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Slurry Manure on Grass: Making it Work

II. Long-term effects

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INTRODUCTION

Liquid manure can be used as the main source of nutrients for production of forage grass (See other poster by Bittman et al.). However, to obtain same immediate response as fertilizer, manure has to be *applied at equivalent rates of inorganic N or twice the rate of total N*. Effective management of manure nutrients is important because farmers must produce high yields with minimum nutrient loss to the environment. The long-term effects on the crop-soil system of using manure as the principal nutrient source for grass production are not yet well understood.

METHODS

STUDY AREA : Coastal BC, Canada

- **1500 mm ann. precipitation; med. texture alluvial soil**
- **Tall fescue (*Festuca arundinacea* Schreb.)**
- **Harvests: May, July, August, and Sept./Oct. (1994-2000)**

TREATMENTS: nutrient applications in years 1994-2000

- **liquid dairy manure vs. NH_4NO_3 (+ other inorganic nutrients)**
- **rates: 50 or 100 kg inorganic-N ha^{-1} applied for each of 4 harvests/ year**
- **manure applied with 'drag-shoe' applicator**

Dairy manure composition:

Water	**91.7%**	**NH4-N**	**0.16%, (wet basis)**
C:N	**13.4 : 1**	**Total-N**	**0.31% (wet basis)**
PH	**6.7**	**C**	**4.1% (wet basis)**

RESULTS

Table 1. Effect of applying fertilizer and dairy slurry (1994-2000) on yield, N uptake and N content of tall fescue (mean of 1998-2000). *Shaded rows are equivalent rates of applied total-N* .

Treatment	Applied N Mineral	Applied N Total	Yield	N Uptake	N Content
	--kg ha^{-1} yr^{-1}--		--kg ha^{-1} yr^{-1}--		--%--
Control	0	0	7.3	129	1.77
Low N					
Fertilizer	200	200	13.2	288	2.18
Manure	200	400	15.0	323	2.16
High N					
Fertilizer	400	400	14.0	389	2.78
Fert./Man.[Z]	400	600	16.8	450	2.67
Manure	400	800	16.5	422	2.56

[Z] Alternating applications of fertilizer and manure.

CROP RESPONSE *(Table 1)*

- **At equal rates of applied *mineral-N*, manure plots had higher yields and N uptake than fertilized plots while alternating (fert./manure) plots had both high yield and N uptake.**
- **At equal rates of applied *total-N*, fertilized plots took up and contained more N, but yielded less, than manured plots (*shaded rows*).**
- **Although high manure increased grass yield compared to fertilizer, it reduced grass cover (not due to wheel traffic) (data not shown).**

RESULTS (cont'd)

Table 2. Effect of fertilizer and dairy slurry (1994-2000) on soil microbial populations 1 and 3 weeks after application (in 1998). *Shaded rows are equivalent rates of total N.*

Treatment	Applied N Mineral	Applied N Total	Bacteria	Protozoa	Nematodes
	--kg ha^{-1} yr^{-1}--		cells mg $soil^{-1}$	cells mg $soil^{-1}$	g $soil^{-1}$
Control	0	0	600	168	246
Low N					
Fertilizer	200	200	---	---	---
Manure	200	400	763	263	1017
High N					
Fertilizer	400	400	521	107	268
Manure	400	800	931	533	1092

SOIL BIOTA (Table 2)

- Manure increased populations of bacteria, bacteria-eating nematodes and protozoa compared to fertilizer and control plots. This suggests that manure increases both N-immobilization and N-mineralization activity in the soil.
- Earthworm numbers (and biomass) were higher in manure than fertilizer treatments (data not shown).

Table 3. Effect of applying fertilizer and dairy slurry (1994-1998) on total soil carbon, nitrogen and organic matter in 1998. *Shaded rows are equivalent rates of applied total-N* .

Treatment	Applied N Mineral	Applied N Total	Total Soil Carbon	Total Soil Nitrogen	Total Soil Org. matter
	--kg ha^{-1} yr^{-1}--		------%------		
Control	0	0	3.45	0.29	8.1
Low N					
Fertilizer	200	200	3.21	0.27	7.8
Manure	200	400	3.82	0.31	8.7
High N					
Fertilizer	400	400	3.56	0.30	7.8
Manure	400	800	3.81	0.31	8.7

SOIL C AND N COMPOSITION (Table 3)

- High manure enriched total N, C and organic matter in the 0-15 cm soil layer compared to control and fertilizer.
- This shows that manure helps to sequester carbon and enriches the soil and probably improves its moisture holding capacity.

Table 4a. Effect of applying fertilizer and dairy slurry (1994-1998) on extractable soil P at 3 soil depths in 1998. *Shaded rows are equivalent rates of applied total-N* .

Treatment	Applied N Mineral	Applied N Total	P in soil layers 0-15cm	15-30 cm	30-60 cm
	--kg ha^{-1} yr^{-1}--		------ppm------		
Control	0	0	135	89	25
Low N					
Fertilizer	200	200	133	94	21
Manure	200	400	162	102	32
High N					
Fertilizer	400	400	136	99	27
Manure	400	800	194	129	22

Table 4b. Effect of applying fertilizer and dairy slurry (1994-1998) on extractable soil K at 3 soil depths in 1998. *Shaded rows are equivalent rates of applied total-N* .

Treatment	Applied N Mineral	Applied N Total	K in soil layers 0-15cm	15-30 cm	30-60 cm
	--kg ha^{-1} yr^{-1}--		------ppm------		
Control	0	0	108	82	101
Low N					
Fertilizer	200	200	33	31	90
Manure	200	400	122	99	112
High N					
Fertilizer	400	400	41	28	70
Manure	400	800	293	146	152

AVAILABLE SOIL NUTRIENTS (Table 4a, b)

- Application of manure increased available soil P in the 0-15 cm depth. Some movement to the 15-30 cm layer is evident in the high manure plots.
- Application of manure increased soil potassium in the 0-15 cm depth. Movement down to the 15-30 cm layer is evident in the high manure plots
- Residual soil NO_3 in Oct. was low for low fertilizer and manure. Residual NO_3 was 65 and 140 kg/ha more than control for high-manure and high-fertilizer, respectively ***(not shown)***.

CONCLUSIONS

- **At equal rates of *total* N, long-term application of manure supported somewhat higher yield than fertilizer whereas fertilizer produced higher N-uptake and N content.**
- **Alternating fertilizer/manure combined high yield, N content and N use efficiency**
- **Manure increased biological activity in the soil and total soil C, N and organic matter.**
- **The imbalance between nutrient ratios in manure and in plants is the greatest long-term challenge to manure application**

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