RESPONSE OF CONTINUOUS CORN TO VARYING RATES AND PLACEMENTS OF STARTER FERTILIZER

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ABSTRACT

Previous research has shown that starter fertilizer, a small amount of fertilizer placed with or near the seed at planting, often accelerates early season growth and increases biomass production, but does not always increase grain yield in corn (*Zea mays* L.). Our objective was to evaluate the effects of starter fertilizer on crop growth and development, as well as grain yield and moisture in continuous corn cropping systems. Treatments consisted of no fertilizer applied at planting (Control), a "Popup" application of 3.4 lbs ac^{-1} N and 5.4 lbs P ac^{-1} placed in-furrow with the seed (PU), an application of 25 lbs ac^{-1} N and 9.8 lbs P ac^{-1} placed 2 inches to one side and 2 inches below (2x2) the seed (S), a combination of 3.4 lbs ac^{-1} N and 9.8 lbs P ac^{-1} applied in-furrow and 21.4 lbs ac^{-1} N and 8 lbs P ac^{-1} applied 2x2 (P+S), and an application of 50 lbs ac^{-1} N and 19.6 lbs P ac^{-1} placed 2x2 (SH). The total N rate applied, but not P rate, was equalized across all treatments with variable sidedress N rates. The study was conducted in 2015 at 3 locations with varying weather conditions, soil types, and management practices. Final plant population was unaffected by starter treatments. Crop growth and development responses to starter fertilizer treatments were similar across all locations. Dry matter and plant height increased 140% and 49%, respectively, with the SH treatment relative to the Control. Other treatments had intermediate effects. Starter fertilizer accelerated the rate of leaf collar appearance throughout the vegetative growth period, beginning as early as the 2-leaf collar stage (V2). As the season progressed, phenological differences among the treatments increased even after total applied N was equalized with the sidedress N applications. Flowering occurred sooner in the P+S and SH treatments than in the Control or PU treatments and the timing of the S treatment flowering was intermediate. On average, grain moisture of the PU, S, P+S, and SH treatments were 0.5, 1.1, 1.6, and 1.7 percentage points lower than the Control treatment. However, grain yield was affected by starter treatments at only one location, increasing by 3.7, 6.2, 7.4, and 9.2 percent relative to the Control for the PU, S, P+S, and SH treatments, respectively. Yield of the SH treatment at that location was significantly higher than that of the PU treatment, but no different than the S or P+S treatment.

INTRODUCTION

Starter fertilizer is the placement of fertilizer with or near the seed at planting. Starter fertilizer often increases the early growth of corn resulting in increased plant height and dry matter (Niehues et al., 2004; Scharf, 1999). These responses sometimes result in increased grain yield and or decreased grain moisture (Vetsch and Randall, 2002), but not always (Bullock et al.,

1993). Our objective is to understand how starter fertilizers affect crop growth and development and the impact of early-season benefits of starter fertilizers on grain yield. Additionally, we want to better define the soil, weather, and management factors that affect corn grain yield response to starter fertilizer and to quantify the frequency and magnitude of the response.

MATERIALS AND METHODS

The study was conducted in 2015 at three Purdue Agricultural Centers (NEPAC, PPAC, and SEPAC) varying in soil types, management practices, and weather conditions. Pioneer brand 1498CHR was planted at a population of 33,000 plants ac^{-1}. Treatments consisted of no fertilizer applied at planting (Control), a "Popup" application of 3.4 lbs ac^{-1} N and 5.4 lbs P ac^{-1} placed in-furrow with the seed (PU), an application of 25 lbs ac^{-1} N and 9.8 lbs P ac^{-1} placed 2 inches to one side and 2 inches below (2x2) the seed (S), a combination of 3.4 lbs ac^{-1} N and 9.8 lbs P ac^{-1} applied in-furrow and 21.4 lbs ac^{-1} N and 8 lbs P ac^{-1} applied 2x2 (P+S), and an application of 50 lbs ac^{-1} N and 19.6 lbs P ac^{-1} placed 2x2 (SH). The total N rate applied, but not P rate, was equalized across all treatments with variable sidedress N rates. The experimental design was randomized complete block with 5 or 6 replications depending on location.

Plant population was estimated at V1 and at V6 from 50-75 ft row^{-1} dependent on field size. Plant growth stage was recorded on 40-60 plants $plot^{-1}$ about weekly throughout the vegetative period to silking. Plant height was determined at V6-V7 on 48 to 72 plants $plot^{-1}$ and above-ground dry matter was determined at V6-V7 on 32-48 plants $plot^{-1}$. Grain yield and grain moisture were obtained with a calibrated yield monitor. The data was cleaned using SMS and ARC GIS. All data was analyzed using SAS version 9.2 (SAS inst., Cary, NC). Everything discussed in the results was significant ($P \leq 0.10$), unless stated otherwise.

