

Selenium supplementation alternatives for the South Island high country

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Abstract

Alternative methods of selenium (Se) supplementation have been evaluated in Merino sheep grazing irrigated pasture at Tara Hills Research Station near Omarama. Unsupplemented ewes and lambs were extremely Se deficient and production losses were high. Barium selenate (Deposel®) injections, intraruminal Se pellets (Permasel®) or the strategic grazing of recently Se-topdressed (Selcote®) pasture for at least one month pre-joining all gave a rapid and large rise in the Se status of ewes and met ewe requirements for 12 months. The barium selenate and intra-ruminal pellet treatments allowed a substantial transfer of Se to lambs at birth, and lambs would not require further Se supplementation until after weaning. With strategic grazing and oral treatments it is necessary to provide lambs with supplementary Se as early as possible. A single application of Selcote Ultra* prills at 1 kg/ha was effective in supplying adequate Se to Merino wethers for 24 months.

Keywords: Deposel, infertility, liveweight, Permasel, Selcote, Selcote Ultra, selenium, sheep, white muscle disease, wool

Introduction

Selenium-responsive diseases of sheep, cattle, deer and horses can be a very important limitation to livestock production in many areas of New Zealand (Andrews *et al.* 1968). The soils and pastures throughout most of the South Island hill and high country are selenium (Se) deficient. A variety of methods of Se supplementation are now available (Grace 1994), including the conventional direct administration of soluble Se compounds either orally or by injection; slow-release Se formulations for direct administration such as intraruminal Se pellets (Millar & Meads 1988) or barium selenate injections (Cawley & McPhee 1984); and Se topdressing with either rapid sodium selenate (Watkinson 1983) or slow-release barium selenate formulations (Watkinson 1989). The initial recommendations for Se topdressing with sodium selenate (Watkinson 1983) were based on complete coverage of

the grazed area on a farm to give protection to all stock for 12 months. However, on properties under extensive grazing and/or low stocking rates, complete coverage is an expensive method of supplementation. An alternative is the topdressing of limited areas of pasture for grazing at strategic times, such as mating, or the use of slow-release, direct-administration products.

This paper reports on two experiments in which alternative methods of Se supplementation have been evaluated with Merino sheep grazing irrigated pasture on a Mackenzie high country yellow-brown earth at Tara Hills Research Station near Omarama in North Otago.

Methods

Experiment 1

Groups of about 40 Merino ewes (4-5 years of age) and their lambs grazed extremely Se-deficient pastures (3-17 µg Se/kg DM) on irrigated flats at Tara Hills High Country Research Station, Omarama. Treatments first applied in April 1983 were:

1. Oral.

Oral dosing of ewes with 5 mg Se as sodium selenate, 3 weeks before joining with rams and 4 weeks pre-lambing; and of lambs with 2 mg Se at tailing (4 weeks of age) and weaning (10-12 weeks of age).

2. Deposel.

Subcutaneous injection of ewes in the neck with 50 mg Se as barium selenate paste (1 ml) (Deposel®; Robert Young & Co (NZ) Ltd. Petone), 3 weeks before joining.

3A. Selcote 4 week.

Grazing of recently Se-topdressed pasture (650 µg Se/kg DM), during the flushing and mating period, beginning 3 weeks before joining and continuing for 4 weeks.

4. Selcote 8 week.

Grazing of recently Se-topdressed pasture (650-550 µg Se/kg DM), during the flushing and mating period, beginning 3 weeks before joining and continuing for 8 weeks.

5A. Control A.

No Se supplementation.

In April 1984 new treatments added were:

3B. Selcote 4 week + Oral.

Ewes from treatments 3 and 4 were combined and grazed on recently Se-topdressed pasture (500 μg Se/kg DM) for 4 weeks during flushing and mating. Half of the lambs from this treatment received oral Se at tailing and weaning.

5B. Control B.

An additional control group of ewes that had received oral Se in the previous year.

6. Permasel.

Oral administration of an intra-ruminal Se pellet (Permasel[®]; Coopers Animal Health N.Z. Ltd), 3 weeks before joining.

