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HYPOMAGNESAEMIA AND DAIRY PRODUCTION

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SUMMARY

The milkfat production of dairy herds suffering from severe hypomagnesaemia was increased by the use of oral magnesium supplements during the first 3 months of lactation. The magnitude of the production response depended on the age distribution of the herd, extent and severity of hypomagnesaemia, level and type of feeding and amount of supplementary magnesium administered. The responses were usually greatest during the initial 4 to 6 weeks of supplementation and where prolonged underfeeding occurred amounted to 5.5-6.5 kg milkfat/cow (heifers excluded) over the whole period. Level of nutrition modified the production response, irrespective of any effects on serum magnesium concentrations, and under high planes of feeding the extra milkfat attributable to magnesium supplements amounted to 2 to 3 kg/cow. Carryover effects during the remainder of the lactation, after supplementation had ceased, virtually doubled these initial production responses. An additional benefit of magnesium supplementation was a marked reduction in the incidence of complicated metabolic disorder during calving.

INTRODUCTION

Recent surveys amongst 890 dairy herds throughout the Waikato, Rotorua and Bay of Plenty (Young *et al.*, 1979; P. W. Young, unpublished) have shown that one-third of the one million dairy cows in this region alone could suffer from hypomagnesaemia in late pregnancy and/or early lactation. The incidence was particularly high on the yellow-brown loam soils of the Matamata, Otorohanga, Southern Waipa and Northern Tauranga (Waihi) counties. Less than 30% of the herds in these areas had mean serum magnesium concentrations within the normal range of 1.7-3.2 mg %. Almost half the herds were below 1.5 mg % and about 10% were below 1.1 mg %. This paper summarises the results from a series of trials designed to study the effect of hypomagnesaemia on the productive performance of dairy cattle and to refine magnesium supplementation techniques to reduce its impact.

MATERIALS AND METHODS

Six trials were conducted from 1974 to 1979, five on the Waimate West Demonstration Farm (WW) in South Taranaki, and one on a

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private farm (M) in the Matamata district. Objectives for the trials were —

Trial 1 (WW, 1974/5):	Comparison of magnesium supplementation commenced prior to the onset of calving with that started on the fourth day after parturition.
Trial 2 (WW, 1975/6):	Evaluation of pasture dusting as a method of administering magnesium supplements to dairy cows during winter/spring.
Trials 3 and 4 (WW, 1976/8):	Examination of the effects of level of nutrition on the extent and severity of hypomagnesaemia in dairy cattle and the magnitude of milkfat production responses to magnesium supplements.
Trials 5 and 6 (WW, 1978/9; M, 1977/8):	Definition of the most economic magnesium dose rate for milkfat production responses.

The animals used in the trials were predominantly Jersey (WW) and FxJ (M.) and each treatment comprised at least 30 to 35 mature cows. These were allocated to treatments on a stratified randomisation based on production index, serum magnesium concentration, age, calving date and previous treatment. Calving commenced about August 1 and the cows were run together (except for nutritional plane comparisons and Trial 2) with the supplemented animals being dosed individually each day. Serum magnesium concentrations were determined for each cow fortnightly and milkfat production was recorded weekly. Supplementation was terminated in all trials in the first week of November and carryover effects on subsequent production were measured in Trials 1-4.

RESULTS AND DISCUSSION

Milkfat Production Responses:

Magnesium supplementation had no effect on the productive performance of heifers in any of the trials and hypomagnesaemia was seldom observed in such animals. Milkfat production responses in mature cows attributable to magnesium supplementation ranged from 2 to 7 kg/cow (Table 1) in the various trials. The actual responses have been standardised to a 70 day supplementation period to allow for small differences which occurred

TABLE 1: MEAN SERUM MAGNESIUM CONCENTRATIONS (±S.E.), MEAN DAILY PRODUCTION (MILK, TEST, MILKFAT) AND MILKFAT PRODUCTION RESPONSES DURING THE SUPPLEMENTATION PERIODS.

