THE JENA EXPERIMENT

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Does biodiversity promote stability against prolonged summer drought?

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Introduction

It is of growing interest, whether biodiversity promotes stability of grasslands against climatic changes, like a prolonged summer drought. Published studies showed inconsistent results on this question. Furthermore it is not yet clear, how land-use of grasslands additionally affect the response to drought. Recent studies showed that species richness decreases resistance but increases the recovery after drought and therefore plays a stabilizing role for resilience So far, it has not been tested, whether those findings can be assigned to a wide range of grasslands that differ not only in diversity but also in land-use. We ask the following questions:

(1) Does species diversity increase the stability of differently managed grasslands to drought?

(2) Do repeated drought events show the same effects, like a single drought?

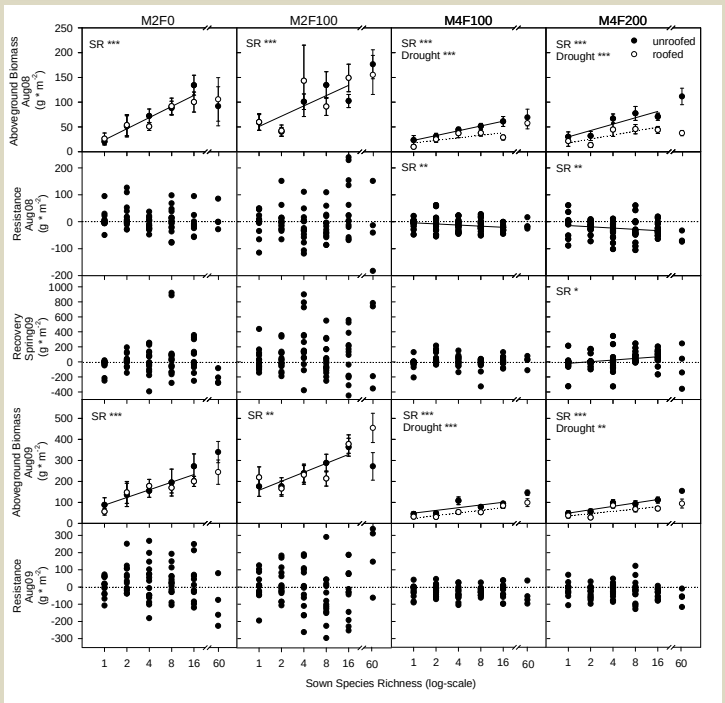
Aerial view of the experimental field site

Installed roofes as drought treatment

Methods

For our study we used the experimental field site of The Jena Experiment with 80 grassland mixtures differing in plant species richness (1, 2, 4, 8, 16, 60) in 2008 and 2009. All plots were divided into four subplots to create a gradient in land-use intensity and again split to apply a summer drought treatment. Land-use treatment varied in mowing regime (**M2**: two cuts, **M4**: 4 cuts per year) and the amount of fertilizer application (**F0**: no fertilizer, **F100**: 100 kg NPK ha^{-1} a^{-1}, **F200**: 200 kg NPK ha^{-1} a^{-1}) and was combined as follows: M2F0, M2F100, M4F100, M4F200.

Drought was simulated by using semitransparent rain shelters during 6 weeks in summer previous to the last annual cut in August. Control plots remained unroofed and received ambient precipitation. Prior to every cut, we harvested aboveground biomass of target species of all treatments and computed resistance (difference of perturbed and unperturbed biomass in August) and recovery (difference of previously perturbed and unperturbed biomass in spring after drought) from the dry weight.



Results

In our experiment, we found a positive relationship of aboveground biomass production and species richness in all treatments, but land-use intensity affected the slope of this relationship. Drought decreased biomass in the frequently mown grasslands (M4) and had mixed effects when exposed to two annual cuts. Therefore species richness only affected resistance negatively in grasslands that had four cuts per year. Until the first cut after the prolonged summer drought in spring 2009 we found an increase of recovery with species richness only in the M4F200 treatment, not in remaining land-use types. Similar to the first drought period in 2008, we found drought effects in 2009 again in the M4-treatments, not in M2-types. In M4F100 there was a significant interaction of species richness and year in the roofed plots due to a steeper slope in the biomass species richness relationship in 2009. Contrary to the first drought period in 2008 the resistance of all land-use types was not related to species richness in 2009.

Conclusions

Our results show, that stability properties of grasslands against summer drought are highly dependent on land-use intensity, especially mowing frequency. The reason for that may be that frequently mown grasslands have no or only a short time when canopies are fully established and therefore are less resistant against drought. Species rich systems are stronger affected by drought effects, than species poor systems, but they also show a greater adaptability against the drought effects after perturbation and therefore become more resistant for future perturbations. The greater potential for adaptation of species rich systems may be explained by a greater ability of species abundance shifts than in species poor systems as predicted by the insurance hypothesis. This hypothesis needs to be confirmed in further analysis of species specific data.

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