Lambs in treatments 2, 3A, 4, 5A, 5B and 6 received no Se supplementation.

The Se-topdressed pasture for treatments 3 and 4 was topdressed 2 weeks before grazing with 1 kg Se prills/ha (10 g Se/ha as sodium selenate; Selcote[®]; Mintech (NZ) Ltd. Nelson) using 30 kg diammonium phosphate (DAP)/ha as a carrier. The pasture for treatments 1, 2, 5 and 6 was topdressed with 30 kg DAP/ha only.

Animals from all treatments were run together on low Se pasture except when treatments 3 and 4 were grazing Se-topdressed pasture. Groups were also separated during lambing. Ewes were joined in May, lambed in October and lambs were weaned in January.

Effects on ewe fertility, ewe liveweight and wool weight, the growth and survival of lambs, concentrations of glutathione peroxidase (a Se-containing enzyme, data not presented) and Se in blood were measured.

Experiment 2

In this experiment a slow-release Se fertiliser (Selcote Ultra[®], ICI CropCare Ltd) containing both sodium selenate and barium selenate was compared with a control treatment. Three adjacent paddocks were subdivided to give 3 replicates in a randomised block design. In October 1991, Selcote Ultra prills were applied at 1 kg/ha (10 g Se/ha) with superphosphate at 24 kg/ha as a carrier. Control paddocks received superphosphate only. Groups of Merino wether hoggets were introduced 2½ weeks later. The sheep continuously grazed control and treated paddocks. Measurements were made on 7 animals per plot. An additional 3 wethers per plot were introduced to the trial after 12

months (October 1992) and 18 months (May 1993). When indicated by low or marginal (Grace 1994) blood Se levels, and loss of condition, control treatment animals from the first, second and third groups were given a remedial drench with 5 mg Se as sodium selenate after 17, 10 and 3½ months respectively.

Pasture Se, liveweights, wool weights and blood Se were measured.

Results and discussion

Experiment 1

Untopdressed pasture was extremely Se deficient (3-17 μg Se/kg DM in year 1; 6-29 μg Se/kg DM in year 2), which was reflected in the poor performance of the control flocks. The Se concentration in the topdressed

Table 1 Effect of Se treatments on lambing performance (Experiment 1).

Year	Treatment	Ewes barren (% ewes joined)	Lambs born per ewe lambing	Lambs tailed per ewe mated
1983	1. Oral	8	1.30	0.98
1983	2. Deposel	5	1.32	1.23
1983	3. Selcote 4 week	0	1.25	1.15
1983	4. Selcote 8 week	7	1.39	1.20
1983	5. Control	28	1.26	0.19
1984	1. Oral	17	1.33	1.02
1984	2. Deposel	27	1.34	0.95
1984	3. & 3B. Selcote 4 week	22	1.21	0.88
1984	5A. Control (2 year)	67	1.30	0.20
1984	5B. Control (1 year)	33	1.32	0.41
1984	6. Permasel	26	1.34	0.85

Figure 1 Pasture Se after topdressing with sodium selenate (Selcote[®]) in 1983 and 1984, and with slow-release Se fertiliser (Selcote Ultra[®]) in 1991.

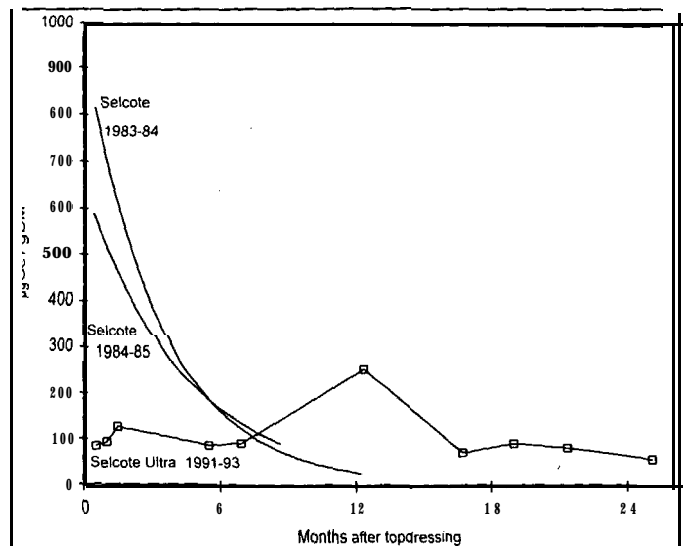


Table 2 Effect of Se treatments on ewe liveweights (corrected for the effect of pregnancy status) and wool production (corrected for the effects of liveweight and pregnancy status) (Experiment 1).

