Soybean Response to Micronutrients in NW Minnesota

Location: Ada and Gully, MN

Fertilizer: Treatments

1) 10 lbs Zinc (Zn) per acre
2) 10 lbs Manganese (Mn) per acre
3) 2 lbs Boron (B) per acre
4) 20 lbs Chloride (Cl) per acre

Treatments were compared to a control (no fertilizer) and consisted of all possible combinations of the four micronutrients studied. Phosphorus and Potassium kept at non-limiting levels. Fertilizer was broadcast and incorporated before planting

Weed Management: Glyphosate

Experimental Design: Randomized complete block design with 4 replications. Yields are reported at 13% grain moisture.

Objective:

The purpose of this study was to determine if there is a potential yield response in soybean to selected micro-nutrients applied broadcast before planting.

Experimental Methods:

The studies at Ada was laid out using a factorial design. There were sixteen total treatments consisting of one, two, three, or four of the micronutrients applied together. All treatments were hand applied prior to planting and incorporated prior to planting. Trials were established at twelve field locations across Minnesota with six established in 2013 and six in 2014.

Initial soil test results are given in Table 1. Soil phosphorus levels were High to Very High at all sites . Soil potassium ranged from Medium to Very High, and zinc (Zn) ranged from low to high using current interpretations for corn. Soil tests were also run for manganese (Mn), boron (B), and chloride (Cl). There currently are no critical levels for these elements for soybean in Minnesota. Soybeans are responsive to Mn, however, yield responses are typically seen in areas of the country with soils that have been historically deficient in Mn.

Research in Michigan has shown soybean yield increases due to Mn and recommendations exist in that state when soil test levels are less than 24 ppm. Sandy soils with high soil pH have been traditionally responsive to manganese in Michigan. Three locations tested lower than this level. Since there is no clear evidence of past yield responses to Mn in Minnesota, we cannot say that Mn was low. However, the high soil pH and relatively low Mn concentration may

Table 1. Initial soil test data for 0-6" samples collected before treatment application for 2013-2014 soybean micronutrient studies.

			Soil Test							
Year	Location	County	P	K	Zn	Mn	B	Cl	OM	pH
			ppm						--%--	
2013	Ada	Norman	14*	177	0.4	11.0	0.57	10.7	3.7	8.1
	Lamberton	Redwood	13	150	0.9	47.2	0.65	6.3	4.5	5.8
	Rochester	Olmsted	47	143	2.1	34.8	0.27	6.3	2.1	5.8
	St. Charles	Winona	14	105	0.8	48.8	0.27	6.8	3.0	6.7
	Stewart 1	McLeod	13*	173	1.5	26.5	0.79	6.0	7.3	7.4
	Stewart 2	McLeod	26	134	1.6	46.6	0.80	6.0	5.2	6.8
2014	Ada	Norman	17	368	1.5	7.3	0.99	14.4	6.1	7.4
	Lamberton	Redwood	34	145	1.9	57.0	0.88	3.4	4.4	5.4
	Rochester 1	Olmsted	25	256	2.8	28.7	0.80	124.5	4.6	6.5
	Rochester 2	Olmsted	17	161	2.5	33.2	0.43	13.2	2.2	5.9
	Stewart 1	McLeod	25	179	1.5	14.1	1.09	3.2	6.5	7.7
	Stewart 2	McLeod	37	172	1.9	31.5	0.91	4.1	4.8	7.0

P, Bray-P1 phosphorus; K, ammonium acetate potassium; Zn, DTPA zinc; Mn, DTPA manganese; B, hot water extracted boron; Mg, amonium acetate extractable magnesium; OM, organic matter loss on ignition; pH, 1:1 soil:water ;na, data not available. not available.

*Olsen-P test was used instead of the Bray-P1

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Soybean Response to Micronutrients Across Minnesota (continued)

Table 2 summarizes yield data collected from the factorial study. There was no clear evidence of a response to micronutrients at any location. In general, the trend was for slightly lower yields with Zn, B, and Cl at Ada 2013 and most other locations that year.

The only location were there was a significant difference in grain yield was at the site near Rochester in 2013 and Stewart in 2014 where the yield with B was around 2 bu/ac less with the 2 lb application rate compared to the control. The Rochester location was on a sandy soil which likely magnified negative impacts of B application. Stewart was a clay loam soil. Boron toxicity symptoms were noted within the same field for a 5 lb/ac B rate in 2011. It appears that the 2 lb rate may still be too much even in a year where soils were cool and excessively wet early in the growing season.

Soil test values were examined but were not helpful in determining where responses would occur. In-fact, the large variation in soil test values and no evidence of a yield response calls into question the value of micronutrient soil tests for use in soybean.

Tissue analysis was also conducted but the data has not yet been returned from the lab for 2014. Plant tissue data from 2013 is not shown but application of boron, zinc, and chloride increase concentration of the respective elements in both trifoliate leaf tissue collected at R2 and in grain nutrient concentration. Tissue nutrient concentration indicates that the micros are being taken up by soybean but are not needed for increasing soybean grain yield.

2-Year Summary

- There was no yield advantage for applying Zn, Mn, B, or Cl to soybean.
- The lack of response was consistent among locations and for the yield average across locations and years.
- The potential effect of the climatic conditions at individual locations may have limited potential for determining treatment differences.
- Soil tests did not aid in the determination of where micronutrient deficiencies may occur.

Table 2. Soybean Gain yield Summary of a micronutrient study conducted near Ada, MN and the average yield across twelve locations studied across MN from 2013-2014.

	Zn Rate (lbs/ac)		Mn Rate (lbs/ac)		B Rate (lbs/ac)		Cl Rate (lbs/ac)	
	0	10	0	10	0	2	0	20
	----------bu/ac----------							
Ada 2013	25.1a	24.4a	26.8a	26.8a	27.1a	26.5a	28.1a	25.4a
Ada 2014	37.5a	38.7a	37.1a	39.0a	37.5a	38.7a	38.1a	38.1a
Twelve Site Average	42.9a	42.7a	42.8a	42.8a	42.9a	42.8a	43.0a	42.7a

*numbers followed by the same letter are not significantly different at $P \leq 0.10$