EFFECT OF CONTROLLED-RELEASE SELENIUM GRANULES APPLIED WITH FERTILISER ON BLOOD LEVELS OF GRAZING SHEEP

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Abstract

Two sheep grazing trials, at Awarua, Southland. and at Wairakei, central North Island, on selenium (&)-deficient and Se-retentive soils under a rainfall of about 1000 mm were used to test the duration of effectiveness of a mixture of standard and controlled-release Selcote® Se granules applied at 0.5 kg/ha each. Selenium concentrations in blood of ewes and lambs were maintained above deficiency levels for 2 years in both trials. Peak values were observed or inferred from both rapid-release and slow-release granules. The pattern of pasture Se was consistent with blood Se values where sampling was sufficiently intensive to allow for the low rate of granule application.

Keywords: Pasture, ewes, lambs, yellow-brown pumice soils, lowland yellow-brown earths, Selcote.

INTRODUCTION

Selenium (Se) granules were approved as a topdressing in 1982 for prevention of deficiency in grazing stock (Watkinson 1983). Since then they have been demonstrated to be long lasting, safe, economical, and flexible in timing and method of application. At the application rate of 1 kg/ha granules, equivalent to 10 g/ha Se as selenate, they can be either mixed with fertiliser or applied on their own at any time of the year.

Selenium is released quickly from the granule under moist conditions and uptake into the plant is rapid, reaching a peak within a week or two. Pasture Se then declines slowly, returning to the original level within 6-9 months on severely deficient soils (e.g. pumice soils), or after 20 to 24 months on marginally deficient soils (e.g. dryland Canterbury soils). Stock grazing from the time of application are fully protected for at least 12 months because of body storage of Se, but stock brought in and grazed on pasture 6 to 9 months after application on pumice soils have little protection until the next application of Se (Watkinson 1983, 1987). Up to 15% of applied selenate is taken up by the pasture, leaving at least 85% of the selenate in the soil (Watkinson 1983), which is reduced to selenite sometimes within a few weeks (Watkinson, unpublished information), lowering its availability. There is therefore a need for a slow-release formulation to protect the selenate against reduction and spread the time interval for which Se is available to pasture plants so that stock are protected at all times over a 12- to perhaps a 24-month period.

METHODS

In joint work with Agtech Developments (NZ) Ltd, testing of slow-release products using field plot trials led to the development of a formulation which could release most of the Se at about 6 months after application. Two sheep grazing trials were carried out, under contract to Agtech Developments, on soils under a rainfall of over 1000 mm that would give low residual pasture Se (through microbial reduction and soil retention) under different climates. One trial was in Southland at Awarua on

Tisbury silt loam while the other was on a pumice soil at Wairakei. A mixture comprising 0.5 kg/ha standard Selcote® granules and 0.5 kg/ha controlled-release Selcote granules was used, the standard product to give immediate protection and the controlled-release formulation longer protection. Lambs and ewes were used because the blood levels of growing animals are lower than those of mature adults because of their increased requirement for growth under decreasing pasture Se concentrations (Watkinson 1983).

Control treatments and Se topdressing replicates were not included because Se topdressing on deficient areas increases natural baseline Se values of pasture and blood by up to about 50 times, so that treatment effects are always significant. In addition, most control animals would be unlikely to survive the 2 years of the trial, and therefore blood Se values at the end of the trial are compared with the initial values. Critical blood values for Se deficiency are 1 O-20 μg/l Se. Further, it is difficult to find animals for trial work in a deficient area that have not been already treated with Se, but as the effect of a Se drench on blood Se disappears within about 3 months, these animals are suitable for experimental work

Awarua Trial

This trial was run by the Southland Co-operative Phosphate Co. on their property at Awarua on Tisbury silt loam (lowland podzolised yellow-brown earth). Fifteen breeding ewes that had previously received a pre-lamb drench and, 3 months later, 15 lambs, were grazed for over 2 years on 3 paddocks of about 2 ha each, treated with Selcote granules in September 1985.

Wairakei Trial

A second trial was run at the MAFTech Wairakei Research Station on Waipahihi gravelly sand (yellow-brown pumice soil, very free draining). Selcote granules were applied on 21 March 1988, and 10 ewes and 10 lambs grazed the treated paddocks continuously for 2 years from 24 March 1988. Only 1 ewe and 7 lambs had not previously been treated with Se.

