NITROGEN SOURCE AND PLACEMENT IN STRIP-TILL CORN PRODUCTION IN SOUTH DAKOTA

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ABSTRACT

Strip tillage is a sustainable practice, mainly used in row cropping systems. In South Dakota, similarly to the mid-west, the most common rotational row cropping system is corn (*Zea mays*)-soybean (*Glycine max*). While South Dakota has well adapted soil conservation tillage practices, conventional tillage is still the leading practice farmers utilize on the eastern third of the state. Strip tillage in corn systems has gained an increased interest in the region, due to the benefits provided and ease as a way of transitioning from conventional tillage. Strip tillage also facilitates the application of fertilizers, potentially improving nutrient accessibility and uptake while reducing negative impacts. A substantial number of studies have addressed P and K nutrient management, leaving a knowledge gap in N nutrient management in strip tilled systems. The objective of this study is to determine N fertilizer sources (Urea, urea with volatilization inhibitor, UAN) with strip-tillage placement, N rates (0, 75, 100, 125, 150 and split treatment (75+50) lbs. N ac^{-1}) compared to a conventional tillage system, N interactions with P and K rates on grain yield and nutrient uptake. Initial results will be presented from the first year of this study.

INTRODUCTION

Corn (*Zea mays L.)* is one of the most important agronomic crops worldwide. This crop serves as a major source of food, animal feed and industrial uses. In the United States, corn is an important crop for farmers, particularly in the Midwest, where is produced in rotation with other row crops; corn - soybean (Glycine max) rotation being the most common system in the region. In South Dakota, corn represents an important agricultural crop, where producers are constantly looking for avenues to improve crop productivity and performance. Due to the intensive management of agricultural systems, including monocropping, intensive tillage and chemical reliance, these practices have shown a negative impact in cropland and natural ecosystems. All these activities raise concern about the long-term effects in soils, sustainability, crop yields and production costs. Dou et al. (2024) found that strip-tillage had similar yields to conventional tillage and produced higher yields than no-till systems. Similar results were documented in South Dakota as well (Tesch, 2025). Strip tillage is a sustainable practice that offers an alternative to conventional tillage by reducing soil disturbances, potentially improving fertilizer placements and reducing soil moisture losses. The goal of

these practices is to optimize nutrient uptake and availability (N, P, K) while maintaining soil health and crop productivity. Nitrogen serves as an essential nutrient for corn growth, development and grain production. Although a lot of research has been done in strip tillage and nutrient management, nitrogen management in strip tillage systems remains an understudied area. Understanding how nitrogen sources, application rates, and placement influences corn nutrient levels and grain yield in strip till systems can provide more insights into fertilizer management practices. Therefore, this study aims to evaluate N management strategies in tillage systems (conventional vs strip-till), to determine: (1) the effects of fertilizer sources, placement and rates on corn grain yield and ear-leaf nutrient concentrations; and (2) evaluate the effects of N and P, K fertilizer application and their potential interactions on corn grain yield. Nevertheless, from a management perspective, the use of banded fertilizers raises two important questions: Are we able to reduce N rates by applying banded fertilizer? Can the banded fertilizer potentially harm crop growth and expected yields?

MATERIALS AND METHODS

Field experiments were started in 2026 at the South Dakota Agricultural Experiment Station near Aurora, SD. (44°18'37.7"N, 96°40'25.0"W), on a Brandt silty clay loam soil (*fine-silty, mixed, superactive, frigid Calcic Hapludoll*). Previous crop was wheat (*Triticum aestivum* L.). The treatments included 6 different N management systems defined by the type of tillage and the type of N source (Table 1). Six N rates were tested (0, 75, 100, 125, 150, and split 75 + 75 lbs N ac^{-1}), and two P-K fertilizer rates (normal and low, approximately 25% lower than the standard recommendation). The experimental design was a randomized complete block design with a split-split plot arrangement with 4 replications. Data was analyzed using R version 4.6.2 using analysis of variance (ANOVA) and regression analyses. Ear-leaf was collected from ten consecutive plants at mid-silking from 3 replications. Samples were dried, ground to pass through a 1mm sieve, and analyzed by a commercial agricultural laboratory for nutrient concentrations.

After reaching physiological maturity, center two rows were harvested by a Massey Fergusson 8XP plot combine, and grain yield was determined at 15.5% moisture level.

Table 1. Description of nitrogen management systems evaluated in the study.

Tillage system	N source	Placement
Conventional tillage	Urea	Broadcasted
Strip tillage	Urea	Banded
Strip tillage	Urea with urease and nitrification inhibitor (protected urea)	Banded
Strip tillage	Urea with urease and nitrification inhibitor (protected urea)	Broadcast
Strip tillage	UAN	Banded
Strip tillage	UAN with 20% slow-release N	Banded

RESULTS AND DISCUSSION

Ear Leaf Nutrient concentrations

Figure 1. shows the N concentration in ear leaf affected by N placement in strip tillage treatments in the first year. No differences were found in the concentration of ear leaf N when the urea with urease and nitrification inhibitor was either banded or broadcasted ($p = 0.709$).

