Effects of Liming and Nitrogen Application on the Cu, Mn, and Zn Concentrations in Herbage from Extensively Managed Pastures

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Introduction In less intensively managed grassland in Central Europe , the micronutrient concentrations in herbage are apparently more likely to be in levels between barely sufficient and deficient than to be excessively high . Insufficient amounts of selenium , copper , manganese , and zinc cause physiological disorders in ruminants .

Materials and methods Three identical experiments on low-input pastures in different locations in low-mountain areas of Central Germany were set up in a Latin Rectangle design with three replicates . The locations were chosen based on a screening of more than 100 locations in which soil pH and carbon content were the most important criteria (Table 1) . At each site treatment plots were laid out to include the effects of liming (= 0 or 4 t CaO ha^{-1}) , and N application (= 0 or 80 kg N ha^{-1} , applied as calcium ammonium nitrate) . Se , Cu , Mn , and Zn were determined by AAS .

Results The three locations show significant differences in Zn , Mn and Cu concentrations in herbage (Figure 1) . Location is the most important factor of variation for all elements . Se was insufficient to meet animal requirements ($<50 \mu g$ kg^{-1} DM) for all locations and treatments . The increasing pH value caused by liming results in a significant decrease in Mn concentrations in several growths . This effect is very important at location A , which has the lowest soil pH (pH 4 .8) , but also for the secondary growth at location C (pH 4 .9) . The effect of liming is less clear for Zn and not significant for Cu , although the effect on soil pH was very clear (Table 1) . Application of nitrogen shows no constant effect on the concentrations of Se , Zn , Mn and Cu . Although N fertilization increases DM yield , no dilution effect is evident .

Conclusions Considering the nutrition of beef cattle , the animal requirements for the essential selenium are not met in any location or treatment . The amounts of zinc and copper are close to the recommended levels (Anonymus 1996) but sometimes even slightly below . The manganese supply is mostly safe but the amounts are very variable (between < 25 and > 175 mg Mn kg^{-1} DM) . The effect of soil pH is of limited importance for the Cu and Zn concentrations , considering values between pH 4. 8 and 6. 6 .

Table 1 *Chemical characteristics of the soils in different experimental locations .*

Location	A	B	C
g C in kg soil DM	40 .1	20 .9	20 .6
g N in kg soil DM	3 .0	3 .0	3 .0
mg Se in kg soil DM	0 .45	0 .31	0 .36
mg Cu in kg soil DM	1 .3	3 .0	3 .0
mg Mn in kg soil DM	156 .5	105 .6	159 .0
mg Zn in kg soil DM	3 .4	3 .2	3 .9
pH (before liming)	4 .8	5 .6	4 .9
pH (limed plots)	5 .9	6 .6	6 .1

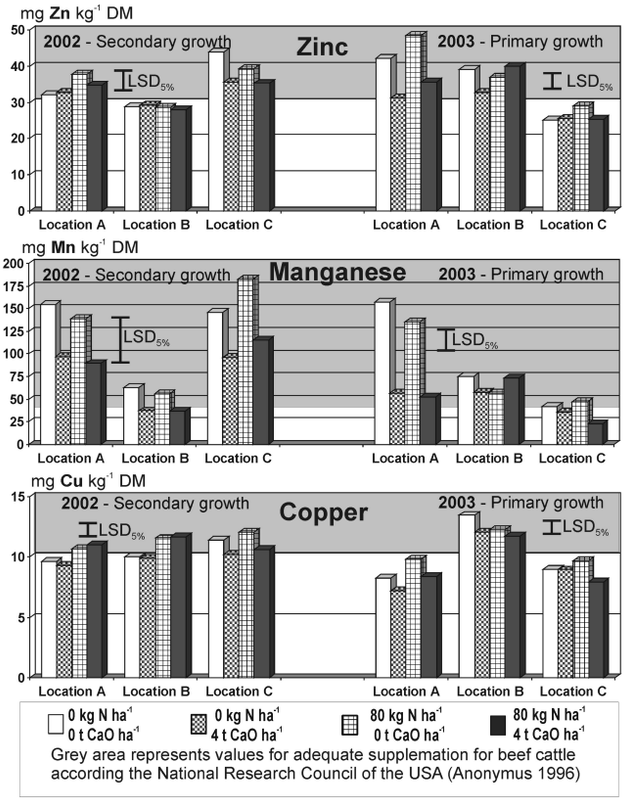

Figure 1 *Effect of liming and nitrogen fertilization on zinc , manganese and copper concentrations in two growths from different locations .*

Reference

Anonymous (1996) . Nutrient requirements for beef cattle . 7th ed . Publ . National Res . Council , National Academy Press , Washington D .C .