ARBORICROP: Next generation agriculture using real-time information from tree crops

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Crop Science and Production Systems

Arboricrop is funded by Innovate UK, as part of a bilateral R&D program between UK and Switzerland (2024 – 2026)

- UK project team is led by Benchmark Control; also includes Adrian Scripps, Hutchinsons, and Niab.

- Switzerland team is led by Vivent Biosignals; also includes Changins Viticulture and Enology, and ECAL Design School.

- Main Research Objective: develop sensors that record tree electrophysiology and indicate stress before visible symptoms appear.

Project Design and Execution:

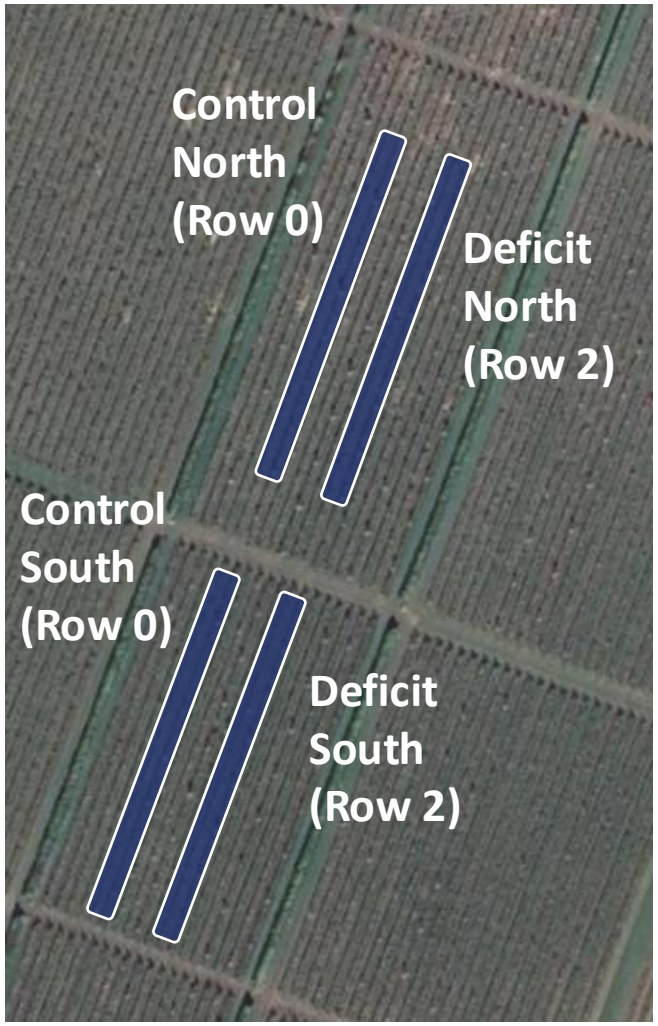
Trial site at Adrian Scripps apple orchard (Gala).

Sensors are installed directly into the trees. 32 Trees and 64 sensors.

Electrodes are connected to the sensors and inserted to tree branch vasculature

Each sensor wirelessly sends data to centralized 5G router in the orchard, which transmits continual data via cellular network

Project Design and Execution:



Sensors were distributed across 2 rows (control and deficit irrigation) and two plots (north and south).

North plot has fast-draining sandy soils, while the South plot has slower-draining clay soils.

Sensors recorded data from June to September 2025, meanwhile ground-truth data was collected on a weekly basis.

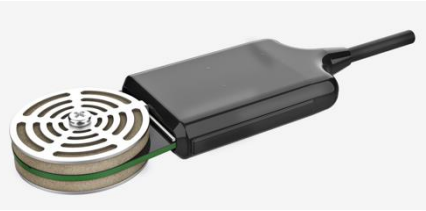
Hypotheses: Deficit North should experience the most water stress, while Control South should experience the least water stress.