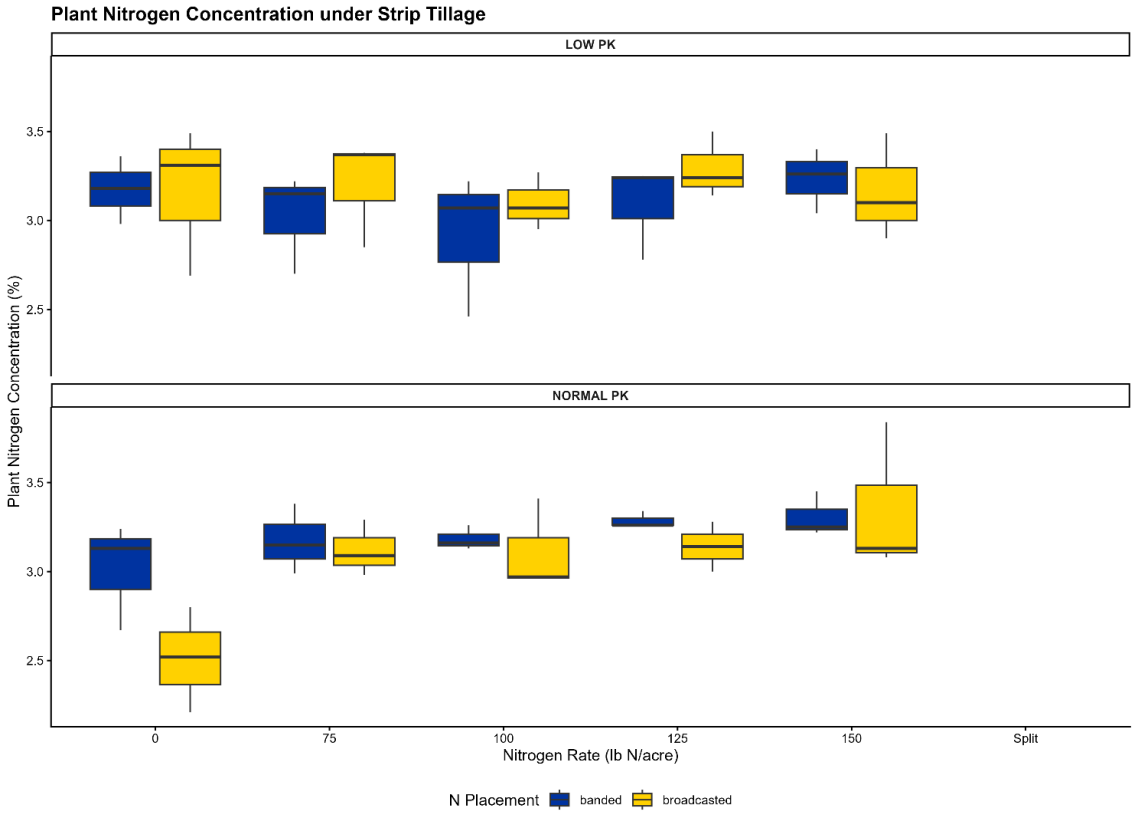


Figure 1 Ear leaf nitrogen concentration (%) at R1 under strip tillage for urea with urease and nitrification inhibitor applied through banded or broadcasted placement at different nitrogen rates (lb N ac^{-1}), under low PK and normal PK fertility levels. Blue and yellow boxplots represent banded and broadcasted application, respectively. No significant difference in ear leaf nitrogen concentration was observed between banded and broadcasted fertilizer application (p = 0.709).

Results show that the fertilizer placement method did not influence the N concentration in the ear leaf of corn during the growing season. These results are consistent with findings of Griesheim et al. (2023), where authors reported that fertilizer placement did not have a significant effect on N uptake despite being differences in N recovery efficiency. This result was expected, as both methods seem to provide enough N availability. Additionally, the absence of differences in ear-leaf N concentration between placement methods may be partly attributed to the ability of corn plants to maintain similar tissue N concentrations once crop N demand has been satisfied.

