PROJECT TITLE

Isohydry of potato plants and tuber water capacitance

CONSORTIUM

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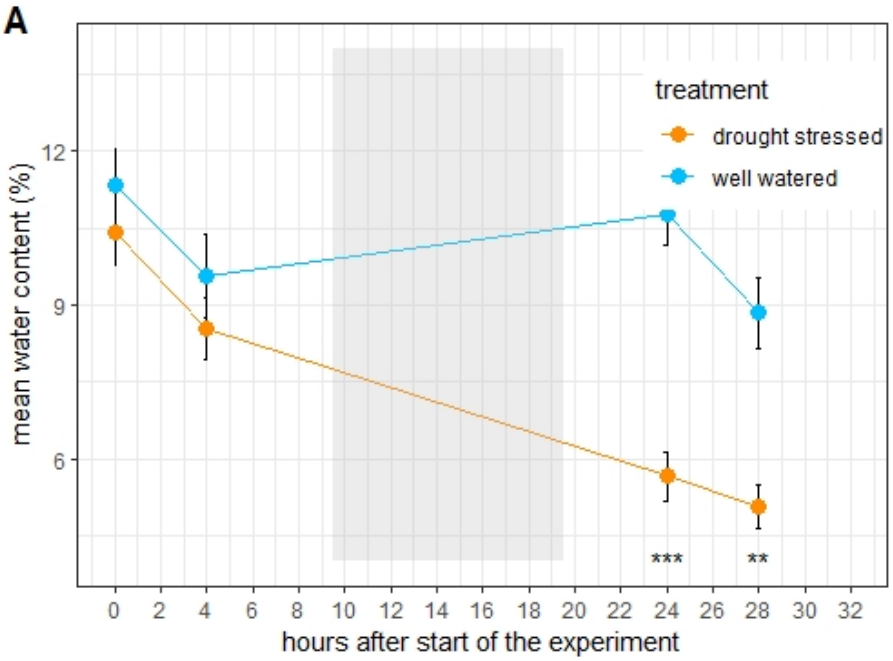
SUMMARY OF THE REPORT

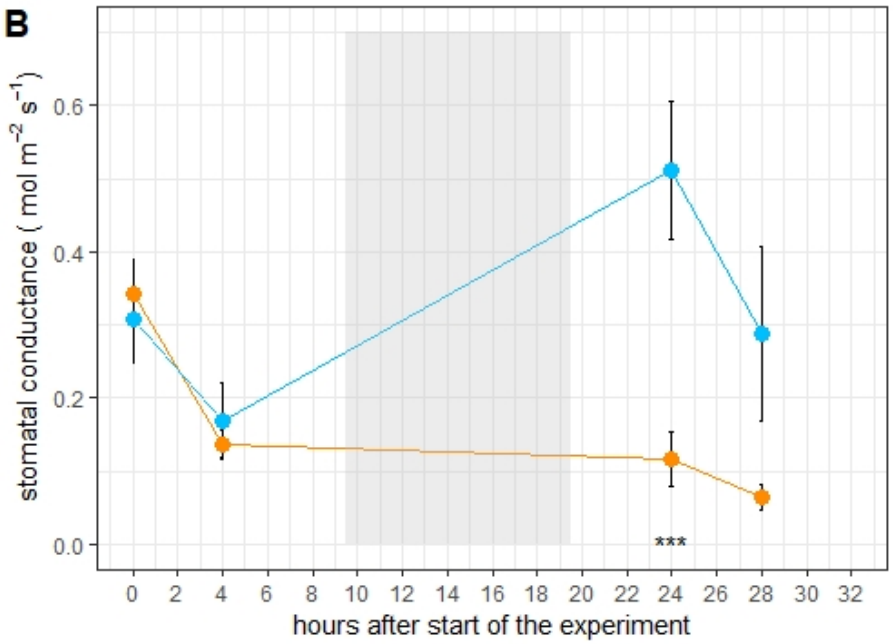
The Project PoTuWa aimed to better understand water relations of potato plants growing in drying soil. While the potato tuber is a large (starch) storage organ, currently very little is known about the role of the tuber as a possible water source under drought stress. Therefore the project PoTuWa investigated above- and below-ground plant and soil water relations using novel MRI technology paired with physiological measurements of the shoot.

