Micronutrients for Corn and Soybean
An Iowa Perspective

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Recent Interest in Micronutrients

- Good grain prices, could afford apply "just in case" to maximize yield
- Next limiting step with lime, P and K issues "solved"; higher yield levels
- Word of deficiencies in other states
- Talk of Glyphosate and Mn issues
- Several micros, many products available, dry and liquid sources, nutrient "packs" offers

Micronutrients for Crops

- Essential but needed in very small amounts (uptake 1-3 lbs or less)
- Boron (B), Chlorine (Cl), Copper (Cu), Chloride (Cl), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Zinc (Zn) [cobalt?]
- Large variation in crops sensitivity
- Is fertilization needed? Not necessarily if soil supplies sufficient amounts

Micros Deficiencies More Likely

Micronutrient	Soil Conditions	Crop
Boron (B)	Sandy or highly weathered soils low in organic matter, drought	Alfalfa, clovers
Copper (Cu)	Acid organic or very sandy soils	Wheat, oats, corn
Iron (Fe)	Calcareous soils pH (> 7.0)	Soybean
Manganese (Mn)	Organic soil with high pH (> 5.8), Calcareous soils pH (> 7.0)	Soybean, wheat, oats, sugar beets
Zinc (Zn)	Sandy or organic, low organic matter due to erosion, calcareous soils	Corn, sorghum
Molybdenum (Mo)	Very acid soils (< 5.5 or so)	Legumes

Adapted from several extension publications in the North-Central region

Manures Supply Micronutrients

Manure source	Iron	Manganese	Boron	Zinc	Copper
	---------- lb/wet ton ----------				
Dairy solid	0.5	0.06	0.01	0.03	0.01
Swine solid	19.0	1.09	0.04	0.79	0.50
Poultry	3.0	0.61	0.08	0.48	0.66
	---------- lb/1000 gal ----------				
Dairy liquid	0.9	0.11	0.03	0.11	0.12
Swine liquid	2.5	0.23	0.06	1.03	0.62

Kent Martin, Crops and Soils Specialist, KSU

Zinc Deficiency in Corn

Zinc in Iowa and Minnesota

- Similar soil-test interpretations and Zn fertilizer recommendations
- Deficiencies sometimes observed in corn, not in soybean
- Apply Zn fertilizer only with less than 0.8 to 0.9 ppm DTPA soil test method
- Recommend 5 to 10 lb Zn/acre broadcast or 1 to 2 lb/acre with the planter

Iron Chlorosis in Soybean

Others Micros in IA and MN

- No proved deficiencies for other micros in corn and soybean in IA or MN
- Old evidence for molybdenum soybean deficiency in very acidic soils (<5.5)
- Other crops and micros
  - Zinc for edible beans in MN
  - Isolated boron deficiencies in alfalfa
    - not in Iowa; some in MN & have recs
  - Copper, maybe chloride in barley and wheat

Manganese & Glyphosate in Soybean

Manganese, Glyphosate for Soybean

Northeast Iowa Brian Lang, ISU Extension Specialist

Treatment Applied	2008	2009	2010
Glyphosate	41.0 a	45.0 a	58.7 a
Glyphosate tank mix with Mn	39.0 a	-	
Glyphosate + Mn 15 days later	45.1 b	46.1 a	57.4 a
Flexstar Fusion + Mn 15 days later	-	-	56.9 a

Mn chelate at 0.3 lb Mn/acre

Manganese, Zinc, Glyphosate for Soybean

North-Central Iowa, Mark Licht, ISU Extension Specialist

Treatment Spray at R2 Stage	2011 (ns)	2012 (ns)
	---------- bu/acre --------	
Control	59.2	63.2
Glyphosate	61.6	64.0
Manganese	59.7	62.2
Zinc	60.9	61.2
Glyphosate + Manganese	60.9	63.0
Glyphosate + Zinc	62.4	58.8
Glyphosate + Manganese + Zinc	61.9	59.6

Mn y Zn (chelates) at 0.44 or 0.77 lb Mn or Zn/acre.

Problems with Micros Diagnosis

- Other than iron in soybean and perhaps zinc in corn, deficiencies in the region are isolated and not well documented
- Soil testing for micronutrients is much less useful than for P, K, pH, or nitrate
- Plant tissue testing
  - Testing early enough to correct deficiency
  - No field calibration data in IA or MN, and in other north-central states interpretations are old and unreliable

