

Phosphorus Runoff from Surface and Subsurface Fertilizer Applications in No-till and Strip-till Fields with Minimal Slope Gradient in Central Illinois

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INTRODUCTION

Many studies have been focused on determining the effect of conservation vs. conventional tillage systems on P runoff. Relatively less has been done to compare differences in P runoff within different conservation tillage practices. Specifically, studies that compared no-till to strip till are scarce. The few available studies have been done in sandy soils or for production systems that are very different from Illinois agriculture (Franklin et al., 2007; Truman et al., 2007). The only studies done in Illinois to compare no-till and strip-till were done in fields with substantial slope gradients and to study only the effect of tillage as no fertilizer treatments were applied (Harschi, et al., 1995; McIssac et al., 1991). A substantial portion of agricultural land in Illinois is in the 0 to 2% slopes category. While the potential for runoff is lower in “flat” landscapes, the effect of conservation tillage practices (no-till and strip-till) along with P application rate and placement method has not been evaluated for such landscapes. Also, in the last few years we have observed firsthand that large precipitation events can cause substantial soil erosion and water runoff even in very “flat” ground. These facts would indicate that research in this “flat” landscapes should be a priority. A few manuscripts recently published from our work in Illinois (Farmaha et al., 2011, 2012a, 2012b; Fernández and White, 2012) indicate some of the benefits associated with strip-till over no-till for corn and soybean production. In addition, in another publication (Fernández and Schaefer, 2012) we discussed the benefits of deep banding fertilizer to reduce surface P levels without negatively impacting corn and soybean yields. In all these recent studies, we have mentioned as a possible hypothesis that the potential for P runoff may be reduced with deep banding of fertilizer in no-till and strip-till systems. Obviously, research is needed to quantify the effect of conservation tillage and P fertilizer placement on P runoff.

MATERIALS AND METHODS

Original study setup

The study is being conducted in commercial fields at three locations near Pesotum, Illinois (East Central Illinois). The fields are in a corn-soybean rotation with 30-inch row spacing in all sites and for both crops. All three sites had soybeans during the 2007 growing season before the start of the study, thus corn was the first crop planted after treatment establishment. Plot size was 20 x 500 ft and treatments remained in the same plot for the duration of the study. The study was set up as a split-plot arrangement in a randomized complete-block design with two replications. The main (whole) plot included three tillage/fertilizer placement treatments: no-till/broadcast (NTBC); strip-till/broadcast (STBC); and strip-till/deep-placed (STDP). The split-plot treatments were blends of P₂O₅ and K₂O made to create seven P-K fertilizer treatments with a control receiving no P or K (0-0 or check). The six additional rates were established in 23 lb P₂O₅ and K₂O / ac increments starting with a blend of 46 lb P₂O₅ / ac and 46 lb K₂O / ac. Strip-till operations were done always in the fall and corn was planted on the location of the strips the following spring. The soybean crop was also planted on the same crop-row position as corn but no tillage operations were performed for soybean.

PROGRESS DISCUSSION

Fall 2013

After soybean harvest, three fertilizer treatments from the original study (0, 92, and 161 lb P₂O₅ acre⁻¹ and K₂O acre⁻¹) were selected for P runoff measurements. Because of treatment application since 2007, by fall 2013 the plots had a large gradient of soil surface P test levels, which made these plots ideal to accomplish the objectives of this study.

We followed similar procedures to Daverede et al. (2003) for rainfall simulation and runoff sample collection and analysis. In the center of each treatment area a microplot (5 x 6.5 ft) was established by installing metal borders on 3 sides with a collection tray on the 4th side. The microplots were installed to be representative of the field with the long sides placed in the middle of a strip-till track. Soil samples next to the micro-plot area were collected at 0-4 and 4-8 inch depths for Bray-P analysis. During the rainfall simulation event 0-1 inch depth soil samples consisting of 12 cores were collected adjacent to the microplot for Bray-P analysis.

Installation of microplot borders and rainfall simulation began one week after fertilizer application. Rainfall simulation started in early November 2013 but was disrupted by inclement weather until December. Thus, samples were collected only in one of the three locations. Runoff water from a 30-minute runoff event was collected from each micro-plot at 5 minute intervals (up to 500 ml) with an additional 1-liter sample collected after the rainfall simulation event. The runoff samples were analyzed for dissolved reactive phosphorus (DRP) and total phosphorus (TP) and algal-available P (AAP.). Sediment from each sample was quantified. The length of rainfall simulation to initial runoff was recorded. The entire volume of runoff was recorded to

calculate P load. Village of Tolono water supply was used for rainfall simulation. Water samples were collected from each source tank load for contaminant analysis.

Spring 2014

Prior to planting, rainfall simulation was performed and runoff samples were collected at two locations. New micro-plots were established in an undisturbed area within the plots. In April samples were collected from the two replications at the Christian field. In May samples were collected from the two replications at the Schaefer field. The third field was not sampled to allow corn to be planted in May in hopes that a timely harvest would allow Runoff sampling in the fall. Spring runoff water was collected for a 30-minute event. The entire runoff volume was recorded from each micro-plot. The runoff that continued after the rainfall ended was collected until flow ended (referred to as the end sample). The end runoff was timed and entire volume collected. A subsample of the 30 minute Runoff and the End Runoff subsample were analyzed for dissolved reactive phosphorus (DRP) and total phosphorus (TP.) Sediment was also quantified for each sample. All samples have been analyzed for algal-available P (AAP.), DRP and TP. Following the spring sample collection corn was planted in each field.

Fall 2014

Following harvest in October, P and K treatments were applied. Soon after fertilizer applications, new microplot borders were installed at the Christian location. Rainfall simulation was conducted during October and November at this site. Rainfall was initiated and continued until a 30-minute runoff event occurred. Runoff water from event was collected and the entire volume was recorded from each micro-plot. A one liter subsample was collected from the total volume. An End-Runoff sample was collected in the same manner as the spring sampling. A subsample of the 30 minute Runoff and the End Runoff subsample were analyzed for dissolved reactive phosphorus (DRP) and total phosphorus (TP.) The Algal available analysis will be completed in February. Sediment was also quantified for each sample. Soil samples from each microplot have been analyzed. Due to nightly temperatures well below freezing during the weeks following work at the Christian location we were unable to simulate rainfall at the Schaefer or Reifsteck locations. Appropriate statistical analysis will be used to analyze the data from each event and results compiled for the final report to be submitted in spring 2015.

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