MICRONUTRIENTS AS STARTER AND FOLIAR APPLICATION FOR CORN AND SOYBEAN

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Abstract

Corn and soybean production under high yield environments can benefit from the combined use of starter and foliar fertilization, including macro and micronutrients. The objective of this study was to evaluate corn and soybean response to starter fertilizers in combination with foliar application of macro and micronutrients to maximize yields. Experiments were conducted in 2010 and 2011 at two locations for corn and soybean under irrigation. Starter and foliar fertilizer treatments were applied in a factorial arrangement with combinations of N, P, K and micronutrients Fe, Mn, Zn, B, and Cu. Soil samples were collected from each location with samples from each small plot. Tissue samples were collected from each plot before foliar fertilizer application and analyzed for the macro and micronutrients included in this study. Plant population, plant height, and grain yield were measured. One location in 2010 (Clay Center) showed potential yield limitations due to population below optimum for both corn and soybean. At both locations, chloride, Zn and Cu showed significant increase in concentration in corn tissue with starter application. Chloride was not part of any treatment but was present in the starter fertilizer used for the study. Early corn biomass was also increased significantly at both locations during 2010 with the use of starters. Corn and soybean grain yield response varied by location, with significant yield increase for soybean with starter application of NPK+micros at Clay Center. However others locations for corn and soybean show no statistically significant effect of treatments in 2010.

Introduction

The use of alternative fertilizer application strategies to achieve maximum yields and enhance nutrient use efficiency has been proposed for decades. Often a combination of broadcast and band applications can provide optimum nutrient uptake in low fertility/low soil test conditions. However, under current reduced tillage systems with high yield potential, broadcast nutrients can remain on the soil surface, limiting root contact, or where the soil surface may have been compacted through wheel traffic. When these conditions become more severe, alternative fertilizer application methods and inclusion of micronutrients should be considered.

With the increase in corn and soybean yields due to important genetic improvements, demand for nutrients has also increased. It is likely that the increased utilization of reduced tillage systems and some soil conditions such as high soil pH found in large areas of the Great Plains may decrease the plant-availability of some macro and micronutrients. Previous work by Gordon (2008) showed that direct application of P and K to soybeans can have a significant impact on soybean yield, with average increases as high as 34 bu/acre. However, further studies are needed to investigate starter and foliar applications with other nutrients to maximize yields in soybean. On the other hand, in corn, fertilizer placed in a band near the seed at planting has frequently

shown positive effects on yield (Rehm and Lamb, 2009). Furthermore, this approach can be especially valuable under conditions of reduced tillage (Kovar and Mallarino, 2001; Haq and Mallarino 2000). In addition, foliar fertilization could in some cases increase nutrient supply at early growth stages when the root system is not well developed. Thus, foliar application of nutrients to corn and soybean in addition to starter fertilizer can help to overcome possible limitations in crop nutrient uptake and increase nutrient use efficiency and yields.

Some soil conditions such as high soil pH and low organic matter may contribute to decrease the supply of micronutrients to crops. Increased nutrient demands from more intensive cropping practices and high yielding potential crops may also require additional micronutrient for optimum yield. Supplementary foliar application of N, P, K, and micronutrients can help to enhance crop yields under these conditions. Consequently, there is an increasing interest from producers about the potential benefits of foliar application of nutrients and the use of micronutrients as complement of their fertilization programs to maximize yields.

The overall objective of this study was to evaluate crop response to starter fertilizers in combination with foliar application of macro and micronutrients to maximize corn and soybean yields. Specific objectives include (1) assessment of corn and soybean grain yield and early growth response to starter application of fertilizers and (2) compare responses with and without additional foliar fertilizers. (3) Verify potential soil parameters that could be related to responses to starter and foliar applied macro and micronutrients. (4) Evaluate tissue testing as a diagnostic tool to explain responses to foliar and starter macro and micronutrient application.

