Soil nutrient processes and not plant physiological properties are the main drivers of post-drought yield outperformance in *L. perenne*

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Background

Reocurring drought events severely restrict forage production. However, experimentally drought stressed temperate forage grasslands have recently been reported to recover quickly after **drought stress and re-wetting (DRW)** and to be even more productive after drought than non-drought stressed control plots (see Fig. 1) (Hofer et al., 2017; Hahn et al., 2021).

Fig. 1 Rainout shelters of 3 x 5 m were placed on used to simulate a severe summer drought of 2 months. Plots were re-wetted immediately after shelter removal.

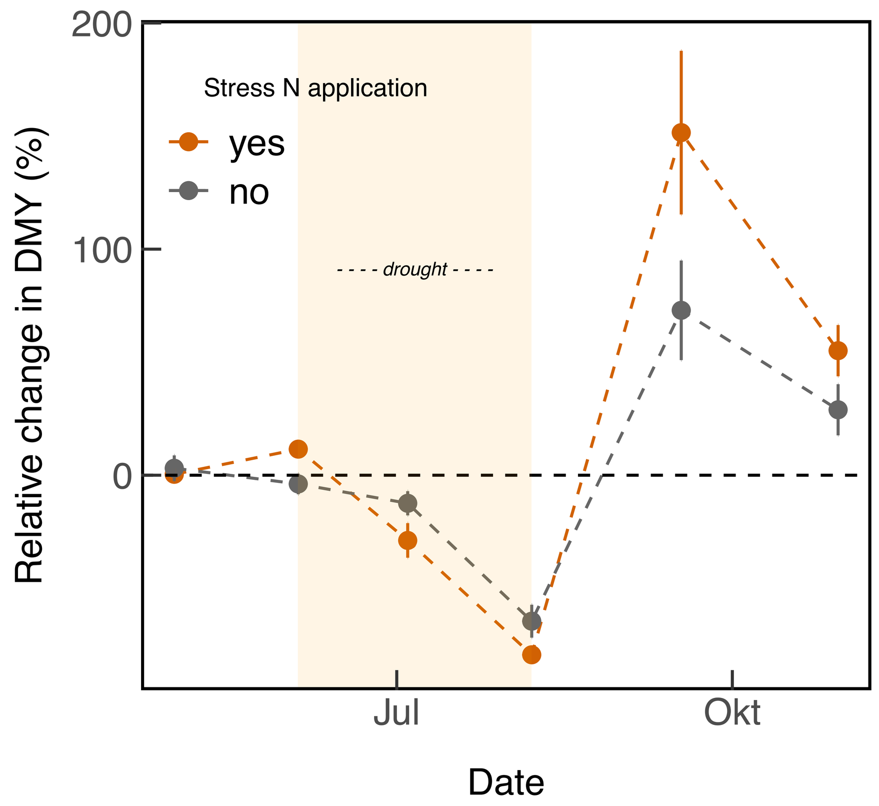


Fig. 2 Relative change in dry matter yield (means ± SE) between DRW vs. control plots at the field site in 2019. Half of the plots were N-fertilized during the drought (orange). The yellow rectangle represents the 2 mt drought period.

Objectives & Methods

To disentangle plant physiological from soil nutrient cycling effects on yield outperformance after DRW, we tested the effects of DRW on...

- forage yield under different N levels
- plant physiology (leaflength, SLA, leaf colour)
- soil nutrient availability

For this, a severe summer drought of 2 months was simulated by placing rainout shelters on an intensively managed *L. perenne* stock (Fig. 1). Immediately after shelter removal, sub-plots were taken from the field site and soils and plants were transplanted according to Fig. 3.

