Improving Corn and Soybean Yields with Starter and Foliar Fluid Fertilizers[1]

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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 fluid fertilizers in combination with foliar application of macro and micronutrients to maximize yields. Experiments were conducted in 2010 and 2011 at four 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 experimental unit. 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. Changes in soybean tissue concentration due to starter fertilizers were observed for B and Mn when compared to the control. Average soybean yield was slightly higher when micronutrients were included in the starter fertilizer, however this different was not statistically significant for combined analysis across sites. Corn plant tissue concentration (V6) was increased for Fe. Early growth was significantly increased over the control with starter fertilizer, however no additional biomass was observed with the addition of micronutrients.

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 action must 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. This may be corrected through

[1] Second year, 2012

some combination of starter and foliar fertilizer application, fertilizer rate adjustment of both 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, fluid 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 as complement of their fertilization programs to maximize yields.

The overall objective of this study was to evaluate crop response to starter fluid 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 fluid 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 4 locations for corn and 4 locations for soybean during 2010 and 2011 in Kansas. 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 fluid 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 fluid fertilizers were applied near the seed using a dribble band placement. The foliar fertilizer application was made before the plant begins the rapid increase in nutrient and dry weight accumulation. For corn, foliar application was around the 6-8 leaf grown stage, and

for soybean around the 5-7 trifoliate. The procedure for fluid 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 Table 1. Soybean tissue analysis showed a significant increase in B concentration with the addition of micronutrients in the starter fertilizer. Concentration of Fe and Zn were similar to the control. Manganese concentration was decreased with the addition of Mn in the starter fertilizer (Fig 1). A decrease in Mn concentration in soybean with the use of chelated (EDTA) source has been observed in previous studies (Randall et al 1975). Average soybean yield was slightly higher when micronutrients were added to the starter fertilizer (Fig 2). This suggests that a lower Mn tissue concentration may not be necessarily indicative of yield response in this case.

Plant tissue analysis in corn showed an increase in Fe concentration with the addition of micronutrients in the starter, other nutrients show no clear difference (Fig 3). However, early growth in corn was significantly increased with starter fertilizers compared to the control (Fig 4). The addition of micronutrients in the starter fertilizer did not contribute to additional early growth, and is likely that the effect in early growth is contributed by N and P. Foliar application of N (derived from methylene ureas and triazone) in corn showed average yield increase at all locations in addition to pre-plant N application. This suggests a possible additional benefit of foliar applications, and additional studies should evaluate different rates and application timing.

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Table 1. Average soil test values for study locations in 2011 and 2012. Loc. 1 and 2 are in 2011.

Crop	Location	pH	P (ppm)	K (ppm)	OM (%)	Soil texture
Soybean	Loc 1	7.1	34	255	1.6	Fine sandy loam
	Loc 2	6.4	28	135	0.9	Loamy fine sand
	Loc 3	7.0	22	480	2.9	Silt Loam
	Loc 4	6.5	14	510	2.1	Silt Loam
Corn	Loc 1	7.4	114	388	1.8	Silt Loam
	Loc 2	6.4	19	242	1.8	Silt Loam
	Loc 3	6.7	21	460	2.9	Silt Loam
	Loc 4	6.3	16	655	2.3	Silt Loam

