



Soil-Moss-Relations: The path of water from dripping to infiltration

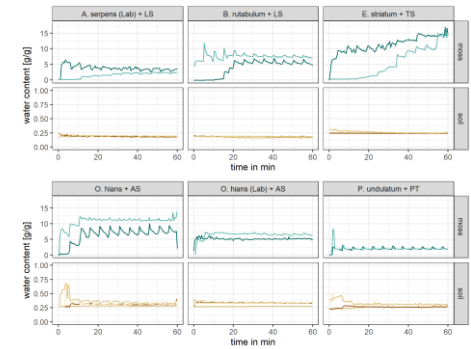
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vEGU21

vPico presentation: Tuesday, **27 April 2021, 09:00** CEST in Session HS10.1

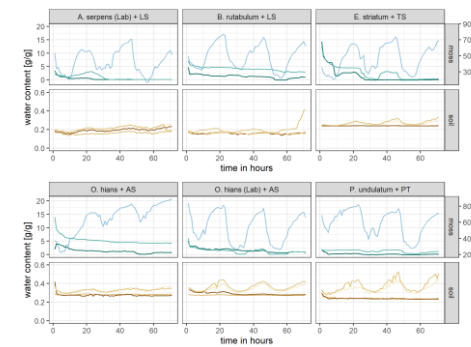
Breakout text chat: Tuesday, **27 April 2021, 09:32-10:30** CEST

Summary



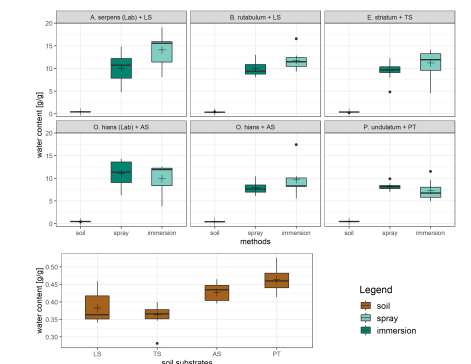
During **artificial irrigation of moss-covered soil substrates**, we observed species- and substrate-specific patterns in temporal progression and achieved level of water content. **Moss cover was no barrier to infiltration** in case of high precipitation amounts of 122 mm, and mosses did not store much of the irrigation water themselves, but passed it on to the soil.

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During 71 hours **desiccation time**, desiccation periods of moss layers and soil surfaces aligned with declining relative humidity (RH), while an increase in water content of moss layer and soil surface was observed with rising RH. **Despite high temperatures and low RH, soil substrates did not desiccate: Moss cover prevented desiccation of soil surfaces without sealing it, as soil surface water content responded to RH.**

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Maximum water storage capacities of moss samples were about 30 times higher than those of soil samples. The influence of different moss structural parameters on maximum water storage capacity is complex, and structures that allow the formation of capillary spaces seem to be of higher relevance for maximum water storage capacities than surface parameters such as LAI or total surface area.

