Assessing Corn Nitrogen Fertilizer Needs Following Rye Seed Production and Frost-Seeded Red Clover

RFR-A20104

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Introduction

This study was designed to investigate nitrogen (N) response in cereal rye seed production, influence of a red clover cover crop on corn N fertilization requirement, and the overall integrated-production system on soil nitrate-N. The study was conducted at two locations. This report summarizes the two-year (2019-20) corn crop results.

Materials and Methods

The study started in the fall 2017 with rye planting following soybean harvest at two Iowa State University Research and Demonstration Farms: the Agricultural Engineering/Agronomy Farm, Boone, and the Northern Research and Demonstration Farm, Kanawha, Iowa. At both Boone and Kanawha, "new" cereal rye sites were established following soybean in fall 2018.

All four sites were soil sampled after soybean harvest (fall 2017 or fall 2018) and phosphorus, potassium, sulfur, or lime were applied as needed before rye planting.

In the two rye years (2018 and 2019), treatments were arranged in a split-split-plot randomized complete block design with inoculated "Ruby" brand red clover seed broadcast in mid-late March at 15 lb pure live seed/acre as the whole plot (with and without red clover), cereal rye as the split-plot (two varieties), and N rate as the split-split-plot (0, 25, 50, 75, 100, or 125 lb N/acre surface-applied urea treated with urease inhibitor).

In the two corn years (2019 and 2020) following the rye production crops, no-till corn with and without clover was the main plot, and N rate the split-plot (0, 50, 100, 150, 200, and 250 lb N/acre). Red clover growth was herbicide-terminated in spring 2019 and 2020. SuperU® (granular urea treated with urease and nitrification inhibitors) was the corn N source, split-applied with 50 lb N/acre at planting and the rest side-dress applied at approximately the V4 corn stage. Canopy sensing (V9 stage) and ear leaf soil-plant analysis development (SPAD) meter readings (R1 stage) were used to assess the corn N status as related to fertilizer N rate and N supplied from the clover. Corn grain yield with and without clover was used to estimate N supplied from the red clover.

Results and Discussion

Figure 1 shows the corn canopy sensing and ear leaf SPAD response to N rate with and without the prior red clover. There was a clear N supply from the red clover to the corn. With no N applied, and the lowest N rates, the corn canopy normalized difference red-edge (NDRE) was greater following clover than the no clover (in the no clover, only prior-year rye crop or volunteer rye). The difference between with and without clover became larger at the R1 corn stage, indicating increased N supply (mineralization) from the killed clover as the early season progressed. This could be expected, especially as the clover was controlled in the spring and the corn was no-till planted. As typically found, canopy sensing and SPAD readings plateaued when adequate or more than adequate N was available to the corn.

Corn yield response, as found for canopy sensing, indicated a clear N supply from the prior-year clover growth (Figure 2). With no fertilizer N applied, there was an approximate 46 bushels/acre greater corn yield following the clover. With adequate N, corn yield was similar between the prior clover and no clover. The difference in agronomic optimum N rate (AONR) was used to determine N supplied by the clover – approximately 50 lb N/acre.

In the two-year study, there was adequate moisture and excellent clover growth following rye harvest, which aided N fixation by the clover and subsequent N release to corn the following year. The results highlight potential to successfully insert a rye grain crop into a corn-soybean system. The combination of the fall-seeded rye crop and frost-seeded red clover "cover crop" provided a "green soil cover" of living plants from the time of soybean harvest, through a rye grain crop, and into a corn crop. Although not studied here, use of a cover crop after corn would provide an additional green cover and hence plant/crop growth on a continuous basis–especially in the spring when the predominance of nitrate is lost from the corn-soybean rotation. Rye N fertilization requirement is low (compared with corn) and rapid rye growth/N uptake during the spring would limit nitrate in the soil system. Such an overall crop production system has potential to have a major effect on loss of nitrate from the soil system.

