General Technical

Effect of topdressing pasture with copper on the copper status of young red deer (*Cervus elaphus*)

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Abstract

The effect of topdressing with 0, 6 and 12 kg copper sulphate/ha in mid March 2000 (day 1) on the Cu status of young red deer hinds (n=11/group) was monitored from April to the following March. The Cu concentration of untreated pasture was 8 mg Cu/kg DM. Application of 6 and 12 kg copper sulphate/ha increased pasture Cu concentrations to 24 and 35mg Cu/kg DM, respectively, at day 36 after which they decreased to 10 mg Cu/kg DM at day 76. In mid April (day 28), before set stocking on untreated and Cu treated pastures, mean serum and liver Cu concentrations were 13.7 µmol/L and 577 µmol/kg fresh tissue, respectively. In the deer on the untreated and the 6 kg copper sulphate treated pasture, mean serum Cu concentrations decreased to 5.6 µmol/L during August and September 2000 (days 129–155) and then slowly increased to above 10 µmol/L by January 2001 (day 269). Mean liver Cu concentrations of the above 2 groups of deer decreased from 577 µmol/kg fresh tissue in April (day 28) to 80 µmol/kg fresh tissue over August to November 2000 (days 129 – 224), before increasing to above 120 µmol/kg fresh tissue in March 2001 (day 324). In contrast, deer on the 12 kg copper sulphate treated pasture had mean serum Cu concentrations above 10.8 µmol/L, except for August and September (days 129–155) when they decreased to 8.6 µmol/L. Their mean liver concentrations decreased from 577 µmol/kg fresh tissue in April (day 28) to 200 µmol/kg fresh tissue during July and October (days 100-185). These results show top-dressing pasture with 12 kg copper sulphate/ha in the autumn increased pasture Cu concentrations for about 70 days and significantly elevated Cu status in young deer for at least 11 months.

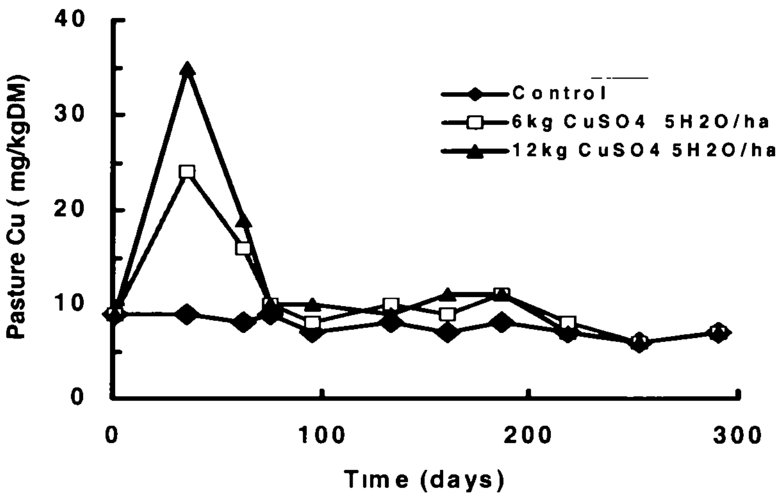
Introduction

Copper is an important trace element in the nutrition of deer (Grace, 1999). Osteochrondosis and enzootic ataxia have been observed in deer when liver Cu concentrations are < 60 µmol/kg fresh tissue and serum Cu concentrations are < 4 µmol/L (Thompson *et al.*, 1994; Wilson *et al.*, 1979, Wilson and Grace, 2001). The Cu status of deer, as determined by serum and liver Cu concentrations, decreases from autumn to spring (Mackintosh *et al* 1986, Wilson and Audige, 1998). This could have a marked influence on the liver Cu stores of the hind and foetus which in turn results in fawns being born with a low Cu status and a greater risk of being Cu deficient, expressed as osteochondrosis. A recent review of the tissue reference ranges to assess the Cu status of deer have suggested that deer are deficient when herd mean serum and liver Cu concentrations are < 5 µmol/L and < 60 µmol/kg fresh tissue, respectively. They are adequate when mean serum and liver Cu concentrations are >8 µmol/L and > 100 µmol/kg fresh tissue respectively (Wilson and Grace, 2001).

While deer can be effectively supplemented using Cu injections or CuO needles (Harrison *et al.*, 1989; Wilson, 1989) other approaches need to be investigated. Most deer farmers have a comprehensive fertiliser policy and therefore increasing Cu intakes via topdressing pasture with Cu could be a cost effective, efficacious, animal friendly and low labour impact approach to prevent Cu deficiency in deer. At present there is a dearth of data relating Cu topdressing to the Cu status of deer.

