

Effects of cover crop diversity on soil water content and N₂O emissions under controlled drought conditions

Pauliina Turunen^{1,2}, Markku Koskinen^{1,2}, Asko Simojoki¹, Jussi Heinonsalo^{2,3}, Mari Pihlatie^{1,2,4}

¹ Department of Agricultural Sciences, Faculty of Agriculture and Forestry, University of Helsinki, Helsinki 00790, Finland,

² Institute for Atmosphere and Earth System Research (INAR), Faculty of Agriculture and Forestry, University of Helsinki, Helsinki 00790, Finland,

³ Department of Forest Sciences, Faculty of Agriculture and Forestry, University of Helsinki, Helsinki 00790, Finland

⁴ Department of Agricultural Sciences, Viikki Plant Science Centre (ViPS), University of Helsinki, Helsinki 00790, Finland

E-mail: pauliina.t.turunen@helsinki.fi

INTRODUCTION

- In northern latitudes, cover crops are usually undersown with the cash crop (here oat).
- Cover crops provide multiple benefits to the soil.
- In dry conditions cover crops may prevent drought stress for the following crop but might also cause drought stress to the main crop.
- Even though cover crops may increase soil organic carbon (SOC) and thus mitigate climate change, the effect of cover crops on nitrous oxide (N₂O) emissions is highly uncertain.

FIELD EXPERIMENT

- Established in 2019 in Viikki research farm, University of Helsinki, Finland.
- 60 plots (sized 4 m x 10 m).
- Treatments: Oat monoculture, Oat undersown with four different diversity levels with 8 cover crops species either alone (D1) or in mixtures of two (D2), four (D4) or eight (D8) species.
- Rainout shelters to remove 50% of the normal rainfall.
- Manual dark chamber method to measure N₂O fluxes.

