Micronutrient Management

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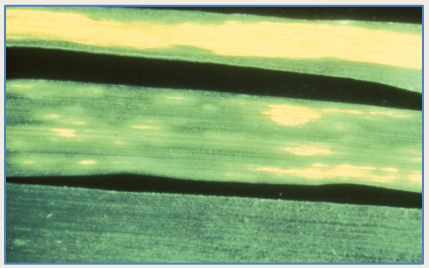
Soil Fertility and Nutrient Management



Essential Nutrients

- Thirteen essential nutrients
  - Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur
  - Iron, manganese, boron, molybdenum, copper, zinc, and chlorine
    - Nickel has recently been added
- By definition, micronutrients are needed in small amount to achieve optimun plant growth.

Essential Micronutrients

- Minor elements or trace elements
- 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
- Excessive levels can cause toxic effects on plants
- In Kansas: Fe, S, Zn, and Cl.
- Other micronutrients: B, Mg, Cu, Mn, and Ni.

Total Micronutrient Levels in the Soil Surface

Micronutrient	Lb/Acre
Iron	70,000
Manganese	1,000
Boron	40
Chlorine	20
Zinc	20
Copper	10
Molybdenum	2

Organic Matter

- Important source of most micronutrients.
- Simple organic compounds as chelates.
- S, Zn and B deficiencies are more likely to occur in soils low in O.M.
- Deficiencies of Cu and Mn are most common in peat soils.

Soil pH and micronutrient availability

- Soil pH affects availability of micronutrients.
- In general the solubility and availability of micronutrients are greatest in acid soils and lowest in high pH calcareous soils.
- Exception is Mo.
- In some soils, high levels of soluble Fe, Al and Mn may be toxic to plants.

Iron (Fe)

- Iron in the plant
  - Catalyst in the production of chlorophyll
  - Involved with several enzyme systems

- Deficiency symptoms
  - Yellow to white leaf color
  - Symptoms first appear on the younger leaves
  - Wide range of susceptibility of different crops
    - Sorghum, field beans and soybeans are more sensitive than corn and alfalfa
    - Varieties differ within crops

Iron deficiency

Factors Affecting Iron Availability

- High soil pH.
- Soils with high salt and carbonate contents.
- Cool, wet springs.
- Poor soil drainage and aeration.
- Susceptible crops/varieties.
- High concentrations of nitrate-N inhibit conversion of Fe^{+++} to Fe^{++}, increasing severity of iron chlorosis.

Soybean Fe Study - 2009

- Varieties (2): high and low IC tolerance.
- Seed treatment: with and without 0.6 lb/acre of EDDHA Fe (6%).
- Foliar treatments:
  - 0.1 lb/acre EDDHA Fe (6%)
  - 0.1 lb/acre HEDTA Fe (4.5%)
  - No foliar trt
- 4 locations with 5 replications

Objectives

- Evaluate fertilization strategies.
- Determine soil parameters (diagnostic):
  - Fe, Mg, P, K, Ca, OM, OC, TN, pH, EC, Carbonates, nitrate-N .
- Determine “optimum” plant tissue level.
- Evaluate possible interaction of parameters, both in soil and plant.
  - Possible Fe-Mn interaction?

Effect of soil nitrate?

