THE EFFECTS OF PHOSPHORUS AND POTASSIUM PLACEMENT ON CORN YIELD IN NO-TILL SOILS

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ABSTRACT

Corn (Zea mays L.) is one of the most widely cultivated cereal crops in the world and requires effective nutrient management strategies to maximize growth and profitability. Phosphorus (P) and potassium (K) are essential nutrients for corn development; however, studies have shown that placing P and K closer to the seed in a band has the potential to improve nutrient use efficiency and increase corn yield over broadcasting. The aim of this two-year study was to assess the impact of P and K fertilizer placement techniques (banded or broadcast) on corn yield and plant nutrient content. The experiment compared broadcast and banded P and K applications using a no-fertilizer check and three broadcast and banding (2 inches from the row) rates (full, 2/3, and 1/2 sufficiency). Additional banding treatments used 1/2 sufficiency rates at 0, 2, 4, 6, and 10 inches from the row, placed 2–4 inches deep.

Across sites, corn yield responded to P rate but showed no consistent response to fertilizer placement. At the 11 ppm P_2O_5 site, applying P above the ½ sufficiency rate increased yield relative to the 0 P check, but broadcast and banded P treatments produced similar yields (145–164 bu/ac). At the 8 ppm P_2O_5 site, the 0 P check produced the lowest yield (204 bu/ac), while all P placement methods produced similar yields (211–219 bu/ac). At both sites, K levels were above 160 ppm critical soil test value and did not increase yield with K fertilization. Overall, results concluded that P rate, rather than banding versus broadcasting or band distance from the row, determined corn yield, and neither placement method nor K application improved yield at these high soil K testing sites.

INTRODUCTION

Phosphorus (P) and potassium (K) are vital macronutrients necessary for the growth and development of corn. Phosphorus is essential for energy transmission, photosynthesis, root development, and initial growth phases, whereas K governs water regulation, nutrient distribution, carbohydrate metabolism, and enzyme activation in plants. Enough of both nutrients fosters robust initial development, augments water-use efficiency, enhances stress resilience, and optimizes yield capacity. Low levels in either P or K might hinder nutrient absorption, diminish photosynthetic efficiency, elevate vulnerability to dry conditions, and reduce corn yield.

Broadcasting P and K fertilizer on the soil surface is the most common application method in South Dakota. When this is done in no-till fields where there is no mechanical mixing of nutrients from tillage, stratification of the nutrients near the top of the soil results. This stratification creates a very nutrient rich area near the surface which interacts with precipitation and meltwater. (Baumgartner, 2026) Stratification of nutrients may restrict nutrient accessibility during arid conditions when root activity is focused deeper in the soil profile and can increase nutrient loss from surface runoff events due to their high mobility with soil particles. Fertilizer placement can affect early season root uptake and the overall return on investment.

According to (Mallarino, 2000), research conducted across the North Central United States has shown that yield responses to deep-banded P and K fertilizers are often inconsistent and depend on soil-test levels, weather conditions, and the degree of nutrient stratification present. Although subsurface banding has been proposed as a strategy to improve nutrient uptake, fertilizer use efficiency, and corn yield, limited recent research has evaluated the effects of P and K placement under South Dakota no-till conditions, particularly with respect to band placement distance from the crop row.

Therefore, this study was conducted to improve understanding of how broadcast and banded P and K applications influence corn productivity and to provide data for refining nutrient management recommendations for no-till corn production systems. The objective of this study was to assess the impact of P and K fertilizer placement method (broadcast vs. banded) and band placement distance from the row on corn grain yield and plant nutrient uptake under no-till management.

