Agroscope | 2019

Assessment of tomato plant status in greenhouse using electrophysiology and supervised machine learning

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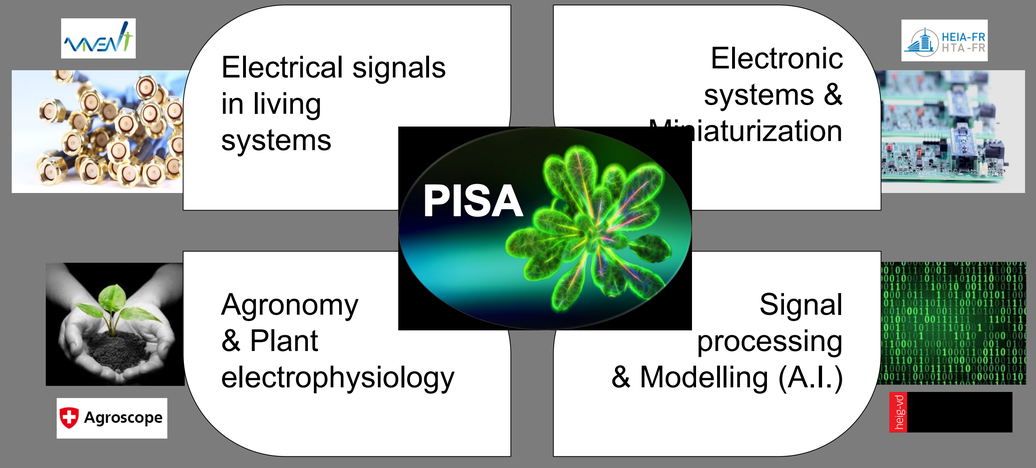
Introduction

Platform applying **I**ntelligent **S**ignal **A**nalysis



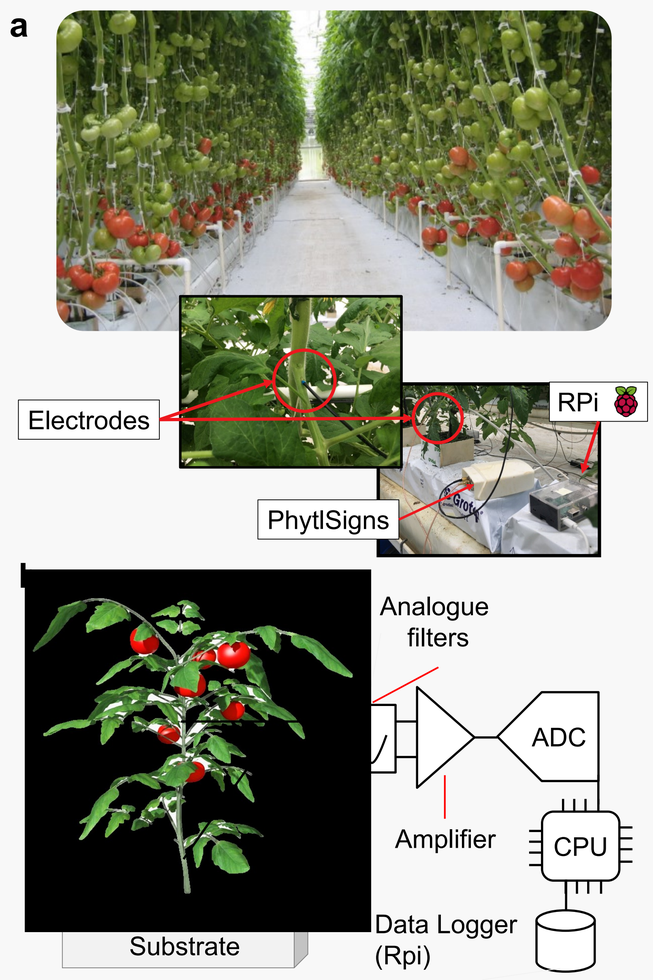
Context

- Electric signals are a **universal** method to rapidly transmit information in living organisms
- In plants, electric signal has been studied for more than a century
- In animals, **bioelectrical activity** measurements in the heart (ECG) or the brain (EEG) provide information about health status

Objectives

- Development and test of an **electrophysiological sensor**
- Enables **real-time** measurements of electric signal in production conditions, without a Faraday cage
- Supervised **machine learning** and automatic classification to detect biotic & abiotic stress