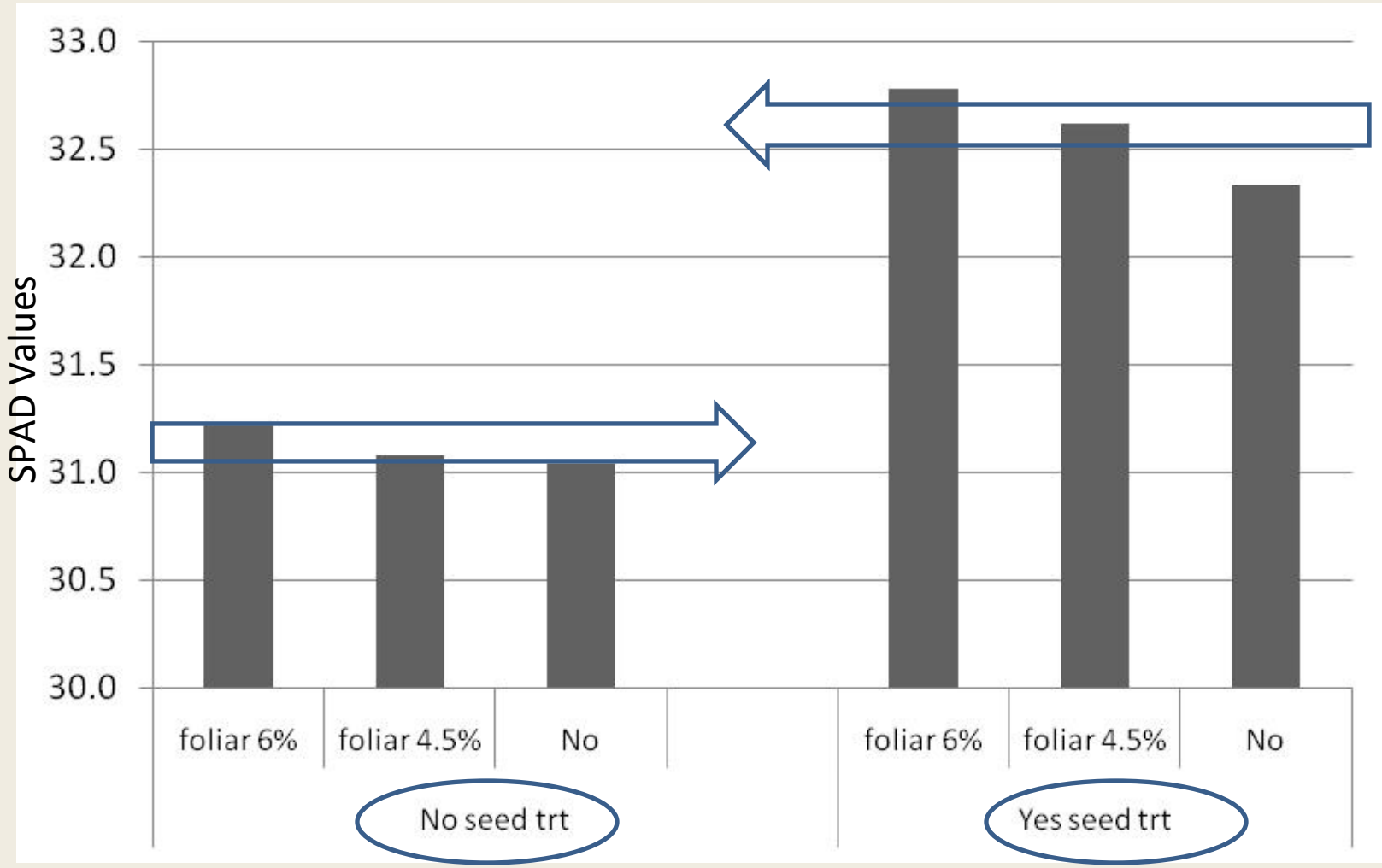
The nitrate theory

- Iron is part of the chlorophyll molecule
- Iron taken up as Fe+++ (ferric)
- Iron in chlorophyll exists as Fe++ (ferrous)
- High concentrations of nitrate-nitrogen inhibit conversion of Fe+++ to Fe++
- Reduce nitrate in soybean plants with the use of a competition crop

