CORN NITROGEN REQUIREMENT IN WINTER CEREAL COVER CROP TRIALS IN SOUTHERN ILLINOIS

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ABSTRACT

Winter cereal cover crops, including wheat (*Triticum aestivum* L.) and winter rye (*Secale cereale* L.) are recommended as the best in-field management strategy by the Illinois Nutrient Loss Reduction Strategy (INLRS) to minimize nitrate-N leaching to the Mississippi River Basin and the Gulf of Mexico. We evaluated the effect of wheat and winter rye on corn grain yield, and nitrogen (N) requirement. Treatments were laid out in a randomized complete block design with four replicates and split-plot arrangements. The main plots were wheat or winter rye vs. a no-cover crop control and the subplots were six-seven rate of N fertilizer. Corn grain yield was consistently higher in the no-cover crop (NOCC) treatment reflecting on higher N availability during the corn growing season. Corn N requirement ranged from 0 to more than 250 lbs of N ac^{-1} reflecting weather conditions and cover crop C:N ratio. Our results indicate that corn N requirement should be adjusted for corn following winter cereal cover crops and it is critical to track N beyond the corn season to evaluate when the immobilized N will be released to capture and utilize that N source.

INTRODUCTION

Illinois Nutrient Loss Reduction Strategy (Illinois EPA, 2015), among other states in the Midwestern, USA, identifies winter cereal cover crops (WCCCs) as the most effective in-field conservation strategy to reduce surface water contamination from nonpoint sources. Among CC species, WCCC can scavenge large amount of residual N and therefore, are much more effective in reducing nitrate-N loss to tile drainage (Singh et al., 2018) than the legumes. However, growers are often hesitant to plant WCCCs before corn due to concerns about soil N immobilization caused by the CC and the slow release of N when corn has its peak N requirement after terminating the WCCC (Nevins et al., 2019).

Currently, Illinois as a part of the North Central region utilizes the Maximum Return to Nitrogen (MRTN) calculator, a tool designed to optimize N fertilizer applications to corn, also known as economic optimum nitrogen rate (EONR). This calculator uses corn price and N fertilizer price to calculate the N rate at which corn yield has the largest economic return (Sawyer et al., 2006). However, the current MRTN

version, does not consider the inclusion of CCs prior to corn planting. Therefore, there is a need to gather data and establish a dataset that differentiates corn's N requirements based on CC options and management practices to develop more precise and tailored N management recommendations. The objectives of this study were to evaluate the effects of wheat and winter rye cover crop as compared to a no-cover crop control on corn grain yield and N requirement.

MATERIALS AND METHODS

Field trials were conducted at the Agronomy Research Center (ARC) in Carbondale, IL (37.750 N, 89.060 W) and Belleville Research Center (BRC). During 2019-2020, two trials were conducted at the ARC site and during 2020-2021, two trials were conducted at the ARC and BRC sites. Treatments were laid out in a randomized complete block design with four replicates and split-plot arrangements. The main plots were wheat or winter rye vs. a no-cover crop control and the subplots were six-seven rate of N fertilizer (0-250 or 300 lbs N/acre with 50 lbs N /acre increments).

Cover crops were planted on late-Oct. to early Nov. with a John Deere 450 series grain drill (John Deere, Moline, IL, USA) and terminated via burndown mid- to late-April. Prior to termination cover crops were sampled from a 7.2 ft^2 area using grass shears. Cover crops were oven dried at 60 ◦C and then ground for carbon (C), N, and C:N determination. We used combustion method with an elemental analyzer to measure C and N.

Corn was planted on mid-May to late-May and harvested on mid-October to early-Nov. Dekalb DKC 64-35 RIB corn seed was planted to depths of 1”-1.25” using a no-till drill at 32 to 33000 ac^{-1} plant population. We used 32% urea ammonium nitrate as fertilizer source and N was injected between V5 to V6 stage of corn. Harvest was conducted on the middle two rows of each subplot with a XP Plot Combine (Kincaid, Haven, KS, USA). Weights were corrected to 15.5% moisture content. We used several models (linear, quadratic, linear plateau, and quadratic plateau) and to identify the best fit for assessing economic optimum rate of N (EONR). Best model was used based on P values and R^2, and root mean square error (RMSE). Statistical analysis was performed with SAS 9.4 (SAS Institute Cary, North Carolina). When treatments were significant, mean separation was conducted using Least Square Means adjusted for Tukey.

RESULTS and DISCUSSION

Cover Crop Performance

Wheat biomass in 2018-2019 (hereon reported as 2019) season was 314 lbs ac^{-1} reflecting late planting and waterlogging conditions at the site in that year. In 2019-2020 (hereon reported as 2020) season, wheat biomass was 3,392 lbs ac^{-1} which was almost 10 times higher than that of 2019. Wheat C:N ratio was 21.9 in 2019 and 35.8 in 2020 (data not shown).

