

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

D.W. Sweeney, P. Barnes,¹ and G. Pierzynski²

Summary

The residual from previous high-rate turkey litter applications, which were based on nitrogen (N) requirements of the previous grain sorghum crop, increased 2019 soybean yield more than that obtained from the residual of phosphorus (P)-based turkey litter applications (low rate) or the control. Even though early soybean growth was unaffected by residual treatments, the dry matter production at the R6 growth stage was greater with N-based litter application than with P-based applications or the control.

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

Previous to this study, a water quality experiment was conducted near Girard, KS, on the Greenbush Educational facility's grounds from spring 2011 through spring 2014. Those treatments, listed below, were fertilizer and turkey litter applications based on 120 lb N/a and 50 lb P₂O₅/a rates applied prior to planting grain sorghum each spring. Individual plot size was 1 acre. The five treatments, replicated twice, were:

¹ Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS.

² Department of Agronomy, Kansas State University, Manhattan, KS.

1. Control: no N or P fertilizer or turkey litter—no tillage;
2. Fert-C: commercial N and P fertilizer only—chisel-disk tillage;
3. TL-N: N-based turkey litter, no extra N or P fertilizer—no tillage;
4. TL-N-C: N-based turkey litter, no extra N or P fertilizer—chisel-disk tillage; and
5. TL-P-C: P-based turkey litter, 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. Soybean was planted on June 7, 2019, and harvested on October 28, 2019. Whole plant samples were taken on June 28 (V4), July 24 (R2), August 19 (R4), and September 23 (R6), 2019.

Results and Discussion

In 2019, the residual from previous high rate turkey litter applications, which were based on N requirements of the previous grain sorghum crops grown from 2011 through 2013, increased 2019 soybean yield compared to that obtained from the residual of P-based turkey litter applications (low rate) or the control (Table 1). The soybean yields with the Fert-C treatment were less than TL-N, but were not statistically different than TL-N-C. The number of pods/plant were greater where N-based turkey litter had been applied in no-till than where a low rate of turkey litter or no fertilizer or litter had been applied. The effect of residual treatments on soybean dry matter production was non-significant through most of the growing season. 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) or the no-N/no-P control, with dry matter from the Fert-C treatment being intermediate.

Acknowledgment

This work is supported by the U.S. Department of Agriculture National Institute of Food and Agriculture, Hatch project KS00-0104-HA; and partially funded by a U.S. Department of Agriculture Natural Resource Conservation Service Conservation Innovation Grant.

Table 1. Residual effect of turkey litter and fertilizer amendments on soybean yield, yield components, and dry matter production during 2019

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	31.3	87.0	151	50	2.2	100	970	2280	5460
Fert-C	46.7	89.1	143	77	2.2	70	710	2780	8090
TL-N	59.3	88.9	155	76	2.1	90	1030	4610	9120
TL-N-C	56.9	86.6	152	91	2.1	80	690	3340	9440
TL-P-C	41.1	86.5	151	62	2.1	100	860	3280	5500
LSD (0.10)	10.3	NS	NS	21	NS	NS	NS	NS	2650

¹Control = no turkey litter or N and P fertilizer with no tillage.

Fert-C = commercial fertilizer 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 application and supplemental N application incorporated with conventional tillage.