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Functional thresholds of plant resistance and recovery to drought

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With ongoing climate change, the predicted increase in climate variability is likely to increase the intensity of extreme drought events. This could significantly amplify the consequences of drought, because ecological responses are often non-linear. The importance of functional thresholds has been widely recognized, where comparably small changes in the stressor can have disproportional large consequences for ecosystem functioning. However, very few studies have actually tested for the functional thresholds of drought responses, which creates large uncertainties in our understanding of drought effects. Here, we aimed to determine the effects of drought intensity on plant productivity and to identify potential thresholds underpinning these responses.

We studied the effects of drought intensity on different measures of plant productivity using a gradient design. In a common garden experiment, we performed an experimental pulse drought of 3.5 weeks on planted monospecific mesocosms composed of the common grass *Dactylis glomerata* and the common forb *Plantago lanceolata*, respectively. We imposed a drought intensity gradient, which ranged from well-watered to extremely dry soil conditions. During drought and post-drought recovery we repeatedly measured productivity-related parameters, including gross primary productivity (GPP), Normalized Difference Vegetation Index (NDVI) and vegetative height, and assessed aboveground net primary production (ANPP) at peak drought and after recovery.

Drought intensity had non-linear effects on all studied parameters both during the resistance and the recovery phase. At peak drought we observed threshold responses at two stages of drought intensity. The first threshold occurred at moderate drought intensity and was related to a distinct downregulation of GPP and plant height. The second threshold was reflected in a steep decline of NDVI and leaf water content. During the recovery phase, high drought intensity stimulated productivity and regrowth rates. This resulted in an overshooting of biomass production by up to 100% in mesocosms previously exposed to severe drought, the effect being related to the first drought intensity threshold, which had led to a downregulation of GPP during drought. The overcompensation following exposure to high drought intensities was more pronounced for *Plantago* than for *Dactylis*. However, highest drought intensities clearly suppressed the recovery capacity of *Plantago* but not of *Dactylis*, which demonstrates species-specific differences in the effects of drought intensity on plant resilience.

We conclude that functional thresholds in drought and recovery responses of productivity are

related and that with increasing drought intensity plants compensate decreased resistance with increased recovery to optimize overall resilience of productivity to drought.