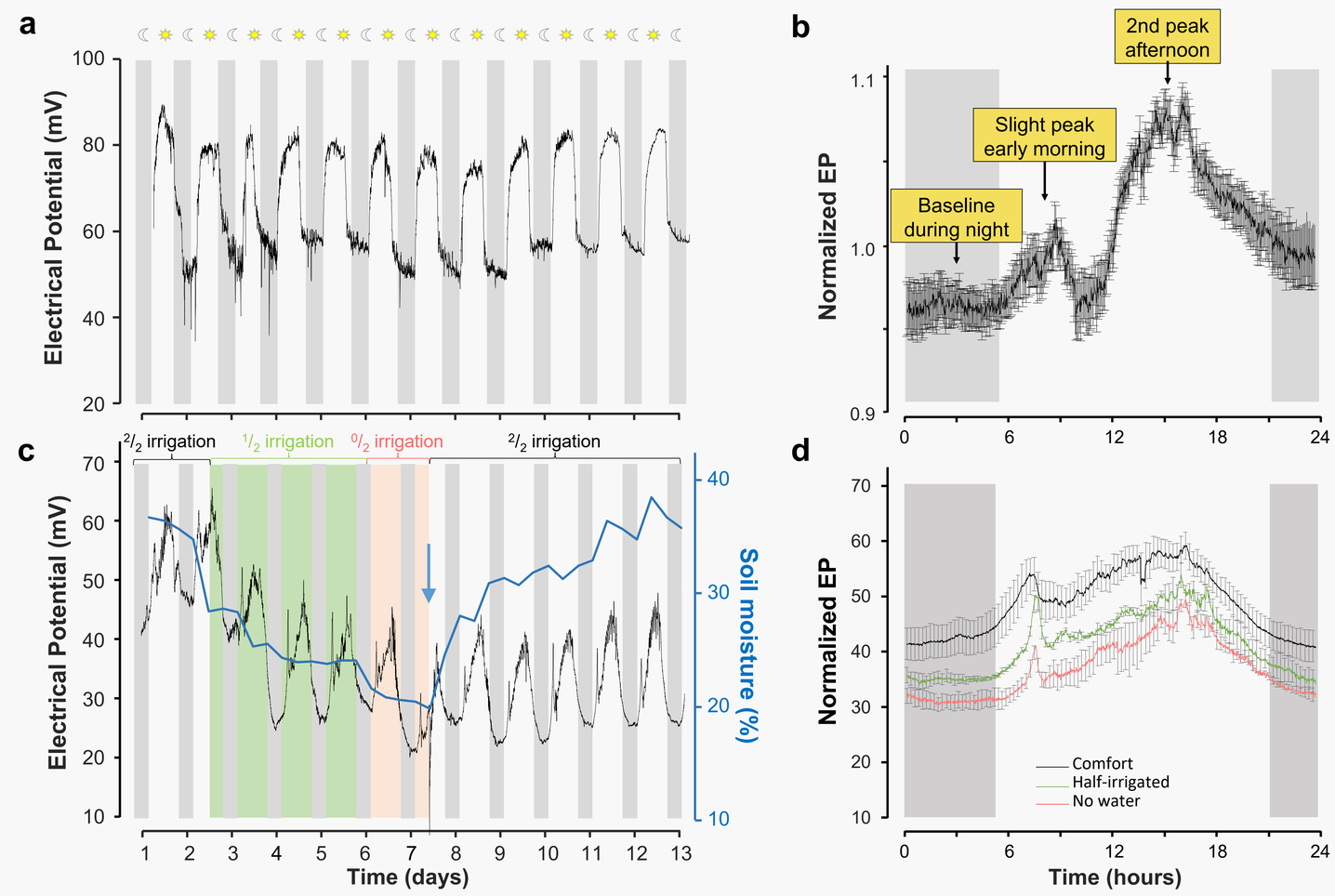
Overcome the Faraday cage…



Enabling electrophysiological recordings outside a Faraday cage

a, Experiments are performed on hydroponic tomato grown in greenhouse. The PhytlSigns device allows monitoring electric signal in 'real' environment without Faraday cage and electrode is inserted in the tomato petiole at the top of the plant (*bottom*). b**,** Schematic representation of the PhytlSigns composed of an amplifier-voltmeter and digitized data are collected into a Raspberry Pi.

