Micronutrient fertilization for corn and soybean

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Introduction

Improvements in crop genetics and increased yield potential with a more intensive production system typically involve a greater demand for commercial fertilizers to secure maximum yields. This raises the question about the role of secondary and micronutrient fertilizers to increase yields. Some soil conditions such as high soil pH and low organic matter may also contribute to decrease the supply of micronutrients to crops. Consequently, there is an increasing interest from producers about the potential benefits of micronutrients as complement of their fertilization programs to maximize yields in corn and soybean.

Recent studies evaluated micronutrients for corn and soybean using small plots with positive results under specific soil conditions. However, yield response is scarce under "average" soil conditions with naturally high productivity. Most of the recent studies were completed using conventional small plots with minimum variability. However, one of the challenges at the field scale is soil variability. This summary presentation include a combination of small plot research as well as strip trials evaluating field-scale soil variability and response to micronutrients. Furthermore, some specific soil conditions such as sandy soils and high pH soils were evaluated in some experiments at specific locations, including average and high yield potential.

Soybean strip trials

Results shown here are for two sites in 2014. Both sites had values above critical soil levels of P, K and Zn according to Kansas State University Soil Testing Laboratory (Table 1). The soil tests for micronutrients showed high variability across the field. Availability of micronutrients can be affected by soil pH. On site 1, the pH ranged from 4.5 to 7.0 (Figure 1). At a pH values <7.0, Zn and Mn showed the lowest soil test values. The same trend can't be easily seen for site 2, likely due to less pH variability when compared to site 1. Tissue concentration of Zn was between the published nutrient sufficiency range (21-50 ppm). Significant differences were found in each site and across sites for Zn tissue concentration; the fertilized treatment had higher values compared to the control (Table 2). Sulfur fertilization had no effect on S tissue concentration, this result is different from those found by Kaiser and Kim (2013), and may be related to the form of fertilizer used for these studies. The tissue Mn concentrations were all above the critical level (Mills, 1996). Manganese tissue concentration was significantly affected only in site 2. Copper fertilization showed no effect on copper concentration in soybean tissue.

Table 1. Chemical analysis of soil previous to fertilizer application for two sites in KS.

Site	Statistics	Organic Matter	P	K	B	Cu	Mn	Zn
		%	*ppm*					
1	Minimum	1.9	24	120	0.35	0.8	10.2	1.0
	Maximum	3.5	123	293	0.87	2.7	76.2	6.1
	Standard Deviation	4.0	24	36	0.10	0.5	15.6	1.1
2	Minimum	2.9	23	157	0.40	1.1	23.5	2.7
	Maximum	3.9	69	256	0.70	2.0	45.1	8.5
	Standard Deviation	0.2	12	24	0.10	0.2	5.2	1.6

