What's New with Micronutrients?

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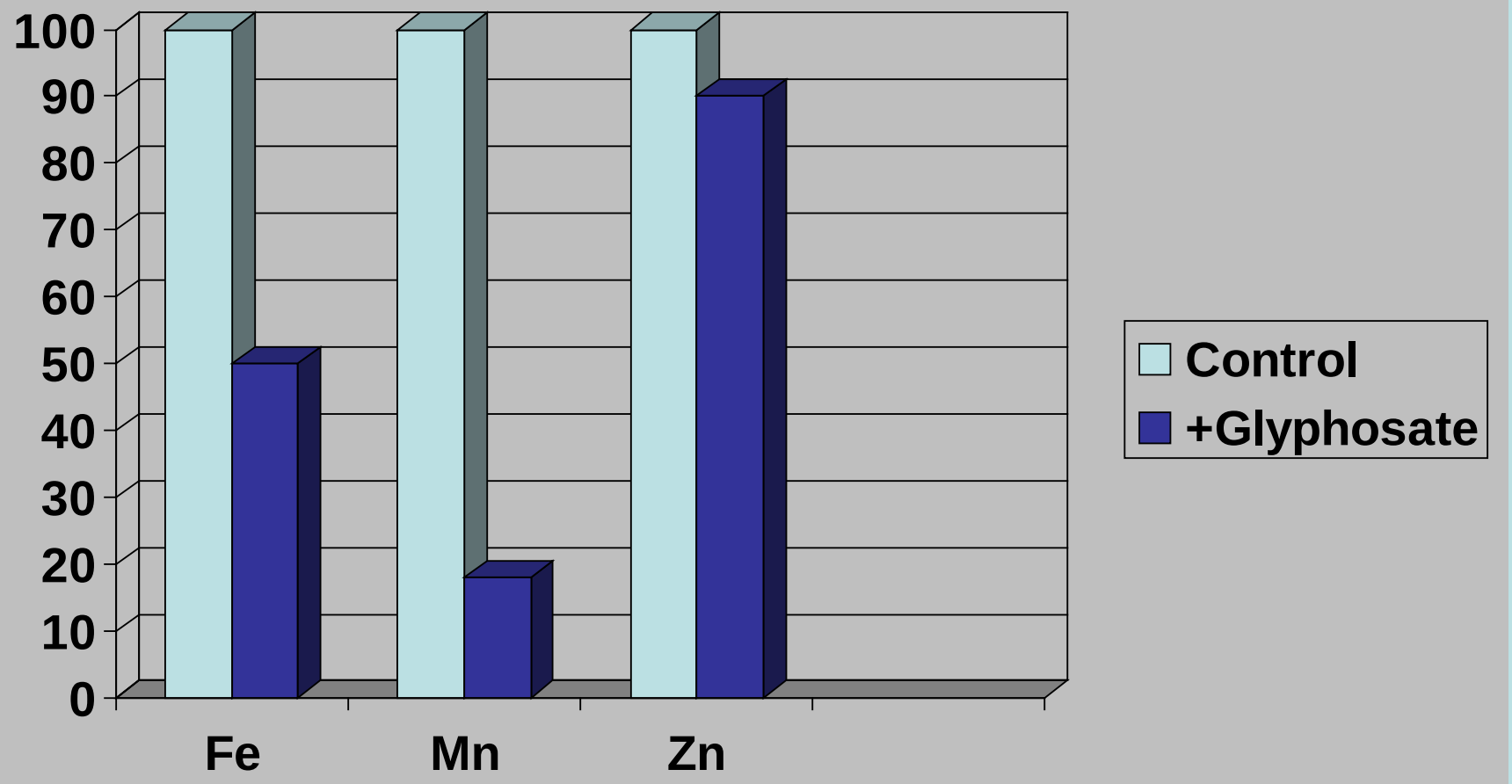
Situation

