IMPROVING CORN AND SOYBEAN YIELDS WITH STARTER AND FOLIAR FLUID FERTILIZERS

Dorivar A. Ruiz Diaz and Nathan Mueller
Dep. of Agronomy, Kansas State University

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 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 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. One location (Clay Center) showed potential yield limitations due to population bellow optimum for both corn and soybean. At both locations, chloride, Fe and Cu showed significant increase in concentration in corn tissue with starter application. Chloride was not part of any treatment but present in the starter fertilizer used for the study. Zinc in corn was also increase significantly in Scandia. Early corn biomass was also increased significantly at both locations with the use of starters. Corn and soybean grain yield was significantly increased with the use of starter N, P, and K, and N,P,K plus 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 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 2 locations (Scandia and Clay Center) for corn and 2 locations for soybean during 2010 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. Plant population bellow-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 (Fig1 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).

Corn grain yield was significantly increased with the use of starter N, P,K, and N,P,K plus micronutrients at Scandia and Clay Center. Soybean grain yield was significantly increased with the use of starter N, P,K, and N,P,K plus micronutrients at Clay Center only. Grain yield increase in 2010 with starter fertilizer was similar for treatments with and without the addition of micronutrients in the starter mix. This suggests that the primary crop response is likely from macronutrients. In Scandia, relatively low levels of soil test P suggest that starter P application likely contributed to corn grain yield response.

Based on one year of data is not possible to provide a more in-depth analysis and summary for specific nutrients associated with crop response, including the effect or foliar fertilization for corn and soybean in combination with starter fertilizer.

REFERENCES

Gordon, B. 2008. Maximizing irrigated soybean yields in the Great Plains. Better Crops. Vol. 92. No 2. pp 6-7.

Haq M.U. and A.P. Mallarino. 2000. Soybean yield and nutrient composition as affected by early season foliar fertilization. Agron. J., 93, 1220–1226.

Kovar, J.L., and A.P. Mallarino. 2001. Starter fertilizer formulations and placement for reduced tillage corn. Fluid Forum Proc. 18:188–194.

Rehm G.W. and J.A. Lamb. 2009. Corn response to fluid fertilizers placed near the seed at planting. Soil Sci. Soc. Am. J. 73:1427-1434.

SAS Institute. 2000. The SAS system for Windows. Release 8.1. SAS Institute, SAS Inst., Cary, NC.

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)	21	114	22	34
K (ppm)	460	388	480	255
Zn (ppm)	1.4	2.5	1.2	4.0
Fe (ppm)	31	21	26	16
Mn (ppm)	23	5.9	17	9
Cu (ppm)	0.88	0.36	0.86	0.33
B (ppm)	0.54	0.31	0.67	0.33

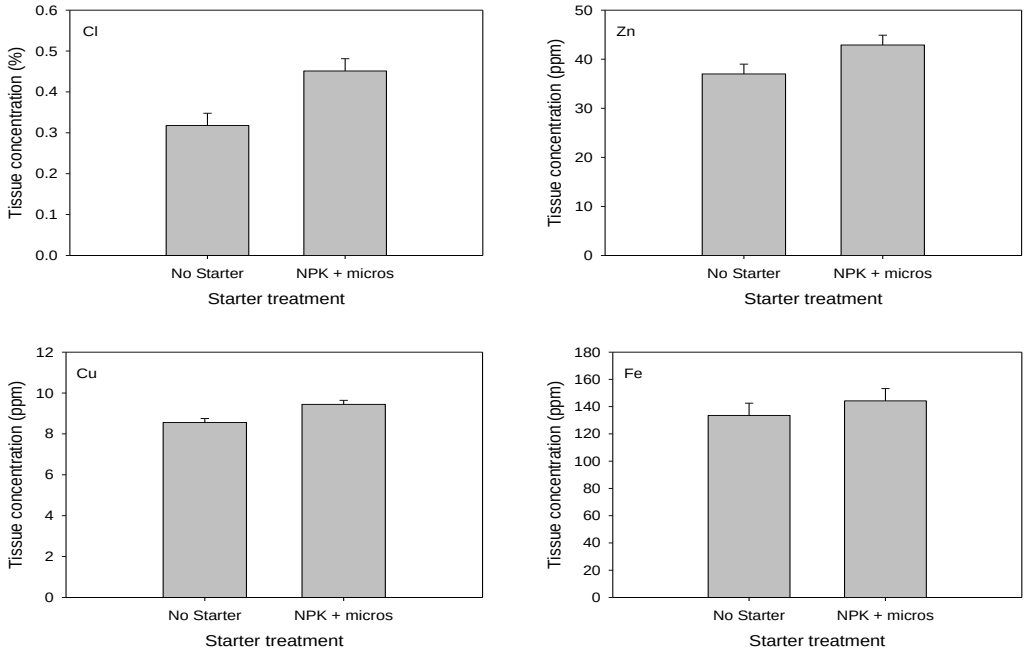

Figure 1. Effect of starter micronutrient application on tissue nutrient concentration in corn. Only nutrients with statistically significant ($p \leq 0.05$) increase is shown here for the Scandia location.

