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Abstract

Several plant nutrients are referred to as micronutrients because very small amounts are needed. Prior research in Iowa and neighboring states showed inconsistent corn and soybean grain yield responses to micronutrient applications, 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 from 2012 through 2014. The micronutrients evaluated were boron (B), copper (Cu), manganese (Mn), and zinc (Zn).

Keywords

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Corn and Soybean Yield Response to Micronutrients in Northern Iowa

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Introduction

Several plant nutrients are referred to as micronutrients because very small amounts are needed. Prior research in Iowa and neighboring states showed inconsistent corn and soybean grain yield responses to micronutrient applications, 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 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 soils were Nicollet and Webster clay loam or silt clay loam. For both trials, corn was planted in 2012, soybean in 2013, and corn in 2014. The row spacing was 30 in. 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 160 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 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 and 3 show corn and soybean grain yield levels ranged from normal to high across the three years of both trials. However, there was no statistically significant yield increase

from application of any micronutrient to the soil or foliage in any trial or year. In contrast to results for grain yield, fertilization often increased the micronutrients concentration in harvested grain (not shown).

A lack of grain yield increase from Zn agrees with interpretations used in Iowa for corn or some other states of the region, because the observed Zn soil-test results using the DTPA method for non-fertilized plots varied from 0.8 to 1.5, which are classified marginal to more than adequate. A lack of yield increases from Cu and Mn agrees with interpretations from other states because test results were much higher than levels considered sufficient. Concerning B, the lowest value considered sufficient by other states correctly predicted no yield increase, but the highest value incorrectly predicted increases in both trials

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, the lowest value considered sufficient by other states correctly predicted no yield increase, but the highest value incorrectly predicted increases in both trials.

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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	0.8	1.0	1.3	0.9	1.5	1.3
Cu DTPA	1.6	1.2	1.5	1.6	1.6	1.5
Mn DTPA	18	20	21	16	18	14
Zn DTPA	1.4	1.8	2.3	0.6	3.0	2.3
Cu Mehlich-3	2.1	2.6	2.7	2.1	3.5	2.7
Mn Mehlich-3	36	36	34	31	49	27
Zn Mehlich-3	1.8	1.9	2.3	1.1	4.3	1.7

†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	153	156	145	153	149	155	ns
2013	Soybean	54.4	50.4	52.0	54.4	52.8	49.0	ns
2014	Corn	185	177	180	185	181	185	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	Corn	146	148	152	142	145	130	ns
2013	Soybean	49.9	45.6	48.8	55.4	52.5	52.5	ns
2014	Corn	183	191	185	186	187	174	ns

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