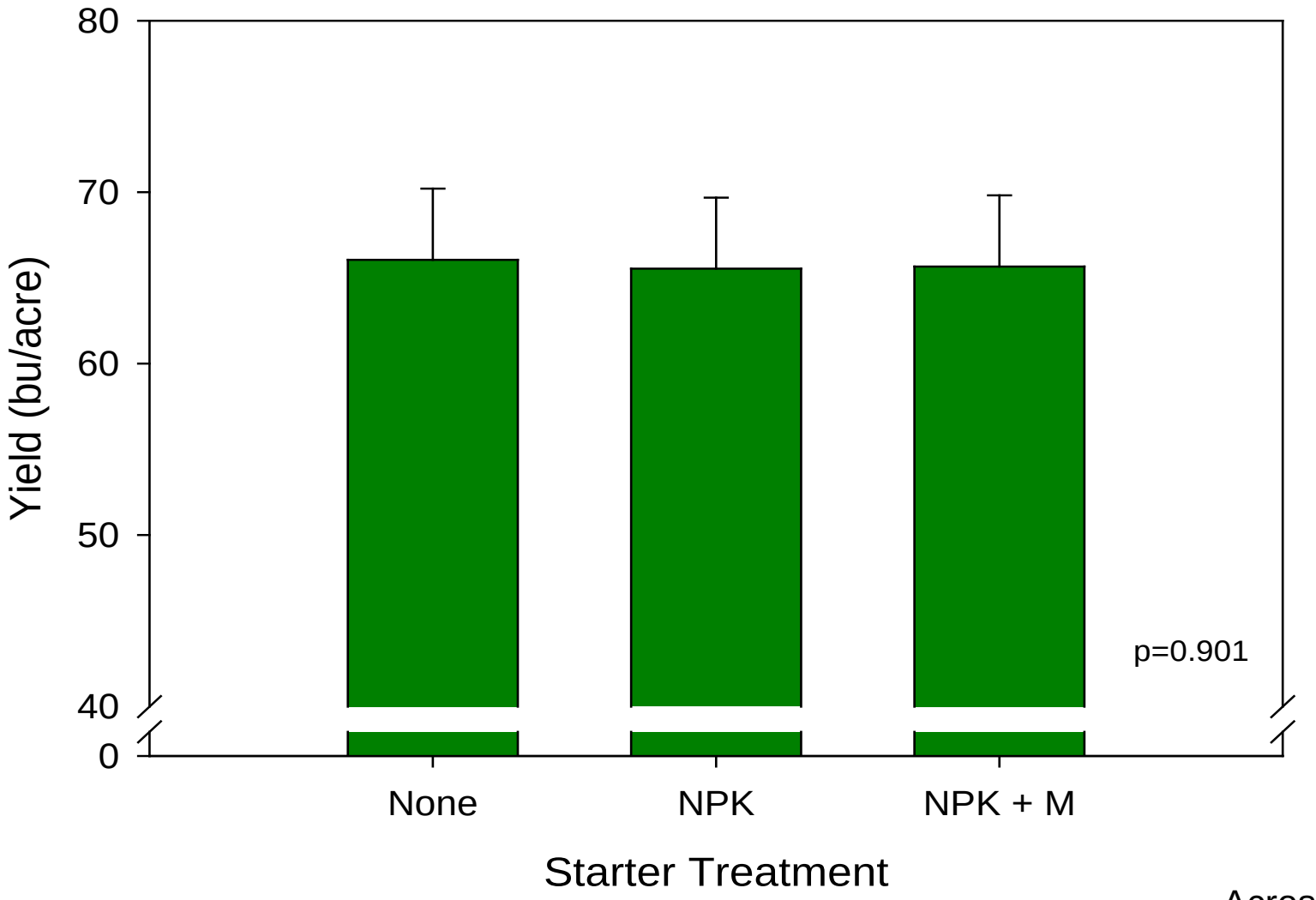
- Cu, Mn, and Zn as EDTA
- Fe as HEDTA

Soybean yield - starter



Across locations

Soybean yield - foliar



Across locations

Soybean response to broadcast micronutrients

- Fertilizer treatments for small plots (10 locations):
  - Five individual nutrients. Broadcast, pre-plant.
  - Mn, Zn, Cu= 10 lbs/acre
  - B= 5 lbs/acre
  - S= 15 lbs/acre
  - Blend
- Strip trial with two treatments: control and blend.
- Soil and tissue analysis.

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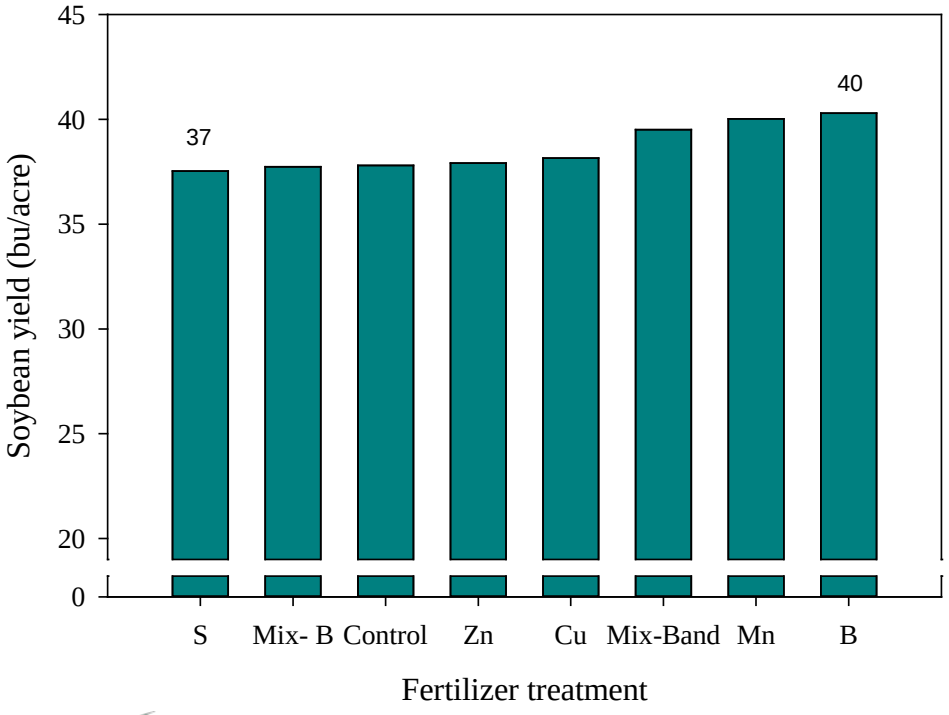
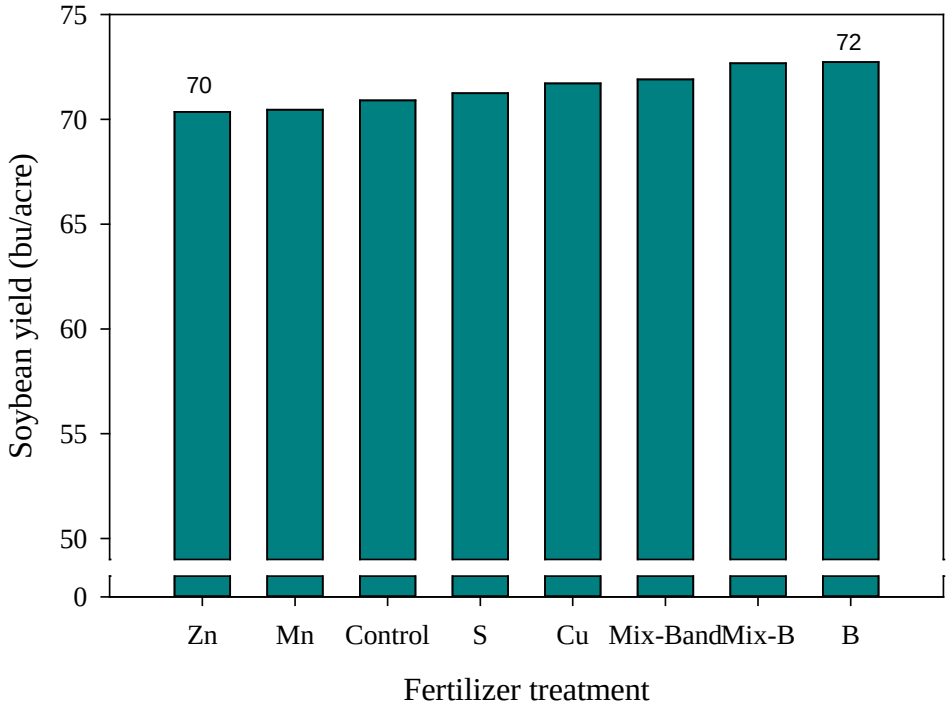
Micronutrients in soybean by yield level

