J. Br. Grassld Soc. (1974) 29, 85

4018

EFFECTS OF COW SLURRY ON HERBAGE PRODUCTION, INTAKE BY CATTLE AND GRAZING BEHAVIOUR

B. F. PAIN AND J. D. LEAVER
National Institute for Research in Dairying, Shinfield, Reading, Berkshire

D. M. BROOM
Department of Zoology, University of Reading, Reading, Berkshire

ABSTRACT

Grassland plots were dressed with different amounts of cow slurry in January or March and grazed by dairy heifers at intervals from late April to August. In the first experiment slurry was applied at levels up to 56 tonnes/ha (22·4 tons/ac) in March. Total herbage DM production was directly proportional to the amount of slurry applied. There was no effect of treatment on percentage herbage utilization. In the second experiment slurry was applied at levels up to 100 t/ha (40 tons/ac) in January or in March. There was no significant effect of time or level of slurry application on herbage production or on animal intake, but the behaviour of the heifers was modified during the first eight weeks after plots had been dressed with 75 or 100 t/ha (30 or 40 tons/ac).

INTRODUCTION

The most economical and convenient method of slurry disposal on the majority of dairy farms is to spread it on the land.

Cow slurry contains appreciable quantities of plant nutrients (7) and the benefits of its use as a grassland fertilizer have been clearly demonstrated (2), increases in yield being attributed primarily to N content. In terms of increased DM production, applications in spring are considered to be the most efficient, for in autumn and winter losses of nitrates and other nutrients occur from surface run-off and leaching.

Excessively high slurry applications on grassland could result in levels of nutrients in herbage which may be harmful to stock in some circumstances. Hypomagnesaemia, for example, is known to be more likely to occur in cattle grazing pasture receiving heavy dressings of N and/or K (3).

The effects of dung pats on the palatability of herbage to grazing cattle and the subsequent wastage of herbage is well documented (6). Less is known of the effects of spreading cow slurry over grassland on utilization by grazing cattle; and refusal of livestock to eat contaminated herbage may be important in deciding the level and timing of slurry dressings to grassland intended for grazing.

The present experiments were designed to compare the effects of different levels of slurry application on herbage production and on intake by grazing heifers. In order to detect any anomalies in grazing and associated behaviour due to slurry application, the behaviour of the heifers was also studied.

MATERIALS AND METHODS

Site. The experiments were carried out on a sandy loam soil overlying Valley Gravel and sown with a perennial ryegrass (*Lolium perenne*), timothy (*Phleum pratense*) and meadow fescue (*Festuca pratensis*) mixture in 1969.

The annual rainfall averaged over the past ten years was 643 mm. In 1971 it was 640 mm and in 1972 556 mm.

Slurry. In 1971 the slurry was obtained from beneath the slatted floor of a cubicle house holding 90 Friesian cows, and was spread on land with a Howard 'Rotaspreader'. The slurry used in 1972 came from a pit which received the floor scrapings from a shed housing 60 Friesian heifers in cubicles. Slurry was spread with a Salopian 'Slurrybuggy' modified to limit the width and improve the evenness of distribution by fitting a large wooden hood with baffles over the rear.

Animals. Fifteen Friesian heifers were used in the 1971 experiment and thirty in 1972. In 1971 the average age was 19 months (range 18–20 months) and the average liveweight 345 kg (range 324–362 kg) at the beginning of the experiment. The initial average age of the heifers used in 1972 was 15 months (range 14–18 months) and average initial liveweight 278 kg (range 244–370 kg).

Herbage sampling. Half-square-metre areas, taken at random, were cut to ground level with a powered hedgetrimmer immediately before (pre-grazing sample) and after (residue sample) the plots were grazed. The samples from each plot were bulked and weighed. Two 200 g aliquots were taken for DM determinations and sub-sampled for chemical analysis.

The amount of herbage DM available (kg/ha) on each plot at the beginning of grazing was derived from the pre-grazing samples. Herbage DM production was determined by subtracting from this the amount remaining at the end of the previous grazing.

The pre-grazing and residue samples taken each time a plot was grazed were used to estimate the amount of grass removed. The results were expressed as intake/heifer per day.

