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Early-Season Corn Response to Broadcast Pre-Plant Phosphorus Fertilizer Application

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Abstract

The objective of this study was to evaluate early-season corn response to different rates of preplant broadcast phosphorus fertilizer and determine the optimum levels using four different soil test methods. The study was conducted in 11 locations across Kansas in 2021. The experimental design is a randomized complete block design with four replications. Fertilizer treatment consisted of five rates of phosphorus fertilizer (0, 30, 60, 90, and 120 lb/a of P_2O_5). Fertilizer was applied one time by broadcast pre-plant. Soil samples were collected at 0- to 6-in. deep before treatment application, composited by blocks, and analyzed for soil test phosphorus using Mehlich 3, Haney H3A, Bray 1, and Bray 2 test methods. Whole plant sampling at V6 was collected for phosphorus uptake analysis. Results show that using early season phosphorus uptake response provided critical levels of 23 and 17 ppm of phosphorus for the Mehlich 3 and Bray 1 methods, respectively. For the Haney H3A method, the critical level was estimated at 15 ppm and for the Bray 2 method had an estimated critical value of 69 ppm. Phosphorus uptake at early season (V6) showed a significant response to broadcast phosphorus fertilization at four of eleven sites.

Keywords

phosphorus, early season, corn, soil test, phosphorus uptake

Early-Season Corn Response to Broadcast Pre-Plant Phosphorus Fertilizer Application

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Summary

The objective of this study was to evaluate early-season corn response to different rates of pre-plant broadcast phosphorus fertilizer and determine the optimum levels using four different soil test methods. The study was conducted in 11 locations across Kansas in 2021. The experimental design is a randomized complete block design with four replications. Fertilizer treatment consisted of five rates of phosphorus fertilizer (0, 30, 60, 90, and 120 lb/a of P_2O_5). Fertilizer was applied one time by broadcast pre-plant. Soil samples were collected at 0- to 6-in. deep before treatment application, composited by blocks, and analyzed for soil test phosphorus using Mehlich 3, Haney H3A, Bray 1, and Bray 2 test methods. Whole plant sampling at V6 was collected for phosphorus uptake analysis. Results show that using early season phosphorus uptake response provided critical levels of 23 and 17 ppm of phosphorus for the Mehlich 3 and Bray 1 methods, respectively. For the Haney H3A method, the critical level was estimated at 15 ppm and for the Bray 2 method had an estimated critical value of 69 ppm. Phosphorus uptake at early season (V6) showed a significant response to broadcast phosphorus fertilization at four of eleven sites.

Introduction

Phosphorus (P) is an essential macronutrient required in relatively large quantities. Usually, the available fraction of the total soil phosphorus is typically low, and phosphorus fertilizer needs to meet crop phosphorus needs (Preston et al., 2019). Inadequate early season P supply can result in limited corn growth. A combination of soil available P and pre-plant fertilization can help meet early corn establishment and growth demands. Soil testing should be performed to determine the correct fertilizer rate for an economic yield response (Mallarino and Blackmer, 1992; Coelho et al., 2019). Critical concentrations of soil test phosphorus (STP) in the early season can be used to identify the response to phosphorus fertilization. Identifying the critical STP could depend on many factors, including soil characteristics, environmental, and other factors. This can also vary depending on the crop; current soil test interpretation guidelines with the Mehlich 3 method suggest a critical value of 20 ppm for all crops in Kansas (Leikam et al., 2003). Determining an appropriate concentration of STP for a specific extract is a fundamental step in making fertilizer recommendations. The objective of this study was to evaluate early-season corn response to different rates of pre-plant broadcast phosphorus fertilizer and determine the optimum levels using four different soil test methods (Mehlich 3, Haney H3A, Bray 1, and Bray 2).

Procedures

The study was conducted in 11 locations across Kansas during 2021 (Table 1). The experimental design was a randomized complete block design with four replications; plots were 10-ft width × 40-ft length. Fertilizer treatments were five rates of phosphorus fertilizer (0, 30, 60, 90, and 120 lb/a of P_2O_5), using mono-ammonium phosphate (MAP) (11-52-0). All fertilizer was applied one time by broadcast pre-plant. Soil samples were collected at 0- to 6-in. deep using a hand probe before treatment application, composited by block. Soil samples were dried at 104°F (40°C) and ground to pass a 2-mm sieve then analyzed colorimetrically for soil test P using four different extraction methods (Mehlich 3, Haney H3A, Bray 1, and Bray 2). Whole plant samples collected at V6 were dried at 140°F (60°C), were ground to pass a 2-mm sieve for P uptake analysis using the nitric-perchloric acid digestion method, and then analyzed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Statistical analysis was performed using R version 4.1 ($P < 0.05$). The critical level for each soil test method was determined using the linear plateau model across locations.

Results

Preliminary results show that using early season P uptake response provided critical levels of 23 and 17 ppm for the Mehlich 3 and Bray 1 methods with an R^2 of 0.88 and 0.87, respectively (Figure 1a, and Figure 1b). The critical level for the Haney H3A method was estimated at 15 ppm with an R^2 of 0.87 (Figure 1c). The critical level for the Bray 2 method was estimated at 69 ppm with an R^2 value of 0.87 (Figure 1d).

Phosphorus uptake at early season (V6) showed a significant response to broadcast P fertilization at four of eleven sites. The responsive sites were 1, 2, 4, and 5 (Table 1). The STP for Mehlich 3 methods showed between 5–21 ppm for the responsive sites. Phosphorus uptake responses across sites were statistically significant, up to 90 lb/a of P_2O_5; a higher rate of P did not increase P uptake (Figure 2a). Across the nonresponsive sites, P uptake per plant was more than 0.4 g (Figure 2b). By comparison, at responsive sites, the highest P uptake was less than 0.2 g per plant (Figure 2b).