Medium yield level



High yield level



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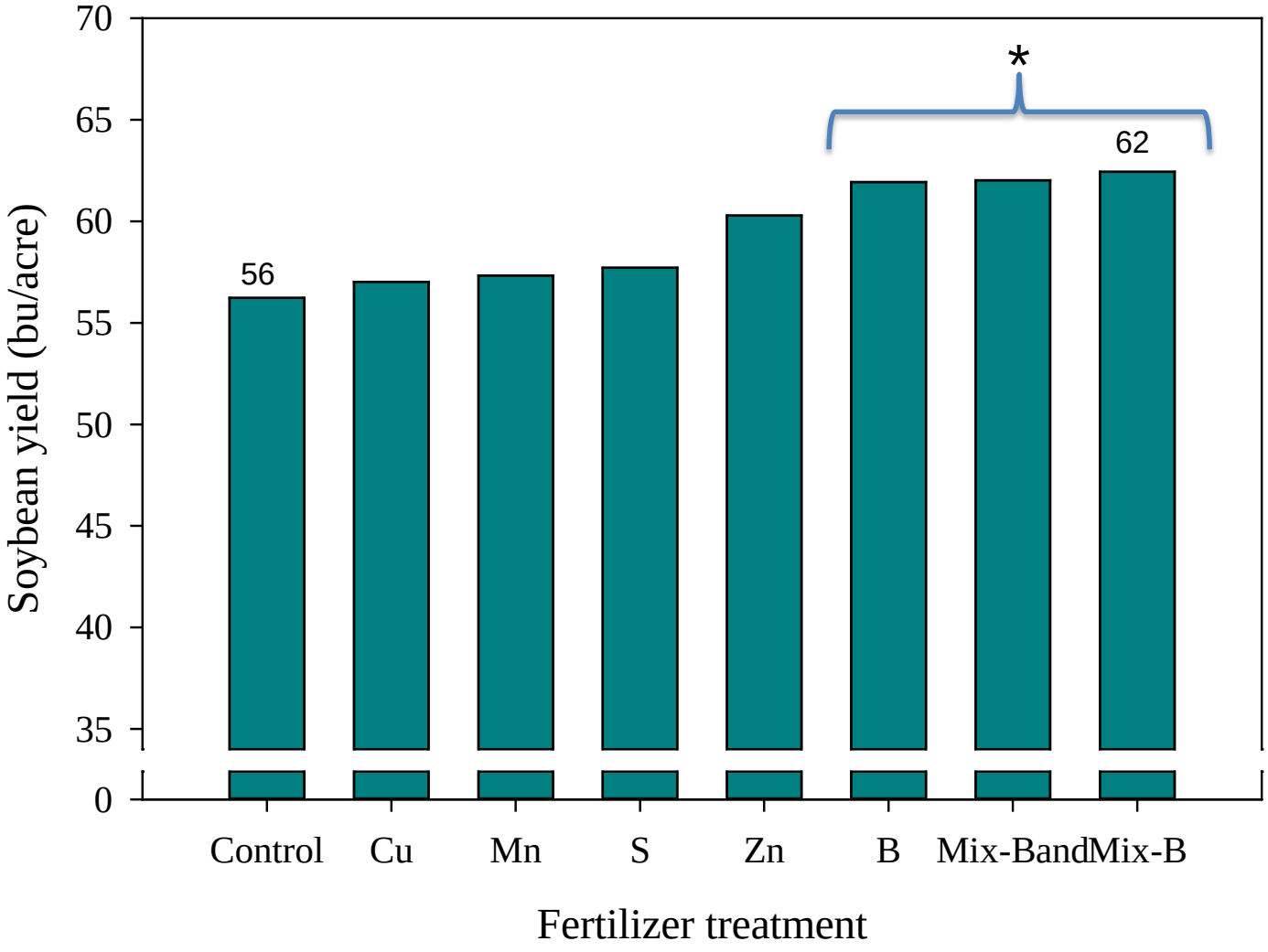
P=0.351

