FIELDNOTES

Strategies to Minimize Dissolved P Losses in No-Till

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Learning Objectives

- Compare the impact of dissolved P and sediment-bound P in surface runoff.
- List and compare conservation practices for mitigating phosphorus in surface runoff.
- Explain how type of fertilizer and application rate impact losses.

Excess phosphorus (P) delivery to streams or lakes via surface runoff results in excess algae growth that impairs water quality. Extensive research has proved that soil conservation practices that reduce soil and water loss from agricultural fields (such as no-till, grass buffer strips, cover crops, and terraces) also greatly reduce sediment-bound (or particulate) P loss. Until recently, however, scarce Iowa research had evaluated the impact of these practices on dissolved P loss with surface runoff. For these reasons, the Iowa Nutrient Reduction Strategy emphasizes total P loss reduction by management practices, although the Iowa P Index considers both P fractions.

The dissolved runoff P fraction is the most critical P form for short-term increased algae growth and surface waters impairment. Research during the last decade on numerous Iowa fields managed with corn and soybean rotations demonstrated the relative impact of several management practices on dissolved P loss with runoff and suggested cost-effective practices that reduce particulate P loss while also reducing or at least not increasing dissolved P losses. Data for a few important practices are discussed in this short publication.

It is well known that soil-test P higher than optimum levels for crops increase both dissolved and sediment-bound P losses with runoff. But there is a rate effect, too. Figure 1 shows effects of the P application rate for corn and soybean across fertilizer and manure sources and many experiments on dissolved and total P losses with runoff. There was a very large effect of the highest P rate applied (100 lb P_2O_5/acre) and a much lower effect of the 50-lb rate. The 50-lb rate is about the annual rate needed to maintain optimum soil-test P for corn and soybean. The 100-lb often is applied only once before corn to maintain optimum STP for the rotation and also when applying N-based manure for corn even in high-testing soils.

Figure 2 shows averages across many experiments and years of tillage and P source effects on losses of dissolved P and total P with runoff. The P rate always was 100 lb P_2O_5/acre

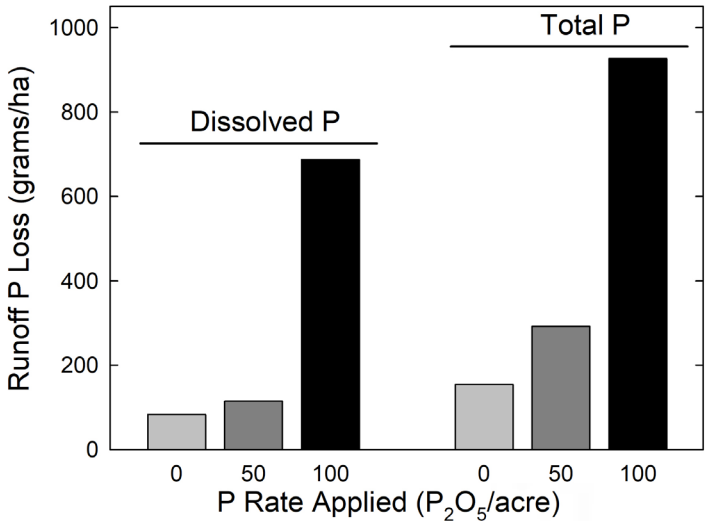

Figure 1. Dissolved and total P in runoff as affected by the P application rate.

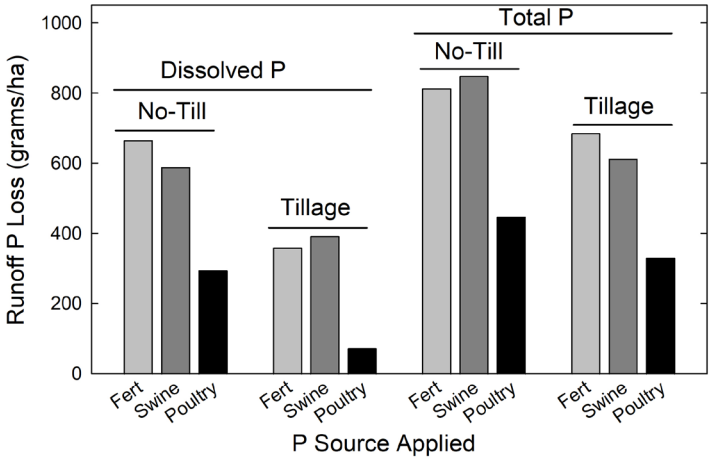

Figure 2. Effects of the tillage system and the P source on dissolved and total P loss with runoff.

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and the fertilizer and solid poultry manure were broadcast whereas liquid swine manure was injected. No-till resulted in much larger dissolved P loss than tillage with all sources but differences for total P loss were much smaller. The most remarkable P source effect was that losses of both dissolved and total P were much smaller for solid poultry manure than for fertilizer or liquid swine manure with both tillage systems. The difference was explained by the physical form and lower water-soluble P in solid poultry manure.