Treatment	Ewe liveweight May 1985	Ewe wool weight September 1984
1. Oral	52.5	3.99
2. Deposel	54.9	4.03
3 & 3B. Selcote 4 week	53.5	4.14
5A. Control (2 year)	51.0	3.59
5B. Control (1 year)	50.3	3.91
6. Permasel	54.2	3.94
Approx SED [†]	1.5	0.14

[†] SEDs for different comparisons vary slightly because of unequal replication.

Table 3 Effect of Se treatments on lamb mortality (% of lambs born) (Experiment 1).

Year	Treatment	4 weeks age (tailing)	Cumulative mortality % 18-20 weeks age (March)
1983-84	1. Oral	19	19
1983-84	2. Deposel	2	4
1983-84	3. Selcote 4 week	8	34
1983-84	4. Selcote 8 week	8	13
1983-84	5. Control	79	100
1984-85	1. Oral	7	12
1984-85	2. Deposel	3	8
1984-85	3A. Selcote 4 week	16 #	22
1984-85	3B. Selcote 4 week + Oral	0 #	0
1984-85	5A. Control (2 year)	54	61
1984-85	5B. Control (1 year)	54	85
1984-85	8. Permasel	15	21

NB Management of treatments 3A and 3B was identical at this stage.

Figure 2 Blood Se (nmol/l) profiles in ewes with different methods of Se supplementation (experiment 1). A) Deposel®, Selcote®, Permasel™. B) Oral and Control treatments. Note different scales.

