



INNOVATION GRANT PROGRESS REPORT

PROJECT TITLE: Quantifying phosphorus loss in changing cropping systems of Northwest Minnesota
REPORTING PERIOD: Q4 2020 / Final Report
FARMER INNOVATOR: NA
COLLABORATING ORGANIZATION/PERSON: University of Minnesota/Lindsay Pease
PHONE NUMBER: 218-281-8608
EMAIL: lpease@umn.edu

Abstract

The purpose of this project was to use to initiate research into a critical gap in knowledge of phosphorus loss in the unique, cold-climate agricultural systems of Northwest Minnesota. The overall objectives of this work were to collect nutrient loss data to identify potential links between land use and phosphorus loss for further investigation, and to leverage this work to secure additional long-term funding for phosphorus management research for row-crop production systems in Northwest Minnesota. Our research findings suggest that surface runoff was a greater source of phosphorus loss than subsurface tile drainage discharge during Summer 2020. Rainfall amount and soils were both identified as critical factors in transporting dissolved phosphorus to tile drains. High levels of observed rainfall and sites located on coarser-textured soils were observed to have slightly higher dissolved P concentrations than sites on finer-textured soils. We were able to successfully leverage this project to secure longer-term research funding for phosphorus management in the Red River Basin.

1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. (*Describe project progress specific to goals, objectives, and deliverables identified in your project proposal.*)

Objective 1: Identify potential links between land use and phosphorus loss

Sample Collection

Samples for this study were collected from four privately owned farms in Northwest Minnesota, from two fields at the Northwest Research & Outreach Center in Crookston, MN. Subsurface and surface water samples were taken from standing surface water in surface ditches or from tile outlets (from lift station wells in the case of pumped outlets) during field visits. Samples were captured and stored in prewashed plastic bottles. Sampling typically occurred monthly from April through October 2020 but varied by site depending on the frequency of field visits.

Laboratory Analysis

Water samples were stored below 4°C, and vacuum filtered through a 0.45 µm pore diameter membrane filter prior to analysis. If water sample analysis was not anticipated within the next 28 days, samples were frozen in plastic vials and stored at -20°C, then thawed to room temperature before analysis. All water samples were analyzed for DRP and TP according to U.S. EPA method 365.1 (U.S. EPA, 1983). Dissolved

reactive phosphorus (DRP) concentrations were determined for the filtered samples colorimetrically by flow injection analysis using a Lachat Instruments (Loveland, CO) QuikChem 8500 FIA Automated Ion Analyzer and application of the ascorbic acid reduction method (Murphy and Riley, 1962). Total phosphorus (TP) analyses were performed on unfiltered samples following alkaline persulfate oxidation (Patton and Kryskalla, 2003) with subsequent determination of DRP.