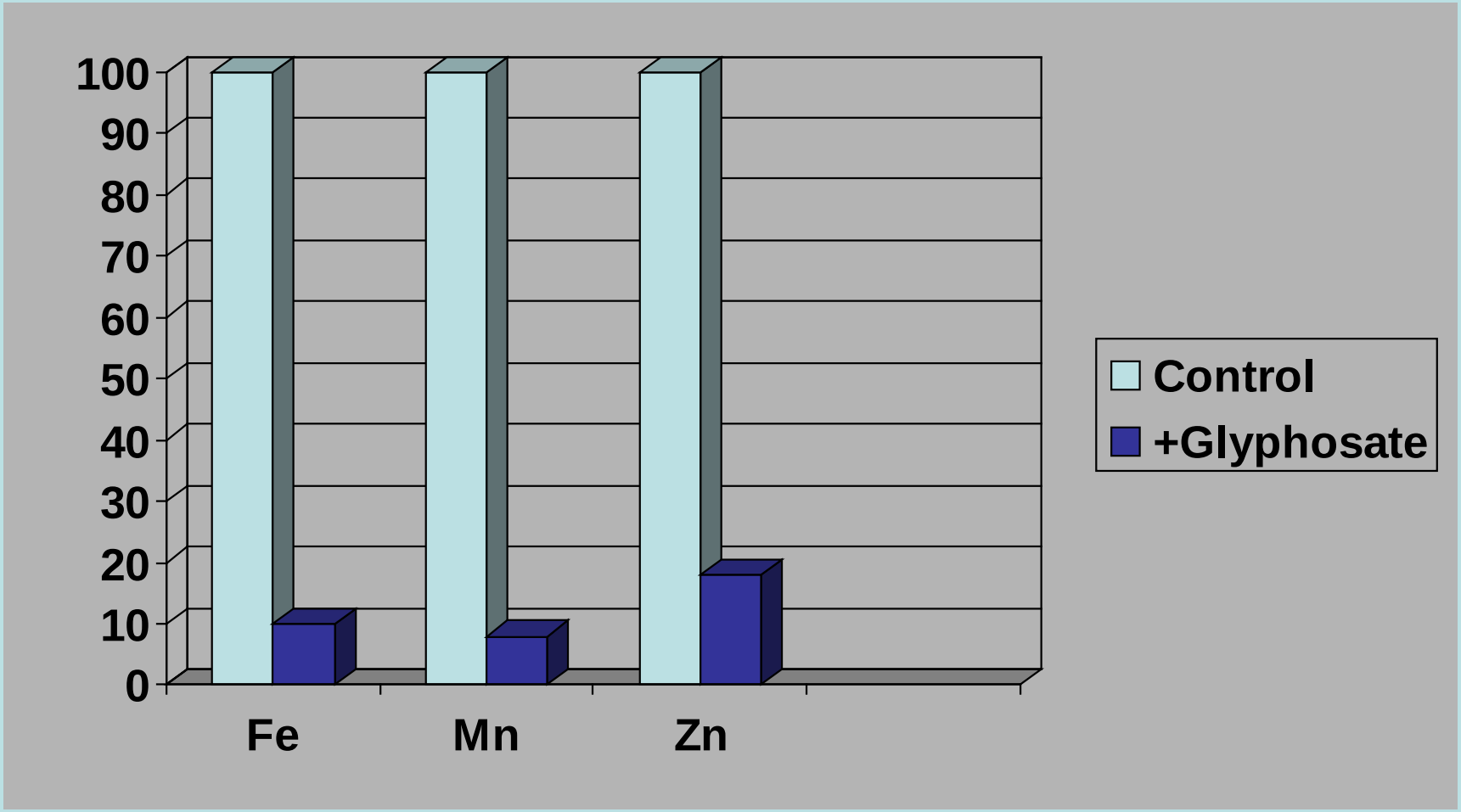
- With high commodity prices the tendency is to chase these small, ~2 bu/ac yield increases
- Micros are being increasingly scrutinized
  - We don't know much about them
  - Past research has shown no response
- Research has shown a link between Glyphosate tolerant soybean and reduced micro uptake and translocation

Purdue work (Huber)
Root uptake (%)



