CORN HYBRIDS WITH CONTRASTING ROOT SYSTEMS: RESPONSE TO SOIL AND FERTILIZER PHOSPHORUS

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Abstract

With current corn genetic improvements for water-limited scenarios, root system architecture and growth are being considered which may affect overall nutrient uptake particularly for immobile nutrients. The objective of this study was to evaluate plant response and phosphorus uptake with contrasting, generally shallow and generally deep rooted corn hybrids. Over the two years there were a total of seven sites, two sites in 2011 and five sites in 2012. The sites are all rain fed except for three sites under irrigation. Throughout the study there were two hybrids that were assessed with starter and broadcast P application methods. The experiment design was a factorial and in a randomized complete block, with two starter, two broadcast and two hybrid combinations for a total of 8 treatments. Early growth biomass was evaluated at the V6 growth stage, including whole plant tissue P concentrations. Ear leaf tissue were also collected at the VT-R1 growth stage and analyzed for P concentration. Finally grain yield is assed at the end of each growing season. Preliminary results show significant differences in grain yield response between hybrids, differences were also significant with broadcast phosphorus fertilizer application. Generally, these two hybrids show different response and further analysis will evaluate P use efficiency for these hybrids.

Introduction

Corn response to starter fertilizer application can vary by hybrid. These differences may be related to different genetics factors including growth habits and differences in root system. With current corn genetic improvements for water-limited conditions, root system architecture and growth are being considered which may affect overall nutrient uptake particularly for immobile nutrients. A hybrid having a high rate of root growth, root biomass and uptake of N and P can be expected to show little response to starter fertilizer. Therefore, a positive response to starter fertilizer may be expected of a hybrid having a slow rate of root growth and/or low nutrient uptake rate (Rhoads and Wright, 1998). Considering that hybrids may differ in rooting characteristics, previous studies in Kansas evaluated the response of several corn hybrids to starter fertilizer application (Gordon and Fjell 1994). This study Gordon and Fjell (1994) evaluated the effects of starter fertilizer on six corn hybrids with maturities ranging from 2530 to 2850 growing degree units (GDU) grown under no-tillage, dryland conditions. Results showed significant differences in amounts of N and P taken up at the V6 growth stage. Differences in N and P concentrations among hybrids also were found in ear leaf tissue at VT (Gordon and Fjell 1994). They suggested that differences in rooting system among corn hybrids can show a significant interaction with nutrient uptake from fertilizer and soil phosphorus. However, the study evaluated specific commercial hybrids available at that time that were not categorized based on root system architecture, and therefore results cannot be applied to general categories based on root system architecture. The objective of this study was to evaluate plant response and

phosphorus uptake for hybrids with contrasting root system including a generally shallow and generally deep rooted corn hybrids.

Materials and Methods

A total of seven sites were established in two years (2011 and 2012), including three irrigated sites and four sites under rain fed conditions. Throughout the study there were two hybrids that were assessed with starter and broadcast P application methods. The experiment design was a factorial in a randomized complete block, with two starter, two broadcast and two hybrid combinations for a total of 8 treatments combinations. Fertilizer treatments included starter fertilizer at 22 kg ha^{-1} P_2O_5 dribble-placed, broadcast fertilizer was applied at 112 kg ha^{-1} P_2O_5 broadcast before planting in the spring. The factorial design also includes combinations of the starter and broadcast treatment. Composite soil samples were collected from the 0-15 cm depth from each block. Samples were analyzed for soil test P by the Mehlich 3 extraction method. Plant nutrient status was evaluated by tissue analysis for total P early in the season (V6) and at tassel (VT). Early growth biomass measured at V6 stage. Grain yield was measured at the end of the season. Statistical analysis was completed using the GLIMMIX procedure in SAS. Sites and blocks within sites were considered as random factors in the analysis. Significance were established at the ≤ 0.05 probability level.