Behaviour observations. A time-sampling technique was used so that all the animals could be watched and the time during which they were engaged in a wide variety of activities could be assessed. The animals were also observed continuously so that details of patterns of behaviour could be recorded.

During time sampling each of the heifers was observed at ten-minute intervals and a record was made on a check sheet of the beast's position in the plot and whether it was standing, lying, walking, grazing, eating, drinking, ruminating, urinating, defaecating, looking, taking part in one of several types of social behaviour, or engaging in a less frequent activity. Analysis of these results indicates the proportion of time spent in each activity by the heifers.

On the same occasions that the time-sampling observations were made, a different observer recorded in detail all behaviour shown by animals. Except where otherwise stated, the Mann-Whitney U Test (5) was used to analyse the behavioural data.

EXPERIMENT 1 1971

Experimental

Slurry was spread at the end of March at levels equivalent to 0, 12 600, 27 400, 36 800 or 56 600 kg/ha in adjacent strips each 9 × 90 m. The strips were each subdivided into five plots 9 × 18 m, each plot providing a day's grazing for three heifers. All the plots received 40 kg/ha inorganic N in early spring and again after each grazing. At the beginning of a grazing period three heifers were put into each of the five plots at the proximal end of the strips for one day. On day two the animals were moved into the second plot of each strip and back fenced. This procedure was repeated until the last row of plots was reached on the fifth day. The first grazing period started approximately seven weeks after slurry application and subsequent grazings took place at three- to five-week intervals during the season (Table 1). The heifers were kept on clean pasture when not on the experiment.

Six pre-grazing and six residue grass samples were taken each time a plot was grazed. The first day of each grazing period was used to allow the animals to acclimatize to the experiment and results from these plots disregarded.

Results

Herbage production. The mean herbage DM production per treatment before each grazing period is shown in Fig. 1, together with total production over the five periods. Regression analyses for herbage production on the level of slurry application showed that total production over the season was positively correlated with level of slurry application ($P < 0.05$). Significant relationships were not established for each grazing period, but it is clear that the slurry

TABLE 1. Dates of grazing periods, Experiment 1, 1971

Grazing period	Dates
1	3–8 May
2	24–29 May
3	14–19 June
4	12–17 July
5	23–28 Aug.

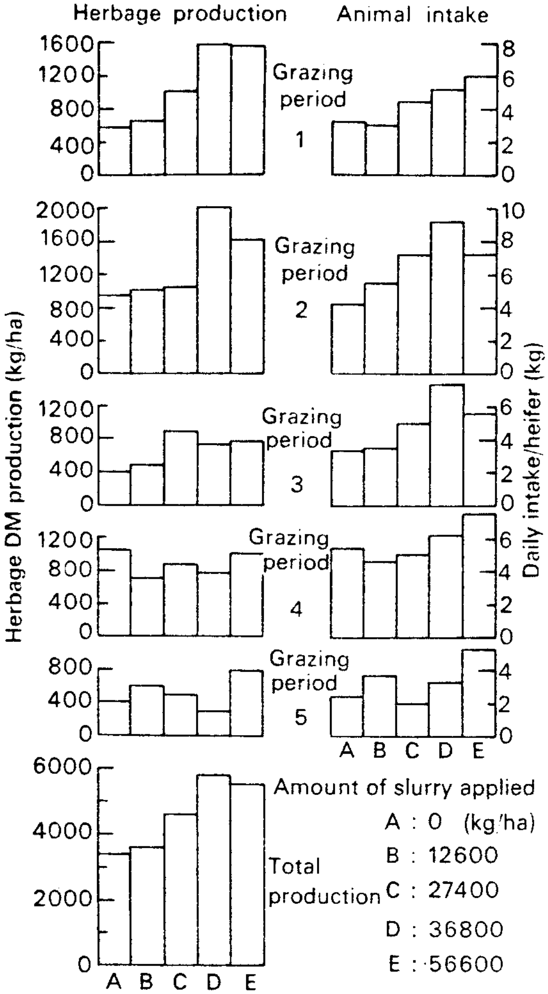

Fig. 1. The effects of slurry application on herbage production and animal intake, Experiment 1.

applications had a noticeable effect on herbage production up to mid-June.

