Extreme drought on grassland: the buffering effect of plant diversity through functional complementary

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Effects of extreme drought on grasslands

Evaluation of the buffering effect of plant diversity

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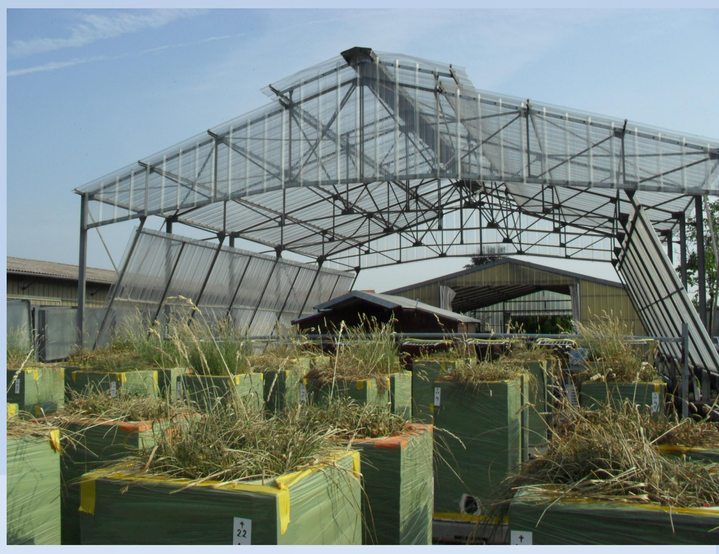
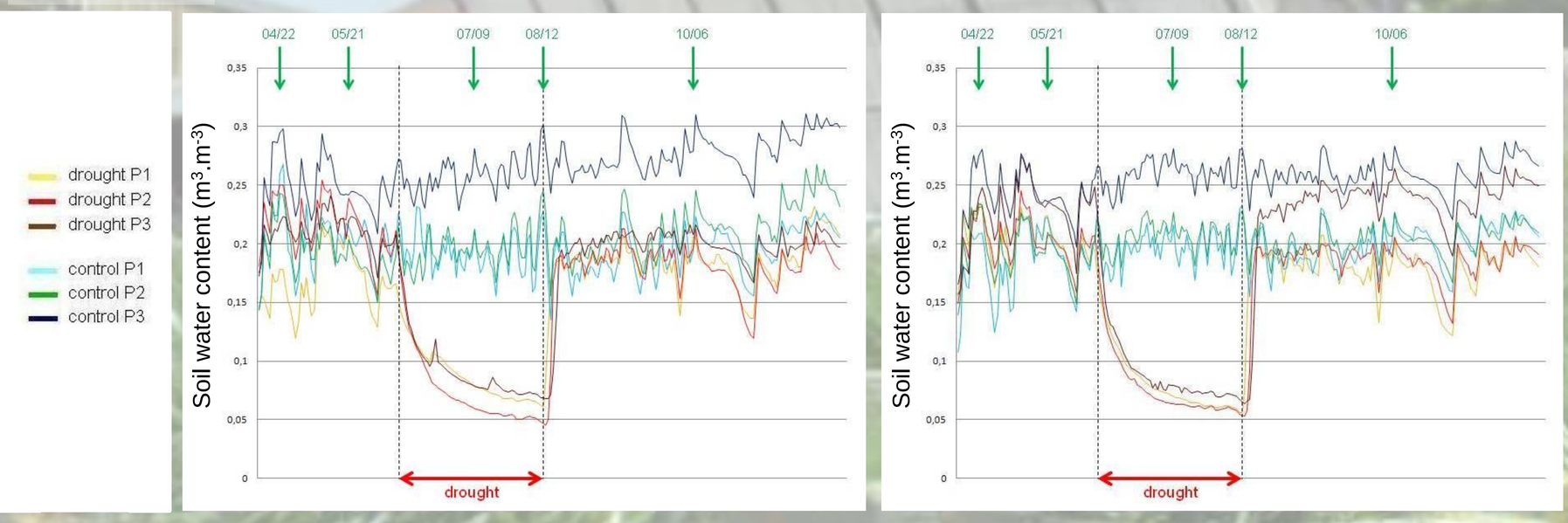
The frequency and magnitude of extreme drought events are expected to increase with climate change, modifying grassland productivity. In this experiment, according to the insurance hypothesis (Yachi and Loreau 1999), we assess the buffering effects of species diversity on the resistance and recovery of grasslands to extreme drought, and examine the mechanisms involved.



Methods

- Species mixtures in 96 large cylindrical pots (93cm deep and 37.5 cm diameter): 5 types of monocultures, 10 binary and one five-species mixture ; two treatments (control and drought) and six replicates by type of mixture
- Species selected representative of temperate, fertile upland grasslands: *Dactylis glomerata*, *Festuca arundinacea*, *Poa pratensis*, *Trisetum flavescens* and *Trifolium repens*.
- Continuous measurements: evapotranspiration of the plant canopy ; soil water content at 15, 30 and 50cm.
- Management: cutting to 5cm at five dates from April 2013 to October 2013.
- In June 2013 an extreme summer drought, simulated by a total rainfall interception from mid-June to mid-August, was applied to half of the pots.
- Cutting dates were used to define major periods of vegetation biomass production during the experiment: during the drought (between May 21 and Aug 12) and after the drought (between Aug 12 and Oct 6). Integrated water-use efficiency (WUE, g kg^{-1}) was calculated as the ratio of biomass to cumulative evapotranspiration for each period.