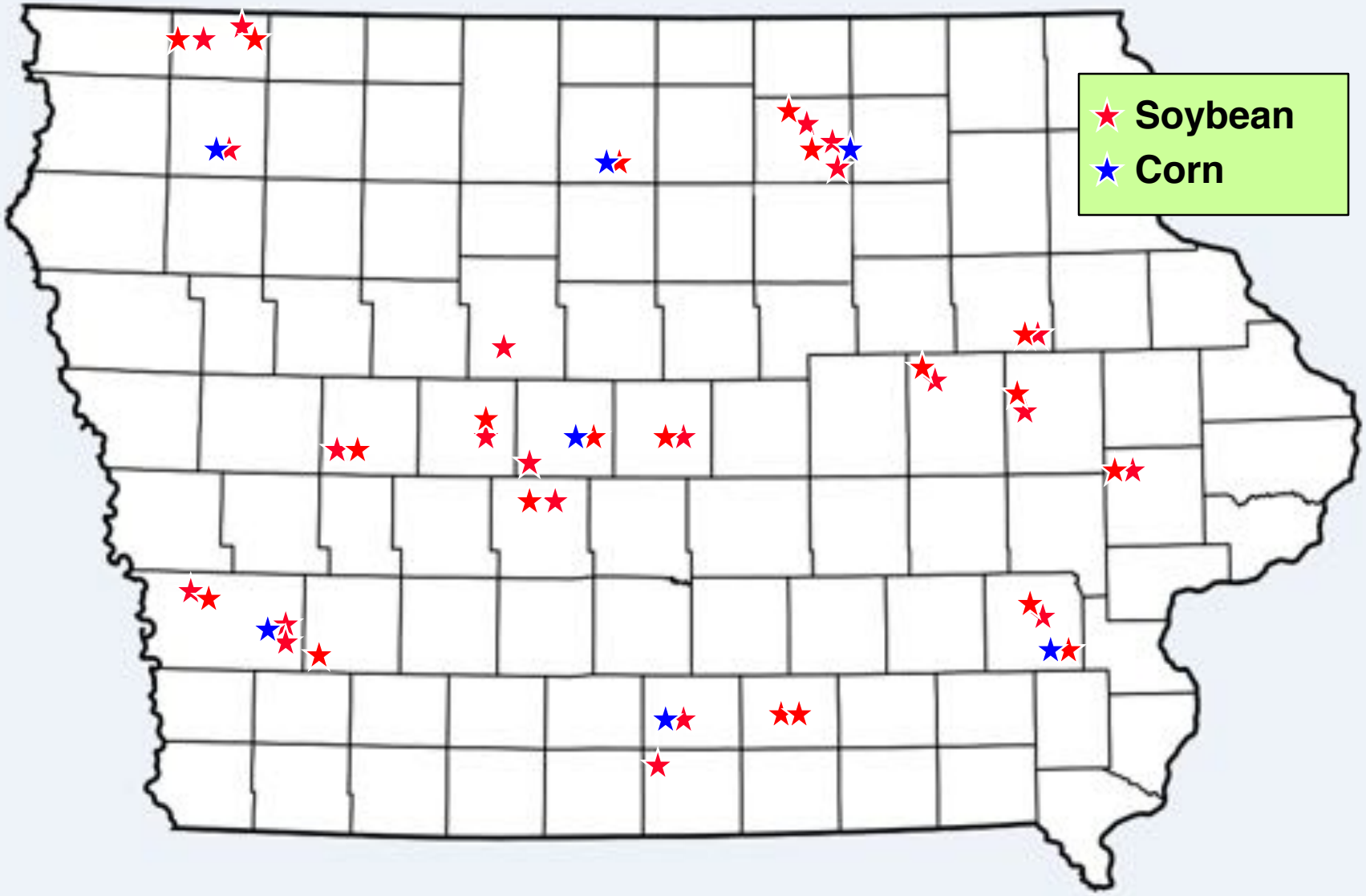
Micronutrient Sources

- Boron: Sodium tetraborate (Borax) and pentaborate, boric acid
- Cu, Fe, Mn, Mo, Zn:
  - Inorganic oxides and sulfates
  - Chelates various (EDTA, EDDHA)
  - Organic complexes (paper, citrus, and sugar industry by-products)
- Water solubility of mineral sources, Fe chelates good for soil application, price

New Foliar Research 2012-2014

- 46 soybean plot trials, 35 on farmers' fields
- 10 corn trials at ISU research farms
- B, Cu, Mn, Zn, and a mixture; 4 replications
- Sources:
  - Boric acid (Max-In B, 8% B)
  - EDTA Cu (Max-In Cu, 5% Cu)
  - EDTA Zn (MicroBolt Zn, 9% Zn)
  - EDTA Mn (MicroBolt Mn, 6% Mn)
- Sprayed twice: at V6 for both crops, V10 in corn, R2-R3 in soybean, with total amount applied:
  - 0.16 lb B /ac (180 g/ha)
  - 0.08 lb Cu /ac (87 g/ha)
  - 0.33 lb Mn/ac (370 g/ha)
  - 0.50 lb Zn/ac (555 g/ha)

Foliar Trials: 46 Soybean, 10 Corn



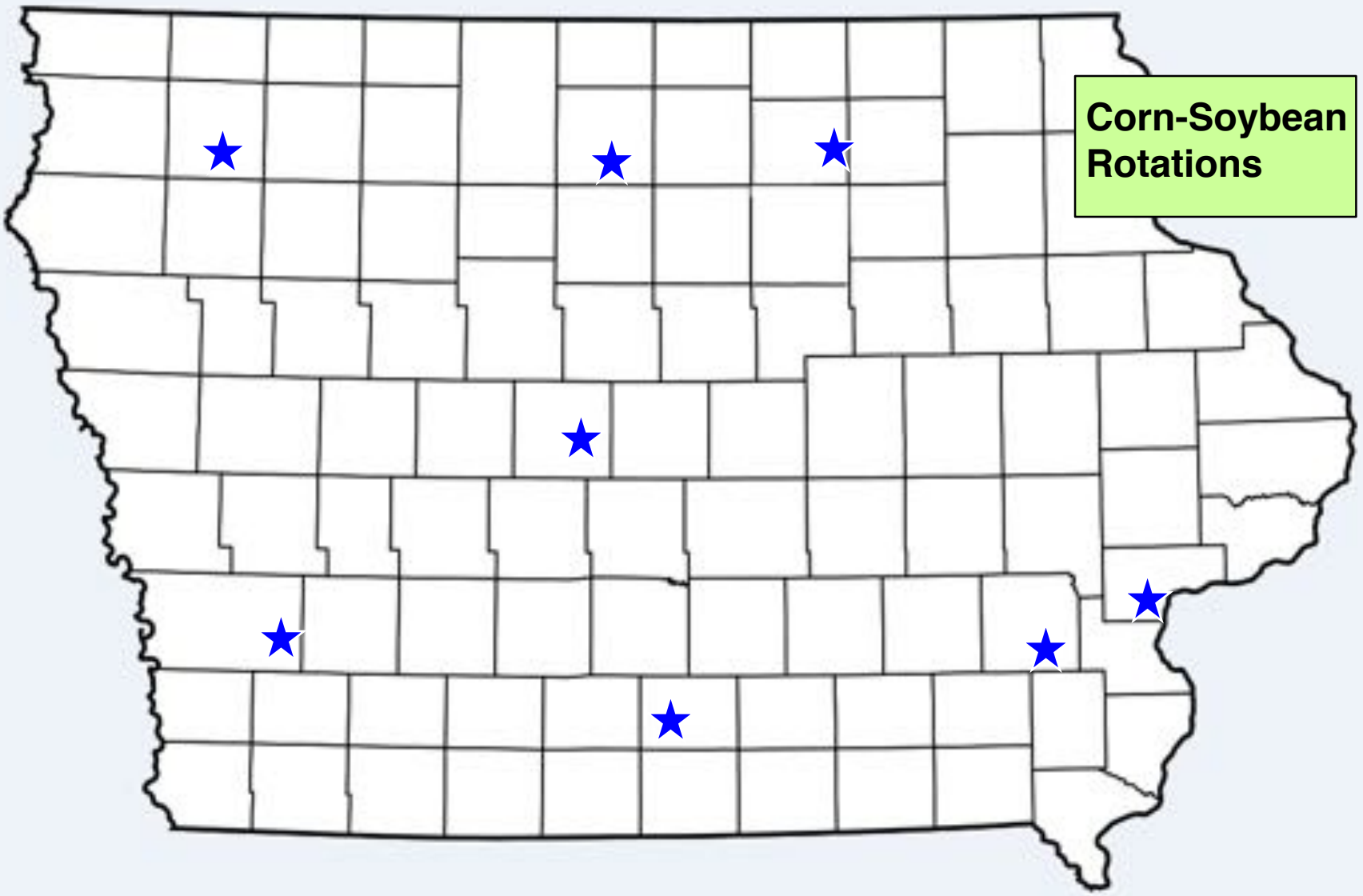
New Foliar Research in 2012 & 2014

- ISU field specialists on-farm project
- 26 corn and soybean strip trials
  - North, NW, and SW Iowa
  - 9 with corn
  - 17 with soybean
  - 3 to 5 replications
- Sprayed a mixture of B, Mn, and Zn
  - One application at V6 to V8 stage
  - 1 pint/acre Max-In Boron (8% B, boric acid)
  - 1 quart/acre Max-In B ZMB (0.1% B, 3%Mn, 4% Zn, 3.6% S)