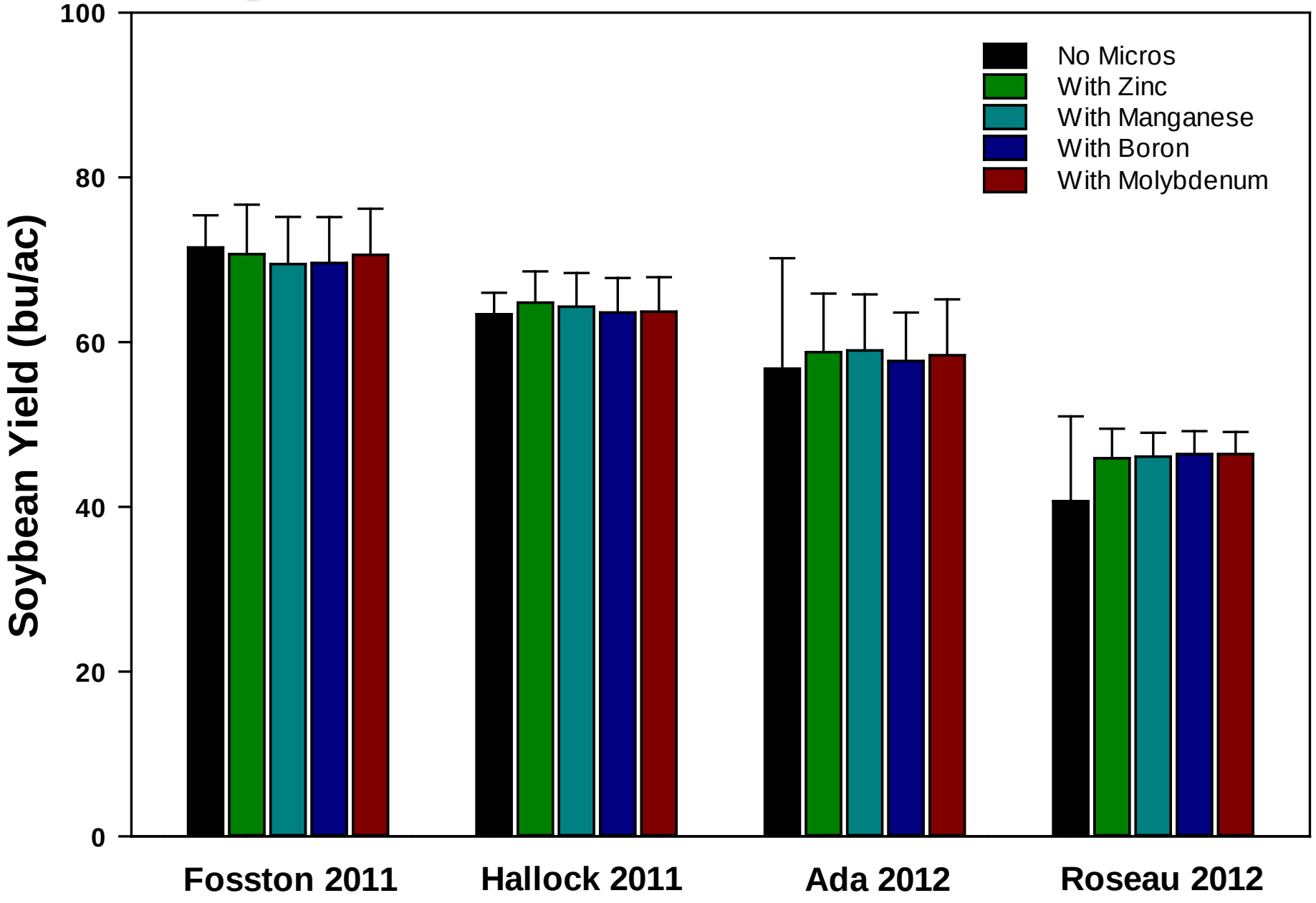
Glyphosate at 2.5% of recommended rate.

Purdue work (Huber)
Translocation to shoot (%)



Glyphosate at 2.5% of recommended rate.

Soybean Micronutrient Yield



MEZ for SB Studies 2011-12

Table 3. Soybean MEZ yield summary by treatment for each location in 2011 and 2012.

	Treatment					
Site	Chk	N	N+P	N+P+S	MEZ	*P*>*F* †
	----------bu/ac----------					
Hallock '11	57	60	60	58	58	0.50
Lamberton '11	52	52	50	54	51	0.42
Rock Dell '11	35	33	35	32	33	0.84
Warroad '11	41c	49a	47ab	51a	44bc	0.02
Waseca '11	51	50	52	53	52	0.38
Crookston '12	32	31	31	31	30	0.72
Hallock '12	51	50	46	45	49	0.81
Lamberton '12	51	49	49	50	49	0.25
Rochester '12	48b	51a	53a	52a	51a	0.05
Rock Dell '12	41	45	45	43	44	0.43
Waseca '12	49b	50b	54a	55a	53a	0.01

† Treatments are significantly different when $P \leq 0.05$. Numbers followed by the same letter are not signfiicantly different

Nitrogen

Nitrogen

Phosphorus

Iowa early season foliar fertilization research, 1994-1998

Trial set	No. of site-years	Site-years with positive yield response	Positive response frequency	Avg. positive yield response	Site-years with negative yield response	Negative response frequency	Avg. negative yield response
			------ % ------			------ % ------	
3-18-18	21	6	29	7	1	5	6
3-18-18 strip trial	8	1	13	1	-	-	-
N-P-K various	27	3	11	8	3	11	10
N-P-K various + micros	18	2	11	7	-	-	-
All trials	**74**	**12**	**16**	**6**	**4**	**5**	**9**

Mallarino et al., 2005 (Better Crops, vol. 89)

Summary on Soybean

- We have not seen any nutrients become more deficient due to higher commodity prices
- Manganese is not any more deficient now than before
- We still have some questions for SB, but I do not think the probability of a response is high
- Gyphosate has not tied up all the micros!

Manganese (Mn)

- Deficient soils are the problem
- Research at Purdue (Huber, 2003) found a relationship between glyphosate resistant soybeans and Mn deficiency in the plant
- Glyphosate resistant soybeans appeared to have problems in Mn uptake and efficiency in the plant
- Plant were exhibiting “Glyphosate Flash” a few days after application
- Problem was worse after over application of glyphosate
- Problem is typified by interveinal chlorosis on new leaves
- Foliar applied or Mn broadcast has been looked at to correct deficiencies
- Actual yield loss from this problem has been debated
  - Application of Mn has been shown to increase yields in irrigated soybeans (Kansas)
  - Other research has not shown a positive response to Mn fertilization (Ebelhar, 2007 Illinois)


Boron Toxicity in Soybeans
5 lb/ac B broadcast preplant
Sandy soil – Dry spring

Corn Micros Data 2011-2012

Table 2. Corn yield (@ 15.5%) summary by treatment for each location.

