PUBLICATIONS

1996

Forage Research in Texas, 1996

EFFICIENT AND SAFE UTILIZATION OF ANIMAL WASTE ON PASTURE

G. W. Evers, M. A. Sanderson, D. S. Doctorian, and R. M. Jones

Summary

Applying 6 tons/acre of poultry litter (PL) in April or October or splitting between the two seasons did not effect annual production of a ryegrass-bermudagrass forage system at Overton. Autumn application did enhance ryegrass growth which improved early forage production. Including clover in the pasture system added to early forage production but suppressed bermudagrass yields during the summer. Applying 75 lbs N and 50 lbs K/acre after each harvest (annual total 450 lbs N and 300 lbs K/acre) only increased yields 3000 to 4000 lbs dry matter (DM)/acre. At Stephenville, there was little response by a bermudagrass-wheat system to spring or fall-applied solid dairy manure. Adding 75 lbs of N after each harvest to supplement manure increased yields four fold. The limited response to dairy manure was probably because of limited mineralization of N.

Introduction

Economics of scale have caused an increase in large confined animal feeding operations, such as broiler production and dairy operations. Animal waste generated in these high animal density feeding operations is usually applied to agricultural land as fertilizer. Because animals use only a small portion of the nutrients they ingest, from 60% to 99% of these ingested nutrients are excreted in the urine and feces (Haynes and Williams, 1993). Advantages of animal waste compared with commercial fertilizer are (1) it contains other nutrients besides N, P, and K that are necessary for plant growth; (2) it adds organic matter to the soil which improves soil structure and water and nutrient holding capacity; (3) release of soluble nutrients such as N, K, S, and B are slower from organic matter than commercial fertilizer, which reduces the chance of loss by leaching; (4) it contains Ca which reduces soil acidity; and (5) nutrient cost may be less than commercial fertilizer (Evers et al., 1995). However, the disadvantages of using animal waste as fertilizer are (1) nutrient content is variable and unknown unless analyzed; (2) high application

Keywords: animal waste / poultry litter / pasture

rates (2-8 tons/acre for poultry litter and 10 to 20 tons/acre for dairy manure) because of low nutrient concentration make long distance hauling uneconomical; (3) odor problems after land application; and (4) nutrient concentration in animal waste may not match crop requirements. Soil phosphorus buildup has been a particular problem. The phosphorus (P_2O_5) level in poultry litter usually exceeds the nitrogen concentration. However, warm-season perennial grasses such as bermudagrass (*Cynodon dactylon* [L.] Pers.) have a N-P_2O_5-K_2O ratio requirement of about 4-1-3 (Evers et al., 1995). Therefore, only a maximum of 25% of phosphorus is ever utilized by the warm-season perennials grass. Repeated applications of animal waste results in a soil P buildup which can cause environmental problems (Sharpley et al., 1993). Clover could serve a dual role in reducing soil phosphorus buildup. Limited soil nitrogen would not prevent legumes from removing phosphorus and other minerals. Secondly, legumes can provide additional nitrogen to the pasture system through N_2-fixation which would enhance grass production to remove more phosphorus (Evers, 1985).

Studies were initiated at Overton with PL and Stephenville with solid dairy waste. Objectives were to study the effect of waste application time on forage production and distribution and the consequences of applying additional nitrogen and potassium fertilizer or adding clover to the pasture system.

Procedure

Overton. The study was begun in October, 1993, on an established 'Coastal' bermudagrass sod overseeded with 'TAM 90' ryegrass (*Lolium multiflorum* L.) at 25 lbs/acre in 7-in. drill rows. Six tons per acre of broiler PL were surface applied either in October or April or split between the two dates. Amount of nutrients applied are reported in Table 1. The amount of nutrients applied the second year at different times is not consistent because different lots of PL were used for the autumn and spring applications. Phosphorus and potassium are reported as elements and fertilizer grade. Each of these treatments was duplicated and fertilized with 75 lbs N and 50 lbs K_2O per acre after each harvest, except the last. Two additional treatments were planting crimson clover (*Trifolium incarnatum* L.) at 20 lbs/acre with the ryegrass with PL applied in October or April.