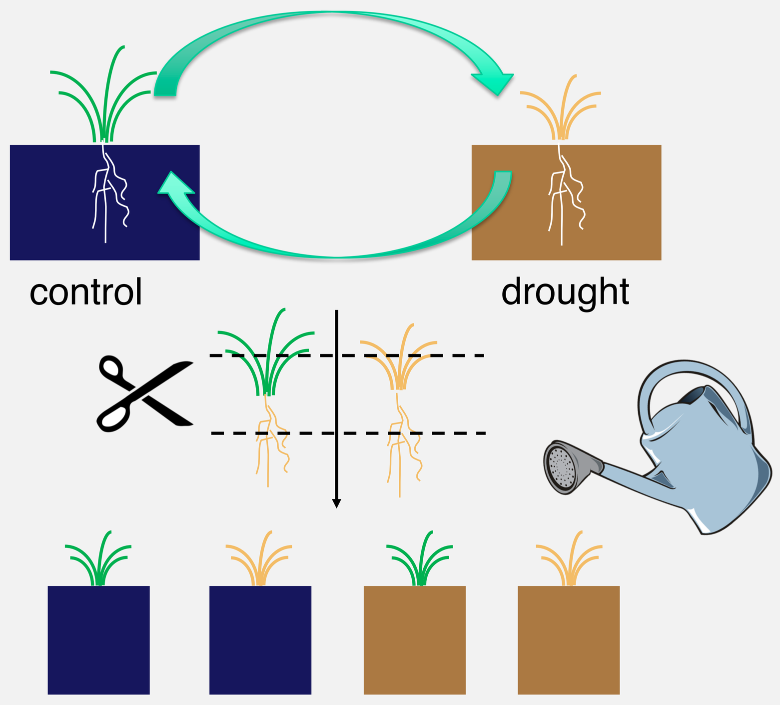


Fig. 3 Transplantation of control plants (green) and DRW plants (brown) into control soil (blue) and DRW soil (brown). Both, control and DRW soil was rewetted after finishing the transplantation.

Conclusions

Although DRW had an effect on the physiology of *L. perenne* by increasing its initial leaf growth rates and SLA, this did not result in increased DMY 1 month after DRW. In contrast, DRW soils induced strongly increased *L. perenne* yields (on average +25%) compared to control soils. Looking at soil nutrients, higher plant available N concentrations were identified as a main factor responsible for the observed yield outperformance of DRW stocks, likely induced by higher N mineralization rates. However, this dependency seems to decrease with increasing fertilizer application.

Results & Discussion

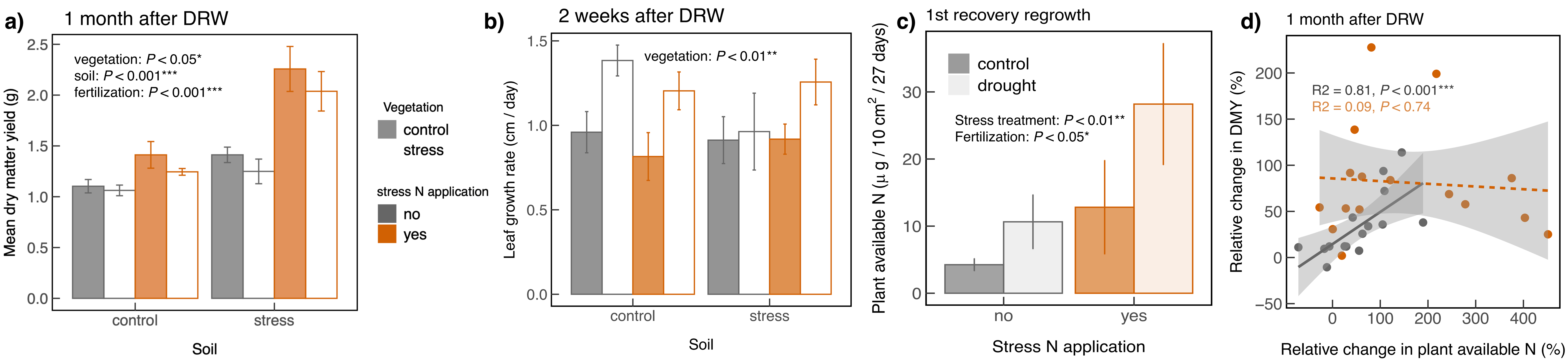
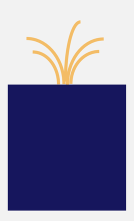
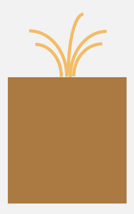


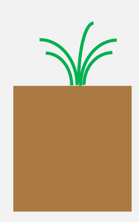
Fig. 4 a) Means ± SE of dry matter yields of control (filled bars) and DRW plants (empty bars) grown on control and DRW soil one month after transplantation and rewetting. Gray bars represent no fertilization during drought stress, orange bars represent mineral N application during drought stress (35 kg N ha^{-1}). **b)** Means ± SE of leaf growth rates of control & DRW plants on control & DRW soil between 7 and 14 days after transplantation and rewetting. **c)** Means ± SE of plant available nitrogen in control (saturated bars) and DRW soil (empty bars) during the first month after DRW. Measurements were performed using PRS (Plant Root Simulator) ion-exchange membranes. **d)** Correlation between relative change in DMY (dry matter yield) and relative change in plant available N (obtained by PRS ion-exchange membranes) of the 1st recovery regrowth on the field site. Gray: plots not fertilized during drought. Orange: plots minerally fertilized during drought (35 kg N ha^{-1}).



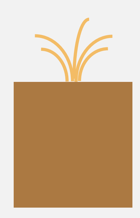
Irrespective of the soil's treatment,
DRW plants show:



- Lower dry matter yield (Fig. 4 a)
- Higher initial leaf growth rates (Fig. 4 b)
- And higher SLA and leaf red & green shares



Irrespective of the plants' treatment,
DRW soils show:



- Increased plant N availability (Fig. 4 c)
- Relative yield outperformance correlated with plant N availability, but only when plots were not N-fertilized (Fig. 4 d)

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