Feedlot Manure Top Dressing for Irrigated Pasture: Good Agricultural Practice or a Health Hazard?

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Salmonella dublin, a major cause of acute salmonellosis in cattle (JOINT WORKING PARTY 1965), was shown to survive for at least 119 days in feces on pasture in summer (FIELD 1948). MAIR and ROSS (1960) showed that salmonellae survived in or on soil for up to 300 days if fecal pats remained intact. In moist, unheaped feces, e.g., on a feedlot surface, salmonellae died out within 90-120 days but in dry feces persisted for as long as 610 days (GUBKIN 1962). Low moisture content has been shown to limit decomposition of manure on feedlot surfaces in the semiarid prairie region (BELL 1975). Feedlot manure used as a top dressing for irrigated pastures could be a source of enteropathogenic bacterial contamination of the grass. Even though newly emerging grass might not come into contact with the manure, bacterial contamination could occur by water splashing from either the manure or the soil during spray irrigation.

The present study used fecal coliform bacteria, which may themselves be pathogenic but are accepted as indicators for the potential presence of salmonella (HOLDEN 1970), and was undertaken to determine: (1) the yields of grass after application of manure at various rates; (2) the extent to which pasture top-dressed with feedlot manure becomes contaminated during irrigation; and (3) how long the contamination will persist.

MATERIALS AND METHODS

Feedlot manure was obtained from a commercial beef feedlot in the fall of 1974 and 5 t were stockpiled in the open. On May 14, 1975, the manure was hand-spread on 36-m^2 plots laid out on an established irrigated pasture of orchardgrass (*Dactylis glomerata* L.). Three rates of top dressing--0, 25, and 125 t/ha--of wet manure were compared. Treatments were replicated four times in a randomized, complete block design. The dry weight, total and $NaHCO_3$-extractable phosphorus (JACKSON 1958, OLSEN et al. 1954), and inorganic (NH_4^+-H plus NO_3^--N) and total nitrogen (Kjeldahl) (BREMNER 1965, AOAC 1950) were determined in a representative sample of the manure.

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The plots were spray-irrigated for 6 hr on July 4 and August 12, 1975. Each plot was cut four times during the growing season with a plot-scale forage harvester and the yield of dry forage determined.

Survival of the fecal coliform bacteria on the spray-irrigated orchardgrass was studied using the most probable number (MPN) technique, used previously for alfalfa (BELL 1976), to enumerate fecal coliform bacteria on the grass. Because the individual culms were small, 10 were taken at each sampling. The plots were sampled 1 hr after irrigation ended and thereafter daily for 6 days or until the fecal coliform bacteria were eliminated. Only two of the four replicates were sampled because of the manpower and material requirements of the microbiological procedures.

The amounts of sunlight reported in Tables 3 and 4 were recorded at the Lethbridge Research Station meteorology site 1 km north of the test plots.

RESULTS AND DISCUSSION

The 25-t/ha application of manure did not increase the yield of orchardgrass over the untreated plots (Table 1). This application supplied only 24 kg inorganic N/ha (Table 2), which is far short of the 170-225 kg N/ha required annually for maximum production from irrigated grass pastures in Western Canada (WILSON and SLEN 1974).

TABLE 1

Yields of orchardgrass after application of various amounts of beef feedlot manure

Manure treatment (t/ha)	Dry matter yield (kg/ha)				
	Cut 1	Cut 2	Cut 3	Cut 4	Total
0	1272 b*	961 a	1149 a	197 a	3579 a
25	1213 b	1482 b	880 a	184 a	3759 a
125	759 a	2917 c	1899 b	778 b	6353 b

*Within a column, means followed by the same letter do not differ significantly ($P < 0.05$).

TABLE 2

Amount of nitrogen and phosphorus applied to test plots as beef feedlot manure

Manure composition (%*)	Manure rate (t/ha) 25	125
N - Total (1.7)	425	2125
N - Inorganic (0.1)	24	118
P - Total (0.6)	150	750
P - $NaHCO_3$-extractable (0.02)	5	25

*Wet weight basis (34.7% water).