	Treatment						
Site	Chk	-Zn	-Mn	-Cu	-B	All	P>F†
	----------bu/ac----------						
Oklee	105	117	109	116	113	109	0.26
Rochester '11	243	238	241	227	237	233	0.30
Staples	189c	191bc	197ab	191bc	202a	199ab	0.03
Westport	196	193	194	199	194	189	0.69
Gaylord	198	189	185	191	184	199	0.12
Montgomery	168	179	191	179	191	190	0.18
Rochester '12	141	152	158	157	155	152	0.74

† Treatments are significantly different when $P \leq 0.05$.

2009-2010 Zinc for Corn: Red River Valley

	Corn Grain Yield (bu/ac)				
Zinc Rate	0	5	10	15	LSD
Polk ‘09	171	164	169	167	ns
Mahnomen ’10	168	169	179	191	13
Red Lake ’10	211	199	195	194	ns
Marshall ‘10	134	132	143	135	ns

**Soil test Zinc (DTPA): Polk ’09 1.36ppm; Mahnomen ’10 0.37 ppm; Red Lake ’10 0.65 ppm; Marshall ’10 0.55 ppm.

***Zinc rates applied as broadcast Zinc Sulfate (36% zinc)

Corn

- Targeting zinc is the best approach
  - Yield increase is still not guaranteed
- Corn can be sensitive to copper deficiency
  - Right now I'm not convinced we see Cu deficiency unless on high organic soils.
- I don't trust the boron soil test
  - I don't think B is a problem for corn
- Corn should not be sensitive to manganese deficiency


Zinc Deficiency

Sulfur Deficiency

Even with high commodity prices you can lose money! –Foliar Ex.

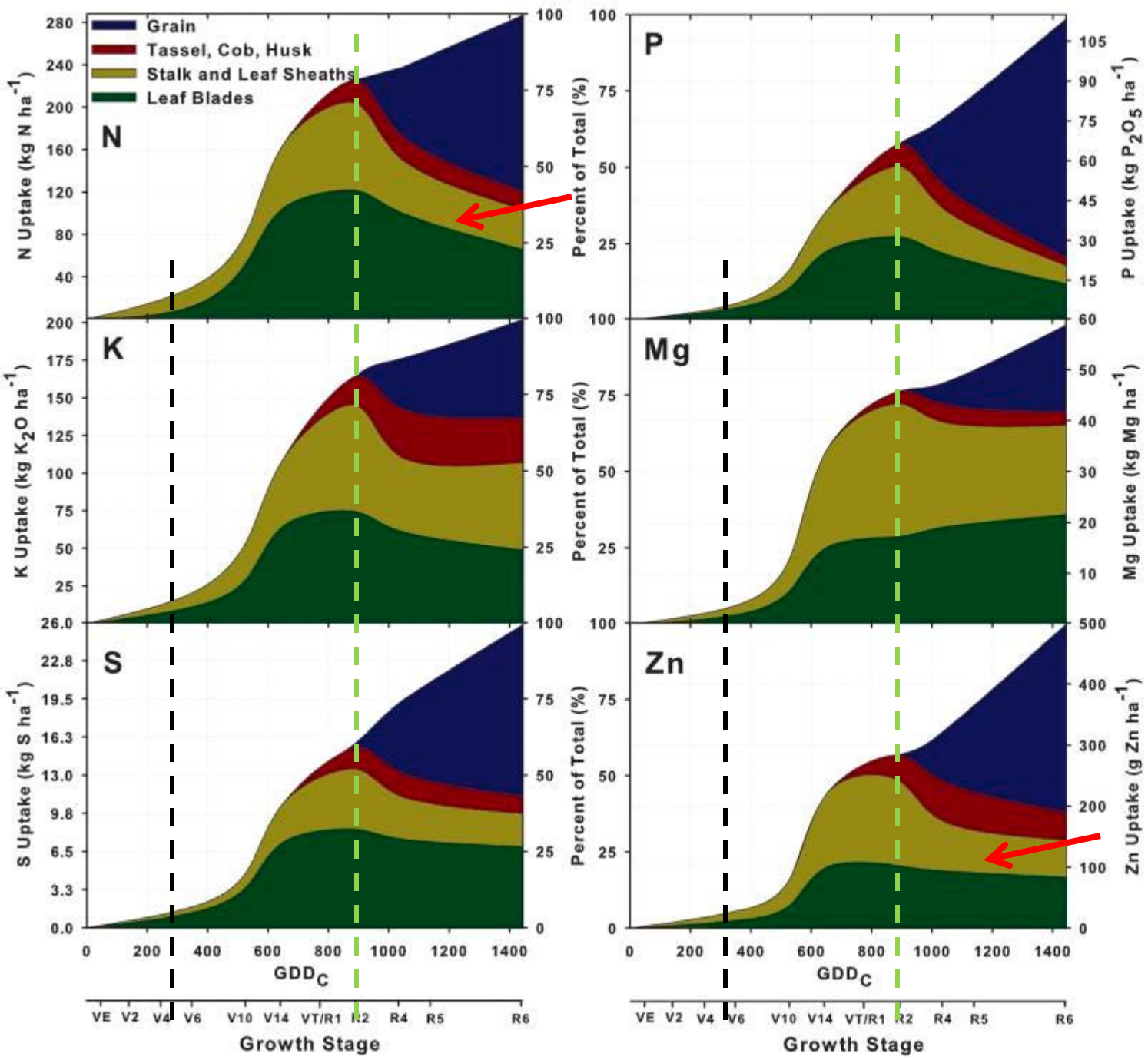
- Say soybeans priced at $20 per bu
- Say you get a response 10% of the time for SB for foliar
- Say the average response is 2 bu
- Fertilizer treatment is $25/ac on 1500 acres
- Total cost: $25 * 1500 = $37,500
- Return: 1500 * 0.1 * 2 * $20 = $6,000

