2021 Final Report Summary Sheet

Grantee Information

Project Title: A Long-term Evaluation of Nitrogen Application Timing and Cover Crops Impacts on the Fate and Availability of Nitrogen Fertilizer and Crop Production on Tile Drained Fields

Institution: Purdue University

Primary Investigator: Dr. Shalamar Armstrong

NREC Project #

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: We received the contracts late causing there to be a delay in spending, but a NCE has been approved.

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: See above and below explanations

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

If you answered "yes" please explain: Delay in sample analysis due to significant malfunction of laboratory instruments, but the issues are being resolved and full execution will occur through the NCE.

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

If you answered "yes" please explain:

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:

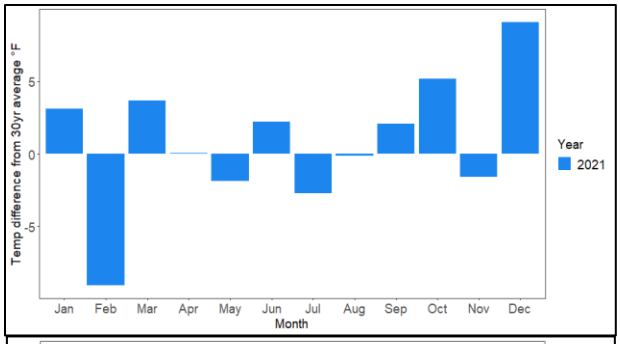
A Long-term Evaluation of Nitrogen Application Timing and Cover Crops Impacts on the Fate and Availability of Nitrogen Fertilizer and Crop Production on Tile Drained Fields

Research Objectives

1. Quantify the impact of N application timing and cover crop inclusion on the distribution of soil NO_3-N, nitrate-N losses through tile drainage, and corn and soybean N uptake and yield.
2. Investigate the impact of cover crop inclusion on N_2O release.
3. Utilize ^{15}N methods to identify whether cover crops primarily take up soil or fertilizer N.
4. Utilize ^{15}N methods to determine the synchrony of the timing and quantity of cover crop residue N release and corn and soybean N demand.

Significant Agronomic Finding of 2021

Weather and Water Quality



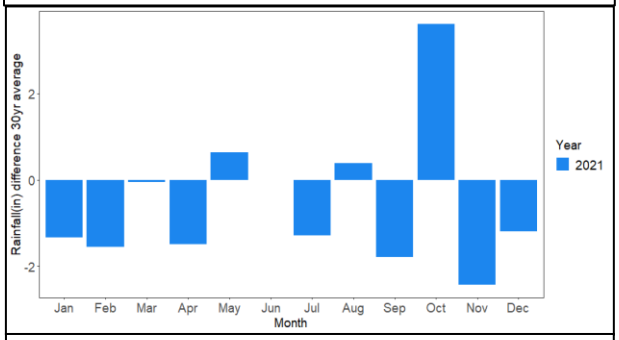


Figure 1. Comparison of ambient air temperature and rainfall relative to the 30-year average.

The weather at the Tile drainage site in 2021was characterized by warmer and dryer conditions relative to the 30-year average (Figure 1). Dryer conditions significantly reduce the tile drainage volumes and total nitrate loss. Cumulative nitrate load and flow weighted nitrate concentrations have been updated (partial water quality analysis to 5/25/21; 6 of 8 events completed, no events in July-October) and the trend of cover crops significantly reducing N loss and concentration continued (Figure 2 and 3). Over a 6-year period cover crops reduced the flow weighted nitrate-N concentration by 37.5% and was equal to the zero control, where no nitrogen fertilizer was added (Figure 2). Additionally, when considering nitrate load over the same 6 years cover crops reduced the mass of nitrate-N loss by 43 and 46% relative to the control and zero control treatments (Figure 3). Another significant observation is the change in the rate nitrate-N loading over time. When considering the zero-control treatment, we observed that the rate of nitrate-N loss decreased significantly over time, where over a six-year period the rate of loss was 34.3 lbs $A^{-1}yr^{-1}$, which was 66% higher relative to the rate of loss over the last 3 year at 12 lbs $A^{-1}yr^{-1}$ (Figure 4). For the non-cover crop control and the cover crop treatment we observed a 21 and 16% reduction in the rate of nitrate-N loss, respectively, when comparing the 6- and 3-year time periods. One implication of the zero control observation is that the rate of loss from the legacy N pool begins to decline after approximately 3 years following tile drainage installation in high organic matter soil (3.4%). Another implication is that cover crops maintained a 47% lower rate of nitrate loss consistent across the 6-year period relative to the N fertilized treatment without cover.

