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Surface Runoff Characteristics from Claypan Soil in Southeastern Kansas Receiving Different Plant Nutrient Sources and Tillage

Abstract

Preliminary results show that two-year average total nitrogen (N) runoff losses and ortho-phosphorus (P) and total P runoff losses in the second year were greater with N-based turkey litter/no-till applications than P-based turkey litter or fertilizer-only applications. Incorporation of turkey litter applied based on N requirements resulted in N and P losses that did not differ from losses from P-based or fertilizer-only treatments. Chemical and statistical analyses of third-year samples will allow for final results and interpretation.

Keywords

fertilizer runoff, surface runoff, water quality, turkey litter, tillage

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Cover Page Footnote

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Surface Runoff Characteristics from Claypan Soil in Southeastern Kansas Receiving Different Plant Nutrient Sources and Tillage¹

D.W. Sweeney, P. Barnes², and G. Pierzynski³

Summary

Preliminary results show that two-year average total nitrogen (N) runoff losses and ortho-phosphorus (P) and total P runoff losses in the second year were greater with N-based turkey litter/no-till applications than P-based turkey litter or fertilizer-only applications. Incorporation of turkey litter applied based on N requirements resulted in N and P losses that did not differ from losses from P-based or fertilizer-only treatments. Chemical and statistical analyses of third-year samples will allow for final results and interpretation.

Introduction

Surface runoff losses of nutrients and sediments are significant threats to surface water quality. In the southeastern part of Kansas, the lack of underground aquifers and the dependence on surface water sources emphasizes the importance of the quality of surface waters to citizens of Kansas and states downstream. Increased fertilizer prices in recent years, especially noticeable when the cost of P spiked in 2008, have led U.S. producers to consider other alternatives, such as manure sources. The use of poultry litter as an alternative to fertilizer is of particular interest in southeastern Kansas because large amounts of poultry litter are imported from nearby confined animal feeding operations in Arkansas, Oklahoma, and Missouri. Incomplete information is available comparing relative nutrient losses in surface runoff following poultry litter applications to crop ground compared with using only commercial fertilizers. This is especially true for tilled soil compared with no-till, because production of most annual cereal crops on the claypan soils of the region is often negatively affected and is rarely improved by planting with no-tillage. The objectives of this study were to compare surface runoff losses of N and P nutrients and sediment from fertilizer and poultry litter and to determine the influence of tillage on nutrient and sediment losses in surface runoff from the use of fertilizer and poultry litter.

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Experimental Procedures

The experiment was conducted near Girard, KS, on the Greenbush Educational facility's grounds from spring 2011 through spring 2014. Individual plot size was 1 acre. A total of 10 plots comprising five treatments were replicated twice. The five treatments were:

1. Control – no N or P fertilizer or turkey litter – no tillage
2. Fertilizer only – commercial N and P fertilizer – chisel-disk tillage
3. Turkey litter, N-based – no extra N or P fertilizer – no tillage
4. Turkey litter, N-based – no extra N or P fertilizer – chisel-disk tillage
5. Turkey litter, P-based – supplemented with fertilizer N – chisel-disk tillage

Fertilizer and turkey litter were applied prior to planting grain sorghum each spring. Analyses were performed on the manure each season prior to application to obtain total N, $\text{NH}_4\text{-N}$, and $\text{NO}_3\text{-N}$. Organic N was assumed to be Total N – ($\text{NH}_4\text{-N}$ + $\text{NO}_3\text{-N}$). Potentially available N is assumed to be (1) 50% of organic N plus (2) 80 % of $\text{NH}_4\text{-N}$ (fraction that does not volatilize) plus (3) $\text{NO}_3\text{-N}$. Total P of the turkey litter was also determined and assumed to be all potentially available. Water flow was measured and samples were collected using a weir-water sampler (Teledyne Isco, Lincoln, NE). Composite samples were collected from each natural rainfall event that produced runoff from approximately early April to mid-November each year. In 2014, samples will be collected from early April to mid-June to determine carryover effects from the third year of application. All water samples were analyzed for sediment, total P, soluble P, ammonium, nitrate, and total N concentrations by standard methods.

Results and Discussion

Because of the highly variable nature of this field-scale project, final results will be presented after collection of three years of data so that flow-weighted concentrations and total losses as affected by treatments can be statistically analyzed and presented. However, two-year results for annual N and P losses from the period from litter and fertilizer application in June 2011 to just prior to application in June 2013 show preliminary observations. Average annual losses of $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and sediment were unaffected by treatment (Figure 1). Average annual total N losses were greater in the N-based turkey litter/no-till treatment with no differences in total N loss from the other treatments (Figure 2). Ortho-P losses (Figure 3) accounted for approximately 70% of the total P loss (Figure 4), and both were affected by a treatment \times year interaction. Ortho- and total P losses were statistically unaffected by treatment in the first year, but P loss in the second year from the N-based turkey litter/no-till treatment was more than twice that from the other treatments. During the first two years of this study, incorporation of the high rate, N-based turkey litter resulted in annual N (Figures 1 and 2) or P losses (Figures 3 and 4) that did not differ from losses from treatments receiving a lower rate, P-based turkey litter application or only fertilizer.