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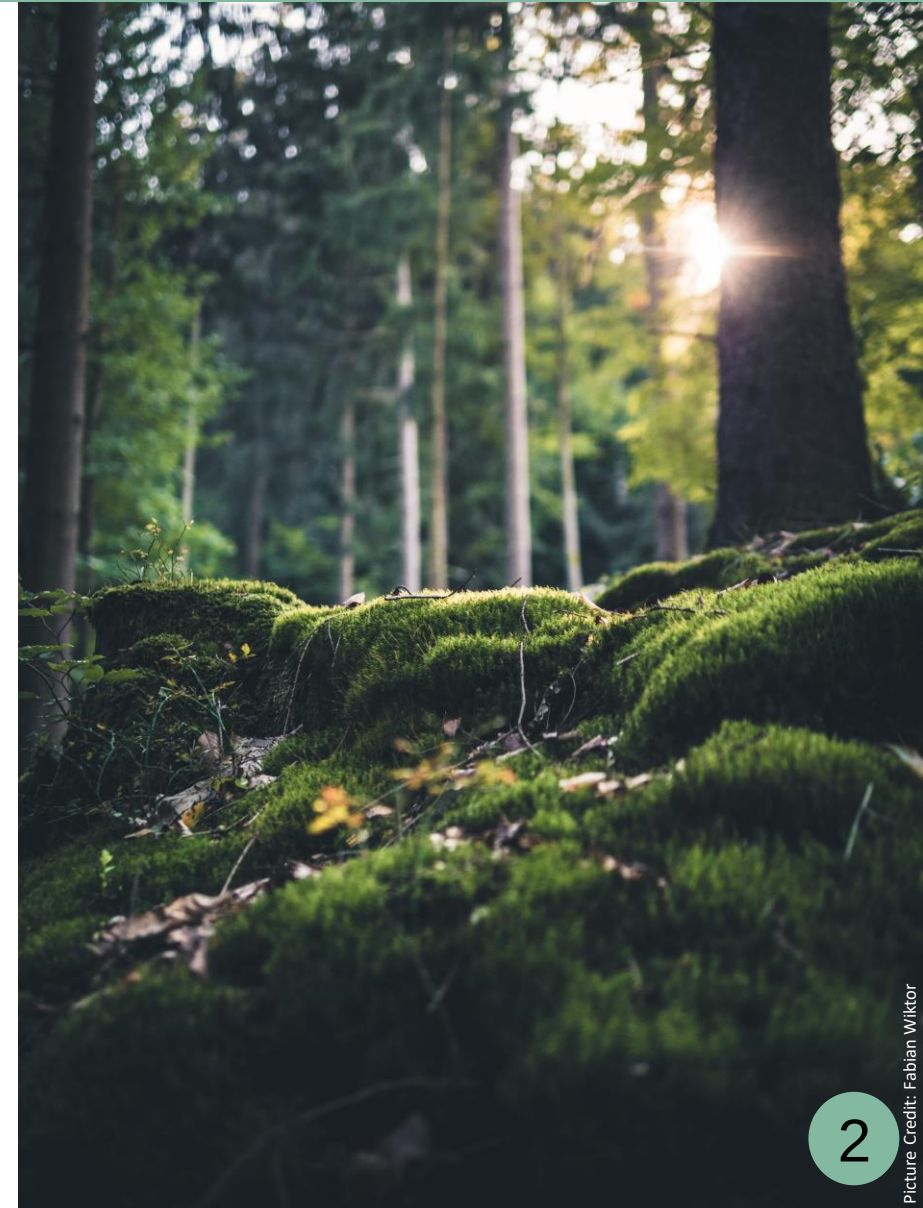
Background & Motivation

Moss layers at ground level play essential roles in forest water balance^{1,2}.

Nevertheless, little is known about the amount of water that mosses release into the atmosphere, and the amount that is transported from soil to moss and vice versa^{3,4}.

