Progress Report to the Maryland Soybean Board - January 2024

Nutrient loss in runoff -cover crops make it better or worse?

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Figure 2 Collecting the first 5 liters of runoff from a simulated rain event using distilled water and the Cornell sprinkler infiltrometer.

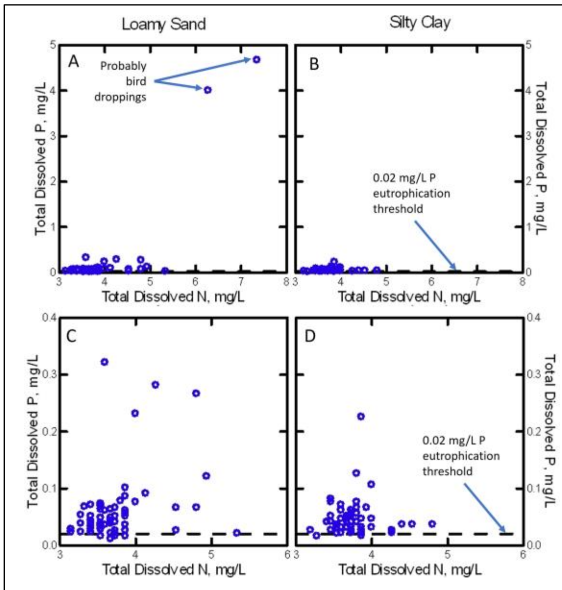


Figure 1 Runoff water concentrations of phosphate-P and nitrate-N during 2022-2023 winter/spring simulated rainfall events across Field 7E (silty clay) and Field 39A (sandy). Both nutrient parameters were very low regardless of cover crop or soil texture, except for 5 outlier samples all from two adjacent subplots in Field 39a. Note the difference on the Y-axis scales.

The main objective of the project is to determine whether cover crops make nutrient loss in runoff better or worse. That is there's some evidence that cover crops reduce runoff volume absorb nutrients and reduce the interaction of runoff water with soil and therefore May reduce the amount and concentration of nitrogen and phosphorus and runoff thus improving water quality impacts of agriculture. Other evidence suggests that cover crops may help stratify nutrients by concentrating them near the surface of the soil resulting in higher concentrations of soluble nutrients especially in organic farms. A special concern revolves around phosphorus loss in runoff in areas where fresh waters are susceptible to eutrophication. This research aims to health define the impact of cover crops on these losses of nutrients. The fieldwork was completed in 2023 and this extension of the project is mostly focused on analyzing the hundreds of samples that have been collected over the previous several years. Thus far we have focused on analyzing the nutrients in runoff from the simulated rainfall trials where we did 36 simulated rainfalls (Figure 1) in two different soils growing corn or soybean with either no cover, rye cover crop, or a three-way mixture of radish -rye - crimson clover. The collected runoff samples have been filtered through a 0.45-micron filter which excludes all particles and defines dissolved nutrients. Then, we analyze this filtrate for the nitrates and phosphates which are considered reactive nutrients in inorganic form. Then we digest a subsample of the filtrate at high temperature and pressure using an autoclave and alkaline persulfate solution. This breaks down all

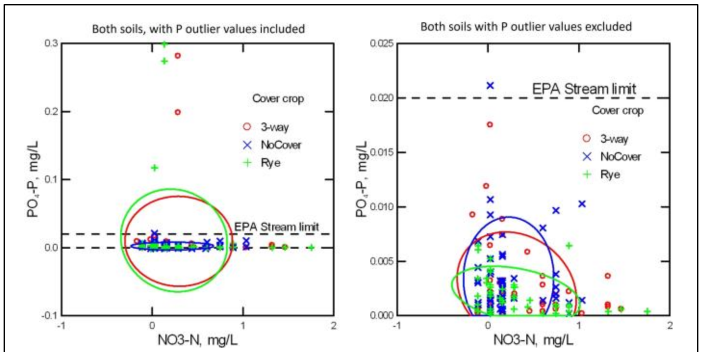


Figure 3 Runoff water concentrations of phosphate-P and nitrate-N during 2022-2023 winter/spring simulated rainfall events across Field 7E (silty clay) and Field 39A (sandy). Both nutrient parameters were very low regardless of cover crop or soil texture, except for 5 outlier samples all from two adjacent subplots in Field 39a. Note the difference on the Y-axis scales with and without the outliers.

the organic forms of nitrogen and phosphorus into nitrate and phosphate ions which can be measured as total dissolved nitrogen or phosphorus. The difference between the total dissolved nitrogen or phosphorus and the nitrate or phosphate concentrations is considered to be the organic nitrogen or phosphorus (Figures 2, 3).