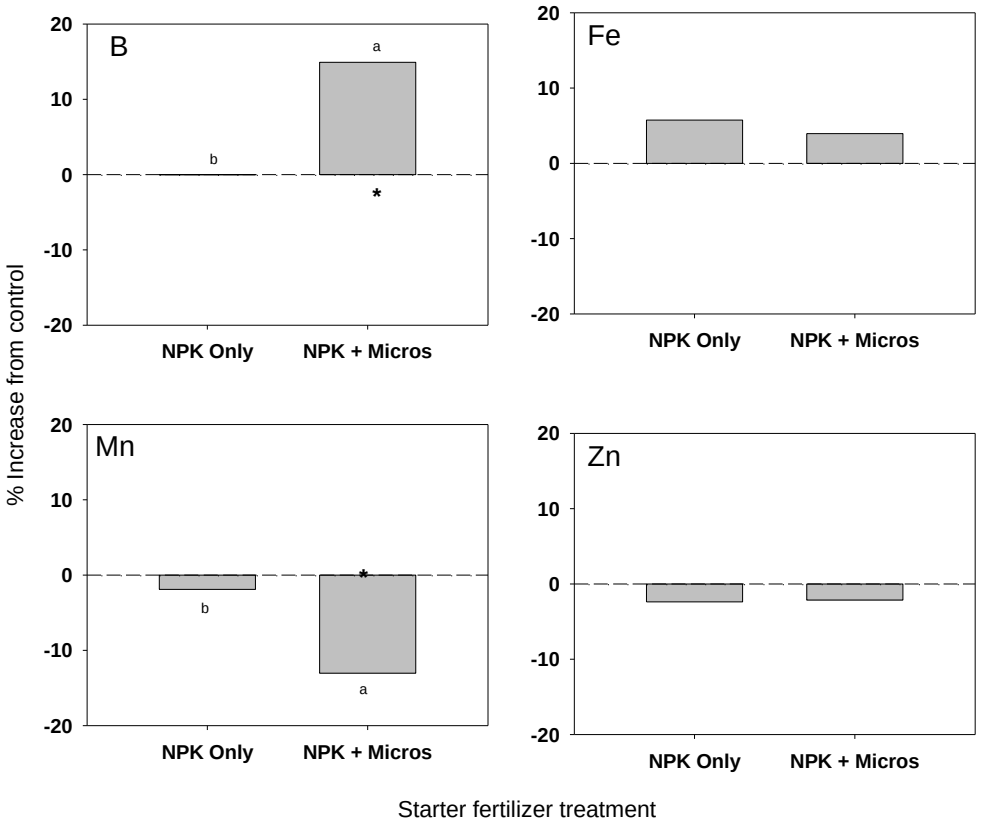

Figure 1. Effect of starter fertilizer application on tissue nutrient concentration in soybean compared to the control. Asterisk (*) indicate statistically significant difference from zero at $p \leq 0.05$. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

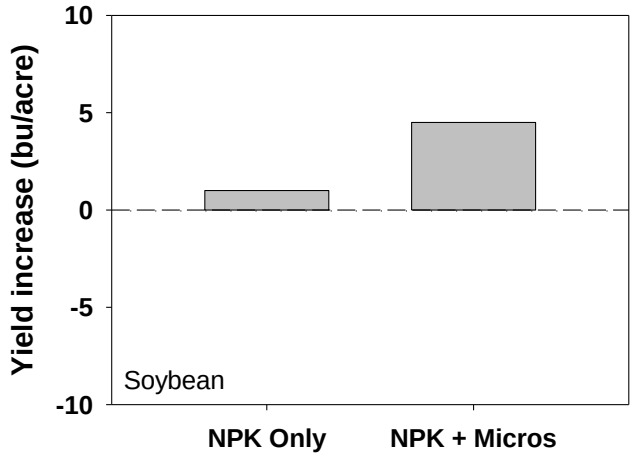

Figure 2. Effect of starter fertilizers with and without micronutrient application on soybean yield increase compared to the control.