The project started in February 2019 and data analysis is still on-going. Several online meetings were initiated to determine the experimental plan. Seed tubers were sent from Lancaster to Jülich(to ensure continuity with previous work at Lancaster) and a preliminary experiment planted on 26th April 2019. The first visit of the researcher from Lancaster was in June 2019 for 10 days to run a pilot experiment, optimise the workflow and prepare the two main experiments. Some pitfalls in the experimental planning were identified and solutions for the main experiments were discussed.

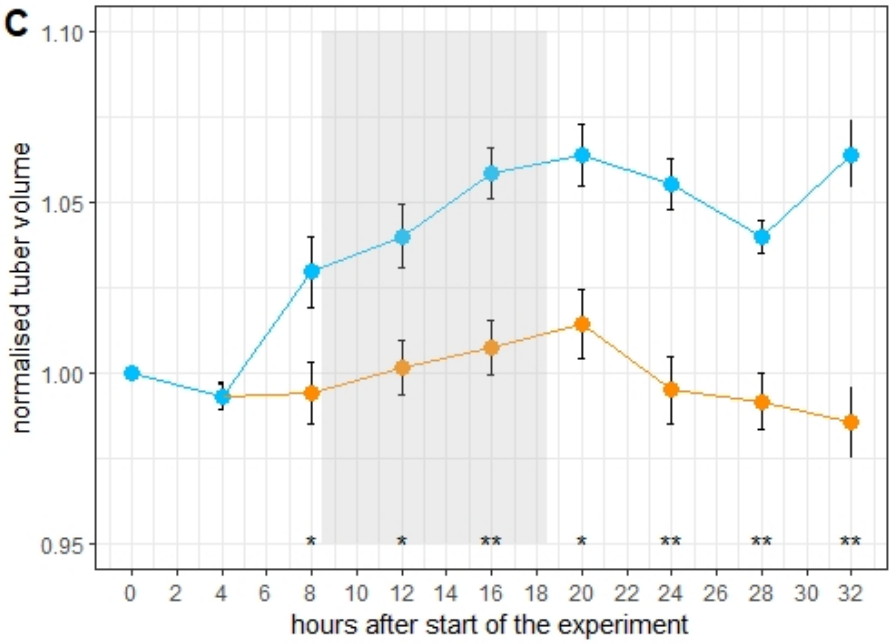
Two experiments were conducted in summer 2019 and 2020. Each experiment imposed two treatments at 6 weeks after emergence: well-watered controls and plants that were allowed to dry the soil. During the growth period, weekly MRI images were taken to describe the growth pattern of the tubers.From the MRI images, tuber volume and tuber water content could be extracted using the software package MeVisLab. Since MRI is a non-destructive method, it was possible to measure the same plants every 4 hours (including night hours) over a time course of 4 days. Shoot physiological measurements were carried out twice daily (30 minutes before the plant underwent MRI imaging). Soil water content was measured at three heights of the pot twice daily, as well as whole plant and leaf transpiration rate, leaf photosynthesis rate and stomatal conductance. All leaf level measurements were conducted on the same leaf on both measuring occasions each day,with its water potential and area determined in the afternoon of that day.