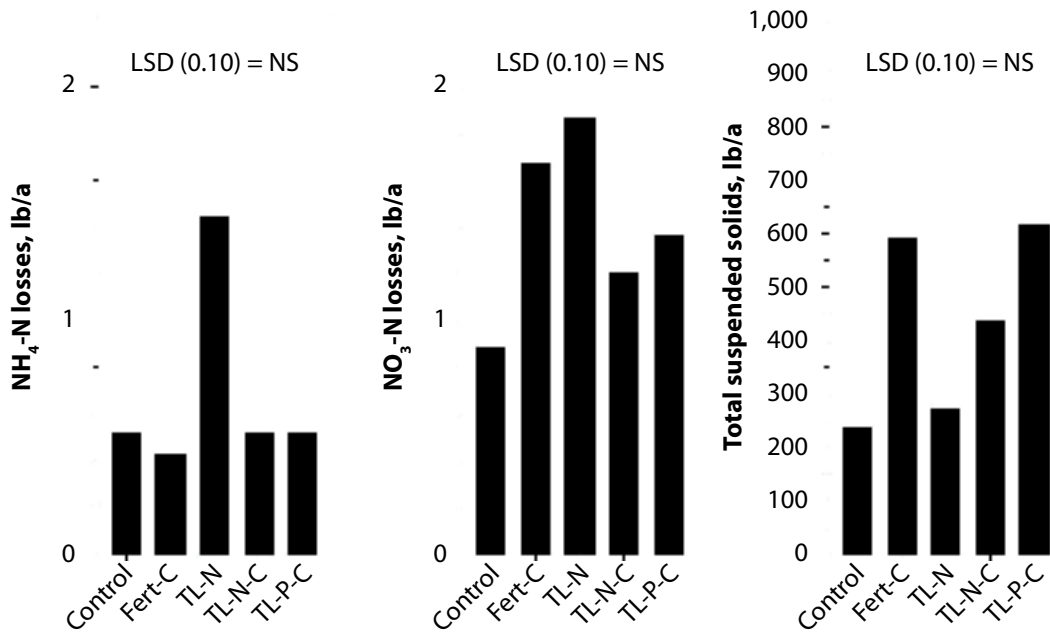


Figure 1. Two-year average $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and total suspended solids losses from claypan soil receiving turkey litter and/or fertilizer. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: Nitrogen-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: Phosphorus-based turkey litter and supplemental N application incorporated with conventional tillage.

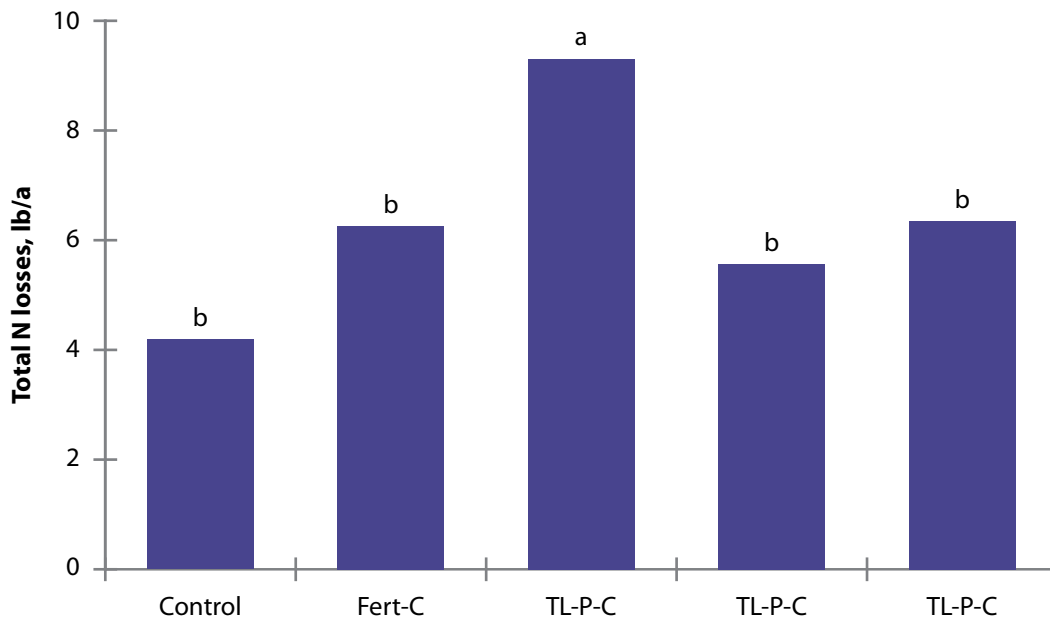


Figure 2. Two-year average total nitrogen (N) losses from claypan soil receiving turkey litter and/or fertilizer. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at $P = 0.10$ according to the LSD test.

