Looking At Improving Corn /Soybean Yields With Fluids

2012 results were evaluated using combinations of fluid starters and foliar fertilizers.

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The Fluid Journal • Official Journal of the Fluid Fertilizer Foundation • Fall 2013 • Vol. 21, No. 4, Issue # 82

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Summary: *No early growth increases were attributed to the micronutrient blend in corn. Grain yield was increased at one site with sandy soil and low organic matter. Across five site-years, there was an increase over the control in soybean height (3 in) and yield (4.5 bu/A) with starter NPK plus micronutrients. Starter NPK plus micronutrients decreased soybean trifoliate leaf MN concentration at all site-years with the use of chelated EDTA micronutrients. This response was attributed to the formation of FeEDTA and increased Fe supply that reduced root Mn absorption and translocation to leaves. Foliar fertilization did not increase yield in corn or soybeans. Starter fertilizers showed more tendencies to increase yield than foliar fertilization in corn and soybeans.*

A relatively small increase in yield may be sufficient to return a profit with micronutrient fertilization, especially when commodity prices are high. As a result, there is an increasing interest in applying micronutrients in geographic regions without a history of micronutrient deficiencies. Starter and foliar fertilization of macronutrients, N, P, and K and secondary nutrients such as S, are usually a supplement to higher rates of nutrient application made during a separate field pass. However, micronutrients are needed by plants in relatively small amounts that could be exclusively applied during planting with NP or NPK starter fertilizers or during foliar applications, which minimizes any additional application cost.

Starter and foliar fertilization of corn and soybeans have been evaluated with varying levels of success in increasing yield. Starter fertilization with N and P often increases corn early growth and early N and P uptake more frequently than it does grain yield. Probability of a yield response with NPK starter fertilizer is higher when soil test P (STP) or K (STK) is low. Starter fertilizers often include NP or NPK mixtures, making it difficult to attribute the response to a single nutrient. Based on our current knowledge of nutrient deficiencies and frequency of occurrence in the Great Plains region of the USA, the likelihood of increasing corn yield with micronutrient fertilizer is higher for Zn, Cl, and Fe and lower for B, Mn, Cu, Mo, and Ni. Soil DTPA (diethylene triamine pentaacetic acid)-Zn at less than 1 ppm has been used as an indicator of potential corn yield response.

An increase in early growth and yield from starter N fertilization of soybeans has been successful in the northern Great Plains. Research on soybean response to starter fertilization, including P, has been shown to increase plant height and yields when STP is low. Preplant and foliar K applications can be effective at increasing soybean height and yield on low STK soils. Furthermore, leaf area index can be increased with P and K fertilization as early as the V2 growth stage. In other studies, foliar NPK fertilization of soybeans had led to only small and inconsistent yield increases where STP and STK are optimum to very high. No additional yield increase with micronutrients (B, Fe, and Zn) added to an NPK foliar fertilization was found in a study conducted in Iowa. However, a positive yield response from the use of NPK foliar fertilizer was measured over 18 site-years. Foliar B application has increased soybean yield where rice is produced in the rotation.

Iron and Zn applications may result in more frequent soybean yield response in the Great Plains region. Soil DTPA-Zn has been proven to be a useful indicator of potential soybean yield response, but soil DTPA-Fe has been less effective. Plant nutrient analysis, in combination with soil analysis, has been used to diagnose and monitor plant nutrient status to correct or prevent deficiencies. There is an increasing interest in using plant analysis as a monitoring and quality assurance tool. For monitoring plant nutrient status, specific plant parts at particular growth stages are needed to compare to established nutrient sufficiency ranges (NSRs). Soybean NSRs have been established based on the youngest uppermost mature trifoliate leaf without the petiole during blooming prior to pod