Soil water content of both treatments was similar during the first 4 hours of the experiments, but re-watering of well watered plants at 6 hours resulted in significant differences as soil water content declined in the drying treatment

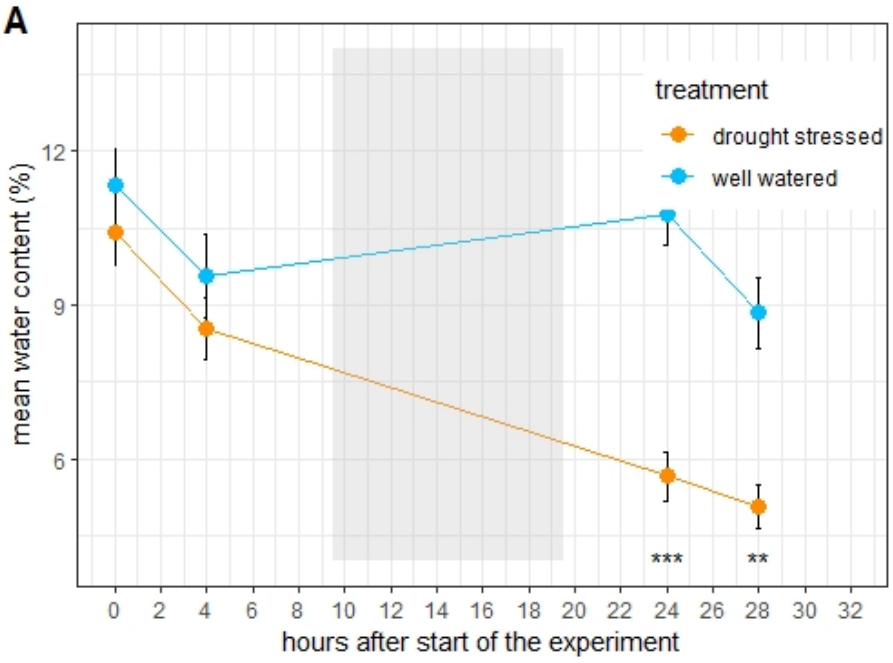


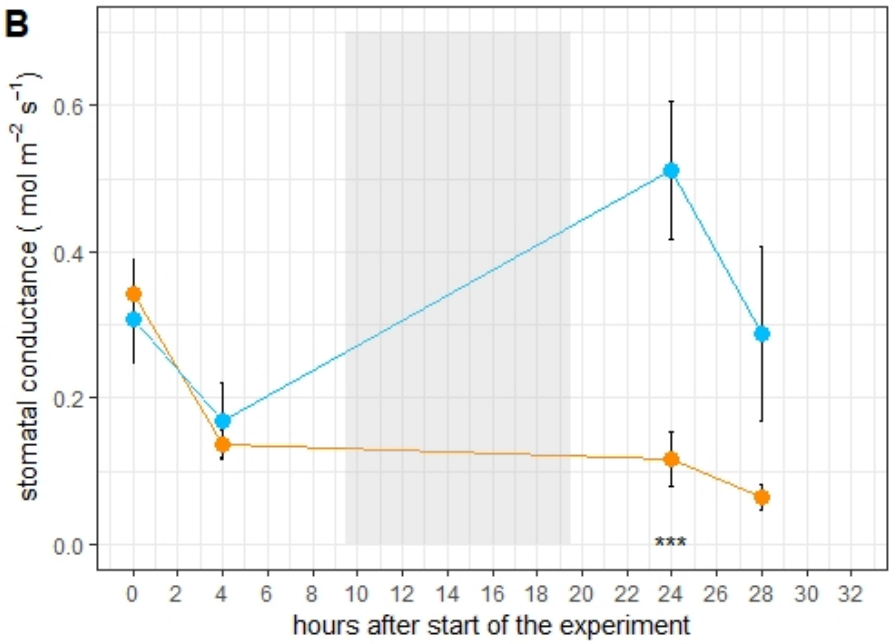


. Similarly, stomatal conductance shows

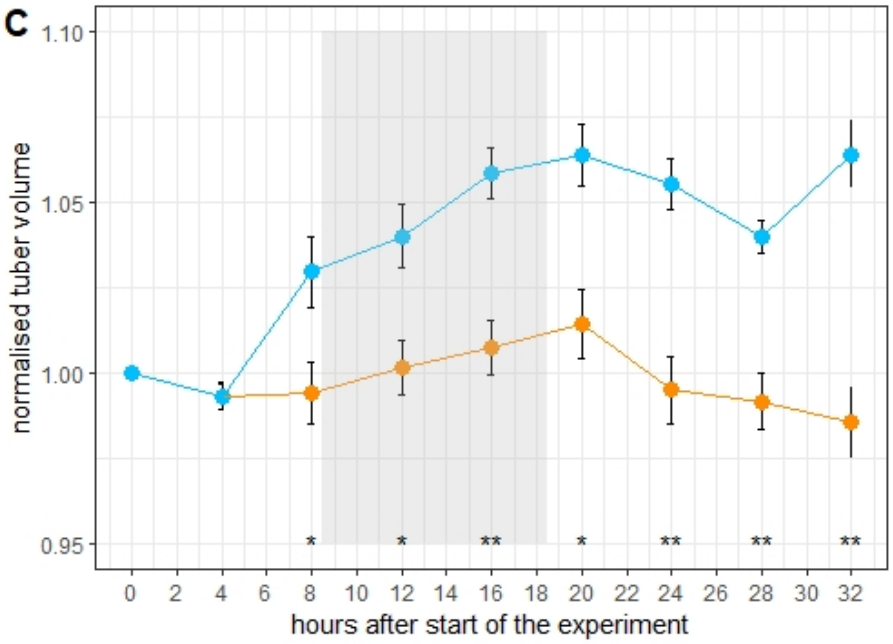


significant differences between treatments one day after imposing stress

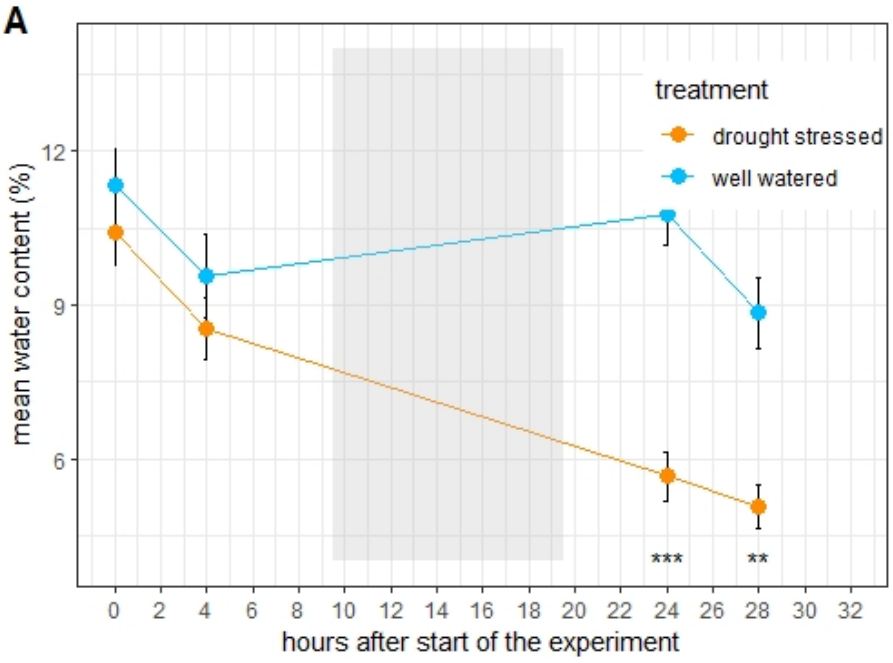


