Cover Crop and Fertilizer Management Effects on Water Quality under No-till

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The Phosphorus Cycle

- Phosphate Added in Fertilizer
- Inorganic Available Phosphate
- Fixed Phosphate
- Uptake of Phosphate
- Mineralization of Organic Phosphate
- Crop Residue and Manure Return Phosphate to Soil
- Runoff to Water Body
- Removal by Crops

With P

Without P
Impacts of P loading
A toxic algal bloom caused a three-day ban on water usage for a half-million residents in SE Michigan and Toledo.

Experts say it’s a ‘wake-up call.’

TAINTED BLOOM

by Ryan Felton
Goals & Objectives

• Understand the effect cover crops and phosphorus fertilizer management has on phosphorus loss.

• Will cover crops reduce P loss?
  • Are P losses from fall surface-applied fertilizer with cover crop comparable to the current BMP of subsurface injecting P fertilizer?
- Management: No-till
- Crop: Soybean
- Fertilizer rate: $54 \text{ kg } \text{P}_2\text{O}_5 \text{ ha}^{-1}$
- Cover crop: Winter wheat
KAW Field Lab
Kansas Agricultural Watersheds Field Lab
Watershed Outlet
Field Measurements

- Runoff volume
- Sediment loss
- P loss
  - Dissolved P
  - Total P
- N loss
  - NO$_3$ & NH$_4$
  - Total N
- Yield
- Biomass
  - Nutrient content of biomass and grain
- Economic feasibility
Field Measurements

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Data Analysis (2015-2016)

- 486 possible measurements (18 watersheds*27 events)
- 7 runoff events produced 84% of the total runoff.
  - Remaining events were small (< 5 mm of runoff).

- Non-normally distributed data required transformations
  - Runoff – square root transformation
  - Total P, dissolved P, and sediment – log_{10} transformation
Precipitation (2015-2016)

- Cover crop planted
- Broadcast P fertilizer application
- 1st runoff event
- Cover crop termination
- Soybean planting & injected P fertilizer application
- 2nd runoff event
- Soybean harvest

Monthly Precipitation (mm)

Cumulative Precipitation (mm)
Cover Crop Impact on Runoff (2015-2016)

No Significant Effect (p=0.778)

No Cover = 136 mm
Cover = 141 mm

Different letters indicate significant difference within event at p<0.05
Cover Crop Impact on Sediment Loss (2015-2016)

71% reduction in sediment loss (p<0.001)

No Cover = 1092 kg ha^{-1}
Cover = 316 kg ha^{-1}

Different letters indicate significant difference within event at p<0.05
Cover Crop Impact on Total P Loss (2015-2016)

No Significant Effect (p = 0.725)

No Cover = 1.12 kg ha$^{-1}$
Cover = 0.94 kg ha$^{-1}$

Different letters indicate significant difference within event at p<0.05
Cover Crop Impact on Dissolved P Loss (2015-2016)

48% Increase in dissolved P loss (p<0.001)

No Cover = 244 kg ha⁻¹
Cover = 469 kg ha⁻¹

Different letters indicate significant difference within event at p<0.05
Fertilizer Placement Impact on Total P Loss (2015-2016)

No Significant Effect (p=0.076)

Control = 0.83 kg ha\(^{-1}\)
Fall Broadcast = 1.30 kg ha\(^{-1}\)
Spring Injected = 0.98 kg ha\(^{-1}\)

Different letters indicate significant difference within event at p<0.05
Fertilizer Placement Impact on Dissolved P Concentration (2015-2016)

2x increase in dissolved P concentration with broadcast fertilizer over injected ($p < 0.001$)

Control = 126 µg L$^{-1}$
Fall Broadcast = 511 µg L$^{-1}$
Spring Injected = 289 µg L$^{-1}$

Different letters indicate significant difference within event at $p<0.05$
Fertilizer Placement Impact on Dissolved P Concentration (2015-2016)

**2x** increase in dissolved P concentration with broadcast fertilizer over injected (p < 0.001)

Control = 126 µg L\(^{-1}\)
Fall Broadcast = 511 µg L\(^{-1}\)
Spring Injected = 289 µg L\(^{-1}\)

Different letters indicate significant difference within event at p<0.05
Conclusions

• The cover crop effectively reduced erosion but increase dissolved P loss.

• Injecting P fertilizer reduces dissolved P loss particularly early on compared to broadcast.

• Neither cover crop or fertilizer effected total P loss overall.