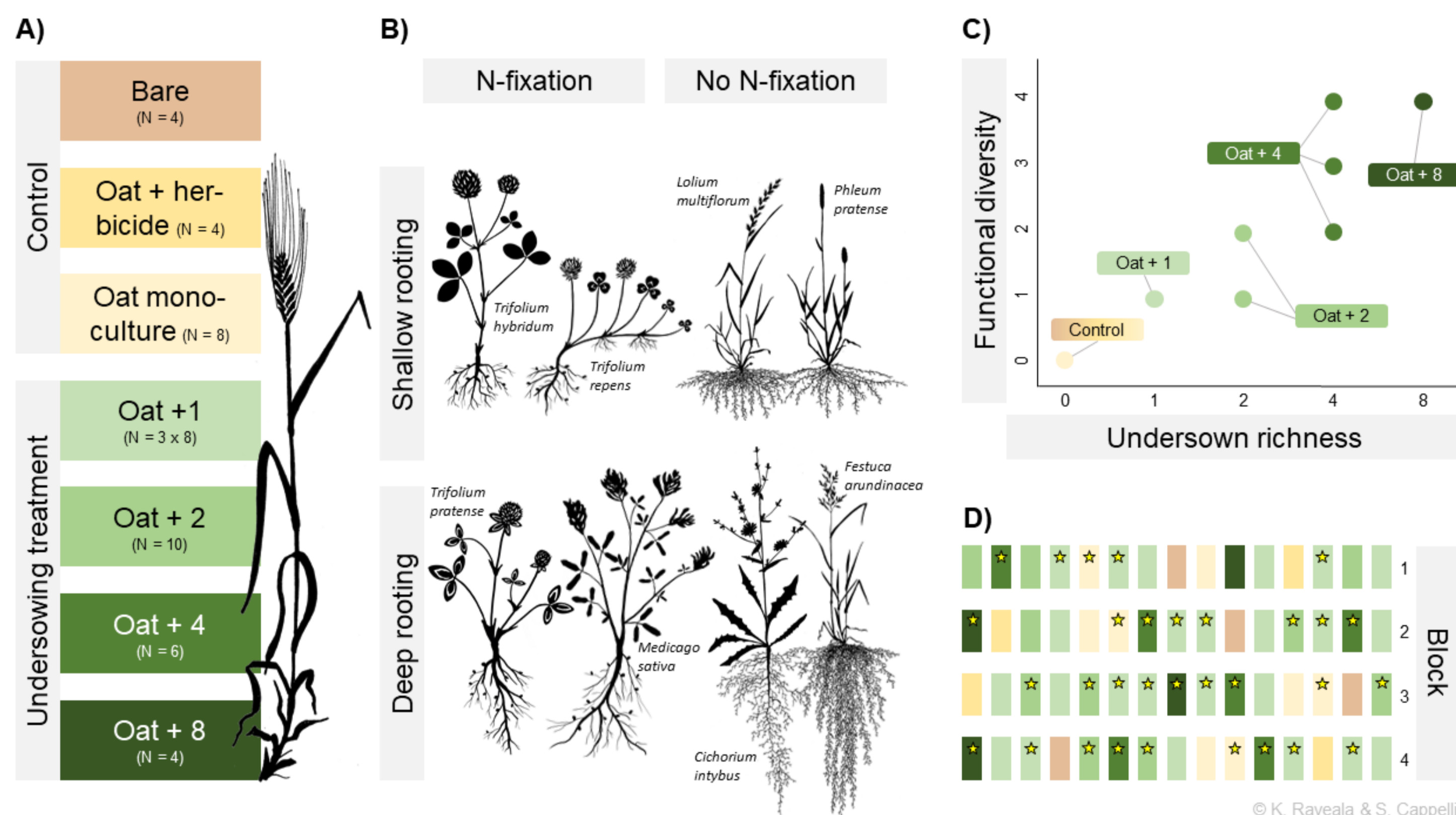


Figure 1. A) treatments, B) cover crop species, C) functional diversity against number of species undersown, D) field design. Stars represent the plots with rainout shelters. Illustration made by Krista Raveala & Seraina Cappelli.



Figure 2. Rainout shelters (Kundel et al. 2018) installed as a split-plot design. Photo by Pauliina Turunen.

PRELIMINARY RESULTS

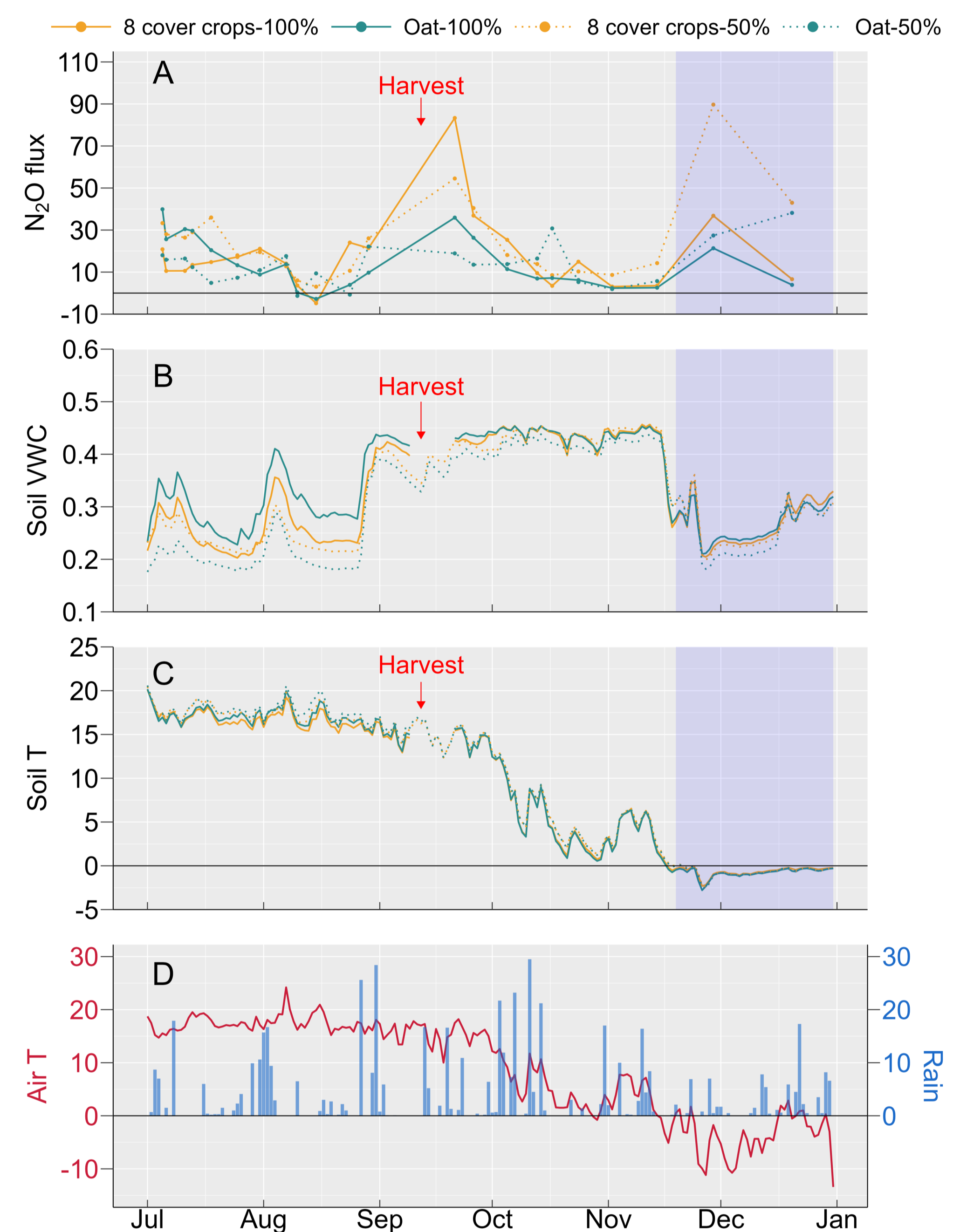


Figure 3. A: Measured N₂O fluxes (µg N₂O m⁻² h⁻¹) from oat monoculture and oat undersown with 8 cover crop species under rainout shelter (50%) and as control (100%). B and C: Soil volumetric water content (m³/m³) and soil temperature (°C) at 14 cm depth and 8 cm depth, respectively, measured with TOMST. D: Average air temperature (°C) and daily rainfall (mm). Blue areas indicate snow cover.