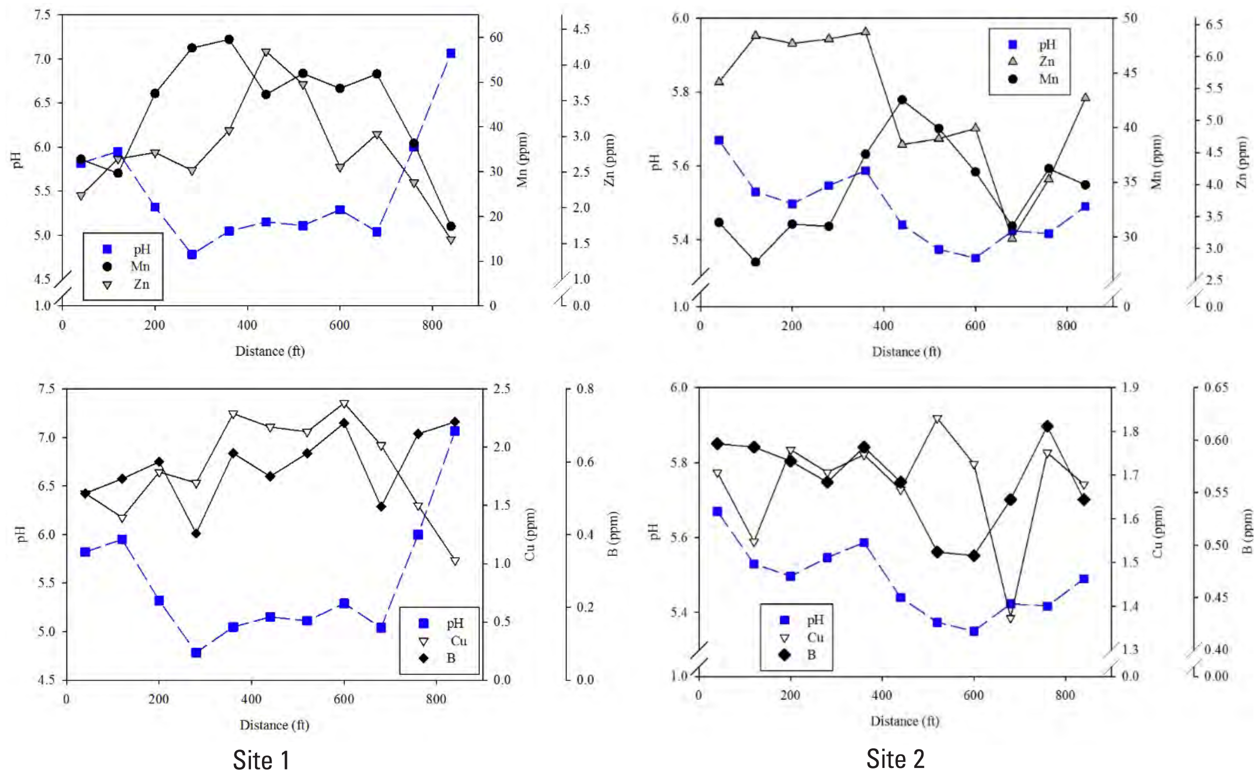

Figure 1. Soil manganese, zinc, copper, boron and pH across sites 1 and 2 in 2014.

Table 2. Copper, zinc, manganese and sulfur concentration on trifoliates at R2-R3 stage for the fertilized and control treatments.

Sites	Treatments		P<F
	Fertilized	Control	
	- - - Cu (ppm)- - -		
1	8.95	9.04	0.587
2	8.87	8.81	0.636
Average	8.907	8.92	0.851
	- - - Zn (ppm)- - -		
1	42.8 a†	39.1 b	0.004
2	42.9 a	38.6 b	<0.0001
Average	42.9	38.8	<0.0001
	- - - Mn (ppm)- - -		
1	94.9	93.8	0.818
2	64.1 a	59.9 b	0.034
Average	79.53	76.84	0.326
	- - - S (%)- - -		
1	0.27	0.27	0.805
2	0.27 b	0.28 a	0.004
Average	0.27 a	0.27 b	0.072

† Numbers followed by different letters between columns for each variable represent statistically significant differences at P ≤ 0.10.

Soybean small plots

A set of studies evaluated (B, Cu, Mn, S, and Zn) for soybean using small plots, with fertilizer application pre-plant. Application rates were 10 lbs/acre for all nutrients except for B (at 2.5 lbs/acre). Yield response across sites with different soils and yield potential was inconsistent, with no significant yield increase to micronutrient application (Tables 3 and 4). Site 1 with sandy soil and low OM showed an average increase in yield (except for B) (table 4). This suggest that some soil types can potentially show yield response to micronutrient application, and careful evaluation of site specific conditions is required to ensure yield response and economic return to micronutrient application. A range of yield potential were evaluated across the different sites, however there is no indication that higher yielding crops may require micronutrients associated with the higher yield potential. Is likely that higher yielding crops are growing in more productive soils, with higher availability of micronutrients, and yield potential alone may not be an indicative of potential response. Soil conditions, including texture, pH and OM can still be considered the main indicators or potential yield response to micronutrients.

Table 3. Initial soil chemical properties of ten sites in 2013 and 2014.

Site	pH	Sand	Clay	OM	P	K	B	Cu	Fe	Mn	Zn
		- - - - % - - - -		%	- - - - - - - - - - - - - - - ppm - - - - - - - - - - - - - - - - -						
					2013						
1	7.1	81	7.0	1.1	27.3	134	0.6	0.2	14.1	10.9	1.1
2	5.9	12	22.5	2.7	9.4	140	1.8	1.3	64.4	40.7	1.2
3	6.5	22	17.5	2.1	38.2	534	0.9	1.0	57.5	43.7	0.8
4	6.7	37	10.0	1.5	33.1	205	0.9	0.8	21.7	19.8	1.3
5	6.9	11	33.0	3.2	59.0	257	1.5	1.2	36.9	24.6	5.0
					2014						
6	5.4	13	27.5	2.4	28.1	262	0.5	1.2	63.3	25.5	0.7
7	5.7	12	21.0	2.0	57.1	211	0.4	2.1	85.8	45.3	1.7
8	5.2	14	24.0	2.3	5.6	115	0.4	1.4	81.6	40.5	1.3
9	7.0	37	17.0	2.0	5.2	211	0.4	0.7	14.9	14.8	0.3
10	5.9	19	22.5	2.6	11.5	501	0.6	1.1	55.2	30.8	1.4

Table 4. Soybean yield (adjusted to 130 g kg-1 moisture) response to secondary and micronutrient fertilizer at 9 sites in 2013 and 2014) (α<.10).

