Fertilizer Management Effects on Phosphorus Concentrations in Runoff from No-till Corn and Soybean

Nathan Nelson, Elliott Carver, Kraig Roozeboom, Peter Tomlinson, Gerard Kluitenberg, and David Abel

Kansas State University
Department of Agronomy

Background and Justification

We need to minimize phosphorus (P) loss from agriculture because P inputs to surface water promote eutrophication and degrade water quality. The timing and placement of P fertilizer affect P loss and are critical components of 4R nutrient management. Although the optimum time for broadcast P applications is likely in the fall for much of the great plains, there are very few studies that investigate P loss from fall broadcast P. More information is needed on the effects of fall-broadcast P fertilizer relative to current best management practice recommendations of subsurface placed P fertilizer

Objective

The objective of this study was to determine the effects of fall broadcast and spring injected fertilizer management systems on P concentrations in runoff water from a no-till corn-soybean cropping system.

Methods

Location

This study was conducted at the Kansas Agricultural Watershed field laboratory near Manhattan, KS from 2015 to 2017 (Figure 1; k-state.edu/kaw).

Field Instrumentation and Cropping System

- Eighteen 1.2-ac watersheds equipped with 1.5-ft H-flumes and ISCO 6700 and 6712 automated water samplers (Figure 2).
- Water depth in H-flume recorded year-round at 1-min. intervals using ISCO 730 bubbler modules.
- Flow-weighted composite water samples collected for each runoff event. One 200-mL sample collected for each 0.02 in. of runoff.
- No-till corn-soybean cropping system. Soybean planted in 2016 and corn planted in 2017.

Experimental Design and Treatments

- 3x2 factorial treatment arrangement in a randomized complete block design with three replications
  - Three levels of fertilizer management
    - Control - 0 lb P_2O_5/ac
    - Fall Broadcast – 55 lb P_2O_5/ac broadcast annually on soil surface in the fall.
    - Spring Injected – 55 lb P_2O_5/ac injected 2 in below and 2 in to the side of the seed at planting.
  - Two levels of cover crop management
    - No cover crop
    - Winter cover crop consisting of small grain (winter wheat or triticale) and brassica (rapeseed).

Data Analysis

- The main effect of fertilizer treatment and the interaction with time was determined with ANOVA using SAS proc glimmix for all runoff events > 0.06 or 0.08 inches for 2015/16 and 2016/17 water years respectively. Data required square root or log transformations to normalize residuals.
- Runoff events, numbered chronologically by day after 1 Jan. 1900, were entered in the model as a repeated measure with compound symmetry covariance structure.
- Results are presented as back-transformed means, averaged over cover crop treatments.

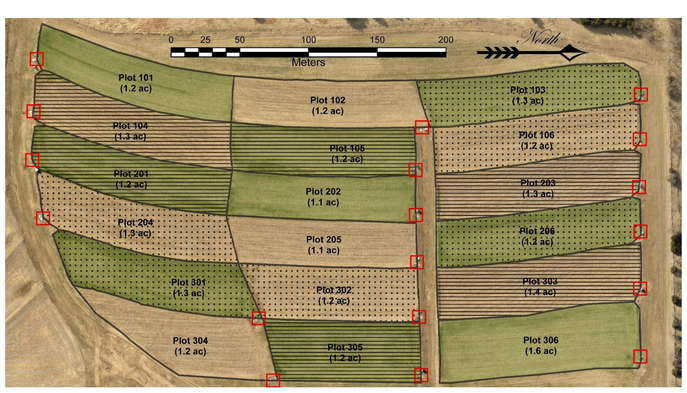

Figure 1. Site map and treatments for the Kansas Agricultural Watershed Field Laboratory.

