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Corn and Soybean Yield Response to Micronutrients in Southern Iowa

Antonio Mallarino
Iowa State University, apmallar@iastate.edu

Pablo Barbieri
Iowa State University, pablob@iastate.edu

Joshua Enderson
Iowa State University

Ryan Oltmans
Iowa State University, oltma028@iastate.edu

Nicholas Piekema
Iowa State University, npiekema@iastate.edu

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Abstract
Micronutrients are needed in very small amounts but are essential for crop growth. Prior research in Iowa and neighboring states seldom showed corn and soybean grain yield responses to fertilization with micronutrients, except for zinc in corn. This report summarizes results of two studies with corn and soybean, one with application to the soil and the other with application to foliage, which were conducted at this farm from 2012 through 2014. The micronutrients evaluated were boron (B), copper (Cu), manganese (Mn), and zinc (Zn).

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Corn and Soybean Yield Response to Micronutrients in Southern Iowa

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Antonio Mallarino, professor
Mazhar Haq, assistant scientist
Pablo Barbieri, research associate
Joshua Enderson and Ryan Oltmans, graduate assistants
Department of Agronomy
Nicholas Piekema, farm superintendent

Introduction

Micronutrients are needed in very small amounts but are essential for crop growth. Prior research in Iowa and neighboring states seldom showed corn and soybean grain yield responses to fertilization with micronutrients, except for zinc in corn. This report summarizes results of two studies with corn and soybean, one with application to the soil and the other with application to foliage, which were conducted at this farm from 2012 through 2014. The micronutrients evaluated were boron (B), copper (Cu), manganese (Mn), and zinc (Zn).

Materials and Methods

The two trials were established on fields that had received no manure or micronutrients in recent years. The soil was Grundy silt loam. For both trials, soybean was planted in 2012, corn in 2013, and soybean in 2014. The row spacing was 30 in. The cornstalks were chisel-plowed in the fall, and residues from both crops were disked in the spring. Uniform, non-limiting rates of phosphorus, potassium, and sulfur were applied across all plots. A rate of at least 180 lb N/acre was applied for corn.

For both trials, six treatments were applied each year to the same plots and were replicated four times. For the trials with application to the soils, treatments were a control; separate applications of B, Mn, or Zn banded with the planter; a mixture banded with the planter; and a mixture broadcast and incorporated into the soil. The granulated fertilizers and application rates (element basis) used were NuBor 10 with 10 percent B at 0.5 lb B/acre banded and 2 lb B/acre broadcast, Broadman20 with 20 percent Mn at 5 lb Mn/acre for both banded and broadcast, and EZ20 with 20 percent Zn at 5 lb Zn/acre for both banded and broadcast treatments. The banded fertilizers were mixed with mono-ammonium phosphate (MAP), which was applied 4 lb N/acre and 21 lb P_2O_5/acre. The same MAP rate was applied with the planter for both the control and broadcast mixture treatments.

For the trial with micronutrients sprayed to the foliage, six treatments were applied each year to the same plots and were replicated four times. The treatments were a control; separate applications of B, Cu, Mn, or Zn; and a mixture of all four nutrients. Fluid fertilizers were sprayed twice to the same plots at the V5/V6 stage of both crops, the V8/V10 stage of corn, and the R2/R3 stage of soybean using a hand-held CO_2 sprayer with a 5-ft spraying width and 15 gal water/acre. The fertilizers were Max-In Boron (8% B), Max-In Copper (5% Cu), MicroBolt Zinc (9% Zn), and MicroBolt Manganese (6% Mn). The total rates applied across both applications for B, Cu, Mn, and Zn (element basis) were 0.16, 0.08, 0.33, and 0.495 lb/acre, respectively.

Soil B was analyzed by the hot-water method, whereas soil Cu, Mn, and Zn were analyzed by both the DTPA and Mehlich-3 methods. Grain was harvested from a central area of each plot, and yield was adjusted to 15.5 percent moisture for corn and 13 percent moisture for soybean. Grain was analyzed for the micronutrients concentration.