Site	Treatments							P > F
	Control	B	Cu	Mn	S	Zn	Mix	
	- - - - - - - - - - - - - - Yield (bu acre) - - - - - - - - - - - - - - - - - - -							
1	29	25	33	35	33	33	35	0.277
2	39	38	37	39	37	38	37	0.761
3	65	71	68	65	66	62	61	0.407
4	56	62	57	57	57	60	62	0.281
5	62	66	61	62	62	61	68	0.597
6	50	49	50	51	50	49	46	0.604
7	79	80	83	79	81	80	77	0.891
8	39	41	39	41	37	37	38	0.553
9	29	26	24	30	27	28	29	0.681
10	61	64	60	59	62	62	60	0.480

Starter micronutrients for corn

The use of micronutrients with starter fertilizers were evaluated at six site-years for corn. Corn early growth (V6) was significantly increased with starter fertilizers (Figure 2). However the addition of micronutrients with the starter (Zn, Mn, Fe, Cu, B) did not contribute to additional plant growth at this stage. Increase in corn plant early growth with starter fertilizers are attributed primarily to N and P fertilizer, and secondary and micronutrients would not be expected to increase early growth. Micronutrient uptake at V6 growth stage followed a similar tendency as plant growth (Figure3). This suggests that increase in plant growth contributed to nutrient uptake in greater extent compared to tissue nutrient concentration. However, some micronutrients such as Zn and Cu tissue concentration were increase with the addition of fertilizer micronutrients in the starter.

Corn grain yield was increased across locations with starter fertilizer treatments. However no additional grain yield increase with micronutrients in the starter fertilizer (Figure 4). One location in 2012 showed a significant increase to starter fertilizer (N, P, K) and additional grain yield increase with the addition of micronutrients (Figure 5). The soil at this location was sandy (80% sand) and very low OM content (0.9%). Is likely that these soil conditions are contributing to the grain yield response to micronutrient application.

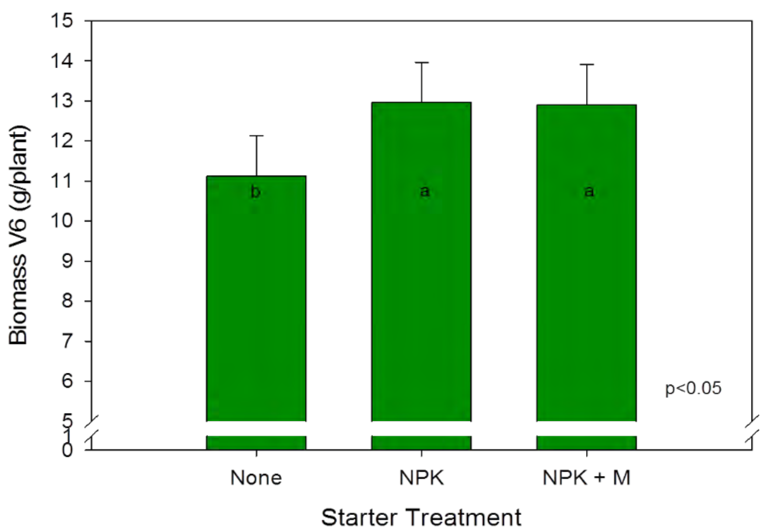

Figure 2. Effect of starter fertilizer application on corn biomass at V6. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