This study reports on the efficacy of Cu topdressing as well as the effect of season on Cu status of grazing deer.

Figure 1. Mean pasture Cu concentrations after top-dressing



Materials and Methods

Experimental design This study was carried out at the AgResearch, Aorangi Deer Research Farm near Palmerston North, on Kairanga loam soils Three Cu treatments were randomised over six 1.2 ha paddocks (2 paddocks/treatment) containing a ryegrass/white clover pasture Treatments were control (no topdressing with Cu), a low Cu treatment (pasture top-dressed with 6 kg copper sulphate ($CuSO_4.5H_2O$)/ha); and a high Cu treatment (pasture top-dressed with 12 kg copper sulphate/ha). The Cu was applied along with 250 kg of 15% potassic super/ha in mid March 2000 (designated day 1 of the study) In mid-April (day 28) pastures were stocked with 11 weaner hinds/treatment which alternately grazed between the 2 paddocks within each treatment Preliminary data for the first 11 months is presented here Deer were treated with an "Ivomec" pour-on about every 5 weeks. All animals were vaccinated against yersiniosis and clostridial diseases post weaning

Sampling Pasture samples were collected along a 150m transect in each paddock at about monthly intervals

All deer were bled and liver biopsied using the procedure described by Wilson (2000) just before being placed on the treated pastures and at about monthly intervals thereafter.

Analytical Copper was determined in the pasture, serum and liver by inductively coupled plasma emission spectrometry (Lee, 1983)

Statistics The differences between treatments were determined by repeat measurement analysis of variance using Minitab (Minitab, 1998)

Results

Pasture minerals

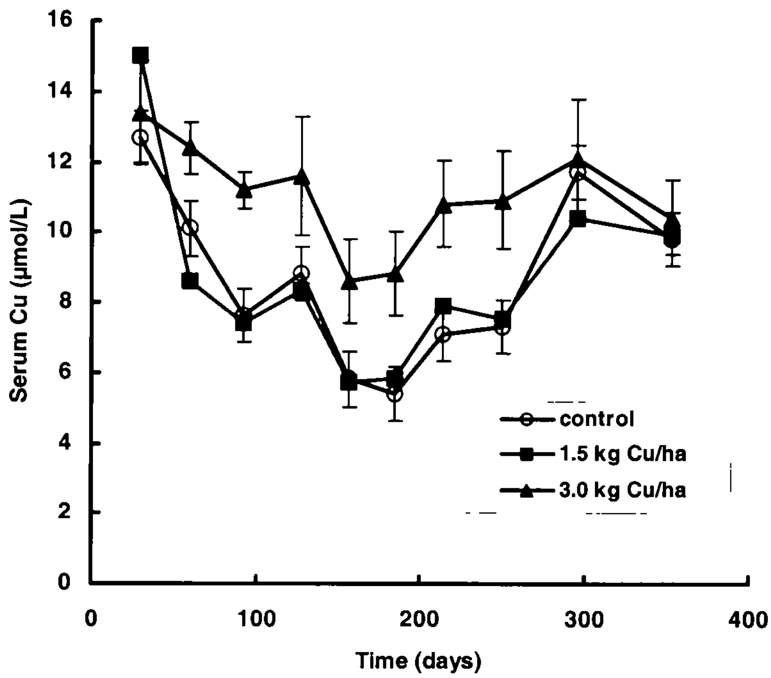
Mean concentrations of minerals in the pasture grazed by the deer were (g/kgDM) Na, 1 0, K, 29 8; Ca, 2 8 P, 3 2, Mg, 2 6 and S, 3 4 , and (mg/kgDM) Mo, 0 7, Mn, 178, Fe, 543, Zn, 37, Co, 0 28, Se, 0 02

Top-dressing with 6 and 12 kg copper sulphate/ha increased pasture Cu concentrations from a baseline of 8 to 24 and 35 mg Cu/kg DM, respectively, at day 36 after which the Cu concentrations decreased to pasture baseline concentrations by day 76 (Figure 1)

