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Compaction from Manure Tanker and Tillage Effects on Corn and Soybean Production

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Abstract
Livestock feeding operations generate manure that contains plant nutrients useful for crop production. But, as the size of individual livestock operations has increased, so has the size of manure application equipment. Axle loads can exceed 10 tons with larger agricultural implements, including manure tankers. Although fertilizer nutrients within manure aid crop production, such loads can compact soil, thereby affecting crop rooting and, ultimately, yield. This experiment was designed to measure effects of compaction from manure tankers on crop yield. Over a period of three years (1999–2001), each spring, soil was compacted with a manure tanker having a full 6,000 gallon tank; then, each fall, corn and soybean yields were measured to determine effects of compaction on both fall chisel and no-till tillage systems.

Disciplines
Agricultural Science | Agriculture

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Introduction

Livestock feeding operations generate manure that contains plant nutrients useful for crop production. But, as the size of individual livestock operations has increased, so has the size of manure application equipment. Axle loads can exceed 10 tons with larger agricultural implements, including manure tankers. Although fertilizer nutrients within manure aid crop production, such loads can compact soil, thereby affecting crop rooting and, ultimately, yield. This experiment was designed to measure effects of compaction from manure tankers on crop yield. Over a period of three years (1999–2001), each spring, soil was compacted with a manure tanker having a full 6,000 gallon tank; then, each fall, corn and soybean yields were measured to determine effects of compaction on both fall chisel and no-till tillage systems.

Materials and Methods

The experimental layout was a randomized complete block for both corn and soybean. The two tillage treatments were fall chisel (fall chisel, spring field cultivate, plant) and no-till. Three compaction treatments were used: 1) compaction every year, 2) compaction only the first year, and 3) no compaction. Compaction was accomplished using a 6,000 gallon manure tank filled with water, approximately four weeks before corn and soybean planting. The entire soil surface within each plot was wheel-tracked. The tank had a tandem axle with 28L × 26 tires inflated to 32 psi on each of the four wheels. Total tank weight of 54,020 pounds was split approximately between the two axles. Total tractor weight, including tongue–hitch weight of the tanker, was 27,440 pounds. Two replications of the tillage treatments were perpendicular to three replications of the compaction treatments. Dates of compaction, planting, and harvest are listed in Table 1.

Results and Discussion

Yields of corn and soybean as affected by compaction are shown in Table 2. Results probably are overstated for compaction effects from fall application because compaction occurred in the spring before planting and because the entire soil surface was compacted, rather than just the areas between rows. From annual compaction, soybean yield consistently was depressed approximately 4 bushels/acre. Yields one year and two years after compaction were depressed 1.5 and 2 bushels/acre, respectively. Corn yields were not consistently affected by compaction. In two of four cases when compaction occurred in the year of yield measurement, corn yield was numerically greater in compacted than in control plots.

Yields of corn and soybean trended higher in the fall tillage treatment than in the no-till treatment (Table 3). With only two replications, however, statistical differences generally were not present because background variability from plot-to-plot was high. No-till yields may have been somewhat reduced in two years because of environmental factors. Ground squirrel damage caused re-planting of corn in one of the no-till replications. In 2001, cornstalks were moderately lodged at harvest in one of the no-till replications. Final corn populations do not seem to be affected by either tillage or compaction (Table 4).

Table 1. Dates of compaction, planting, and harvest of Kanawha, IA, compaction experiment.

		Planting		Harvest	
Year	Compaction	Corn	Soybean	Corn	Soybean
1999	March 26	May 10	May 10	October 9	September 25
2000	March 14	April 27	April 27	September 29	September 21
2001	April 19	April 27	April 27	October 17	October 1

Table 2. Yields of corn and soybean as affected by compaction in Kanawha, IA, compaction experiment.

	Corn				Soybean			
Year	Ea Yr	Once	None	$LSD_{0.05}$*	Ea Yr	Once	None	$LSD_{0.05}$
	-----------------bu/a------------------				-----------------bu/a------------------			
1999	161	165	164	NS[†]	51.9	52.9	55.1	1.2
2000	151	156	158	NS	56.4	58.6	60.1	1.4
2001	152	145	149	NS	43.1	45.2	47.2	2.0

* Least significant difference at P = 0.05 level.
[†] Differences are not statistically significant.

Table 3. Yields of corn and soybean as affected by tillage in Kanawha, IA, compaction experiment.

	Corn			Soybean		
Year	FT	NT	$LSD_{0.05}$*	FT	NT	$LSD_{0.05}$
	-----------------bu/a-------------------			-----------------bu/a-------------------		
1999	172	155[†]	NS[‡]	54.5	52.1	NS
2000	160	150	3	59.2	57.5	NS
2001	156	140[§]	NS	47.9	42.4	NS

* Least significant difference at P = 0.05 level.
[†] Replanting from ground squirrel damage in one block lowered yield.
[‡] Differences are not statistically significant.
[§] Cornstalks were moderately lodged in one block.

Table 4. Final corn population in Kanawha, IA, compaction experiment, plants/acre.

	Tillage			Compaction			
	FT	NT	$LSD_{0.05}$*	Ea Yr	Once	None	$LSD_{0.05}$
1999	24,800	24,100	NS[†]	24,100	24,600	24,700	NS
2000	24,700	25,700	NS	25,000	25,500	25,200	NS
2001	24,800	24,100	NS	24,500	24,300	24,600	NS

* Least significant difference at P = 0.05 level.
[†] Differences are not statistically significant.