The effect of Se-amended fertilisers on the Se status of grazing sheep

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Summary

Introduction

Selenium (Se) is an important trace element for sheep. Grazing pastures with Se concentrations <0.03 mg/kg DM results in an inadequate Se intake and poor animal performance. Ewes with blood Se concentrations <130 nmol/l are Se-deficient and will respond to Se supplementation in terms of a decrease in percent of barren ewes, increased percent of lambs, decreased perinatal mortality, as well as preventing white muscle disease in their lambs. Likewise, lambs with blood Se <130 nmol/l will respond to Se supplementation in terms of improved growth rates. Blood Se >250 nmol/l reflect an adequate Se status in sheep.

Selenium-amended fertilisers were developed and evaluated using sheep. This study reports a trial using Ravensdown Selprill Double in a Se-amended fertiliser and its impact on the Se status of grazing ewes and their lambs.

Study design

This study was designed to evaluate and compare Ravensdown Selprill Double with Selcote Ultra prill, providing 10 g Se/ha, in terms of changes in blood Se concentrations in grazing sheep.

The treatments, namely an untreated control, 0.5 kg Ravensdown Selprill Double, and 1 kg Selcote Ultra prill/ha were mixed with 15% potassiac superphosphate applied at the rate of 250 kg/ha in October 2004 on three 1-hectare farmlets. This is Day 1 of the study. After 4 weeks (Day 28) ten 14-month old Romney ewes were randomly placed on each farmlet. In early March 2005 two Suffolk rams were run with each small flock of 10 ewes. The ram groups were rotated around the flocks at weekly intervals over the six-weekly mating period. Lambing began in early September 2005 and lambs were weaned in mid December 2005.

Blood samples for Se determinations were collected from the ewes at Days 25, 65, 123, 157 (mating), 289, 346 (docking) and 427 (weaning). Blood was collected from the lambs at Days 357 and 425; that is, at an average of 4 and 13 weeks of age.

Pasture samples were taken over three 80-120 m transects/farmlet at 4-5 weekly intervals for Se determinations.

Results

Untreated pasture contained 0.01-0.03 mg Se/kg DM. The mean Se concentrations increased to 0.69 and 0.56 mg/kg DM within 29 days for pasture treated with the Ravensdown and Selcote prills, respectively. Regardless of the prill treatment the pasture Se concentrations then decreased to 0.07 mg Se/kg DM at Day 121, and to 0.04 mg Se/kg DM at Day 190, after which in the case of the Ravensdown prill treatment the Se concentrations decreased further to 0.03 mg/kg DM at Day 388. In contrast, for the Selcote prill treatment the pasture Se concentrations increased, to reach a peak of 0.2 mg/kg DM at Day 339, before decreasing again to 0.04 mg/kg DM.

The mean blood Se concentrations of the untreated ewes over the study decreased from an initial 754 nmol/l to 166 nmol/l at lambing, before remaining at about 200 nmol/l up to weaning. For ewes on the Ravensdown prill-treated pasture the mean blood Se concentration increased to 3,330 nmol/l at Day 123, before decreasing to 692 nmol/l at Day 425. In contrast, in the case of the ewes on the Selcote prill-treated pasture the mean blood Se concentration increased to 1,990 nmol/l at Day 65, before decreasing to 1,104 nmol/l at Day 289, after which it then increased to 1,500 nmol/l at Day 425.

Increasing the Se status of the ewe increased the Se status of her lamb. At docking the mean respective blood Se concentrations for the ewes and their lambs were: untreated control 202 and 134 nmol/l, Ravensdown prill 692 and 596 nmol/l, and Selcote prill 1353 and 993 nmol/l. Likewise, at weaning the mean respective blood Se concentrations for the ewes and their lambs were: untreated control 184 and 84 nmol/l, Ravensdown prill 603 and 467 nmol/l, and Selcote prill 1,850 and 1,580 nmol/l. The lambs from the ewes grazing the untreated control pasture were Se deficient and this was reflected in their poorer health.

Conclusions

Selenium-amended fertilisers are a very effective approach to increase and maintain an adequate Se status (i.e. >250 nmol/l) of a flock grazing Se-deficient (0.01-0.03 mg Se/kg DM) pasture for at least a year.