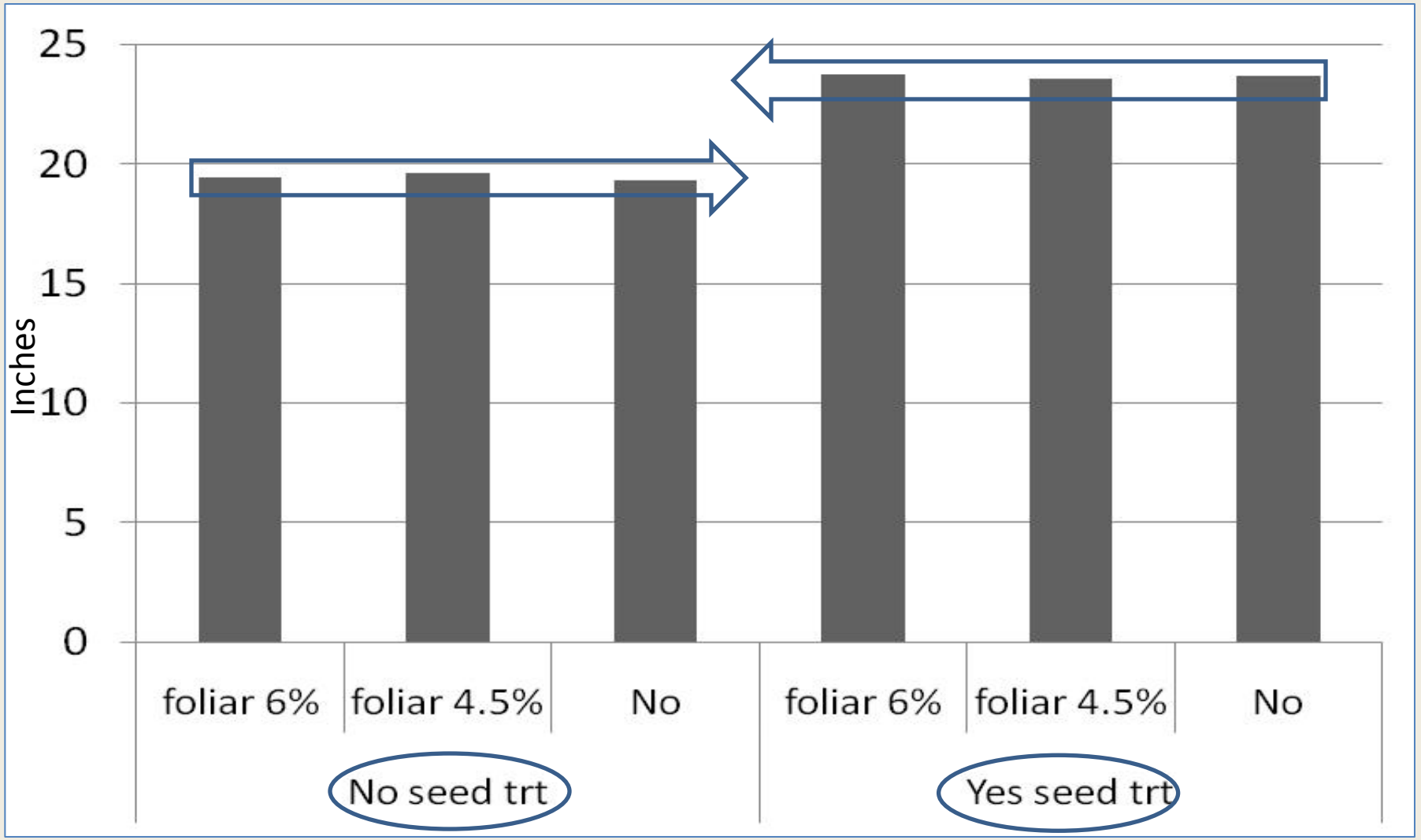
Soybean seed treatment with Fe chelate

Seed treatment

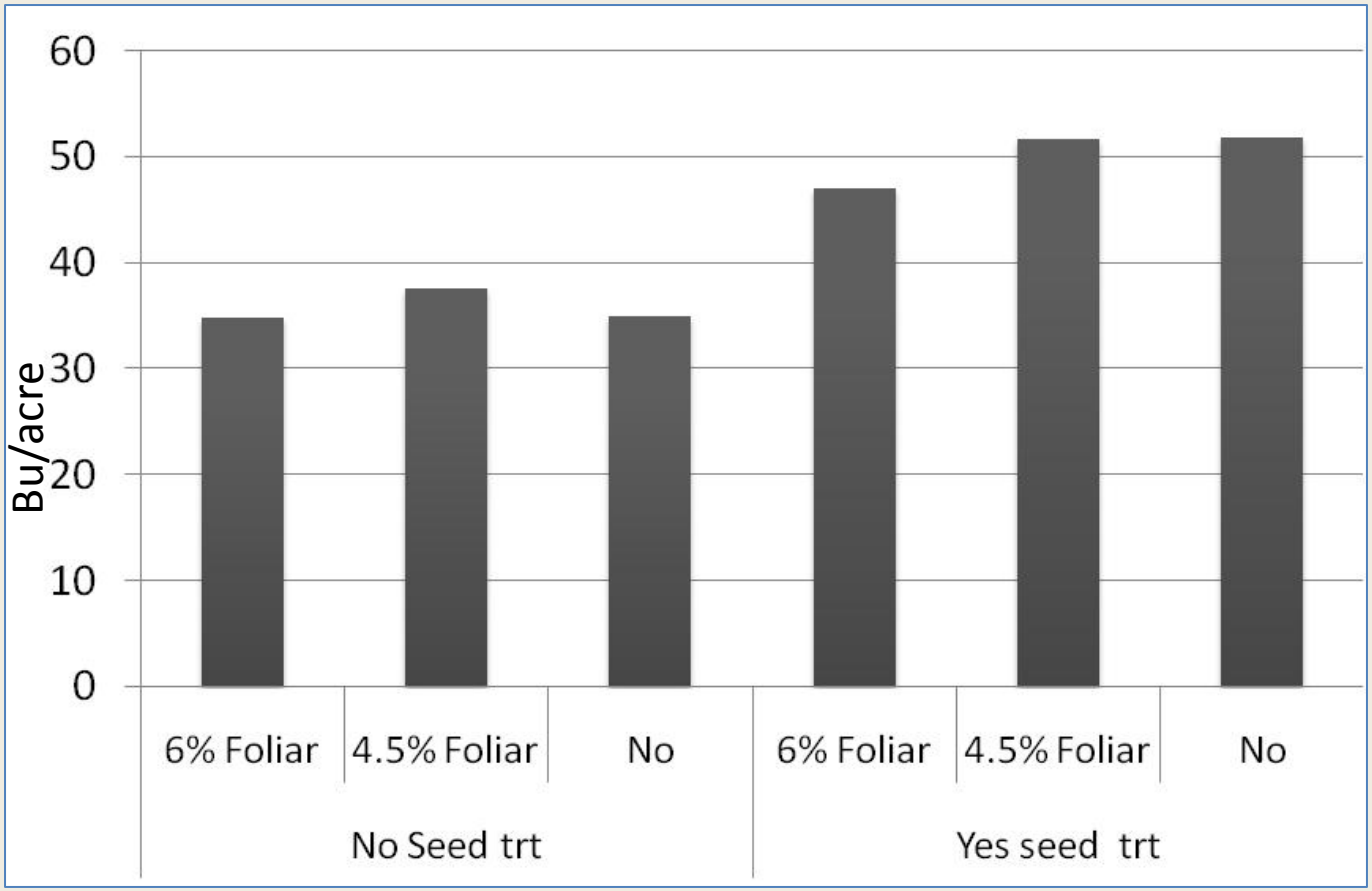