Micronutrients soybean – Responsive site



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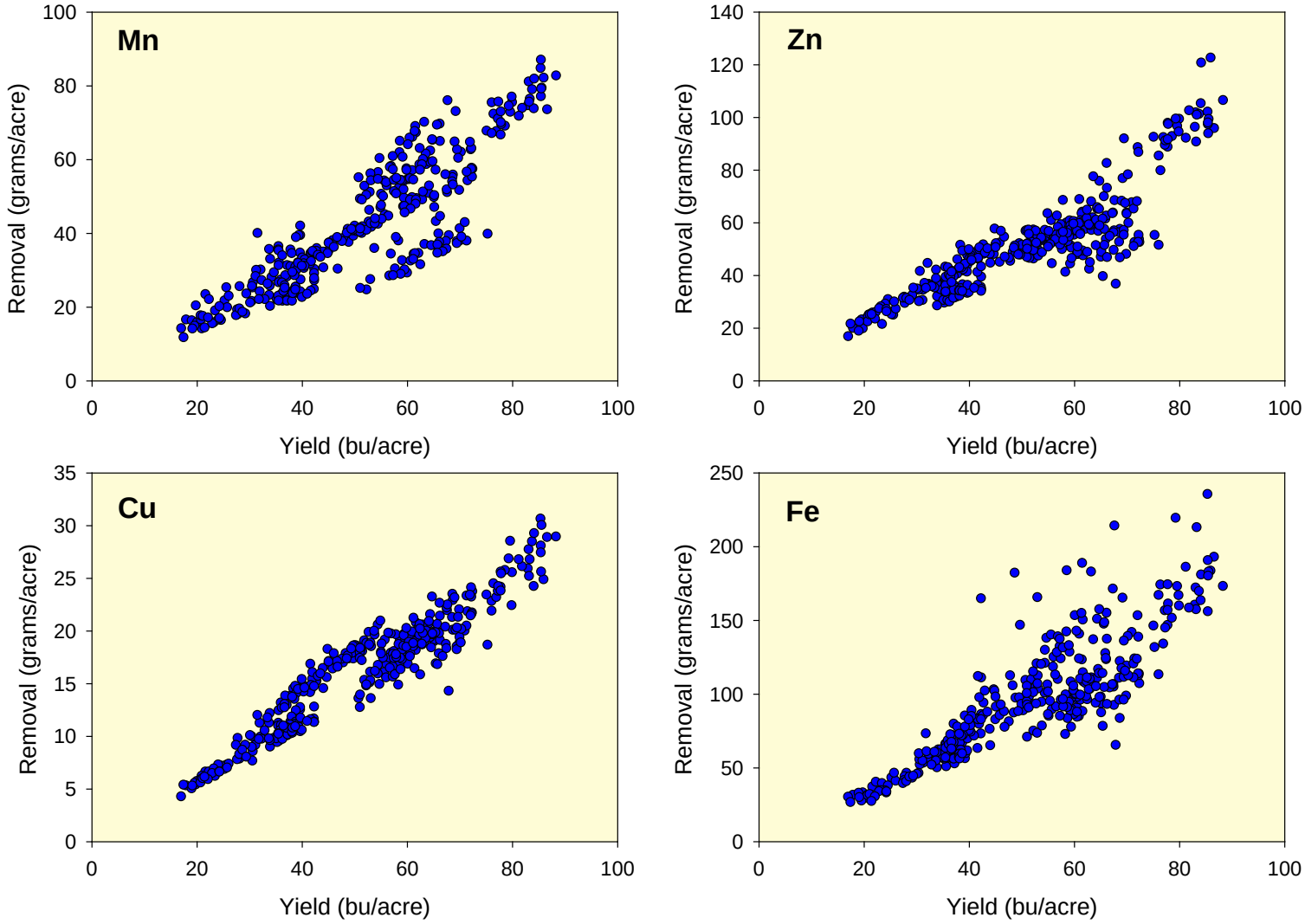
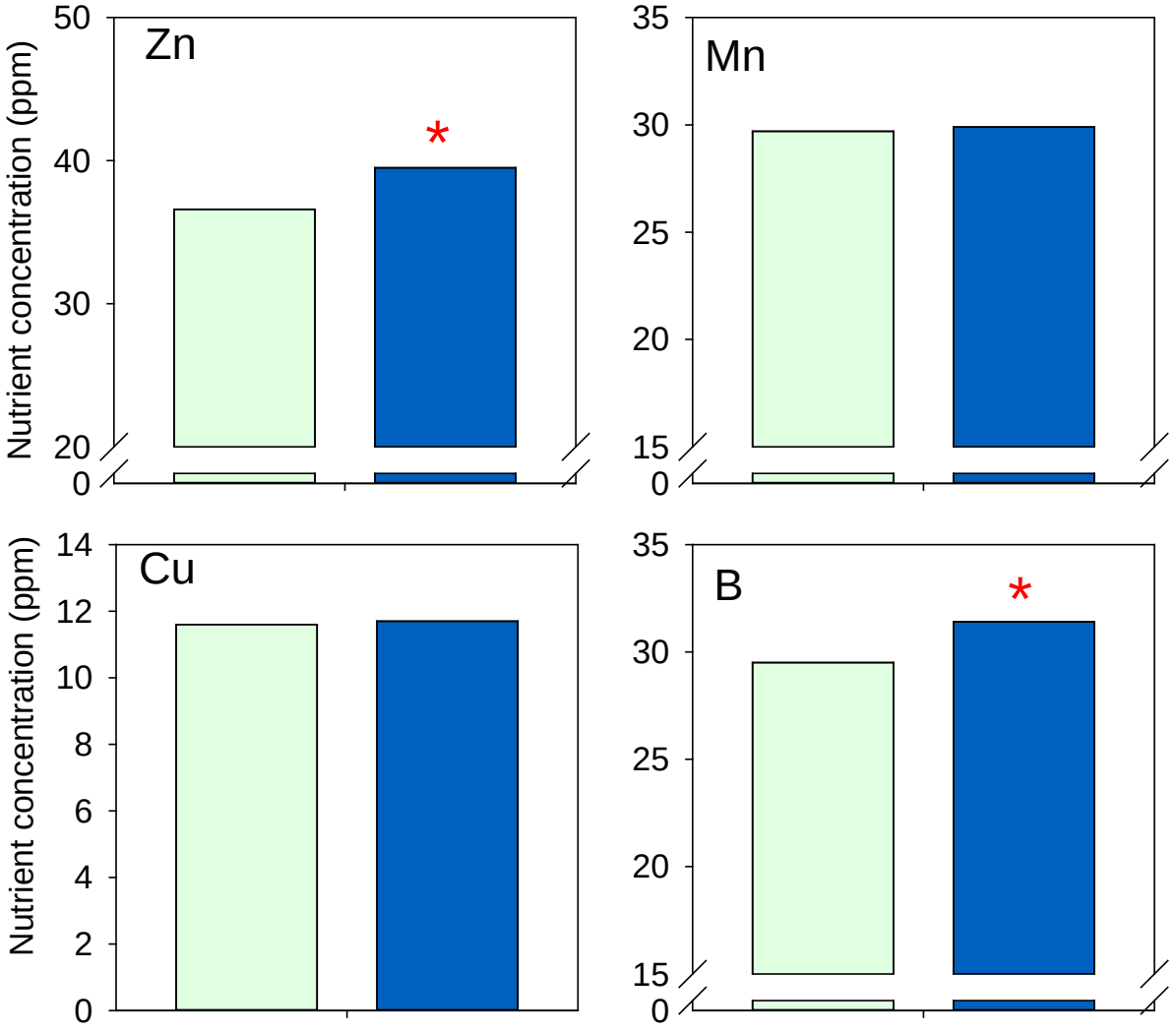
Micronutrients soybean – Responsive site

Soil parameter	
pH	6.8
Soil test P (ppm)	24
Soil test K (ppm)	114
CEC (meq/100g)	4.5
OM (%)	0.9
Sand (%)	80
Clay (%)	5