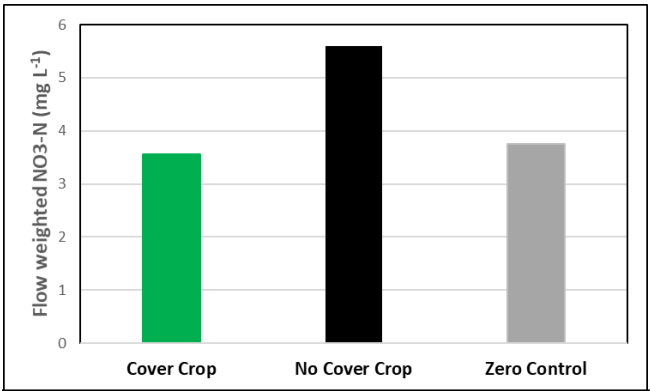


Figure 2. Flow weighted nitrate-N concentration averaged over a 6-years period.

Thus, we hypothesize that consecutive cover crop adoption of cereal rye will result in significant greater nitrate loss reductions, especially if the fertilizer N rate remains constant.

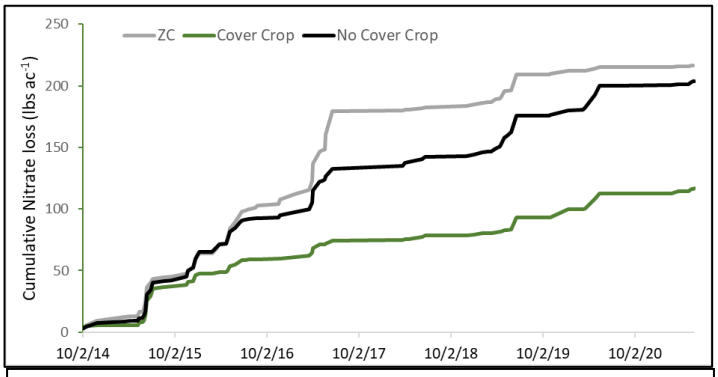


Figure 3. Cumulative nitrate-N loss over a 6-year period for the zero control, no cover crop, and cover crop treatments.

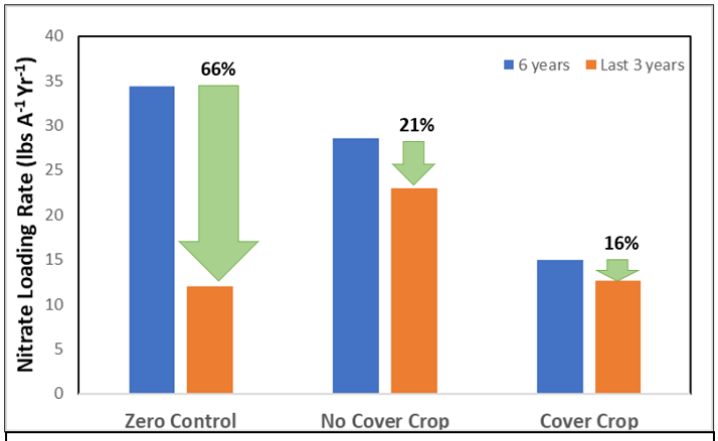


Figure 4. Rate of nitrate-N loading over a 6-years of the study and the last 3 years for the zero control, no cover crop, and cover crop

Agronomic Findings

Cover crops were planted late due to late corn harvest, thus our spring biomass average only 230 lb A^{-1} of biomass. There was no significant difference among treatments although the precision strip and precision reduced strip treatments has a 50 and 75% lower seeding rate relative to the conventional control treatments. This finding is consistent to observation at other sites, where precision plating cover crops at a lower rate is results in equal biomass production, justifying lower seeding rates.