Trial Treatment	*Serum mg%*	*Mean Daily Production* *Milk l/cow*	*Test %*	*Milkfat kg/cow*	*Milkfat Responses kg/cow/70 d*
1. Calving:					
control	1.29 ± 0.26	12.5	4.8	0.60	
supplement					
(a) Pre + Post	2.00 ± 0.31	14.0	4.9	0.69	6.25***
(b) Post	1.88 ± 0.33	13.7	5.1	0.70	7.0 ***
2. Pasture Dust:					
control	1.53 ± 0.11	15.2	5.4	0.82	
supplement	1.86 ± 0.09	16.1	5.4	0.87	3.5 +
3. Nutrition:					
High Plane —					
control	1.32 ± 0.08	14.3	5.3	0.76	
supplement	1.94 ± 0.10	14.6	5.4	0.79	2.5 n.s.
Low Plane —					
control	1.23 ± 0.11	13.1	4.9	0.64	
supplement	1.81 ± 0.12	13.7	5.3	0.72	5.25**
4. Nutrition:					
High Plane —					
control	1.36 ± 0.11	16.0	5.4	0.86	
supplement	1.92 ± 0.06	16.2	5.5	0.89	2.0 n.s.
Low Plane —					
control	1.29 ± 0.15	13.2	5.1	0.67	
supplement	1.73 ± 0.14	13.7	5.5	0.75	5.5 ***
5. Dose Rate:					
control	1.39 ± 0.17	14.0	5.2	0.73	
5 g Mg	1.62 ± 0.15	15.1	5.1	0.77	2.75 +
10 g Mg	1.74 ± 0.14	15.2	5.2	0.80	5.0 **
15 g Mg	1.88 ± 0.02	16.1	5.0	0.81	5.5 ***
6. Dose Rate:					
control	1.37 ± 0.07	15.8	4.2	0.66	
5 g Mg	1.60 ± 0.06	17.4	4.3	0.74	5.5 ***
10 g Mg	1.72 ± 0.05	16.8	4.5	0.76	6.5 ***

+ $P < 0.10$

in the length of trials and mean calving dates between treatments. Productions for the 1 or 2 cows rejected each year from the unsupplemented (control) groups because of severe and recurring grass staggers have been excluded. While production responses in most trials were due to a combination of higher milk yield and milkfat test, there were exceptions in which a marked increase in one parameter or the other accounted for most of the extra production. Carryover effects during the remainder of the lactation usually doubled the production gained during the supplementation period.

The mean serum magnesium levels (Table 1), derived from all the blood samples taken from the control cows over the supplementation period, indicate the severe hypomagnesaemia which occurred in the various trials and the relatively small range in values between trials. The magnitude of the milkfat production response throughout any particular trial appeared to depend on interactions between stage of lactation, severity of hypomagnesaemia and level of nutrition. Treatment differences were usually greatest (10 to

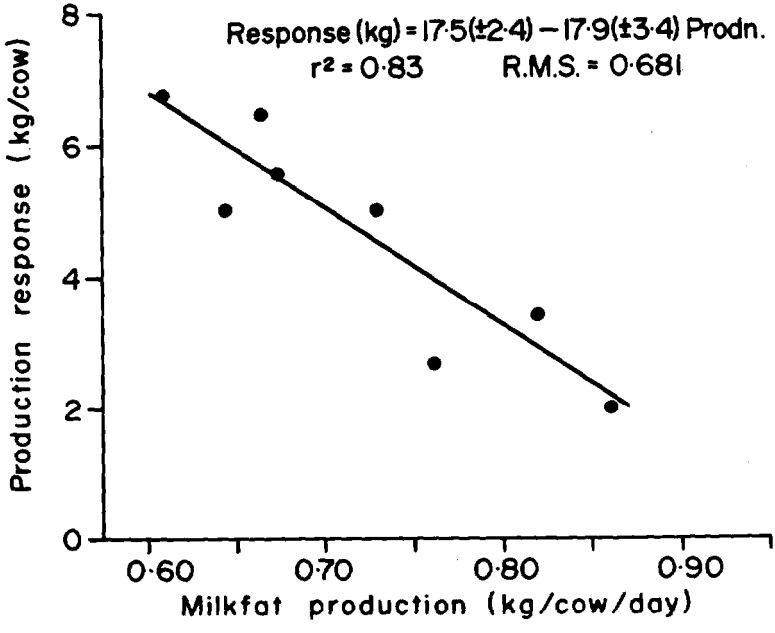

FIG. 1: *Relationship between production responses (kg/cow/70 d) to magnesium supplements in different trials and mean levels of milkfat production (kg/cow/d) in untreated cows.*

25%) during the initial 4 to 6 weeks of lactation. This generally coincided with periods when the cows were being underfed and serum magnesium concentrations were at their lowest level. Thereafter, the size of the production response fluctuated according to seasonal trends in serum magnesium concentrations and feed supply. The responses seldom exceeded 5% during the last month of supplementation unless abnormal climatic conditions prevailed, mean serum magnesium concentrations remained below 1.5 mg% and milkfat production levels in the control animals were below 0.70 kg/cow/d.

