SELENIUM AND SULPHUR CONCENTRATIONS IN PRIMARY GROWTHS OF DIFFERENT PLANT COMMUNITIES

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Abstract

The factorised evaluated data of seven different grassland swards and two harvest dates of primary growths led to following results: Regarding the concentrations of selenium and sulphur, a selenium antagonist, and the N/S ratio, there were no significant plant community x harvest date, plant community x year, and harvest date x year interactions. The selenium concentrations, which never met the requirements of ruminants, were the highest in young herbage of a *Bromion racemosi* community reaching 49 µg kg^{-1} DM. The average of all swards and treatments was 33 µg kg^{-1} DM of selenium. Apparently, repeated application of selenate-bearing fertiliser is worthwhile in extensive grazing systems. Sulphur concentrations met the requirements of ruminants throughout. Because of the N/S ratio < 15,7 the effect of additional sulphur supply is limited. Thus sulphur should not be fertilised, when selenium-bearing fertilisers are applied.

Keywords: selenium, sulphur, N/S ratio, plant community, harvest date

Introduction

Apparently, selenium is non-essential for plants in temperate climates, but it is essential for animals. Selenium is an integral part of glutathionperoxidase and dejodase in animal body.

Selenium supply of plants is mainly influenced by selenium level in soil, soil reaction, and sulphur. Arid regions are generally rich in selenium, while there is selenium deficiency in many coastal areas (Gissel-Nielsen, 1993). Sorption of selenate and selenite decreases with increasing pH and the availability gets better for plants (Gissel-Nielsen, 1993; Anke *et al.*, 1998). Selenate and sulphate are antagonists (Murphy and Quirke, 1997), so sulphate hinders the uptake of selenate.

Sulphur is essential for plant and animal. Ruminants need sulphate to synthesise sulphuric aminoacids and preliminary stages of coenzymes. Because of the rapid decline of sulphur emissions (Dämmgen *et al.*, 1998), sulphur leaching in humid climates, and dependency of sulphur availability on the pH, it is deduced that there is sulphur deficiency in herbage from North and Central European grassland with a high nitrogen level (Murphy and Boggan, 1988; Murphy and O'Donnell, 1989; Murphy and Quirke, 1997).

The analysis of literature concerning sulphur and selenium gives few information on the factor plant community and the interaction plant community x harvest date. These investigations should present first assessments of this problem.

Material and Methods

The samples were taken in the Westerwald, a typical low mountain range in Germany. Altitudes of seven experimental sites (see figure 1 and 2) vary between 350 and 500 m above sea level. Depending on altitude, the annual rainfall is between 700 and 900 mm, the mean annual temperature is 7 - 8 °C. The soils can be characterised as stony, frequent shallow loams, developed from slate and greywacke of Devonian era and Carboniferous period. The soil reaction was determined in 0.01 M $CaCl_2$. The minimum was pH 4.4, a *Festuco-Cynosuretum*, the maximum was pH 5.4, a *Lolio-Cynosuretum*. The reaction of the other sites is pH 4.9 including a variance from pH 4.7 up to pH 5.2. The variants can be gathered from figure 1 and

2. The sampling was carried out during two years using the factor year as repetition and the interaction year x plant community x harvest date as allowance for error. Significant differences are clarified by different letters ($P<0.05$).

Crude protein was determined by using the Kjeldahl method. Selenium and sulphur were broken down by a microwave treatment in HNO_3. Afterwards, selenium concentrations were determined by hydride atomic absorption spectroscopy (Flowing injection system FIAS 200, autosampler AS 90, AAS model 4100, all instruments by Perkin-Elmer), total sulphur contents were determined by ICP-AES (Zhao and McGrath, 1994), using a Perkin-Elmer Optima 3000.

Results and Discussion

No analysed objective shows significant two-way interactions. Concerning the selenium concentrations there are no significant factorial effects at all. With the exception of *Bromion racemosi,* selenium concentrations are extremely low (figure 1). So there are no significant differences between the other plant communities, neither there are differences between different harvest dates. But higher selenium concentrations in herbage from *Bromion racemosi* indicate, that there could be variability in this region to a certain extent. According to the National Research Council (Anonymous, 1985), forage rations for cattle should contain 50-300 µg Se kg^{-1}, the optimum for sheep is between 100 µg Se and 200 µg Se kg^{-1} DM. The limit of tolerance is 2000 µg Se kg^{-1} for both. No sample meets the requirements for cattle nutrition. Harvest date has the most important influence on sulphur concentrations (Figure 2), averaging 2.3 g S in may and 1.6 g S kg^{-1} DM in July. There is also a significant effect caused by plant community. Sulphur concentrations are the highest in *Lolio-Cynosuretum* at the highest pH reaching 2.7 g and 2.1 g S kg^{-1} respectively. Nevertheless, there is a significance between sulphur concentrations in *Lolio-Cynosuretum* at pH 5.4 and those in the same plant

community at pH 4.7, apparently because the sulphur availability depends on pH. The National Research Council (Anonymous, 1985) indicates sulphur requirements of 0.8 g - 1.5 g S kg^{-1} for cattle and 1.4 g - 2.6 g S kg^{-1} for sheep. Therefore, even over-ripe herbage meets the requirements for ruminants without exception. According to Saalbach (1972), sulphur amounts on grassland are effective when the N/S ratio exceeds values between 12 and 14. Harvest date has the most important effect on the N/S ratio. The mean of this measure for efficiency of sulphur amounts is 12.6. and 9.8 respectively. Apparently, selenium amounts are worthwhile on described conditions and in comparable cases to avoid animal defects in extensive grazing systems, while there is obviously no urgent need for additional sulphur amounts under comparable circumstances. It is probably the case, that the selenate/sulphate antagonism is no additional difficulty to estimate the efficiency of selenate-containing multinutrient fertilisers.