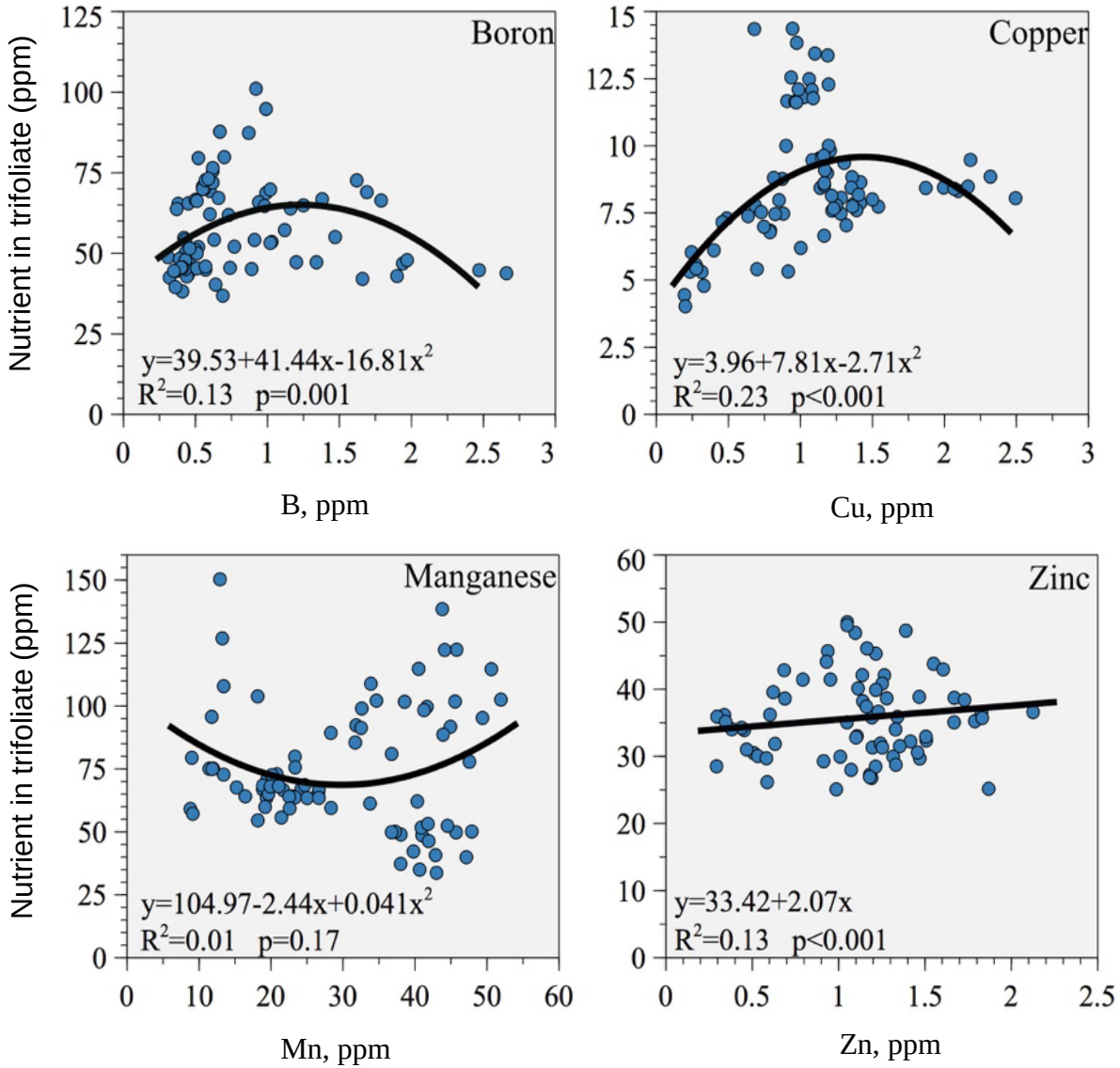
Micronutrient removal with the seed



Seed nutrient with micronutrient fertilizer application



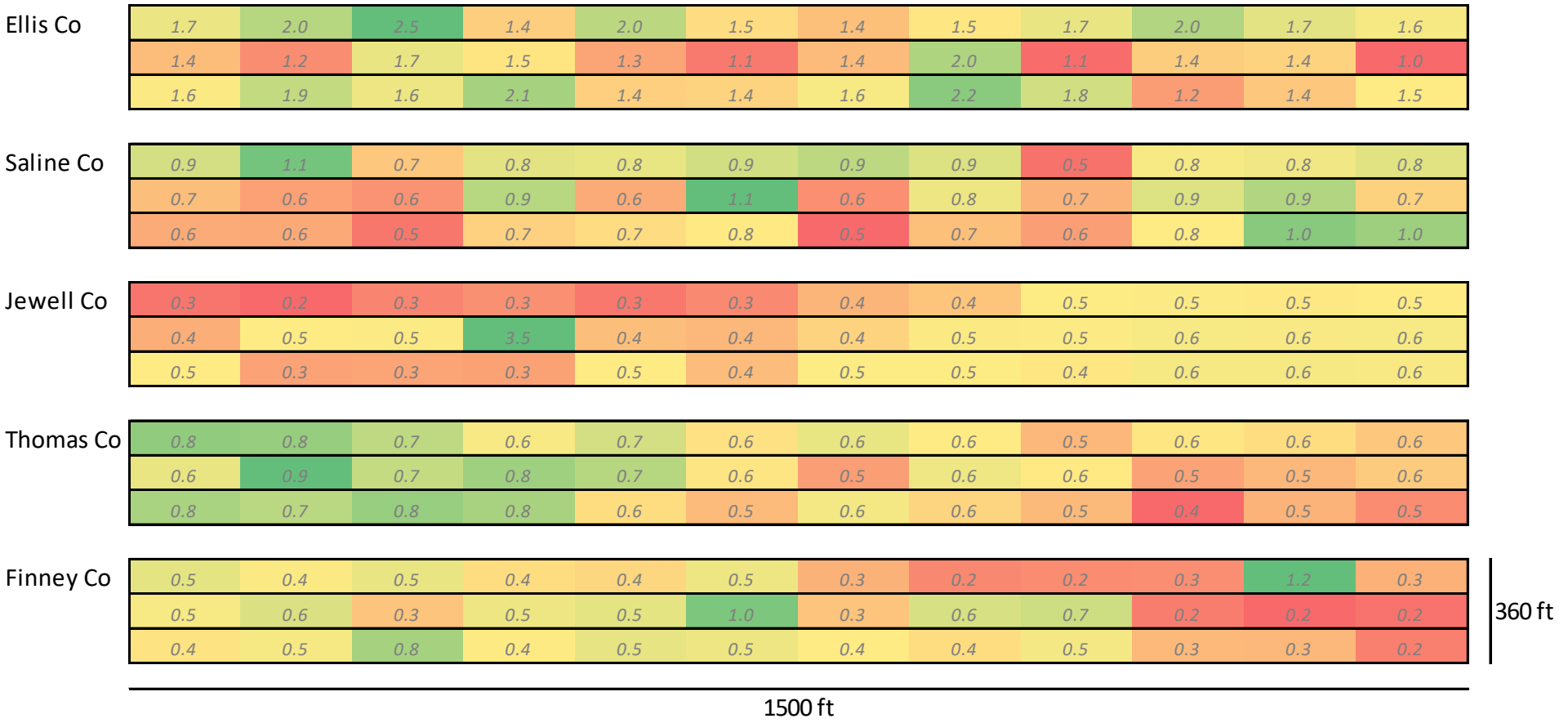
Soybean tissue and soil test



Summary

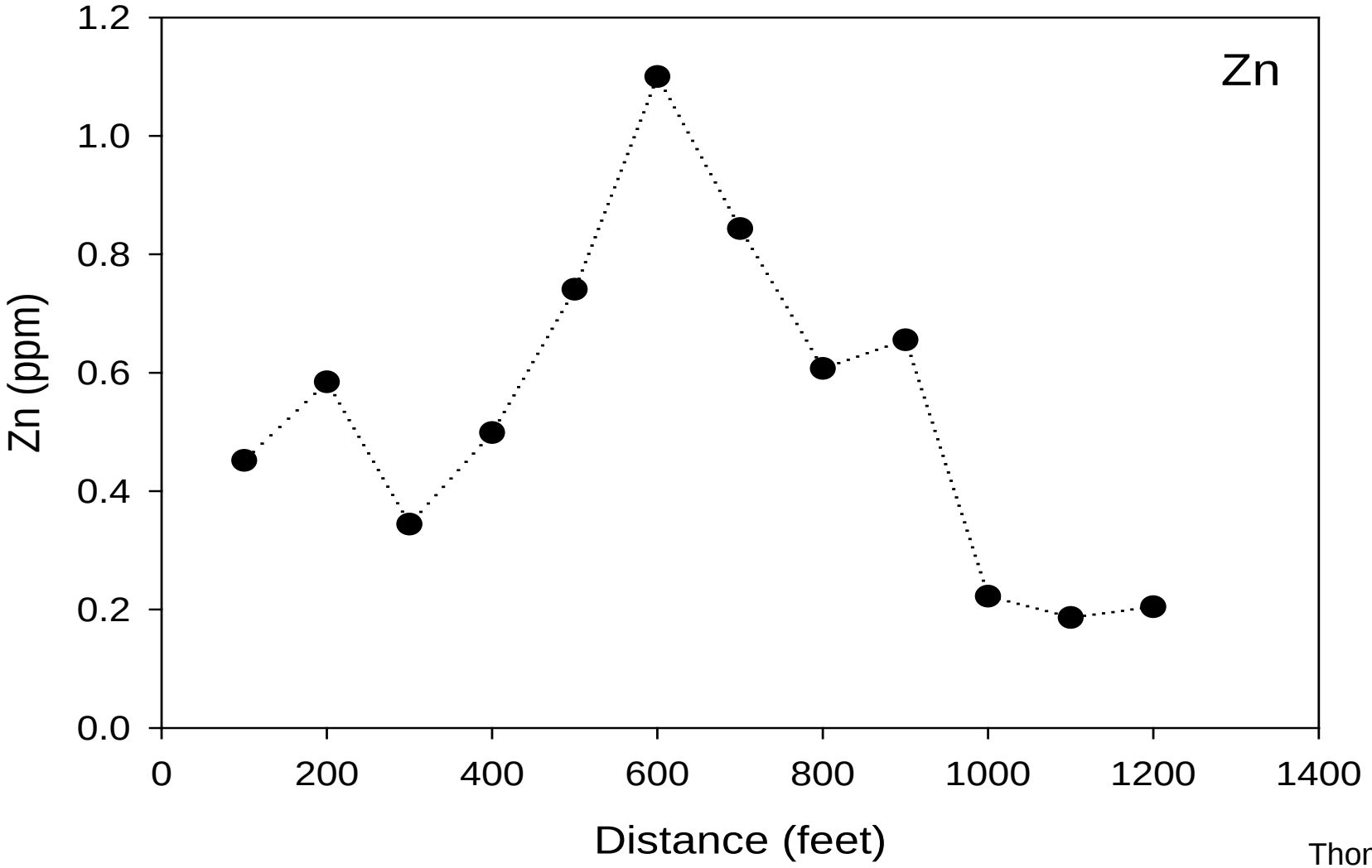
- Changes in leaf tissue micronutrient concentration show poor relation to yield.
  - Soil test vs tissue test also show poor relation for most micronutrients.
- Soil conditions (sandy, low OM, high pH) are key factors for possible yield response.
- Chelated sources may not be the best option for soil-application in some soils in soybean (EDTA-Mn).