New Micros To Soil Research 2012-2014

- 8 trials, 3 years each, 4 began with corn and 4 with soybean
- Treatments
  - B, Mn, Zn planter band with MAP
  - Mixture band or broadcast with MAP
- Solid granulated fertilizers
  - Boron: NuBor 10 (boric acid, 1.5% S):
    - banded, 0.5 lb B/ac
    - broadcast, 2 lb B/ac
  - Mn: Broadman20 (12% S), 5 lb Mn/ac
  - Zn: EZ20 (14% S), 5 lb Zn/ac

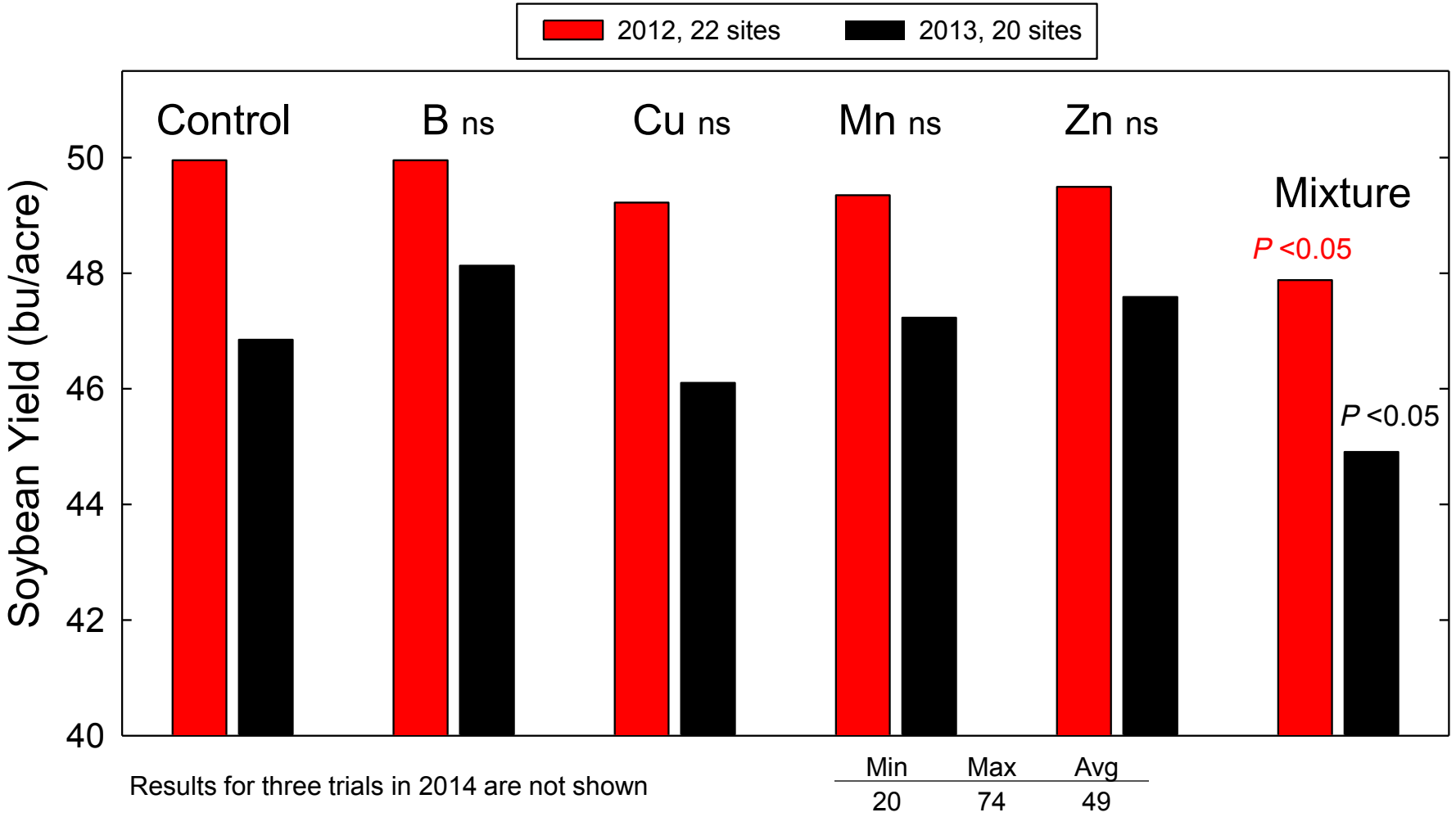
Micros to Soil: 8 trials, 3 years each



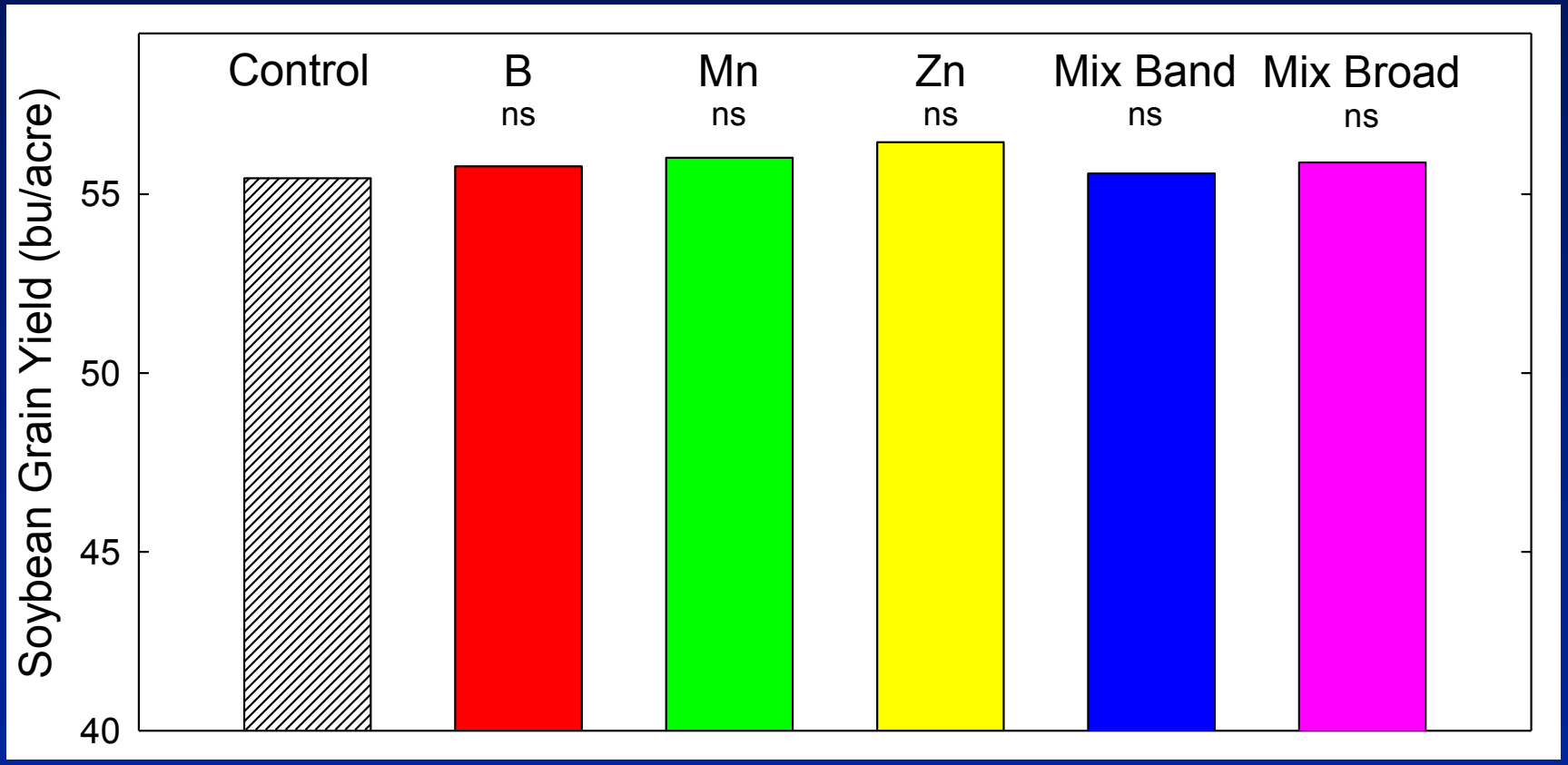
Yield Response Results

- Foliar fertilization plot trials (56 fields)
  - No grain yield increase at any trial
  - Yield decrease at one soybean trial from Cu, Zn, and the mixture
  - Yield decrease from the mixture each year
- Foliar fertilization strip trials (26 fields)
  - One soybean yield increase
  - One corn yield decrease
- Fertilization to soil (8 fields, 3 years each)
  - No yield increase or decrease at any trial