There appear to be litter difference in soybean yield among treatments. However, we did observe sightly greater yield for the precision planted cover crops realtive to the conventional planted treatment.

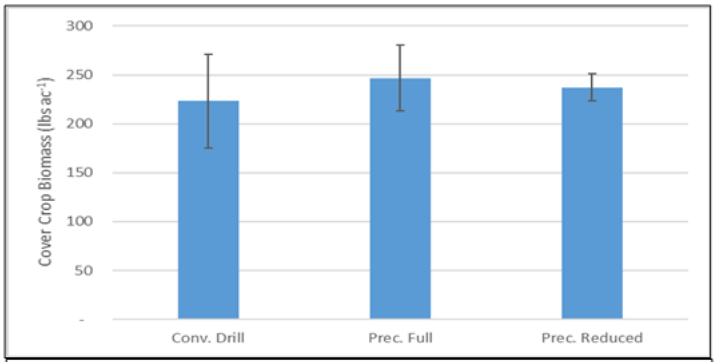


Figure 5. Spring cover crop biomass.

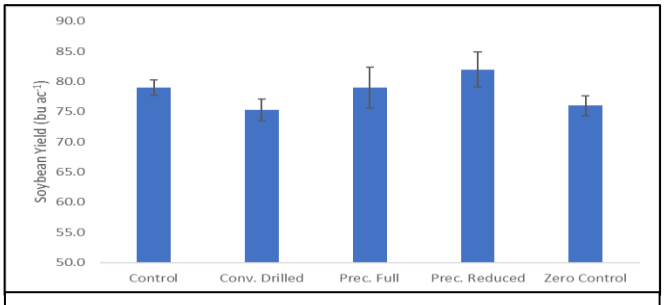
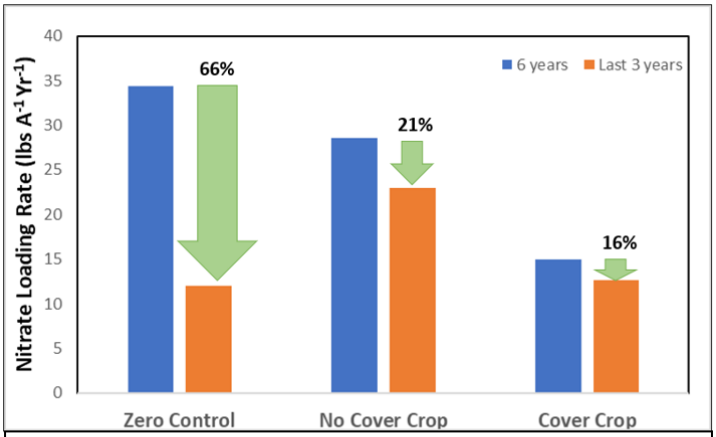


Figure 6. Soybean yield among treatments (2021).

Summary Highlight



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Another significant observation is the change in the rate nitrate-N loading over time. When considering the zero-control treatment, we observed that the rate of nitrate-N loss decreased significantly over time, where over a six-year period the rate of loss was 34.3 lbs A^{-1} yr^{-1}, which was 66% higher relative to the rate of loss over the last 3 year at 12 lbs $A^{-1}yr^{-1}$ (Figure 4). For the non-cover crop control and the cover crop treatment we observed a 21 and 16% reduction in the rate of nitrate-N loss, respectively, when comparing the 6- and 3-year time periods. One implication of zero control observation is that the rate of loss from the legacy N pool begins to decline after approximately 3 years following tile drainage installation in high organic matter soil (3.4%). Another implication is that cover crops maintained a 47% lower rate of nitrate loss consistent across the 6-year period relative to the N fertilized treatment without cover.