Chlorophyll meter readings



Plant height at maturity



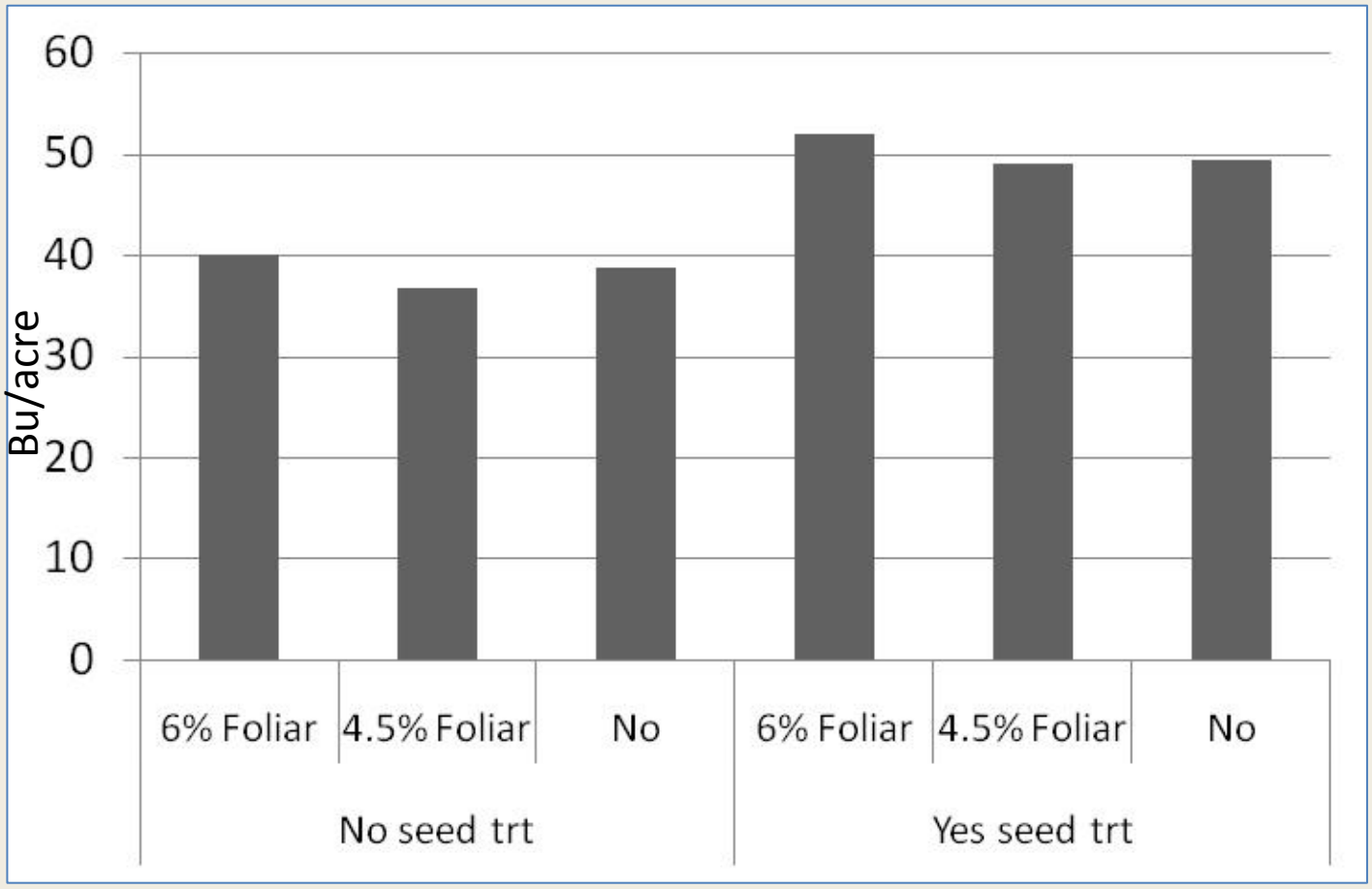
Soybean yield: seed and foliar treatment