References

Anke, M., Dorn W., Gunstheimer G., Arnold W., Glei M., Anke S. and Lösch E. (1998). Effect of trace and ultratrace elements on the reproduction performance of ruminants. Czech. Vet. Med. **43**:272-282.

Anonymous (1985). Nutrient requirements of domestic animals. 6. Ed. Publ. National Res. Council, National Academy Press, Washington D.C.

Dämmgen, U., Walker K., Grünhage L. and Jäger H.J. (1998). The atmospheric sulphur cycle. In: Schnug E., Sulphur in agroecosystems. Kluwer Academic Publishers, Dordrecht, 73-114.

Gissel-Nielsen, G. (1993). General aspects of selenium fertilisation. Norw. J. Agric. Sci. **11**: 135-140.

Murphy, M.D. and Boggan J.M. (1988). Sulphur deficiency in herbage in Ireland. 1. Causes and extent. Irish J. Agric. Res. **27**:83-90.

Murphy, M.D. and O'Donnell T. (1989). Sulphur deficiency in herbage in Ireland. 2. Sulphur fertilisation and its effect on yield and quality of herbage. Irish J. Agric. Res. **28**:79-90.

Murphy, M.D. and Quirke W.A. (1997). The effect of sulphur/nitrogen/selenium interactions on herbage yield and quality. Irish J. Agric. and Food Res. **36**:31-38.

Saalbach, E. (1972). Über den Schwefelbedarf landwirtschaftlicher Nutzpflanzen. (On sulphur requirements of agricultural plants.) Landw. Forschg. Sonder. **27**/ VDLUFA-Kongress Kiel, 224-228.

Zhao, F. and McGrath S.P. (1994). Extractable sulphate and organic sulphur in soils and their availability to plants. Plant and Soil **164**:243-250.

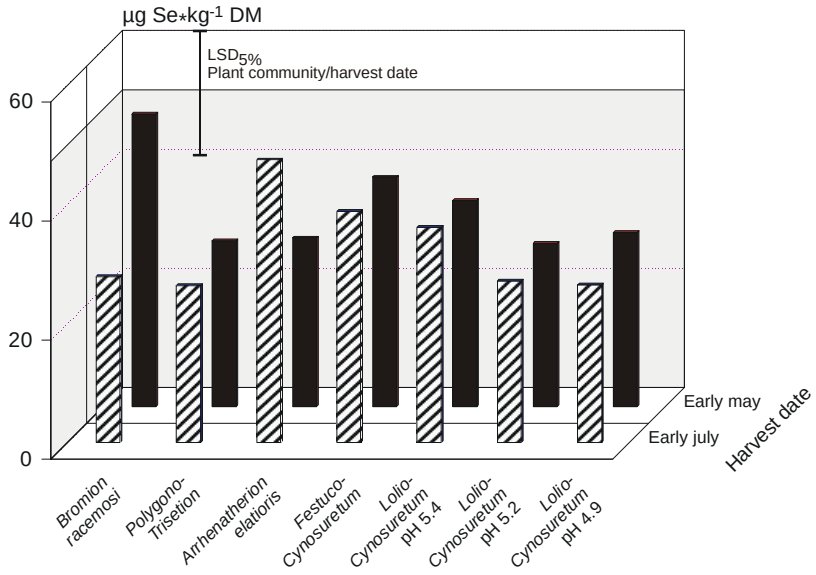

Figure 1 - Effects of plant community and harvest date on selenium concentrations.

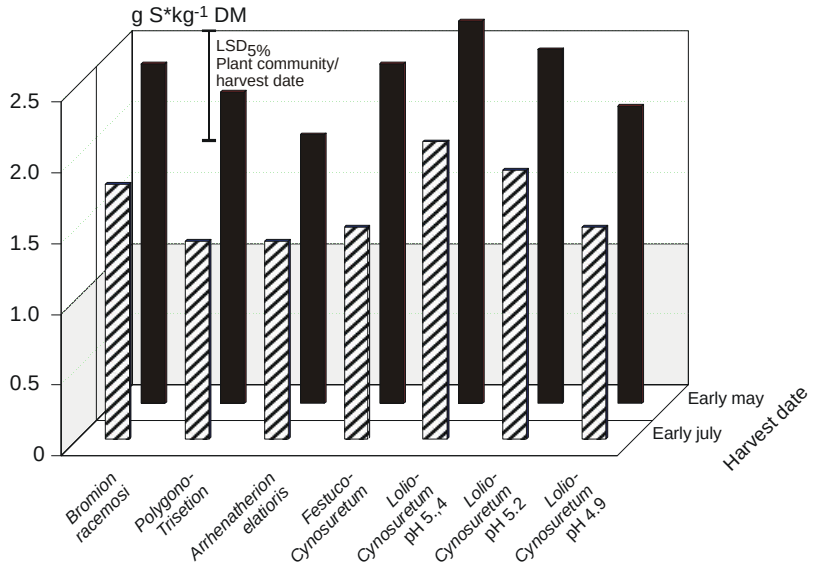

Figure 2 - Effects of plant community and harvest date on sulphur concentrations.