Winter rye biomass in 2020 was 2890 lbs ac^{-1} at the ARC site and 2908 lbs ac^{-1} at the BRC site. Winter rye C:N ratio was 20.6 and 17.1 for ARC and BRC, respectively. Differences in C:N ratio was mainly due to N in the plant in which the N in winter rye was higher at the BRC site.

Corn Grain Yield and Optimum Nitrogen Rate

In 2019, a challenging year, corn grain yield was low but the NOCC treatment responded linearly to the N application (Fig. 1A) and therefore, EONR could not be calculated and could be higher than 250 lbs N ac^{-1}. In 2019, for the wheat treatment, corn grain yield was around 150 bu ac^{-1} at which the EONR was 164 lbs N ac^{-1}. In 2020, there was a clear separation between the NOCC treatment and wheat treatment (Fig. 1B). This indicated that there was a yield drag with wheat incorporation into the corn system. In 2020, the EONR for the NOCC was 161 and for the wheat cover crop was 220 lbs N ac^{-1} (Fig. 1B). This presents a 59 lbs ac^{-1} N difference between the two cover crop management practices.

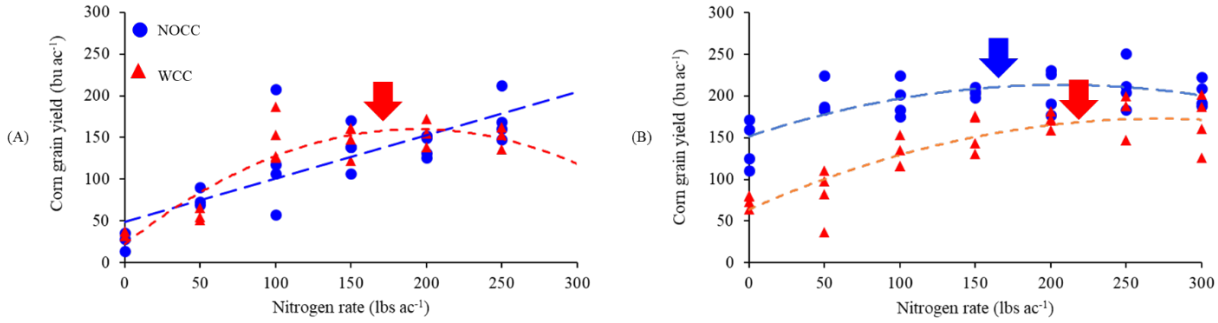

Fig. 1. Corn response to N rate and cover crop management (NOCC vs. wheat) in 2019 (A) and 2020 (B). Circles indicate NOCC and triangles indicate wheat as cover crop (WCC).

In 2020, at the ARC site, corn grain yield was comparable between winter rye and the NOCC treatment and the EONR was slightly higher for the NOCC (204 lbs N ac^{-1}) than the NOCC (201 lbs N ac^{-1}) (Fig. 2A). In contrast, winter rye impacted soil N (data not shown) and resulted in response of corn to N fertilization (EONR = 184 lbs N ac^{-1}). The NOCC treatment produced comparable grain yield with no N fertilizer requirement which could be due to excessive N mineralization during the growing season of corn (Fig. 2B).

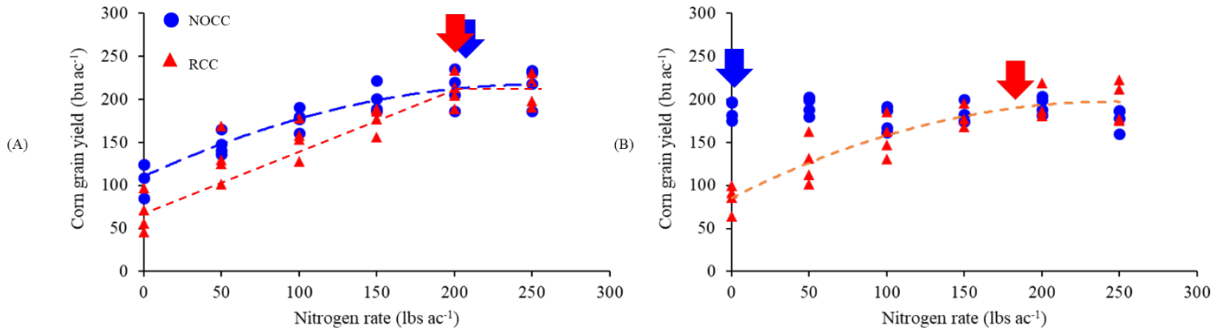

Fig. 2. Corn response to N rate and cover crop management (NOCC vs. winter rye) in 2020 at the ARC (A) and BRC (B) sites. Circles indicate NOCC and triangles indicate winter rye as cover crop (RCC).

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