# ASSESSING THE EFFECTIVENESS OF GREEN-SEEKER ALGORITHM IN MINIMIZING NITROGEN LOSS IN CORN PRODUCTION

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## ABSTRACT

To improve water quality, nitrogen (N) management in corn production systems should shift from current N decision support system [maximum return to N (MRTN)] which suggests a single rate N addition to sensor-based (Green-Seeker) active N management (variable N rate approach). Single rate N recommendations often result in under- and over-N addition and either increase environmental N losses or cause corn yield penalty. Our objectives were to evaluate if sensor-based N management improves N fertilizer use, and influence soil nitrate-N dynamics, nitrous oxide ($N_2O$) emissions, and nitrate-N leaching during a corn growing season as compared to the MRTN and a no-N control. Our results indicated that compared to a flat-rate N management (MRTN), sensor-based decreased N fertilizer requirement, reduced corn grain yield by 10 bu ac$^{-1}$, and significantly reduced $N_2O$-N emissions and nitrate-N leaching. Future research should explore sensor-based N management effect on corn yield and environmental footprints at multi-site-years.

## INTRODUCTION

Illinois Nutrient Reduction Strategy has set a goal to reduce nitrate-N leaching by up to 15% by 2025 (IEPA, IDOA, and University of Illinois Extension, 2015). 4R nitrogen (N) management practices are among recommended strategies to minimize nutrient losses  to Illinois water and the Gulf of Mexico. 4R N practices not only can benefit a reduction leaching of N as nitrate-N, it can also reduce nitrous oxide ($N_2O$) emissions. Applying the right rate is one of the most effective strategies that could significantly reduce environmental N losses (Morris et al., 2018). Nitrogen requirement to achieve maximum yield for corn is determined by N responsiveness, N availability, and potential yield. All three factors vary spatially and temporally. All three factors are independent of each other and independent of time. Precision N management could reduce this variability and improve N use and thus, reduce N losses. There is a knowledge gap about evaluating variable rate N management effect on corn grain yield and N loss and therefore, our objective was to evaluate MRTN performance vs. a GreenSeeker N rate on corn grain yield and nitrate-N leaching.

## MATERIALS AND METHODS

### Experimental Site, Design, and Treatments

The trial was conducted at the Agronomy Research Center in Southern Illinois University in Carbondale, IL. Treatments were laid out in a randomized complete block design (RCBD) with five replicates in 2022 and is replicated in 2023 (data for 2023 are not shown). The treatments were (i) no-N control; (ii) N fertilizer at MRTN recommended at planting; (iii) N fertilizer at MRTN recommended rate at sidedress timing; (iv) N fertilizer applied based on GreenSeeker algorithm recommendation (sidedress). Experimental plots were 60 ft long and 10 ft wide. A no-till drill was used to plant corn (Dekalb "DKC64-35RIB") at 32,000 seeds $ac^{-1}$ on 18 May 2022. Corn N fertilization occurred at V8 growth stage and UAN 32% was used to fertilizer the plants at sidedress timing. Each plot that had N (except zero-N control) received a 55 lbs N $ac^{-1}$ as starter N. The rate of MRTN was 203 lbs N $ac^{-1}$.

### Measurements

Soil samples were collected using a soil probe (0-6 inches) over the corn growing seasons of 2022 and analyzed for nitrate-N and ammonium-N. Closed vented chambers made of aluminum were constructed for the gas sampling. The chambers were placed in between the corn rows on anchors fixed to the soil. Air samples were collected a total 21 times during the corn growing seasons using syringes at 0, 15, 30 and 45 minutes each sampling day and analyzed for $N_2O$ using gas chromatography (GC). Nitrous oxide emission rates were calculated by regressing $N_2O$ concentration (ppm) vs. time. The cumulative $N_2O$ emissions were estimated by linear interpolation between sampling periods. Soil volumetric water content (VWC) and temperature were measured at each $N_2O$ emission sampling date. Corn grain yield was combine harvested. Prior to harvest, grain subsamples and plant subsamples were collected to measuring grain N and aboveground N content. Yield-scaled $N_2O$ emissions were calculated as $N_2O$ fluxes/corn grain yield. Nitrate-N leaching was evaluated using resin bag lysimeters. These resin bags placed around 12-16 inches in the soil (depending on the clay pan layer). After removal, they were analyzed for nitrate-N concentrations. We used an OI analytical flow solution IV for analyzing nitrate-N.

## RESULTS AND DISCUSSION

### Corn Grain Yield

Corn grain yield was 175 bu $ac^{-1}$ for the MRTN treatment which was 10 bu $ac^{-1}$ higher than that of the GS treatment. However, about 80 lbs N $ac^{-1}$ less was applied to corn based on GreenSeeker recommendation which compensated for the lower yield in 2022 (data not shown).

### Soil nitrate-N trends

Soil nitrate-N was consistently higher in the MRTN-upfront treatment as compared to the no-N control and GS treatment. Soil nitrate-N reached its peak before VT stage of corn and then at R1 and any dates after that, all treatments had similar nitrate-N concentrations (Fig. 1).