Foliar, Soybean Yield Averages



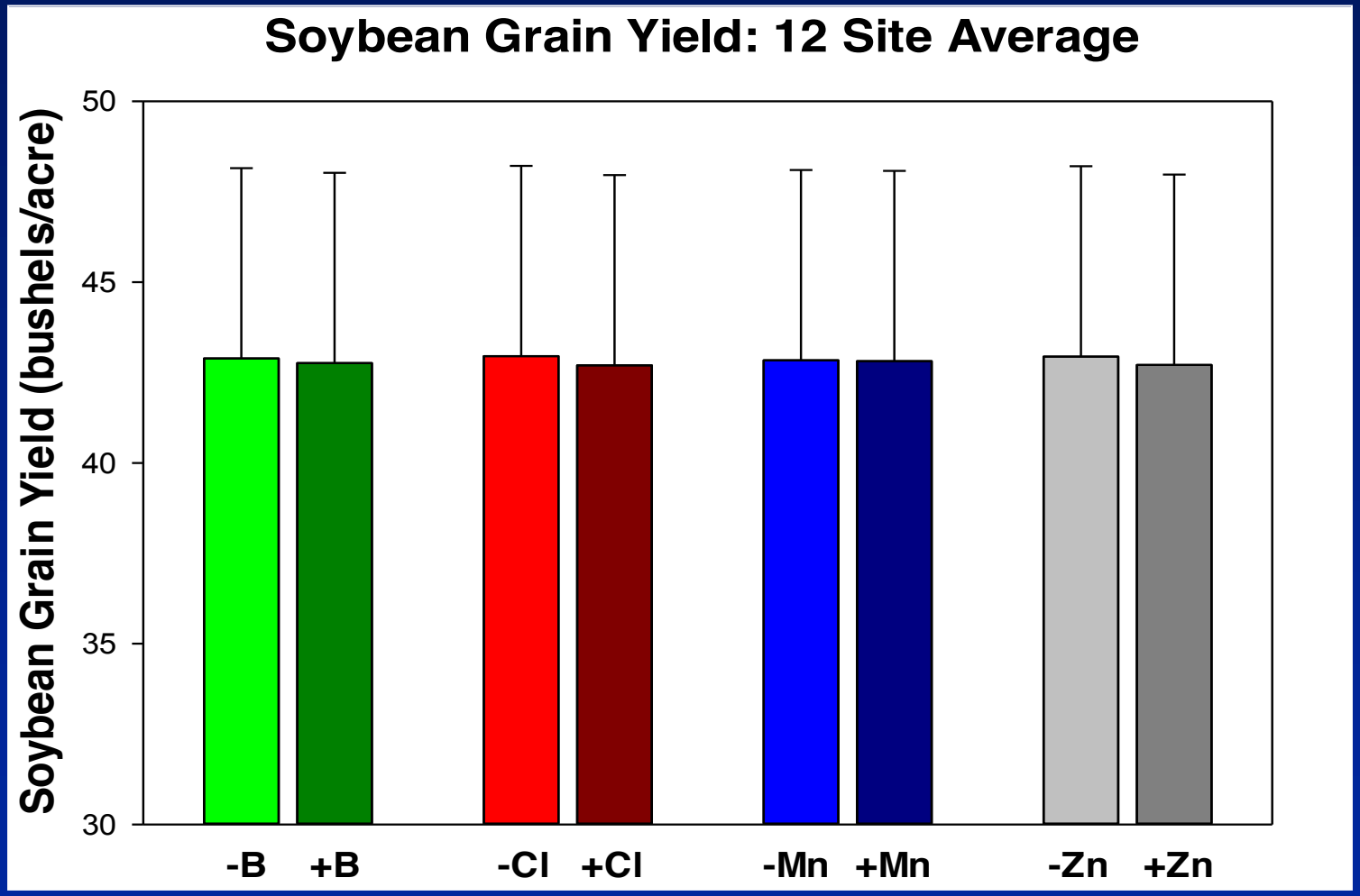
To Soil, Soybean Yield Averages



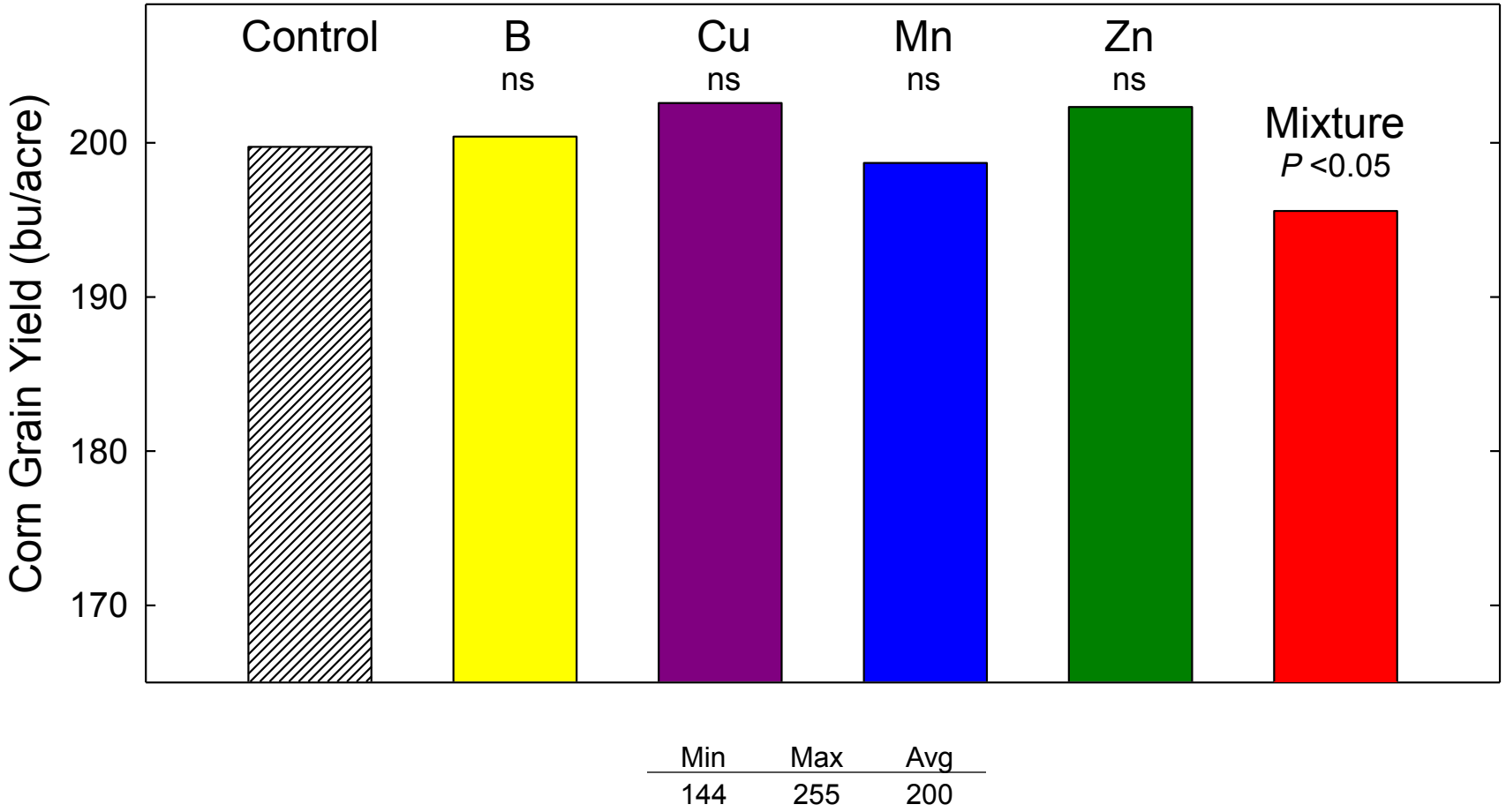
Min	Max	Avg
38	72	56

Recent Minnesota Soybean Research

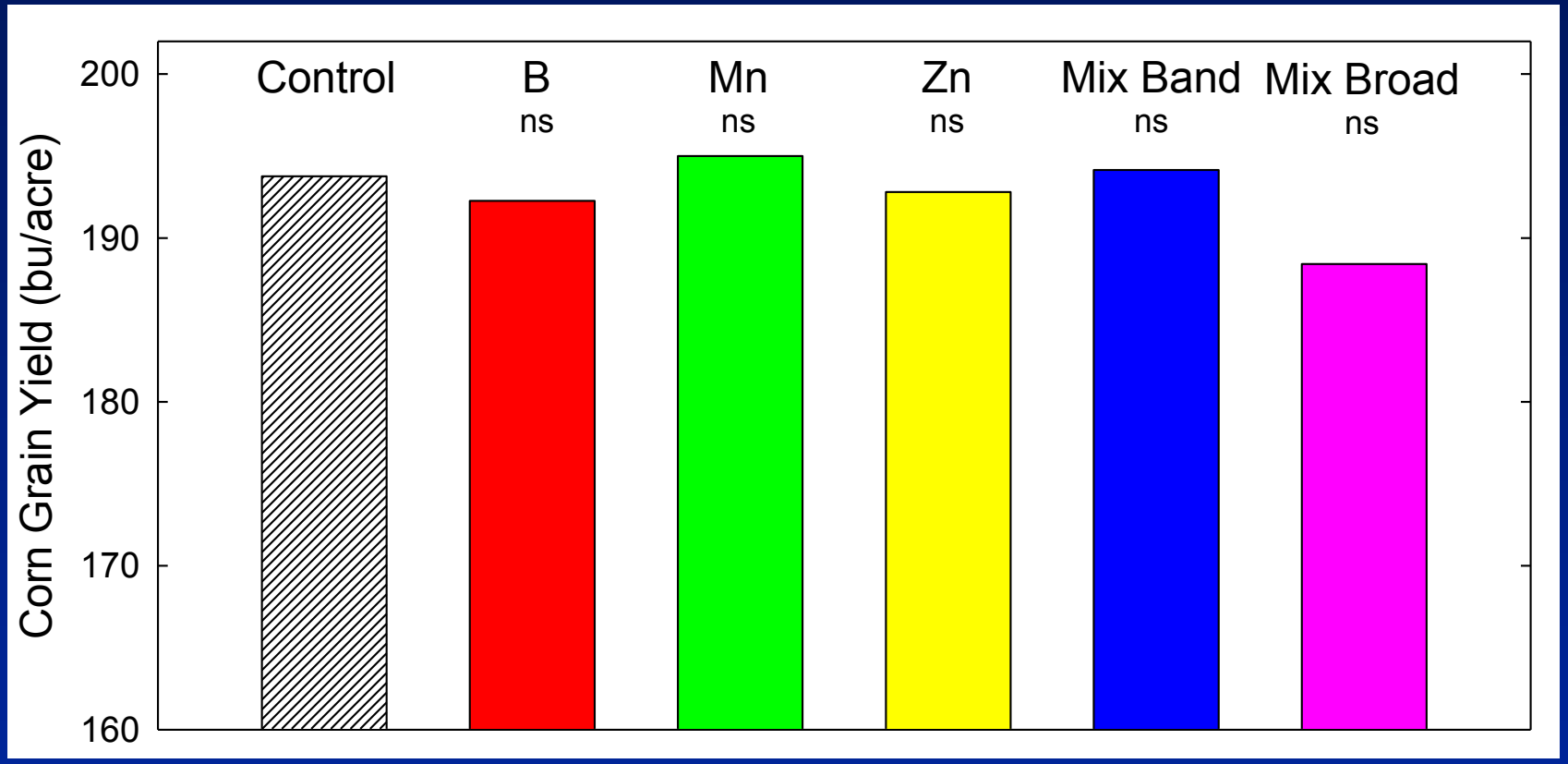