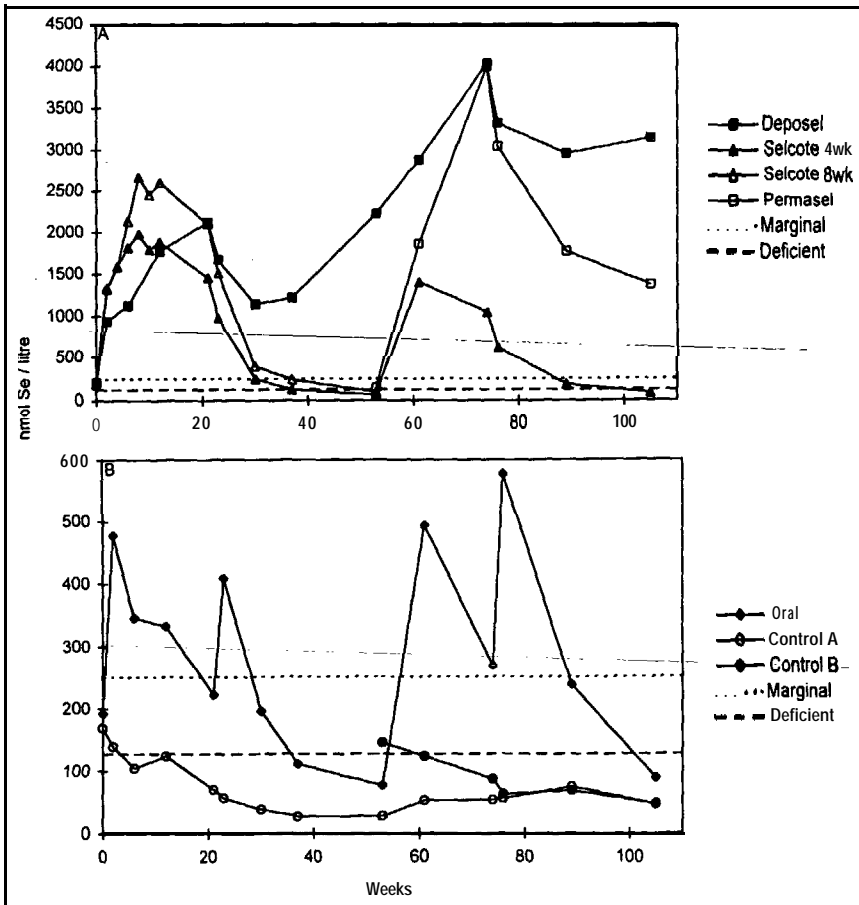
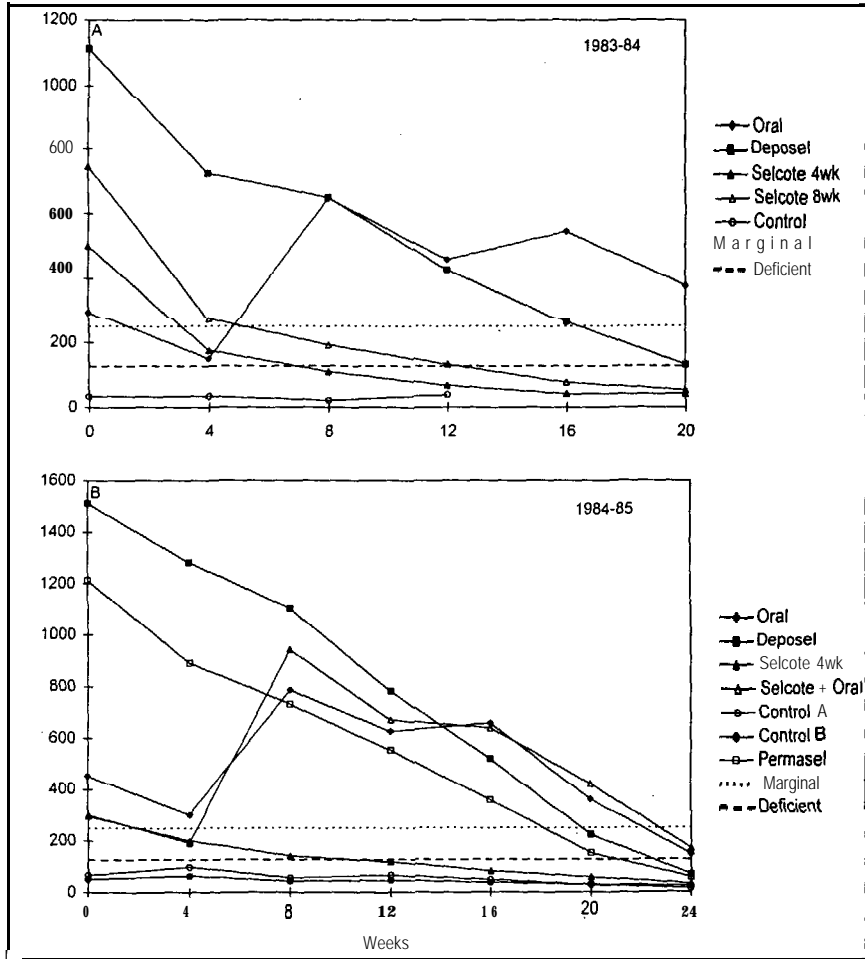


Figure 3 Blood Se (nmol/l) profiles in lambs with different methods of Se supplementation (experiment 1), A) 1983-84. B) 1984-85.



paddock peaked at about 700 µg Se/kg DM and declined with a half life of about 75 days (Figure 1).

There were more barren ewes in the control group than in the Se-supplemented groups, but treatments did not differ in the number of lambs born per ewe lambing (Table 1). The reason for the higher level of barrenness in Se supplemented groups in the second year was not identified, but was not related to Se status or ewe liveweights. After 2 years, liveweight and wool production in the control group were reduced (Table 2), and ewe mortality increased. A very low number of lambs tailed per ewe mated in the control group (Table 1) reflected both barrenness and