Results and discussion

Soil test P varied by location from low to high (table 1), and plant response to P fertilizer application (starter and broadcast) was observed for some parameters including grain yield for broadcast P application (table 2). Plant early growth was different among hybrids and significantly affected by fertilizer application (Fig 1). Plant P uptake was generally higher for the shallow rooted hybrid, especially with fertilizer P application (Fig 2). Results also show significant differences in grain yield between hybrids, and statistical difference in grain yield with the addition of broadcast phosphorus fertilizer. However no statistical differences in grain yield were found with starter phosphorus fertilizer, although average grain yield across sites show a slight increase in grain yield (Fig 3).

Preliminary results indicate that the two hybrids with contrasting rooting systems response differently to fertilizer P application. This suggests that groups of hybrids with similar root system may express similar response to P fertilizer application and soil P use. Further analysis is currently evaluating differences in P use efficiency and possible implications of hybrid selection for P management under different management system (irrigated and rain fed) as well as tillage system.

Table 1. Preliminary soil test results. Samples collected from each block at the 0-15 cm depth.

Soil Test	Site						
	Belleville Rain fed 2011	Topeka Rain fed 2011	Belleville Rain fed 2012	Hutchinson Irrigated 2012	Hutchinson Rain fed 2012	Rossville Irrigated 2012	Scandia Irrigated 2012
	ppm						
Phosphorus	42	23	53	23	59	15	15
Potassium	339	220	458	277	242	189	615

Table 2. Partial analysis of variance (ANOVA) across site years.

Response variable	Fixed Effect						
	Hybrid (H)	Starter (S)	H x S	Broadcast (B)	H x B	S x B	H x S x B
	p > F						
Early Growth	0.019	<0.001	0.538	<0.001	0.975	0.362	0.729
P Uptake	0.105	<0.001	0.794	<0.001	0.445	0.065	0.395
Ear Leaf P Conc.	0.487	0.527	0.682	0.976	0.361	0.978	0.269
Grain Yield	<0.001	0.413	0.169	0.001	0.297	0.158	0.472

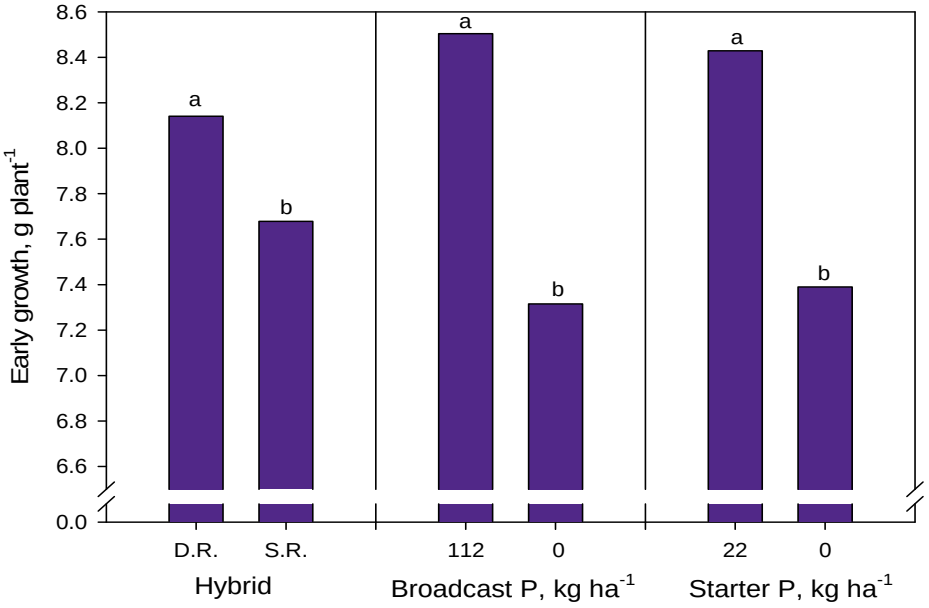

Figure 1. Early growth at the V5-V6 growth stage. D.R. = Deep rooted hybrid, S.R. = Shallow rooted hybrid. Results were summarized across all sites throughout the 2011-2012 growing seasons. Different letters indicate statistically significant differences at the 0.05 probability value.