Samples and analysis

Two pasture samples were taken monthly, pasture growth permitting, dried and then ground for analysis. The Wairakei trial area was intensively sampled twice to give duplicate samples, while the Awarua trial area was sampled from only 1 or 2 caged areas until February 1987 when it was also sampled intensively. Whole blood samples, using heparin as an anticoagulant, were taken every 2 months for analysis. Pasture and blood were analysed for total Se by the method of Watkinson (1979).

RESULTS AND DISCUSSION

Se concentrations in pasture and blood for the two trials are shown in Fig. 1

Pasture Se

Topdressing granules at 1 kg/ha gave a very low density of particles per unit area and the less intensive sampling in the Awarua trial (Fig. la) picked up only some effect of the standard granules, in the October and November 1985 samples. Pasture Se in the samples taken more intensively from February 1987 were low and showed no clear pattern. Comparison of the 2 years shows that low values were consistently obtained over December-February, a period of high plant growth rate.

The effects of both standard and slow-release granules can be seen in the

Wairakei trial (Fig. 1 b), partly because of the intensive sampling and partly because the natural pasture Se levels were very low at about 10 μg/kg Se.

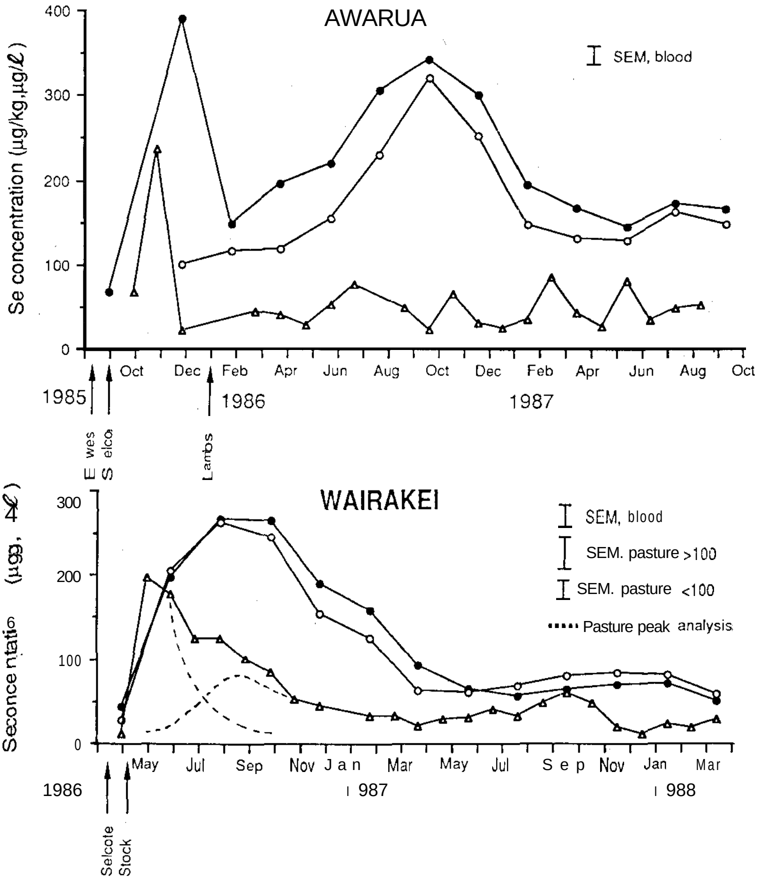

Figure 1: Selenium in pasture (Δ) and blood of ewes (●) and lambs (O) grazing pasture topdressed with standard Selcote (0.5 kg/ha) and controlled-release Selcote granules (0.5 kg/ha) in trials at Awarua (a) and Wairakei (b). The long- tailed pasture peak et Wairakei is analysed into 2 peaks (see text).

The increase in pasture Se concentration resulting from either applying sodium selenate mixed with fertiliser or in standard granules peaked within 1 month and, on pumice soil, returned to the initial level within 6-9 months (Watkinson 1967). In the Wairakei trial, the pasture Se peaked after 1 month and then declined slowly. This long-tailed peak can be regarded as the sum of two overlapping peaks: a large peak after 1 month from the standard granules and a smaller one immediately after the slow-release granules. Subtracting the exponential decay curve for the Se released by the standard granule from the observed data, gave a smaller peak, reflecting the Se contributed from the slow-release granules 5 or 6 months later in August-September (Fig. 1 b). This finding is consistent with earlier work showing a peak 6 months after application from similar slow-release granules (Watkinson, unpublished work). A small second peak in pasture Se was observed 12 months later in September 1987, while low pasture values associated with pumice soil, <20 µg/kg Se, were not seen until about 21 months after the application of the granules.