Introduction

The Se concentration of New Zealand pastures range from 0.005 to 0.07 mg/kg DM (Grant and Sheppard 1983). Pastures containing <0.03 mg/kg DM do not provide an adequate Se intake for grazing sheep and they will become Se-deficient (Metherell *et al* 1996; Grace and Knowles 2002). Flocks with a blood Se <100 nmol/l are characterised by a low lambing percent (19 vs 123%), high percent of barren ewes (28 vs 8%), a high mortality at 4 weeks of age (8 vs 79%), and the presence of white muscle disease in lambs (Metherell *et al* 1996). Likewise, lambs with a blood Se <130 nmol/l will respond in terms of liveweight gains (10-60 g/day) to Se supplementation (Grace and Knowles 2002). Blood Se concentrations of >250 nmo/l reflect an adequate Se status in sheep (Grace 1994). While fertiliser usage on sheep farms is not as great as for dairy farms, there are still opportunities to use Se-amended fertilisers to prevent Se deficiency in grazing flocks. The use of Se-amended fertilisers to prevent Se deficiency in sheep is well documented (Watkinson 1983).

This study was design to evaluate the efficacy of Ravensdown Seprill Double, and compare its responses in pasture and grazing sheep to a currently available commercial Se prill Selcote Ultra (Nufarm, Auckland, New Zealand).

Methods and Materials

Animals

The study was carried out on the AgResearch Flock House sheep farm, near Bulls in the lower North Island. The property has Se-deficient pastures (0.01-0.03 mg Se/kg DM), and responses in lambs to Se supplementation have been observed (Grace and Knowles 2003). Thirty 14-month Romney ewes were randomly divided into three groups of 10 animals and placed on a 1-hectare farmlet.

All procedures involving the sheep were approved by the Crown Research Institutes' Animal Ethics Committee, Palmerston North.

Treatments

The treatments for the sheep trial were:

Group 1, control pasture no Se-amended fertiliser applied.
Group 2, Ravensdown Selprill Double applied at the rate of 0.5 kg/ha to provide 10 g Se/ha.
Group 3, Selcote Ultra prills applied at the rate of 1.0 kg/ha to provide 10 g Se/ha.

The prills were mixed in 15% potash superphosphate which was applied at the rate of 250 kg/ha in early October 2004. This is Day 1 of the study. After 4 weeks, during which the rain "washed" the Se-amended fertiliser into the soil, the sheep were placed on their respective treatments in November 2004 (Day 28). The flocks were managed according to accepted New Zealand sheep farming practice.

The ewes were joined with the ram in early March 2005 (Day 152). Two Suffolk rams were run with each small flock, and these rams were rotated each week for 6 weeks to ensure there was no ram effect bias on the treatments. Lambing started in early August 2005 (Day 315), docking occurred in early September 2005 (Day 346), and they were weaned in mid December 2005 (Day 425).

Collection of samples

Pasture

Within each farmlet, pasture samples were collected along three 80-100 m transects prior to the start of study, and at about monthly intervals during the study. The herbage from the transects were then mixed thoroughly and subsampled for Se determinations.

Blood

Prior to placing the ewes on the experimental pastures (Day 25), and on Days 65, 123, 157 (mating), 289, 346 (docking) and 425 (weaning) blood was collected from the jugular vein using a 10 ml vacutainer containing K_3EDTA. Blood was also collected from their lambs at docking and weaning.

Chemical analyses

The Se concentrations in the pasture and blood were determined using the method of Watkinson (1979).

Results

Pasture Se

The pasture Se concentrations of the untreated pastures ranged from 0.01-0.03 mg/kg DM. Applying the Se prills to provide 10 g Se/ha (Figure 1) increased the mean Se concentrations to 0.69 and 0.56 mg/kg DM within 29 days for pasture treated with the Ravensdown and Selcote prills, respectively. Regardless of the prill treatment the pasture Se concentrations then decreased to 0.07 mg Se/kg DM at Day 121, and to 0.04 mg Se/kg DM at Day 190, after which in the case of the Ravensdown prill treatment the Se concentrations decreased further to 0.03 mg/kg DM at Day 388. In contrast, for the Selcote prill treatment the pasture Se concentrations increased to reach a peak of 0.2 mg/kg DM at Day 339, before decreasing again to 0.04 mg/kg DM.