In general, the nutrient levels in the runoff from both fields were quite low and within EPA guidelines, although such guidelines are not clear for the total nutrients dissolved in runoff. The usual guidelines for nutrients in runoff are less than 10 ppm nitrate-nitrogen as a drinking water standard or less than 2 ppm nitrate-nitrogen for water quality. The equivalent water quality standard for phosphorus is much lower, 0.02 parts ppm phosphate phosphorus being the threshold that is expected to cause eutrophication.

Generally, the levels of N and P in the runoff from both fields were mainly below this 0.02 ppm standard. We did encounter several plots with much higher levels of phosphorus in runoff which we ascribed to the activity of Canada geese defecating in the plots. Two plots, in particular, on the sandy field had total dissolved phosphorus and nitrogen levels 10 to 100 times higher than all the other plots.

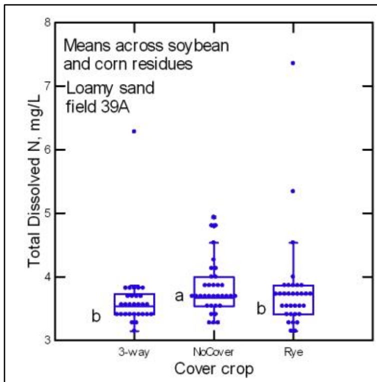


Figure 4 On the sandy soil, averaged across corn and soybean residue plots, both cover crops reduced TDN in runoff compared to no cover crop plots.

Nutrient concentrations are highly variable, and the data are rarely normally distributed as required for the use of a regular analysis of variance (ANOVA) statistical treatment. We transformed the data using log transformation, but it still did not meet the requirements in many cases. So, we used non-parametric statistical approaches such as the Kruskal-Wallis non-parametric test to see if any of the categories differed with regard to the nutrient levels, and then we used an Inman test to make pairwise comparisons.

Using this approach, we found that on the sandy soil, runoff carried more TDN without a co er crop than with either of the cover crops planted (Figure 4). For the total dissolved N there was an interaction between the soil type on the two fields and the cover crop treatments. On the silty soil runoff from plots with no-cover crop contained more total dissolved N (TDN) with soybean residue than with corn residue (Figure 5, left). For the total dissolved phosphorus, there was an interaction between the type of crop residue present and the cover crop treatment (Figure 5, right).

Although we are continuing to analyze data from our runoff samples, it appears that in general runoff from no-till fields with a history of cover cropping but not a history of manure application is quite low in nutrients. While some cover crop effects were statistically significant there was no evidence that cover crops made the loss of nutrients greater. In some cases, cover crops reduced the concentration of nutrients in the runoff. In some cases, there were significant differences in nutrient concentrations in the runoff between corn and soybean residues. Although we have looked for it in our data, we have seen little evidence that the winter kill of radish in a mixture with clover and rye produces phosphorus runoff concentrations any higher than those coming from no-till plots without cover crop or with just a pure rye cover crop.

We expect to use the next few months of the project to finish analyses of the remaining samples and write a final report.