Animal intakes. The daily herbage DM intakes per heifer during each grazing period are illustrated in Fig. 1. The intakes ranged from 2·0 to 9·3 kg/heifer per day during the experiment. The increased herbage production on the slurry treatments was reflected in significantly higher animal intakes ($P<0·01$). Differences between the treatments were most marked during the first three grazing periods.

Herbage utilization. For the whole experiment animal intakes were positively related to the amount of grass available at the beginning of each grazing period ($P<0·01$). During the course of the experiment percentage herbage utilization ranged from 49% at the first grazing period to 73% at the last. There was no significant difference between the treatments. Between 87% and 96% of the total herbage DM produced over the experimental period was utilized by the heifers.

Chemical analyses. The initial soil N level before slurry application was 0·14%. The slurry at 20·5% DM contained 0·36% N, 0·12% P and 0·53% K.

There was some evidence that the higher levels of slurry application increased the amounts of N, K, P and crude fibre in the herbage (Table 2). This effect was most obvious at the first grazing period and, for the later grazings, there was very little difference between the treatments.

TABLE 2. Herbage composition, Experiment 1, 1971

		Level of slurry application (t/ha)				
		0	12·6	27·4	36·8	56·6
		Total N content (%)				
Grazing period	1	2·2	2·5	2·7	2·7	2·9
	2	2·8	2·4	2·8	2·4	2·6
	3	2·7	2·9	2·6	2·3	3·1
	4	2·3	2·3	2·3	2·4	2·3
	5	1·5	1·4	1·4	1·4	1·4
		P content (%)				
Grazing period	1	0·31	0·33	0·35	0·36	0·37
	2	0·37	0·36	0·38	0·36	0·40
	3	0·37	0·37	0·37	0·37	0·38
	4	0·33	0·32	0·32	0·32	0·35
	5	0·26	0·34	0·28	0·28	0·32
		K content (%)				
Grazing period	1	1·48	1·68	2·43	2·05	2·70
	2	1·76	1·76	1·80	1·76	2·10
	3	1·76	1·76	1·56	1·68	2·00
	4	1·90	1·90	2·00	1·78	2·20
	5	1·98	1·98	1·98	2·30	2·00
		Crude fibre content (%)				
Grazing period	1	19·0	18·7	18·1	18·6	23·4
	2	22·5	21·6	20·6	23·5	23·1
	3	22·2	23·4	24·5	25·5	25·1
	4	25·3	23·8	24·0	24·1	26·0
	5	25·8	24·7	24·0	24·8	23·9

EXPERIMENT 2 1972

Experimental

Slurry was spread at the beginning of January or in mid-March at levels equivalent to 0, 25, 50, 75 or 100 t/ha. The slurry treatments received 40 kg/ha inorganic N in early spring and again at the end of each grazing. The control plots received 40 kg/ha or 80 kg/ha of inorganic N at the same times.

The treatments were randomized across a row of ten plots, each 7×50 m, and replication was threefold. During each grazing period three heifers grazed in the first row of replicates for two days. At the end of the second day the animals were removed from the plots and put on clean pasture for a day to ensure that there were no carry-over effects on their intakes. The heifers were then re-randomized and moved into the second row of replicates for a further two days. This procedure was repeated for the third row of plots. The first grazing period began approximately six weeks after the mid-March slurry application and the plots were grazed again at two- to six-week intervals during the season (Table 3). The heifers grazed extensively on clean pasture when not on the experiment.

Twelve pre-grazing and twelve residue grass samples were taken from each plot at each grazing period.

During the first, second and fourth grazing periods behaviour observations were made during approximately two hours in the morning and afternoon of the day when the animals were first put into the plots and on the afternoon of the second day in each plot. The time sampling technique was used to observe the behaviour of all the heifers on the experiment. Continuous records of behaviour were made for the animals on the plots with no slurry and on those dressed at 100 t/ha in March or January. Each heifer was watched for twelve minutes.

TABLE 3. Dates of grazing periods, Experiment 2, 1972

Grazing period	Dates
1	27 Apr.–4 May*
2	18–26 May*
3	7–15 June
4	22–29 June*
5	17–25 Aug.