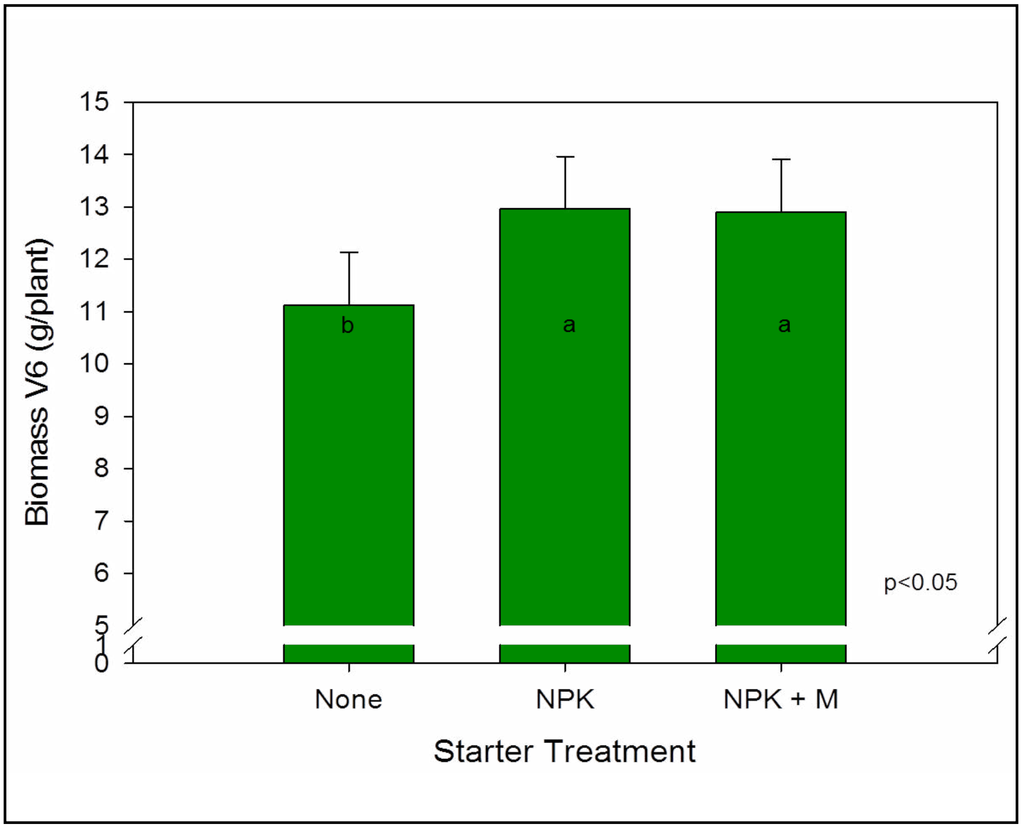

Figure 1. Effect of starter fertilizer application on corn biomass at V6. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

set (R1 to R2 growth stage). However, relatively few changes have been made to the nutrient sufficiency ranges since the 1960s. Given the growing interest and use of plant analysis to make fertilizer recommendations, ongoing research is needed to confirm that the corn and soybean NSRs are robust across time, environments, and genetics (soybean varieties and corn hybrids).

The overall purpose of this 2012 (2010 to 2012) study was to:

- Evaluate corn and soybean response (growth, plant nutrition, and yield) to combinations of starter and foliar fertilization that contain NPK with and without a blend of micronutrients (FE, Mn, Zn, Cu, and B)
- Determine which combination of starter and foliar fertilization increases yield under irrigated conditions in Kansas.

Methodology

Sites. All sites had no history of visible micronutrient deficiency symptoms.

Irrigation. All sites were irrigated with pivot sprinkler irrigation systems in corn/soybean rotations. Irrigation was applied