Traditional ground-truth data:

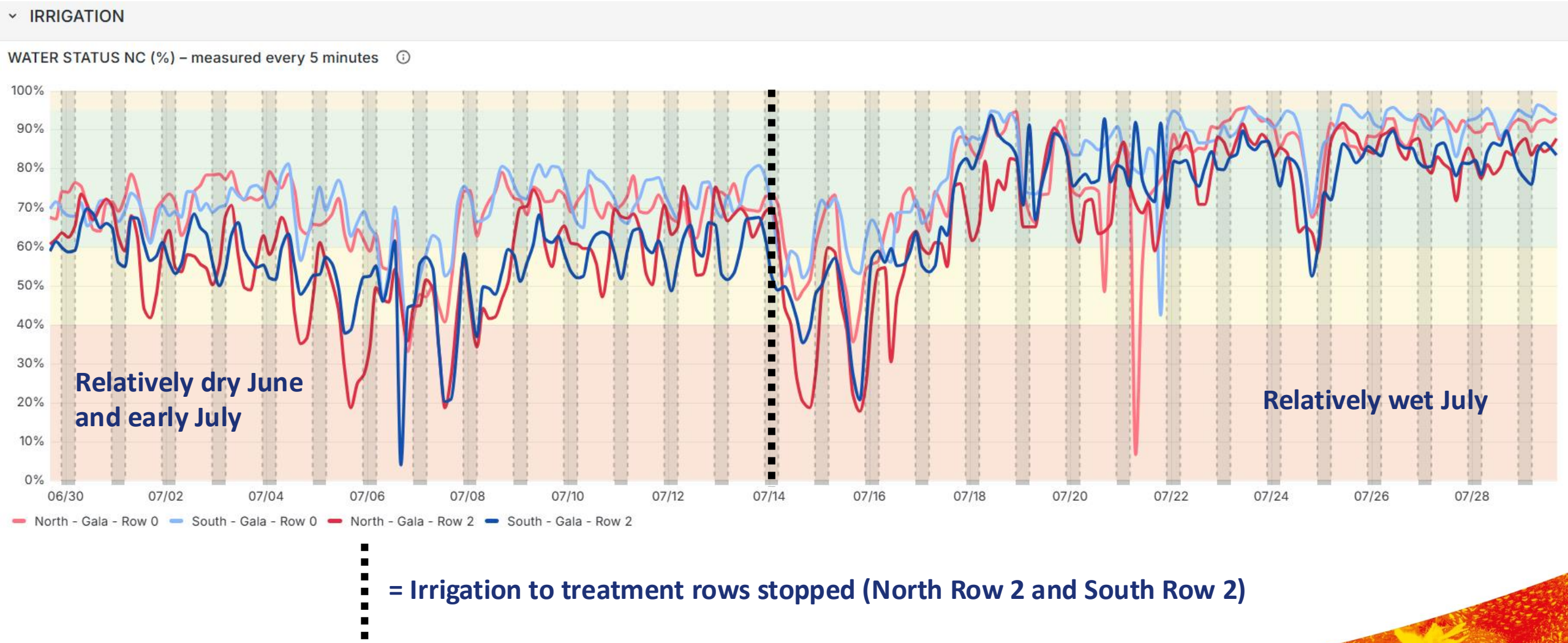
1) Stomatal conductance (gsw), measures leaf transpiration.

2) Stem water potential (SWP), is a measure of water stress.

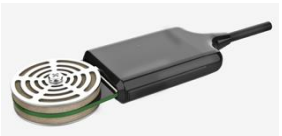
3) Soil matric potential (Soil or SMP), measures the available soil water.

