Understanding the fate of phosphorus in alternative manure applications

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Introduction

- Application of manure in both spring and fall has been a common practice in dairy farms due to limited space to store manure. In no-till cropping systems, manure is typically broadcasted on the soil surface, which makes it susceptible to leaching or run off.
- Phosphorus is a key nutrient for crop growth that can be lost by run off from the surface applied manure into the streams and water resources and results in eutrophication and water impairment.
- Therefore, it is important to employ other manure application methods, such as manure injection, which can alleviate the environmental concerns associated with broadcast application of manure.

Objective

- This study evaluated whether injecting manure could prevent phosphorus run off compared to the broadcast application method.

Materials and Methods

- This study was conducted at the Penn State's Agronomy Research Farm in Rock Springs, PA, from 2012 to 2014.
- Broadcast and inject manure application methods were replicated 6 times in In 12 lysimeter plots. Figure 1 represents the color coordinated blocks that are paired based on the drainage and hydrology of the plots.
- Manure was either injected with a shallow disk injector (Figure 3) or broadcast (Figure 4) in fall prior to a winter annual or spring prior to corn.
- Corn silage was planted on 1 June 2012, 7 May 2013 and 13 May 2014 and winter wheat/rye was planted on 4 Oct 2013 and 28 Oct 2014. Figure 6 shows manure application dates.
- Each plot has berms and collected water that fell on it. There are two collection houses for all 12 plots, and for each plot there is an outlet for surface runoff and shallow lateral flow or leachate (Figure 2).
- Each PVC outlet pipe is fitted with a tipping bucket system to measure total volume, as well as with a sub-sampler to catch a portion of the runoff for total P concentration.
- Total P yield was calculated as total P concentration x water volume

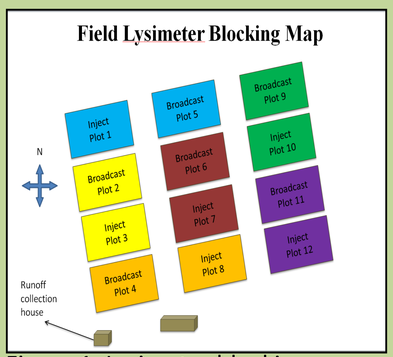


Figure 1. Lysimeter blocking map

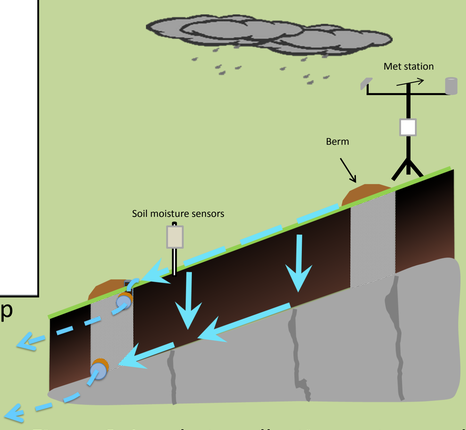


Figure 2. Leachate collecting system and drainage at the representing plots.

Figure 3. Manure injection method

Figure 4. Broadcast application of manure

Results

- Each data point represent an individual event that had enough precipitation for sample collection and analysis.

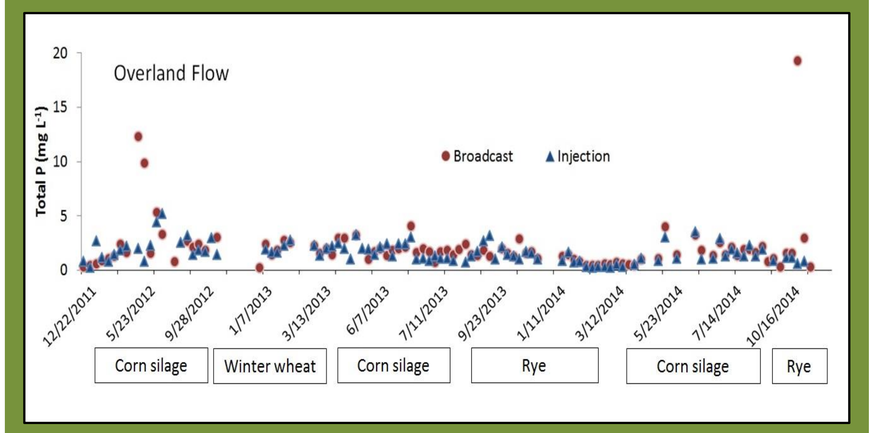


Figure 5. Total overland Phosphorus (P) Concentration (mg/L)averaged across plots that broadcast or injected manure.