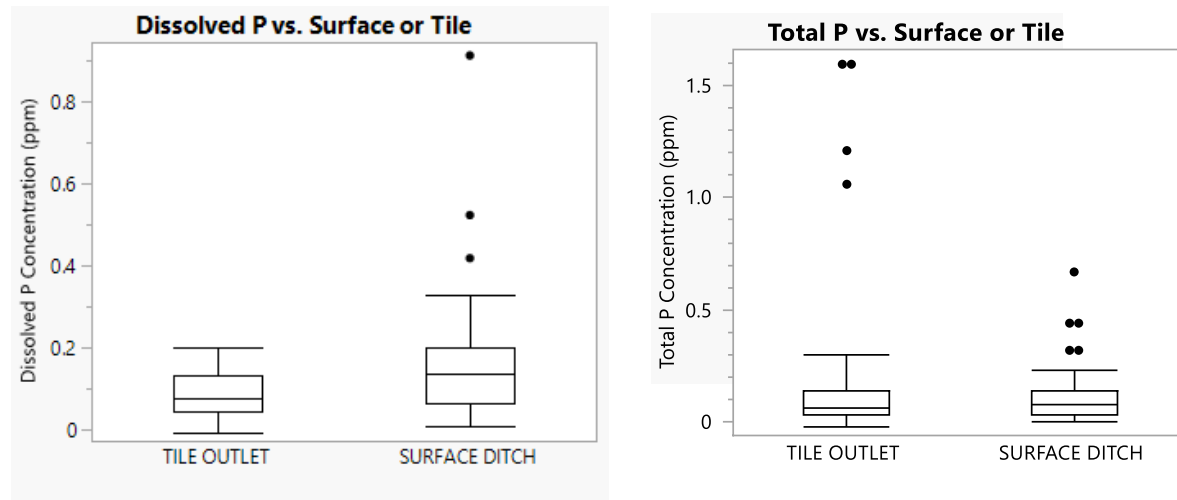
Data Analysis

Each site's total and soluble phosphorus loss data was analyzed using non-parametric statistical tests due to recording a lower number of observations than anticipated, and a non-normal distribution of the data. A similar approach was used in Pease et al (2018) for analysis of nutrient concentrations in grab-sampled subsurface drainage discharge.

Objective 2: Incorporate research results into a broader network of phosphorus research in Minnesota, Manitoba, and North Dakota

This project was successfully leveraged to acquire funding for more intensive sampling infrastructure in the Red River Basin watershed. The larger-scale project is a basin-wide, regional research network on phosphorus management in the Red River Basin watershed beginning in Spring 2021. This research network will collaborate with, and build upon, existing edge-of-field research sites from the Minnesota Department of Agriculture and the Minnesota Agricultural Water Resource Center's Discovery Farms Program, one existing EOF research site in Manitoba in partnership with the University of Manitoba and Canada's Agricultural Water Futures program. This broader effort will allow us to evaluate the efficiency of different phosphorus fertilizer application strategies in the Red River Basin from both agronomic and water quality perspectives.

2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT TO DATE. *(There may be none to report at some stages of the project)*



Dissolved P concentrations were greater in surface ditches than in tile outlets. This supports our initial hypothesis that the installation of tile does not increase dissolved P loss. There were several sampling events where very high concentrations of Total P were observed from the site at the NWROC in Crookston. The high concentrations observed at this site may be a result of sediment accumulation in the tile lines following the 2019 drainage system installation.

Preliminary data analyses suggest that the amount of rainfall and landscape position (whether a farm is situated on lake plain or beach ridge soils) are two significant factors that influence phosphorus losses in the Red River Basin, but we were not able to identify statistically significant differences between cropping systems. Specifically, phosphorus concentrations from sites on beach ridge soils were more likely to peak following periods of heavy rainfall than sites on lake plain soils. This suggests that dissolved phosphorus behaves similarly to nitrate; it is more likely to leach from coarser-textured soils compared to finer-textured soils. These findings align with results of Pease et al. (2018) and support our initial hypothesis. Longer-term investigation on the differences in P loss between landscapes is needed.

3.) CHALLENGES ENCOUNTERED. *(Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project proposal.)*

COVID-19 Impacts on Data Collection and Sample Analysis

The frequency of water sampling, timeliness of laboratory analyses, and quality control checks deviated from the anticipated workplan due impacts from the COVID-19 pandemic. These impacts include university restrictions on facility access, limited availability of trained personnel, and difficulties hiring and training new personnel under university guidelines. As a result, lab sampling was repeated on all water samples due to a potential cross-contamination issue that was identified during sample processing and analysis.

4.) EDUCATION AND OUTREACH ACTIVITIES. *(Describe any opportunities to engage with farmers, influencers or the media about your project.)*

This project was discussed in an April 2020 episode of the MN Corn Growers Association podcast. A general update on research plans and data collection was given by Dr. Pease during the Virtual IA-MN-SD Drainage Research Forum on December 1, 2020, and the Virtual Conservation Drainage Network meeting on April 8, 2021. Project findings will also be shared at UMN Extension events during Summer 2021, including the UMN Northwest Research & Outreach Center Crops & Soils Field Day in July 2021.

5.) HOW CAN WE HELP? *(Please let us know how we can improve the experience or assist in your project if possible.)*

No changes needed! The process and experience went smoothly from my perspective.

References

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- Patton, C.J., and J.R. Kryskalla. 2003. *Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory—Evaluation of Alkaline Persulfate Digestion as an Alternative to Kjeldahl Digestion for Determination of Total and Dissolved Nitrogen and Phosphorus in Water*. Denver, CO.
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