

Response of Soybean Grown on a Claypan Soil in Southeastern Kansas to the Residual of Different Plant Nutrient Sources and Tillage¹

D.W. Sweeney, P. Barnes,² and G. Pierzynski³

Summary

The residual from previous high-rate turkey litter applications, which were based on nitrogen (N) requirements of the previous grain sorghum crop, increased 2018 soybean yield more than that obtained from the residual of phosphorus (P)-based turkey litter applications (low rate), commercial fertilizer, or the control. Even though early soybean growth was sporadically affected by residual treatments, the dry matter production at the R6 growth stage tended to be where the N-based litter was applied.

Introduction

Increased fertilizer prices in recent years—especially noticeable when the cost of phosphorus spiked in 2008—have led U.S. producers to consider other alternatives, including 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. Annual application of turkey litter can affect the current crop, but information is lacking concerning any residual effects from several continuous years of poultry litter applications on a following crop. 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 by no-till planting. The objective of this study was to determine if the residual from fertilizer and poultry litter applications under tilled or no-till systems affects soybean yield and growth.

Experimental Procedures

A water quality experiment was conducted near Girard, KS, on the Greenbush Educational facility's grounds from spring 2011 through spring 2014. Fertilizer and turkey litter based on rates of 120 lb N/a and 50 lb P₂O₅/a were applied prior to planting grain

¹Partially funded by U.S. Department of Agriculture Natural Resource Conservation Service Conservation Innovation Grant.

²Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS.

³Department of Agronomy, Kansas State University, Manhattan, KS.

sorghum each spring. Individual plot size was 1 acre. The five treatments, replicated twice, 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; and
5. Turkey litter, P-based: supplemented with fertilizer N – chisel-disk tillage.

Starting in 2014 after the previously-mentioned study, soybean was planted with no further application of turkey litter or fertilizer. Prior to planting soybean, tillage operations were done in appropriate plots as in previous years. A sub-area of 20 × 20 ft near the center of each 1-acre plot was designated for crop yield and growth measurements. Samples were taken for dry matter production at V3-V4 (approximately 3 weeks after planting), R2, R4, and R6 growth stages. Yield was determined from the center 4 rows (10 × 20 ft) of the sub-area designated for plant measurements in each plot.

Results and Discussion

In 2018, the residual effects of turkey litter and fertilizer amendments affected soybean yield, stand, pods/plant, and dry matter production (Table 1). The two treatments which had previously received a high application rate of turkey litter based on N requirements, regardless of tillage system, resulted in greater yields than from plots that had received low rates of turkey litter (P-based), commercial fertilizer, or no fertilizer N or P. The number of pods/plant were greater where N-based turkey litter had been applied in no-till than where fertilizer, a low rate of turkey litter, or no fertilizer or litter had been applied. In addition, stand was slightly improved where fertilizer or the high rates of turkey litter had been applied. The effect of residual treatments on soybean dry matter production was sporadic. However, by R6, dry matter production was greater where turkey litter had previously been applied on an N-basis (high rate) than on a P-basis (low rate), with dry matter from the fertilizer treatment being intermediate.

Table 1. Residual effect of turkey litter and fertilizer amendments on soybean yield, yield components, and dry matter production during 2018

Residual amendment ¹	Yield	Stand (×1000)	Seed weight	Pods/ plant	Seeds/ pod	Dry matter			
						V3	R2	R4	R6
	bu/a	plants/a	mg			----- lb/a -----			
Control	25.5	96	143	33	2.0	60	790	2410	3530
Fert-C	41.3	102	150	3743	2.2	100	1440	2900	5150
TL-N	59.8	100	138	5160	2.2	100	1300	2830	6440
TL-N-C	63.0	103	146	4353	2.2	110	2370	4200	6530
TL-P-C	33.9	96	157	3134	2.0	80	1190	2570	3870
LSD (0.05)	15.6	4	NS	13	NS	NS	760	NS	1600

¹Control, no turkey litter or N and P fertilizer with no 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 application and supplemental N application incorporated with conventional tillage; and Fert-C, commercial fertilizer incorporated with conventional tillage.