MATERIALS AND METHODS

This study was conducted in 2025 at two no-till corn production sites located near Beresford and Freeman, South Dakota. At Beresford, initial soil analysis revealed an Olsen P value of 11 ppm, indicating a medium classification, but the K concentration was at 174 ppm, categorizing it as very high. At Freeman, the initial soil analysis revealed a P concentration of 8 ppm Olsen and 160 ppm K. At both locations, treatments included an unfertilized control along with multiple P and K fertilizer placement strategies. Broadcast and banded P and K applications consisted of a no-fertilizer check and three broadcast and banding (2 inches from the row) rates (full, 2/3, and ½ sufficiency rate recommendation) Additional banding treatments used ½ sufficiency rates at 0, 2, 4, 6 and 10 inches from the row, placed 2-4 inches deep. Phosphorus was supplied as monoammonium phosphate (MAP, 11-52-0) and K as potash (0-0-60), Sufficiency application rates were determined using SDSU fertilizer recommendation equations based on Olsen P and ammonium acetate K soil test values. (Clark et al., 2023)

RESULTS AND DISCUSSION

Phosphorus

Corn grain yield in Beresford responded positively to P fertilization. (Figure 1) The control treatment yielded 140 bu/ac, whereas fertilized treatments produced yields ranging from 145 to 159 bu/ac. The highest yield was observed when P was banded 4 inches from the row at the ½ sufficiency rate (159 bu/ac); however, yields were not consistently affected by fertilizer placement method or distance from the row so there was no significant difference. Broadcast applications at the full, two-thirds, and ½ sufficiency rates yielded 146, 145, and 156 bu/ac, respectively, and were statistically similar to the banded treatments. Although yield tended to decline when fertilizer was placed 6 inches from the row (145 bu/ac), this reduction was not statistically significant. Likewise, increasing the banded fertilizer rate at the 2-inch placement distance from ½ to two-thirds or full sufficiency did not result in additional yield increases. These results suggest that under the soil fertility conditions present at Beresford, P application rate had a greater influence on corn yield than fertilizer placement method or band distance from the row.