References

Coelho, M.J.A., D.A. Ruiz Diaz, G.M. Hettiarachchi, F.D. Hansel, and P.S. Pavinato. 2019. Soil phosphorus fractions and legacy in a corn-soybean rotation on Mollisols in Kansas, USA. Geoderma Regional. 18:228. https://doi.org/10.1016/j.geodrs.2019.e00228.

Leikam, D. F., Lamond, R. E., & Mengel, D. B. (2003). MF2586. Soil Test Interpretations and Fertilizer Recommendations. Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan, KS.

Mallarino, A. P., & Blackmer, A. M. (1992). Comparison of Methods for Determining Critical Concentrations of Soil Test Phosphorus for Corn. Agronomy Journal, 84(5), 850–856. https://doi.org/10.2134/agronj1992.00021962008400050017x.

Preston, C.L., Ruiz Diaz, D.A., & Mengel, D.B. 2019. Corn response to long-term phosphorus fertilizer application rate and placement with strip-tillage. Agronomy Journal 111 (2), 841-850.

Table 1. Study sites and soil properties for corn studies in 2021

Location	County	Soil series	pH	Mehlich 3 P	Bray 1 P	Bray 2 P	Haney H3A P
				ppm			
1	Republic	Crete	6.5	5	6	31	5
2	Republic	Crete	6.1	7	8	41	7
3	Dickinson	Geary	5.8	21	23	65	14
4	Shawnee	Bismarckgrove	7.6	21	19	70	23
5	Gove	Keith	7.2	20	19	183	25
6	Logan	Keith	6.4	22	21	145	23
7	Gove	Keith	6.6	25	23	160	30
8	Gove	Ulysses	6.2	35	37	148	26
9	Saline	Longford	5.4	38	41	79	23
10	Riley	Bourbonais	6.3	45	34	134	55
11	Brown	Kennebec	6.3	45	43	96	40

Samples were collected at 0- to 6-in. depth.

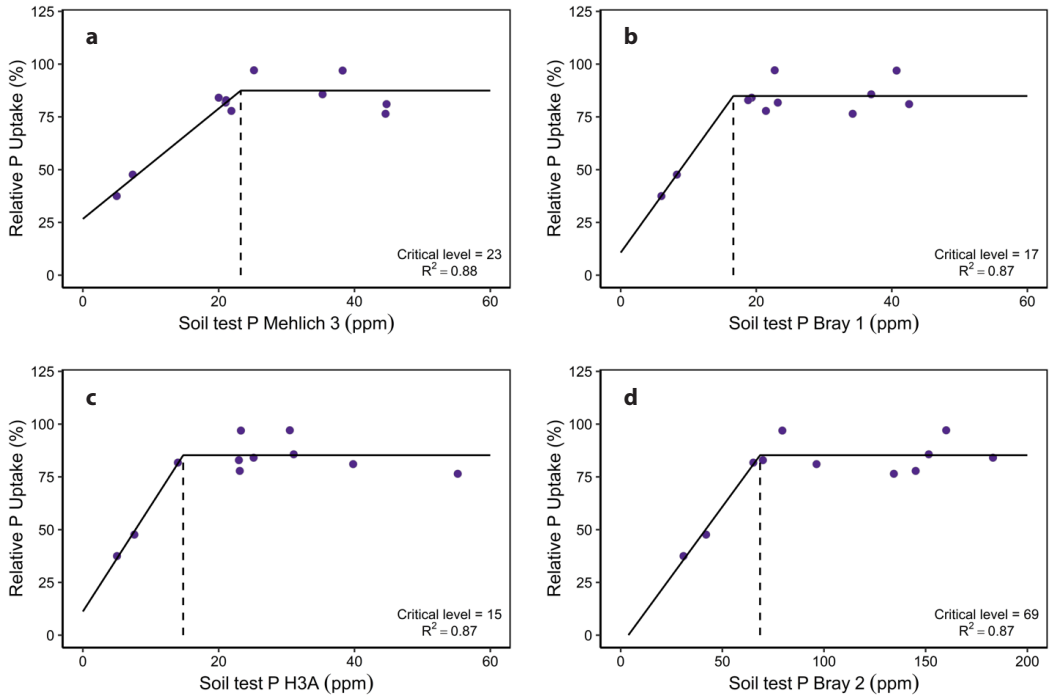

Figure 1. Relative P uptake in corn at the V6 growth stage using four different soil P extraction methods and analyzed colorimetrically.

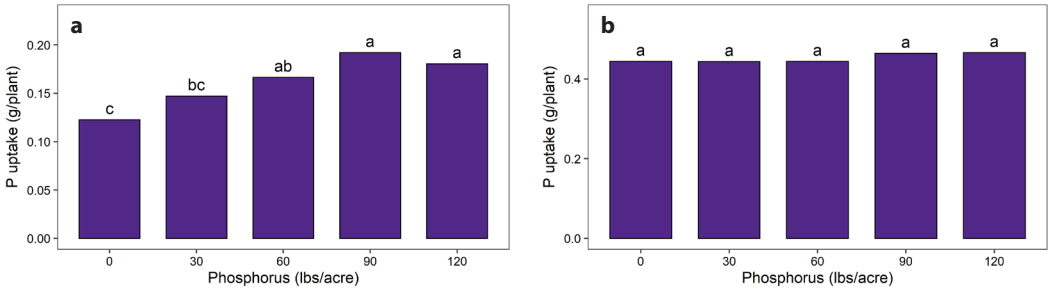

Figure 2. Phosphorus uptake at different phosphorus (P_2O_5) application rates across responsive sites (a) and non-responsive sites (b).
†Means with the same letter are not significantly different among treatments ($P < 0.05$)