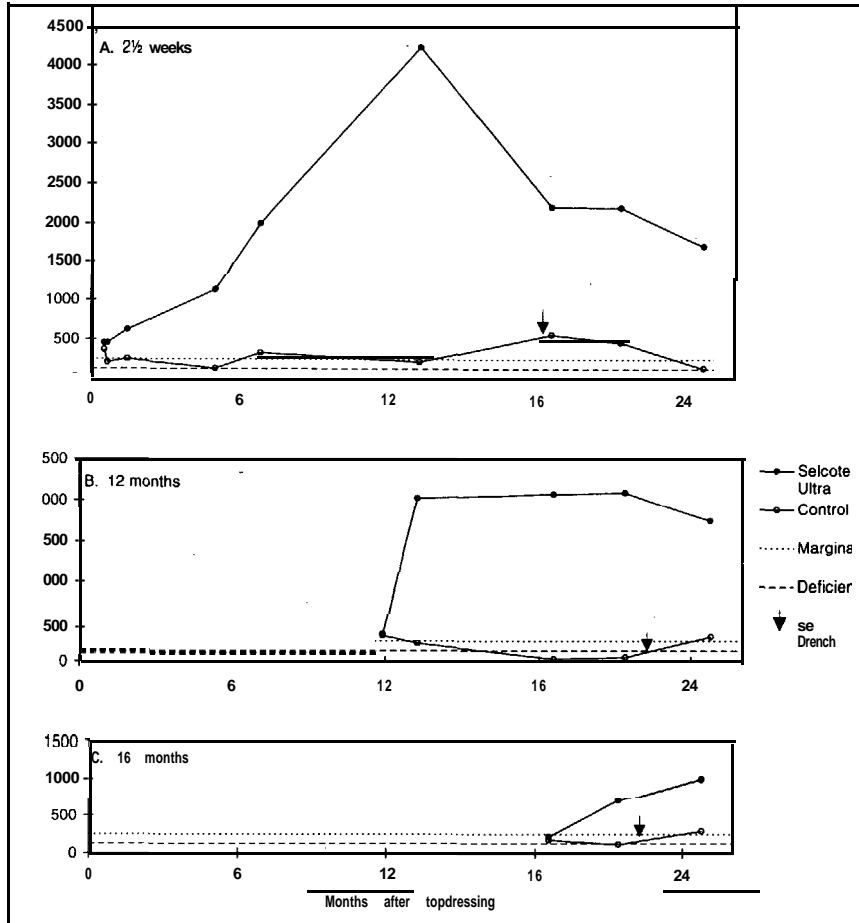
Table 4 Effect of Se treatments on mean lamb birthweight, liveweight at 4 weeks, weaning (10-12 weeks age) and in March (18-20 weeks age). Adjusted for effects of birth rank and sex (Experiment 1).

Treatment	Liveweight (kg)			
	Birthweight	4 weeks	Weaning	March
1983-84 1. Oral	4.2	11.0	17.8	22.1
1983-84 2. Deposel	4.5	12.0	18.5	21.4
1983-84 3. Selcote 4 week	4.1	11.6	16.9	19.1
1983-84 4. Selcote 8 week	4.3	12.0	17.9	19.6
1983-84 5. Control	4.3	9.2	0.7	-
Approx. SED [†]	0.14	0.39	0.65	0.68
1984-85 1. Oral	4.3	10.3	18.9	21.9
1984-85 2. Deposel	4.7	10.7	19.8	22.1
1984-85 3. Selcote 4 week	4.4 #	10.4 #	17.1	18.2
1984-85 3B. Selcote 4 week + Oral	4.5 #	10.5 #	20.5	23.6
1984-85 5A. Control (2 year)	4.2	9.6	16.7	18.7
1984-85 5B. Control (1 year)	4.2	10.1	17.0	17.1
1984-85 6. Permasel	4.5	10.5	18.4	20.3
Approx. SED [†]	0.13	0.35	0.83	0.93

NB Management of treatments 3A and 3B was identical at this stage.

† SEDs for different comparisons vary slightly because of unequal replication.

