2021 Final Report Summary Sheet

Grantee Information

Project Title: N Management Systems in Tile-Drained Fields: 4R Plus – Rate, Source, Time, Place, and Cover Crops

Institution: University of Illinois at Urbana-Champaign

Primary Investigator: Lowell Gentry

NREC Project # [redacted]

Is your project on target from an IMPLEMENTATION standpoint? ☒ Yes ☐ No

If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ Yes ☐ No

If you answered "no" please explain:

Yes and no…We were able to apply P and K fertilizers in year 1, but we are concerned that extreme input prices will force us to suspend P and K application this spring.

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☒ Yes ☐ No

If you answered "no" please explain:

Have you encountered any issues related to this project? ☒ Yes ☐ No

One of our two vehicles cannot be repaired now due to parts shortages and is indefinitely in suspended animation. We are forced to rent from the U of I carpool on a monthly basis.

Have you reached any conclusions related to this project that you would like to highlight? ☒ Yes ☐ No

If you answered "yes" please explain:

Tile respond quickly to management. For example, as soon as we stopped applying fall N in one of our 6 treatments last year, the tile nitrate concentrations fell in line with the other 12 tiles that have not received fall N during the past 5 years.

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ Yes ☐ No

If you answered "yes" please explain and provide details for any upcoming outreach:

I presented information from this study six times in the past year for various meetings. I introduced Dr Yu's isotope probing techniques and preliminary results in my presentations on Agronomy Day and at the IFCA convention this week.

Please write a detailed summary report that includes: Details of each objective and the progress made towards its competition, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please **include a one page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.**

N Management Systems in Tile-Drained Fields: 4R Plus – Rate, Source, Time, Place, and Cover Crops

PI: Lowell Gentry, Principal Research Specialist in Agriculture, Department of Natural Resources and Environmental Sciences, University of Illinois, W-503 Turner Hall, 1102 S. Goodwin Ave., Urbana, IL 61801. (217) 333-1769. lgentry@illinois.edu.

Collaborators: Dan Schaefer, (IFCA) and **Eric Miller**, (custom farming). **Zhongjie Yu** (Assistant Professor in NRES)

Location: On-farm research conducted in Douglas County on Dick Searls land.

Objectives:

The overall goal of this study is to compare and contrast combinations of 4R Nutrient Stewardship practices designed to maximum economic yields while limiting tile nutrient loss.

The objectives are:

1. To determine crop nutrient accumulation (N, P, and K) and grain yield under various combination of 4R nutrient management in a corn soybean rotation.
2. To determine tile nutrient concentrations and loads (N, P, and K) under various combination of 4R nutrient management.
3. To document the feasibility and success rate of various 4R nutrient strategies to more fully understand the advantages and limitations of a given production system over time (i.e. presumably with varying weather scenarios).

This study represents a systems comparison approach where various N management strategies are employed to evaluate corn yield, grain quality, and tile nitrate loss. Secondarily, we will investigate strip-till and deep banding of P and K versus broadcast application on system productivity and tile nutrient loss.

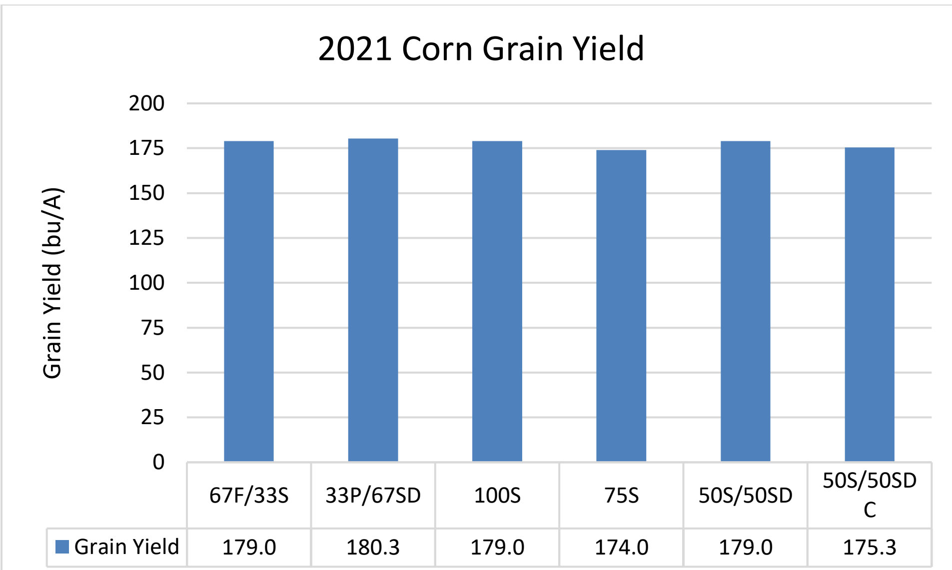
Treatments:

We are using 36 tile-drained plots (100 ft wide by approx. 2000 ft long) to accommodate six N treatments with three replicates and both crop phases. This study builds on research conducted at this site during the past 5 years. The six treatments are: 1) (67F/33S) 67% anhydrous ammonia with inhibitor in the fall and 33% anhydrous ammonia with inhibitor preplant in the spring; 2) (33P/67SD) 33% UAN at planting and 67% UAN at side-dress; 3) (100S) 100% anhydrous ammonia preplant in the spring; 4) (75S) 75% anhydrous ammonia preplant in the spring; 5) (50S/50SD) 50% anhydrous ammonia preplant in the spring and 50% UAN at side-dress and 6) (50S/50SD C) 50% anhydrous ammonia preplant in the spring and 50% UAN at side-dress plus cover crop. The cover crop is cereal rye ahead of soybean and winter wheat ahead of corn. All plots receive strip till. Deep banding of P and K occurs in Treatments 1-4, whereas broadcast application of P and K in the spring occurs in Treatments 5 and 6. All tiles have been monitored for one year.

Results:

Corn yield:

Wet soil conditions in May prevented planting until early June, which limited grain yields. Yields ranged from 174 to 180 bu/A across the treatments.



Corn grain yield harvested in the fall of 2021 in response to the six fertilizer N treatments.

The lack of yield reduction in the 75% N rate treatment (75S) suggests that the EONR was below our fertilizer N rate of 180 lbs/A. The late planting limited yield potential, decreasing the N requirement to maximize yield.

Winter wheat cover crop ahead of corn:

Winter wheat was terminated on May 5. We collected above ground biomass of the winter wheat cover crop on April 18 and May 5 to determine growth rates during the spring. Data from the two sampling dates for biomass will be used to develop cover crop growth rate models for an NREC project conducted by Jonathan Coppess and Rabin Bhattarai.

Winter wheat biomass more than doubled between April 18 and May 5 with 0.22 and 0.53 tons/A accumulated, respectively. The biomass threshold of 0.5 tons/A was achieved, which again proved to be enough growth and nitrate uptake to reduce tile nitrate (blue dots). See tile concentration graph below.

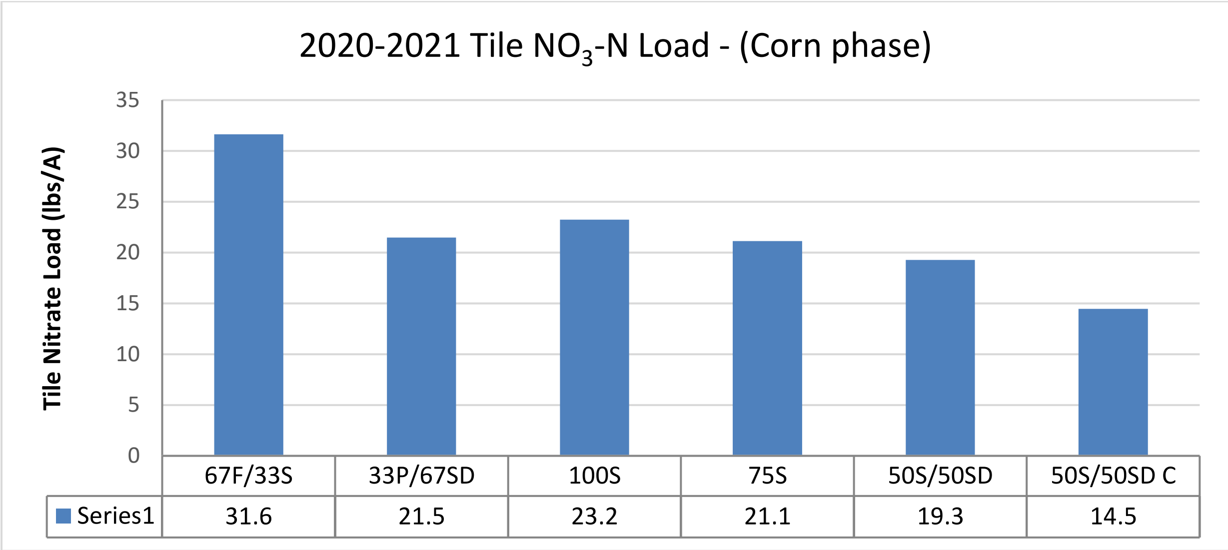
Tile nitrate concentrations and loads:

Tile nitrate concentrations throughout the drainage season of 2020-2021 for the 6 fertilizer N treatments. Each dot is the average of three replicates.

