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Corn and Soybean Yield Response to Micronutrients in Northeast Iowa

Abstract

Several essential plant nutrients are required in very small amounts and are referred to as micronutrients. Prior research in Iowa and neighboring states showed inconsistent 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, conducted at this farm from 2012 through 2014. The micronutrients evaluated were boron (B), copper (Cu), manganese (Mn), and zinc (Zn).

Keywords

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Disciplines

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Corn and Soybean Yield Response to Micronutrients in Northeast Iowa

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Introduction

Several essential plant nutrients are required in very small amounts and are referred to as micronutrients. Prior research in Iowa and neighboring states showed inconsistent 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, conducted at this farm from 2012 through 2014. The micronutrients evaluated were boron (B), copper (Cu), manganese (Mn), and zinc (Zn).

Materials and Methods

Two trials with corn-soybean rotations were established on fields that had received no manure or micronutrients in recent years and had Floyd or Readlyn loam soils. Crops were planted in rows spaced 30 in. apart. The foliar fertilization trial was managed with no-till. For the trial with application to the soil, the cornstalks were chisel-plowed in the fall, and residues from both crops were field cultivated 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 P₂O₅/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 CO₂ 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 the yield was adjusted to 15.5

percent moisture for corn and 13 percent moisture for soybean. A grain sample was taken from each plot to be analyzed for the micronutrient 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 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 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 the soil) and 3 (for the trial with application to the foliage) show corn and soybean grain yield levels ranged from normal to very high across the three years. However, there were no statistically significant yield increases from application of any micronutrient in any trial or year. In contrast to results for grain yield,

fertilization often increased the micronutrients concentration in grain (not shown).

A lack of grain yield response to Zn agrees with interpretations used in Iowa or other states of the region, because the observed Zn soil-test results for the DTPA method for non-fertilized plots varied from 1.7 to 5.8, which are classified as higher than adequate. A lack of response to Cu and Mn agrees with interpretations from other states because soil-test results were much higher than levels considered sufficient. Concerning B, the lowest value of interpretations from other states predicted no yield increase at any site or year, but the highest value predicted increases that were 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, interpretations from other states predicted a yield increase in some years of both trials that was not observed.

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

Soil test	Soil fertilization trial			Foliar fertilization trial		
	2012	2013	2014	2012	2013	2014
B	0.5	0.5	0.5	0.5	0.5	0.7
Cu DTPA	1.3	2.6	2.7	1.3	1.4	1.2
Mn DTPA	21	19	22	16	22	18
Zn DTPA	3.2	2.5	5.8	2.1	1.7	4.0
Cu Mehlich-3	2.8	3.9	4.4	3.0	3.2	2.0
Mn Mehlich-3	50	61	40	46	45	29
Zn Mehlich-3	4.6	1.4	5.5	3.2	3.4	3.1

†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 to the soil on corn and soybean grain yield.

Year	Crop	Fertilizer treatment						Statistics†
		Control	B	Mn	Zn	Mixture banded	Mixture broadcast	
2012	Corn	161	157	161	163	162	159	ns
2013	Soybean	68.6	67.7	67.9	69.3	65.4	66.9	ns
2014	Corn	196	196	196	194	196	197	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.

Year	Crop	Fertilizer treatment						Statistics†
		Control	B	Cu	Mn	Zn	Mixture	
2012	Soybean	73.3	73.9	73.3	72.3	74.1	71.8	ns
2013	Corn	198	198	199	201	204	200	ns
2014	Soybean	72.9	71.4	71.3	72.1	72.3	68.6	ns

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