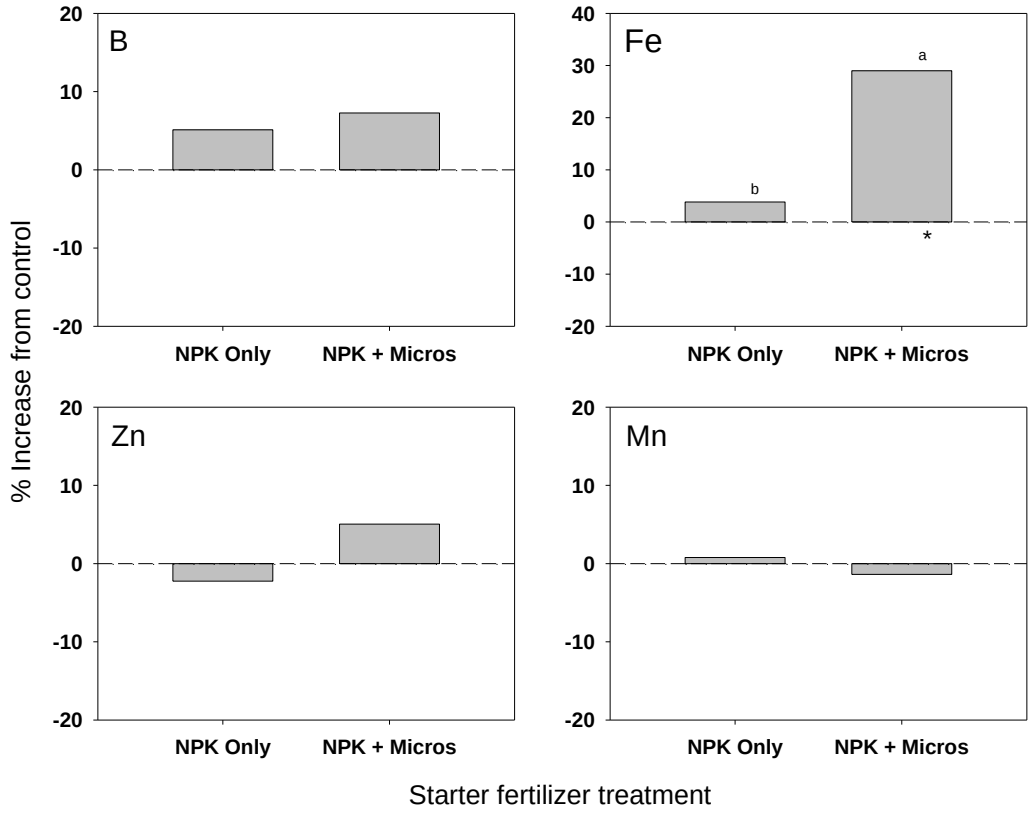

Figure 3. Effect of starter fertilizer application on tissue nutrient concentration in corn compared to the control. Asterisk (*) indicate statistically significant difference from zero at $p \leq 0.05$. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

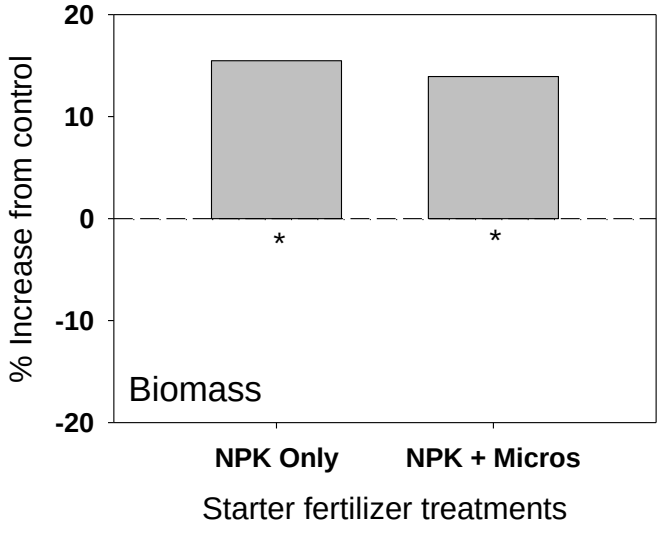

Figure 4. Increase in corn early growth biomass (V6) as affected by starter fertilizer treatments compared to the control. Asterisk (*) indicates statistically significant difference from zero at $P \leq 0.05$.

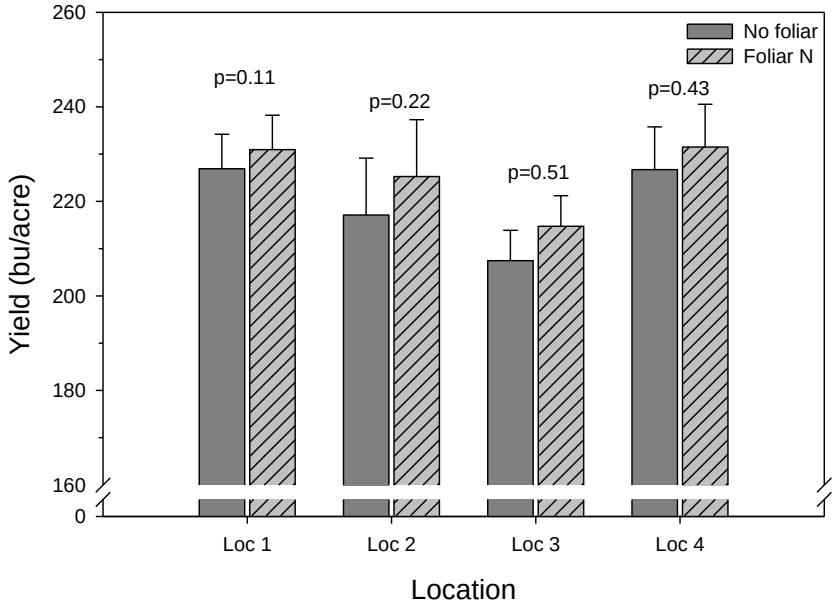

Figure 5. Foliar fertilizer application to corn at 4 locations during 2010 and 2011. Probably values for mean comparisons are included for each site. Pre-plant N rates were: Loc 1: 180 lbs; Loc 2: 180 lbs; loc 3: 200 lbs; loc 4: 200 lbs N/acre.