Field variability soil Zn



Zn (DTPA)

Field variability soil Zn



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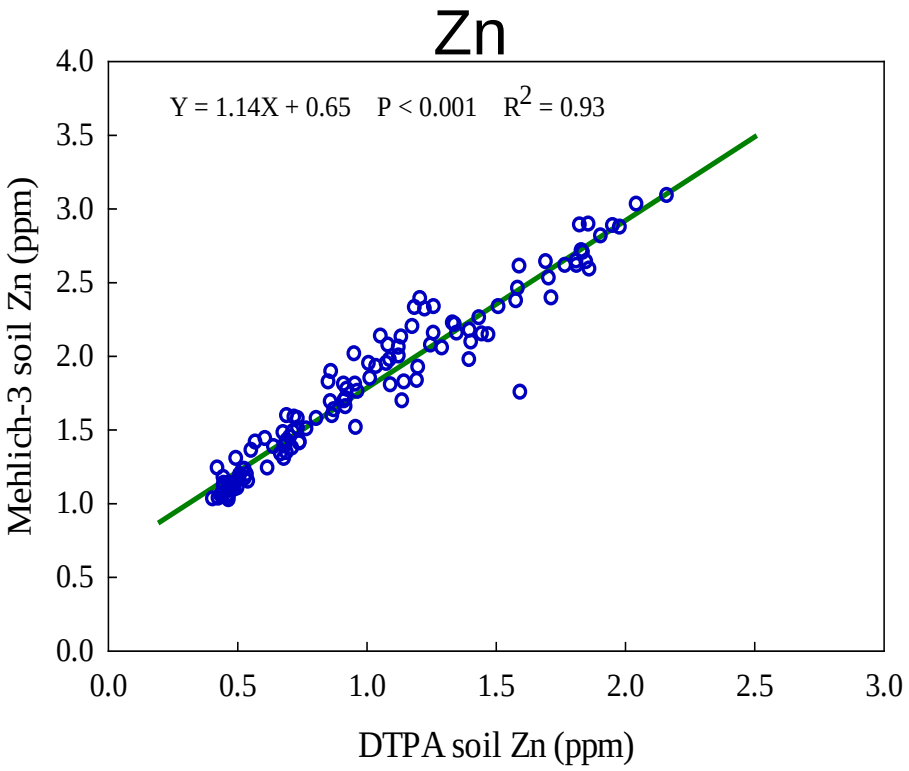
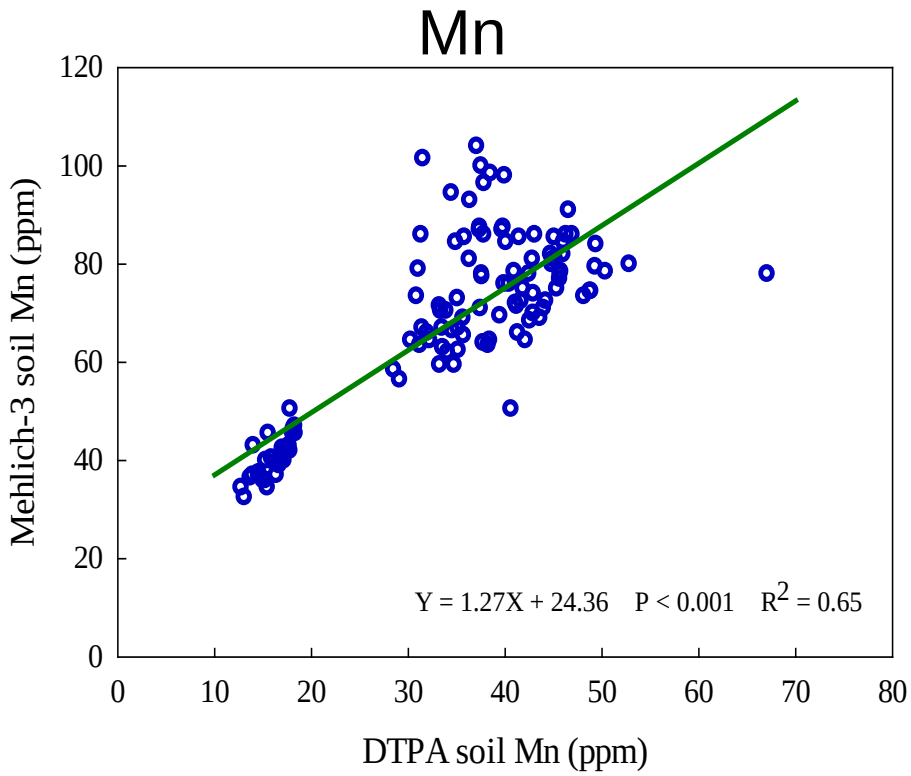
Soil test for micronutrients: DTPA vs Mehlich-3





Cu and Fe : similar to Mn. Zn show the best correlation

Iron chlorosis in soybean

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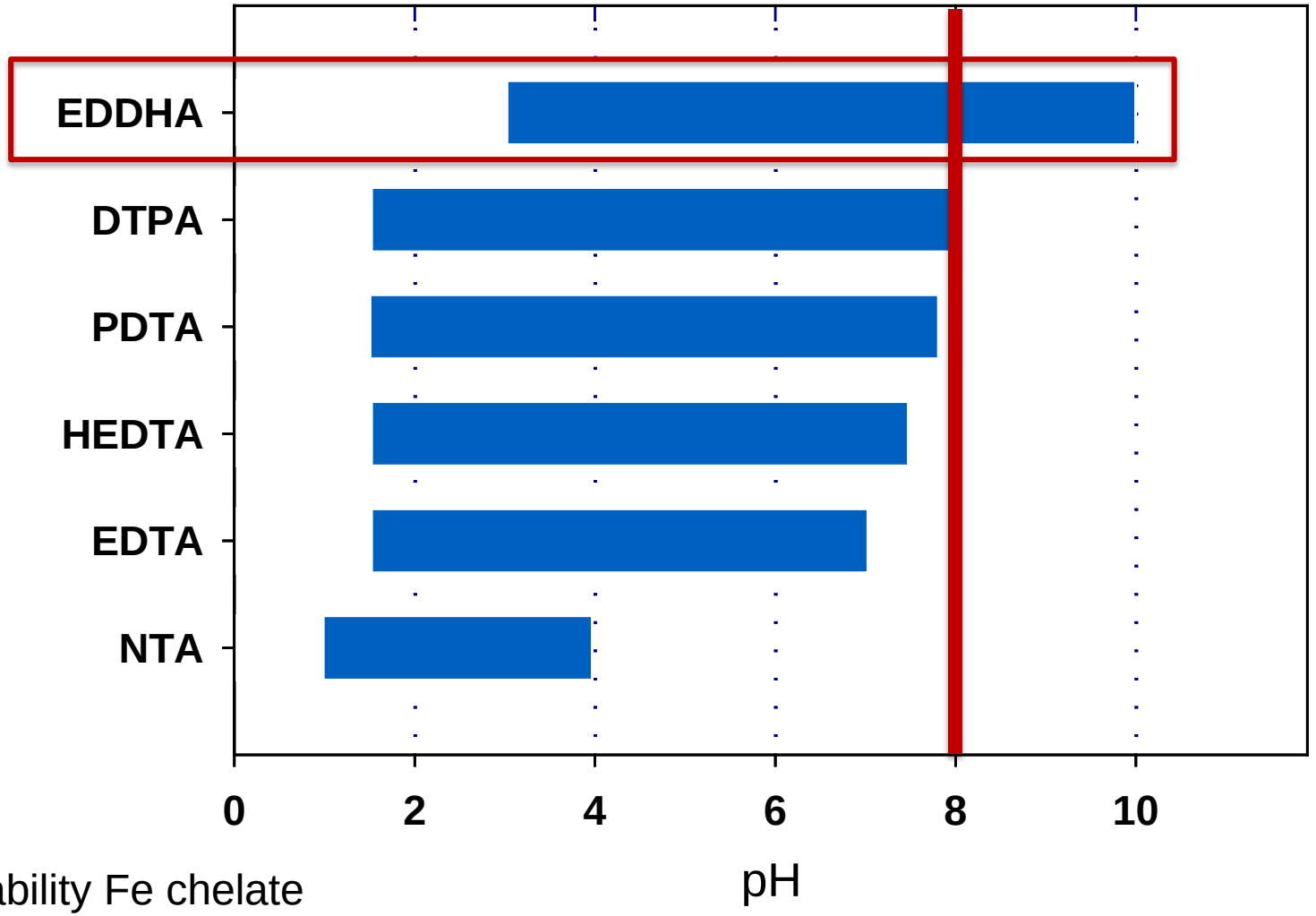
IDC in soybean on high pH soils