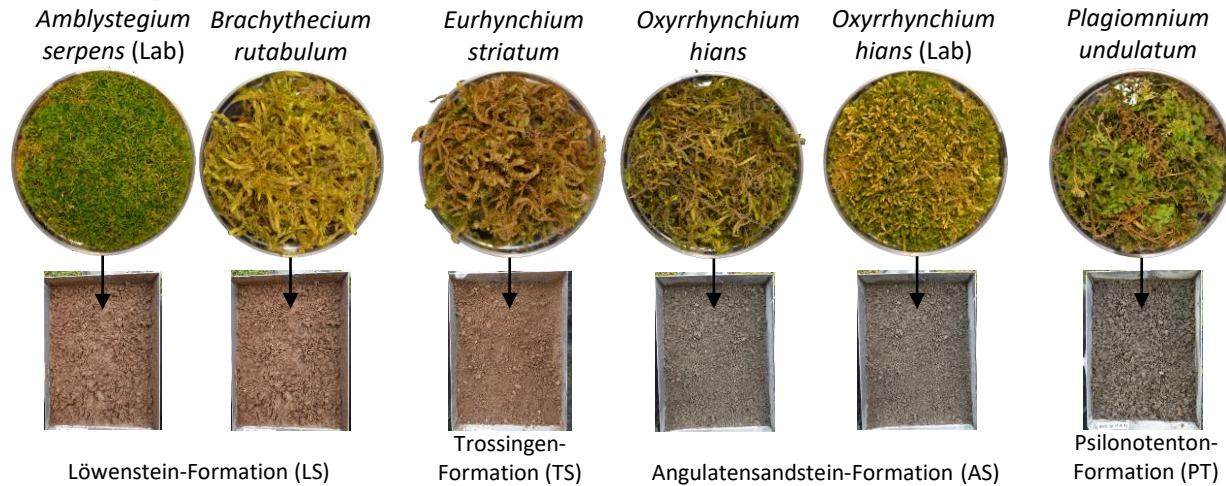
Particularly the **influence of different moss species on water movement** through moss layers into the soil had been largely disregarded in this context, but has shown large effects on e.g. erosion control⁵. To contribute to closing this knowledge gap, we examined water **absorption and evaporation patterns in moss-covered soil substrates** typical for a Central European temperate forest during and after artificial irrigation. Hereby, we addressed the following questions:

- Is maximum water storage capacity species-specific and controlled by structural traits?
- Are there differences in the temporal dynamics of water content during irrigation and subsequent desiccation, depending on the moss species and underlying soil substrates?



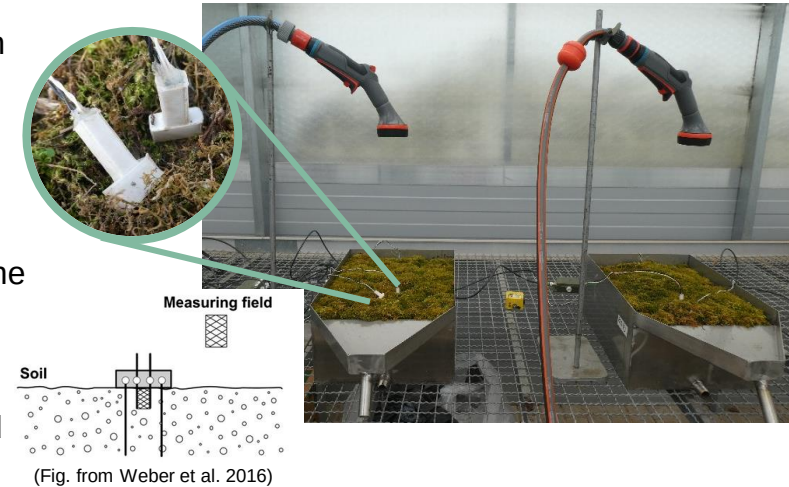
Methods

Samples



Irrigation & desiccation experiment

Samples were irrigated in 5 min intervals with 6 L h⁻¹ for 1 hour. The subsequent desiccation process was monitored for 71 hours. Water content during irrigation and desiccation was measured in the **moss layer**, the **soil surface**, and **3 cm soil depth** with Biocrust Wetness Probes.⁶ Air temperature and relative humidity were recorded with a Tinytag.



Maximum water storage capacity

Calculation of maximum water storage capacity (max WSC):

$$\max WSC = \frac{(\text{wet weight} - \text{dry weight})}{\text{dry weight}}$$

1. Soil samples:

Core cutter samples (100cm³) were dried at 105°C. After measuring dry weight, they were immersed in water until saturated and weighed again.

2. Moss samples:

Samples were dried at 30°C.

a) Spray technique

After measuring dry weight, we sprayed the samples with water, pipetted off excess water and weighed them.

b) Immersion technique

After measuring dry weight, mosses were immersed in water for 5 min, drained for 2 min and then weighed.