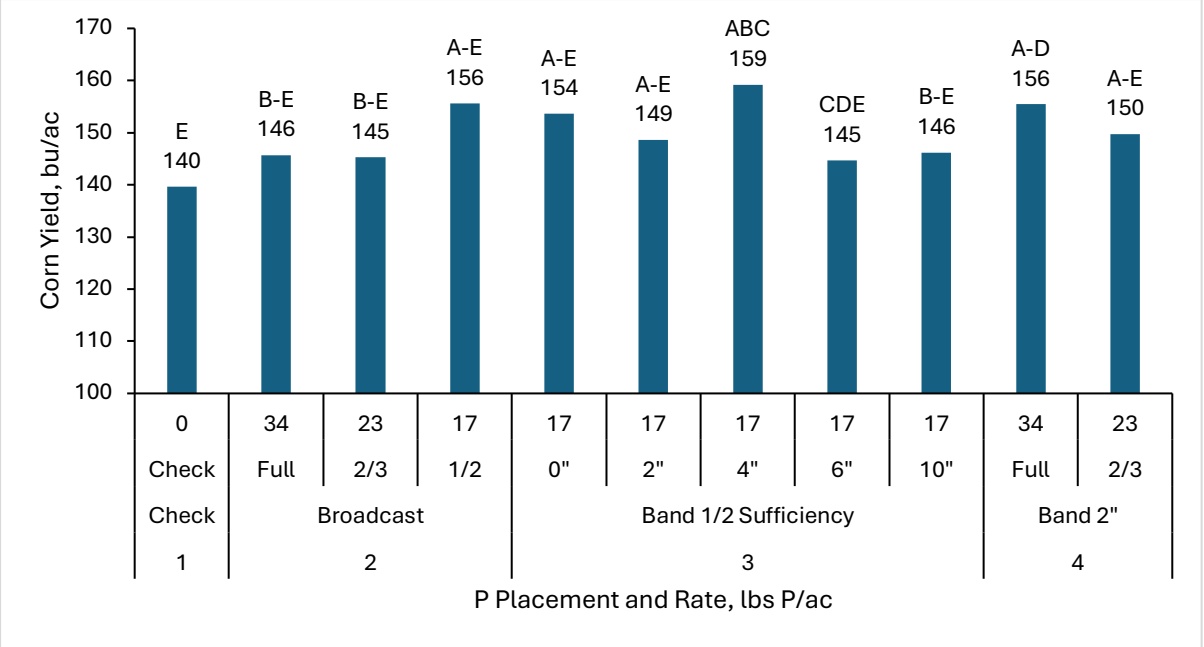


Figure 1. Corn grain yield response as a function of phosphorus (P) placement and rate in Beresford, SD in 2025. Phosphorus placement was either broadcast applied on the soil surface or banded 0, 2, 4, 6, or 10" from the row at full, 2/3, or 1/2 the SDSU sufficiency rate recommendation. Bars that share at least one letter are not significantly different.

Corn grain yield at the Freeman site responded positively to P fertilization (Figure 2). Compared with the unfertilized control (174 bu/ac), P fertilization increased grain yield by 12 to 16%, with fertilized treatments ranging from 194 to 201 bu/ac. However, no significant differences were observed among fertilizer rates or between broadcast and banded applications. These results indicate that P fertilization was necessary to optimize corn yeild at this site, whereas fertilizer placement method had little influence on yield.

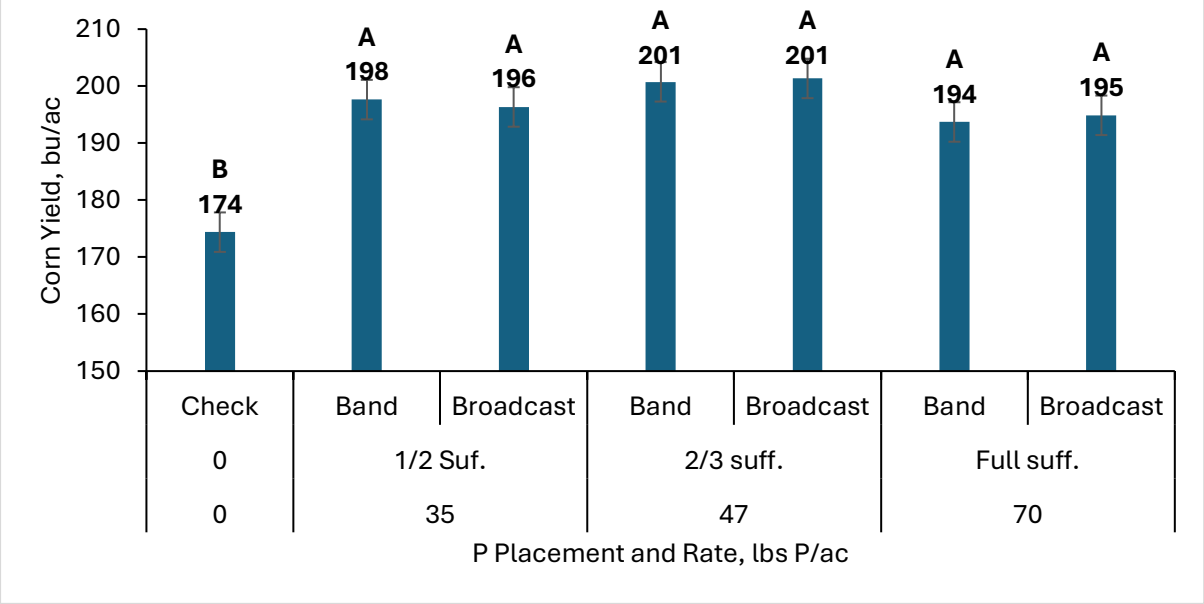


Figure 2 Corn grain yield response as a function of phosphorus (P) placement and rate in Freeman, SD in 2025. Phosphorus placement was either broadcast applied

on the soil surface or banded approximately 2 in. (5 cm) from the row at full, 2/3, or 1/2 the SDSU sufficiency rate recommendation. Bars that share at least one letter are not significantly different.

