
VOLUME 62 2002

Mineral nutrients in pasture species

I. S. CORNFORTH

Ruakura Soil and Plant Research Station
Ministry of Agriculture and Fisheries, Hamilton

ABSTRACT

Grazing animals obtain most of the mineral nutrients they require from pasture plants. Whilst a knowledge of plant composition alone is of limited value, it is one of a series of clues which can be used to help diagnose or predict animal mineral status. Factors which influence the concentration and availability of minerals in plants are summarised in an attempt to aid the interpretation of plant analyses.

Keywords Pastures; mineral composition; animal nutrition; trace elements

INTRODUCTION

Grazing animals obtain their mineral requirements from plants and therefore from the soil on which plants grow. Unfortunately this chain of supply is not as simple as it might appear. Management, season and weather influence the link between a particular soil and the plants which grow on it. Similarly the link between feed composition and the mineral status of animals is influenced by the amount and type of feed consumed, the presence of components which control nutrient absorption and on the health of the animal. The result is that in isolation, knowledge of soil type or properties, or of the mineral composition of a pasture sample cannot diagnose animal health problems associated with mineral status but may suggest the likelihood of a deficiency occurring.

The nutrient elements of greatest concern for livestock production in New Zealand are those for which plant and animal requirements are similar (P and S) and those for which animals have greater requirements than pasture plants (Na, Se, Co, I, Cu, Ca and Mg). Molybdenum must also be considered because in excess it can induce Cu deficiency in animals.

Conditions of Risk

Rather than prepare a detailed review of the influence of each environmental and management factor on the supply of each mineral nutrient, their effects have been summarised in Tables 1 and 2. Information in Tables 1 and 2 has been collected from many sources; the most recent review of the topic is by Reid and Horvath (1980). These tables indicate the soil, plant and

TABLE 1 Conditions of greatest risk for deficiencies of magnesium, calcium, phosphorus and sodium.

	Magnesium	Calcium	Phosphorus	Sodium
Season	Late winter/spring	Winter/spring	Winter	
Weather	Cool[1]/dull	Cool	Cool	
Pasture maturity	Young	Mature	Mature	Young
growth rate	Rapid	Rapid		
species	Grasses	Cocksfoot, Timothy	Grasses	Legumes, natrophobes[2]
Soil pH	Low[3]	Low	Low	
OM			Low	
moisture	Wet		Dry	
Stock	Cattle	Pigs, poultry	Cattle	
Soil contamination	Low			
Soil type	Sandstones, granites, YBL, YBPu	Leached sands, granites	Peats, high P retention soils, leached sands	Inland, free draining soils
Interactions	High K, N[4], Na	High K, N[4]		High K[5]

[1] K/Ca + Mg ratio and the risk of Mg deficiency also increases when warm weather follows a cool period.
[2] See Smith *et al.*, 1978.
[3] Mg supply is small in acid soils but Mg-free lime can decrease Mg uptake.
[4] Ammonium-nitrogen.
[5] Nitrogen fertiliser decreases the effect of excess K.
(YBL – Yellow brown loam; YBPu – Yellow-brown pumice soil).

TABLE 2 Conditions of greatest risk for trace element deficiencies

	Low copper	Low cobalt	Low selenium	Low iodine	High molybdenum
Season	Spring	Spring/summer	Late spring/ autumn	Summer	Late winter/spring
Pasture					
maturity	Old	Old	—	—	Young
growth rate	Rapid	Rapid	Rapid	Rapid	Slow
species	*Grass dominance, fescues*	Fescues, cocksfoot timothy, phalaris	White clover, paspalum, kikuyu	Goitrogens (W. clover, Cruciferae)	Clover dominance or yorkshire fog, cocksfoot
Soil					
pH	High	High	—	High	High
organic matter	High	High	High	Low	High
water	Dry	Dry	Wet	—	Wet
Stock	Calves	Lambs	Young stock	Newborn lambs	Cattle
Soil contamination	High	Low	Low	Low	High
Soil types or parent rocks (PR)	Peats, sands, podzols, shallow rendzinas, upland YB earths	SI granites, YBPu, Taupo & Kaharoa ash soils	Taupo & Kaharoa pumice, peats, N podzols, gleys, SI, YG earths, Manawatu sands, coarse acidic PR	Sands, inland SI areas sedimentary PR	Peats
Interactions	High S, Fe and Mo	High N	High S, P	High Ca intake	

(YBPu—Yellow-brown pumice soil; YG—Yellow-grey; YB—Yellow-brown)

seasonal conditions of greatest risk for the major and trace nutrients respectively. Table 2 also includes conditions associated with excessive concentrations of Mo in pasture.

Herbage Analysis

Interpreting herbage analysis is difficult because we do not know what or how much an animal eats, the availability of minerals in feed or the ability of the animal to absorb and store the minerals it consumes.