Acknowledgements

Funding for the study was provided by the Leopold Center and the Iowa Nutrient Research Center. Appreciation is extended to the research farm managers and staff for their efforts with this study.

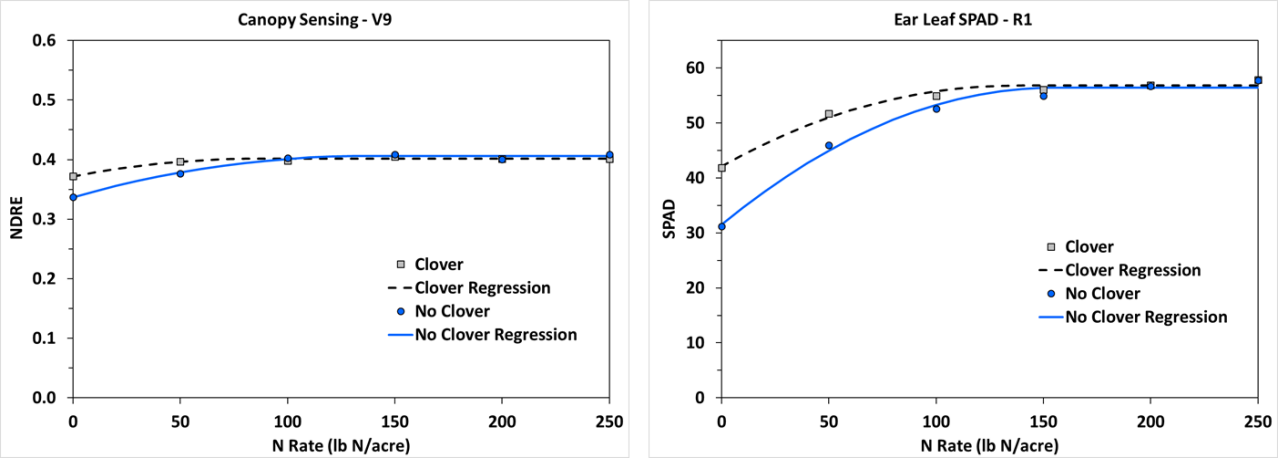

Figure 1. Corn canopy sensing (V9 stage) NDRE sensing index and ear leaf SPAD readings response to fertilizer N rate and the prior red clover, 2019-2020. Preliminary data and analysis.

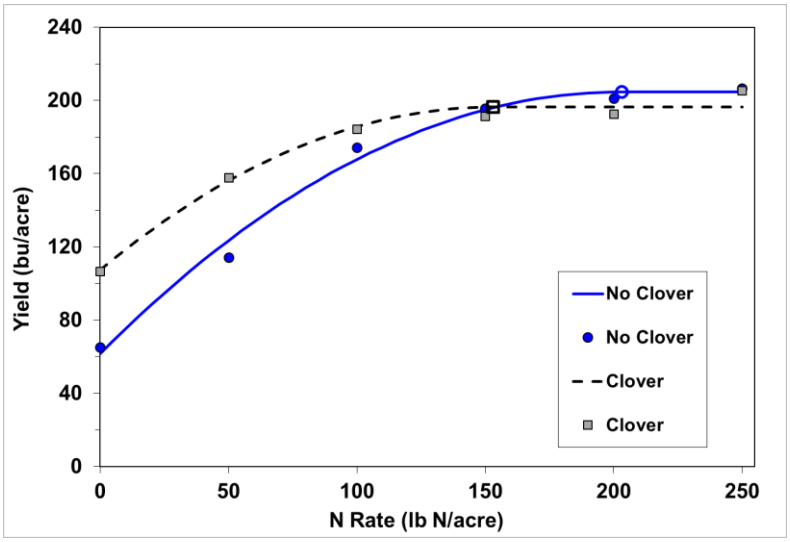

Figure 2. Corn grain yield response to fertilizer N rate and prior red clover, 2019-2020. The open symbols represent the AONR with and without clover based on the N rate response equations. Preliminary data and analysis.