Experimental design was a complete randomized block with four replications. Plots were 10 x 20 ft with 5 ft alleyways between plots and replications. A 4 x 20 ft strip was harvested from the center of each plot with a sickle bar harvester monthly from March to October, 1994, and January to September, 1995. A subsample of the harvest forage was hand separated to determine botanical composition and then dried to calculate dry matter percentage. Data analysis was with PC-SAS and mean separation by Waller-Duncan Multiple Range Test (SAS Institute, 1987).

Stephenville. The study was started in May 1994 on an established Coastal bermudagrass sod. Solid dairy manure was applied on 17 May 1994, 21 October 1994 and 25 April 1995. Sufficient manure was applied to result in 300 lbs N per acre equivalent applied all in spring (Treatment 1), all in fall (Treatment 2), or split equally between spring and fall (Treatment 3). However, because of variability in manure composition in spring and fall of each year, the total amount of N applied in manure was unequal among treatments (Table 2). Each of the manure treatments was duplicated and fertilized with 75 lbs N per acre after each harvest. In 1994, N was applied on 9 June and 31 August to bermudagrass and 10 November to the overseeded wheat. In 1995, an additional 50 lbs of N was applied to the wheat on 17 February and 75 lbs N was applied to bermudagrass on 25 April, 2 June, and 29 August. Plots were overseeded with 'Wintex' winter wheat in October 1994 at 85 lbs/acre in 10-in. drill rows.

Plots were 10 ft by 20 ft and separated by a 5-ft buffer strip. Treatments were arranged in a randomized complete block design with four blocks. Blocks were separated by a 10-ft alley. A 2.83 by 20-ft strip was harvested from the center of each plot four times in 1994 and five times in 1995. Winter wheat was harvested on 25 April 1995.

Results and Discussion

Overton. Time of PL application had a major influence on ryegrass production in 1994 (Table 3). Ryegrass production was twice as great when PL was applied in autumn than in spring. Splitting the PL into autumn and spring applications resulted in intermediate ryegrass yields. Adding N and K fertilizer with the PL increased ryegrass yields but not significantly within PL application dates. Adding clover to the spring PL treatment increased ryegrass yields 80% which was probably due to the additional N provided by the clover. Adding clover to the autumn PL treatment increased ryegrass yields only 25% because of the available N from the PL. Clover yield was less in the autumn PL treatment because of increased ryegrass competition for light and moisture.

Timing of PL application or splitting in two applications vs one, had no effect on bermudagrass yields (Table 3). Applying N and K fertilizer increased bermudagrass yields 23% to 40%, but it was significant only when PL was applied in the spring or split between spring and autumn. Bermudagrass production was suppressed following a clover-ryegrass mixture. Adding N and K fertilizer increased total forage production by 3000 to 4000 lbs dry matter/acre. Utilization of the 450 lbs N ranged from 5.4 to 9.6 lbs dry matter/lb N fertilizer applied. About 60% of the N in PL is available the first year (Payne and Donald, 1990). Treatments receiving PL and commercial fertilizer received approximately 600 lbs N/acre. Nitrogen utilization efficiency for 400 lbs N/acre by bermudagrass is 12 to 16 lbs DM/lb N for this area (Evers et al., 1995). Although the ryegrass and bermudagrass responded to the commercial fertilizer, the increased yield was not enough to cover fertilizer costs.

Ryegrass yields in 1995 were double those in 1994 because of above average winter temperatures (Table 4). However, the ryegrass responses to treatments were similar. Higher ryegrass production occurred when N and K fertilizer was added and when PL was applied in the autumn, regardless of commercial fertilizer or clover treatment. As in 1994, clover yields were higher in the spring applied PL treatment because of less ryegrass competition. The combined ryegrass-clover production was always greater than ryegrass alone for similar PL application times.

