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# Evaluating the Impact of Long-Term Phosphorus Placement on Corn and Soybean Rotation under Minimum Tillage System

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## Summary

Phosphorus (P) management is typically done with a focus on the long term, given its impact on soil fertility. The main objective of this study was to evaluate the effect of long-term P placement on corn and soybean yields under a minimum tillage system in Kansas. Long-term research trials were established in Scandia (irrigated field) and Ottawa (rainfed) in 2006. Fertilizer treatments were applied annually to corn, including broadcast, deep-band, and starter/deep-band at 40 lb/a of $P_2O_5$, with a control having no phosphorus fertilizer. Corn and soybean responded significantly to P fertilizer at both locations (compared to the control). In the higher-yielding Scandia location, split starter/deep-band application showed a statistically significantly higher yield than broadcast or deep-band. Yield response at the Ottawa location was similar for all the P fertilizer placements.

## Introduction

Phosphorus (P) is a crucial nutrient for corn (*Zea mays* L.) and soybean (*Glycine max* L.) and is often managed by producers through the application of fertilizers. Phosphorus fertilizers are applied based on soil test results, crop demand, and environmental factors (Beegle and Durst, 2017). However, the efficiency of P fertilizers is often influenced by factors such as crop and fertilizer placement (Hansel et al., 2017). Therefore, there is a need to evaluate the long-term impact of P fertilization practices on crop yield and to identify the most effective management practices for optimizing P fertilizer use.

Strip tillage (minimum tillage) is a tillage system that involves tilling only a narrow strip of soil where seeds are planted, leaving the rest of the field untilled, and it is common practice among some farmers (Al-Kaisi, 2012; Adee et al., 2016). Corn and soybean are widely grown crops in Kansas. Therefore, understanding the impact of P fertilizer placement on a corn and soybean rotation is critical for improving P fertilization practices and enhancing crop productivity. This study aimed to evaluate the response of corn and soybean to long-term P placement under a strip tillage system in two different locations in Kansas.

## Procedures

Long-term research trials were established at the North Central Experiment Field near Scandia (irrigated field) and East Central Experiment Field near Ottawa (rainfed) in 2006, with soil specifications in Preston et al. (2019). Fertilizer treatments include broadcast, deep-band, and split application of half starter and half deep-band (starter/deep-band), all at 40 lb/a of $P_2O_5$ and a control with no phosphorus fertilizer. The experimental design was a randomized complete block with four replications. A two-year corn-soybean rotation was used at both locations, with all rotation phases present every year. Fertilizer treatments were only applied to corn each year.

At harvest, grain yield was calculated and adjusted to 15.5% moisture for corn and 13% for soybean. The P removal in grain was calculated by multiplying the yield (bu/a) by 0.38 for corn and 0.80 for soybean (Leikam et al., 2003). ANOVA was performed for yield difference using ($P < 0.05$) Linear Mixed-Effects Models from the lme4 R package (Bates et al., 2015), and all data analyses were performed in R version 4.1.

## Results

This study showed that corn and soybean responded significantly to P fertilizer at both locations compared to the control (Figures 1 and 2), indicating the importance of P fertilization for crop productivity. Moreover, the split starter/deep-band application demonstrated a statistically significantly higher yield in the higher-yielding Scandia location than broadcast or deep-band (Figure 1), suggesting that the placement of P fertilizer can affect crop yield in the long term.

However, yield response at the Ottawa location was similar for all the P fertilizer placements (Figure 2), implying that the impact of P placement can vary across different soil types and environmental conditions. In addition, the cumulative $P_2O_5$ removal over time for all treatments was higher for Scandia than Ottawa (Figure 3), with the same cumulative fertilizer application of 640 lb/a of $P_2O_5$ for both locations.

The starter/deep-band treatment has 1879 (lb/a) cumulative $P_2O_5$ removal in Scandia, and Ottawa has 1247 (lb/a), indicating that the effect of P placement can be location-specific. These findings can aid in improving P fertilization practices, especially for corn farmers in high-yielding areas, by optimizing the placement of P fertilization.