Materials and Methods

The experiment was conducted in 2 locations (Scandia and Clay Center) during 2010 and 2 locations (Scandia and Rossville) during 2011. Each location has both corn and soybean. Studies were located under high yield potential irrigated conditions. The field studies consisted of small-plot field research of six rows wide by 50 feet in length. Macronutrients treatments included N, P, and K, and micronutrients included Fe, Mn, Zn, B, and Cu. Starter fertilizer treatments and foliar treatments were applied in various combinations in a factorial arrangement. Three starter treatments (none, N, P, K only, and N, P, K + micros) were combined with three foliar treatments (none, N, P, K only, and N, P, K + micros) for a total of nine treatment combinations.

Starter fertilizers were applied near the seed using a dribble band placement. The foliar fertilizer application was made around the V6-V8 growth stage for corn, and for soybean around the V5-V7 stage. The procedure for fertilizer application simulated procedures commonly used by producers. Foliar fertilizer was diluted into water and applied with a hand-held CO2-powered sprayer. Fertilizer used for starter application was a 4-10-10 formulation, micronutrients Zn, Cu, and Mn were chelated EDTA. Iron was a chelated HEDTA, and B was derived from boric acid. Foliar N, P, K was applied using a 10-10-10 fertilizer formulation.

Soil samples at the 0-6 inch depth were collected from each individual plot and analyzed for routine soil properties and soil properties that can help identify the likelihood of response to foliar and starter treatments. Analysis included soil organic matter, soil test phosphorus, soil test potassium, and soil pH by standard methods in addition to micronutrients Fe, Mn, Zn, B, and Cu.

Tissue samples were collected 1-3 days before foliar treatment for total N, P, K, and micronutrients. At harvest, yield was recorded for each plot and a grain samples were collected. Statistical analysis was completed with the GLIMMIX procedure in SAS 9.2 (SAS Institute, 2000). Plant population was used as covariate in the analysis.

Results and Discussion

Average soil test levels are presented in Tables 1 and 2 for years 2010 and 2011. Data presented for crop response to treatments correspond to 2010 only (Clay Center and Scandia sites). Plant population below-optimum for the Clay Center location (data not shown) indicated potential limitation for grain yield in corn and soybean. At both locations, chloride, Fe and Cu showed significant increase in concentration in corn tissue with starter application (Fig 1 and 2). Chloride was not originally part of a fertilizer treatment; however one of the starter fertilizer source (4-10-10) included some chloride. In Kansas, corn (as well as wheat and sorghum) can show yield increase to the application of Cl. Zinc in corn was also significantly increased in Scandia only. Early corn biomass increased significantly at both locations with the use of starter fertilizer (Fig 3).

Starter and foliar fertilizer did not significantly change corn grain yield at either location in 2010 (Table 3). Soybean yield was not significantly different among any of the treatments at Scandia. At Clay Center, when no foliar fertilizer was applied, NPK+miconutrients starter fertilizer increased yield. However, when no starter fertilizer was applied, NPK+miconutrients foliar fertilizer decreased yield at the Clay Center location. The NPK+miconutrients foliar product did cause some moderate leaf burn, and this may explain some of the lower yield.

Additional years and sites are required to provide a more in-depth analysis and summary for specific nutrients associated with crop response, including the effect or foliar fertilization and micronutrients for corn and soybean in combination with starter fertilizer.

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Table 1. Average soil test values for Scandia and Clay Center in 2010.

	Corn		Soybean	
Soil test	Scandia	Clay Center	Scandia	Clay Center
pH	6.7	7.4	7.0	7.1
P (ppm)	11	114	11	34
K (ppm)	462	389	480	255
Zn (ppm)	1.4	2.5	1.1	4.1
Fe (ppm)	31	21	26	16
Mn (ppm)	23	4.9	17	9
Cu (ppm)	0.88	0.36	0.86	0.33
B (ppm)	0.54	0.31	0.67	0.33

Table 2. Average soil test values for Scandia and Rossville in 2011.