1. Varieties: high and low IDC tolerance.
2. Chelated Fe with the seed: with and without ortho-ortho EDDHA chelate Fe.
3. Foliar treatments:
   - 0.1 lb/acre EDDHA Fe (6.0%)
   - 0.1 lb/acre HEDTA Fe (4.5%)
   - No foliar treatment

- 8 locations: pH= 8.1-8.5; CaCE=4-14%

Fe chelate sources and stability under different pH



pH stability Fe chelate

Chelated Fe fertilizer for Fe chlorosis in soybean

Chelated Fe fertilizer: ortho-ortho EDDHA Fe (6.0%)

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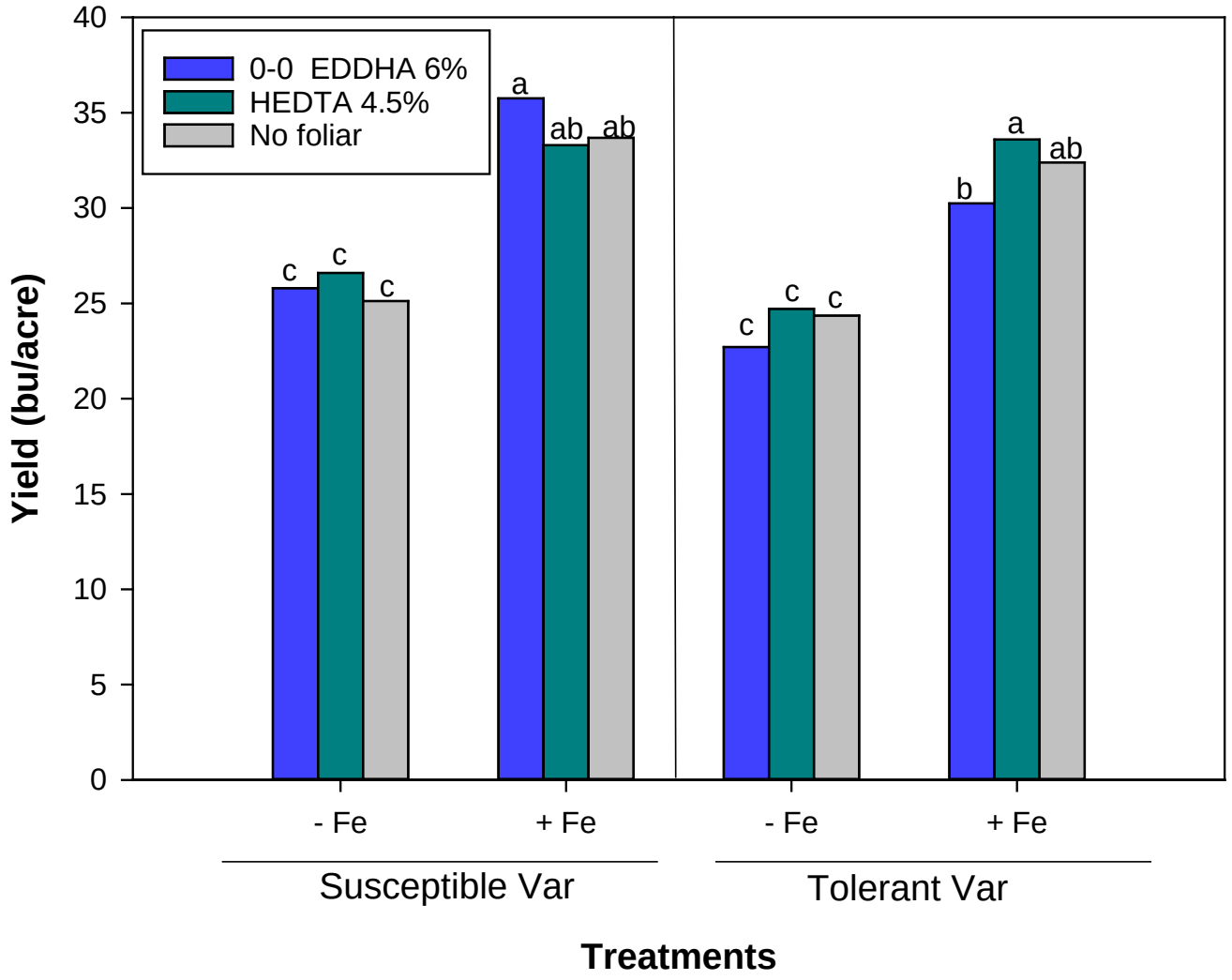
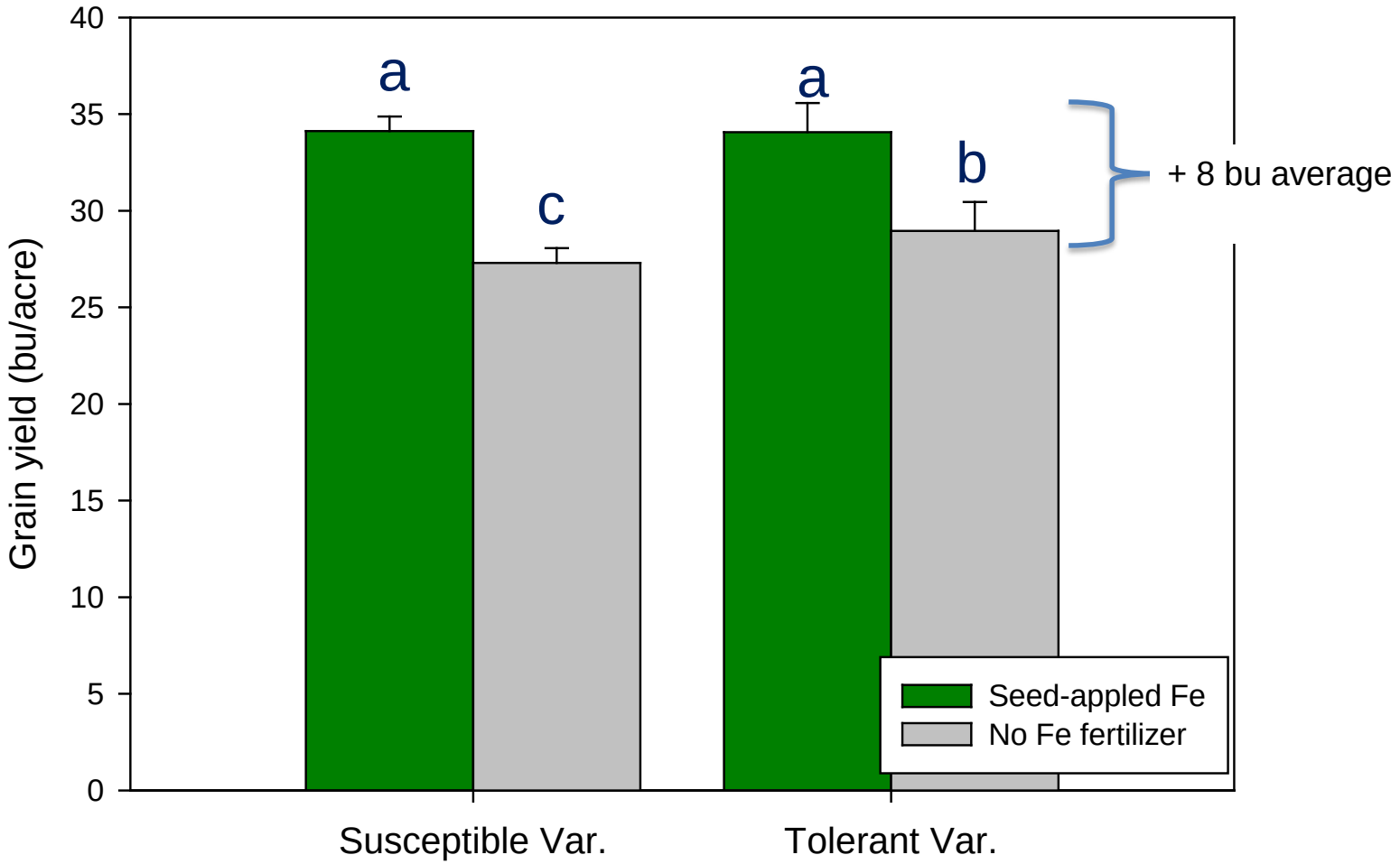
Chelated Fe fertilizer for Fe chlorosis in soybean

