EVALUATION OF SOYBEAN RESPONSE TO MICRONUTRIENTS USING STRIP TRIALS

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ABSTRACT

Limited studies are available on soybean response to micronutrients and particularly in field- scale strips. The objective of this study was to evaluate soybean tissue response to micronutrient fertilizers in fields with high soil variability. The experimental design consisted of two strips, an unfertilized and fertilized replicated three times. The treatments included an untreated control and a blend of Cu, Mn and Zn at a rate of 10 lb acre^{-1} and B at a rate of 2.5 lb acre^{-1}. Soil samples were collected before fertilizer application at a depth of 6 in. Composite samples (10-12 cores) were taken from an area of 15 ft. from marked points located in the center of the grids along each strip, each grid was 80 ft. long. When the soybeans reached the stage R2-R3, thirty uppermost trifoliates were collected from each sampling point in the strips. Significant differences were found in each site and across sites in Zn tissue concentration, the fertilized treatment showed higher values compared to the control. Sulfur and copper fertilization had no effect on soybean tissue concentration and Mn had significant effect only in one site.

INTRODUCTION

An intensified production system frequently involve greater demand for commercial fertilizers to guarantee maximum production of a particular crop. This need for incrementing commercial nutrient inputs raises questions about the role of secondary and micronutrient fertilizers. One of the challenges at the field scale is soil variability. When experiments are done on small plots, only small variability of soil properties are exhibited as opposed to larger strips. Limited studies are available for soybean (Glycine max [L.] Merr.) response to micronutrients and even less in large-scale field strips. The objective of this study was to evaluate tissue response to micronutrient fertilizers in fields with high soil properties variability.

MATERIALS AND METHODS

Three strip trials were established through 2014 and 2015. The selected locations were in Goff and Grantville in the northeast Kansas. Management practices were those used by the producers such as variety selection, planting dates and seeding rates. The experimental design consisted of two strips, an unfertilized and fertilized replicated three times. The length of each strip was approximately 900 ft. long and the width varied by site, 35-40 ft. depending on the equipment used by each producer. The treatments included a blend of Cu, Mn and Zn at a rate of 10 lb acre^{-1}and B at a rate of 2.5 lb acre^{-1}. The fertilizer utilized was granular sulfate-based and was broadcasted previous to planting. The area was divided in three blocks and the sampling scheme was a systematic grid points. The grids were 80 ft. long and the width varied among sites depending on the width of the strip. Soil samples were collected before fertilizer application at a depth of 6 in. Composite samples (10-12 cores) were taken from an area of 15 ft. from marked points at the center of each grid. The analysis included soil test phosphorus, soil test potassium and soil pH, in addition to the micronutrients B, Cu, Mn, and Zn. Soil pH was determined on 1:1 (soil:water). Soil phosphorus was determined by Mehlich3-extraction (Frank et al., 1988). Soil organic matter test was collected per block and was analyzed by the method of Walkley-Black (Combs and Nathan, 1998). Copper, Mn and Zn were analyzed by DTPA extraction (Whitney, 1998) and B by the hot water method. When the soybeans reached the stage R2-R3, thirty uppermost trifoliates were collected from each strip. Tissue samples were oven dried at 65°C to after be ground and submitted to the Kansas State Soil Testing Laboratory. The analysis of tissue sample was for total P, K, Cu, Mn and Zn. Cupper, manganese, and zinc were digested with HNO_3.For the statistical analysis, the program utilized was SAS 9.3 with the GLIMMIX procedure (SAS,2010). Statistical differences were established at a 0.10 probability level.

RESULTS AND DISCUSSION

Results are only shown 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 between 4.5 to 7.0 (Figure 1). At a pH values <7.0, Zn and Mn presented the lowest values. The same trend can't be easily seen in Figure 2, likely due to less pH variability when compared to site 1. As pH increases soil test for micronutrients show a decrease. Tissue concentration of Zn was between the 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.

SUMMARY

Soil pH tends to affect soil test values for the micronutrients evaluated in this study. Zinc tissue concentration was higher with the Zn fertilizer treatment. Both fertilized and control strips were above the nutrient sufficiency range considered as critical level in the literature. Sulfur and copper tissue concentration were not affected by fertilization. Manganese showed no consistent response. Results from this study showed that some nutrients such as Zn can be increased in the tissue with broadcast fertilizer application in soybean. However, other nutrients such as S, Cu, and Mn showed no clear response in plant tissue concentration.

REFERENCES

Frank, K., D. Beegle, and J. Denning.1998. Phosphorus. P.21-26. In: J.R. Brown (ed.) Recommended chemical soil test procedures for North Central Region. North Central Reg.Res. Publ. 221 (Rev.). SB 1001. Missouri Agric. Exp. Stn. Columbia.