Results

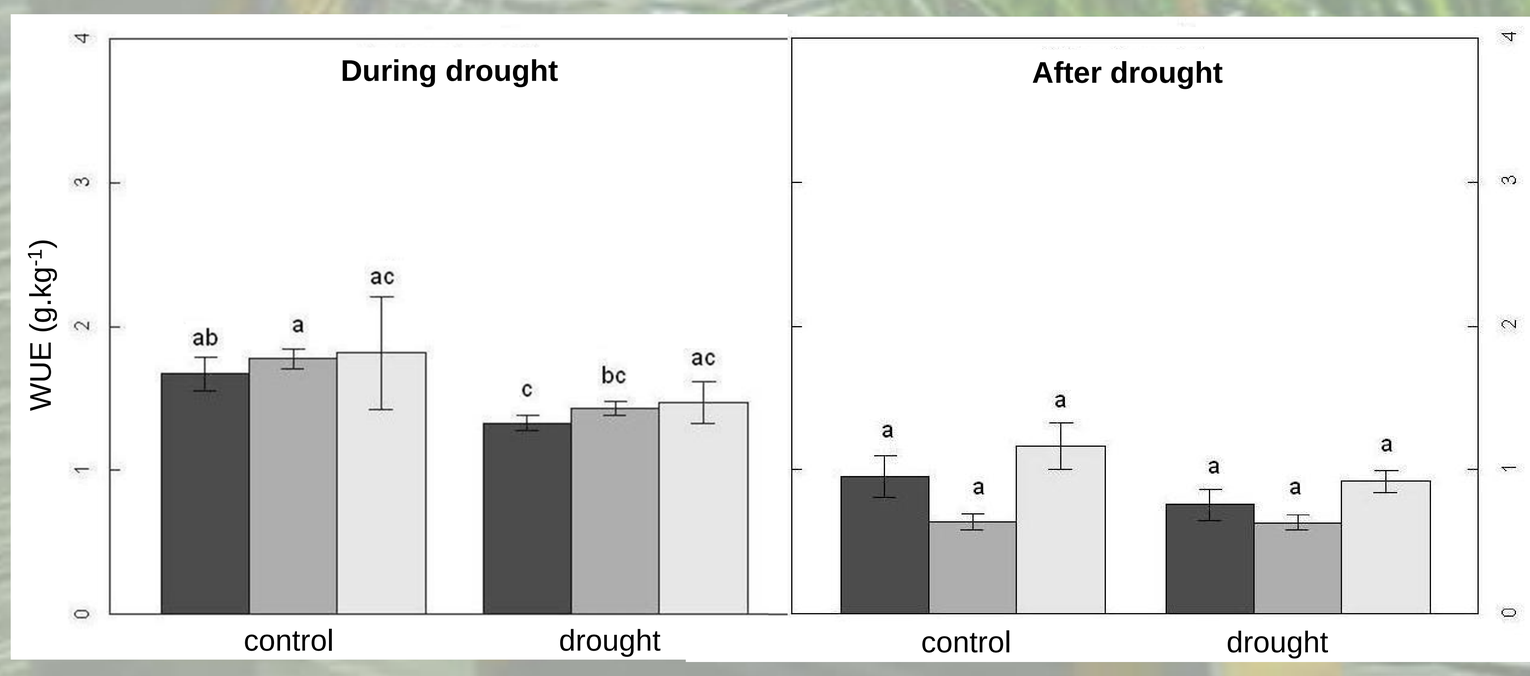


Time course of soil water content for monocultures (a), binary (b) and 5 species mixtures (c), measured at three depths (P1: 15 cm; P2: 30 cm; P3: 50 cm). Green arrows correspond to cut dates.

- WUE showed a significant drought x diversity interaction, with smaller drought-induced decreases in WUE in the 5-species mixture
- During the drought, the largest decrease of soil moisture was observed between 30 and 50cm for the 5 species mixture, and between 15 and 30cm for the other mixture

➔ Presence of deeper active roots in diverse mixtures.

Mechanisms of complementarity by niche differentiation could involve better resource partitioning and increased water use efficiency, resulting in higher drought resistance for high diversity mixtures



WUE of the three diversity levels: monocultures in black, binary in dark grey, and mixtures of 5 species in light grey. Means ± standard errors are shown.

Conclusion: A buffering effect of species diversity during drought occurs for the 5-species mixtures, possibly due to belowground niche differentiation

Reference: Yachi, S. and Loreau M., 1999. "Biodiversity and ecosystem productivity in a fluctuating environment: the insurance hypothesis", *Proceedings of the National Academy of Sciences USA* 96:1463–1468.

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