In contrast, the yield of plots receiving top dressing at the heavy rate (118 kg inorganic-N/ha, Table 2) was double that of the untreated plots (Table 1). It is unlikely that the rate of top dressing could be increased sufficiently to provide the maximum recommended amount of nitrogen because of the thickness of the required manure blanket. Even at 125 t/ha, the yield of the first cutting was seriously reduced by the manure cover (Table 1). We believe that large lumps impeded the growth of the grass and also that the manure layer reduced heat absorption by the soil during spring. After the first passage of the forage harvester and the action of weather, this effect was no longer observed.

On a field scale, to apply 125 t/ha, about half the amount needed to satisfy the nitrogen demand for maximum yield, would require at least three passes with a conventional manure spreader. Furthermore, the 5-cm covering of manure would hamper the harvesting of the grass crop.

The levels of fecal coliform contamination immediately after each irrigation were vastly different (Tables 3 and 4). The highly variable contamination observed after the first irrigation (Table 3) was not caused by splashing from the manure since the untreated plots were as contaminated as those that had been top-dressed. This contamination occurred because the irrigation water had been fecally contaminated. At the time of irrigating, it was later discovered, liquid waste from a packing house lagoon on a neighboring property overflowed into the irrigation supply ditch. The massive contaminations, apparently occurring at random throughout the samples tested, probably reflect the

presence of discrete particles of fecal material of packing house origin on some of the culms. Notwithstanding that this contamination was from a source other than the manure, it can be seen that the fecal coliform bacteria were essentially eliminated from the pasture after exposure to between 50 and 65 hr of bright sunlight.

TABLE 3

Number of fecal coliform bacteria per gram of dry orchardgrass after applying feedlot manure and spray-irrigating once

Time after irrigation stopped (hr)	Manure rate (t/ha)						Exposure to bright sunlight (hr)
	0		25		125		
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	
1.5	72	>4135	108	222	134	525	1.5
19	178	64	>2067	21	>3607	>2547	11.3
44	36	5	447	770	55	6	27.4
69.5	>3525	9	>2522	110	454	5	34.0
95	184	77	>2981	210	>2794	67	39.7
119	57	34	2	15	194	4	51.7
143	<2	<2	<2	1	<2	1	65.2

TABLE 4

Number of fecal coliform bacteria per gram of dry orchardgrass after applying feedlot manure and spray-irrigating twice

Time after irrigation stopped (hr)	Manure rate (t/ha)						Exposure to bright sunlight (hr)
	0		25		125		
	Rep 1	Rep 2	Rep 1	Rep 2	Rep 1	Rep 2	
1	3	2	4	2	<2	2	0.7
19	<2	<2	4	<2	4	2	8.6
43	1	7	5	14	<2	7	20.3
67	<2	<2	6	9	<2	<2	24.6
91.5	<1	<2	<2	<1	<2	4	35.4

There was little contamination of the pasture after the second irrigation when the water contained only 80 fecal coliforms/100 ml (Table 4). Within the confidence limits ($P < 0.05$) of the MPN technique ($x/5 < x < 5x$, where x is the MPN index), we conclude that overwintered feedlot manure used as a top dressing does not significantly contaminate the grass with enteropathogenic bacteria after irrigation. However, should such contamination occur, it can be expected to be rapidly eliminated by exposure to bright sunlight. The rapid die-off of fecal coliform bacteria on grass contrasts markedly with their prolonged survival in the soil or in fecal pats where they are protected from the bacteriocidal effects of sunlight.

SUMMARY

Top dressing a spray-irrigated pasture of orchardgrass with 125 t/ha of overwintered beef feedlot manure almost doubled the yield of dry forage: 6353 kg/ha vs. 3578 kg/ha for the plots receiving no manure. Even at this rate of application, the manure did not contaminate the irrigated grass with enteropathogenic bacteria after irrigation. When the grass became contaminated through the use of fecally polluted irrigation water, the fecal coliforms, indicator organisms with survival characteristics similar to the salmonellae, were effectively eliminated from the grass after exposure to 65 hr of bright sunlight.

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