Combs, S.M., and M.V. Nathan. 1998. Soil organic matter. p. 53–58. In: J.R. Brown (ed.) Recommended chemical soil test procedures for the North Central Region. North Central 17 Reg. Res. Publ. 221 (Rev.). SB 1001. Missouri Agric. Exp. Stn. Columbia.

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

Liekam, D.F., R.E., Lamond, and D.B. Mengel. 2003. Soil test interpretations and fertilizer recommendations. MF-2586.Kansas State Univ. Agr. Exp. Stn. and Coop. Ext., Manhattan, KS.

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.

SAS Institute S. 2010. The SAS system for Windows, SAS Institution, Cary, NC

Whitney, D.A. 1998. Micronutrients: Zinc, Iron, Manganese, and Copper. p 41-44. In Recommended Chemical Soil Test Procedures for the North Central Region" North Central Regional Publication No. 221 (Revised). University of Missouri Agricultural Experiment Station, Columbia, MO

Table 1. Chemical analysis of soil previous to fertilizer application for the three sites.

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

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	<.0001
Average	42.9	38.8	<.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	0.269 a	0.274 b	0.072

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

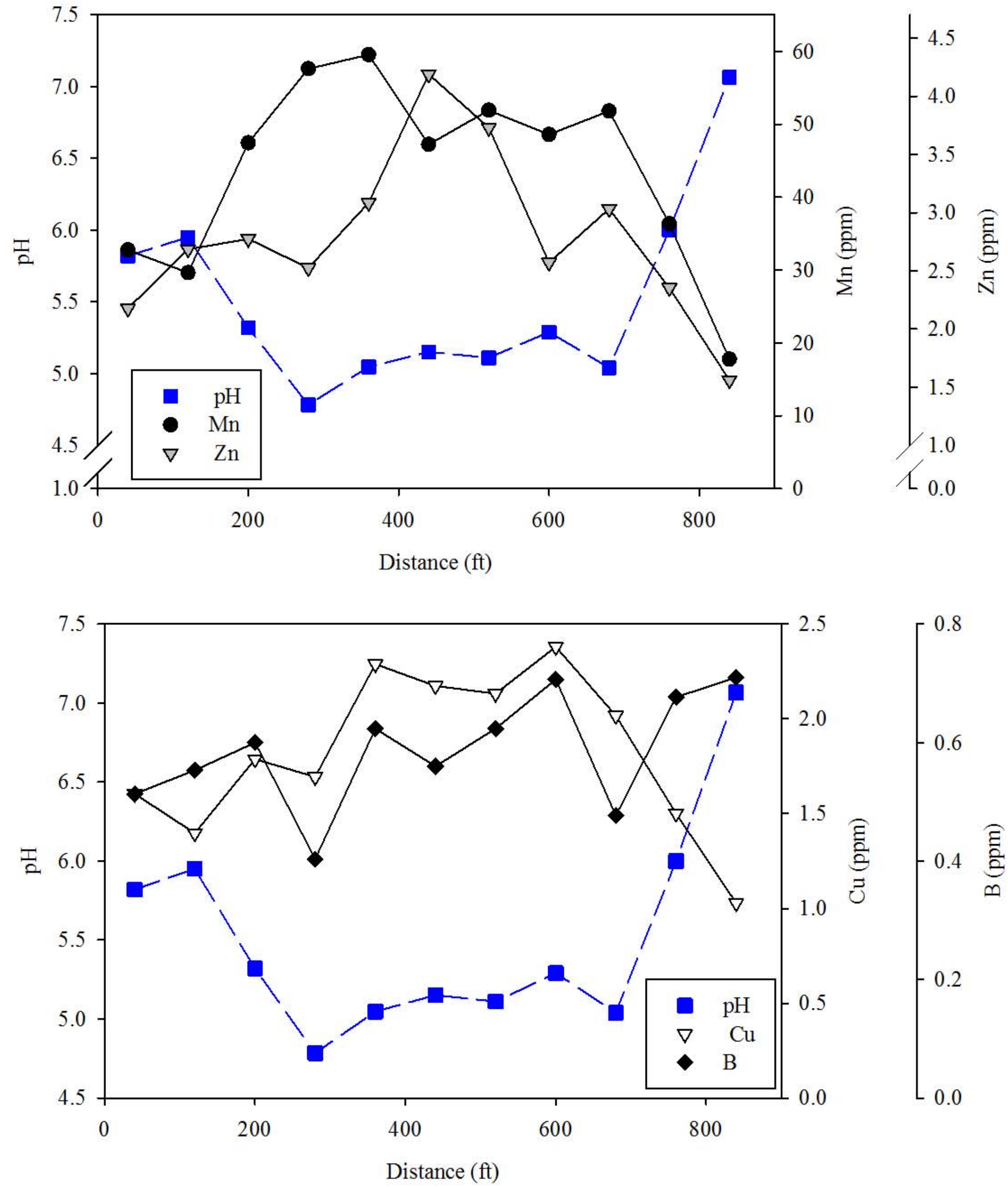

Figure 1. Soil manganese, zinc, copper, boron and pH across Site 1 in 2014.

