RESPONSE IN THE ROOT AND SHOOT ZONE OF PERMANENT GRASSLAND MODEL ECOSYSTEMS IN A FIVE YEARS FACE EXPERIMENT

A. Lüscher, M. Daepp, T. Hebeisen, J.P. Almeida, H. Isopp, D. Suter, U.A. Hartwig, H. Blum, M. Frehner and J. Nösberger

Institute of Plant Sciences, Swiss Federal Institute of Technology (ETH), 8092 Zürich, Switzerland

Objectives

- Longterm response of *L. perenne* and *T. repens* and their competitive ability to elevated CO_2 and N fertilisation
- Annual and seasonal fluctuations in yield and species proportion as affected by CO_2 and N
- Basic processes responsible for interspecific differences in the response to elevated CO_2 and N

Materials and methods

Trifolium repens and *Lolium perenne* were grown in monocultures and bi-species mixture at 35 and 60 Pa CO_2 partial pressure in Eschikon near Zürich from 1993 to 1997. N fertilisation was 14 and 56 g m^{-2} y^{-1} respectively. Cutting intervals were 4 weeks from 1993 to 1995 and 5 weeks in 1996 and 1997.

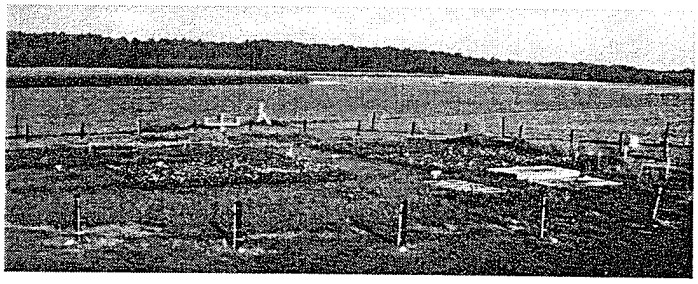
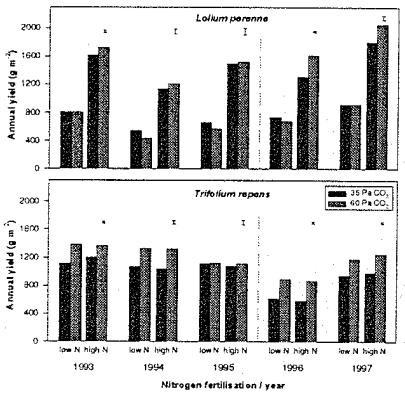
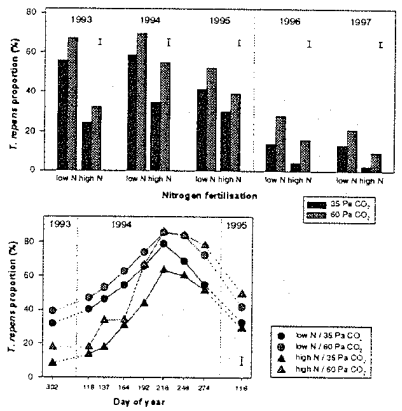


Fig. 1: Annual dry matter yield of *L. perenne* and *T. repens* monocultures from 1993 to 1997 (bars=SE)



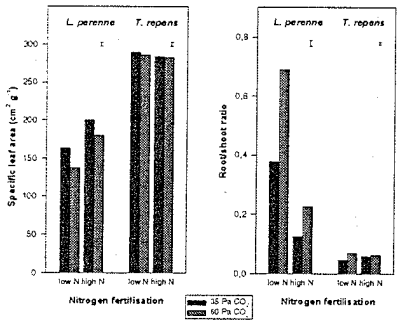
- consistent interspecific differences in the CO_2 response at low N fertilisation
- CO_2 response of *L. perenne* increased over the years
- high N fertilisation doubled the yield of *L. perenne* but had no effect on *T. repens*

Fig. 2: Annual and seasonal variation in yield proportion of *T. repens* in bi-species mixture with *L. perenne* (bars=SE)



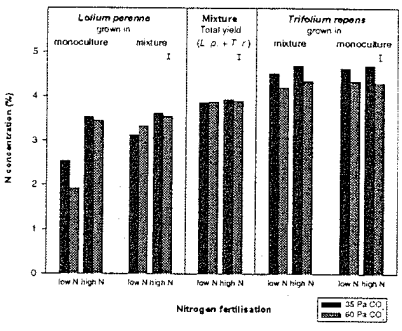
- *T. repens* proportion increased at elevated CO_2 in all years and N treatments
- CO_2 effect on *T. repens* proportion persisted at cool temperatures in autumn and spring
- strong annual and seasonal fluctuations in *T. repens* proportion

Fig. 3: Specific leaf area (SLA) and root/shoot ratio of *L. perenne* and *T. repens* (1993-95, bars=SE)



- reduced SLA in *L. perenne* indicates a sink limitation of the CO_2 response
- increased root/shoot ratio in *L. perenne* indicates N limitation at low N and elevated CO_2
- SLA and root/shoot ratio of *T. repens* were not affected by CO_2 indicating large sink

Fig. 4: N concentration of total mixture yield and of yields of *L. perenne* and *T. repens* grown in monocultures and in the bi-species mixture (1993-95, bars=SE)



- reduced N concentration at elevated CO_2 and low N suggests N-limitation of *L. perenne* when grown in monoculture
- when grown in mixture at low N *L. perenne* profited from the N_2-fixing *T. repens*
- at low N and elevated CO_2 forage quality for ruminant nutrition of *L. perenne* might decrease below the critical value of 2.1% N

Conclusions

- Interspecific differences in response to elevated CO_2 and N fertilisation led to important changes in yield and botanical composition
- N nutrition is a driving factor for the plant species' yield response to CO_2
- N fertilisation can counteract CO_2-induced changes in *T. repens* proportion
- Changes in CO_2 response over years and strong fluctuations in species proportion stress the importance of longterm experiments
- Increased root mass, decreased N concentration in plant material and increased proportion of N_2-fixing *T. repens* may affect C and N cycles of the grassland (see also posters of Daepp *et al.* and of Hartwig *et al.*)