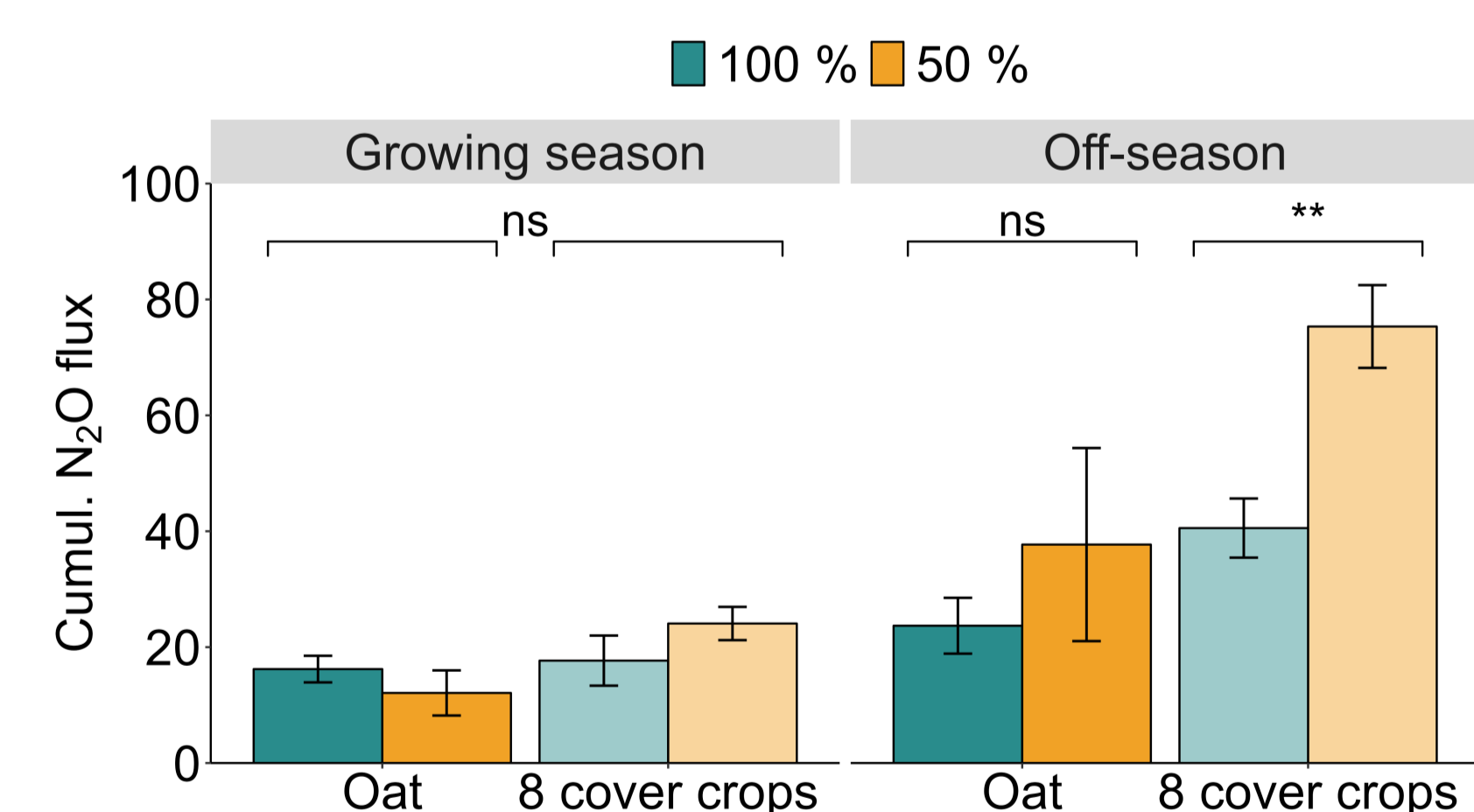


Figure 4. Cumulative N₂O fluxes (mg N₂O m⁻²) during growing season and off-season. *** p-value < 0.001, ** p-value < 0.01, * p-value < 0.05, ns p-value > 0.05.

CONCLUSIONS

- N₂O emissions are higher during off-season than during growing season.
- Prolonged drought may lead to elevated N₂O emissions during freeze-thaw events.
- Off-season fluxes should be included when assessing cover crops and drought effects on annual N₂O emissions.

REFERENCES

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Kundel, D., Meyer, S., Birkhofer, H., Fliessbach, A., Mäder, P., Scheu, S., van Kleunen, M., & Birkhofer, K. (2018). Design and Manual to Construct Rainout-Shelters for Climate Change Experiments in Agroecosystems. *Frontiers in Environmental Science*, 6. <https://doi.org/10.3389/fenvs.2018.00014>