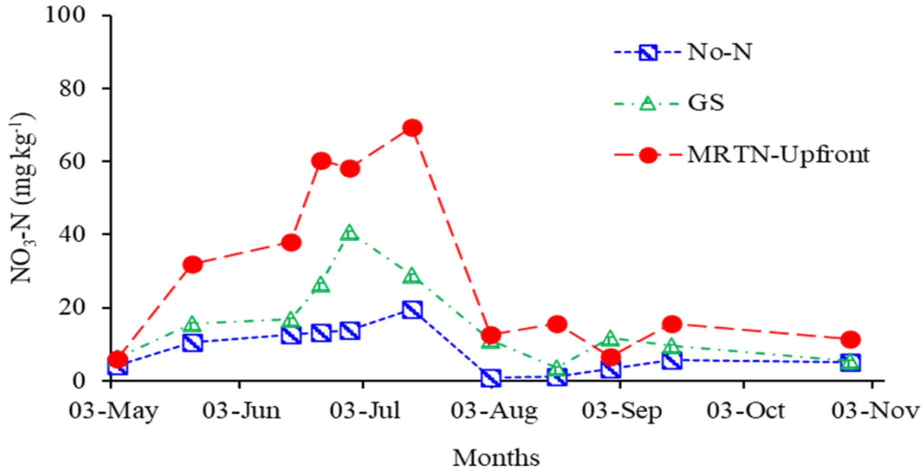


Fig. 1. Soil $NO_3$-N as influenced by N management in 2022. No-N is no fertilizer control, GS indicates GreenSeeker-based N rate and MRTN-Upfront is 203 lbs N ac$^{-1}$ at planting.

**Cumulative $N_2O$-N emissions**

Cumulative $N_2O$-N emissions were higher in the MRTN-upfront treatment than the GS and the no-N control (Fig. 2) in line with higher N availability during the corn growing season in that treatment. Cumulative $N_2O$-N emissions were comparable to other reports in IL (Preza-Fontes et al., 2022; Wiedhuner et al., 2022).

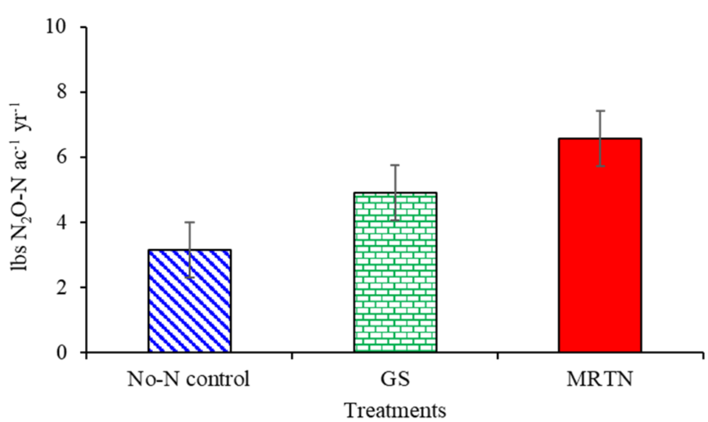


Fig. 2. Cumulative $N_2O$-N emissions during the corn growing season as influenced by N management in 2022. No-N is no fertilizer control, GS indicates GreenSeeker-based N rate and MRTN-Upfront is 203 lbs N ac$^{-1}$ at planting.

**Nitrate-N leaching**

Nitrate-N leaching was higher in the MRTN treatment (upfront and sidedress) as compared to the GS and the no-N control. Implementing GS resulted in much lower N application that the MRTN which in turn, decreased both corn grain yield (10 bu $ac^{-1}$) and nitrate-N leaching. In 2022, nitrate-N leaching from the GS treatment was similar to that of the no-N control which is encouraging (Fig. 3).

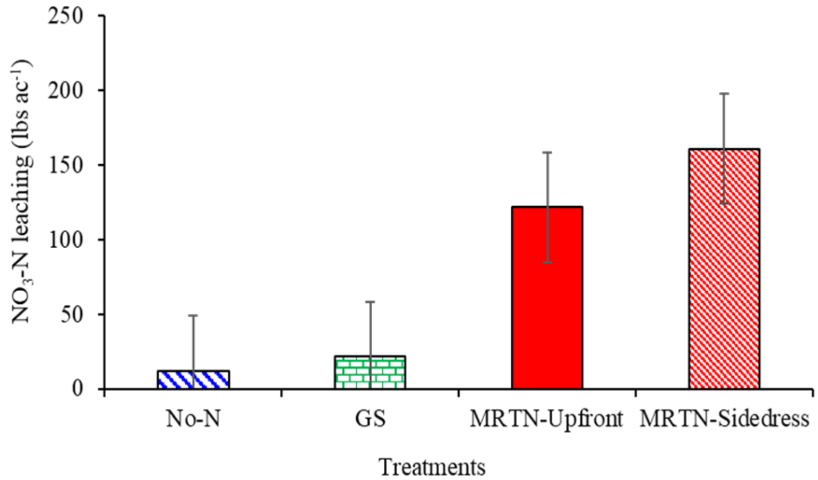


Fig. 3. Nitrate-N leaching during the corn growing season as influenced by N management in 2022. No-N is no fertilizer control, GS indicates GreenSeeker-based N rate and MRTN-Upfront is 203 lbs N $ac^{-1}$ at planting and MRTN-sidedress is 203 lbs N $ac^{-1}$ that was applied as 55 lbs N $ac^{-1}$ at planting and the rest at sidedress timing.

## PRELIMINARY CONCLUSION

In this preliminary trial, we observed that GS algorithm suggested 80 lbs $ac^{-1}$ less N application to corn resulting in 10 bu $ac^{-1}$ less yield. However, both $N_2O$-N and nitrate-N losses were reduced by the GS treatment compared to the MRTN. We require more site-years to confirm these results and fine tune the GS algorithm.

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