*behaviour of animals recorded

Results

Herbage production and animal intakes. The total herbage DM produced and the mean daily intake per heifer over the five grazing periods are given for each treatment in Table 4. There were no significant effects of level or time of slurry application on the amount of herbage DM produced at each grazing or on the total production over the experimental period. Similarly, for animal intakes, there were no significant differences between the ten treatments at each grazing, or for the mean intake averaged over the five grazing periods. The total herbage DM utilized over the five periods ranged from 87% to 99%, with no significant differences between treatments.

Chemical analyses. The initial soil N level determined before slurry application was 0·29%. The slurry DM content was 21·7% in January and 16·2% in March. The slurry contained on average 0·35% N, 0·16% P and 0·34% K.

Chemical analyses of pre-grazing herbage samples averaged over the five grazing periods are given in Table 5. The levels of total N, P and K were greater in plots where slurry was applied in March rather than in January, but they were only slightly above the controls. The highest levels, recorded at the first grazing period on the

TABLE 4. Total herbage DM production and mean daily intake per heifer, Experiment 2, 1972

	Slurry applied (t/ha)	Inorganic N* (kg/ha)	Total herbage DM production (kg/ha)	Mean daily intake/-heifer (kg)
	0	40	5666	6·3
	0	80	5113	5·8
January application	25	40	4678	6·0
	50	40	4988	5·4
	75	40	5395	5·8
	100	40	4623	5·2
March application	25	40	5089	6·0
	50	40	4280	4·9
	75	40	5520	5·3
	100	40	5716	6·3

*Level of inorganic N application in early spring repeated at the end of each grazing period slurry-treated plots, were 3·49% N, 0·45% P and 3·20% K.

Regressions of average herbage composition on the amount of slurry applied in March or January were calculated. There were significant, positive effects in both instances for phosphorus ($P<0·001$ and $P<0·01$ for January and March application, respectively) and for potassium where slurry was applied in January ($P<0·05$).

Behaviour observations. In 21 hours of observation the heifers spent 32% of their time grazing and there were no significant correlations between time spent grazing and level of slurry application. The pattern of grazing was, however, affected by slurry application. The detailed, continuous recording showed that the time between lowering the head to start grazing and raising it again, i.e. the grazing-bout length, was on average significantly shorter on the plots where slurry had been applied at 100 t/ha in March than on the other plots ($P<0·01$). The median grazing-bout length on plots dressed at 100 t/ha in March was 20 seconds, while on the other three treatments for which behaviour was observed (two treatments with no slurry and the 100 t/ha in January) the median was 28 seconds.

The behaviour of the animals was not correlated with treatment for any measure, except for lying and ruminating. The animals spent significantly less time lying on plots most recently treated with the two heaviest slurry applications than on the other plots ($P<0·05$). During the first grazing period the animals spent 28% of the time lying on plots dressed at 75 t/ha in March, 27% on plots dressed with 100 t/ha in March and, on average, 38% on the other eight treatments.

Ruminating is normally correlated with lying and for the first grazing period, a Spearman rank correlation (9) between the two measures gave $r=0·52$ ($P<0·0001$). The median time spent ruminating was 9% for 75 t/ha applied in March, 12% for 100 t/ha applied in March and, on average, 15% for the other eight treatments. By the second grazing period the only difference in behaviour among the animals was that lying occurred less frequently in the 100 t/ha in March treatment (18% in 100 t/ha in March, 32% in 75 t/ha in March and, on average, 34% in the other eight treatments, $P<0·01$). No differences in the behaviour of the animals were apparent by the fourth grazing period. There was never any difference in behaviour of heifers in plots treated with slurry in January and those in untreated plots.

DISCUSSION

In Experiment 1 there was a clear response of herbage DM production to the amount of slurry applied. Even though the plots received the same quantities of inorganic N, the total herbage DM produced on the 36·8 and 56·6 t/ha slurry treatments was 60–70% greater than the con-