Tile nitrate concentrations ranged from a low of 1 ppm in the beginning of the drainage season to a high of 19 ppm for two of the treatments during the week of June 24 when 5 inches of precipitation occurred. Tile nitrate concentrations spiked following side-dress application for all 6 fertilizer N treatments.

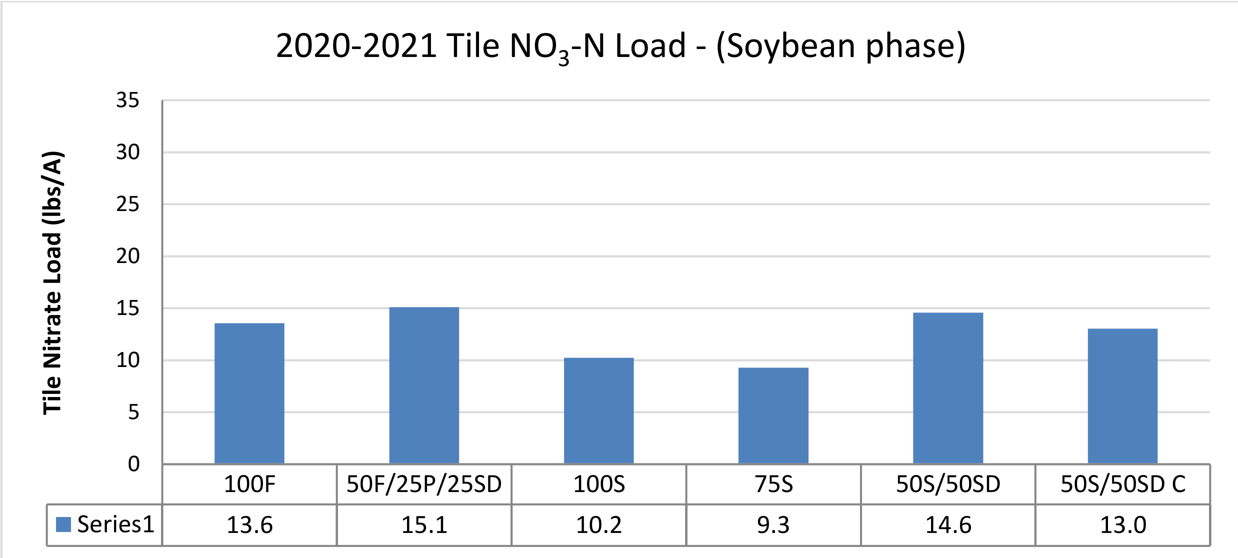
It is clear that fall fertilizer N application with an inhibitor lost the most tile nitrate (black dots); however, the spring fertilizer N application with inhibitor appeared to minimize N loss as this treatment fell in line with the other treatments by the end of the drainage season.

It is interesting to note that the treatment that no longer received fall fertilizer N application compared to the past 5 years (formerly 50F/25P/25SD changed to 33P/67SD) had no elevated tile nitrate suggesting no lag time in nitrate loss from the past treatment (red dots).



Tile nitrate loads during the drainage season of 2020-2021 for corn across the 6 fertilizer N treatments.

During the corn phase of the rotation, tile nitrate loads ranged from a low of 14.5 lbs/A for the cover crop treatment (50S/50SD C) to a high of 31.6 lbs/A for the fall N treatment (67F/33S). Tile nitrate load from the cover crop treatment was 25% less than the companion treatment.