Labels	Average yield
W/O Seed trt	**36**
6% Foliar	35
4.5% Foliar	38
No	35
W seed trt	**50**
6% Foliar	47
4.5% Foliar	52
No	52

Var AG2906: Very Good IC tolerance

Soybean yield: seed and foliar treatment



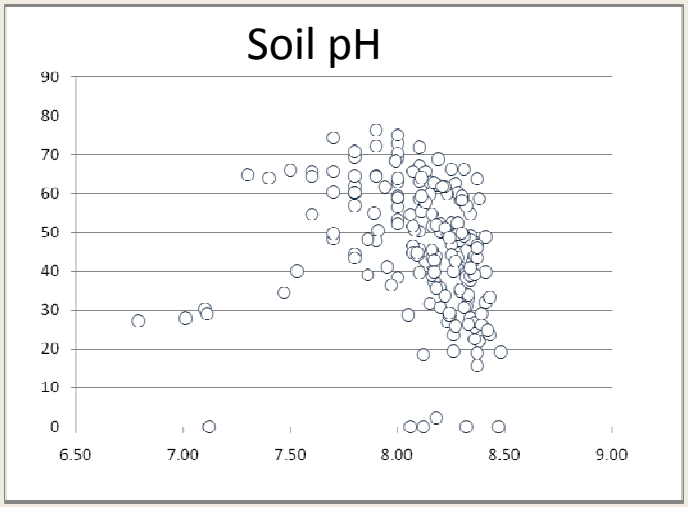
Labels	Average yield
W/O Seed trt	**39**
6% Foliar	40
4.5% Foliar	37
No	39
W/ seed trt	**50**
6% Foliar	52
4.5% Foliar	49
No	49