Micronutrients

- Since we seldom see issues with micronutrients therefore we have trouble identifying critical levels using the sufficiency approach
- Best option is to assume everything is okay and use the mean values and standard deviation of mean
- Gives a sort of sufficiency range

Tissue Testing

- Do we know if the current data actually has any yield data to back it up
- Responses are not as likely to some nutrients, where did the sufficiency data come from?
- When do you take the sample, early in the season the total amount of nutrients taken up is low
- Micros are immobile, what does that mean for tissue concentration and nutrient placement and timing?



Illinois Data

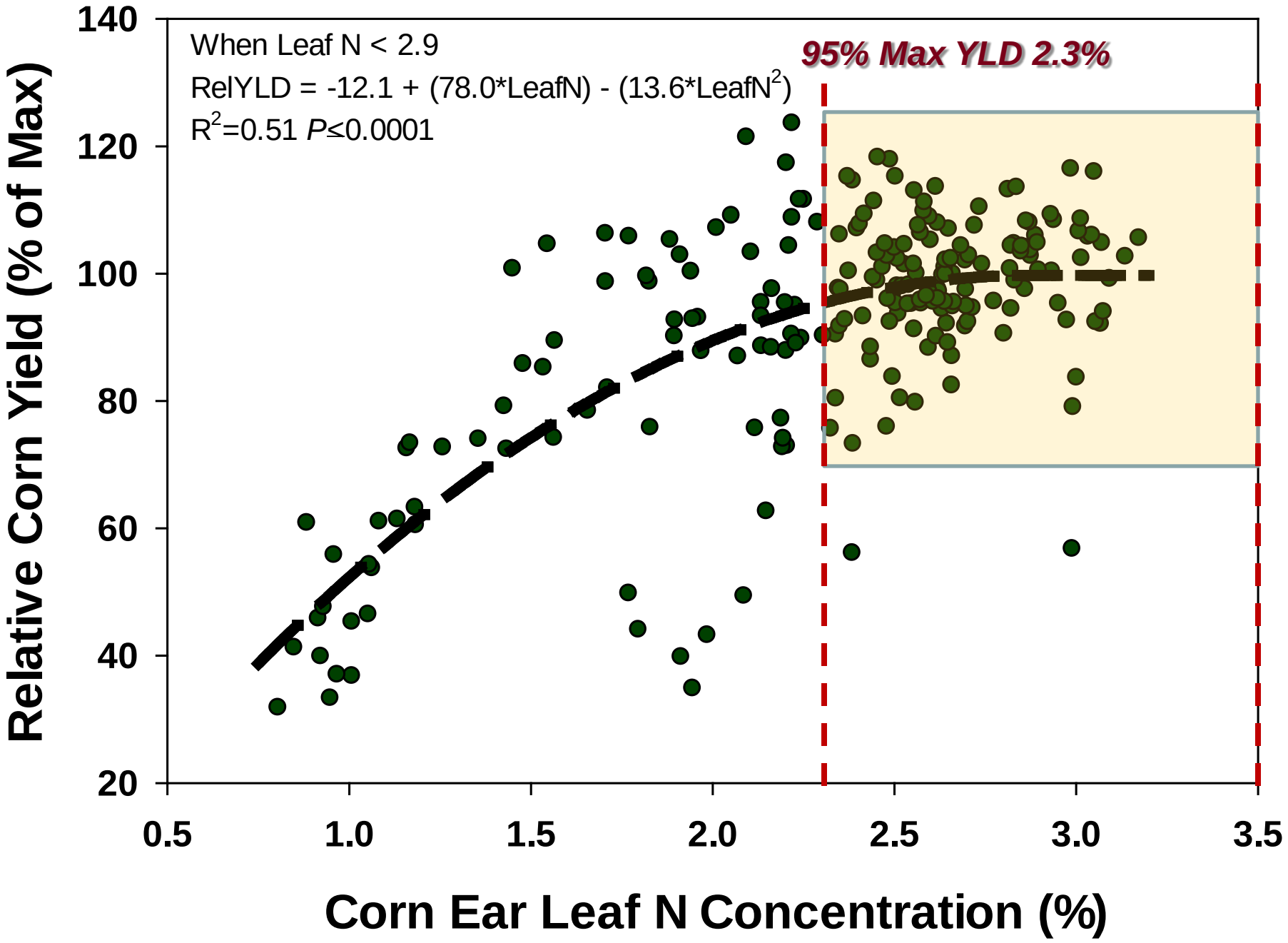
Published in Agronomy Journal

Bender, Haeglele, Ruffo, and Below

Uptake of transgenic hybrids

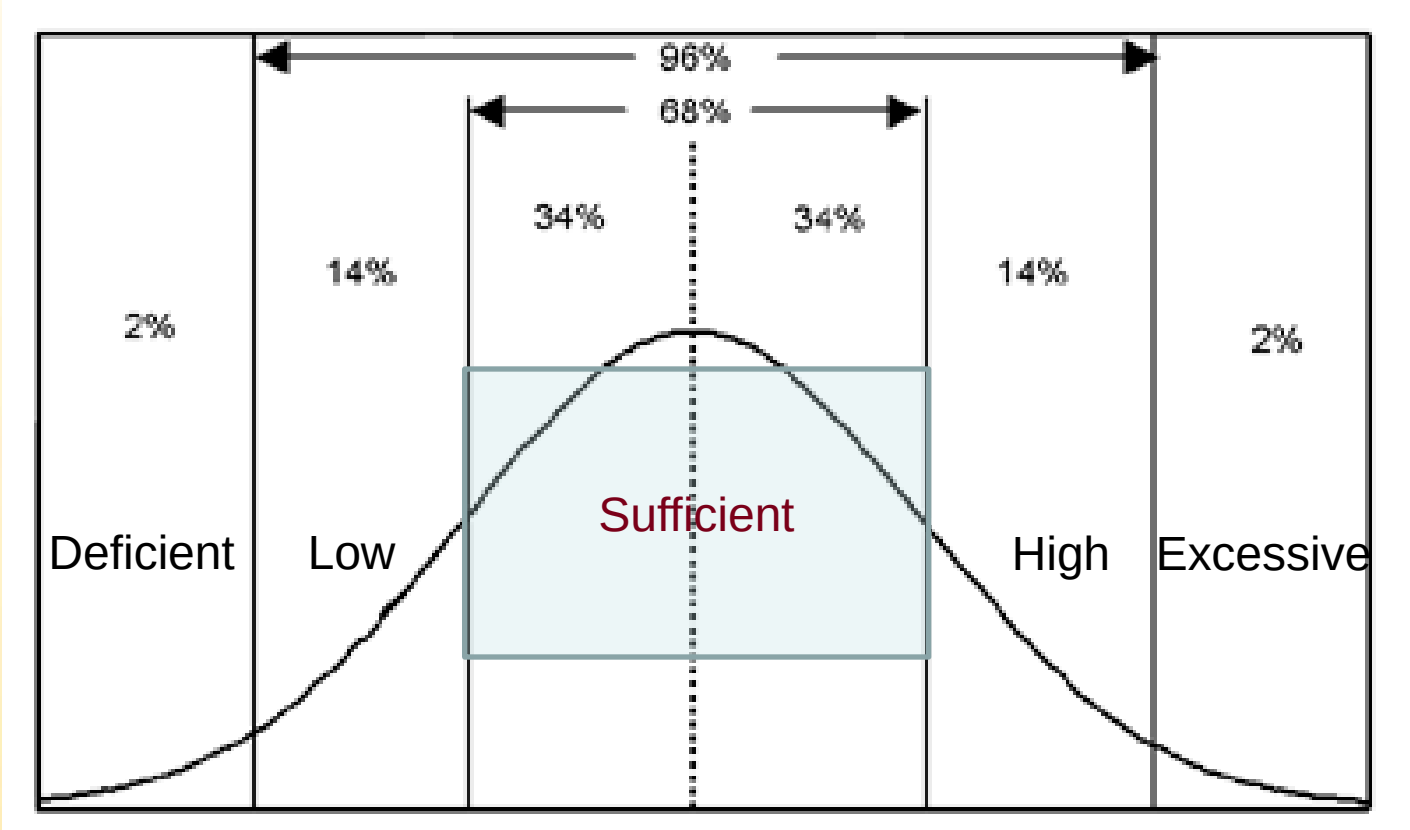
6 hybrids

https://www.agronomy.org/publications/aj/articles/0/0/agronj2012.0352?highlight=


When Leaf N < 2.9
RelYLD = -12.1 + (78.0*LeafN) - (13.6*LeafN2)
R2=0.51 P≤0.0001
95% Max YLD 2.3%
Relative Corn Yield (% of Max)
140
120
100
80
60
40
20
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Corn Ear Leaf N Concentration (%)

Normal Distribution Curve

How it Relates to Plant Analysis?