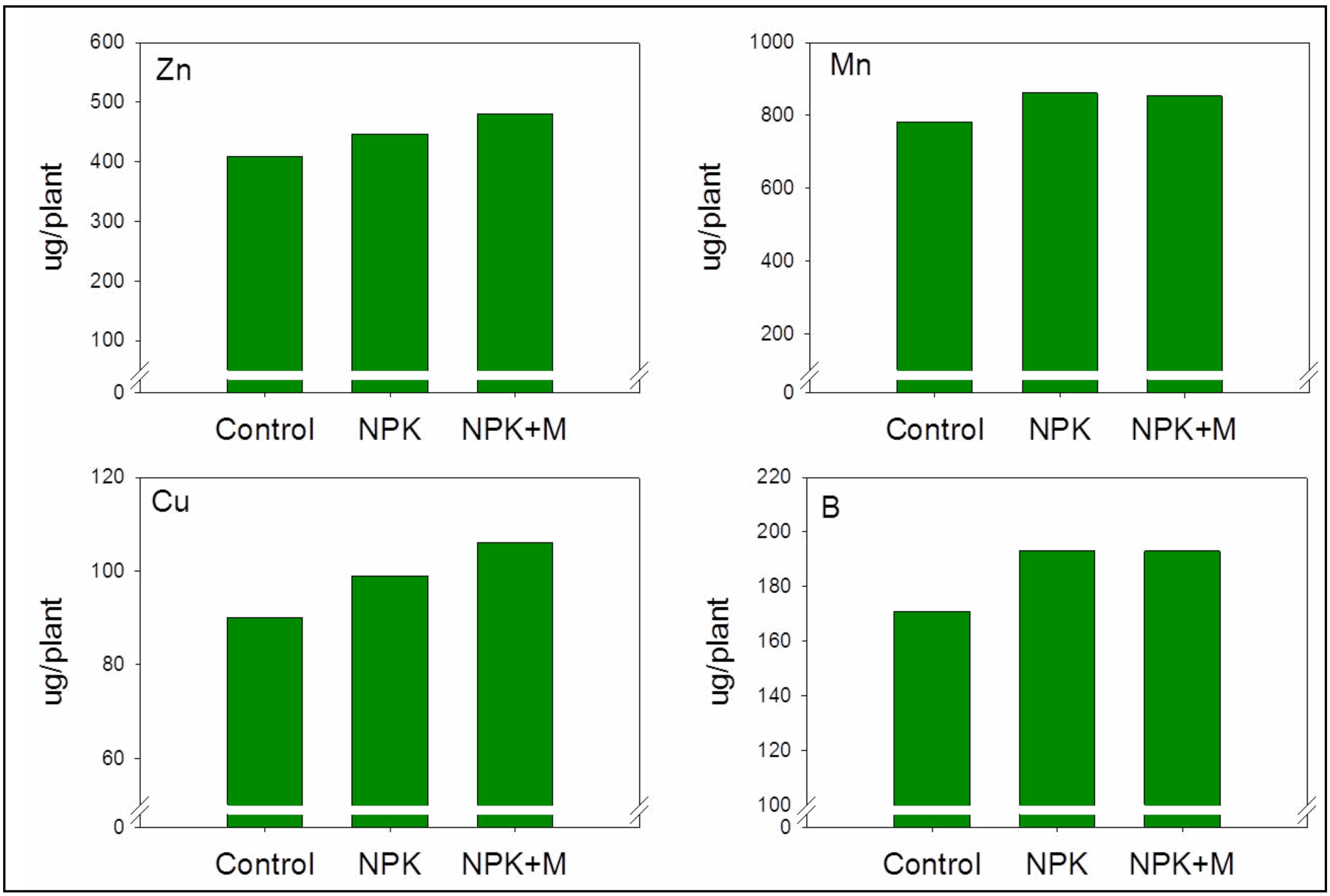

Figure 2. Effect of starter fertilizers with and without micronutrient application on corn tissue nutrient concentration at V6.

as needed during the growing season.

Rates. Corn N fertilizer rates varied from 150 to 250 lbs/A, depending on the site.

Plot size was 30 or 50 feet in length and 10 or 15 feet in width, with row-spacing of 30 inches, except for soybean row spacing, which was 15 inches at one site.

Design. The experimental design was a factorial arrangement in a randomized complete block design with three replications.