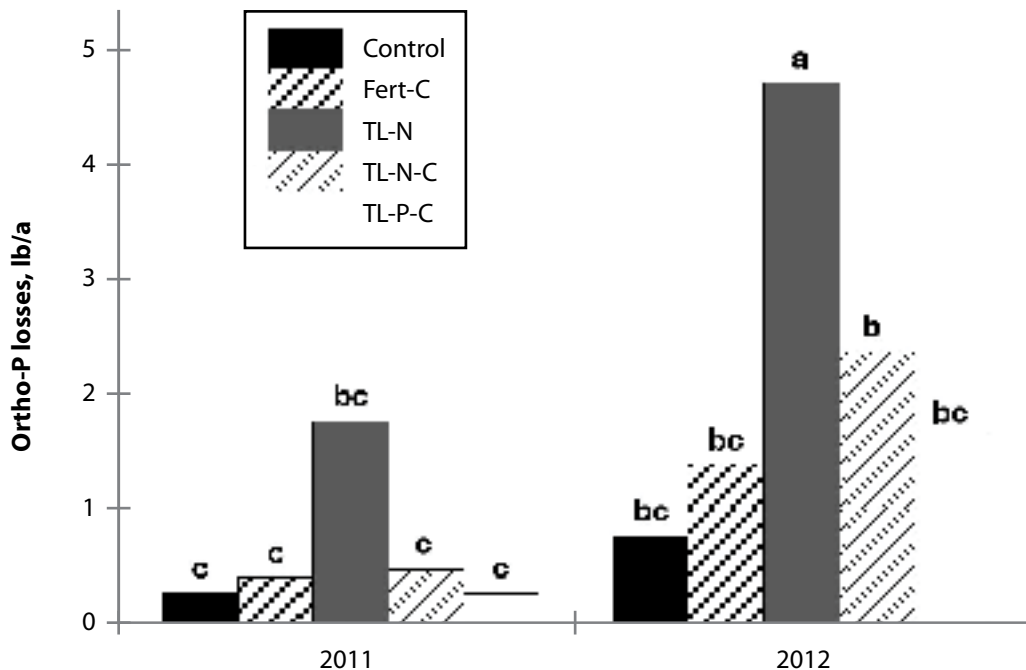


Figure 3. Ortho-phosphorus (P) losses from claypan soil receiving turkey litter and/or fertilizer in 2011 and 2012. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at $P = 0.10$ according to the LSD test.

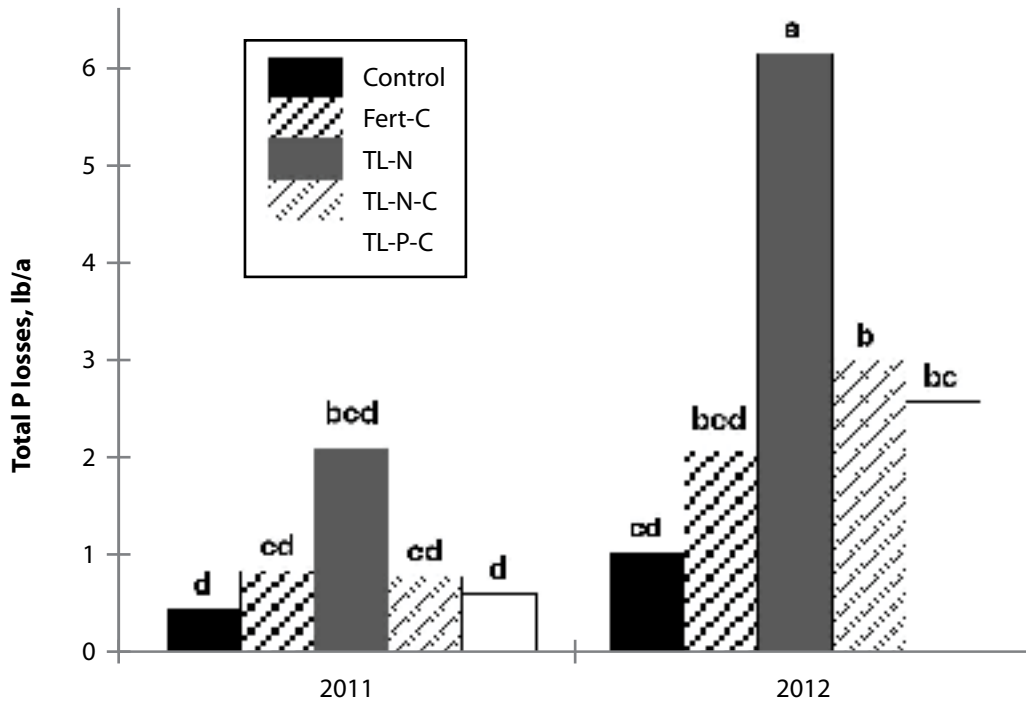


Figure 4. Total phosphorus (P) losses from claypan soil receiving turkey litter and/or fertilizer in 2011 and 2012. Control: no fertilizer or turkey litter application with no tillage. Fert-C: commercial fertilizer only incorporated with conventional tillage. TL-N: N-based turkey litter application with no tillage. TL-N-C: N-based turkey litter application incorporated with conventional tillage. TL-P-C: P-based turkey litter and supplemental N application incorporated with conventional tillage. Bars with the same letter are not statistically different at $P = 0.10$ according to the LSD test.