Serum Cu

Mean serum Cu concentration at the commencement of the trial was 13 75 μmol/L In deer on the control and 6 kg copper sulphate/ha treatment pastures, mean serum Cu concentrations decreased to 5.6 μmol/L over days 129 to 155 (August/September) before increasing to 10 μmol/L at day 269 (January) (Figure 2) Deer on the 12 kg copper sulphate/ha topdressed pasture had mean serum Cu concentrations above 10.6 μmol/L except over days 129 to 159 when they were 8 6 μmol/L

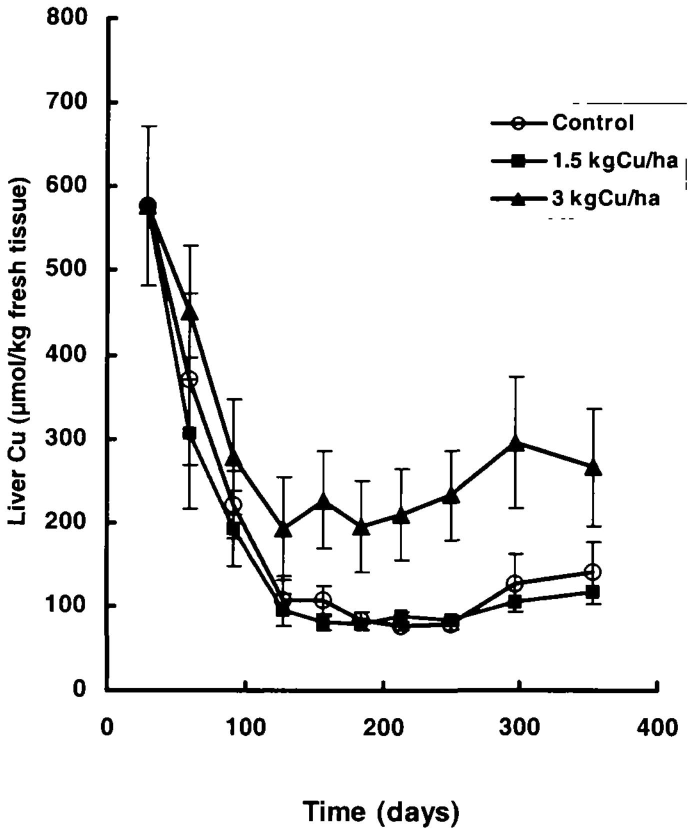
Figure 2. Mean (SE) serum Cu concentrations



Liver Cu

Initial mean liver Cu concentration in April was 577 μmol/kg fresh tissue. On control and 6 kg copper sulphate/ha topdressed pasture, mean liver Cu concentrations decreased to 100 μmol/kg fresh tissue at day 100 (July) and then to 80 μmol/kg fresh tissue over days 129–224 (August to November, 11 months of age) (Figure 3) They then increased to 120 μmol/kg fresh tissue at day 324 (February, 14 months of age) In contrast, in the deer on the 12 kg copper sulphate/ha pasture the mean liver Cu concentrations decreased from 577 to 200 μmol/kg fresh tissue at day 100 (July) and then slowly increased to 280 μmol/kg fresh tissue at day 324 (February, 14 months of age).

Figure 3. Mean (SE) liver Cu concentrations



Discussion

Top-dressing was effective in increasing the Cu concentrations in pasture, dependent on the rate of Cu application, but the effect on pasture Cu concentrations was relatively short term. By day 76 there was no difference between the Cu concentrations of untreated and treated pastures. A similar result has been observed by West *et al* (1998) and Morton and Smith (2000). The responses in pasture Cu concentrations to Cu applications are likely to be variable because of factors such as soil type, pasture species and season (Fleming, 1965) To be effective in changing the Cu status of deer, pasture Cu concentration needs to be > 35 mg/Cu/kg DM about 30 days after the application of the Cu

The monthly observations allowed a detailed profile of the effect of season on Cu status of the young deer to be followed for nearly a year Although seasonal changes in the Cu status of grazing deer had been reported earlier (Mackintosh et al, 1986, Audige and Wilson, 1998) the more regular and frequent observations made in this study now allow the rate of decrease in the Cu status of deer, in terms of serum and liver Cu concentrations, over the autumn, winter and spring to be determined in more detail Although the serum and particularly the liver Cu concentrations of the deer in March indicated that the Cu status of the deer was adequate (Wilson and Grace, 2001) 3 months later, in June, all of the deer had a reduced Cu status Those animals on the untreated and 6 kg copper sulphate/ha treated pasture became at risk of Cu deficiency according to proposed reference values. The deer on the pasture topdressed with 12 kg copper sulphate/ha also showed a decline in Cu status during winter but because their serum and liver Cu concentrations were > 8 5 µmol/L and > 200 µmol/kg fresh tissue, respectively, their Cu status remained "adequate".