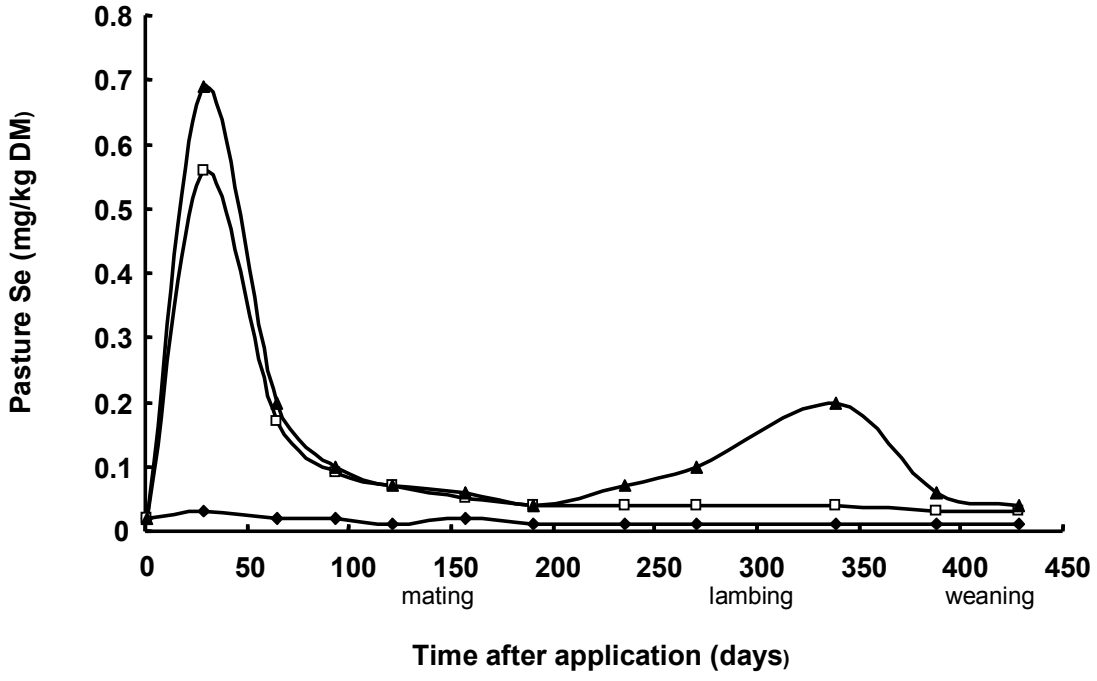

Figure 1. The effect of no Se (♦) and applying 10 g Se/ha as Selcote (▲) and Ravensdown (□) prills on mean pasture Se concentrations of sheep farmlets. Each data point is a mean of pasture sampled from 3 transects.

Blood Se

The mean blood Se concentrations of the untreated ewes over the study decreased from an initial 754 nmol/l to 166 nmol/l at lambing, before remaining at about 200 nmol/l up to weaning (Figure 2). For ewes on the Ravensdown prill-treated pasture the mean blood Se concentration increased to 3330 nmol/l at Day 123, before decreasing to 692 nmol/l at Day 367. In contrast, in the case of the ewes on the Selcote prill-treated pasture the mean blood Se concentration increased to 1,990 nmol/l at Day 65 before decreasing to 1,104 nmol/l at Day 289, after which it then increased to 1,500 nmol/l at Day 425.