… that allows long-term monitoring of electrical potential in greenhouse



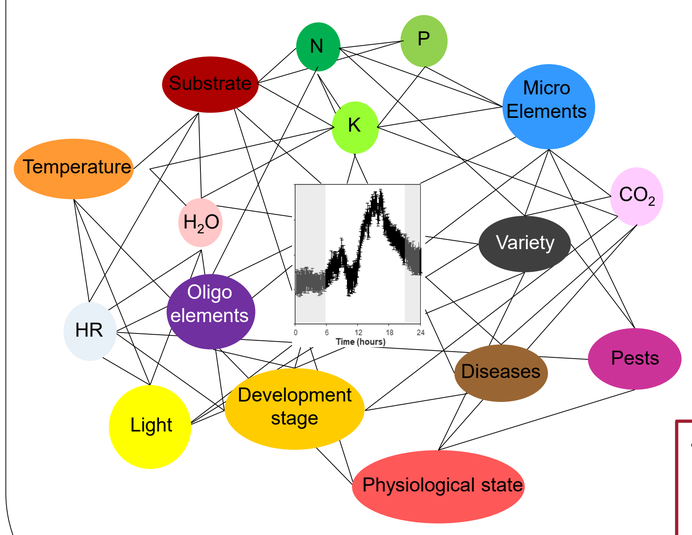
Electrical potential variations on tomato is modified in response to water deficit

Hydroponic tomato plants in soilless culture are grown in the greenhouse. **a,** Representative long-term recording of electric potential (EP) shows cyclic variations in controlled condition. **b,** EPs variations from all tomato plants are split into 24 hours cycles and normalized to the mean during 24h. Results represent mean ± s.e.m, n=60. **c,** Representative long-term recording of electric potential (EP) of tomato plants submitted to different irrigation regime: optimal, half-irrigated, or without irrigation. Evolution of soil water content in the substrate during the experiment is superimposed in blue with the secondary y axis. Blue arrow indicates the moment when roots were watered again after drought condition. **d,** PhytlSigns signals are averaged per 24 hours cycles; Results represent mean ± s.e (n≥10).

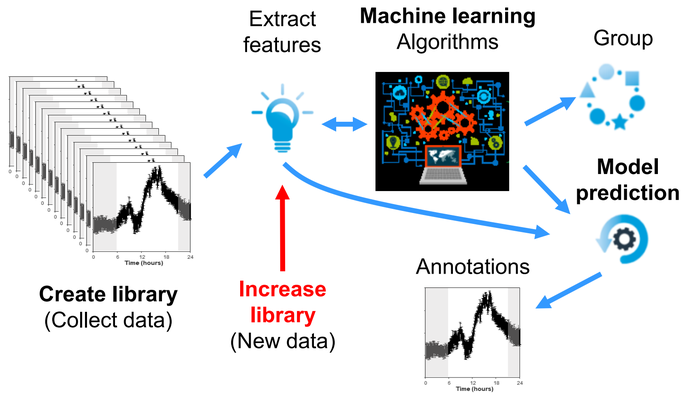
- Electrical potential (EP) shows cyclic variations
- Water regime modify the electrical variations

Machine learning to model electrical variations

- Different factors affect the electrical potential



- Create a big database in order to predict



→ Prediction model for
- Water deficit : 98% accuracy (GBT)
- Day/Night rythm : 95% accuracy (GBT)

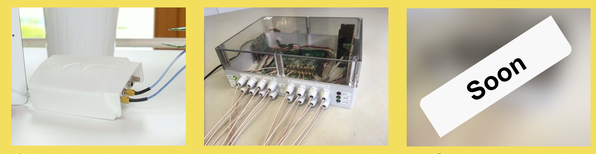
→ Ongoing experiment on nutrient deficit & spider mites

Conclusions

→ Real-time assessment of plants' physiological status using bioelectrical activity

→ Allow automatic irrigation management according to actual plant needs/demands and therefore diminish water waste

→ Agronomic tool for decision support or taking preventive measures



Single channel | Multi-channel | Commercial

Patent

* UK Patent Application No. 1903652.4, filing date: 18 March 2019 in the name of Vivent sárl; Electrophysiological assessment of plant status using supervised machine learning

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