	Corn		Soybean	
Soil test	Scandia	Rossville	Scandia	Rossville
pH	6.3	6.4	6.5	6.4
P (ppm)	16	19	14	28
K (ppm)	655	243	511	109
Zn (ppm)	2.5	1.3	2.0	1.4
Fe (ppm)	94	91	93	61
Mn (ppm)	78	67	85	41
Cu (ppm)	1.54	1.39	1.65	0.41
B (ppm)	0.85	0.55	0.97	0.31

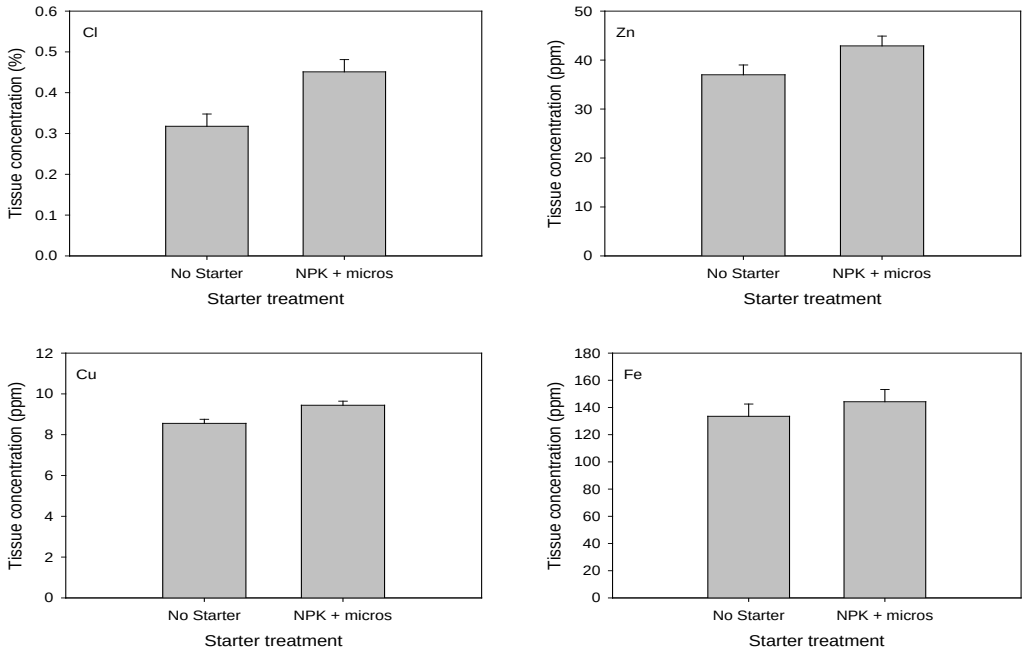

Figure 1. Effect of starter micronutrient application on tissue nutrient concentration in corn. Only nutrients with statistically significant ($p \leq 0.05$) increase is shown here for the Scandia location.