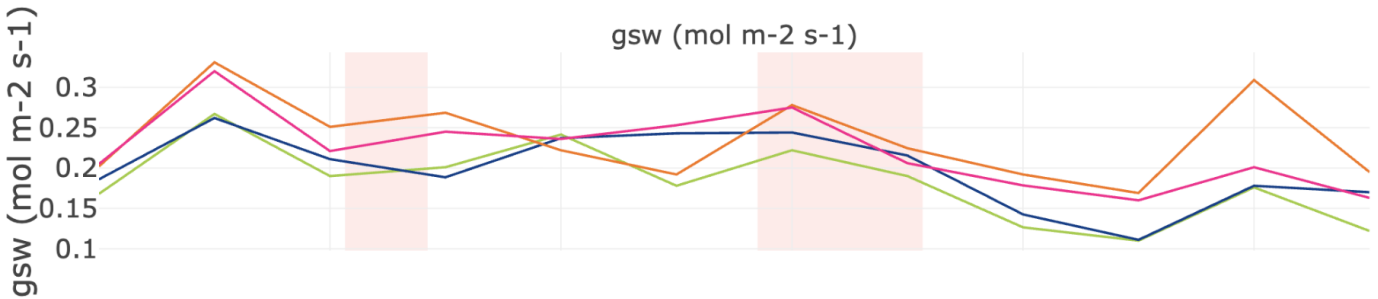


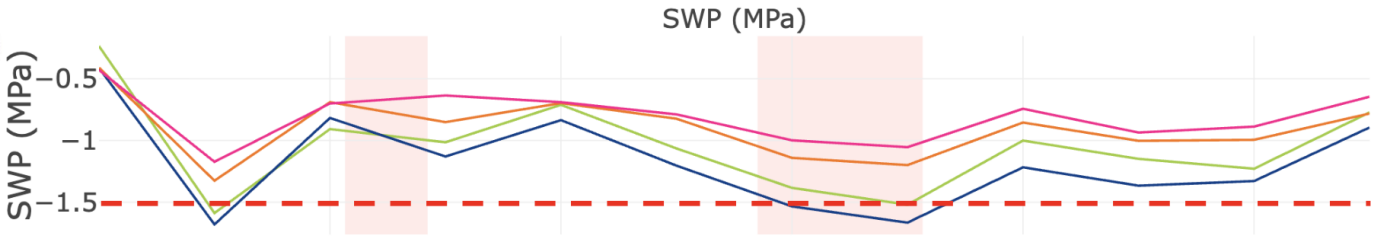
Vivent Dashboard provides real-time information of plant water status, as determined by sensor electrophysiology and data modeling