Blood Se

In both trials the blood Se levels in stock after 2 years on the Selcote-treated pasture was appreciably greater than levels that would have existed in stock not treated with Se.

Although all ewes in the Awarua trial had earlier received a pre-lamb Se drench giving an average blood Se before Se topdressing of 68±4 (SEM) µg/l Se, the levels of both ewes and 1985 lambs after 2 years on the Se treated area were well above this at 166±7 and 148±7 µg/l, respectively. Similarly, the blood Se of lambs in the Wairakei trial increased from 27±5 µg/l to 60±15 µg/l Se after 2 years, while the Se concentration in ewes increased from 1 Of3 µg/l (undrenched animals) to 53±12 µg/l Se.

The pattern of blood Se concentration versus time was quite different in the two trials. The Awarua trial showed a peak after about 3 months from the standard granules, followed by two broader peaks, the first much larger, after 12 and nearly 24 months from the slow-release granules. In the Wairakei trial, the first broad peak of blood Se concentration after about 5 months was evidently a combination of effects from the standard and slow-release granules, reflecting the slow tailing of the first pasture peak A second broad, shallow peak was observed after about 21 months, lagging the small pasture peak by about 3 months, typical of the pattern observed in other studies (Watkinson 1983). In both trials, therefore, the slow-release granules had an effect for approximately 12 months after that expected from the standard granules. The Awarua trial showed a greater delayed response than the Wairakei.

As found previously (Watkinson 1983), lamb blood was lower in Se than ewe blood. This was accentuated in the Awarua trial because lambs from untreated ewes started grazing the treated area only 3 months after application and did not derive any Se from the ewes before weaning. The blood Se of lambs was always lower than that of the ewes, but concentrations in the two groups of animals began converging after 20 months. In the Wairakei trial lambs grazed the treated area from the start of the study and their blood Se was the same as that of ewes for 4 months until pasture Se concentrations began decreasing. The lamb blood Se decreased more rapidly than that of ewes, but then responded more rapidly to the second pasture peak so that values exceeded that of the ewes for the last 5 months. These changes in relative blood levels of lambs and ewes can be explained in terms of increasing body weight in the lambs but not the ewes, on first decreasing then on increasing levels of pasture Se.

The slower response in blood Se to the slow-release granules in the Awarua trial could have been due to the granules having a slower release, or to an interaction of the granule with the soil-pasture environment. These differences, however, did not affect the overall result so that even with a faster response on the severely deficient pumice soil, the blood Se concentration of grazing stock was appreciably above those of Se-deficient animals (20 µg/l) 2 years after application of the mixture of Selcote granules.

In order to enhance the pasture Se concentrations from 20 months onwards for the pumice soil and to give a more uniform blood Se level it could be advantageous to increase the proportion of slow-release granules from 50% to 75% or more. Under these conditions, stock of unknown low Se status would have their status maintained or improved when brought on to a Se-deficient property at any time within 2 years of applying the granules.

CONCLUSIONS

Controlled-release Selcote granules increased the usefulness of Se topdressing by extending the time of effectiveness from 1 to 2 years for deficient and retentive soils under a rainfall of up to at least 1000 mm. Use of the new granules would permit mixing with fertiliser where it was applied every 1 or 2 years, or the option of applying the Selcote granules every 2 years on their own (Watkinson 1983) if fertiliser were applied less frequently.

Acknowledgements

Agtech Developments (NZ) Ltd for permission to publish information on trials with Selcote granules; G. Kirkman and N. Young of Southland Co-operative Phosphate Co. for running the trial on their property at Awarua; M. Fraser and R. Hunter of Wairakei Research Station for running the Wairakei trial; AA Judge and G.C. Milligan for assistance with selenium analyses.

References

Watkinson, J.H. 1979. Semi-automated fluorimetric determination of nanogram quantities of selenium in biological material. *Analytica Chimica Acta 105:* 319-25.

Watkinson. J.H. 1983. Prevention of selenium deficiency in grazing animals by annual topdressing of pasture with sodium selenate. NZ *Veterinary Journal 31:* 78-85

Watkinson. J.H. 1987. Annual topdressing of pasture with selenate pellets to prevent selenium deficiency in grazing stock: Research and farming practice in New Zealand. *Proceedings of the Third International Symposium: Selenium in Biology and Medicine. Part B*: 783-92. Edited by G.F. Combs, J.E. Spallholz, O.A. Levander, J.E. Oldfield. Published by Avi, New York. 1138 p.