## Acknowledgments

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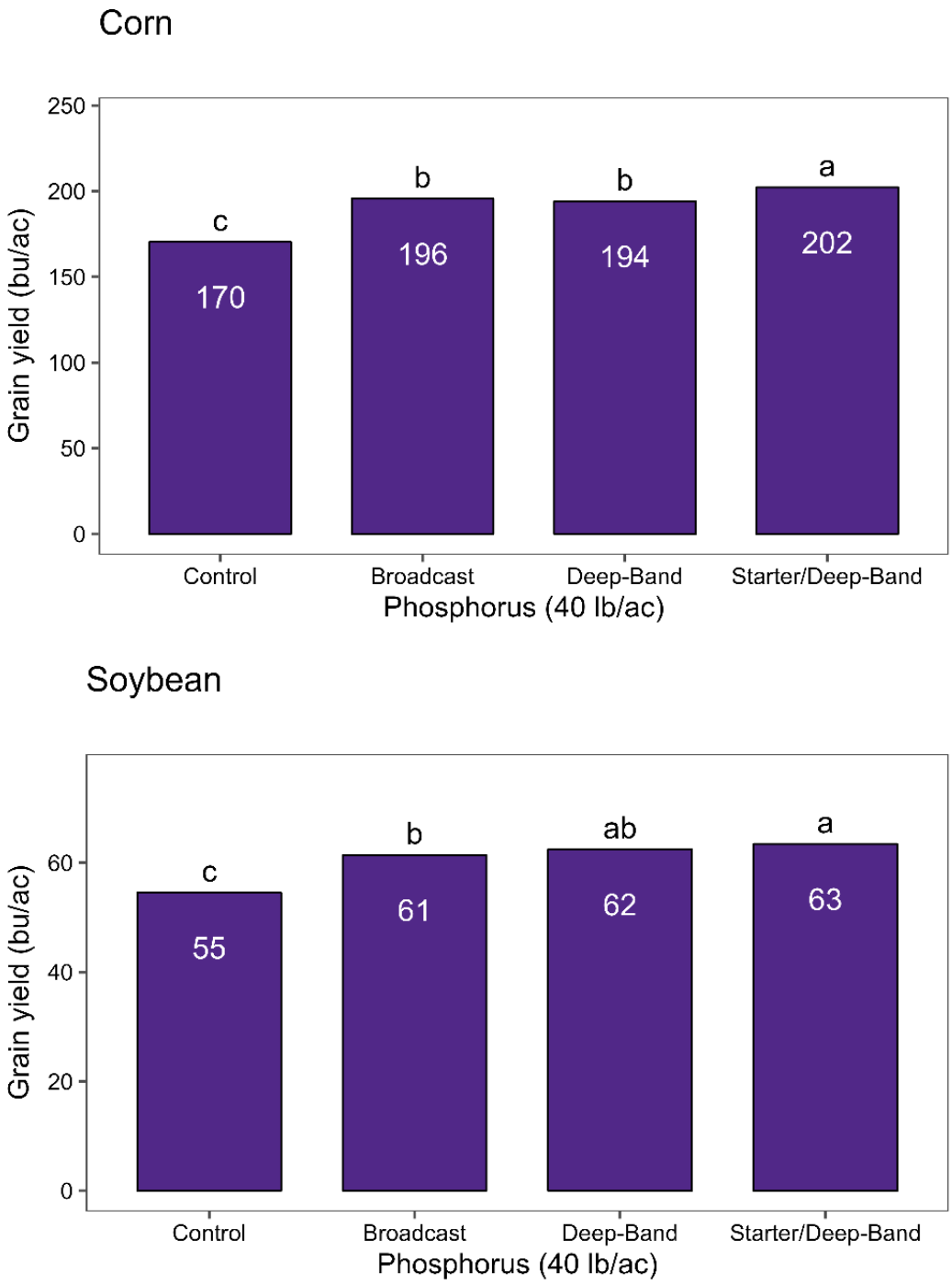



**Figure 1. Scandia (high-yielding) grain yield with different P fertilizer placements at 40 lb/a of $P_2O_5$. Means with the same letter are not significantly different among treatments ($P < 0.05$).**