Results and Discussion

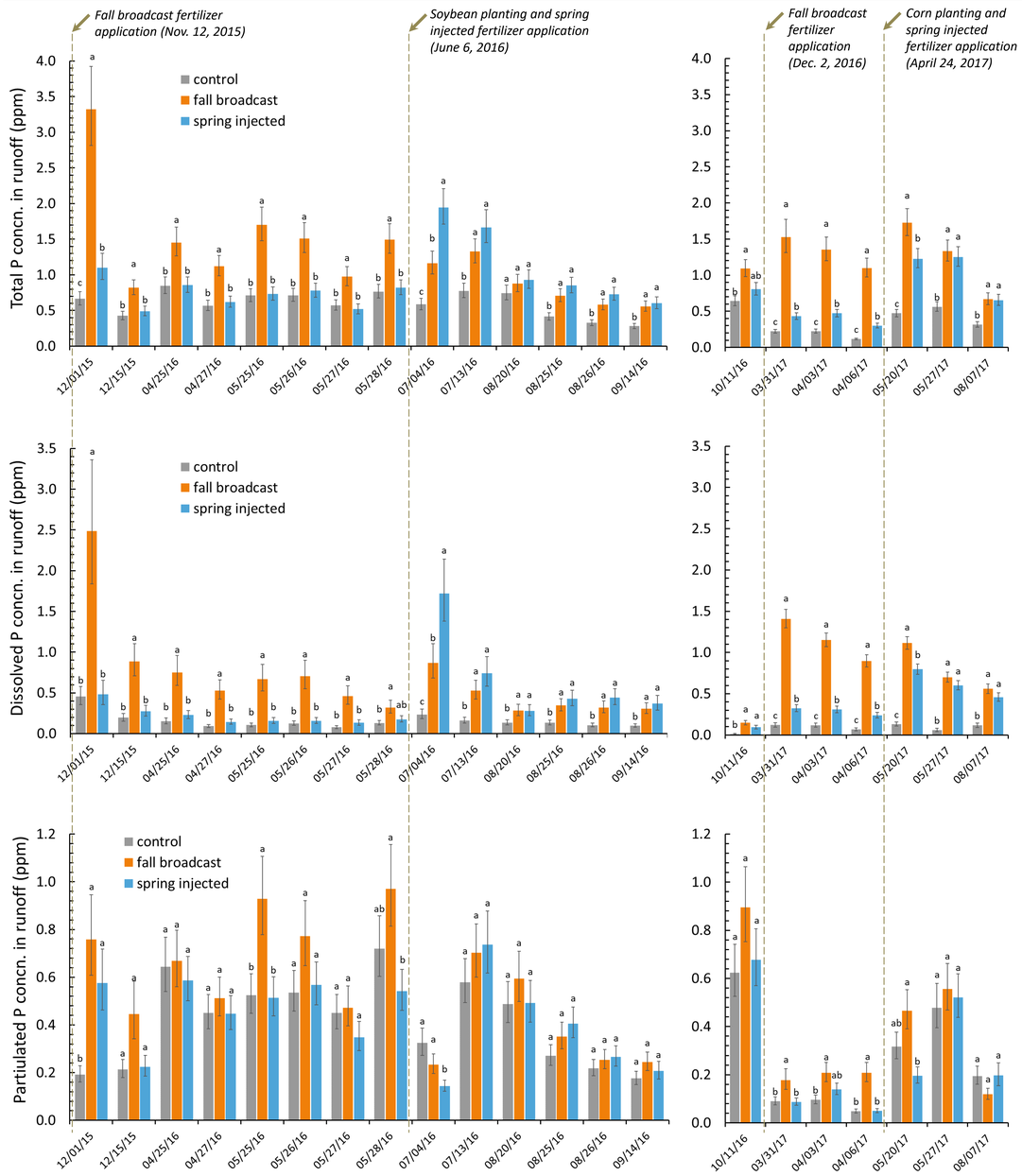

Figure 3. Total P concentrations in runoff by event (letters indicate significant differences within an event). Total P concentration in runoff from spring injected fertilizer was less than fall broadcast and equal to the control prior to spring fertilizer application. After spring fertilizer application, total P concentration increased in runoff from the spring injected treatment and was greater than or no different from fall broadcast and tended to be greater than the control for the remainder of the water year. This general pattern was repeated in the 2016/17 water year.

Figure 4. Dissolved P concentrations in runoff by event (letters indicate significant differences within an event). Treatment effects on dissolved P concentrations in runoff were similar, yet more pronounced, to that observed for total P. The dissolved P concentrations increased following fertilizer application and declined over time afterwards.

Figure 5. Particulate P concentrations in runoff by event (letters indicate significant differences within an event). There was a minimal and inconsistent treatment effect on particulate P concentrations in runoff. This indicates that fertilizer management effects on total P concentrations are primarily due to changes in dissolved P concentration.

Figure 2. H-flumes and equipment for monitoring flow, collecting water samples, and monitoring precipitation at watershed outlets.

Conclusions

- Spring subsurface placement of P fertilizer maintains smaller dissolved P concentrations in runoff water compared to fall broadcast fertilizer application.
- Spring subsurface P placement decreased total P concentrations in runoff, primarily because of decreased dissolved P.
- Subsurface P placement remains the best management practice for reducing P loss from agricultural fields, even if broadcast applications are made at times when runoff is reduced.

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