Bermudagrass production in 1995 was 40% to 50% less than it was in 1994 because of poor moisture conditions from July to October. Adding N and K fertilizer increased bermudagrass production, especially when PL was applied in autumn or was split. In 1995, applying PL in the spring, with or without fertilizer, produced higher bermudagrass yields than applying PL in the autumn. As in 1994, total forage production was influenced by adding N and K fertilizer.

<u>Stephenville</u>. Forage yields were low from the plots that received only dairy manure in 1994 and 1995 (Table 5). This probably resulted from limited mineralization of nitrogen in the manure. Applying 75 lbs N/acre after each harvest greatly increased forage yield. Applying all manure in the spring along with supplemental N fertilizer resulted in the highest forage yields. Bermudagrass forage yields were much higher in 1995 than 1994 because only 150 lbs commercial N fertilizer was applied in 1994, whereas in 1995, 275 lbs commercial N was applied. Even though the amounts of N applied in manure among treatments were different

(Table 6), the forage yields were relatively similar (Table 5). This indicates that the bermudagrass and wheat were using mostly inorganic N from commercial fertilizer and the N in manure was mostly unavailable.

Literature Cited

Evers, G. W. 1985. Forage and N contributions of arrowleaf and subterranean clovers overseeded on bermudagrass and bahiagrass. Agron. J. 77:960-963.

Evers, G. W., J. L. Gabrysch, and J. M. Moran. 1995. Use of poultry litter as fertilizer on Coastal bermudagrass pasture. p. 133-138. Forage Research in Texas, 1994. Texas Agric. Exp. Stn. CPR-5252.

Haynes, R. J. and P. H. Williams. 1993. Nutrient cycling and soil fertility in the grazed pasture ecosystem. Adv. Agron. 49:119-199.

Payne, V.W.E. and J. O. Donald. 1990. Poultry: Waste management and environmental protection
manual. Alabama Coop. Ext. Ser. Circ. ANR-580.

SAS Institute. 1987. SAS/STAT Guide for personal computers, version 6 edition. Cary, NC.
Sharpley, A. N., T. C. Daniel, and D. R. Edwards. 1993. Phosphorus movement in the landscape. J. Prod. Agric. 6:492-500.

Table 1. Amounts of nutrients applied in 6 tons/acre of broiler poultry litter at Overton from October 1993 to September 1995.

Nutrient	Oct 93 - Sept 94 all treatments	Oct 94 - Sept 95 autumn	spring	split
	---------------------------------	lbs/acre	-------------------------------	
Nitrogen (N)	257	434	319	377
Phosphorus (P)	263	190	158	174
as P_2O_5	597	432	360	396
Potassium (K)	298	292	239	266
as K_2O	359	352	271	312
Calcium (Ca)	151	122	392	257
Magnesium (Mg)	82	55	56	56
Zinc (Zn)	6.0	5.3	5.0	5.2
Iron (Fe)	12.0	5.2	5.7	5.5
Manganese (Mn)	4.9	6.6	4.9	5.8
Copper (Cu)	3.1	6.9	3.8	5.4
Sodium (Na)	87.2	92.4	67.2	79.8

Table 2. Amounts of nutrients applied in dairy manure during 1994 and 1995 at Stephenville.

	Time of application					
	Spring		Autumn		Split spring/autumn	
Nutrient	1994	1995	1994	1995	1994	1995
	---lbs per acre---					
N	350	214	251	184	300	199
P	168	100	121	148	144	124
as P_2O_5	385	229	277	339	330	284
K	298	204	253	362	275	283
as K_2O	358	245	304	434	330	340
Ca	352	520	436	988	394	754
Mg	108	88	112	148	110	118
Zn	4	4	4	7	4	5
Fe	11	23	42	17	26	20
Mn	3	4	4	6	3	5
Cu	0.8	0.5	0.7	0.9	0.7	0.7
Na	89	42	58	73	74	57
Tons manure applied	10.5	13.6	13.0	17.0	11.8	15.4

Table 3. Dry matter production of ryegrass-bermudagrass in 1994 from 6 tons broiler poultry litter per acre with or without N and K fertilizer or clover.