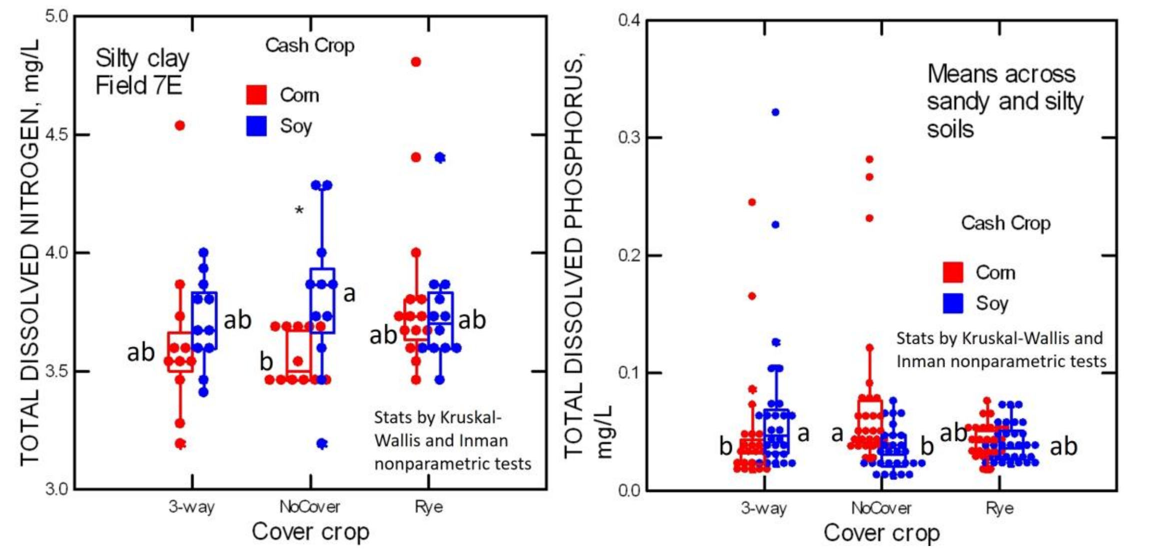
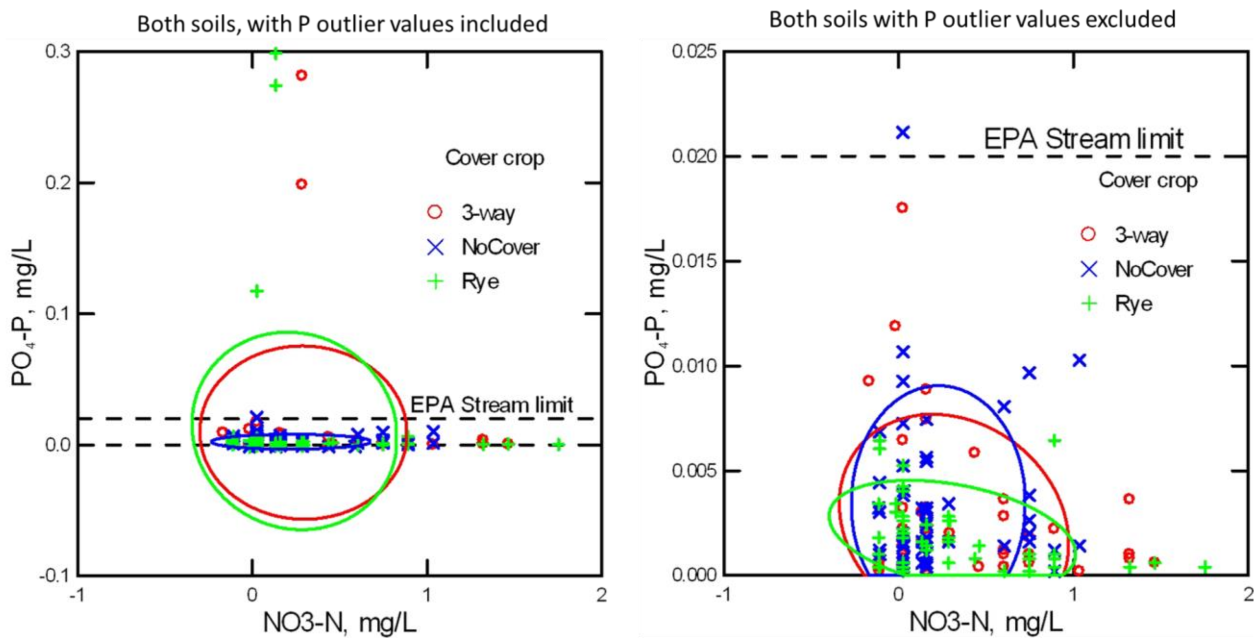


Figure 5 (Left) On the silty soil runoff from plots with no-cover crop contained more total dissolved N (TDN) for soybean residue than for corn residue. (Right) Averaged across sandy and silty soils, runoff from plots with no cover crop in corn residue had more total dissolved P (TDP) than from no cover in soybean residue. For plots with soybean residue, those with the 3-way mixture had higher TDP runoff than those with no cover crop, but not different from those with rye cover crop.



Both soils, with P outlier values included
Cover crop
3-way
NoCover
Rye
EPA Stream limit
PO_4-P, mg/L
NO3-N, mg/L
0.3
0.2
0.1
0.0
-0.1
-1
0
1
2
Both soils with P outlier values excluded
EPA Stream limit
Cover crop
3-way
NoCover
Rye
PO_4-P, mg/L
NO3-N, mg/L
0.025
0.020
0.015
0.010
0.005
0.000
-1
0
1
2