1-1-2015

Corn and Soybean Yield Response to Micronutrients

Antonio Mallarino
Iowa State University, apmallar@iastate.edu

Joshua Enderson
Iowa State University

Ryan Oltmans
Iowa State University, oltma028@iastate.edu

Mazhar Haq
Iowa State University, mazhar@iastate.edu

Josh Sievers
Iowa State University, sieversj@iastate.edu

Corn and Soybean Yield Response to Micronutrients

Abstract

Micronutrients are essential for crop growth, although they are needed in very small amounts. Prior research in Iowa and neighboring states had shown 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

Agronomy

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences | Natural Resources and Conservation

Corn and Soybean Yield Response to Micronutrients

RFR-A1454

Antonio Mallarino, professor
Joshua Enderson and Ryan Oltmans, graduate assistants
Mazhar Haq, assistant scientist
Department of Agronomy
Josh Sievers, farm superintendent

Introduction

Micronutrients are essential for crop growth, although they are needed in very small amounts. Prior research in Iowa and neighboring states had shown 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

The two experiments were conducted on fields that had received no manure or micronutrients in recent years. The soil was Marcus silty clay loam. For both studies, crops were soybean in 2012, corn in 2013, and soybean in 2014; all planted in rows spaced 30 in. apart. 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 the trial with fertilizer application to the soil, six treatments were applied each year to the same plots and were replicated four times. The 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 fertilizer application 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 the yield was adjusted to 15.5 percent moisture for corn and 13 percent moisture for soybean. A grain sample was taken for analysis of the micronutrient concentration.

Results and Discussion

Table 1 shows the soil micronutrient levels without fertilizer application for trials with micronutrient fertilization to the soil or foliage. 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). The Mehlich-3 test is recommended for P and K but not for Cu, Mn, and Zn at this time 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 show the common variation observed in soil testing. Therefore, some decreases or increases for non-fertilized plots can be attributed to crop removal or undetermined year effects.

Iowa State University has micronutrients soil-test interpretations only for Zn in corn and sorghum. Soil Zn levels less than 0.9 ppm by the DTPA method are considered deficient. Other states suggest approximately similar values. Other states consider soil-test 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) sufficient for crops, but these interpretations may or may not apply to Iowa conditions.

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 high 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 (for corn) or some other states of the region (for corn and other crops), because the observed DTPA soil-test results for Zn were sufficient or very close. Also, a lack of yield response to Cu and Mn agrees with interpretations from other states because observed soil-test results were much higher for both nutrients. The observed soil-test results for B were intermediate within the wide range deemed sufficient among various states.

Conclusions

There was no corn or soybean grain yield response to 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 response from Cu, Mn, and Zn. For B, however, interpretations used in some states predicted no yield response but those used in others predicted a response but was not observed.

Acknowledgements

We thank financial support from Agrium, Brandt, DuPont-Pioneer, the Fluid Fertilizer Foundation, the International Plant Nutrition Institute, the Iowa Soybean Association, Nachurs, Wilbur-Ellis, and Winfield Solutions.

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

Soil test	Soil fertilization trial			Foliar fertilization trial		
	2012	2013	2014	2012	2013	2014
	ppm					
B	1.2	1.2	1.6	1.2	1.3	1.6
Cu DTPA	-	-	-	1.6	1.8	1.7
Mn DTPA	40	34	38	34	39	35
Zn DTPA	0.9	1.2	2.7	0.8	1.0	3.2
Cu Mehlich-3	-	-	-	3.9	4.4	2.7
Mn Mehlich-3	70	69	57	69	95	51
Zn Mehlich-3	1.4	0.8	2.9	1.4	2.4	1.9

†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 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	
		bu/acre						
2012	Soybean	72.2	71.3	72.5	72.2	72.5	71.5	ns
2013	Corn	242	237	242	245	242	241	ns
2014	Soybean	65.8	64.5	65.9	64.6	65.8	64.8	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	
		bu/acre						
2012	Soybean	65.5	66.0	64.3	66.1	66.5	66.0	ns
2013	Corn	251	247	258	251	256	261	ns
2014	Soybean	61.0	61.0	61.5	61.9	63.1	63.6	ns

†ns, not significant at statistical probabilities ≤ 0.05.