Dr. Daniel Kaiser, 2013-2014



Foliar, Corn 2012-2014 Averages

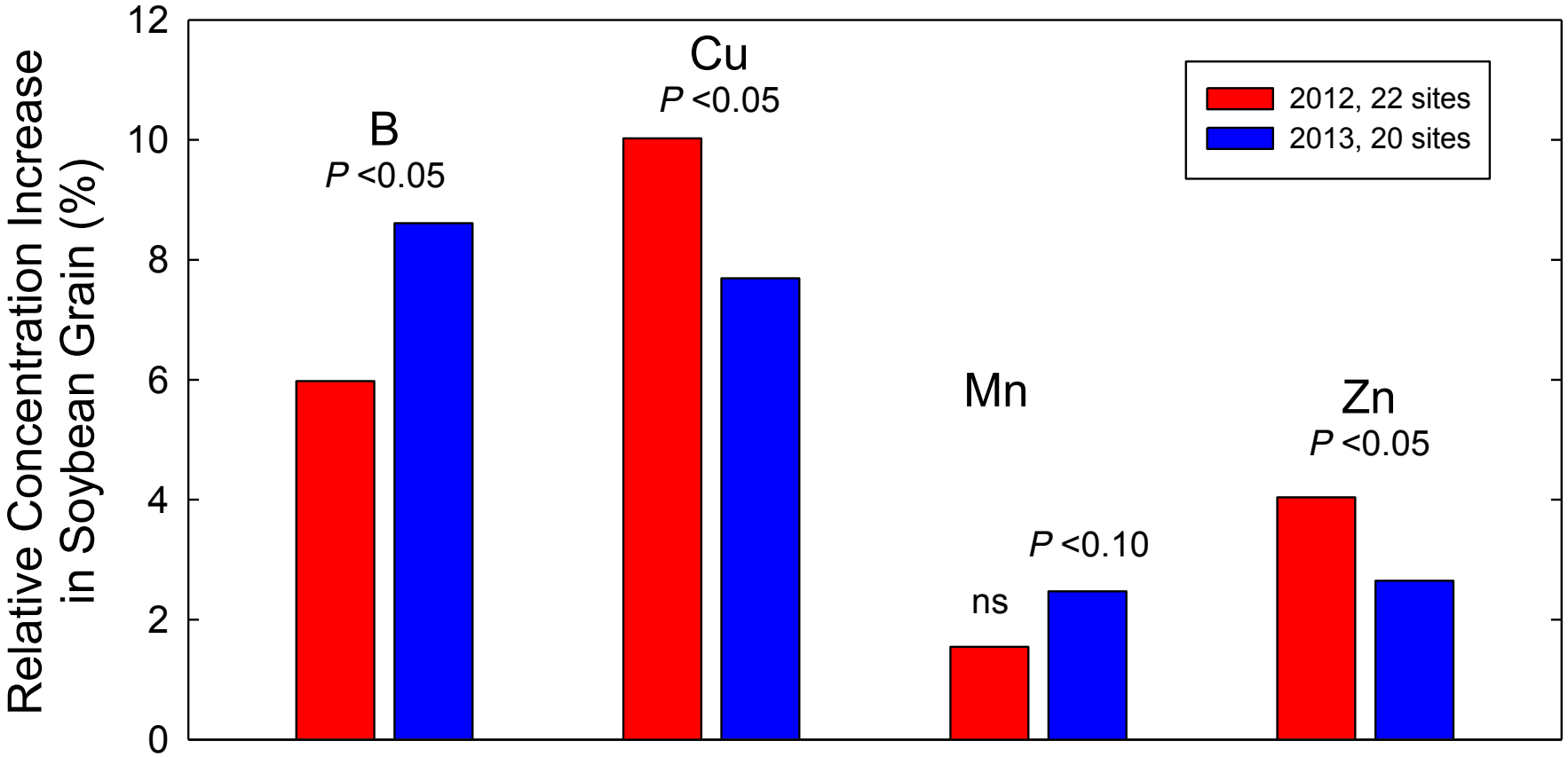


To Soil, Corn Yield Averages



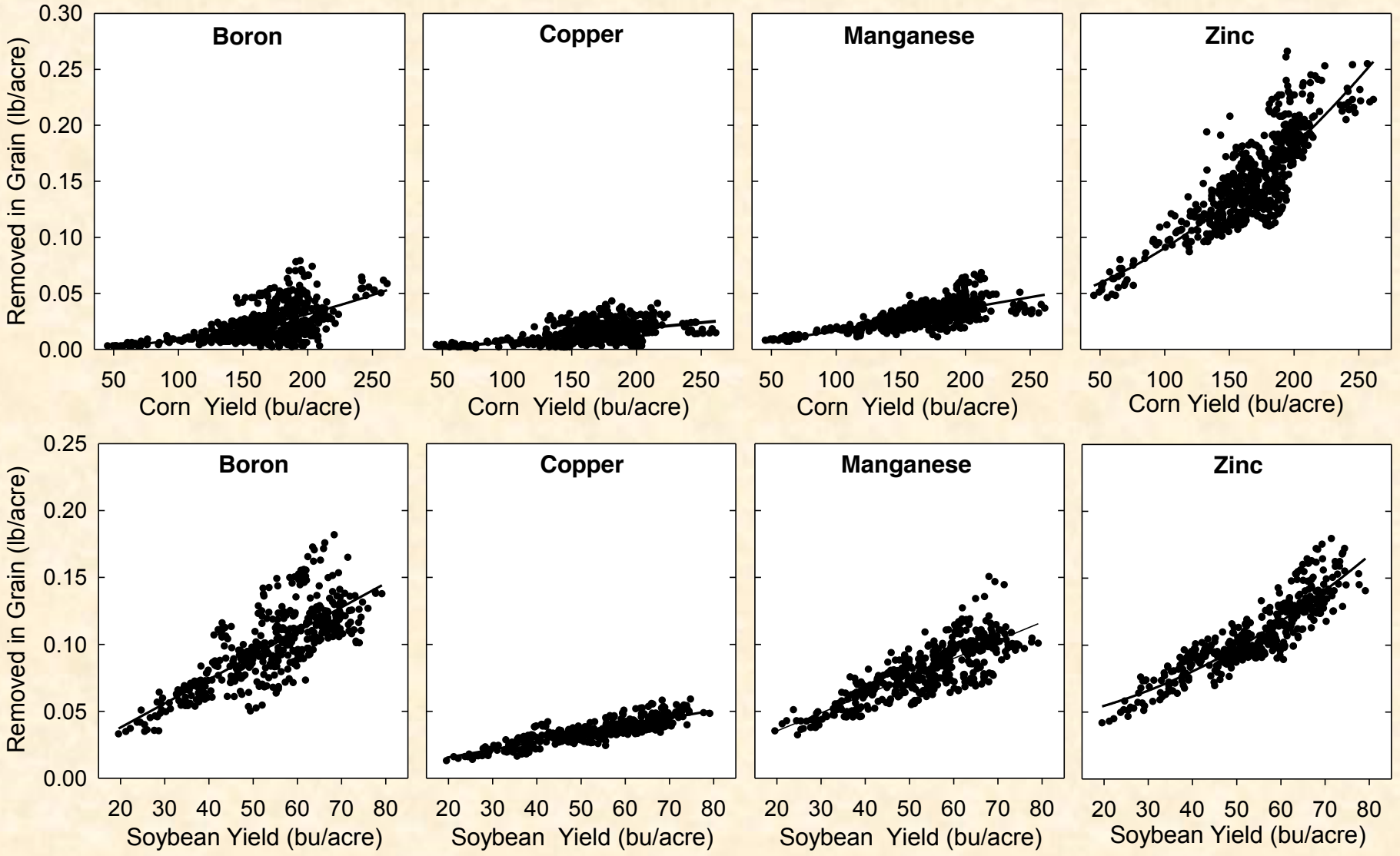
Min	Max	Avg
152	242	193