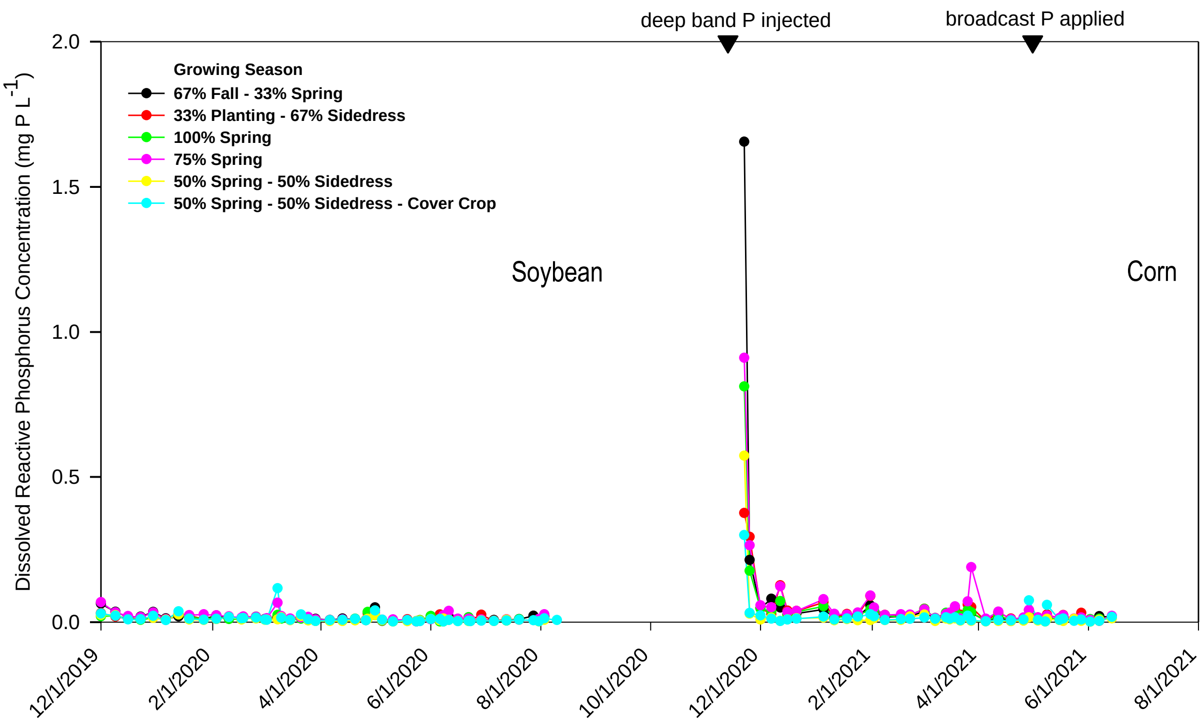
Tile nitrate loads during the drainage season of 2020-2021 for soybean across the 6 fertilizer N treatments from the 2020 crop year. No fertilizer N is applied to soybean.

Soybean plots lost less tile nitrate than corn plots. During the soybean phase, tile nitrate ranged from 9.3 lbs/A for the reduced rate treatment (75S) to a high of 15.1 lbs/A for the former 3-way split N treatment (50F/25P/25SD). The cereal rye stand was poor due to windy conditions when broadcasting and biomass only reached 0.22 tons/A and had little or no effect on tile nitrate load.

Note: When averaging tile nitrate loads across both phases (21.9 lbs/A for corn and 12.5 lbs/A for soybean), our tiles lost 17.2 lbs of nitrate/A, which was below the Embarras River nitrate load of 19.1 lbs/A during the 2021 water year (October 1, 2020 through September 30, 2021).

Tile dissolved phosphorus concentrations:

Following soybean harvest, treatments (67F/33S, 33P/67SD, 100S, and 75S) received deep banded DAP fertilizer when strip-tilling in the fall of 2020 while the other two treatments received a broadcast DAP application in the spring. This provided both a comparison of deep banding in the fall versus no application, as well as an evaluation of broadcast DAP application in the spring. In addition, spring DAP application of the 50S/50SD C treatment may have increased cover crop growth. Note: Regardless of when and how DAP was applied, the total N rate for each plot was maintained at 180 lbs/A by decreasing the spring or side-dress application N rate accordingly.



Tile dissolved phosphorus concentrations during the drainage season of 2020-2021 for corn across the 6 fertilizer N treatments.

Tile dissolved P concentrations spiked across all 6 treatments during the first tile flow event of the season; however, tile concentrations averaged about two-fold higher for treatments receiving the deep banded fertilizer P for several months. It is likely that dry soil conditions created preferential flow paths for either fertilizer P or mineralized P (from the disturbance of strip-till) to be transported to the tiles. We were very surprised to find a strong first flush event following deep banding of fertilizer P as it is presumed that deep banding is a BMP compared to spring broadcast. We found no flushing of the spring broadcast P fertilizer into the tiles. These findings highlight the interaction of antecedent soil moisture conditions and time between fertilizer P application and a major rain event. When applying P, farmers and operators need to be aware of imminent rain events to minimize P losses.

Collaboration with Dr. Zhongjie Yu:

We are pleased to welcome a new collaborator to this study, Dr. Zhongjie Yu in NRES. Dr. Yu's study aims to understand and quantify the sources of tile nitrate using dual isotope probing. His research will investigate sources of soil nitrate from mineralized N (i.e. last year's residue and/or ancient humified organic matter). His preliminary results from our tile water and river water samples are very encouraging as he can unequivocally fingerprint the source of tile nitrate at distinct times during the drainage season. For cross reference between the two studies, please refer to his report for the NREC study (2021-4-360649-46).

Photo showing the strip-till unit with deep banding capabilities used in our study to apply P and K in the fall.