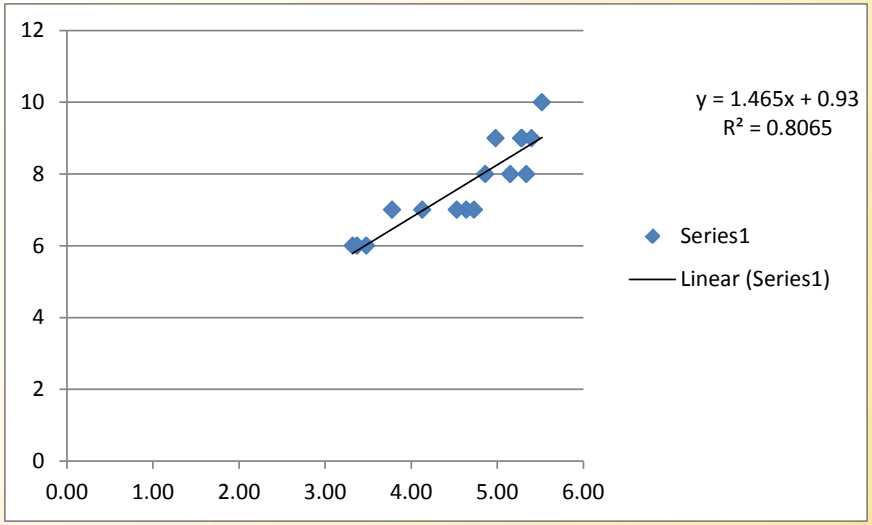


	2 Stdev	1 Stdev	Mean	1 Stdev	2 Stdev
R2 soybean Manganese	22	48		100	126
		35-57 bu	36-64 bu	51-67 bu	

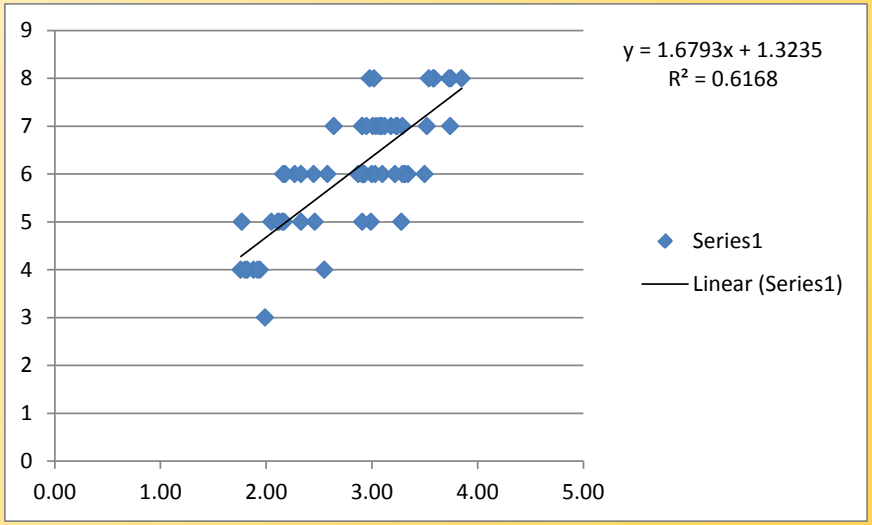
Copper vs. Nitrogen in Flag Leaves

1 location 4 Varieties and 4 N rates: 2010

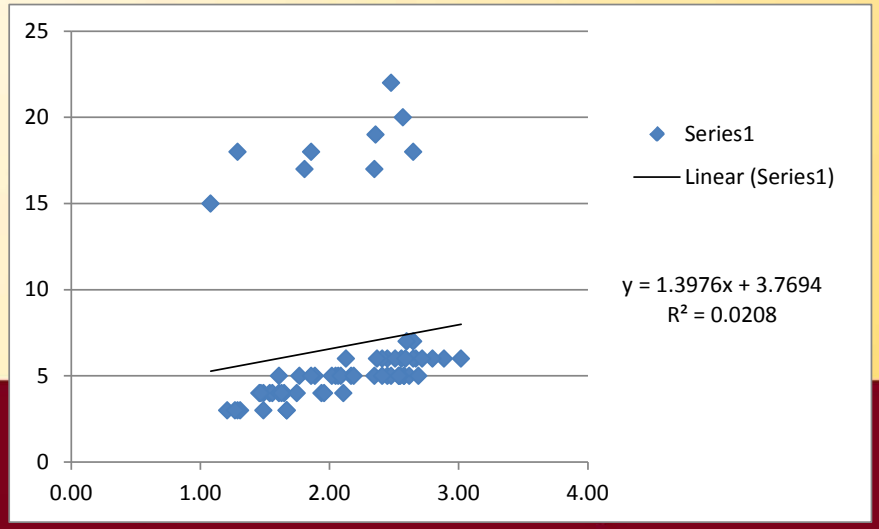
Pre-Anthesis



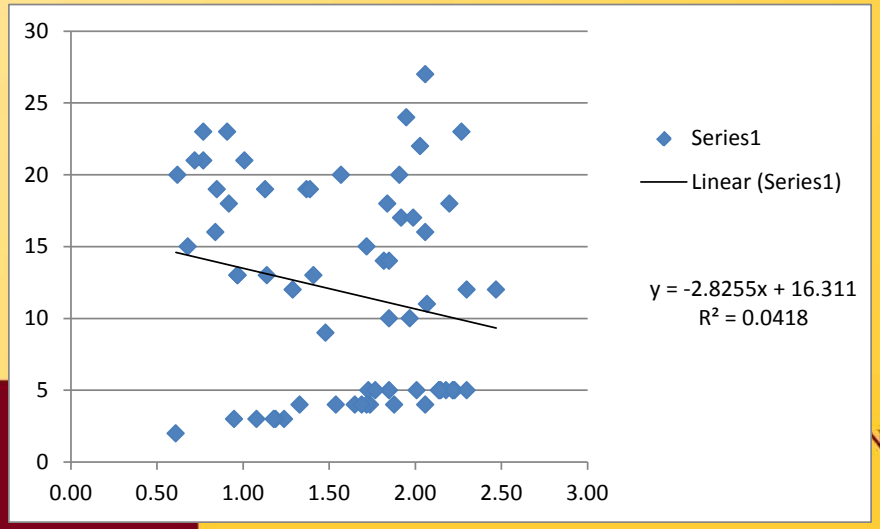
Anthesis



Anthesis + 10d



Anthesis + 20d



NSION

Hybrid Differences - 2012

6 Southern MN locations – 34 hybrids

Hybrid	N (%)	P (%)	K (%)	Zn (ppm)
Agrigold 6252 VT3 Pro	***2.69***	***0.24***	***1.39***	***15.9***
Dairyland DS9501 SSX	2.83	***0.30***	***1.36***	16.9
DKC 48-12	2.86	***0.31***	1.59	***18.7***
DKC 52-04	***3.09***	0.27	***1.36***	***18.7***
G2 5X-0004	2.80	***0.33***	***1.38***	***14.6***
Pioneer 0062 XR	***2.64***	0.28	1.59	***15.6***
Pioneer 9917 AM1	2.79	0.29	1.58	17.9
Renk RK629VT3P	2.84	***0.25***	***1.66***	16.4
Titan Pro X2M00-SS	2.84	***0.25***	***1.47***	***18.3***
Wensman W9288 VT3PRO	2.85	***0.25***	***1.43***	17.8

Hybrids represent a subset of the 34 hybrids sampled, LSD=0.30 from analysis of all 34 hybrids

Location Differences - 2012

Location	N (%)	P (%)	K (%)	Zn (ppm)	Precip. Jun-Jul
Hutchinson	2.61(11)	0.30(44)	2.11(247)	17(3.7)	8.52
Lamberton	2.74(29)	0.22(36)	1.14(151)	17(0.9)	2.00
Morris	2.90(12)	0.33(12)	1.52(119)	16(1.5)	4.28
Rochester	3.03(9)	0.28(22)	1.25(138)	18(1.0)	6.50
Rosemount	3.13(31)	0.25(10)	1.51(156)	18(1.3)	10.69