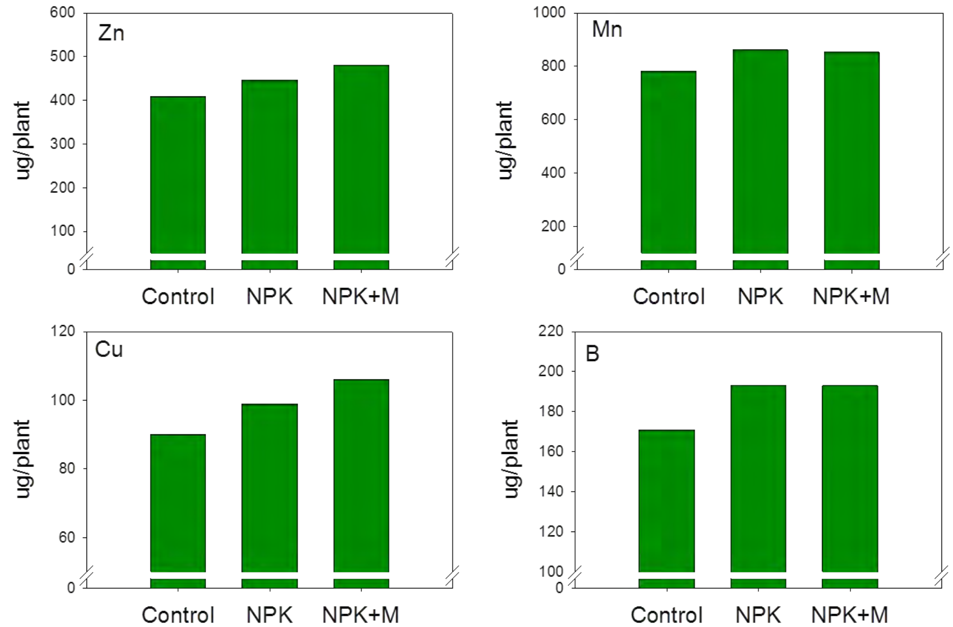

Figure 3. Effect of starter fertilizers with and without micronutrient application on corn tissue nutrient concentration at V6.

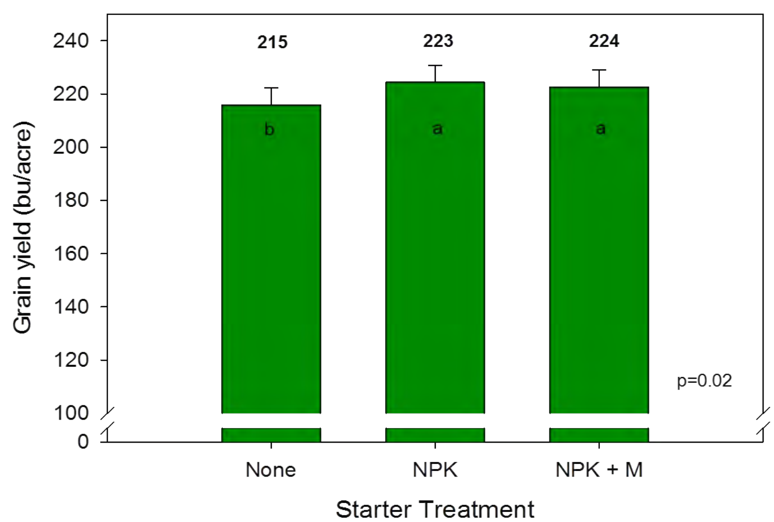

Figure 4. Effect of starter fertilizer application on corn grain yield. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

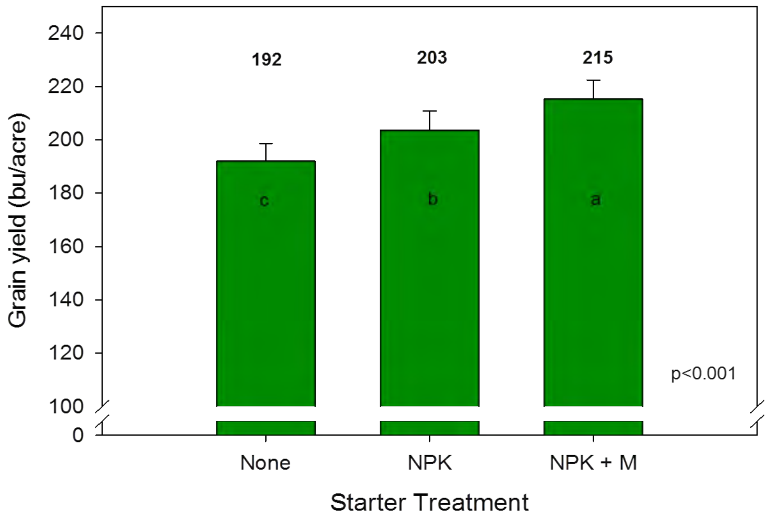

Figure 5. Corn grain yield response for one responsive location in 2012 (Rossville). This location was sandy with low organic matter content. Letters indicates statistically significant difference.

References

Kaiser, D.E., and K.I. Kim. 2013. Soybean response to sulfur fertilizer applied as a broadcast or starter using replicated strip trials. Agron J. 105: 1189-1198

Mills, H.A., and J.B. Jones Jr. 1996. Plant analysis handbook II: A practical sampling, preparation, analysis, and interpretation guide. MicroMacro Publishing, Inc. Athens, GA.