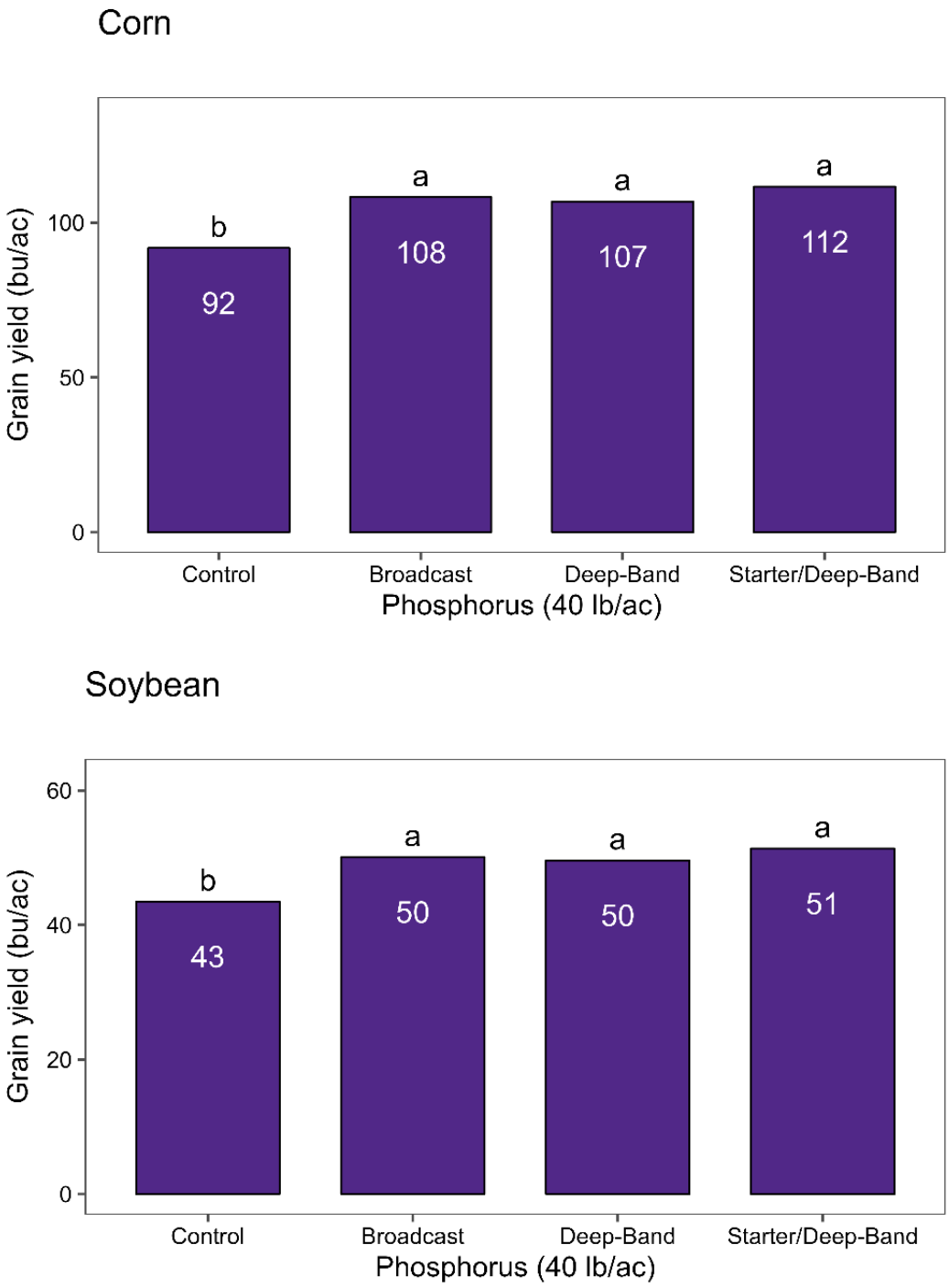
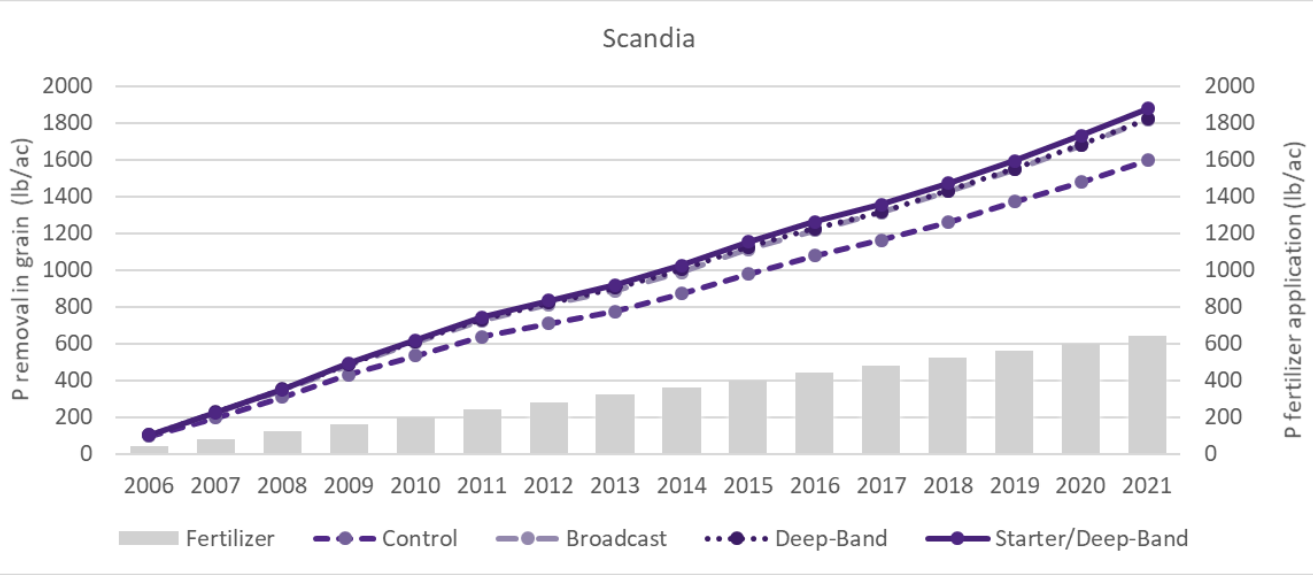