RESULTS AND DISCUSSION

Plant populations were unaffected by starter treatments at either sampling date or at any location. Plant growth response to starter fertilizer was similar at each location. Plant height (data not shown) and dry matter (Fig. 1) increased by an average of 49-140% respectively when comparing the Control and SH treatments. Other starter treatments generally had intermediate effects.

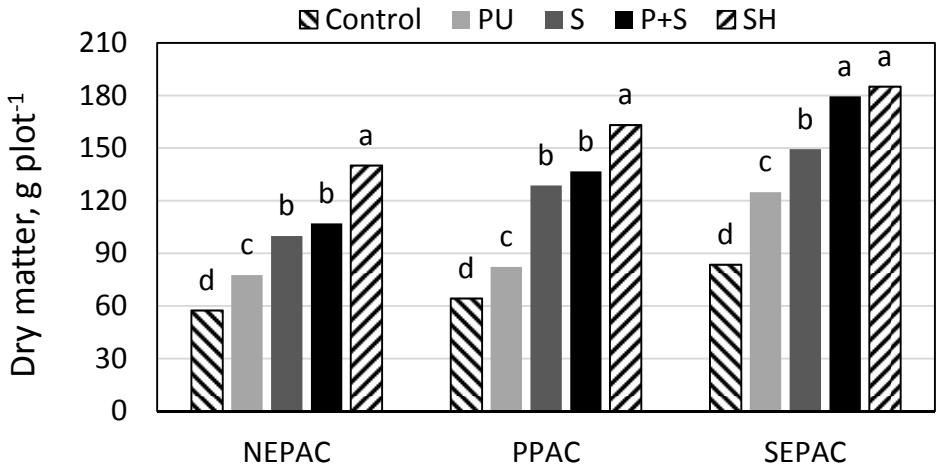

Figure 1. Starter fertilizer effects on the above-ground plant dry matter of 16 harvested plants at V6-V7 at three locations (NEPAC, PPAC, and SEPAC). Control=no starter, PU=in-furrow at 3.4 lbs ac^{-1} N and 5.4 lbs P ac^{-1}, S=25 lbs ac^{-1} N and 9.8 lbs P ac^{-1} 2 inches to one side and 2 inches below (2x2) the seed, P+S=3.4 lbs ac^{-1} N and 9.8 lbs P ac^{-1} in-furrow and 21.4 lbs ac^{-1} N and 8 lbs P ac^{-1} 2x2, and SH=50 lbs ac^{-1} N and 19.6 lbs P ac^{-1} 2x2.

Starter fertilizer accelerated the appearance of leaves throughout the vegetative growth period. Enhanced development could be detected as early as V2 (data not shown). Differences among treatments increased as the season progressed. When Control plants had 10-12 leaf collars, the SH treatment was approximately 2 leaf collars ahead (Fig. 2). Other treatments had similar or slightly lesser effects.