Chelated Fe fertilizer: ortho-ortho EDDHA Fe (6.0%)

Soybean yield with seed-applied and foliar Fe fertilizer



Soybean varieties with seed-applied Fe fertilizer



Liesch and Ruiz Diaz, Agronomy Journal

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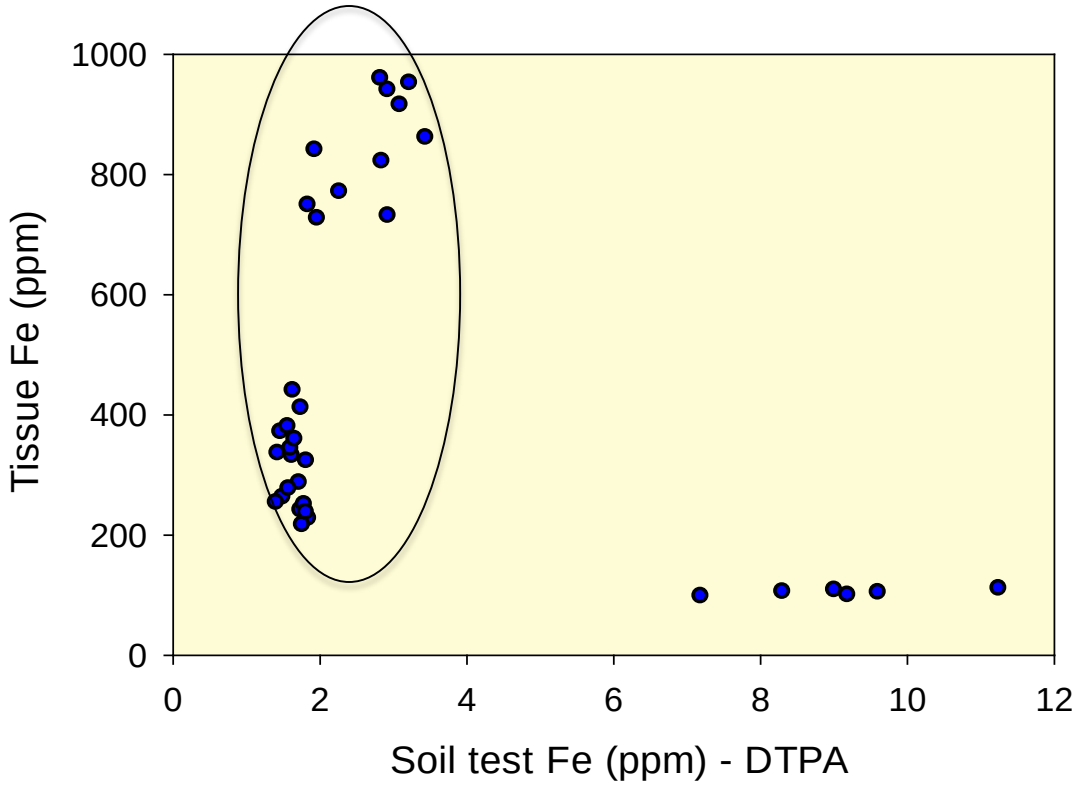
Fe tissue test for IDC soybean?



Limited conversion of Fe^{+3} to Fe^{+2} ?

Summary – Soybean Fe

- Select a soybean variety that is tolerant to IDC, but also keep in mind yield potential for each variety.
- The type of chelated Fe fertilizer can be very important, particularly on “extreme” high pH soils.
  - EDDHA is relatively expensive but needed in high pH/calcareous soils.
- Foliar application increase the “greenness” (SPAD meter). But seed-applied Fe provide the yield increase.

Summary – Soybean Fe

- Probability of Fe deficiency can not be explained well by a single soil parameter.
- Conventional tissue test (total Fe) show no value as diagnostic tool for Fe chlorosis.