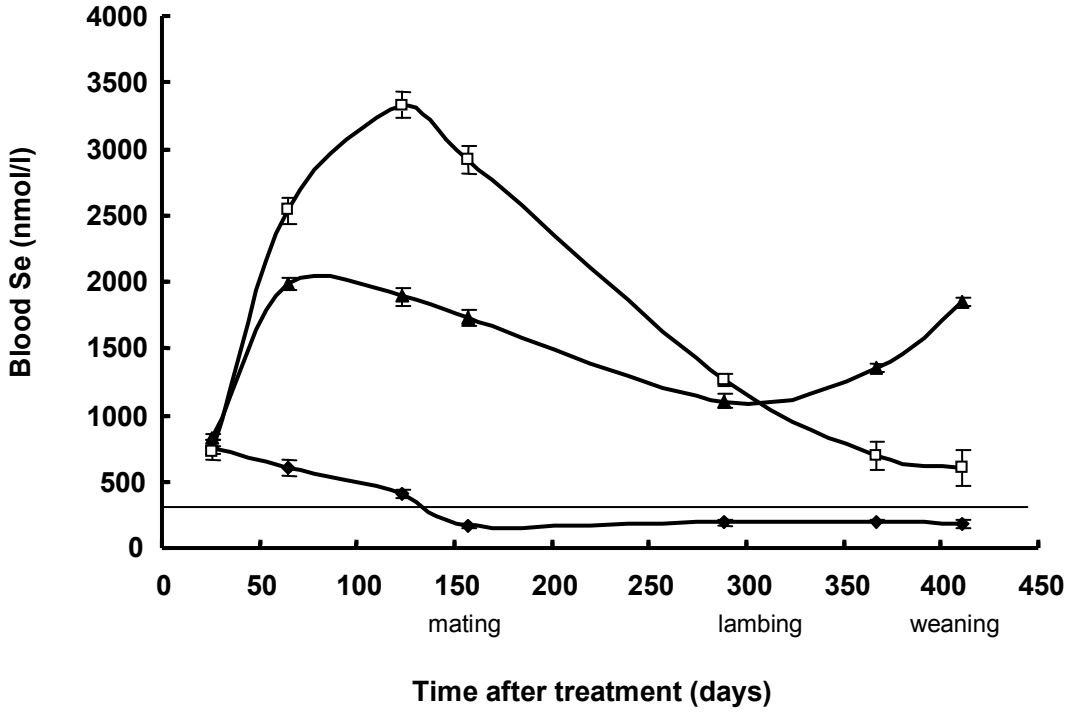

Figure 2. The effect of no Se (♦) and applying 10 g Se/ha as Selcote (▲) and Ravensdown (□) prills on mean blood Se concentrations of grazing ewes (n=14). Vertical bars represent standard errors. Values above the horizontal line at 250 nmol/l reflect an adequate Se status for sheep.

The effect of the ewe Se status, as determined by blood Se concentration, on the Se status of their lambs at docking (4 weeks old) and weaning (13 weeks old) is shown in Table 1.

Table 1. Effect of dam Se status, as determined by blood Se concentration (nmol/l), on the Se status of their lambs in flocks grazing untreated pasture and pastures treated with 10 g Se/ha as Ravensdown Se prills and Selcote Se prills.

	Ewe	**Lamb**	**Ewe**	**Lamb**
Age of lamb (weeks)		4		13
Untreated	202	134	184	84
Ravensdown prill	692	596	603	467
Selcote prill	1353	993	1850	1570

Lambs born to ewes with a high Se status also had a higher Se status from docking (4 weeks of age) through to weaning (13 weeks old), when compared with lambs from ewes with a low Se status as a result of grazing untreated control pastures. The lambs from ewes grazing untreated pastures were Se-deficient and in poor condition.

Discussion

Pastures containing <0.03 mg Se/kg DM do not provide adequate Se for sheep, and blood Se concentrations of <130 nmol/l are associated with an impaired reproductive performance (Metherell *et al* 1996), poor growth rates (Grace and Knowles 2002), and white muscle disease (Metherell *et al* 1996). Further, changes in blood Se concentrations are good indices of the Se status of a flock. The application of Se-amended fertilisers had a marked effect on the pasture Se concentrations, increasing them to 0.56-0.70 mg/kg DM within 29 days, before decreasing to 0.07 mg/kg DM after 121 days, and still remaining above 0.04 mg/kg DM after 339 days. The peak Se concentration reached in pasture, as well as the rate of decline, will be dependent on factors such as the application rate, the form of Se in the product, soil type and botanical composition. An application rate of 10g Se/ha is effective in increasing pasture Se concentrations and, thereby, increasing the Se intakes of grazing sheep without causing any Se toxicity problems. The maximum blood Se concentration observed in this study was 3,300 nmol/l, while blood Se concentrations of >13,000 nmol/L are considered to be in the toxic range (Hodges

et al 1986). Further, blood Se concentrations of 7,000 nmol/l with no associated animal health problems have also observed in an earlier trial where sheep grazed pastures topdressed with Se-amended fertiliser (Sanson 1990).

The observed profiles of changes in Se, that is, the increase and decrease in Se concentrations, in the pasture and blood Se are markedly different, particularly for the Ravensdown Se prill (Compare Figures 1 and 2). When daily Se intakes exceed Se requirements, sheep are able to "store" the Se in body proteins as seleno amino acids. However, if the Se intakes are inadequate then the Se status is maintained from the "stored" Se. These changes are reflected by the increase and decrease in blood Se concentrations. As there is a rapid increase followed by a marked decrease within 120 days in pasture Se concentrations, this means that for 90-100 days, the daily Se requirements of grazing livestock are exceeded and the Se is stored in the liver and other tissues. However, at low Se intakes blood Se concentrations remained elevated above 250 nmol/l, using tissue Se stores, for at least a further 250 days, thus ensuring an adequate Se status in the flock for at least 12 months.

In contrast to dairy farms, where most of the property is topdressed annually, the area topdressed on sheep farms is smaller. Using Se-amended fertilisers on a sheep farm is, therefore, likely to involve more planning and management to ensure that all the ewes graze pastures with a high Se content pre-mating. To be effective ewes should graze continually pastures that have been topdressed with Se-amended fertiliser for at least 16 weeks before being transferred to Se-deficient pasture. This management protocol will ensure that the blood Se concentration of the ewes will remain >250 nmol/l for 12 months (Millar and Meads 1987).

Conclusion

This study concluded that the application of Se-amended fertilisers, providing 10 g Se/ha, was a low labour input, cost effective, safe and efficacious approach to prevent Se deficiency in grazing sheep.

Acknowledgements

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