Fertilizers. The starter fertilizer factor consisted of three treatments: control, NPK, and NPK plus a micronutrient blend of Fe, Mn, Zn, Cu, and B (referred to hereafter as NPKM). Rates were 4, 10, and 10 lbs/A of N, P_2O_5 and K_2O. Starter fertilizer was surface dribbled over the row. The foliar fertilizer factor consisted of the same three treatments: control, NPK, and NPKM. The factorial arrangement resulted in nine combinations between starter and foliar treatments. The foliar fertilizer was applied at the V6-V8 corn growth stage and at the R2 soybean growth stage. The rates were 2, 2, and 2 lbs/A of N, P_2O_5 and K_2O using a 10-10-10 (N-P_2O_5-K_2O) fertilizer formulation. Foliar fertilizer was applied using a CO_2 pressurized backpack sprayer adjusted to 0.134 MPa and diluted into 20 gal/A of water.

Micronutrients. The micronutrient mix contained B derived from boric acid, CuEDTA (ethylenediamine tetraacetic acid), MnEDTA, ZnEDTA, and FeHEDTA (N-hydroxyethyl-ethylenediamine triacetic acid) at rates of 0.5 lbs/A for each micronutrient. The foliar micronutrient blend contained the same products used for starter at rates of 0.2 lbs/A for each micronutrient.

Soil samples. Composite soil samples were collected from each small plot from the 0- to 6-inch depth prior to planting. Soils were oven dried, crushed to pass through a 2 mm sieve. Soil samples were analyzed for pH (1:1 soil water), P by Mehlich-3 colorimetric method, K by ammonium acetate, organic matter (OM) by weight loss on ignition or Walkley-Black method, cation exchange capacity (CEC) by summation, Fe, Mn, Zn, and Cu by DTPA, and B by hot water.

Plant samples consisted of five or ten above-ground whole corn plants collected near the V6 growth stages from each small plant prior to foliar application. Plant samples for soybeans consisted of 30 of the uppermost fully-expanded trifoliolate leaves without petioles at the R2 growth stage from each small plot prior to the foliar fertilizer treatment.

Plant analysis. Plant samples were oven dried at 65o C for 3 to 5 days, weighed, and ground to pass a 2mm screen. After digesting with HNO3 and 30 percent H2O2, the concentration in plant samples for P, K, Ca, Mg, S, Cu, Fe, Mn, Zn, and B was determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES). Total N for plant samples was determined by dry combustion, using a LECO FP-528 Nitrogen Analyzer.

Plant height. Soybean plant height was recorded at full maturity (R8 growth stage).

Grain yield was determined from the center 2 or 4 rows of each small plot and adjusted to 13 and 15.5% moisture for soybeans and corn, respectively.

Data were analyzed with the MIXED procedure in SAS 9.2 (SAS Institute) with blocks as a random factor. For analysis across sites, both site-year and block within site-year were considered as random factors. Statistical significance was determined at p = 0.10.