Potassium

Corn grain yield in Beresford showed little response to K fertilization or placement. (Figure 3) The unfertilized control yielded 145 bu/ac, while fertilized treatments ranged from 139 to 163 bu/ac. The greatest yield was observed when K was banded 4 inches from the row at the ½ sufficiency rate (163 bu/ac), whereas the lowest fertilized yield occurred when K was banded 6 inches from the row (139 bu/ac). Despite this numerical variation, all treatments shared common significance groupings and therefore were not statistically different. Broadcast and banded applications produced comparable yields across all rates evaluated, and increasing K rates at the 2-inch band distance did not improve productivity. Given the high initial soil test K level at the site (174 ppm), these findings indicate that additional K fertilization was not required to maximize corn yield and that fertilizer placement had minimal influence on crop yield.

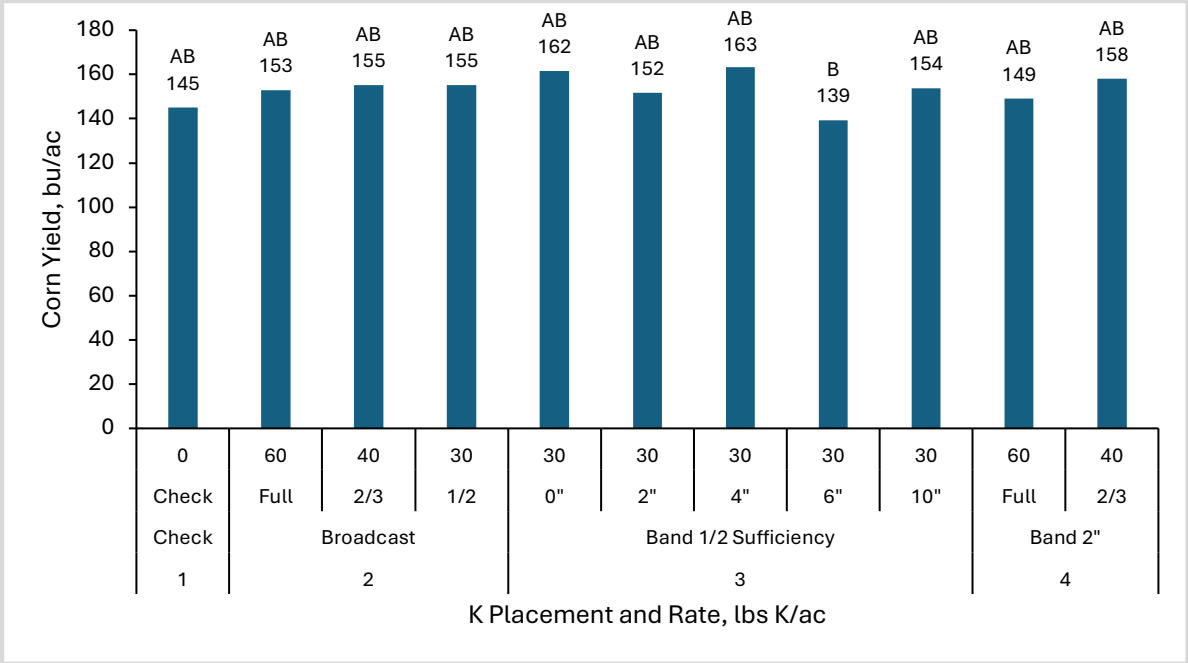


Figure 3 Corn grain yield response as a function of potassium (K) placement and rate in Beresford, SD in 2025. Potassium placement was either broadcast applied on the soil surface or banded 0, 2, 4, 6, or 10 in. from the row at full, 2/3, or 1/2 the SDSU sufficiency rate recommendation. Bars that share at least one letter are not significantly different.

Corn grain yield at Freeman was not significantly affected by K fertilizer placement or rate. (Figure 4) Yields varied by only 7% across treatments, ranging from 197 to 211 bu/ac. Both broadcast and banded K applications produced similar yields regardless of application rate, and no statistical differences were detected among treatments. The absence of a significant yield response suggests that existing soil K levels were sufficient to meet crop demand.