Treatment	Ryegrass	Clover	Bermuda	Total forage
	-------------------------	lbsDM/acre	-------------------------	
Spring (S)	1307	--	9410	10718
S + NK[1]	1885	--	12418	14303
Autumn (A)	2955	--	8704	11660
A + NK	3408	--	10664	14072
Split (SA)	1858	--	8669	10527
SA + NK	2719	--	12110	14830
S + clover	2369	1109	6799	10277
A + clover	3739	815	6551	11105
CV (%)	30	69	17	16
Contrast	-------------------------	P>F	-------------------------	
S, A, SA vs S, A, SA with NK	.057	--	.001	.001
S + clover vs S	.064	--	.036	.746
A + clover vs A	.163	--	.079	.685
S + clover vs A + clover	.020	.020	.834	.545
S, A vs SA	.567	--	.704	.576
S vs A	.006	--	.551	.492
S + NK vs A + NK	.011	--	.147	.865

[1]75 lbs N and 50 lbs K_2O/acre applied after each harvest total 450 N lbs and 300 lbs K_2O/acre.

Table 4. Dry matter production of ryegrass-bermudagrass in 1995 from 6 tons broiler poultry litter per acre with or without N and K fertilizer or clover.

Treatment	Ryegrass	Clover	Bermuda	Total forage
	-----------------------------lbsDM/acre-----------------------------			
Spring (S)	2926	--	6358	9284
S + NK[1]	4769	--	7603	12373
Autumn (A)	5241	--	4309	9550
A + NK	7593	--	6125	13718
Split (SA)	4492	--	4736	9228
SA + NK	7190	--	7498	14689
S + clover	2455	2959	4522	9936
A + clover	4638	1235	3542	9415
CV (%)	12	48	18	10
Contrast	-----------------------------P>F-----------------------------			
S, A, SA vs S, A, SA with NK	.001	--	.001	.001
S + clover vs S	.256	--	.016	.412
A + clover vs A	.150	--	.285	.863
S + clover vs A + clover	.001	.001	.176	.510
S, A vs SA	.255	--	.335	.782
S vs A	.001	--	.008	.735
S + NK vs A + NK	.001	--	.047	.099

[1]75 lbs N and 50 lbs K_2O/acre applied after each harvest for a total of 450 lbs N and 300 lbs K_2O/acre.

Table 5. Forage yields at Stephenville in 1994 and 1995 from dairy manure and commercial nitrogen fertilizer.

	1994	1995		
Treatment	Bermudagrass	Wheat	Bermudagrass	Total forage
	----------------------lbs dry matter per acre----------------------			
Spring (S)	2556 c[2]	250 c	4265 b	4515 c
S + N[1]	9566 a	3306 a	14778 a	18084 a
Autumn (A)	1940 c	827 c	3421 b	4248 c
A + N	8386 ab	2337 ab	14146 a	16483 ab
Split (SA)	2963 c	599 c	3746 b	4345 c
SA + N	7684 b	2286 b	13526 a	15812 b

[1] Total N was 150 lbs on bermudagrass in 1994 and 350 lbs from October 1994 to September 1995.

[2] Yields within a column followed by the same letter are not significantly different (.05 level).

Table 6. Total amounts of nitrogen applied in manure and commercial fertilizer to each treatment at Stephenville.

	Summer 1994			Nov. 1994 to Sep. 1995		
	Manure	Fertilizer[1]	Total	Manure	Fertilizer[2]	Total
			lbs N per acre			
Spring (S)	350		350	214		214
Autumn (A)	251		251	184		184
Spring/Autumn (SA)	300		300	107[3]		107
S+N	350	150	500	214	350	564
A+N	251	150	401	184	350	534
SA+N	300	150	450	107	350	549

[1]Commercial nitrogen fertilizer was applied at 75 lbs/acre on 9 June and 31 August.

[2]Commercial nitrogen fertilizer was applied at 75 lbs/acre on 10 November 1994, 25 April 1995, 2 June 1995, and 29 August 1995. An additional 50 lbs N/acre was applied to wheat on 17 February 1995.

[3]Does not include N in manure applied on 21 November 1995.