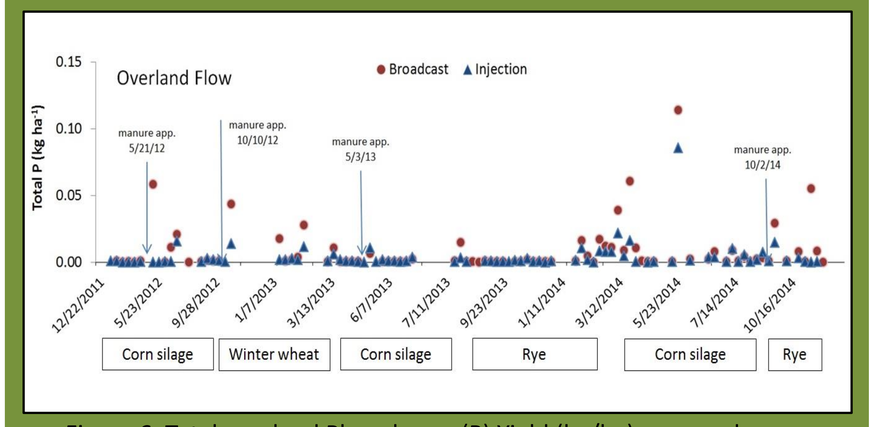
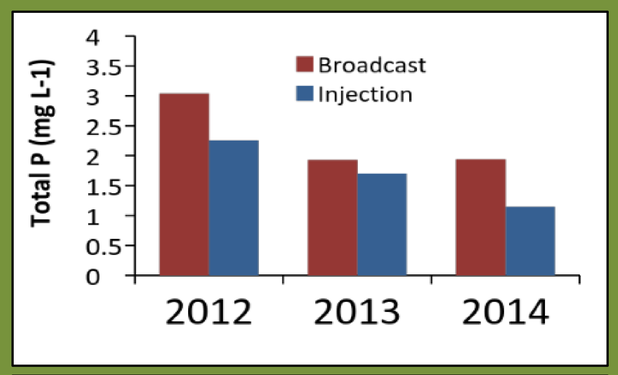


Figure 6. Total overland Phosphorus (P) Yield (kg/ha) averaged across manure broadcast and injection treatment plots.

- Very large spikes in total P concentration (mg/L) and P yield (kg/ha) in overland flow were observed with broadcast application of manure and high rainfall events (Figure 5).
- When P yield losses (kg/ha) in overland flow are compared, there were more occasions when manure P loss was higher from the broadcast manure than injected manure (Figure 6).
- Runoff monitoring results from the field lysimeters highlight the benefit of manure injection with regard to mitigating phosphorus (P) losses in overland flow



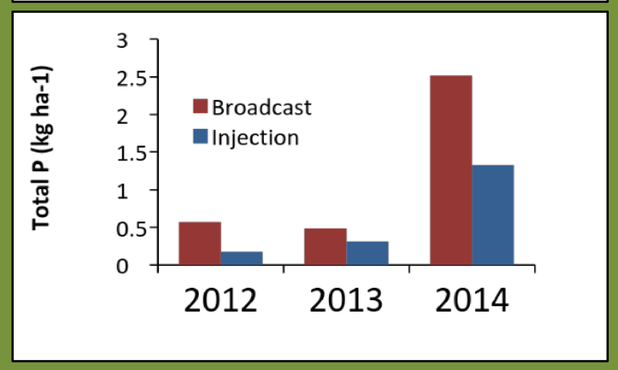


Figure 7. Annual total phosphorus (P) concentration and yield for the lysimeter Plots.

- The total phosphorus concentration and yield were calculated from the samples collected at each rain event. Then the data was summed across events to calculate annual total.
- Overall, annual total P in overland flow 1.19 kg /ha/yr with broadcast application. vs averaged 0.6 kg /ha/yr with injection.
- As seen in figure 7, total phosphorus losses was higher in broadcast in all years compared to the injection method.

Conclusions

Our results indicated that broadcast application of manure makes it vulnerable to run off which increases the potential of manure as a source of P for the crops. Manure injection reduces run off and conserves manure P by putting the manure directly into the soil. As a result, water resources will be less contaminated by manure when it is injected into the soil then when it is broadcast.

Acknowledgements

This study is funded by the Northeast Sustainable Agriculture Research and Education (NESARE) program and the Pasture Systems & Watershed Management Research in USDA, ARS.