MINERAL INTAKE AND UTILIZATION BY DAIRY COWS OFFERED GRASS FERTILIZED WITH DIFFERENT LEVELS OF NITROGEN

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ABSTRACT

In four zero-grazing experiments, the effects of N fertilizer (450 to 300 to 150 kg/ha/yr) on intake and utilization of some grass minerals (Ca, P and Mg), were investigated. Grass was offered ad lib to 12 cows per N treatment. A reduction in N fertilizer resulted in lower mean contents and intakes of Ca and Mg while P content and intake increased in late summer/autumn. The output of these minerals in milk and urine was relatively low. Therefore, a reduced intake of Ca and Mg resulted in a lower faecal output of these minerals. The ratio between intake and requirement varied for Ca between 141% and 210%, for P between 115% and 140% and for Mg between 73% and 97%. Nevertheless, no signs of hypomagnesemia were obtained at the lowest levels of Mg intake as a consequence of a reduction in N fertilizer.

KEYWORDS

grass, N-fertilization, minerals, intake, utilization.

INTRODUCTION

Because of environmental pollution due to N-losses as ammonia volatilization and nitrate leaching, the disadvantages of an intensive grassland management with high nitrogen application levels, became more and more realized in the Netherlands. In order to reduce these N-losses to the environment, grass has to be fertilized with reduced amounts of N. Besides the effects of reducing N fertilizer on protein and carbohydrate utilization, also the effect on mineral content (Ca, Mg and P), -intake and -utilization is important. With frequent cutting, a reduction in N fertilizer decreases Ca and Mg content, but increases P content (Minson, 1990). The objective of this study was to investigate the effects of reduced amounts of N fertilizer at similar yield of forage (1500 to 2000 kg/ha) on Ca, P and Mg content of grass and on intake and utilization of those minerals.

MATERIALS AND METHODS

Four zero-grazing feeding trial experiments with 36 dairy cows in each experiment were carried out in spring/early summer (May/June/July) of 1991 and 1992 and in late summer/autumn (Aug./Sept.) of 1992 and 1993. During 2 weeks of these trials which lasted 10 weeks in spring and 8 weeks in autumn, balance studies were carried out, using 9 cows (3 per treatment). Treatments were different rations (N_{450}, N_{300} and N_{150}) based on fresh daily-cut grass (mainly *Lolium Perenne*) fertilized at levels of 450, 300 and 150 kg N/ha/year, respectively. The botanical composition of grass, the scheme of nitrogen fertilization and the method of measuring DM-yield in the field has been published by Valk et al. (1996). In addition to fresh grass, cows received 2 kg compound in spring and 3 kg in the autumn experiments in two equal amounts twice daily after milking. In 1 kg of those compound feeds, Cr_2O_3 was added in a concentration of 4000 ppm.

During the weeks in which the balance study was carried out, intake and milk yield were individually measured during 3 consecutive days. Milk samples were taken during 2 consecutive days and analyzed for Ca, Mg and P. Faecal output was measured using the Cr_2O_3-method by taking samples from every dung path excreted between 6.30h a.m. and 3.00h p.m. during 3 consecutive days. Samples were pooled and analyzed for DM, ash, Cr, Ca, Mg and P. The minerals were analyzed according to the procedure described by De Ruig (1986). Urine was quantitatively collected during 48 hours and urine samples from every patch were proportionally pooled and analyzed for DM, Ca, Mg and P.

Data were subjected to ANOVA, using per experiment the model: $Y_i = \mu + Nfer_i + \varepsilon_i$, where μ= mean, $Nfer_i$ = effect of N treatment and ε_i = standard error.

RESULTS AND DISCUSSION

In agreement with Minson (1990), Ca and Mg content of grass decreased in both seasons at decreasing levels of N fertilizer (Table 1). However, P content did not change in spring and was higher for low fertilized grass in late summer/autumn. Because grass was cut more or less at the same stage of maturity, no depression effect of N fertilizer on P content (Minson, 1990) might be expected. It was likely that in these experiments in which grass was only cut and removed from the field, less soil P was available at the high N fertilizer plots resulting in lower P contents of grass (Minson, 1990). Using the NRLO requirement system (Anonymous, 1990), the ratio between intake and requirement varied between 141% and 210% for Ca, 115% and 140% for P and 73% to 97% for Mg. Because output in milk was very constant and output in urine relatively low, the extra ingested amounts of these minerals were excreted in the faeces. A reduction of N fertilizer from 450 kg to 150 kg/ha/year reduced the faecal output of Ca and Mg with 25% and 20%, respectively. In late summer/autumn, faecal-P output was increased by approx. 25%.

Although Mg-intake on diet N150 in spring/early summer was 73% of the requirement, the output of Mg in the urine was 2.9 g, which was higher than the critical level of 2 g mentioned by Puls (1988). Also the mean Mg-concentration in the urine did not indicate signs of hypomagnesemia. It was likely that under these low Mg-intake levels, the absorption of Mg was increased in accordance with McDowell (1992).

In late summer/autumn, Mg-intake on N150 was only 8% lower than the requirement, but Mg production in the urine and the Mg-concentration were low indicating Mg-deficiencies. In those trials the Mg-intake from MgO, which was added to the compound, was relatively high (46%). It could only be speculated that the lower observed intake of N150 grass, which resulted in a lower amount of fermentable organic matter in the rumen in combination with a low Mg-content of grass and a relatively high passage rate of digesta through the rumen, negatively influenced the utilization of MgO.

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Table 1
Mineral composition of grass and intake and excretion of minerals by dairy cows offered grass fertilized with different amounts of nitrogen (N_{450}, N_{300} and N_{150}).

	Spring/early summer				late summer/autumn			
Treat	N_{450}	N_{300}	N_{150}	SE[1]	N_{450}	N_{300}	N_{150}	SE
Composition (g/kg DM)								
Ca	7.7[a]	6.6[b]	6.0[b]	0.4	9.0[a]	7.2[b]	6.8[b]	0.5
Mg	2.1[a]	1.7[b]	1.4[c]	0.2	2.1	2.0	1.7	0.3
P	3.8	3.7	3.8	0.3	3.3[a]	3.9[ab]	4.4[b]	0.5
Intake (g/cow/day)								
Ca	137[a]	127[a]	113[c]	6	169[a]	141[b]	122[c]	8
Mg	51[a]	45[a]	38[b]	5	54	56[a]	48[b]	4
P	71	73	73	1	73[a]	83[b]	84[b]	2
Faecal output (g/cow/day)								
Ca	101	88	81	15	135[a]	105[b]	93[b]	12
Mg	38	33	28	5	44	43	38	4
P	46	50	48	6	49	58	61	8
Urine output (g/cow/day)								
Ca	4.1	3.2	4.6	1.5	2.7[a]	2.3[a]	4.5[b]	1.7
Mg	3.4	3.9	2.9	1.3	4.2	2.6	1.6	1.6
P	0.2	0.2	0.2	0.05	0.2	0.2	0.2	0.05
Milk output (g/cow/day)								
Ca	27	29	28	1	28	29	26	3
Mg	2.5	2.3	2.3	0.3	2.7	2.9	2.5	0.2
P	22	21	21	1	20	23	20	2

[1] SE = standard error of the mean.
[a,b,c] Means in the same row with different superscripts differ significantly ($P<0.05$).