TABLE 5. Herbage composition, Experiment 2, 1972

Results averaged over five grazing periods

	Slurry applied (t/ha)	Inorganic N* (kg/ha)	N	Nitrate-N	P	K	Mg	Crude fibre
			percentage					
	0	40	1·75	0·04	0·24	1·97	0·13	22·9
	0	80	2·53	0·13	0·27	2·06	0·15	21·9
January application	25	40	2·23	0·12	0·26	1·93	0·15	22·9
	50	40	1·91	0·08	0·28	2·11	0·14	23·1
	75	40	1·99	0·08	0·29	2·16	0·14	22·2
	100	40	2·14	0·12	0·32	2·32	0·14	23·5
March application	25	40	2·33	0·14	0·29	2·19	0·15	22·6
	50	40	2·27	0·12	0·29	2·46	0·14	22·4
	75	40	2·27	0·10	0·33	2·34	0·14	22·6
	100	40	2·22	0·11	0·31	2·24	0·14	24·6

*Level of organic N applied in early spring repeated at the end of each grazing period trol. This response was most marked at the first two grazing periods. From June onwards there was very little difference between the treatments.

The results of Experiment 2 differed from those of Experiment 1 in that, although higher levels of slurry application were used, the herbage DM production was very similar on slurry treatments and on controls. This may be explained to some extent by fertility differences between the two experimental areas. Prior to 1972, the area used for Experiment 2 was grazed intensively for several years and the initial soil N level was about twice that of Experiment 1.

No significant differences were found in herbage production on the plots spread with slurry in January or in March. Spring-applied slurry is thought to be more efficient as a fertilizer than winter-applied slurry, because of the leaching of plant nutrients that occurs during wet winter periods (4).

The percentage of nutrients in the slurries used in the two years was very similar, except for K levels, which were higher in 1971.

The levels of N, P and K in herbage in both experiments were only slightly increased after slurry treatment compared with the controls. Nitrate-N concentrations, however, may have been underestimated because analyses were carried out on oven-dried material.

An attempt was made to quantify the amount of herbage rejected during the grazing periods by comparing animal intake and grazing behaviour on clean control plots with that on the slurry treatments. Slurry did not reduce intakes in either experiment, nor affect the total time spent grazing in Experiment 2, even when applied at 100 t/ha. Interpretation of the results from Experiment 1 was difficult because the amount of herbage available at the beginning of grazing periods increased with the level of slurry application. Although more grass was produced on the slurry plots, animal intakes were correspondingly higher and there were no significant effects of treatment on percentage herbage utilization at each grazing period, or on total utilization over the whole experiment. The results of Experiment 2 were clearer in that herbage production and animal intakes were very similar on all treatments.

In both experiments the heavier slurry applications effectively smothered the sward. Sufficient time elapsed between spreading and grazing for rain to wash off the sward and for plants to grow up through the slurry blanket. Even so, a mat of fibrous material was still present at ground level when grazing began because of the relatively high DM content of the slurries used. The period between slurry application and grazing which is sufficient to allow satisfactory herbage intakes may not, of course, be the same as that required to avoid hazards from pathogens in slurry (8).

The application of slurry in January or March did not affect the heifers' herbage intake nor the time spent grazing, even in early May. There was, however, evidence from behaviour observations that the animals were better able to detect the slurry, or its effects, in the plots dressed at 75 or 100 t/ha in March. The pattern of grazing was slightly modified in that a bout of grazing was likely to be terminated earlier in the 100 t/ha in March treatment, suggesting that the animals found the herbage less palatable and moved on a few steps. During the periods of observation, the heifers were less likely to lie and to ruminate in plots treated with 75 or 100 t slurry/ha in March. This effect was apparent during the first and second grazing periods (end of April–May), but not in the fourth (June). Since the behaviour was sampled at two different times of day, it seems likely that on those plots with the heaviest and most recent slurry application the animals remained standing for a higher proportion of the two days of the grazing period. This might have resulted in more grazing in these plots, but it did not do so. The significant reduction in ruminating during the first grazing period is probably a consequence of the reduction in the time spent lying, but might reflect a difference in herbage intake which was not detected.

It is likely that the effects of slurry application on herbage production, animal intake and grazing behaviour recorded in these experiments would be modified by different soil and climatic conditions. Stocking density, known to have an effect on herbage utilization of pasture contaminated by dung pats (1), may also have an important bearing in situations where slurry is spread on grazing areas.

ACKNOWLEDGEMENTS

The authors wish to thank Mrs R. J. Fulford for statistical analyses of agronomic data, and Miss B. J. Goldstraw and Miss S. Rae for technical assistance.

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(*No. 998. Received for publication 24 November 1973*)

Printed in Great Britain