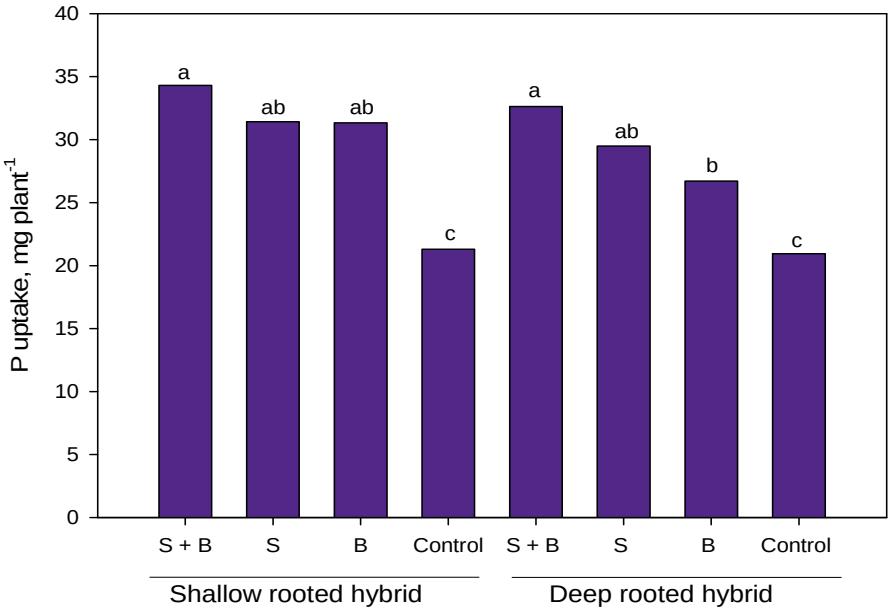

Figure 2. Phosphorus uptake. S = Starter, B = Broadcast. Results were summarized across the two sites from the 2011 growing season. Different letters indicate statistically significant differences at the 0.05 probability value.

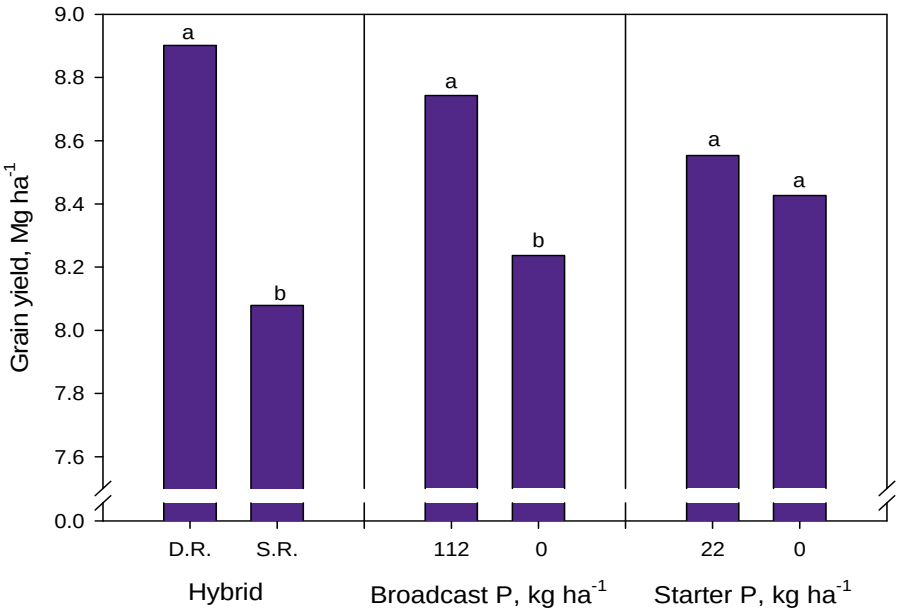

Figure 3. Grain yield. D.R. = Deep rooted hybrid, S.R. = Shallow rooted hybrid. Results were summarized across five sites from the 2011-2012 growing seasons. Different letters indicate statistically significant differences at the 0.05 probability value.

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