Nitrogen Recovery by Orchardgrass From Dairy Manure

V.R. Kanneganti, S.D. Klausner and S.R. Kaffka

Introduction

With increasing manure production per unit cropland available for its disposal, greater recovery and recycling of manure N through crop uptake is needed on dairy farms to minimize environmental problems. On a 100-cow dairy farm, approximately 7 metric tons of N per year is not accounted for in mass balance equations. A substantial but unknown amount of this unaccounted N is being leached into the groundwater as nitrate.

Livestock producers need information on perennial grass forage crops which can utilize large quantities of manure N, yield good quality forage and fit into traditional crop rotations while allowing flexible and higher rates of manure application. Orchardgrass (*Dactylis glomerata* L.) is a well-adapted perennial crop with high yield potential. To develop effective manure management guidelines for this crop, its N recovery potential needs to be quantified. This study was initiated with the objective of quantifying N recovery potential of orchardgrass in response to liquid or solid dairy manure applied in spring with or without fertilizer N.

Materials and Methods

Dairy manure was surface applied at a rate to supply 150 kg total N/ha/yr to an established orchardgrass, either as liquid or as solid with bedding material, in April of each year in an experiment conducted for 2 years on a sandy loam soil in New Milford, Connecticut. Average composition of the manure is shown in Table 1. Manure treatments were superimposed with ammonium nitrate fertilizer applied at 0, 75, 150 and 300 kg N/ha in 1990, and 0, 150, 300 and 600 kg N/ha in 1991. The 3 x 4 factorial (no manure, liquid and solid manure, each superimposed with 4 rates of fertilizer N) was arranged in a randomized complete block design and replicated 3 times. Fertilizer P and K were applied according to soil test recommendation. Forage was cut in each plot from a 1m by 5m area to measure forage yield and N uptake (= N concentration in forage x forage yield). The crop was managed under a 4-cut system. N recovery by the crop was calculated by comparing N uptake on plots receiving manure or fertilizer with that of the check plot (no manure, no fertilizer), as follows:

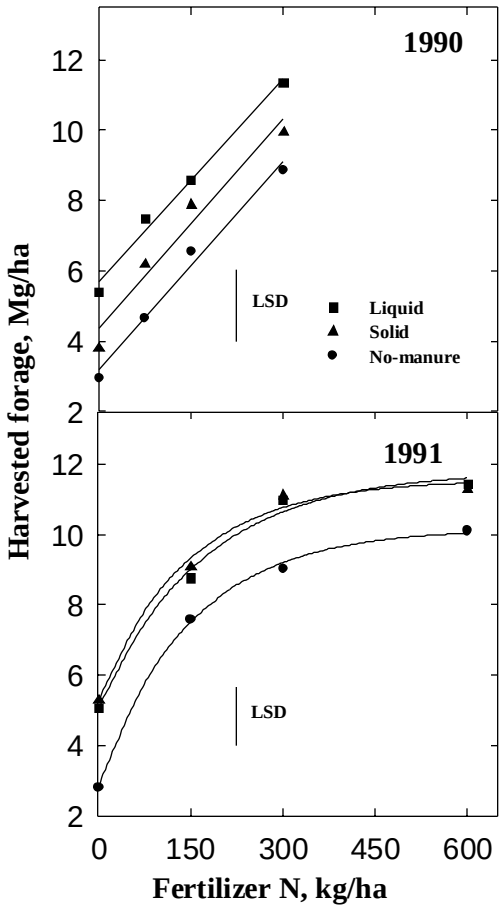
$$ANR = ((NTRT-NCHK)/NTOT)*100$$

where ANR is the apparent N recovery, NTRT is N uptake from manure or fertilizer treatment plot, NCHK is N uptake from check plot, and NTOT is the total N applied, all measured in kg N/ha/yr.

Results and Discussion

Forage yield. Effects of liquid and solid manure with or without fertilizer N on annual forage yield are shown in Fig. 1. In both years, yield increased significantly up to 300 kg fertilizer N/ha. In neither year was the interaction between N source and fertilizer rate significant, suggesting that the effects of solid or liquid manure on yield were similar at all rates of fertilizer N. Averaged over fertilizer N rates, liquid manure N increased dry matter yields over no-manure by 43% (2450 kg/ha) in 1990 and 23% (1684 kg/ha) in 1991 (Fig. 1). The corresponding values for solid manure N were 21% (1204 kg/ha) in 1990 and 24% (1812 kg/ha) in 1991.