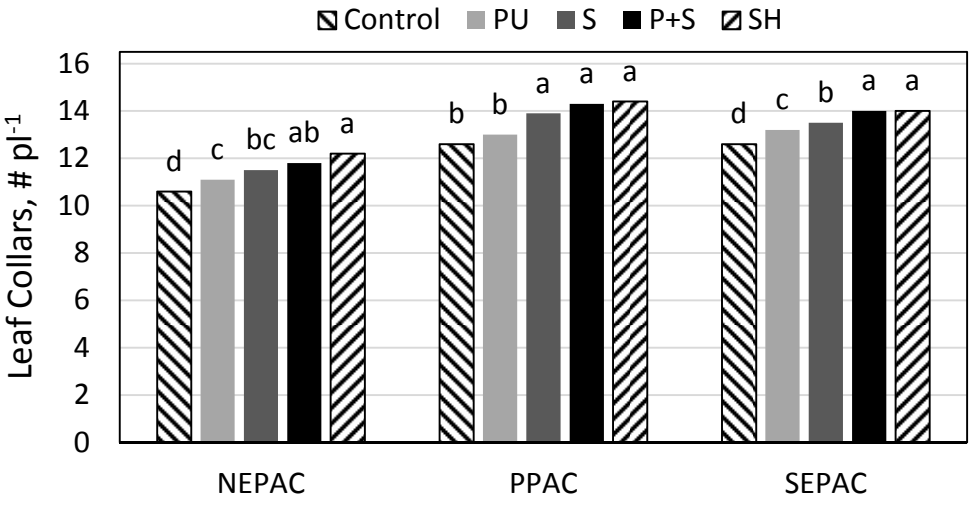

Figure 2. Starter fertilizer effects on the number of leaf collars when control plants had 10-12 leaf collars at three locations (NEPAC, PPAC, and SEPAC). Starter fertilizer effects on above-ground plant dry matter at V6-V7 at three locations (NEPAC, PPAC, and SEPAC). Control=no starter, PU=in-furrow at 3.4 lbs ac^{-1} N and 5.4 lbs P ac^{-1}, S=25 lbs ac^{-1} N and 9.8 lbs P ac^{-1} 2 inches to one side and 2 inches below (2x2) the seed, P+S=3.4 lbs ac^{-1} N and 9.8 lbs P ac^{-1} in-furrow and 21.4 lbs ac^{-1} N and 8 lbs P ac^{-1} 2x2, and SH=50 lbs ac^{-1} N and 19.6 lbs P ac^{-1} 2x2.

Plots that received starter fertilizer also reached tasseling (VT) and silking (R1) earlier than the control treatments. The magnitude of treatment differences varied between locations, but generally the P+S and SH treatments had the greatest percentage of plants at VT&R1 at the last staging date while the S treatment was intermediate and the Control and PU treatments were the lowest.

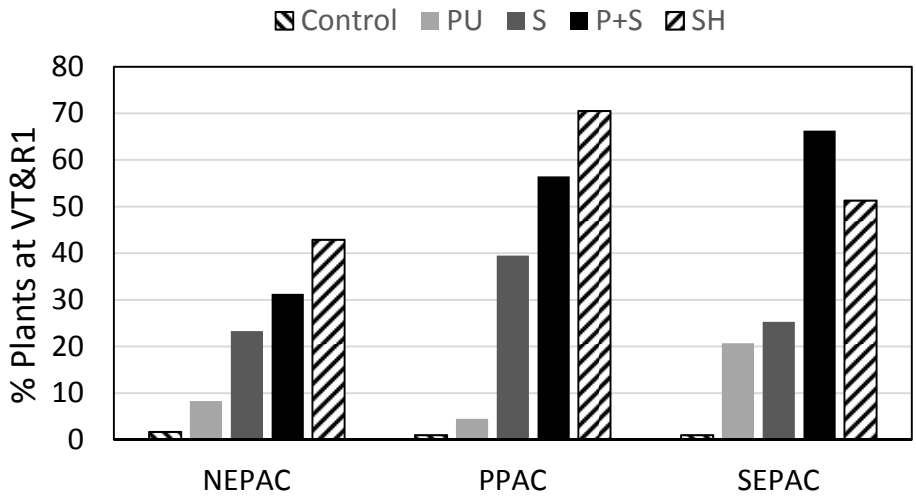

Figure 3. Starter fertilizer effects on the percentage of plants at VT and/or R1 at three locations (NEPAC, PPAC, and SEPAC). Starter fertilizer effects on above-ground plant dry matter at V6-V7 at three locations (NEPAC, PPAC, and SEPAC). Control=no starter, PU=in-furrow at 3.4 lbs ac^{-1} N and 5.4 lbs P ac^{-1}, S=25 lbs ac^{-1} N and 9.8 lbs P ac^{-1} 2 inches to one side and 2 inches below (2x2) the seed, P+S=3.4 lbs ac^{-1} N and 9.8 lbs P ac^{-1} in-furrow and 21.4 lbs ac^{-1} N and 8 lbs P ac^{-1} 2x2, and SH=50 lbs ac^{-1} N and 19.6 lbs P ac^{-1} 2x2.

PU, S, P+S, and SH averaged 0.5, 1.1, 1.6, and 1.7% drier at harvest than the no starter Control treatment averaged over all locations (data not shown). This was most likely due to the plants pollinating earlier when starter fertilizer was applied.

Grain yield was only affected by the starter fertilizer treatments at NEPAC. PU, S, P+S, and SH yielded 168, 172, 174, and 177 bu ac^{-1} respectively while the control yielded 162 bu ac^{-1}. No other locations had any significant differences among treatments.

SUMMARY

Starter fertilizer treatments consistently increased early season plant height, dry matter, and accelerated plant development resulting in earlier silking and drier grain at harvest when compared to a no starter control. These effects were consistent across all locations with varying tillage, planting date, and yield level. Increasing N and P rates within treatments increased the overall plant response to all measurements where there were significant differences. Despite the consistent increases in plant growth, development, and grain moisture, grain yield was only increased at one location.

ACKNOWLEDGEMENTS

We gratefully acknowledge the support provided by the Indiana Corn Marketing Council, DuPont-Pioneer, A&L Great Lakes Labs, John Deere, and all of the Purdue Ag Center staff.

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NORTH CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY CONFERENCE

Volume 32

November 2-3, 2016
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Web page**: www.IPNI.net**

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