Grain Yield

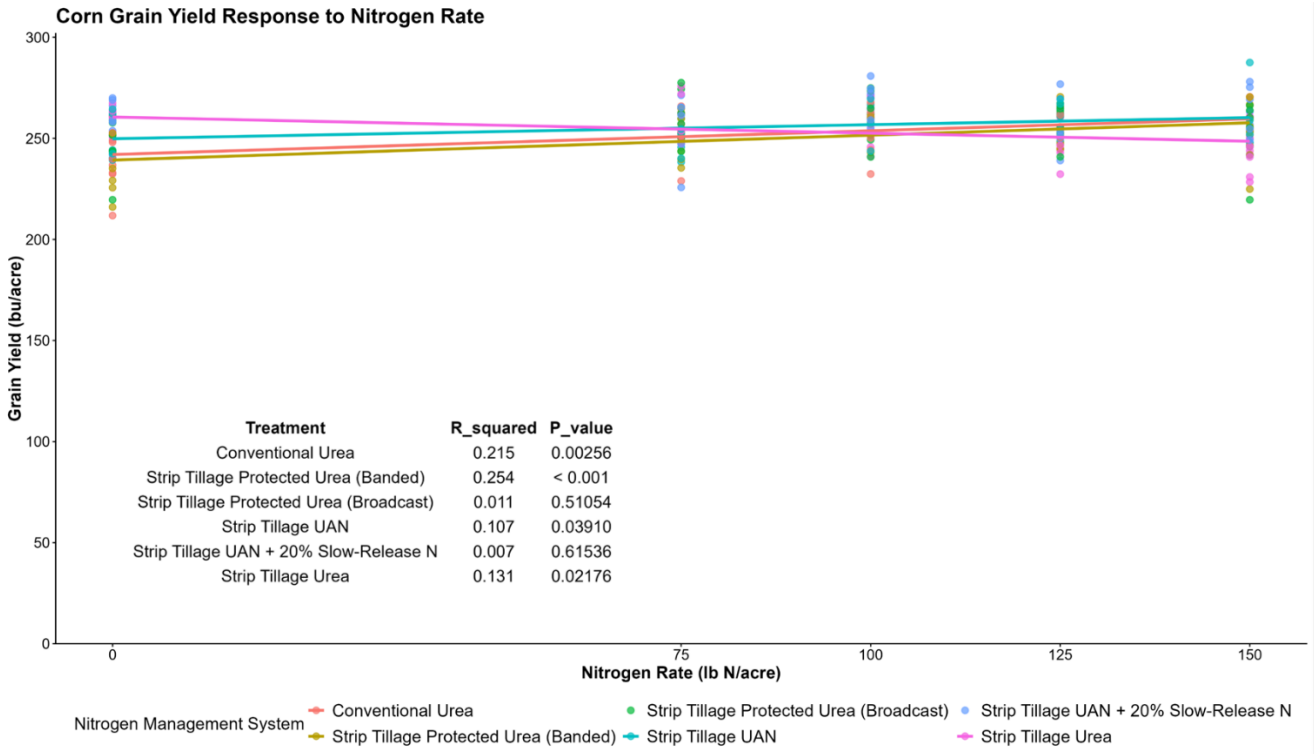


Figure 2. Corn grain yield (bu/acre) response to nitrogen application rates (0, 75, 100, 125, and 150 lb N/acre) under different nitrogen management strategies. Each line represents a separate linear regression for treatment. Points represent individual yield observations. corresponding R^2 and p-values are presented for each regression. Only significant regressions ($p < 0.05$) were plotted in the graph.

As shown in Figure 2, corn yield responded differently to N rate, source, and placement. In general, grain yield increased with increasing N rate, for conventional urea, strip tillage banded protected urea and strip tillage UAN positive responses were observed between 100 and 150 lbs N ac^{-1}. On these treatments, conventional urea showed the strongest yield response to increasing N rate. Strip tillage urea showed a negative impact on N rates, suggesting rates greater than 100 lbs N ac^{-1} can be harmful for the crop. This shows that additional urea N did not consistently improve productivity and could be potentially harmful at higher dosages.

The results suggest that the effectiveness of increasing N rates depended on both fertilizer source and placement. While conventional urea, protected urea banded, and UAN generally benefited from additional N, the response was not consistent across all treatments. Similar trends were reported by Wiatrak et al. (2011), who studied fertilizer management in strip-tilled dryland corn in South Carolina and found that UAN exhibited a gradual increase in grain yield with increasing N rate, whereas other N sources showed stable responses or declines at higher N rates. Differences between

studies may be related to variations in crop management practices, soil properties, and environmental conditions. In a similar way, Al-Kaisi et al. (2007) reported that corn yield responses to N fertilization were influenced by both tillage system and N rate. From an agronomic perspective, the relatively stable yield responses observed for strip-till surface applied protected urea and the declining response observed for strip-till banded urea suggest that N rates above 100 lbs N ac^{-1} did not consistently result in additional grain yield. Therefore, applying N beyond the rate required to maximize crop productivity most definitely increase production costs without providing a corresponding yield benefit. In addition, Nash et al. (2013) demonstrated that strip-till banded urea could produce corn yields comparable to other N management systems, depending on application timing and environmental conditions. Corroborating the data presented in figure 2.

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