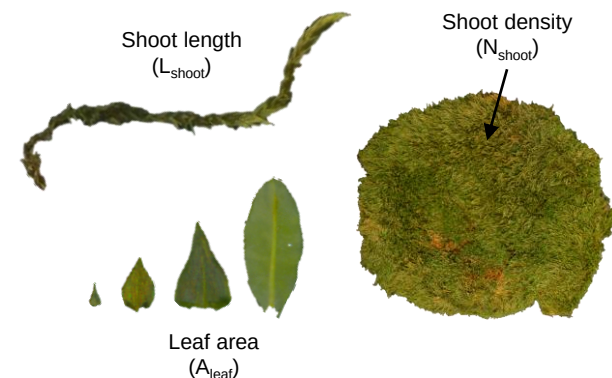
Moss structure

Measured traits:

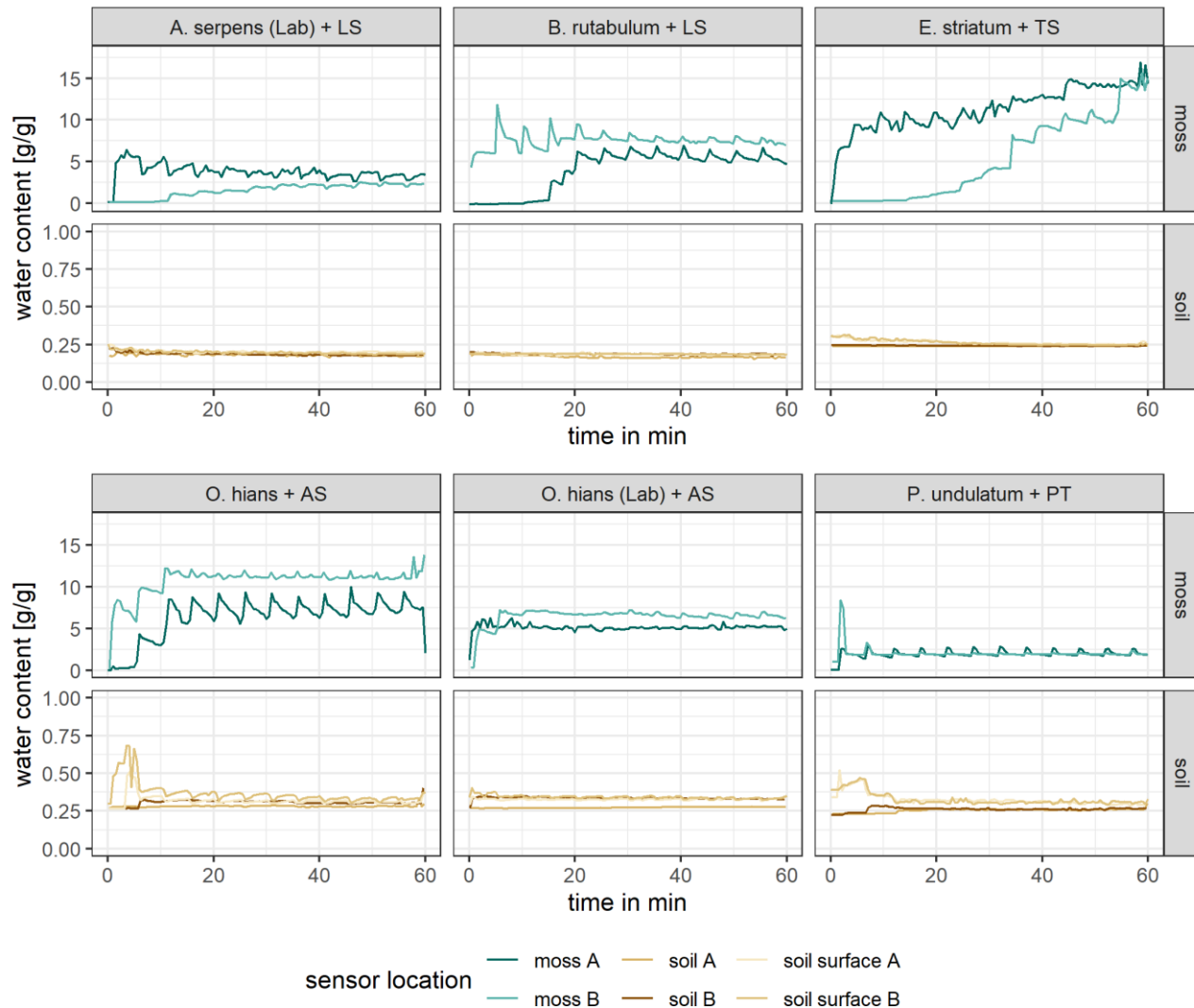
- Cushion height, volume and density
- Shoot density
- Shoot length
- Leaf frequency
- Leaf area

