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

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Abstract

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.

Keywords

Soybean, turkey litter, fertilizer, residual, tillage

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Cover Page Footnote

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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 2017 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 marginally affected by residual treatments, the greatest dry matter production at the R6 growth stage was where the N-based litter had been applied and incorporated.

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

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litter were applied prior to planting grain sorghum each spring. Individual plot size was 1 acre. The five treatments, replicated twice, were:

- Control – no N or P fertilizer or turkey litter – no tillage;
- Fertilizer only – commercial N and P fertilizer – chisel-disk tillage;
- Turkey litter, N-based – no extra N or P fertilizer – no tillage;
- Turkey litter, N-based – no extra N or P fertilizer – chisel-disk tillage; and
- 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 2017, the residual effects of turkey litter and fertilizer amendments affected soybean yield, pods/plant, and seeds/pod (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 and the number of seeds/pod were greater where N-based turkey litter had been applied than in the other residual treatments. Dry matter production was marginally affected by residual treatment through the R4 growth stage. However, at R6, dry matter production was greatest where turkey litter had previously been applied on an N-basis (high rate) and incorporated.

Table 1. Residual effect of turkey litter and fertilizer amendments on soybean yield, yield components, and dry matter production during 2017

Residual amendment ¹	Yield bu/a	Stand (× 1000) plants/a	Seed weight mg	Pods/ plant	Seeds/ pod	Dry matter			
						V4	R2	R4	R6
						----- lb/a -----			
Control	22.7	122	143	30	2.0	440	1420	4130	3830
Fert-C	45.1	123	155	37	2.1	530	2360	5380	5760
TL-N	64.0	115	174	51	2.3	560	2920	5950	5540
TL-N-C	62.5	125	177	43	2.4	570	3300	5830	7650
TL-P-C	40.2	118	154	31	2.1	520	2290	4840	5460
LSD (0.05)	15.6	NS	NS	9	0.1	NS	1110	NS	1070

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.