Figure 4 Blood Se (nmol/l) profiles in wethers introduced to control or Se-topdressed (Selcote Ultra®) pastures at intervals of A) 2½ weeks, B) 12 months and C) 18 months after topdressing (experiment 2).



perinatal lamb mortality (Table 3). Post-mortems of lambs from the control group in every case showed lesions typical of white muscle disease, a myopathy of cardiac or skeletal muscle. In the first year a lower lamb tailing percentage in the oral treatment group than in the barium selenate and top-dressing treatments was due to higher lamb mortality in the first 28 days before treatment (Table 3). Cardiac lesions were observed in some lambs dying in the oral treatment group, but there was no indication of white muscle disease in lambs from the topdressing or barium selenate groups that died before 28 days of age. However, there were lesions of white muscle disease in lambs from the topdressing and 4 weeks grazing treatment that died at 10 weeks or older. In year 1, lamb birth weight did not differ between treatments, but in year 2 the control lambs had lower birthweights than those born to Se-

supplemented ewes. The surviving lambs in the control treatment had much lower weight gains than lambs from the other treatments (Table 4). At 4 and 8 weeks of age lambs in the oral treatment were lighter, but subsequently liveweight gains were greater in the oral treatment. Post-weaning gains in the topdressing treatments were very low (Table 4).

Blood Se (Figure 2) and glutathione peroxidase profiles (data not presented) demonstrated that barium selenate injections, intra-ruminal Se pellets or the strategic grazing of recently Se-topdressed pasture for at least one month pre-joining all gave a rapid and large rise in the Se status of ewes. The blood Se levels in ewes given a barium selenate injection or intra-ruminal pellet remained above 250 nmol Se/l, that is maintained adequate Se status, for more than 12 months, although variation between animals was considerable in the latter

treatment. Se levels pre-lambing and after 12 months were similar in the strategic grazing and oral treatments. Both groups were in the deficient range by 12 months and further Se supplementation would be required before the next mating.

Grazing of recently Se-topdressed pasture for at least one month, timed for the pre-mating or pre-lambing periods, should meet the requirements of the ewe for one year.

The barium selenate and intra-ruminal pellet treatments allowed a substantial transfer of Se to lambs at birth (Figure 3) and lambs would not require further Se supplementation until after weaning. With strategic grazing and oral treatments, blood Se levels were marginal by tailing. Hence it is necessary to provide supplementary Se as early as possible, e.g., at tailing and certainly at weaning, in order to maintain potential growth rates and prevent post-weaning Se-responsive ill-thrift.

Experiment 2

Pasture Se in the control paddocks was again extremely Se deficient (10–23 µg Se/kg DM).

In the treated paddocks pasture Se levels (Figure 1) and blood Se levels were elevated for 24 months (Figure 4). Blood Se also significantly increased in the animals introduced at 12 and 18 months. Marked differences in liveweight developed between the treatment and original control group during the second year (68.0 vs 61.5 kg, SED 1.41 kg). The difference in liveweight at the end of the trial, although of similar magnitude, was not significant. There were no significant differences in liveweight for the animals introduced at 12 and 18 months after Se topdressing even although blood Se levels in the control sheep were very low before the Se drench was given.

These results show that pasture treated with Selcote Ultra® prills at 1 kg/ha is still effective in providing Se to the sheep 24 months post application.

Conclusions

Barium selenate injection (Deposel®), intra-ruminal pellets (Permasel®) or the grazing of pasture recently topdressed with sodium selenate (Selcote®) for at least one month during flushing and mating will increase the Se status of ewes sufficiently to prevent Se-responsive embryonic mortality, and the carry-over effect will prevent congenital white muscle disease in lambs. If the lambs from these treatments are not given supplementary

Se, or grazed on Se-topdressed pasture, they are likely to suffer post-weaning ill-thrift and possibly delayed white muscle disease. With strategic grazing of Se-topdressed pastures by ewes in the autumn, lambs should be given Se as early as possible, e.g., at tailing, and certainly at weaning. These strategies are at least as effective as conventional oral dosing of ewes and lambs.

Under the conditions of severe Se deficiency in experiment 1, there was some evidence that oral dosing of ewes at currently recommended rates and frequencies may not be adequate to avoid lamb mortality and reduced growth rates caused by Se-responsive diseases.

A single application of barium selenate fertiliser (Selcote Ultra's) at 1 kg/ha will supply adequate Se for grazing sheep for 2 years.

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