Calculation of moss surface area and LAI for all studied species:

$$A_{bryo} = L_{shoot} N_{shoot} \frac{A_{leaf}}{1 \text{ cm shoot}} \quad \rightarrow \quad LAI = \frac{A_{bryo}}{\text{sample area}}$$

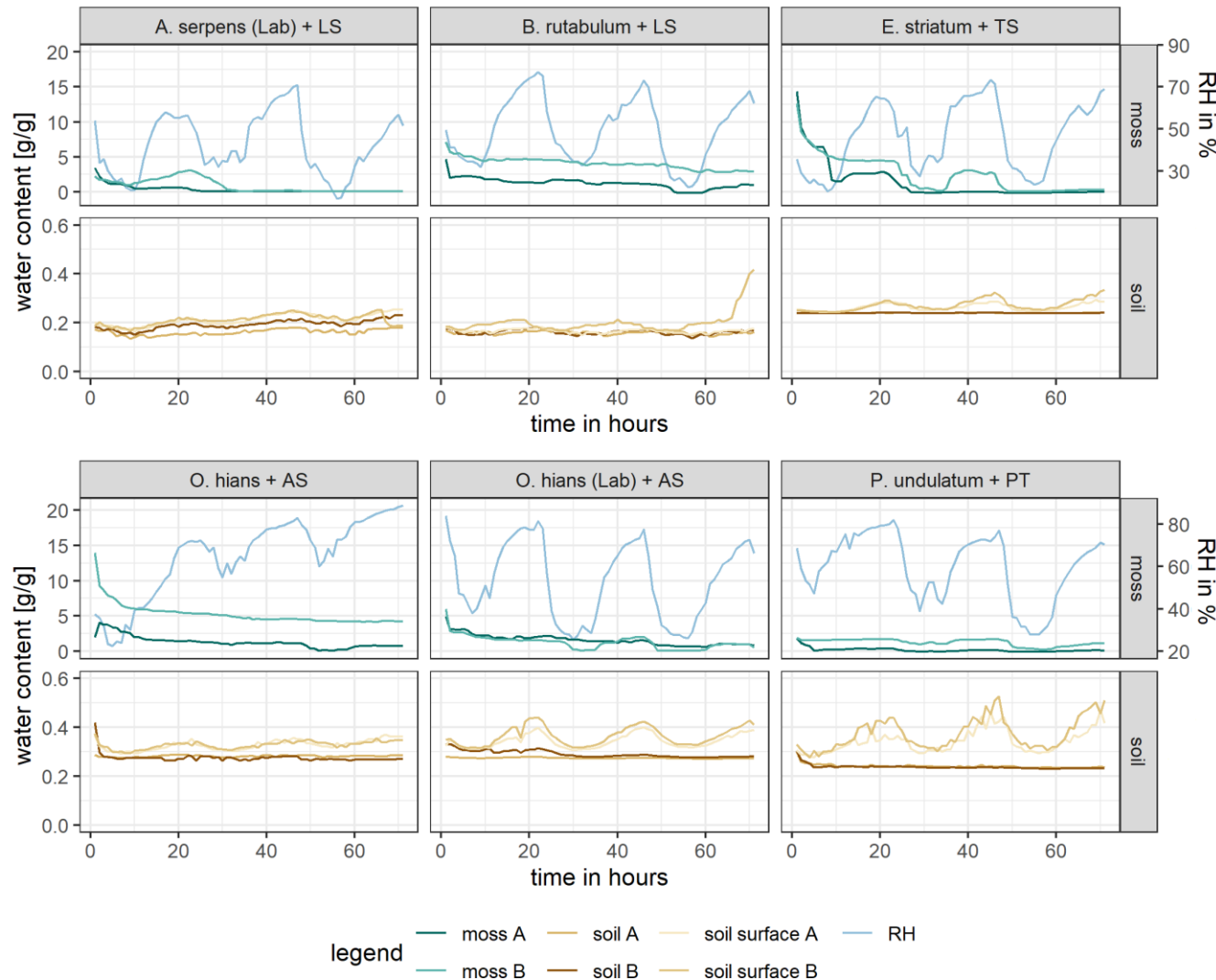


Irrigation Process



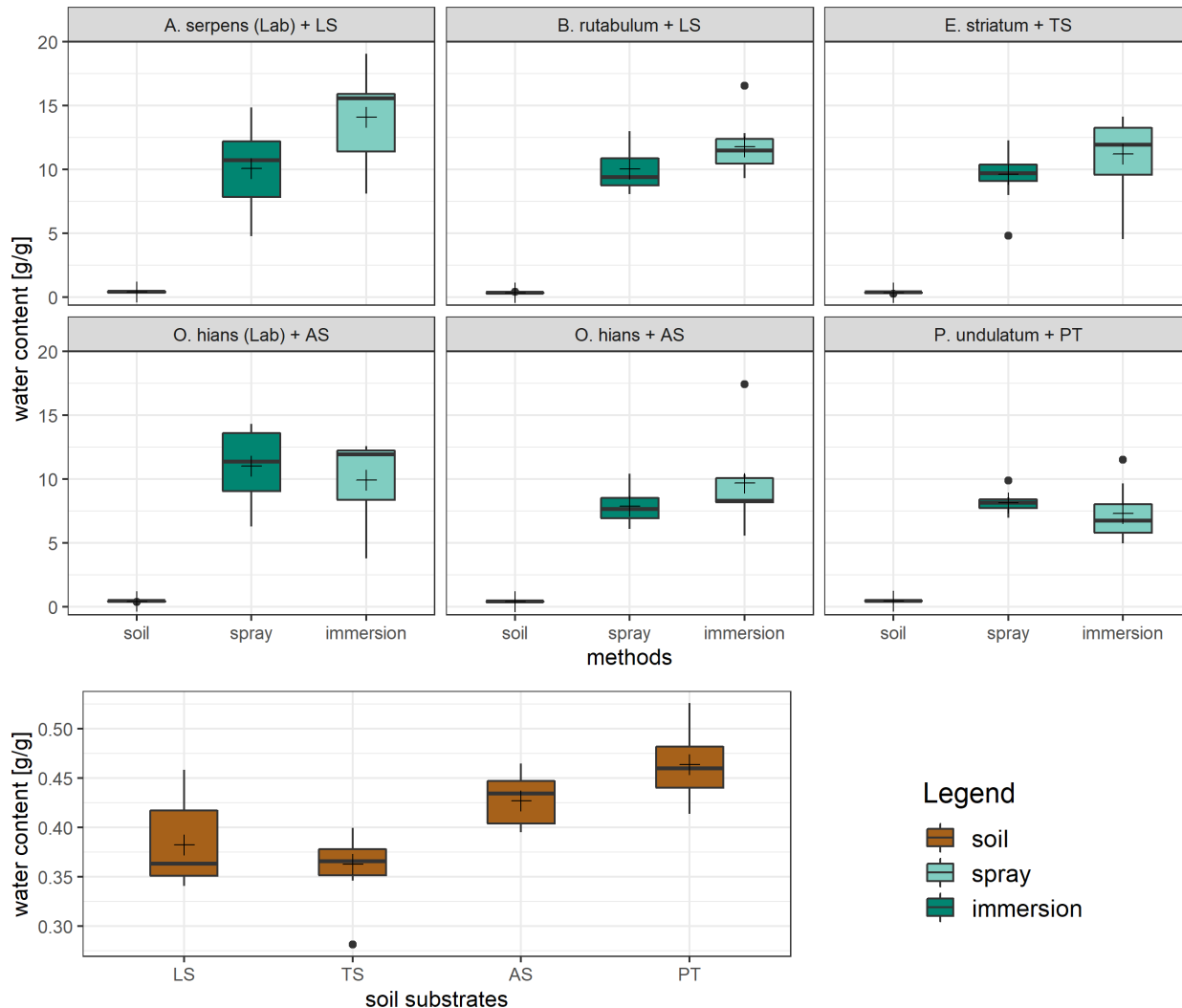
- We observed species/substrate-specific patterns of water content during irrigation, both in temporal progression and the achieved water content level.
- Water content of the moss duplicates (except *P. undulatum*) differed, primarily until equilibrium in water content was reached.
- Irrigation cycles at 5 min intervals are particularly evident in *B. rutabulum*, *O. hians* and *P. undulatum*.
- Soil substrates AS and PT increased water content in first 10 min, indicating percolation of water through the substrate.
- Maximum water storage capacities were not reached in both mosses and soil substrates, indicating different mechanisms when soil and moss are studied together as a “soil-moss-system” compared to their behaviour when studied alone.
- **Mosses were no barrier to infiltration in case of high precipitation rates.**