Estimates of animal requirements in terms of mineral concentrations in feed have been published (Reid and Horvath, 1980; Grace, 1983). These assume that nutrient availability in the feed is normal and that there is adequate feed. Mineral concentrations well in excess of these values usually allow us to eliminate those nutrients from suspicion unless large concentrations of elements known to interfere with nutrient availability suggest induced deficiencies.

Animals grazing muddy pastures also eat large amounts of soil. There is an unresolved debate on the need to wash pasture samples before analysis. Soil contamination greatly increases the apparent concentration of some nutrients, especially trace elements. Soil eaten with pasture can increase the supply of cobalt to animals but at the same time decrease the availability of copper. The degree of soil contamination on samples can be estimated from their iron content.

Relationships Between Herbage Analysis and Animal Mineral Status

Surveys have been made of the cobalt, selenium and copper status of stock in Northland (I. P. M. McQueen, pers. comm.) and the magnesium status of dairy cattle in the Waikato (Young *et al.*, 1979; C. Feyter, pers. comm.). Correlation coefficients between mineral concentrations in mixed herbage and serum Se, Cu, Mg and vitamin B_{12} in Table 3 indicate that

TABLE 3 Correlation coefficients between mineral concentrations in mixed herbage and in serum (I. P. M. McQueen and C. Feyter, pers. comm.)

Mineral	Sheep	Cattle
Cobalt[1]	0.587***	0.420***
Selenium	0.653***	0.823***
Copper	0.064	0.000
Available copper[2]	0.168	0.269
Magnesium (July)		0.083
(Sept)		0.147

[1] Herbage Co correlated with serum vitamin B_{12}.
[2] Available copper calculated by the formula given by Suttle and McLauchlan 1976.

herbage analysis was a useful indicator of Se supply, was less valuable for Co and was of no value for Cu and Mg. Subsequent work by Clark (1983) indicates that animal tissues (serum and liver) are more reliable than pasture samples for predicting the response of lambs to supplementation with vitamin B_{12}.

Mineral Status of New Zealand Pastures

Smith and Middleton (1978) and Smith and Cornforth (1982) summarised data on the mineral status of New Zealand pastures. The compostition of pasture samples from nearly 6000 sites was compared with estimates of animal requirements. While accepting uncertainty about the animal requirements and the weak link between herbage composition and animal mineral status emphasised throughout this paper, the incidence of samples which contain less Na, P and Mg than the estimated requirements of dairy cows must be cause for concern. For example, about 25% of all samples contained less than 0.1% Na while in some districts the proportion was as great as 70%. Similarly from 8 to 36% of samples from North Island districts contained less Mg than the estimated requirements of dairy cows. Of the 1540 Waikato pasture sites surveyed, 28% contained less than 0.2% Mg. The survey of Mg status of dairy cows already referred to (Young *et al.*, 1979) found that half the 120 herds examined in the Matamata area had serum Mg values less than 1.5 mg/100 ml. In this example the herbage survey underestimated the severity of the Mg supply problem.

CONCLUSION

While plant composition alone is of limited value in predicting or diagnosing animal mineral status, it is one of a series of clues which, when assessed together, improve our ability to identify mineral deficiencies. These clues include all the soil, plant, seasonal and management factors which influence the composition of plants and the availability of plant minerals to animals.

REFERENCES

Clark R. G. 1983. Diagnostic data as a basis for mineral therapy in poor lamb growth. Lamb Growth. *Ed.* A. S. Familton, Lincoln College. pp. 193-212.

Grace N. D. 1983. A summary of the mineral element requirements of sheep and cattle. The mineral requirements of grazing ruminants. *Ed.* N. D. Grace. *New Zealand Society of Animal Production Occasional Publication No. 9:* 135-141.

Reid R. L.; Horvath D. J. 1980. Soil chemistry and mineral problems in farm livestock. A review. *Animal feed science and technology* **5:** 95-167.

Smith G. S.; Cornforth I. S. 1982. Concentration of nitrogen, phosphorus, sulphur, magnesium and calcium in North Island pasture in relation to plant and animal nutrition. *New Zealand journal of agricultural research* **25:** 373-387.

Smith G. S.; Middleton K. R. 1978. Sodium and potassium content of topdressed pastures in New Zealand in relation to plant and animal nutrition. *New Zealand journal of experimental agriculture* **6:** 217-225.

Smith G. S.; Middleton K. R.; Edmonds A. S. 1978. A classification of pasture and fodder plants according to their ability to translocate sodium from their roots into aerial parts. *New Zealand journal of experimental agriculture* **6:** 183-188.

Suttle N. F.; McLauchlan M. 1976. Predicting the effects of dietary molybdenum and sulphur on the availability of copper to ruminants. *Proceedings of the Nutrition Society* **35:** 22A.

Young P. W.; O'Connor M. B.; Feyter C. 1979. Importance of magnesium in dairy production. *Proceedings Ruakura Farmers' Conference* 110-120.