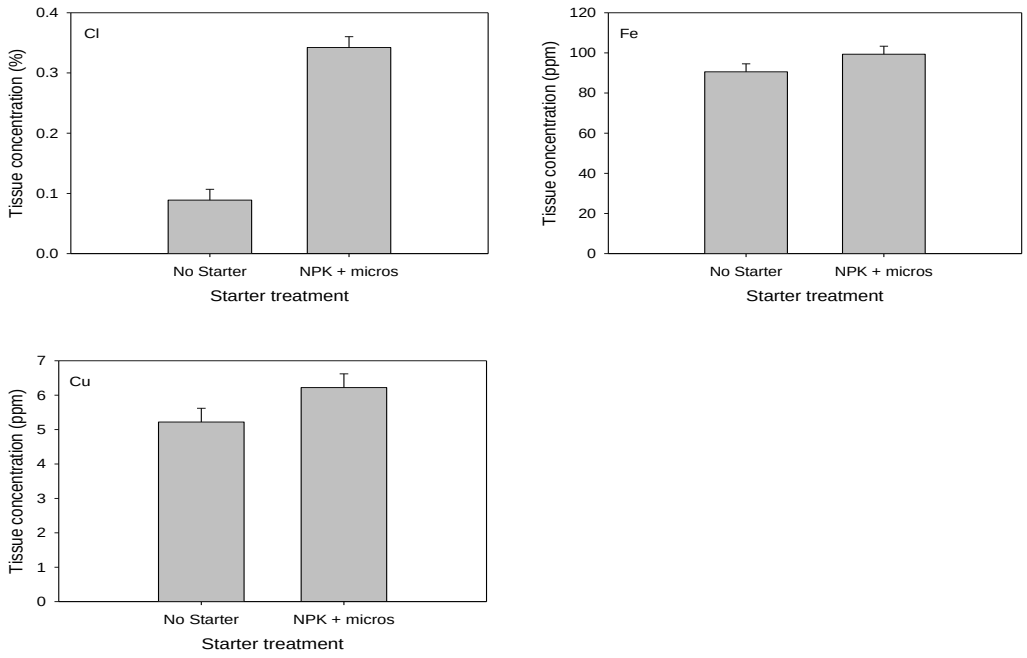

Figure 2. Effect of starter micronutrient application on tissue nutrient concentration in corn. Only nutrients with statistically significant ($p \leq 0.05$) increase is shown here for the Clay Center location.

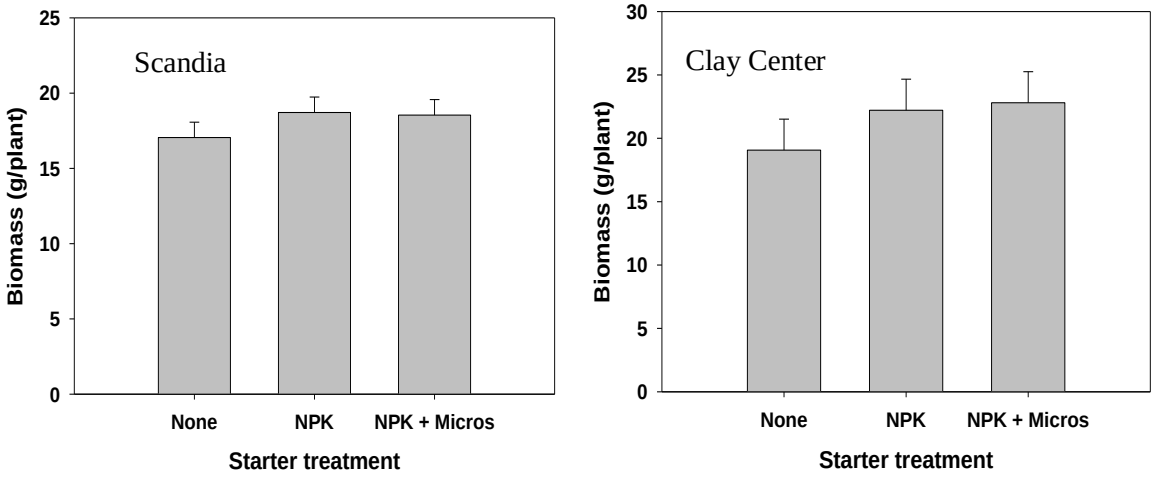

Figure 3. Corn early growth with starter fertilizer application in Scandia and Clay Center.

Table 2. Corn and soybean yield as affected by starter fertilizer application for Scandia and Clay Center in 2010.

	Corn		Soybean	
Starter Treatment	Scandia	Clay Center	Scandia	Clay Center
	- - - - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - - - -			
None	204 b†	228 b	63 a	56 b
NPK	207 a	231 a	63 a	58 b
NPK + micros	209 a	231 a	65 a	63 a

† Different letters within a column indicate statistically significant differences at $p \leq 0.05$