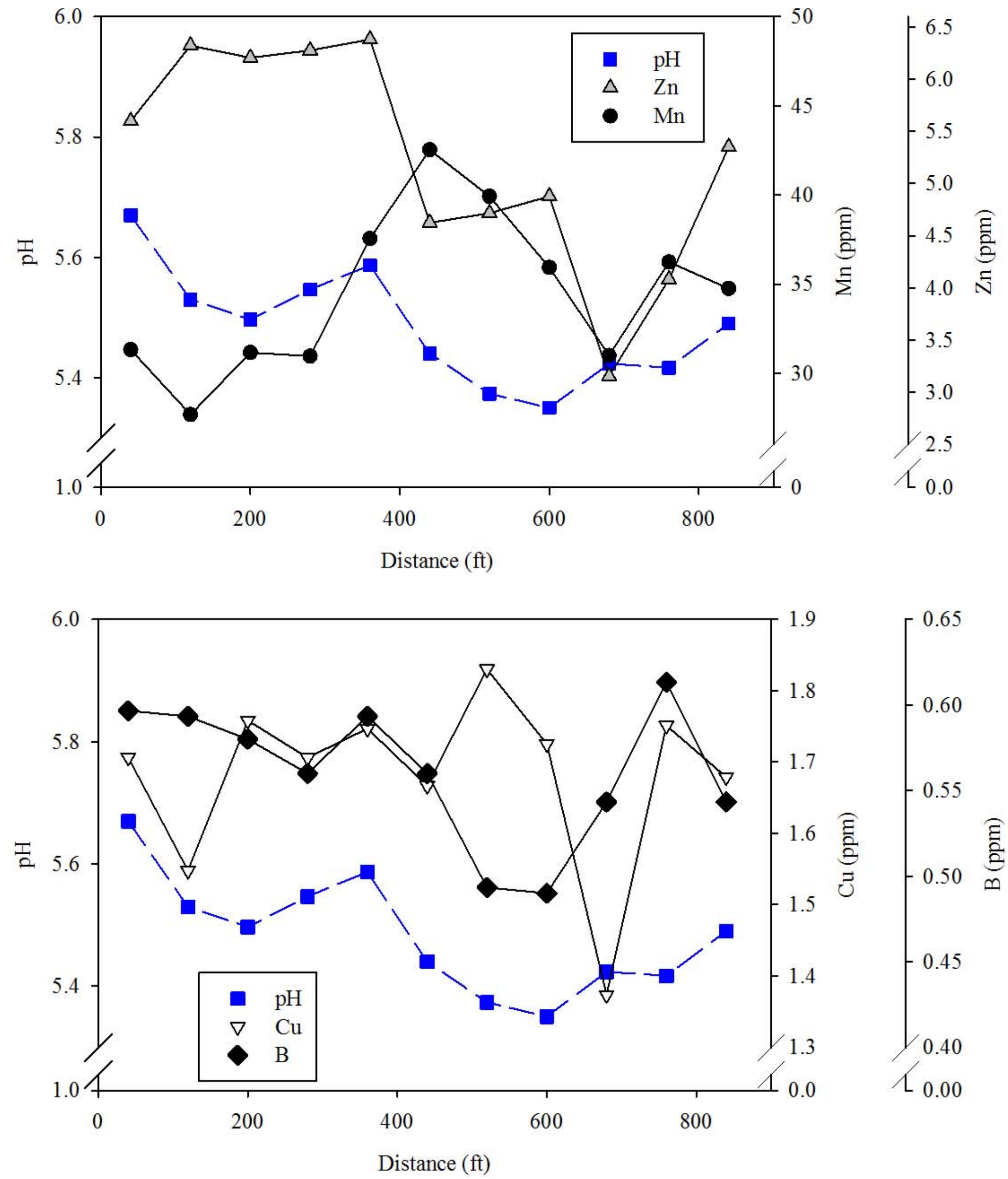

Figure 2. Soil manganese, zinc, copper, boron and pH across Site 2 in 2014.

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