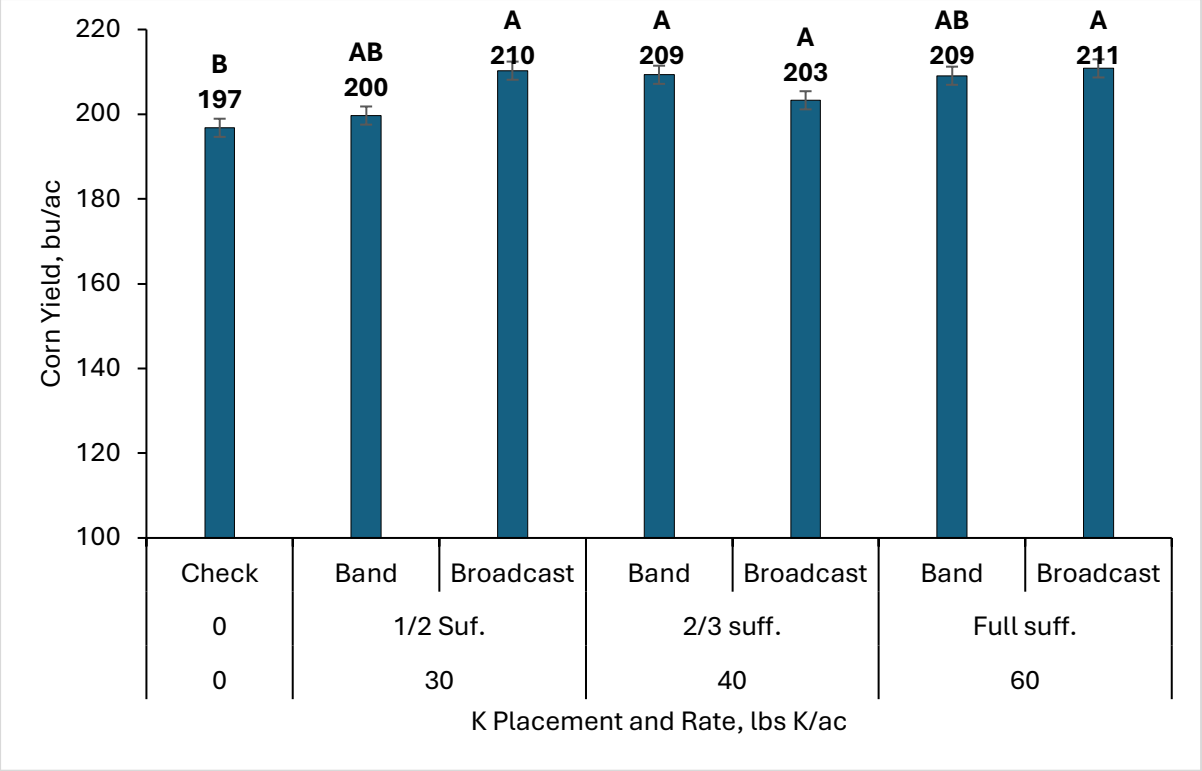


Figure 4 Corn grain yield response as a function of potassium (K) placement and rate in Freeman, SD in 2025. Potassium placement was either broadcast applied on the soil surface or banded approximately 2 in. (5 cm) from the row at full, 2/3, or 1/2 the SDSU sufficiency rate recommendation. Bars that share at least one letter are not significantly different.

CONCLUSIONS

The influence of P and K fertilizer placement on corn grain yield was evaluated across two no-till environments differing in soil test P levels but characterized by high soil test K concentrations. Corn grain yield responded positively to P fertilization at both locations; however, no significant yield advantage was observed for banded compared with broadcast applications. Potassium fertilization did not significantly affect grain yield at either site, indicating that soil K supply was sufficient to meet crop demand under the conditions of this study. Collectively, these findings demonstrate that corn yield in no-till systems was more strongly influenced by P rate than by fertilizer placement strategy, while the agronomic response to K fertilization was negligible when soil test K levels exceeded established critical thresholds.

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