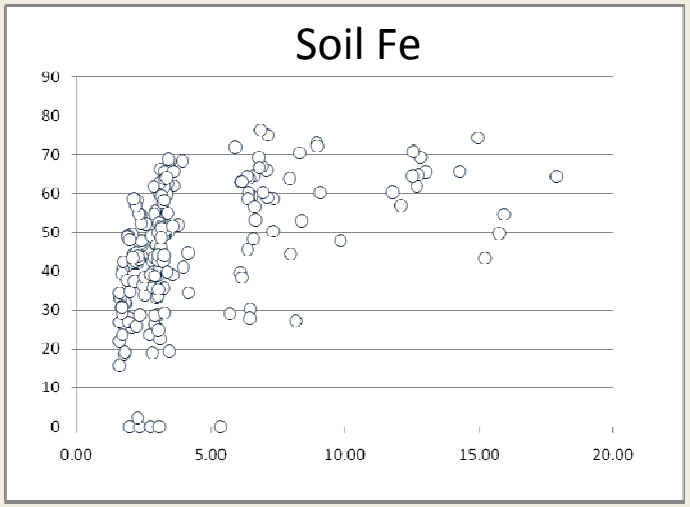
Var AG3205: Low IC tolerance

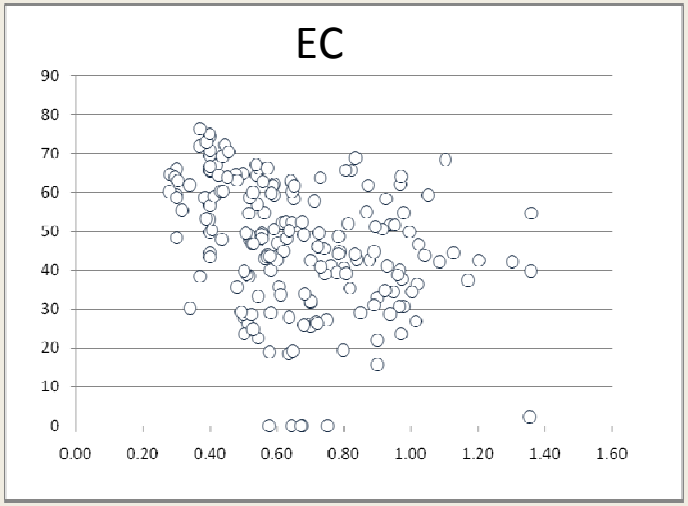
Are these yield values significantly different?

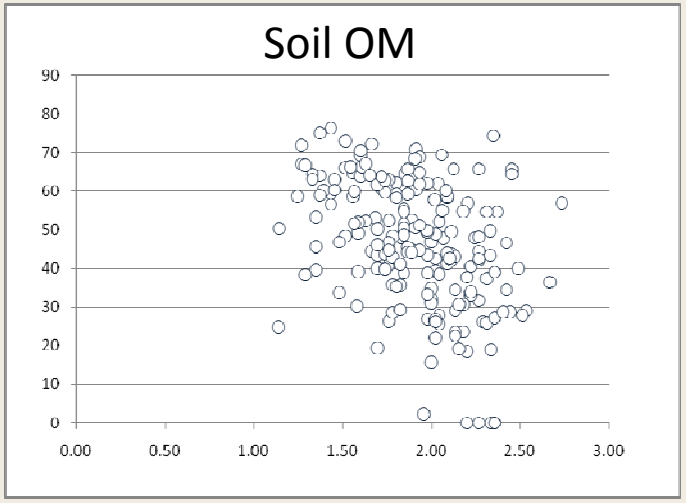
Effect	F Value	Pr > F	Significance
Variety	2.11	0.1487	NS
Seed trt	69.6	<.0001	S
Foliar	0.05	0.9553	NS
Var*Seedtrt	0.19	0.6616	NS
Var*Foliar	2.1	0.1268	NS
Seedtrt*Foliar	0.1	0.9004	NS
Var*Seed*Foliar	0.27	0.7631	NS

Some soil parameters









Foliar Applications

- Applications must be done before plants are severely damaged by chlorosis and may need to be repeated.
- One of several iron chelates/complexes may be used. Economical benefit need to be evaluated.
- Critical timing
  - By the first or second trifoliate leaf

Fertilizer Sources of Iron

- Deficiencies occur more frequently than most other micronutrients in Kansas
- Patchy or irregular appearance in the field
- Success with iron fertilization is difficult
  - Difficulty in correcting Fe deficiency with soil-applied fertilizer
    - Iron quickly converted to unavailable form.

Common Iron Fertilizers

Fertilizer Source	Fe (%)
Iron Sulfate	19-40
Iron Chelates	5-12
Other Organics	5-11
Manure - best	??

Average animal manure micronutrient content of different animal sources

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

Manure/Biosolids as source of micronutrients

- Biosolids/manure can be excellent sources of Fe and micronutrient nutrition for higher plants
- Soils with application histories can show higher micronutrient availability levels than those receiving commercial fertilization.
- Maintaining adequate soil pH for crop production should ensure good micronutrient availability.

Summary -Fe

- Fe deficiency potential can not be explained well by a single soil parameter.
- Development of an “index” may be the best alternative.
- Foliar treatment seems to increase the “greenness” effectively. But seed coating provides higher yield increases.

Summary – other micros

- The ability to coat seed with micronutrient is a concept that deserve further investigation.
- There is again a recent interest for foliar application of nutrients.
- Increased interest for mixing micronutrients with fluid fertilizer for band application.
- Several nutrients in each dry fertilizer granule uniform distribution of nutrients?

Questions?

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