UTILISING SOIL AND PLANT ANALYSIS FOR THE PREVENTION OF COBALT DEFICIENCY IN NEW ZEALAND.

M B O'Connor[1], J Waller[1], J Morton[2] and M F Hawke[3]

[1] AgResearch, Ruakura Agricultural Research Centre, Private Bag 3123, HAMILTON

[2] AgResearch, Agricultural Research Centre, Private Bag 50034, MOSGIEL

[3] Private Bag 3020, ROTORUA

ABSTRACT

The addition of trace elements to fertiliser is a well accepted method of overcoming deficiencies in plants and animals in New Zealand. Cobalt sulphate, for instance, is commonly added to fertiliser to prevent Co deficiency in grazing animals. New Zealand farmers annually apply 130 tonnes of cobalt sulphate to permanent pastures at rates up to 350g/ha/annum. Cobalt deficiency is normally diagnosed by the analysis of animal tissues or plant material. Soil Co analyses have traditionally been considered unsatisfactory for diagnostic purposes. Research, however, suggests that the relationship between soil and plant Co for particular soils is sufficiently promising to consider using soil Co analysis as an advisory tool for predicting the likely Co status of pasture. Soil Co "reserves" can then be modified by fertiliser Co usage to provide conditions which will minimise the likelihood of Co deficiency occurring in grazing animals.

KEYWORDS

Trace elements, cobalt, soil testing, grazing animals

INTRODUCTION

The addition of trace elements to fertiliser is a well accepted method of overcoming trace element deficiencies in plants and animals in New Zealand. Cobalt, copper, selenium, molybdenum and boron are commonly applied in this way. Cobalt deficiency in animals is widespread in many areas of New Zealand. It is controlled by the regular application of cobalt sulphate mixed with fertiliser or by injection of stock with vitamin B_{12}. Annually the farming sector in New Zealand applies 130 tonnes of cobalt sulphate to pasture at rates varying from 60 to 350g/ha depending on previous usage. Diagnosis of cobalt deficiency is usually by analysis of animal tissue (vitamin B_{12} analysis of serum and liver) or plant samples (critical level 0.08ppm for sheep, 0.04ppm for cattle). Soil Co analyses have been considered unsatisfactory for deficiency diagnosis.

This paper discusses recent research which suggests the use of EDTA extractable soil cobalt as an advisory tool in determining likely pasture Co status and hence assisting in the prevention of cobalt deficiency in grazing animals.

EXPERIMENTAL

Between 1991 and 1995 five on-farm surveys were conducted in different areas of New Zealand involving 560 farms in total and covering a range of major soil groups. Duplicate soil and pasture samples were taken from each property for analyses. Information on Co topdressing history was obtained from the farmers. Animal tissue samples (lamb livers) for vitamin B_{12} analysis were obtained on 78% of the farms surveyed. Pasture samples were analysed for Co and Fe and soil samples for EDTA extractable Co (Sherrell, 1990) and Mn content.

Statisical analysis involved the use of a Bayesian smoothing technique (Upsdell, 1994) to estimate the fitted values and their confidence intervals for the pasture Co/EDTA extractable soil Co relationship. Relationships were estimated for some of the major soil groups in New Zealand. Adjustments were made for soil Mn which is implicated in soil Co availability (Adams et al, 1969).

RESULTS AND DISCUSSION

The relationship between EDTA extractable Co and pasture Co is shown in Figure 1 for yellow-brown pumice soils in the Central North Island of New Zealand. Soil Co and soil Mn together accounted for approximately 36% of the variation on pasture Co. Although other surveys in the series accounted for a lot less of the variation we believe more controlled trial work e.g. using fixed monitoring sites, would improve the relationship considerably.

An alternative presentation of the data considers the percentage probability of obtaining a certain pasture Co concentration given a range of soil Co values. For example, we know the critical concentration of Co in the pasture for sheep is 0.08ppm (Clark and Millar, 1983). The question really is what level of EDTA extractable soil Co is needed to exceed this critical concentration of 0.08ppm in the pasture. Soil Co levels required for an 80% probability of achieving 0.08ppm in pasture (80% is considered attainable), adjusted for soil Mn status, are shown in Figure 2. Values range from 0.75 to 1.7ppm across the various soil groups.

In practice on a YBP (yellow-brown pumice soil) if the Co status was 1.4 instead of 1.7ppm, then the calculations suggest it would require 350 g/ha/annum of Co SO_4 for 3 years to raise the soil Co "reserve" to 1.7ppm. Similar calculations could be made for other soil groups shown in Figure 2.

The approach of using soil Co (EDTA - Co) as an indicator of "reserve" Co in the soil and relating this to the probability of achieving above a critical level in the herbage shows promise. The approach is not aimed at diagnosing a deficiency of Co but rather as an advice tool aiming at achieving conditions which will minimise the likelihood of Co deficiency occurring in grazing animals. The approach may well be possible for other trace elements e.g. copper.

REFERENCES

Adams, S.N. Honeysett, J.L., Tiller, K.G., Norrish, K. 1969. Factors controlling the increase in cobalt in plants following the addition of cobalt fertiliser. Australian Journal of Soil Research **7**: 29-42.

Clark, R.G., Millar, K.R. 1983. Cobalt *in* The mineral requirements of grazing ruminants. N.D.Grace ed. New Zealand Society of Animal Production, pp 27-37.

Sherrell, C.G. 1990. Effect of Co application on the cobalt status of pastures. 2. Pastures without previous cobalt application. New Zealand Journal of Agricultural Research **33**: 305-311.

Upsdell, M.P. 1994. Bayesian smothers as an extension of non linear regression. New Zealand Statistician. **29**: 66-81.

Figure 1
Relationship between EDTA-extractable soil Co and plant Co concentrations on yellow-brown pumice soils.

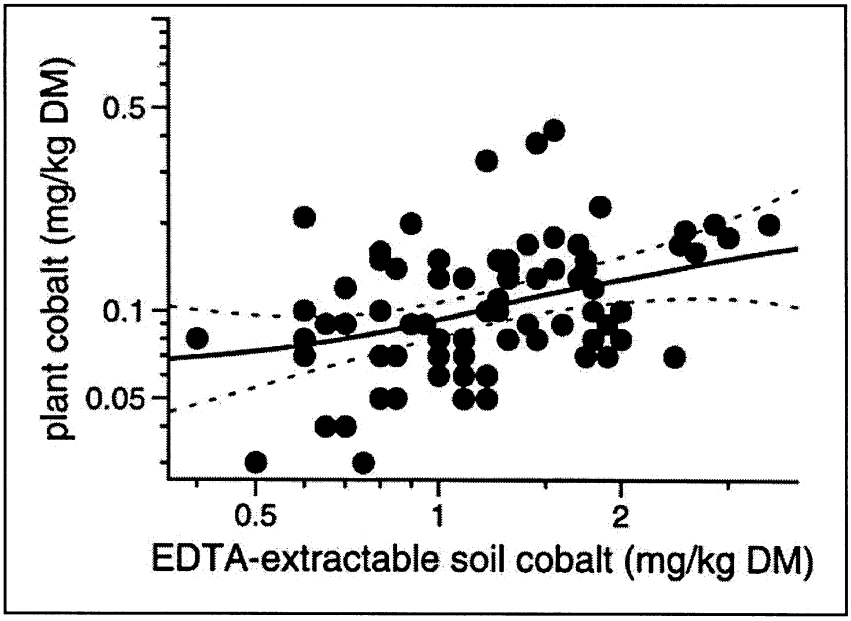

Figure 2
Relationship between soil and pasture Co using a probability approach. An 80% probability is considered attainable.