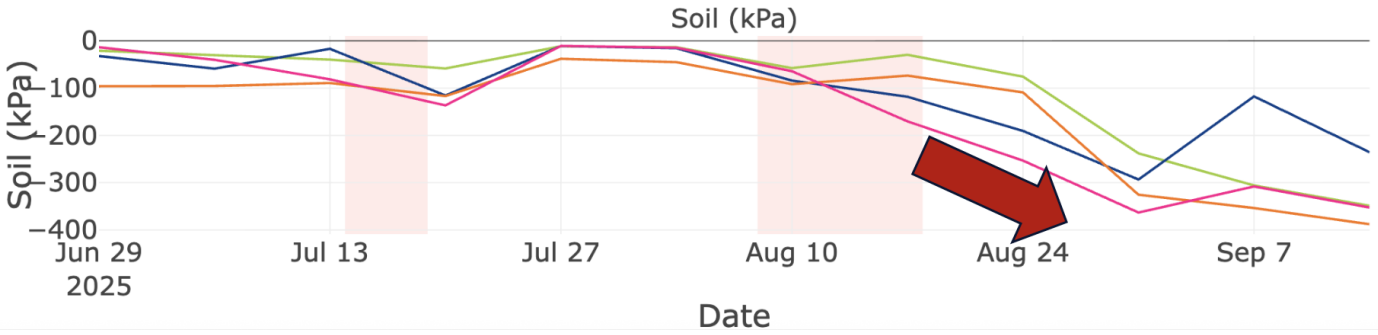


Ground-truth data collection, weekly snapshot measurements





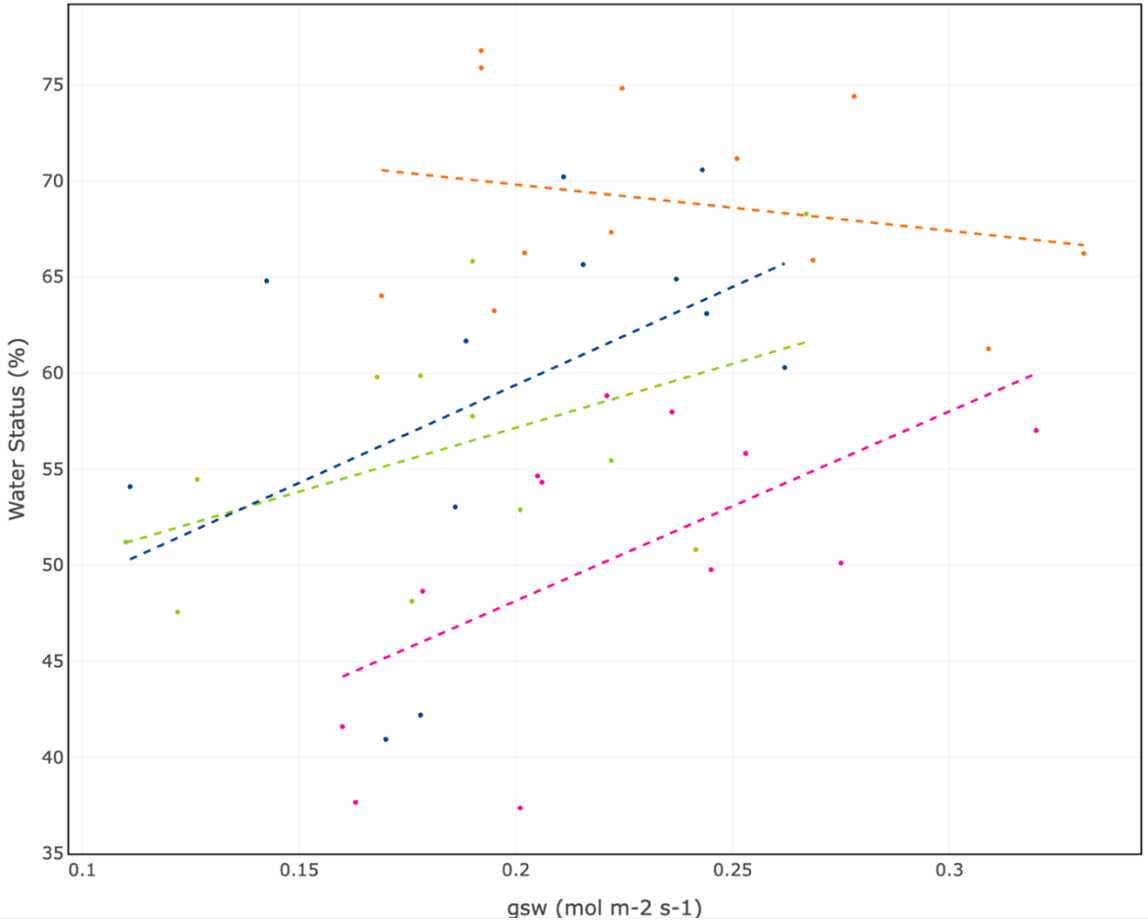




Two different periods of deficit irrigation:
-- 1st in July (only Row 2)
-- 2nd in August (both Rows)

First treatment was less effective due to wet July, but August was sufficient to induce water stress

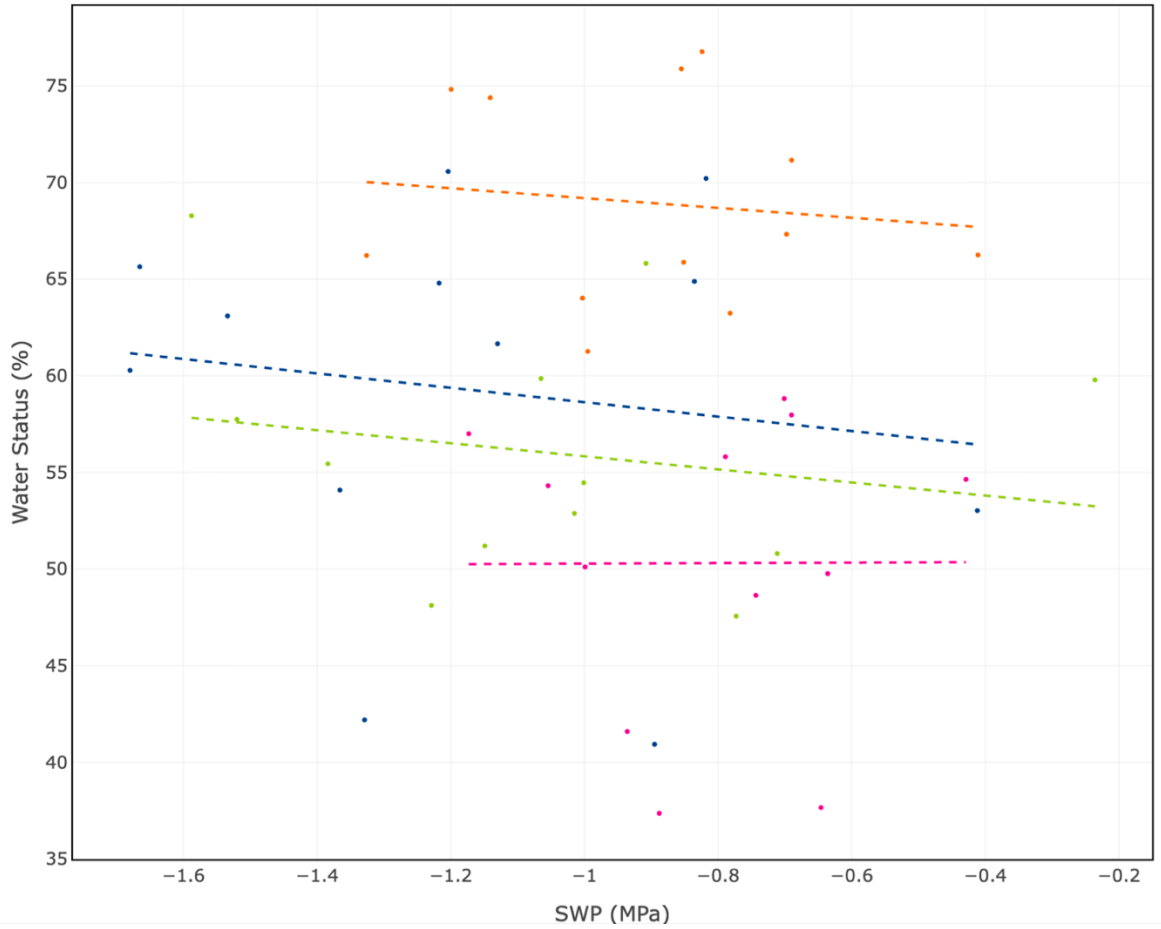
Comparison of Vivent sensor and ground-truth data (gsw)