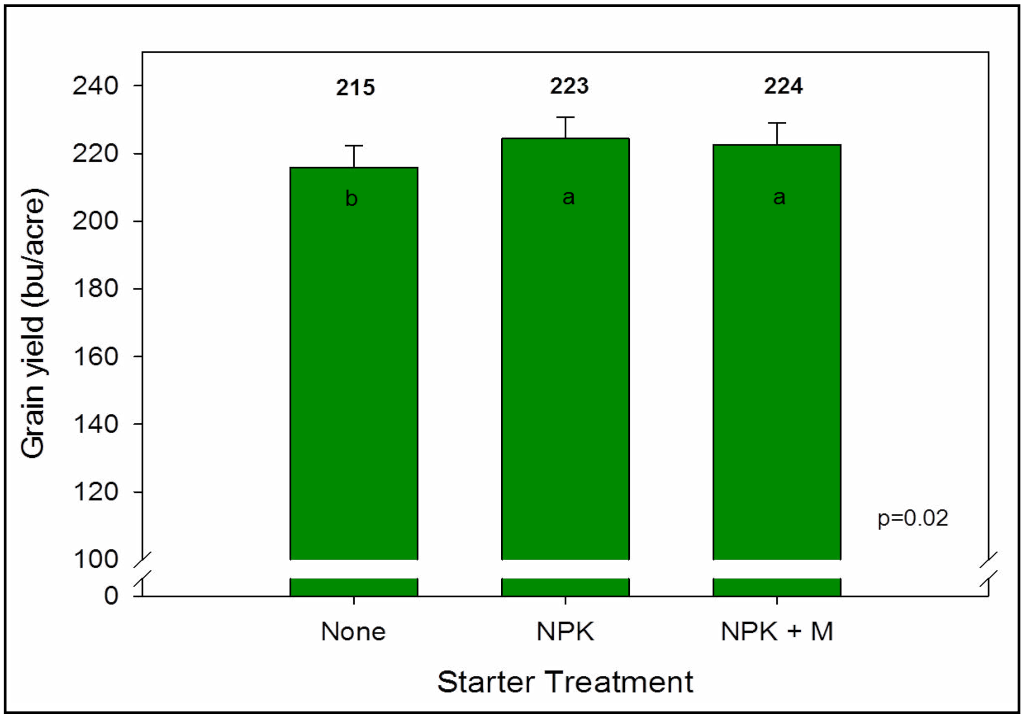

Figure 3. Effect of starter fertilizer application on corn grain yield. Letters indicate statistically significant difference between treatments at $p \leq 0.05$

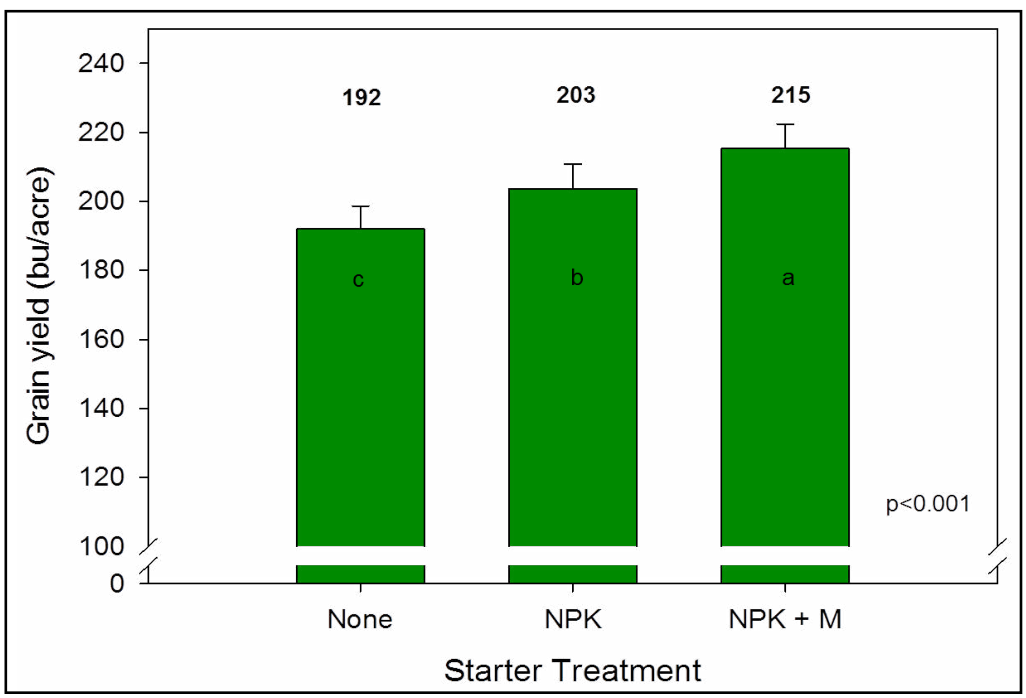

Figure 4. Corn grain yield response for one responsive location in 2012 (Rossville). This location was sandy with low organic matter content. Letters indicates statistically significant difference.

