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Corn and Soybean Response to Micronutrients

Abstract

Scarce prior research on micronutrients fertilization for corn and soybean has shown inconsistent yield responses in Iowa and the Corn Belt. Therefore, the objective of an experiment conducted during 2012 and 2013 was to evaluate the effect of boron (B), manganese (Mn), zinc (Zn), and their mixture on corn and soybean grain yield. Iowa State University has no interpretations of soil or tissue tests for micronutrients, other than for Zn in corn and sorghum.

Keywords

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Disciplines

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Corn and Soybean Response to Micronutrients

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Introduction

Scarce prior research on micronutrients fertilization for corn and soybean has shown inconsistent yield responses in Iowa and the Corn Belt. Therefore, the objective of an experiment conducted during 2012 and 2013 was to evaluate the effect of boron (B), manganese (Mn), zinc (Zn), and their mixture on corn and soybean grain yield. Iowa State University has no interpretations of soil or tissue tests for micronutrients, other than for Zn in corn and sorghum.

Materials and Methods

The site had no history of manure or micronutrient application. Soil type was Toolesboro sandy loam with pH 6.2, 3.6 percent organic matter, and 8.7 percent clay. Corn was planted in 2012 and soybean was planted in 2013. Tillage was chisel-plowing of cornstalks in the fall and disking of cornstalks and soybean residue in the spring. Corn (Pioneer P1395AM1) and soybean (Pioneer 92Y75) were planted using a 30-in. row spacing. Six treatments replicated four times, applied in spring of each year to the same plots, were a control, single application of B, Mn, or Zn banded with the planter, a mixture of the three micronutrients banded with the planter, and a similar mixture broadcast and incorporated into the soil by disking. Each plot had eight crop rows (20 ft wide) and 55 ft long. Granulated fertilizers were used, and the nutrient sources and application rates were the following:

- Boron: NuBor 10, with 10 percent B at

0.5 lb B/acre for planter-banded and at 2 lb B/acre for broadcast.

- Manganese: Broadman20, with 20 percent Mn at 5 lb Mn/acre both for planter-banded and broadcast.
- Zinc: EZ20, with 20 percent Zn at 5 lb Zn/acre both for planter-banded and broadcast.

The plots were irrigated as needed, and the water had such small nutrient concentrations that the amounts applied were insignificant in relation to the fertilizer rates applied. In 2012, the amounts applied with the water were less than 0.134, 0.033, and 0.033 lb/acre of B, Mn, and Zn; whereas in 2013 the amounts applied were less than 0.028 lb/acre for the three nutrients.

All micronutrient fertilizers banded with the planter were mixed with MAP at 4 lb N/acre and 21 lb P₂O₅/acre. The same MAP rate was applied with the planter for the control and the broadcast mixture treatments. Uniform, non-limiting rates of phosphorus (P), potassium (K), and sulfur (S) were applied across all plots. For corn, a uniform rate of at least 200 lb N/acre was applied.

The initial soil-test levels were 0.18 ppm for B, 2.1 ppm for Mn, and 1.2 ppm for Zn. Soil B was analyzed by the hot-water extraction method, and both Mn and Zn by the DTPA method. At the V5 to V6 crop growth stage, the above ground portions of plants were sampled from each plot. Ear leaves of corn (blades) were sampled at the R1 (silking) stage, and the uppermost mature trifoliolate leaves of soybean were sampled at the R2 to R3 stage. Plant tissue samples were analyzed for the concentrations of B, Mn, and Zn. Grain was harvested from a central area of each plot, and yield was adjusted to 15.5 percent moisture for corn and 13 percent for soybean.

Results and Discussion

Table 1 shows results of plant tissue analyses. Fertilization with B and Zn alone or in mixture increased the B and Zn concentration of corn plants at the V5-V6 growth stage, but Mn fertilization did not. No fertilization treatment increased consistently the concentrations of micronutrients in corn ear leaves at the R1 stage, in soybean plants at V5-V6 stage, or in soybean leaves at R2-R3 stage. Inconsistent effects of micronutrient fertilization on plant tissue concentrations have been observed before, and can be explained by dilution of the small amounts applied in the plant dry matter produced.