Conclusions:

--Statistical correlation in 3 of 4 locations; South Row 0 (orange) did not experience water stress throughout the season. Confirms hypothesis based on irrigation and soil type

Comparison of Vivent sensor and ground-truth data (SWP)



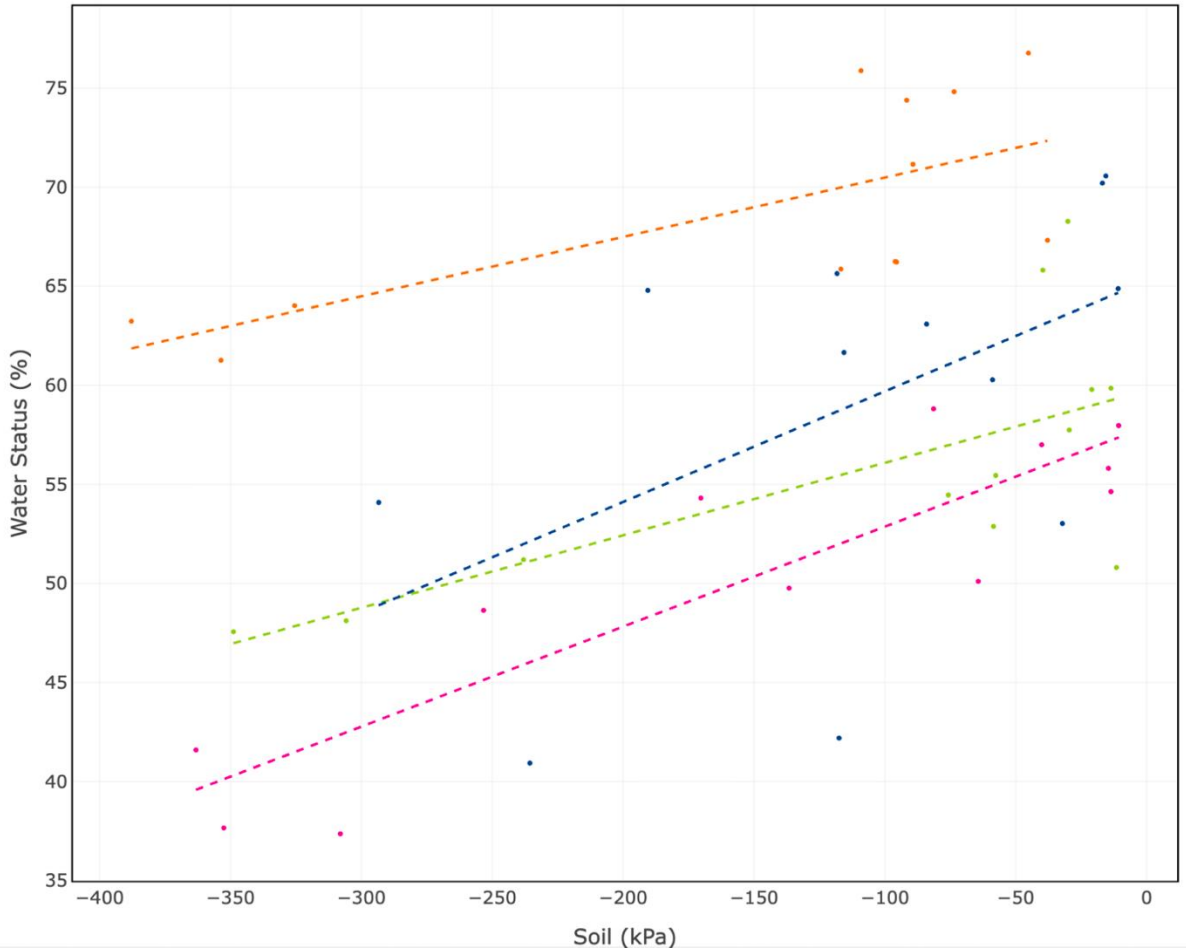
- North - Gala - Row 0
- North - Gala - Row 0 fit (R^2=0.04)
- North - Gala - Row 2
- North - Gala - Row 2 fit (R^2=0.02)
- South - Gala - Row 0
- South - Gala - Row 0 fit (R^2=0.01)
- South - Gala - Row 2
- South - Gala - Row 2 fit (R^2=0.00)