N recovery. ANR represents the apparent amount of N recovered by the crop from fertilizer or manure. Averaged over the years, 40% of the 150 kg N/ha/yr of liquid manure N was recovered in forage in each year (Table 2). N recovery from liquid manure was 6% greater in 1990 than in 1991 (Table 2), suggesting that N losses were lower in 1990 than in 1991. In 1990, manure application was followed by a 33 mm rainfall over a 7 day period, which may have reduced volatilization losses of ammonia.



With solid manure N applied at 150 kg N/ha/yr without fertilizer N, 13 and 39% of manure N (19 and 59 kg N/ha, respectively) were recovered by the crop in 1990 and 1991, respectively (Table 2). In addition to N available from solid manure applied in 1991, more N was probably available from residues of the 1990 application, resulting in greater ANR in 1991. In contrast, no residual effects of liquid manure on forage yield or N uptake were observed (Fig. 1, Table 2).

Summary

Averaged over the years, orchardgrass recovered 40% of the liquid manure N and 26% of the solid manure N applied each year. On an annual basis, the crop recovered 430 kg soil N/ha from plots receiving liquid manure in combination with 600 kg fertilizer N/ha. This study demonstrates that intensively managed orchardgrass has the potential to absorb large quantities of manure N, suggesting that orchardgrass may be planted in fields that receive large quantities of manure on a regular basis.

Figure 1. Annual forage dry matter yield in response to fertilizer N with or without dairy manure. (Symbols represent average yields. Curves are best-fit functions (linear in 1990 and Mitscherlich in 1991):

1990:	*No-manure:*	$Y = 3172 + 19.7\ X;$	$R^2 = 0.90;\ RMSE = 777$
	Solid manure:	$Y = 4354 + 19.9\ X;$	$R^2 = 0.77;\ RMSE = 1230$
	Liquid manure:	$Y = 5685 + 19.3\ X;$	$R^2 = 0.75;\ RMSE = 1267$
1991:	*No-manure:*	$Y = 10175 - 7356\ e^{-.0068\ X}.$	$R^2 = 0.95;\ RMSE = 666$
	Solid manure:	$Y = 11573 - 6314\ e^{-.0069\ X}.$	$R^2 = 0.83;\ RMSE = 1129$
	Liquid manure:	$Y = 11812 - 6764\ e^{-.0059\ X}.$	$R^2 = 0.88;\ RMSE = 947$

where Y = forage yield, kg/ha; X = Fert N, kg N/ha; RMSE = Root of mean square error, kg/ha)

Table 1. Composition of liquid and solid dairy manures.

Manure	Dry matter content	Total-N	NH_4-N	Total-P	Total-K
	- - % - -	- - - - - - - - - % dry wt. Basis - - - - - - - - -			
			1990		
Liquid	11.2	5.75	2.20	0.76	2.87
Solid	28.1	1.99	0.57	0.78	2.31
			1991		
Liquid	6.9	4.30	1.45	0.97	4.40
Solid	13.9	4.00	0.74	0.84	3.86

Table 2. Apparent nitrogen recovery (ANR) by orchardgrass from fertilizer and from liquid and solid manures applied with or without fertilizer N.

	1990			1991			2 yr combined		
Manure type	Fert. N	Total[1] N	ANR	Fert. N	Total N	ANR	Fert. N	Total N	ANR
	- - kg N/ha - -		%	- - kg N/ha - -		%	- - kg N/ha - -		%
None	0	0	-	0	0	-	0	0	-
	75	75	55	150	150	95	225	225	82
	150	150	71	300	300	87	450	450	82
	300	300	64	600	600	59	900	900	60
Liquid	0	150	43	0	150	37	0	300	40
	75	225	59	150	300	66	225	525	63
	150	300	63	300	450	72	450	750	68
	300	450	62	600	750	49	900	1200	54
Solid	0	150	13	0	150	39	0	300	26
	75	225	40	150	300	65	225	525	54
	150	300	42	300	450	69	450	750	58
	300	450	52	600	750	49	900	1200	50

[1]Total N = fertilizer N + 150 kg manure N (for manure treatments), or
= fertilizer N only (for no-manure treatments)