Crop grain yield levels were high in both years. The grain yield results in Table 2 indicate no statistically significant yield increases due to application of any micronutrient in any year. Fertilization did increase the micronutrients concentration of corn grain in 2012 (not shown, analysis of soybean grain samples have not been completed).

Iowa State University has micronutrients soil-test interpretations only for Zn in corn, for which DTPA soil-test values less than 0.9 ppm are considered deficient or marginal. Other states of the north-central region have similar interpretations. Therefore, no yield increase was expected because the initial Zn soil-test level was 1.2 ppm. Other states consider sufficient soil-test levels of 0.5 to 2 ppm for B and 1 to 2 ppm for Mn, but these may or may not apply to Iowa soils. A yield increase could have been expected from B since the initial level was 0.18 ppm but not from Mn because it was 2.1 ppm.

Iowa State University has no interpretations for plant tissue test results, and no other state of the north-central region has any for corn or soybean at the V5-V6 growth stage.

Guidelines in Illinois and some states of the north-central region suggest possible deficiencies for corn if concentrations in ear leaves are less than 10, 15, and 15 ppm for B, Mn, and Zn, respectively. Guidelines for soybean suggest possible deficiencies if concentrations in leaves at early podding are less than 25, 20, and 15 ppm for B, Mn, and Zn, respectively. Concentrations observed for corn ear leaves in the control plots (Table 1) would have suggested a grain yield increase for the three nutrients, which did not occur. The concentrations observed for trifoliolate soybean leaves in the control plots would have suggested a yield increase for B and Mn but not for Zn, but there was no yield increase for any nutrient.

Conclusions

There was no crop yield increase from application of B, Mn, or Zn. A lack of yield increase for Zn agreed with current Iowa State University soil-test interpretations for Zn. A lack of yield increases from B and Mn indicated that soil and tissue interpretations from other states may not apply to Iowa.

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Table 1. Effect of micronutrients fertilization on the concentration of boron, manganese, and zinc of plant tissue at two growth stages.

| Crop | Year | Stage | Nutrient | Control | Nutrient | Mixture | Mixture |
|---------|------|-------|----------|---------|-----------------|---------|-----------|
| | | | | | alone | banded | broadcast |
| | | | | | ----- ppm ----- | | |
| Corn | 2012 | V5-V6 | B | 6 | 8 | 10 | 14 |
| | | | Mn | 18 | 19 | 14 | 15 |
| | | | Zn | 26 | 29 | 29 | 30 |
| | | R1 | B | 4 | 4 | 5 | 6 |
| | | | Mn | 13 | 12 | 9 | 11 |
| | | | Zn | 11 | 11 | 11 | 11 |
| Soybean | 2013 | V5-V6 | B | 85 | 27 | 25 | 26 |
| | | | Mn | 21 | 19 | 20 | 21 |
| | | | Zn | 37 | 29 | 31 | 27 |
| | | R2-R3 | B | 23 | 28 | 31 | 44 |
| | | | Mn | 24 | 25 | 22 | 24 |
| | | | Zn | 34 | 29 | 26 | 65 |

Table 2. Effects of fertilization with the micronutrients boron, manganese, and zinc on corn and soybean grain yield.

| Crop | Year | Control | B | Mn | Zn | Mixture | Mixture | Statistics* |
|---------|------|---------|------|------|---------------------|---------|-----------|-------------|
| | | | | | | banded | broadcast | |
| | | | | | ----- bu/acre ----- | | | |
| Corn | 2012 | 199 | 196 | 193 | 193 | 185 | 185 | ns |
| Soybean | 2013 | 55.5 | 54.9 | 57.3 | 58.0 | 54.1 | 56.0 | ns |

*ns, not significant at $P \leq 0.10$ or $P \leq 0.05$.