Nutritional effects, as reflected in the productive performance of the unsupplemented cows over the experimental period, accounted for 83% of the difference in production response between the various trials (Fig. 1) other than that due to magnesium dose rate. The greatest production increases from magnesium supplementation are clearly going to accrue under conditions of severe underfeeding during the first 3 months of lactation. When adjustments are made for the proportion of heifers in the herd (17 to 20%), and carryover effects, the additional production can amount to 8 to 10 kg milkfat/cow. Level of nutrition can modify the size of the production response (trials 3 and 4) irrespective of any beneficial effects on serum magnesium concentrations. Where very high planes of feeding are maintained, with the cows averaging in excess of 0.75 kg milkfat/cow/d, the extra production obtained over the whole lactation amounts to about 4 kg/cow. The main justification for the use of magnesium supplements under these circumstances would be to safeguard against metabolic disorders and act as a cushion against unexpected feed shortages.

DOSE RATE:

Insufficient data has been obtained to develop a model which will accurately predict milkfat production responses to various rates of magnesium supplementation at different levels of productive performance and degrees of hypomagnesaemia. The following equation

$$\text{Prodn Response (kg/cow)} = 24(\pm 1.5) - 34.4(\pm 2.3)\ \text{Prodn} + 2.4(\pm 0.17)\ \log \text{Mg dose (g/cow/d)}$$

[$r^2 = 0.99$, RMS = 0.024; 2 df]

was derived from Trials 5 and 6 and suggests that 10 g Mg/cow/d was probably the optimum economic dose rate under the conditions

prevailing in those trials. Additional increments of production at higher rates of supplementation would barely pay for the extra magnesium used.

Magnesium dose rate effects on serum magnesium concentrations would become important where a high incidence of grass staggers or hypomagnesaemic tetany was likely to occur. The mean values in Table 1 tend to obscure the marked variation which can occur in the responsiveness of individual cows to supplementary magnesium intake. At the 10 g Mg/cow/d rate there were still almost 10% of the respective herds below 1.0 mg% (Fig. 2) which is often regarded as the critical value in terms of susceptibility to tetany (Hemingway and Ritchie, 1965). Magnesium dose rates may therefore need to be increased substantially when severe tetany-provoking conditions prevail or where methods of administration are employed which are less efficient than individual dosing (Young, *et al.*, 1979).

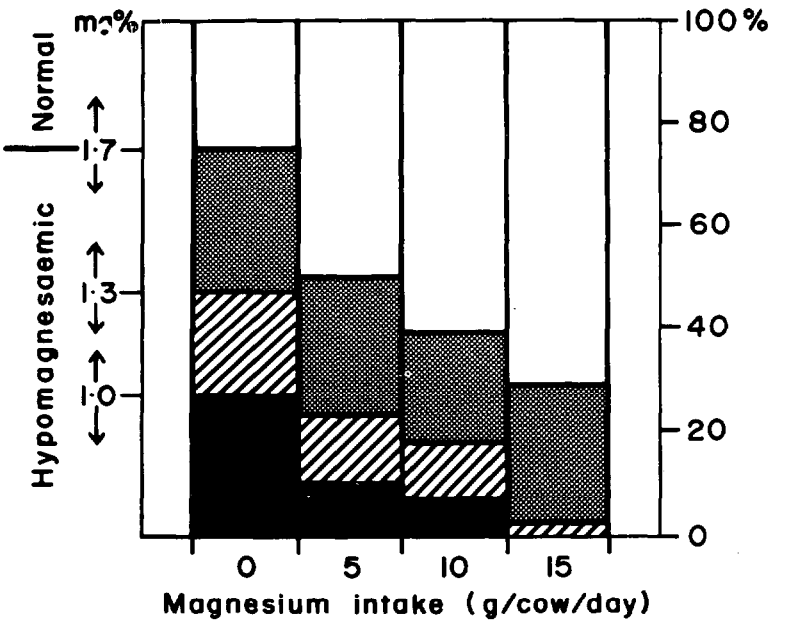

FIG. 2: *Proportions of herds within various serum magnesium level ranges at different supplementary magnesium intakes.*

METABOLIC DISORDERS:

Starting magnesium supplementation before calving did not confer a production advantage (Trial 1), but could have marked effect on the incidence of metabolic disorders over the calving period (Table 2). Supplementation commenced prior to or within 24 hours after parturition reduced the number of cases to about one third of that recorded in the untreated animals.

TABLE 2: METABOLIC DISORDERS DURING CALVING. (WAIMATE WEST — 4 YEARS)

	Unsupplemented	+ *Mg*
Cow deaths	11	4
Total cases	57	18
Clinical incidence %	22	7***

The predominant clinical signs in many of the cases in the unsupplemented cows were consistent with hypocalcaemia (milk fever) complicated by hypomagnesaemia. Analysis of serum samples from as many cows as possible immediately after calving supported this diagnosis.

While these results highlight the prophylactic value of magnesium supplementation, they also emphasise the importance of accurate diagnosis and the limitations in present knowledge of calcium/magnesium interactions in the aetiology of the milk fever/grass staggers syndrome.

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