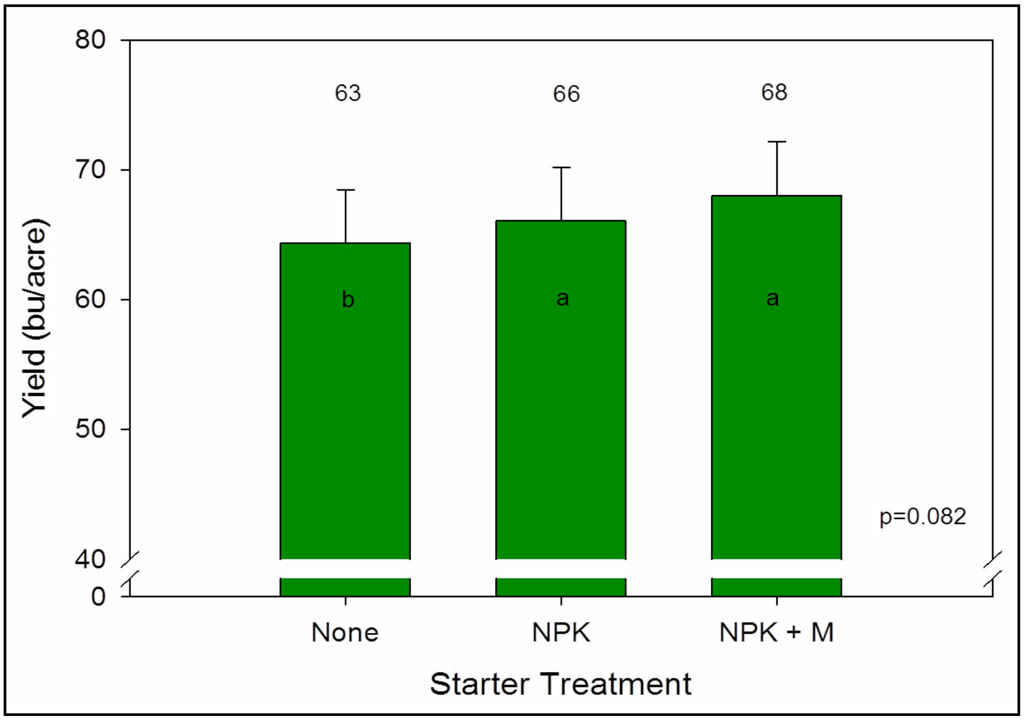

Figure 5. Soybean yield response to starter fertilizer application with or without micronutrients.