**Figure 2. Ottawa (low-yielding) grain yield with different P fertilizer placements at 40 lb/a of $P_2O_5$. Means with the same letter are not significantly different among treatments ($P < 0.05$)**



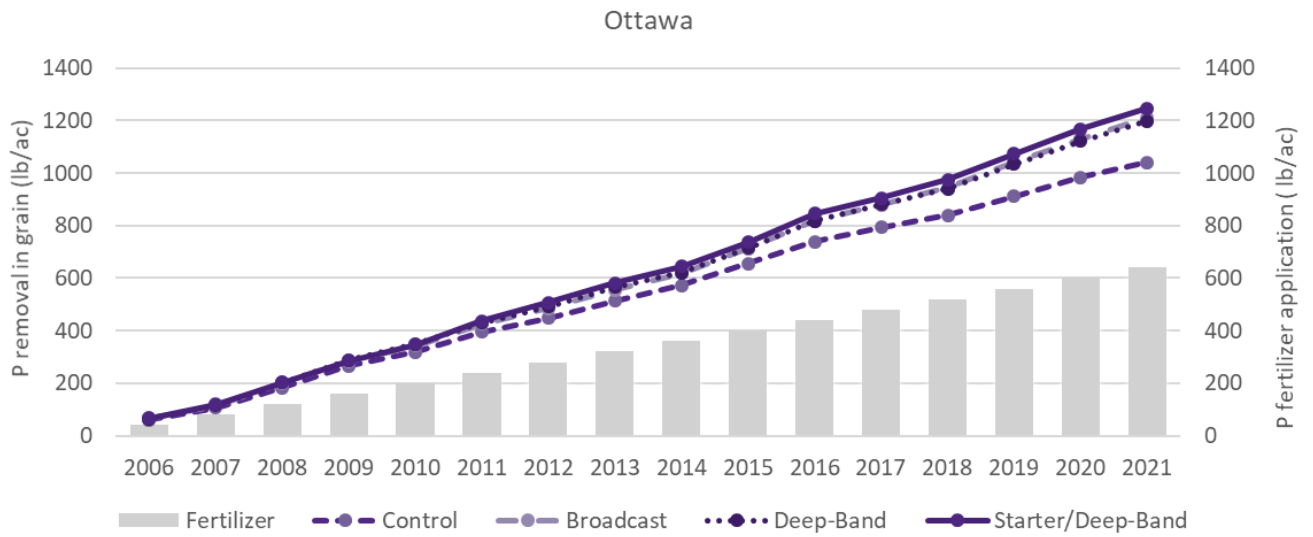




**Figure 3. Cumulative $P_2O_5$ removal vs. cumulative fertilizer application as $P_2O_5$ over time to all treatments for Scandia and Ottawa locations.**