Conclusions:

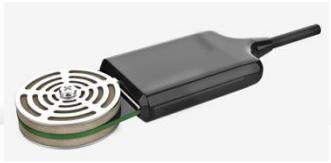
--No correlation with SWP, which is a bit surprising.

--SWP is often the first indication of water stress; perhaps SWP is more sensitive than Vivent data or ”out-of-sync” in these comparisons.

Comparison of Vivent sensor and ground-truth data (SMP)



- North - Gala - Row 0
- North - Gala - Row 0 fit (R^2=0.46)
- North - Gala - Row 2
- North - Gala - Row 2 fit (R^2=0.27)
- South - Gala - Row 0
- South - Gala - Row 0 fit (R^2=0.49)
- South - Gala - Row 2
- South - Gala - Row 2 fit (R^2=0.80)



Conclusions:

--Statistical correlations with SMP in all four locations.

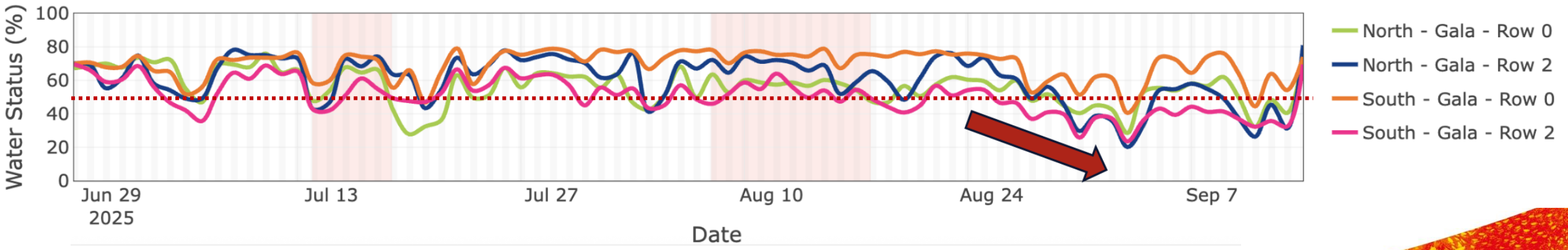
--While SMP did reach equivalent lows in South Row 0, the Water Status did not drop below 60%. Water may be available in those soils below the SMP sensor depth (max 45 cm depth)

Next steps and future directions:

- Consideration of other parameters that Vivent can model, including nutrition deficiencies (nitrogen, potassium, calcium, phosphorus, and manganese).

- Integration with existing agronomic tools and forecasting (Omnia Digital Farming, led by Hutchinsons).

- Develop a system for automated irrigation based on water status, ie: actuate irrigation if value continually stays below 50%



Project Achievements:

- Production of reliable sensor hardware and communication software for continual real-time assessment of plant electrophysiology in orchard systems (Benchmark Control and Swiss partners).

- Models that predict water status and plant health based on electrophysiology data that agree with “gold-standard” physiology measurements (gsw and SMP; Vivent, Niab, and Adrian Scripps).

- Potential exploitation in digital farming systems management (Vivent and Hutchinsons).

- Thank you to Innovate UK and Innosuisse for funding, and to the project partners and Niab team members for execution!

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