Foliar, Soybean Grain Concentration



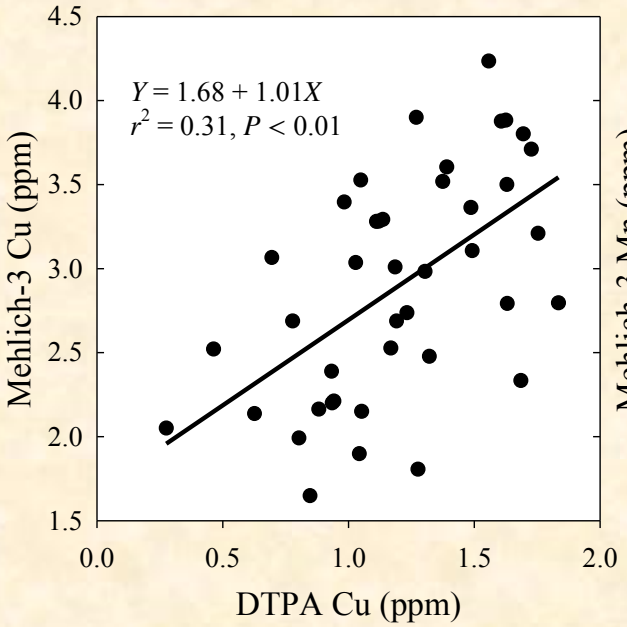
Crop Harvest Removes Micronutrients from Soils

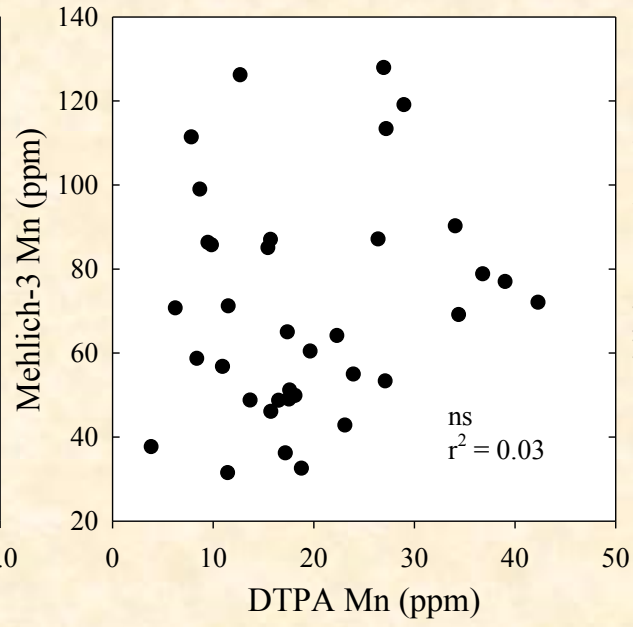
Micronutrients Removal and Yield Level

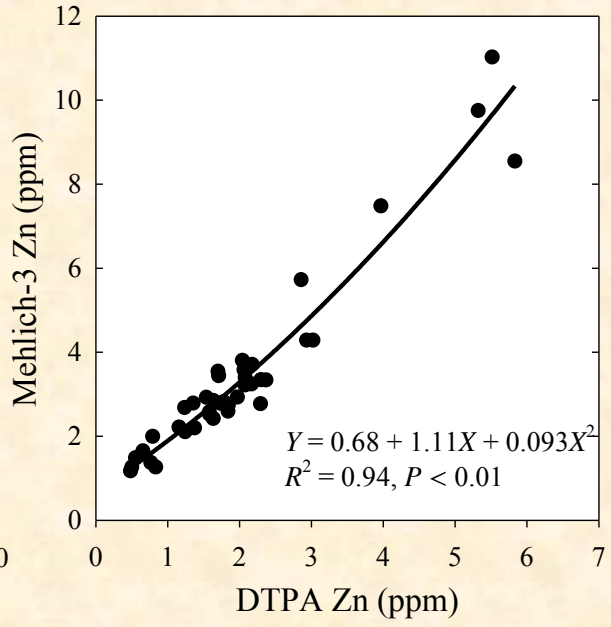


DTPA vs Mehlich-3 Soil Tests

The NCERA-13 Committee recommends the DTPA test for Cu, Mn, and Zn
But many labs use the Mehlich-3 test, when there are no field calibrations anywhere in the North-Central Region