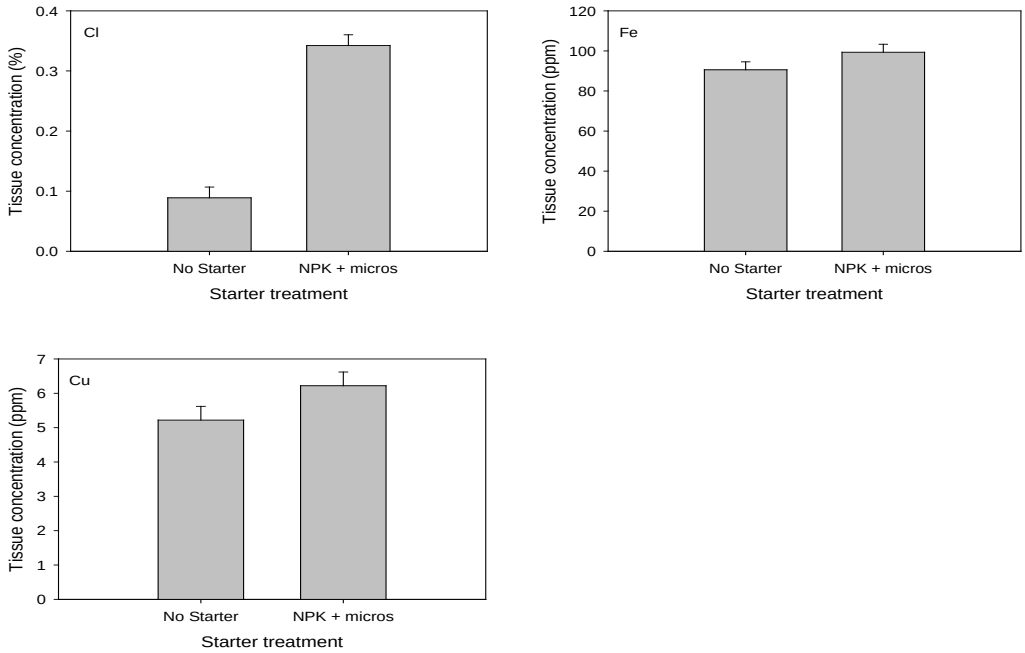

Figure 2. Effect of starter micronutrient application on tissue nutrient concentration in corn. Only nutrients with statistically significant ($p \leq 0.05$) increase is shown here for the Clay Center location.

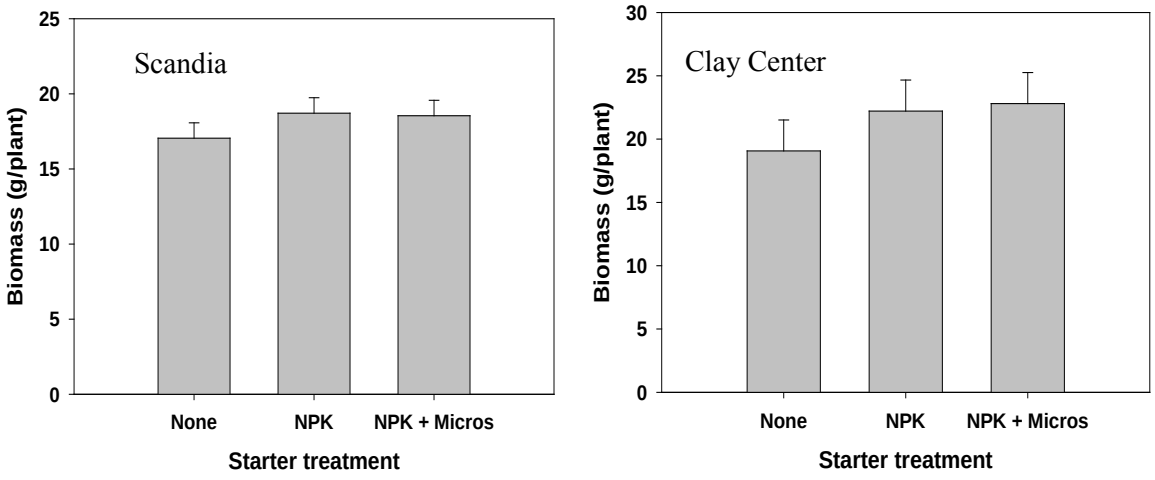

Figure 3. Corn early growth with starter fertilizer application in Scandia and Clay Center.

Table 3. Yield response to starter and foliar treatments for corn and soybean during 2010.

	Corn yield		Soybean yield	
Starter treatment	Clay Center	Scandia	Clay Center	Scandia
	- - - - - - - - - - - - - - - - - - bu/acre - - - - - - - - - - - - - - - - - -			
Control	229	212	57b	64
NPK	232	214	50b	64
NPK+micros	232	209	64a	65
Foliar treatments				
Control	232	214	58	63
NPK	232	212	59	63
NPK+micros	228	209	50	63

PROCEEDINGS OF THE

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NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY CONFERENCE

Volume 27

November 16-17, 2011
Holiday Inn Airport
Des Moines, IA

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Published by:
International Plant Nutrition Institute
2301 Research Park Way, Suite 126
Brookings, SD 57006
(605) 692-6280
Web page: www.IPNI.net