Waseca	2.75(6)	0.25(9)	1.51(177)	19(0.8)	5.32
Crookston	3.07(67)	0.26(10)	1.78(143)	18(0.4)	5.41
Fergus Falls	2.75(45)	0.24(18)	0.95(129)	21(1.5)	7.10*
Staples	3.22(14)	0.33(36)	2.52(100)	22(6.8)	9.63*

Number in parentheses represents the soil test value.
*Precipitation is given for the nearest weather station

Does Low = Deficient

Corn Zn Study Example – 4 locations

Zinc Rate (lb/ac)			Zinc Rate (lb/ac)	
0	15		0	15
Yield (bu/ac)			Ear Leaf Zn (ppm)	
201	206		25	31
185	193		19	27
207	212		12	12
121	124		19	26

** Data averaged across 3 sources of zinc

- Zn soil tests were >0.75
- No statistical yield response at any location
- Zn levels were marginal to low at most sites when no Zn was applied

Tissue Sampling

- Tissue sufficiency levels were not made with the intention of using them for predicting where fertilizer is needed
- Early season samples are worthless, especially if you are only taking one sample from a field
- Chances are the probability is the same that a treatment will work even if you have a tissue sample

Micronutrient Deficiency Sensitivity

- Zinc – corn and edible beans
- Boron – alfalfa
- Copper – small grains, corn?
- Chloride – small grains
- Iron - soybeans
- Manganese – reported effects in soybeans, no data in MN
- Molybdenum - soybeans

Thank You
Questions?

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http://www.extension.umn.edu/nutrient-management/index.html