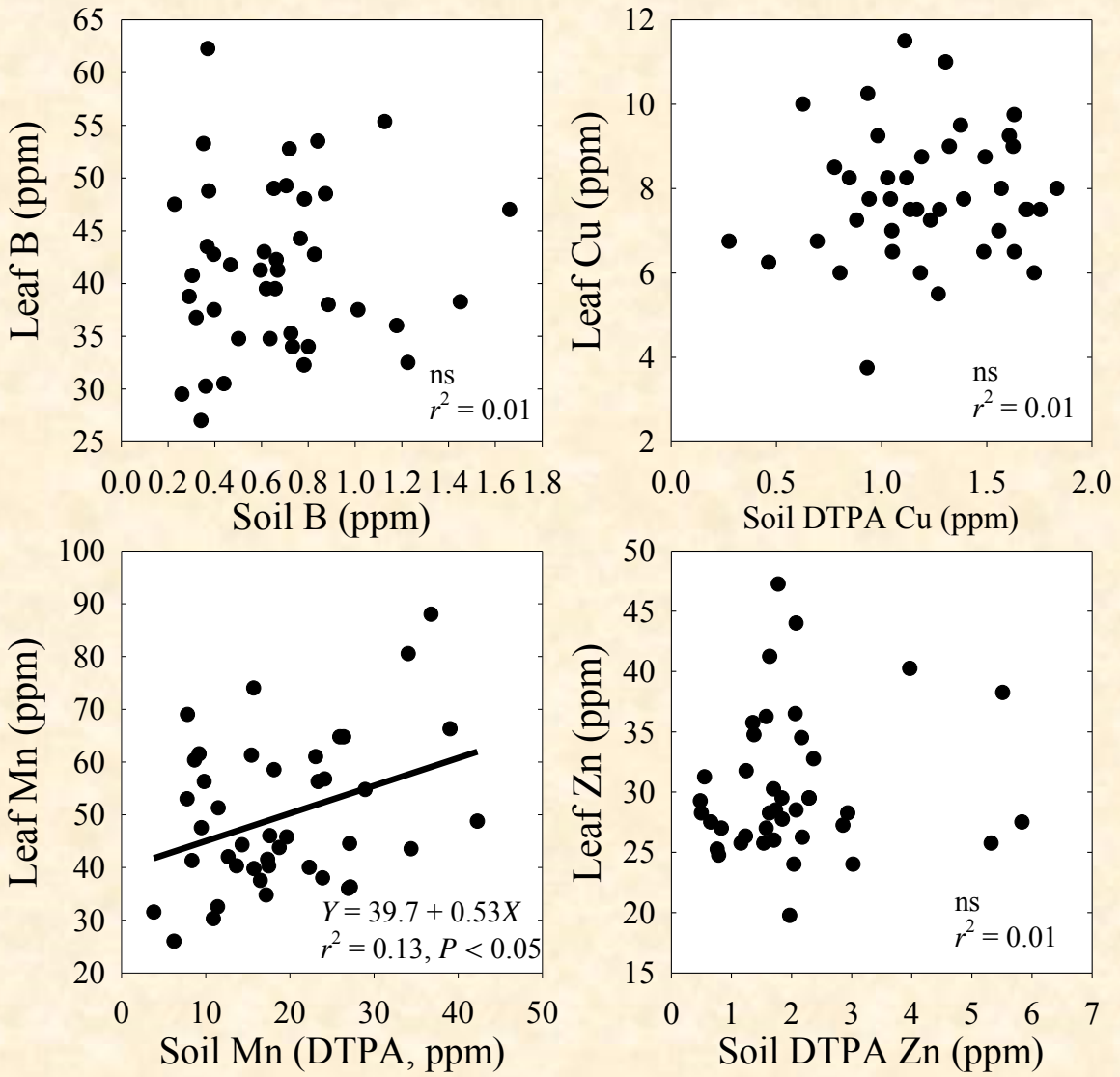






Consideration of pH improves the correlation

Soil & Tissue Tests Didn't Agree Well



Yield Response, Soil Tests, & Expectations

Soil Testing, Single Nutrient Evaluations
80 Sites-Years with Corn and Soybean

Expectation of Yield Increase According to Interpretations In Some States of the North-Central Region

Micronutrient	Soil Test (ppm)	Sites with Expected Yield Increase
Boron (hot water)	0.25 to 2.0	At 1 or all sites
Copper (DTPA)	≥ 0.2	At none
Manganese (DTPA)	≥ 2.0	At none
Zinc (DTPA)	0.75 to 3.0	At 4 or 65 sites

Yield Response, Tissue Tests, & Expectations

Soybean Tissue Testing at R2/R3 Stages
56 Single Nutrient Evaluations

Expectation of Yield Increase According to Interpretations in Some North-Central States and Published Values for the US

Micronutrient	Tissue Test (ppm)	Sites with Expected Yield Increase
Boron	21 to 55	At none or all sites
Copper	10 to 30	At 39 or all sites
Manganese	21 to 100	At none or all sites
Zinc	21 to 50	At 2 or all sites

Published Interpretations & Expectations

Corn Tissue Testing at the Silking Stage
24 Single Nutrient Evaluations

Expectation of Yield Increase According to Interpretations in Some North-Central States and Published Values for the US

Micronutrient	Tissue Test (ppm)	Sites with Expected Yield Increase
Boron	4 to 25	At none or all site-years
Copper	5 to 20	At none or all site-years
Manganese	15 to 150	At 1 or all site-years
Zinc	15 to 70	At 6 or all site-years

So What Are the Findings?

- Very unlikely corn and soybean yield response to micronutrients in Iowa and Minnesota, except for Zn in corn
- Most published sufficiency levels for soil or tissue tests are too high and encourage unneeded fertilization
- Can't develop reliable interpretations without responses, but the lowest published sufficiency could be used as preliminary guidelines

When Are Micros Deficiencies Likely?

Micronutrient	Soil Conditions	Crop
Boron (B)	Sandy or highly weathered soils low in organic matter, drought	Alfalfa, clovers
Copper (Cu)	Acid organic or very sandy soils	Wheat, oats, corn
Iron (Fe)	Calcareous soils pH (> 7.0)	Soybean
Manganese (Mn)	Organic soil with high pH (> 5.8), Calcareous soils pH (> 7.0)	Soybean, wheat, oats, sugar beets
Zinc (Zn)	Sandy or organic, low organic matter due to erosion, calcareous soils	Corn, sorghum
Molybdenum (Mo)	Very acid soils (< 5.5 or so)	Legumes

Adapted from several extension publications in the North-Central region

So What Should You Do?

- The yield level is not a good indication of micronutrients need
- Don't trust much published soil or tissue test interpretations, may use the lowest suggested sufficiency values
- Lime acid soils and watch sandy, badly eroded, or calcareous soils
- If you see a deficiency early, spray and remember the field or spot for next year

Supporters of New Research 2012-2014

- Several Iowa farmers
- Iowa Soybean Association
- Agrium Advanced Technologies
- Brandt
- Nachurs
- Pioneer-Dupont
- Wilbur-Ellis
- Winfield Solutions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