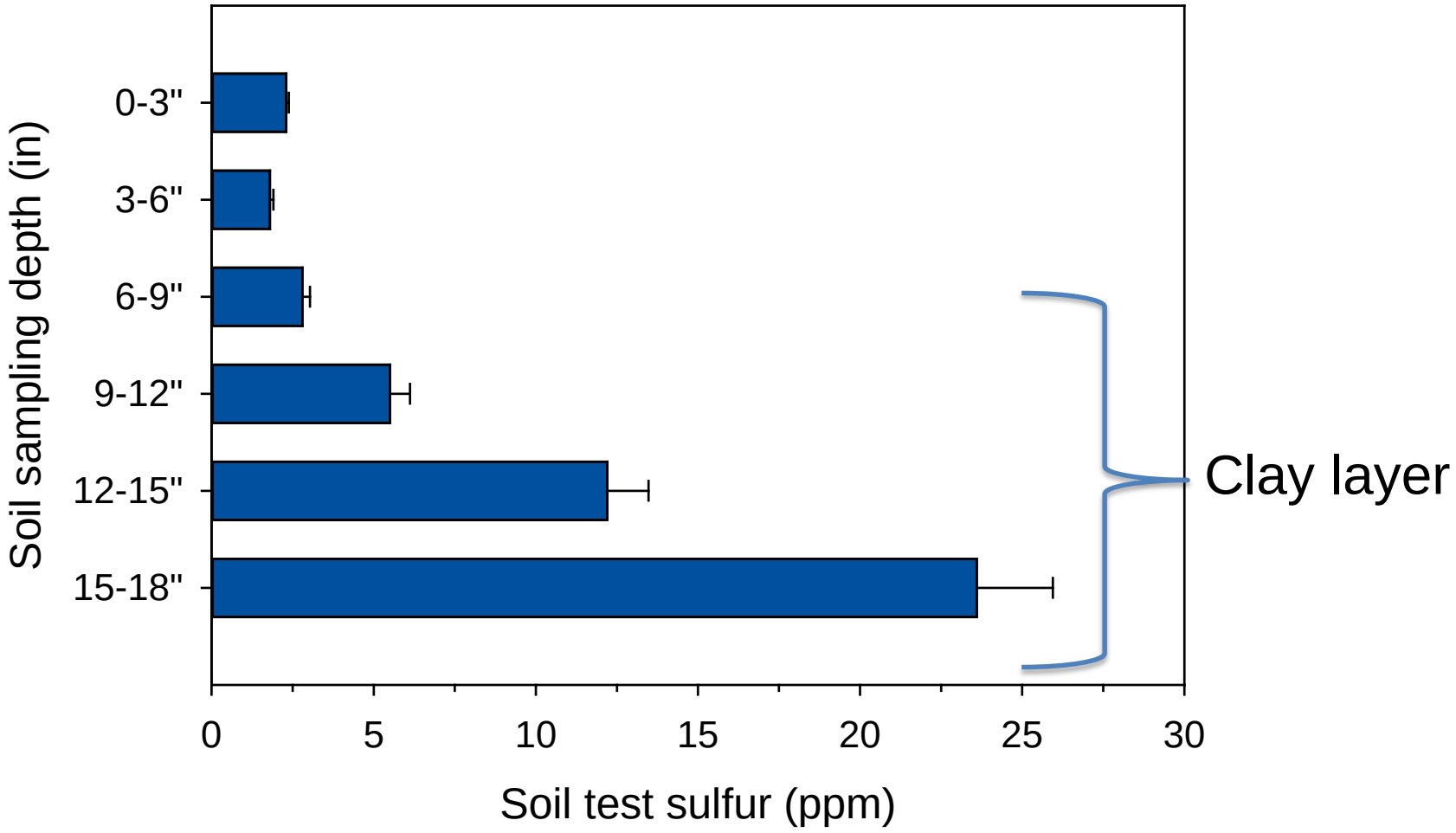
Boron toxicity in soybean – rate and seed contact

Ruiz Diaz, 2017

Soybean and sulfur fertility?

- Removal with the seed harvest= 0.2 lbs S/bu.
  - Corn and wheat remove about 0.1 lbs S/bu.
- Sulfur deficiency is more common in wheat and corn.
- Removal with soybean may affect the next crop (e.g. wheat after soybean)

Soil test sulfur and accumulation in clay layers



2018

Summary

- In general, response to micronutrients are very limited for “normal” soils.
- Some soils can show response, and may be a good investment for the producer:
  - sandy, high pH with calcium carbonate.
  - IDC in high pH soils.
- Yield potential only (high yielding crops) is not an indication of micronutrient response.

Micronutrients for Soybean Production in the North Central Region

NCSRP North Central Soybean Research Program

Iowa State University Extension and Outreach

K-State Research and Extension

University of Minnesota Extension

Purdue Extension | Local Faces

UW Extension

Thank you!
Questions?

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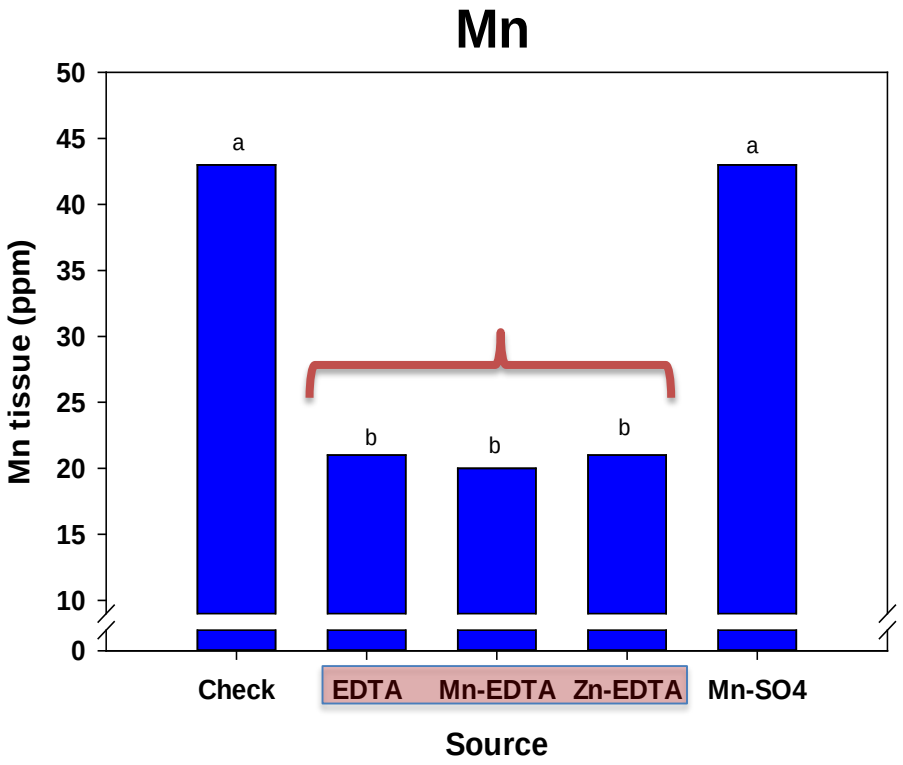
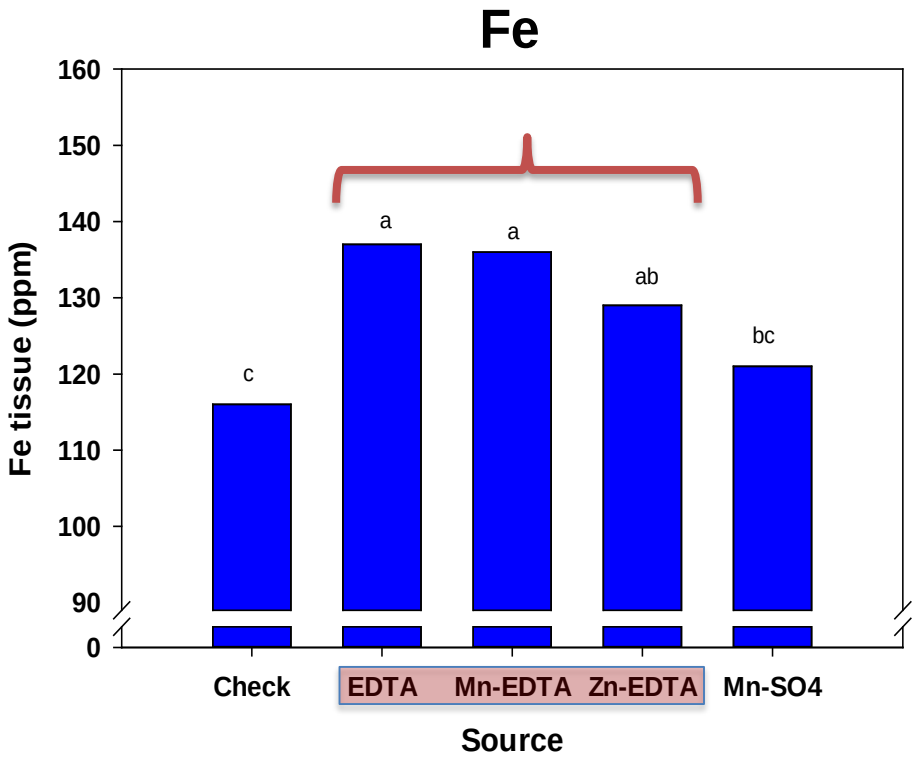
Metal substitution with chelates: Soybean tissue (Mn and Fe)





pH=6.8, CEC=15, OM

Mueller and Ruiz Diaz, 2011