Deer grazing pasture top-dressed with 12 kg copper sulphate/ha had an increase in Cu intake equivalent to 2-3 times their dietary Cu requirements, for less than 30 days This maintained a significantly higher and adequate Cu status for nearly 1 year compared with the low treatment and no treatment groups. The mechanisms of this apparent carry-over effect, in terms of Cu biochemistry and metabolism, are not understood It is not related directly to increasing liver Cu stores, as has been observed when CuO needles are administrated (Booth *et al.*, 1989), because the liver Cu concentrations still continued to decrease even though Cu intakes were at their highest.

Factors causing the decrease in Cu status of deer over winter and spring are not well understood. A similar decline in Cu status has been observed in cattle and sheep (West and Sargeson, 1998, Knowles *et al*, 2000) and in these species, increasing Mo and soil intakes have been implicated In this study, the change in Cu status does not appear to be related to increased Mo intakes because over days 50 to 155 the pasture Mo concentrations remained low (ie < 1 8 mg Mo/kg DM). During this period soil intakes did increase, as reflected by high pasture Fe concentrations (769 - 1050 mgFe/kgDM), but while ingested soil has been shown to reduce Cu absorption in sheep in some studies (Suttle, 1975) in others it has not (Grace et al, 1997)

Acknowledgement

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References

Booth, D H, Wilson, P R, Alexander, A M 1989 The effect of oral oxidised copper wire on liver copper in farmed red deer *New Zealand Veterinary Journal 37* 98-101

Grace, N D 1999: Soils, pastures and trace elements in deer *Proceedings of a Deer Course for Veterinarians, Deer Branch NZVA* No 16 Ed P R Wilson 69-79

Grace, N D, Rounce, J R; lee, J 1997 Effect of soil ingestion on the the storage of Se, vitamin B12, Cu, Cd, Fe, Mn and Zn in the liver of sheep fed Lucerne pellets *New Zealand Journal of Agricultural Research 39* 325-331

Harrison, T J, Sykes, A R., Familton, A.S 1989. Efficacy of copper in deer and sheep An evaluation and comparative study *Proceedings of the New Zealand Society of Animal Production* 49 11-14

Minitab Inc 1998 State College, Pennsylvania

Knowles, S O, Grace, N D, Lee, J 2000 Impact of Cu x Mo interaction on the Cu status of grazing cattle and sheep In *Trace Element Update* Pp 66-81 Foundation for Continuing Education of the New Zealand Veterinary Association, Palmerston North

Lee, J 1983 Multi- element analysis of animal tissues by inductively coupled emission spectrometry *ICP Information Newsletter* 8 553- 561

Mackintosh, C G, Wilson, P. R.; Beatson, N S Turner, K, Johnstone, P 1986: Preliminary report of the liver: serum copper relationship in red deer *Proceedings of a Deer course for Veterinarians, Deer Branch NZVA* . No 3 Ed P R Wilson· 156-164

Morton, J D, Smith, L C 2000 Pasture update from solid and liquid applications of cobalt and copper sulphate *Proceedings of the New Zealand Grassland Association* 62 45-48

Suttle, N F 1975 An effect of soil ingestion on the utilisation of dietary copper by sheep *Journal of Agricultural Science 109.* 249-254

Thompson, K G, Audige, L, Arthur, D G, Julian, A F, Orr, M B, McSporran, K D, Wilson, P R 1994· Osteochondrosis associated with copper deficiency in young farmed red deer and Wapiti-X red hybrids *New Zealand Veterinary Journal 42* 137-143

West, D M, Sargeson, N D 1998 Copper supplementation of grazing cattle using pasture topdressing and individual animal treatment *Proceedings of the New Zealand Grassland Association* 60 229-232

Wilson, P R, Orr, M B, Key, E L 1979 Enzootic ataxia in red deer *New Zealand Veterinary Journal 27* 252-254

Wilson, P R and Audige, L 1998 Serum copper levels and supplementation seasonal and farm variation *Deer Course for Veterinarians Deer Branch NZVA No 15 Ed PR Wilson 189-206*

Wilson, P R; Grace, N D 2001 A review of tissue reference values to assess the trace element status of farmed red deer (*Cervus elephas*). *New Zealand Veterinary Journal 49* (in press)