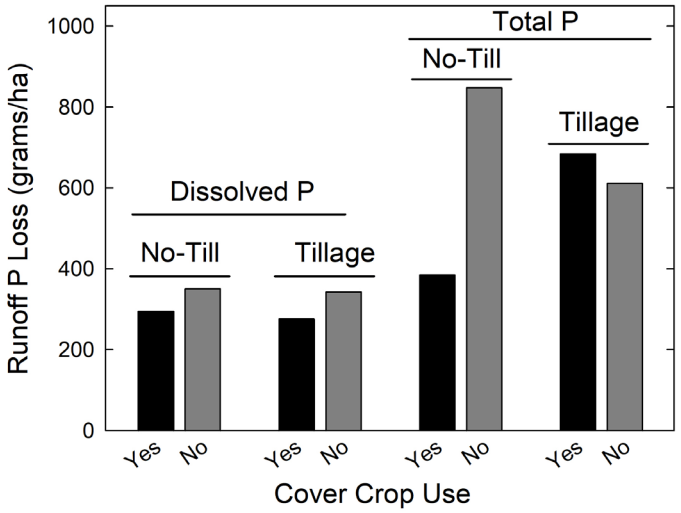

Figure 3. Effects of the tillage system and use of a cover crop on dissolved and total P loss with runoff.

A 5-year experiment with three replications was conducted in a field 5 km south of Ames using 12 small watersheds (1.5 to 3 acres) to study dissolved and total N and P losses with runoff as affected by cover crops (cereal rye or none) and tillage systems (no-till and chisel-plow/disk tillage) managed with corn-soybean rotations. Figure 3 shows average annualized results for P losses. The dissolved P loss was not affected by the tillage system but use of a cover crop slightly reduced losses. For total P, however, the cover crop drastically reduced the loss with no-till but slightly increased it with tillage. Moreover, the total P loss with no-till without the cover crop was larger than with tillage with or without the cover crop. Therefore, use of a cover crop is very useful mainly with no-till to reduce P loss.

A replicated study was conducted during 3 years at the Neal Smith National Wildlife Refuge in Jasper County under natural rainfall to evaluate prairie filter strips effects on dissolved and total P losses from small watersheds (0.5 to 3.2 ha) managed with no-till corn-soybean rotations. The prairie seed mixture included more than 20 species but the dominant species that persisted over time were Indiangrass, little bluestem, and big bluestem. The treatments were no filter strips (100% of the area with row crops), 10% of the area with a strip at the footslope, 10% with strips at the footslope and in contour strips upslope, and 20% of the area with a strip at the footslope and in contour strips upslope.

Figure 4 shows that the study confirmed results from the earlier research in that prairie filter strips results in a remarkable reduction of total P losses compared with 100% of the area managed with no-till corn and soybean. The dissolved P and total P loss reductions were almost identical for the three strips designs. However, the P loss reduction compared with 100% crop area was smaller for dissolved P and significantly larger for total P. On average, the dissolved P reduction was 55% whereas the total P reduction was 92%. The study demonstrated that using prairie strips in fields managed with no-till corn and soybean has a good potential to greatly reduce total P loss and lower but still significant potential to reduce dissolved P loss.

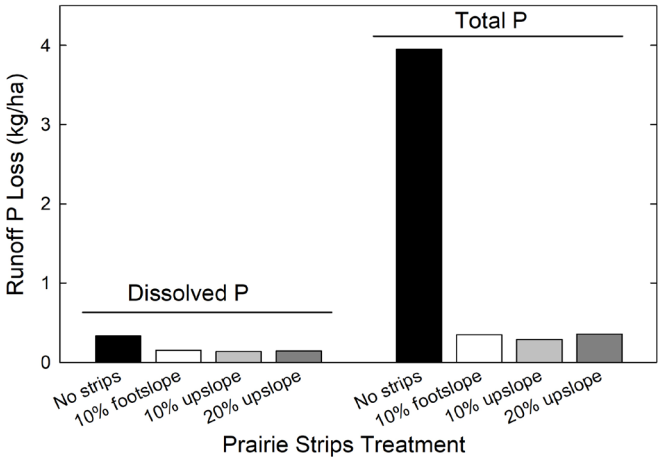

Figure 4. Effects of prairie filter strips on dissolved and total P loss with runoff for corn-soybean rotations managed with no-till.

Resources

Agricultural Phosphorus Management and Water Quality Protection in the Midwest: https://www.agronext.iastate.edu/soilfertility/info/RP189_N_Water.pdf

Previous proceedings – minimizing P loss from corn and soybean fields: https://www.agronext.iastate.edu/soilfertility/info/Runoff%20dissolved%20P%20ICM%20conf%202021%20article.pdf

Final project report – Reduction of Phosphorus and Sediment Loss with Surface Runoff by Prairie Filter Strips in Central Iowa Watersheds with Corn-Soybean Rotations: https://www.agronext.iastate.edu/soilfertility/info/Neal%20Smith%20P%202013-15%20Report.pdf

Science-Based Trials of Rowcrops Integrated with Prairie Strips: https://www.nrem.iastate.edu/research/STRIPS/