Desiccation Process



- Water content in moss layers generally decreased, but remained $\pm$ at same levels at the soil surface and in 3 cm soil depth.
- Studied moss species differed in maximum water content, evaporation rates and their response to climatic changes. Moss sample duplicates slightly differed from each other in regard to water content values, but generally showed comparable patterns.
- Leaf frequencies correlated positively with evaporation rates (Spearman's correlation $\rho = 0.832$, $p < 0.001$), whereas LAI correlated negatively (Spearman's correlation $\rho = -0.78$, $p < 0.001$).
- Diurnal fluctuations depended on the microclimate: Desiccation periods aligned with declining RH, while we observed an increase in water content of moss layers and soil surfaces with rising RH.
- **Despite high temperatures and low RH, soil substrates did not desiccate → Moss cover prevented desiccation of soil surface without sealing it, as soil surface WC responded to RH.**

Maximum water storage capacities



- Maximum water storage capacity ranged from 14.1 g g⁻¹ for *A. serpens* (Lab) to 7.3 g g⁻¹ for *P. undulatum* when immersed in water, and from 11.04 g g⁻¹ for *O. hians* (Lab) to 7.9 g g⁻¹ for *O. hians* when sprayed.
- Maximum water storage capacity in the **immersion technique** was increased by:
 - high leaf frequency (Spearman's correlation rho = 0.32, p < 0.05)
 - small leaf area (Spearman's correlation rho = -0.3, p < 0.05)
 - cushion and shoot density (GAM)
- For the **spray technique**, no individual correlations with the surveyed moss structural traits were deduced; but GAM showed an influence of LAI and moss cushion height on maximum water storage capacity.
- Soil substrates** absorbed around 30 times less water than the moss samples, and maximum water storage capacity was influenced by bulk density, grain size distribution and total carbon content.

References & Contact

References:

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Our work:

Thielen, S.M.*, Gall, C.*, Ebner, M., Nebel, M., Scholten, T., and Seitz, S.: Down came the rain: Water's path from moss to soil. Submitted to *Journal of Hydrology and Hydromechanics*.

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