Results and Discussion

Table 1 shows the soil micronutrient levels for plots without fertilizer application for both trials. The hot-water test for B and the DTPA test for Cu, Mn, and Zn are the soil-test methods recommended by the north-central region soil-testing committee (NCERA-13). This committee recommends the Mehlich-3 test for P and K but not for Cu, Mn, and Zn because of non-existing calibrations with crop response in the region. Soils also were analyzed by this method, however, because it is being used by some private laboratories. The soil-test data across the three years for the non-fertilized plots of both trials show the common temporal variation observed in soil testing. Decreases or increases over time might be attributed to crop removal interacting with undetermined year effects.

Iowa State University has micronutrients soil-test interpretations only for Zn in corn and sorghum. A soil Zn level less than 0.9 ppm by the DTPA method is considered deficient or marginal (see Extension Publication PM 1688). Other states of the region have approximately similar interpretations for Zn. Other states consider sufficient levels of 0.5 to 2 ppm for B (hot-water method), and 0.2 ppm for Cu and 1 to 2 ppm for Mn (both by the DTPA method), but these interpretations may or may not apply to Iowa soils and crops varieties.

Tables 2 (for the trial with application to soil) and 3 (for the trial with application to foliage) show that corn and soybean yield levels ranged from normal to high except for the drought-affected 2012 cropping season. There was no statistically significant yield increase from application of any micronutrient in any trial or year. In contrast to results for grain yield, however, fertilization often increased the micronutrients concentration in grain (data not shown).

A lack of grain yield response to Zn agrees with interpretations in Iowa (for corn) and some other states of the region, because the observed Zn soil-test results using the DTPA method for non-fertilized plots varied from 1.8 to 2.9, which are classified as more than adequate. A lack of yield response to Cu and Mn agrees with interpretations from other states because observed soil-test results were much higher than the lowest sufficient levels. Concerning B, the lowest of interpretations from other states predicted a yield increase in 2012 that was not observed.

Conclusions

There was no corn or soybean grain yield increase from micronutrients applied to the soil or foliage in any trial or year of the study. Soil-test interpretations in the north-central region correctly predicted a lack of yield increases from Cu, Mn, and Zn. For B, however, even the lowest interpretations from other states predicted a yield increase in some or all years of both trials that was not observed.

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Table 1. Soil micronutrient soil-test levels for two trials.†

	Soil fertilization trial			Foliar fertilization trial		
Soil test	**2012**	**2013**	**2014**	**2012**	**2013**	**2014**
	ppm					
B	0.3	0.5	0.6	0.2	0.6	0.9
Cu DTPA	1.3	1.3	1.2	1.3	1.5	1.2
Mn DTPA	20	25	24	24	32	22
Zn DTPA	2.3	1.9	2.1	1.8	1.8	2.9
Cu Mehlich-3	2.2	2.4	2.6	2.5	2.4	1.8
Mn Mehlich-3	46	41	52	55	49	40
Zn Mehlich-3	2.4	1.2	2.8	2.8	2.0	2.6

†6-in. soil samples taken before fertilization each year. Values are averages for each site in 2012 and for the control plots in 2013 and 2014.

Table 2. Effect of fertilization to the soil with boron, manganese, and zinc on corn and soybean grain yield.

		Fertilizer treatment						
Year	**Crop**	**Control**	**B**	**Mn**	**Zn**	**Mixture banded**	**Mixture broadcast**	**Statistics†**
		bu/acre						
2012	Soybean	37.9	39.1	38.2	38.2	38.3	37.4	ns
2013	Corn	160	165	169	172	171	167	ns
2014	Soybean	66.9	71.3	69.7	69.5	67.4	70.3	ns

†ns, not significant at statistical probabilities ≤ 0.05.

Table 3. Effect of foliar fertilization with boron, copper, manganese, and zinc on corn and soybean grain yield.

		Fertilizer treatment						
Year	**Crop**	**Control**	**B**	**Cu**	**Mn**	**Zn**	**Mixture**	**Statistics†**
		bu/acre						
2012	Soybean	35.9	36.8	37.1	35.6	36.1	37.0	ns
2013	Corn	156	159	160	155	155	153	ns
2014	Soybean	67.0	66.5	68.1	68.1	66.2	66.7	ns

†ns, not significant treatment differences at statistical probabilities ≤ 0.05.