ID # 21-18

EFFECT OF APPLICATION OF FARMYARD MANURE TO LEY ON FORAGE YIELD AND QUALITY OF GRASS SILAGE

T.M. Pauly[1] and L. Rodhe[2]

[1] Swedish University of Agricultural Sciences (SLU), Dept. of Animal Nutrition, SE - 753 23 Uppsala, Sweden; [2]Swedish Institute of Agricul

07 Uppsala, Sweden.

Abstract

A two-year field trial was performed on ley near Uppsala, Sweden, with the following treatments (3 plots/treatment): A, no manure or fertiliser; B, manure applied in Oct.; C, manure applied in Oct. followed by rolling plots in May; D, manure applied in May; E, mineral fertiliser only. Apart from cattle manure, plots allocated to treatments B, C and D received the same amount of mineral nutrients as treatment E. The objective of this experiment was to get an indication of how different times of manure application (before or after the growth period) affected forage yields and the quality of the resulting silage. Annual forage yields (2 cuts /year) did not differ significantly in either year among treatments that received manure. Only the unfertilised control treatment (A) had a significantly lower yield. No differences were found between treatments that received only mineral fertilisers (E) or mineral fertilisers and manure (B, C and D). The 1998 ensiling experiment resulted in a very low overall silage quality, indicated by excessive formation of ammonia and very high counts of *Clostridium* spores (>10^6 cfu/g silage). In 1999, the best silage, with the lowest counts of *Clostridium* spores (<50 cfu/g), was produced from plots, which received manure in Oct. and were rolled in May (C). The same treatment without rolling in May (B) resulted in silage with a significantly higher pH, more butyric acid, and more *Clostridium* spores (>10^5 cfu/g). Other silage from manured plots, particularly that made from unchopped forage, also had high counts of *Clostridium* spores.

Keywords: silage quality, spores, *Clostridium*, cattle manure, fertiliser.

Introduction

Field trials in Scandinavia have shown that the application of cattle manure to cultivated grassland might be sufficient to maintain a good P and K status in the soil. However, earlier work suggested that there might be a risk of the silage being of low hygienic quality from a manured ley, particularly when solid or semi-solid manure was applied. However, this problem did not arise with slurry if it was applied to the ley directly after the cut (Rammer et al., 1994). The main risk associated with the application of farmyard manure is of getting clods of manure in the harvested forage (Rammer and Lingvall, 1997). When this forage is ensiled, there are frequently large numbers of clostridial spores multiplying in the silage, resulting in low silage quality, high spore counts in faeces and, usually, spore-contaminated milk (contaminated through faeces on the cows' teats). Spore contamination lowers the value of the milk because it becomes unsuitable for the production of many types of hard cheese. Swedish advisors recommend autumn (Oct.) as an appropriate time for applying solid farmyard manure to ley. This recommendation has, however, not been verified by research work. In this study we investigated how the forage yield and quality of the resulting silage was influenced by the time of the manure application.

Material and methods

In 1998 and 1999, a randomised block trial with 5 treatments was conducted near Uppsala, Sweden (60°N, 18°E). Manure from dairy cattle (19% DM, 0.42% fresh weight of N) was applied on 3 ley plots per treatment. The 5 treatments were: A, no manure or fertiliser; B, manure applied in Oct.; C, manure applied in Oct. followed by rolling the plots in May;, D, m – Manure applied in May;, E, m – Mineral fertiliser only. The main vegetation period in this region ilasts from May to October, with February as the coldest month (mean temp. –4°C) and July as the warmest (mean temp. 17°C). The manure was applied with a modified precision spreader at a rate of approx. 25,000 kg/ha. All plots, except treatment A, received the following amounts of mineral nutrients (in kg / hectare): in May, 110 kg N, 25 kg P and 100 kg K; after the first cut in June, an additional 50 kg N. The soil is heavy clay; the rainfall between April and August was 319mm in 1998 and 176 mm in 1999. The botanical composition of the ley was predominately timothy (*Phleum pratense*) and meadow fescue (*Festuca pratensis*). Forage yields were determined by weighing and DM determination for each plot at both the first cut in June and the second cut in August. The fresh forage from the first cut (21-28% DM) was ensiled in small laboratory silos. The forage from 3 plots per treatment was mixed, chopped in at the cutter head (all treatments) or left unchopped (D & E only) and ensiled in 3 silos per treatment. Silos were stored for approx. 100 days at 25±2°C before they were opened and sampled for analysis of silage quality. Dry matter (DM) content was determined by drying for 16 hrs at 65°C followed by milling through a 1 mm sieve and a seco 5 hrs at 105°C. DM contents were corrected for lost volatiles (Rammer, 1996). The pH of the silage juice was measured with a common pH-meter (Metrohm 654). Total nitrogen content was determined by Kjeldahl technique (Bremmer & Breitenbeck, 1983) and ammonia nitrogen by direct distillation on a Kjeltec