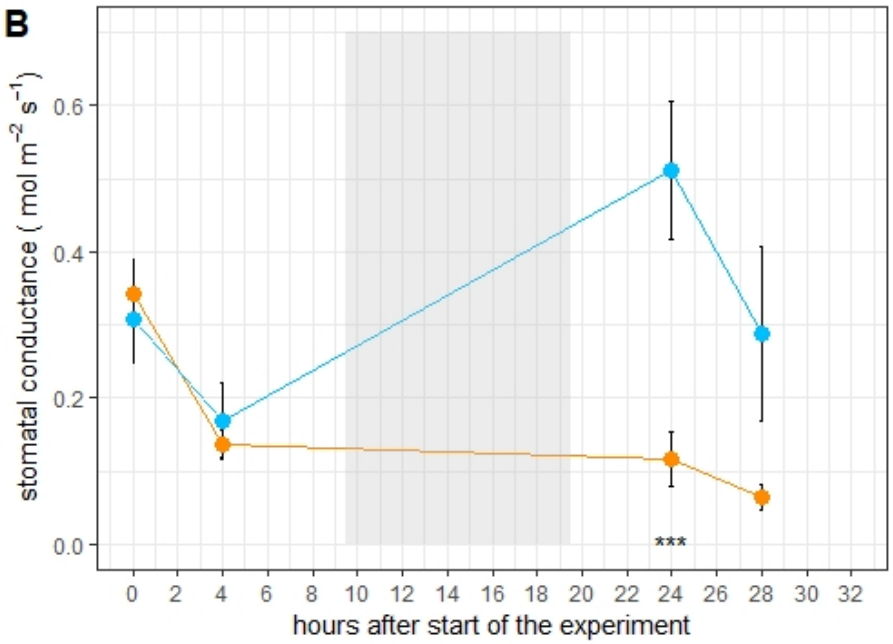


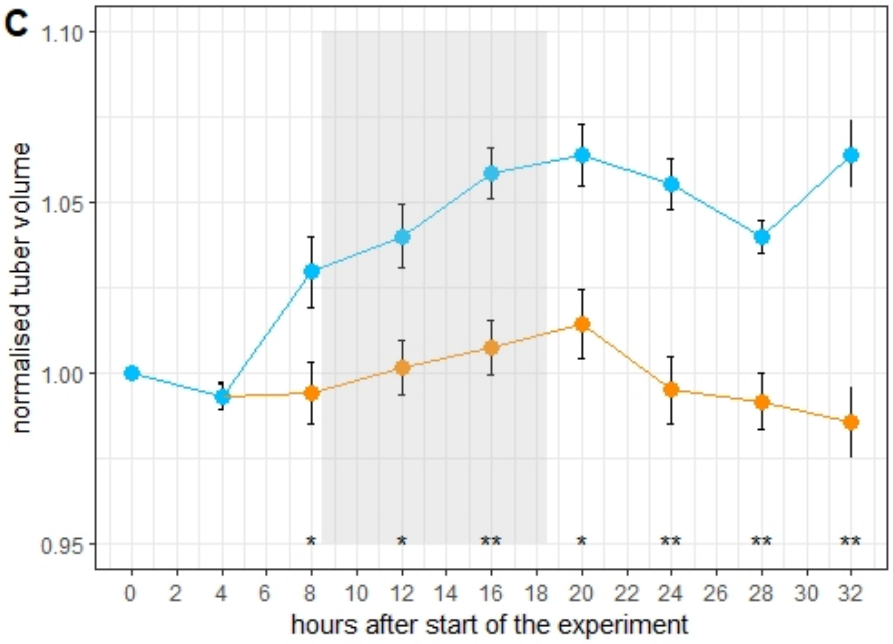
. Preliminary analysis shows that tuber volume



of drought stressed plants is already significantly smaller than in well watered plants in the first night after imposing drought stress


A
treatment
drought stressed
well watered
mean water content (%)
12
9
6
***
**
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
hours after start of the experiment


B
stomatal conductance (mol m^{-2} s^{-1})
0.6
0.4
0.2
0.0
***
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
hours after start of the experiment


C
normalised tuber volume
1.10
1.05
1.00
0.95
*
*
**
*
**
**
**
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
hours after start of the experiment

This unique dataset indicates that soil drying restricts tuber growth even before shoot physiological measurements detected differences, and well before visible leaf wilting occurred (not detected in this study). This finding can inform irrigation scheduling on farms in the future to prevent yield losses through drought stress.