Constrasting seasonal drought stress responses of asymbiotic nitrogen fixation in prairie ecosystems

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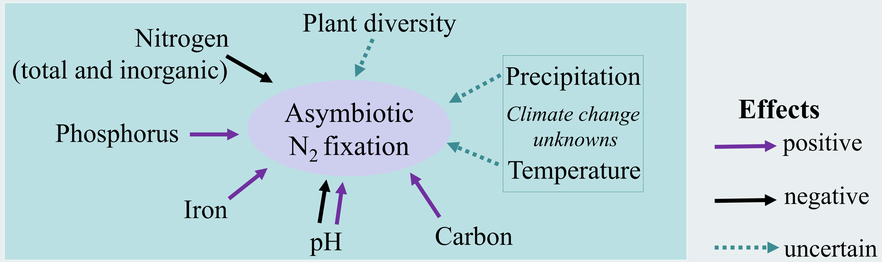
- Asymbiotic nitrogen fixation (ANF) drought stress response in high- and low-diversity prairies along the U.S. Pacific Northwest varied seasonally.
- ANF in high-diversity prairies of southern Oregon had consistent negative response to drought (−40% precipitation) in Fall and Spring seasons.
- Half of ANF variability was explained by phosphorus and iron availability in soils under ambient conditions but not under drought stress.

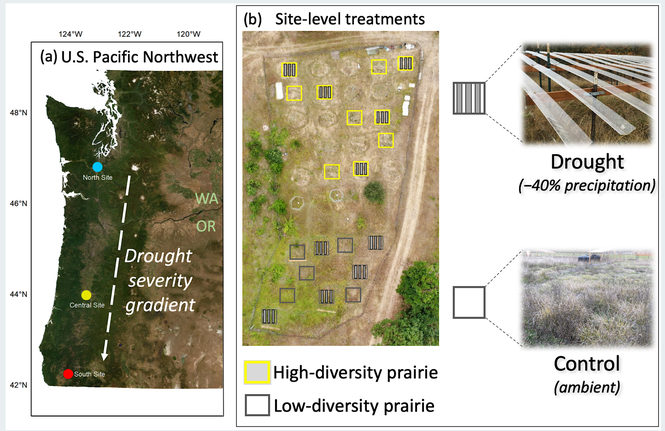
Motivation/Research questions

We are investigating patterns of asymbiotic nitrogen fixation (ANF) and its biogeochemical controls, which may influence plant community composition and prairie productivity, under experimental drought (−40% precipitation) to address a major challenge for sustainable agriculture in the U.S. Pacific Northwest region.



i) Does soil ANF respond to drought stress in prairie ecosystems along the U.S. Mediterranean drought severity gradient? If so, does the response differ between low- and high-diversity prairies and seasons?
ii) Do biogeochemical controls on ANF respond to drought stress along drought severity gradient?

Methods

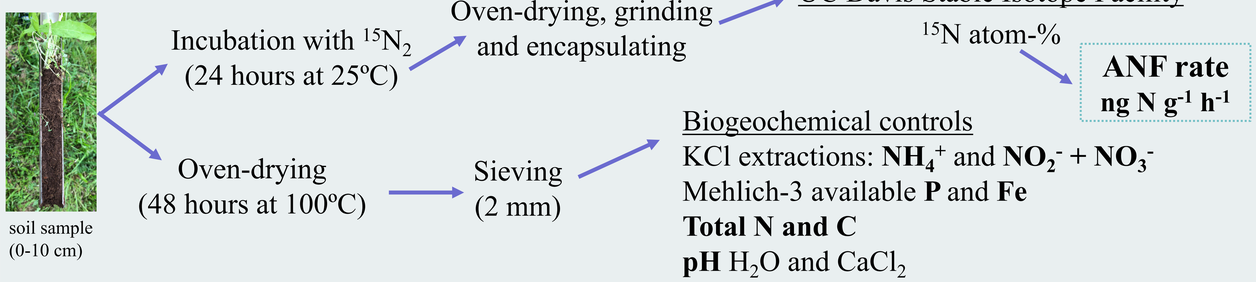


High-diversity prairie

Low-diversity prairie

Photos: Kaye Shek

Figure 1. Study region map and the three study sites representing the U.S. Pacific Northwest drought severity gradient. At each site, composite soil samples (n = 3) were collected in the fall and spring seasons from five co-located high- and low-diversity prairie plots under control (ambient) and drought (−40% precipitation) conditions.