Auto System 1030. Lactic and butyric acid content of the silage juice was determined by HPLC technique (Andersson & Hedlund, 1983). *Clostridium* spores were enumerated after 5 d anaerobic cultivation at 37°C on supplemented RCA medium (Jonsson, 1990). Results were evaluated for each year separately.

Results and discussion

In 1998 and 1999, composite forage yields from both the first and second cut did not differ significantly among plots which received manure (average: 1998, 10400 kg DM/ha; 1999, 5750 kg DM/ha). Only the unfertilised control treatment (A) had a significantly lower yield (ca. –55%). No differences were found between the plots manured at the beginning of the growing season (D) and those manured at the end (B, C) nor between treatments which received only mineral fertilisers (E) or mineral fertilisers and manure (B, C, D). Some differences between treatments occurred in the first cut, but low yields were compensated in the second cut and therefore did not affect total yield. The 1998 ensiling experiment resulted in an very low overall silage quality (Table 1), indicated by very high counts of *Clostridium* spores (>10^6 cfu/g silage). Differences between treatments were small. In 1999, there were more pronounced differences between treatments (Table 1). Silage produced from plots which received manure in Oct. and were then rolled in May (C) contained very low numbers of *Clostridium* spores (<50 cfu/g), in contrast to the same treatment with no rolling in spring (B); this had a significantly higher pH, more butyric acid and more *Clostridium* spores (>10^5 cfu/g). Rolling in early spring might have integrated the manure clods into the surface soil, thus reducing the amount of manure that could contaminate the forage at harvest (in a similar way to the rolling of mole hills to avoid contamination by soil). Other silage from manured plots, or silage made from unchopped forage, had high counts of *Clostridium* spores. In conclusion, differences in forage yield resulting from different application times were rather small. For silage quality, the treatment with manure application at the end of the growing season and rolling at the beginning (C) appeared to be the most promising.

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Table 1 - Chemical composition and spore counts of silage after approx. 100 days of storage. Viable counts of *Clostridium* spores in $\log_{10}$ cfu/g silage (cfu = colony-forming units). $LSD_{0.05}$ is the least significant difference between treatments at 5% probability level.

Analyses	Treatments							$LSD_{0.05}$
	A Control chopped	B Manure in Oct. chopped	C Manure in Oct. + rolling chopped	D Manure in May chopped	D Manure in May long	E Mineral fertiliser only, chopped	E Mineral fertiliser only, long	
1998								
DM content, %	26	22	22	22	26	23	25	1.2
pH	4.8	5.7	5.8	5.7	5.3	5.7	5.2	0.2
Ammonia-N, % of total N	11	30	31	33	19	23	15	3.9
Lactic acid, % fresh weight	0.4	<0.1	<0.1	<0.1	0.2	0.1	0.5	0.2
Butyric acid, % fresh weight	0.5	0.9	0.8	1.1	0.8	0.7	0.3	0.2
Clostridium spores, log cfu/g	6.5	6.5	6.5	6.4	6.4	6.5	6.1	0.2
1999								
DM content, %	29	28	27	27	28	28	26	1.1
pH	4.0	4.5	4.2	4.2	4.5	4.1	4.9	0.3
Ammonia-N, % of total N	5	10	8	7	9	7	12	2.8
Lactic acid, % fresh weight	1.4	1.2	1.6	1.5	1.1	1.7	0.6	0.4
Butyric acid, % fresh weight	0.04	0.4	<0.02	0.2	0.1	<0.02	0.2	0.3
Clostridium spores, log cfu/g	2.3	5.4	<1.7	4.7	5.6	<1.7	6.1	1.3