Impact of Manure Source and Application Rates on Nutrient Losses from Three One-Acre Inch-Simulated Rainfall Events

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Introduction

- Phosphorus (P) transport from agricultural lands receiving animal manure is an ongoing water quality concern.
- Manure differs in physical and chemical characteristics such as nutrient content, moisture, presence or absence of bedding material, and density.
- There has been less investigation on how manure source and their application rates affect runoff volume, soil and nutrient losses primarily nitrogen (N) and P, during runoff

Objectives

- To determine the application rate effect of swine liquid manure (SLM) and broiler litter (BL) in conventionally tilled soil from a series of three one-acre inch-simulated rainfall events on
- A) Runoff volume
- B) Sediment losses
- C) Phosphorus and nitrogen losses

Materials and Methods

- Surface soil (Decatur silty clay loam; 0-0.06 m) was collected from a farm in North Alabama managed under a corn – wheat-soybean rotation.
- The soil was dried, homogenized, and packed in portable tray (0.55 x 0.30 x 0.06 m^3) at bulk density of (1.22 gcm^{-3})
- **Broiler litter (BL)** was applied at **62, 124, 186, and 249 kg P ha^{-1}** corresponding to a field application rate of 2.2, 4.5, 6.7, and 8.9 Mg ha^{-1}
- **Swine liquid manure (SLM)** was applied at **5, 9, 14, and 18 kg P ha^{-1}** corresponding to application rate of 47, 94, 140, and 187 kL ha^{-1}.
- A control with no manure application was also included. Each treatment was replicated three times for a total of 30 trays.
- Three successive 1 acre-inch rainfall was applied at **7, 14, and 21 days** after manure application using a rainfall simulator (Fig1).
- Runoff water was collected at each rain event and volume was recorded.
- A subsample of runoff water was used for determination of Total suspended solid (TSS), NO_3-N and NH_4-N, DRP, and TP using standard protocols.
- Load = runoff volume x nutrient concentrations.

Results and Discussion

Fig. 1: Rainfall simulator used in the study

Table 1: Soil chemical properties

Soil properties	Units			
Organic matter	%		2.7	
Soil pH (1:1)			5.0	
Total P	µg/g soil		400	
KCl extractable NH_4^+	µg/g soil		9.0	
KCl extractable NO_3^-	µg/g soil		45	
Extractable Nutrients		Morgan	Mehlich-1	Mehlich-3
Extractable P	µg/g soil	2.0	23	52
Extractable K	µg/g soil	93	132	193
Extractable Ca	µg/g soil	809	675	1063
Extractable Mg	µg/g soil	47	47	49
Extractable Al	µg/g soil	46	97	938
Extractable Fe	µg/g soil	1.0	3.0	92

Table 2: Manure analysis

Manure product	pH	Moisture content	Total C	Total N	Total P	Total K	Total Ca	Total Mg	Total S
		%							
Poultry litter	6.5	25	41	3	2.6	3.3	4	1	2
Swine manure	7.5	100	1.2	0.03	0.02	0.05	0.01	0.01	<0.01