Results

i) ANF drought stress response varies seasonally

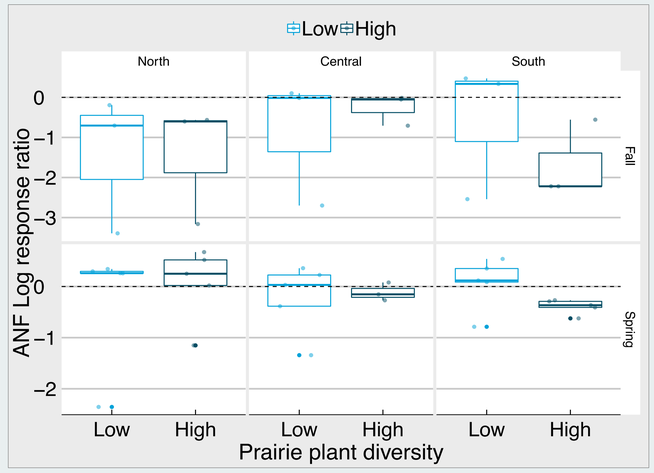
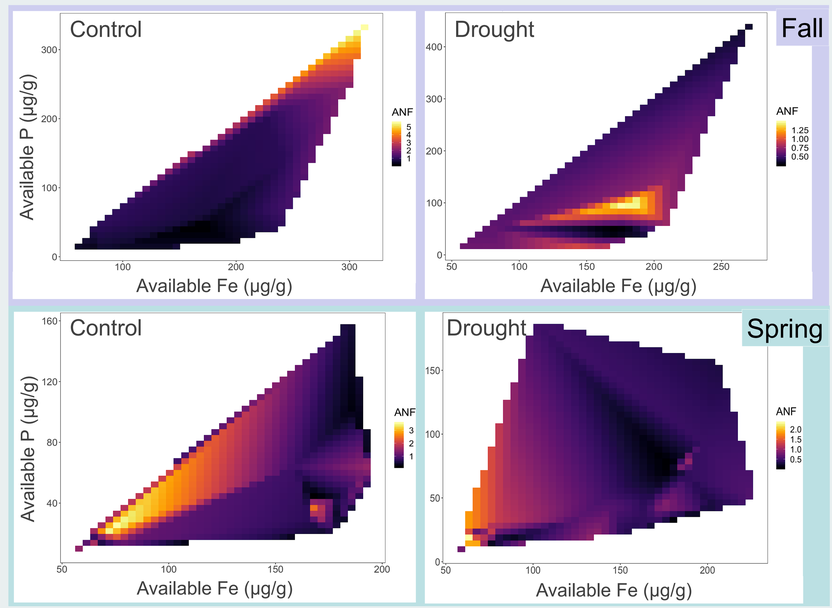



Photo: Toby Maxwell

Consistent negative drought response of soil ANF in high-diversity prairies in southern Oregon in the fall and spring seasons.

Figure 2. Log response ratio [$\log_{10}$(ANF drought / ANF control)] of soil ANF in samples collected in the three study sites along the PNW drought severity gradient.

ii) Biogeochemical controls on ANF are seasonally affected by drought



Available Fe and P, interacting with treatment, significantly explained 50% of ANF in control ($p<.001$) but not in drought soils ($p>.1$). Generalized additive model, R^2_{adj} = 0.44, variance explained = 50%.

Figure 3. Interpolation of ANF rate (ng N g dry weight^{-1} h^{-1}) as a function of available iron (Fe, x axes) and available phosphorus (P, y axes) in control and drought praire soils sampled in the fall and spring seasons.

Acknowledgements

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