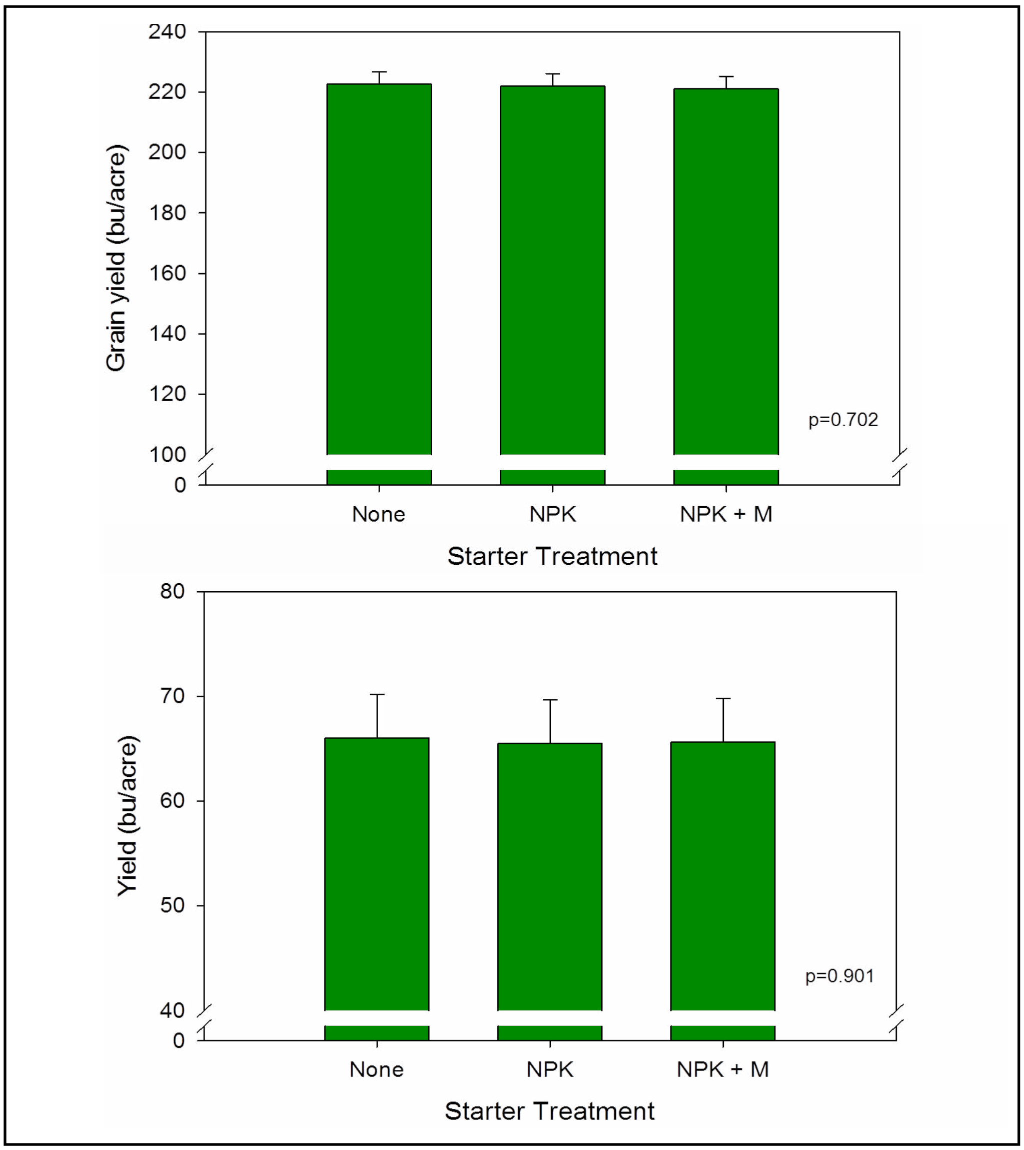

Figure 6. Corn and soybean yield response to foliar fertilizer application with or without micronutrients.

Summing up

Corn early growth (V6) was significantly increased with starter fertilizers (Figure 1). However, the addition of micronutrients with the starter (Zn, Mn, Fe, Cu, B) did not contribute to additional plant growth at this stage.

Increase in corn plant early growth with starter fertilizers is attributed primarily to N and P fertilizer. Secondary and micronutrients would not be expected to increase early growth.

Micronutrient uptake at V6 growth stage followed a similar tendency as plant growth (Figure 2). This suggests that increase in plant growth contributed to nutrient uptake in greater extent compared to tissue nutrient concentration. However, some micronutrients such as Zn and Cu tissue concentration were increased with the addition of fertilizer micronutrients in the starter.

Soybean height at maturity was maximized by an NPKM starter fertilizer treatment without foliar fertilization, with an increase in height of 3 inches over the control.

Yield. Corn grain yield was increased across locations with starter fertilizer treatments. However, no additional grain yield increase occurred with micronutrients in the starter (Figure 3) although one location in 2012 did show an additional increase by using an NPK starter with the addition of micronutrients (Figure 4). The soil at this location was sandy (80% sand) and very low in OM content (0.9%). It is likely that these soil conditions contribute to grain yield response to micronutrient application. Micronutrients may be beneficial under specific soil conditions.

Soybean yield was increased with starter fertilizers. However, yield increase with micronutrients was not statistically significant despite an average increase in yield across locations (Figure 5).

No yield increases were measured in corn or soybeans even when a yield response was measured with starter fertilization (Figure 6).

The results of this study suggest producers have a higher probability of response to fluid fertilization at planting compared to foliar application during the growing season.

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