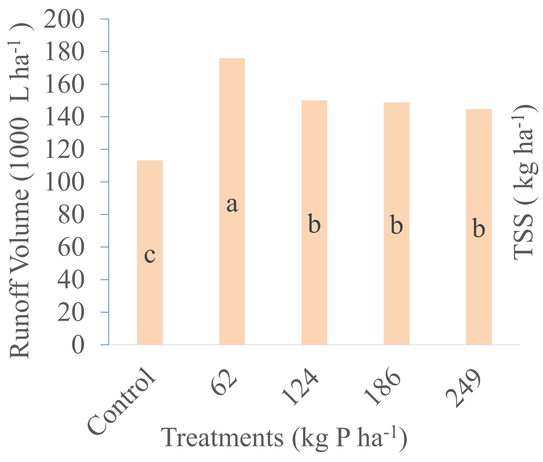

Fig. 2: Effect of BL rate on runoff volume

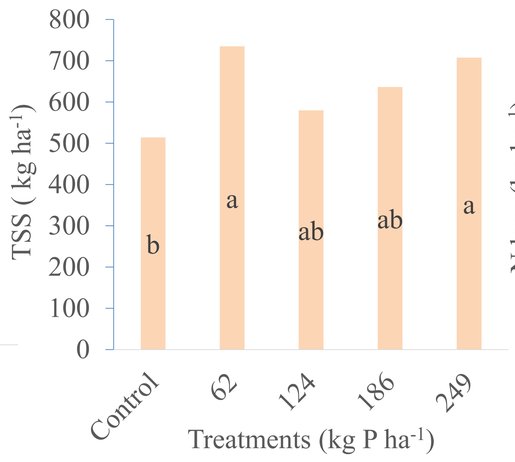

Fig. 3: Effect of BL rate on soil loss

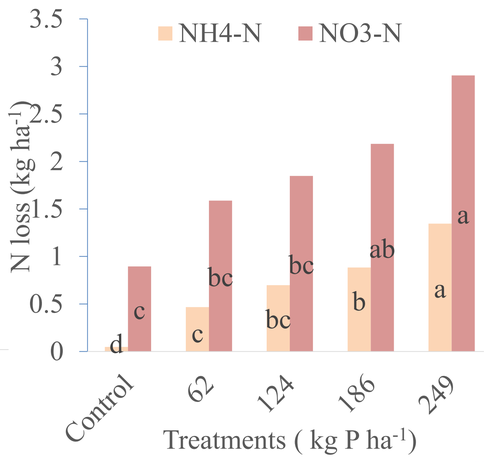

Fig. 4: Effect of BL rate on nitrogen loss

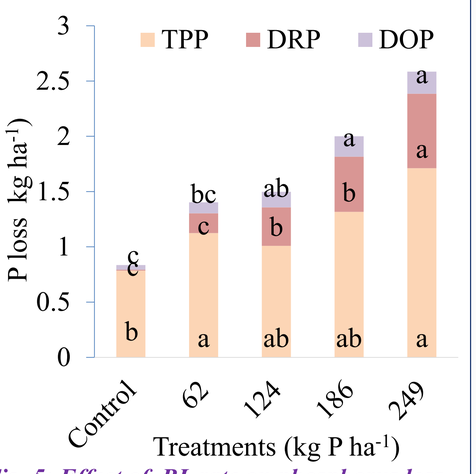

Fig. 5: Effect of BL rate on phosphorus loss

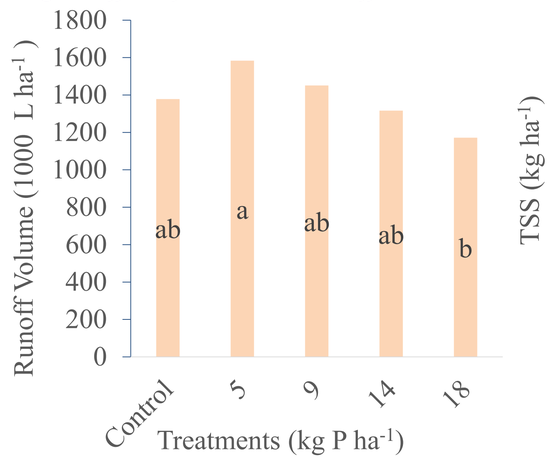

Fig. 6: Effect of SLM rate on runoff volume

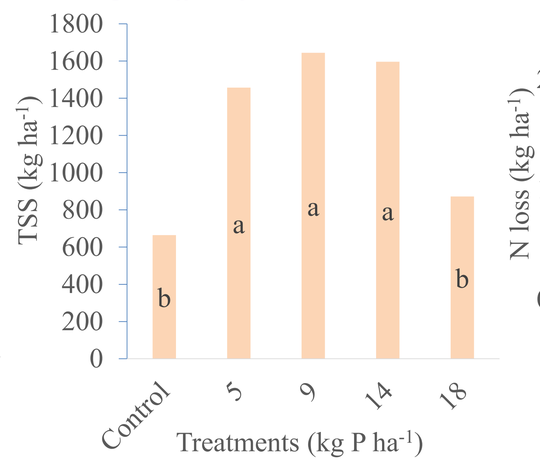

Fig. 7: Effect of SLM rate on soil loss

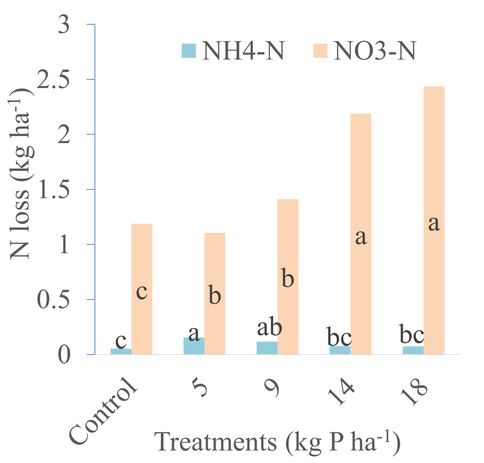

Fig. 8: Effect of SLM rate on nitrogen loss

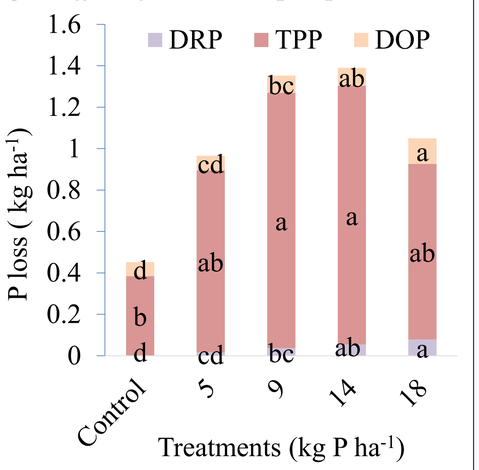

Fig. 9: Effect of SLM rate on phosphorus loss

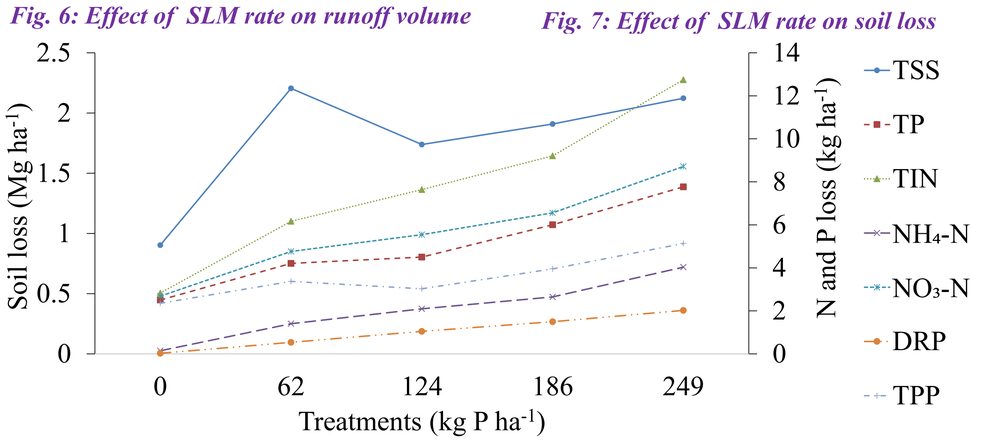

Fig. 10: Effect of BL rate on cumulative soil and nutrient losses over three acre–inch rain

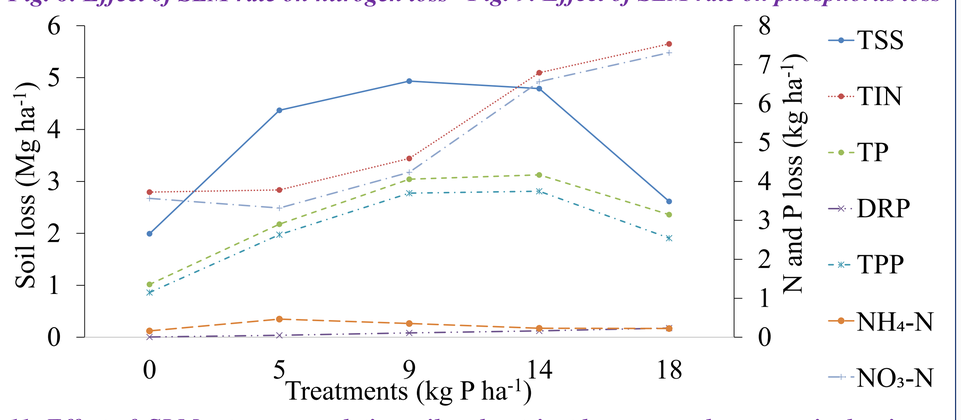

Fig. 11: Effect of SLM rate on cumulative soil and nutrient losses over three acre–inch rain

- There was a significant effect (P<0.05) of BL and SLM application rate on runoff volume, soil and nutrient losses.
- Soil losses increased with increase in application rate, however losses declined with greater application rate for both BL and SLM (*Fig. 3 &7*).
- BL application increased runoff volume whereas SLM did not affect the runoff volume. Runoff volume was nine folds greater in SLM compared to BL.
- Nitrate-N loss was greater than NH^4-N for both BL and SLM (*Fig. 4 &8*).
- Particulate P was the primary P species in runoff water followed by DRP and DOP for both BL and SLM (*Fig. 5 &9*).
- Cumulative N and P losses increased with increasing rate of BL application whereas no consistent pattern was found in SLM.
- Cumulative soil losses was greater in SLM than BL (*Fig. 10 & 11*).

Acknowledgment

This research was supported by USDA-NRCS-ENTSC (Agreement No. NR2174820002C001), U.S. Department of Agriculture- Agricultural Research Service (Agreement No. 58-6010-9-011)