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Smart nutrient management of soilless tomato in greenhouse using electrophysiology and machine learning

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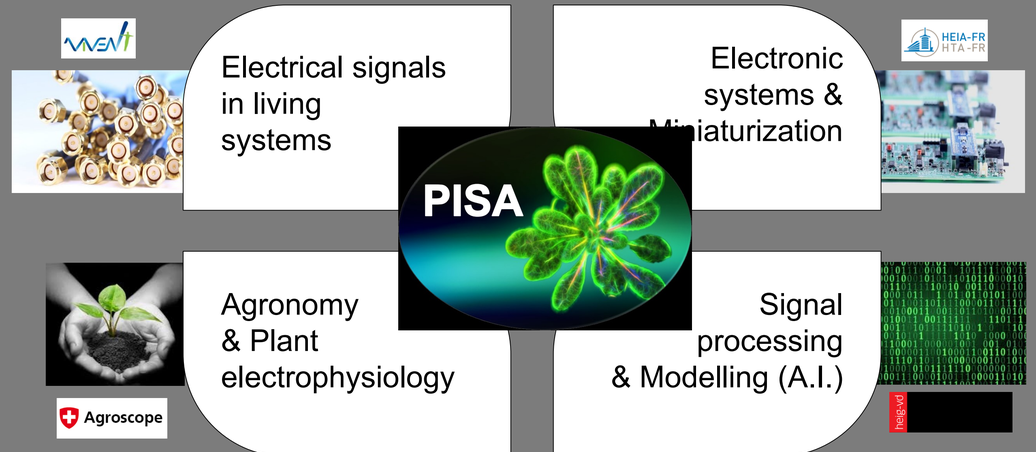
Introduction

Platform applying Intelligent Signal Analysis



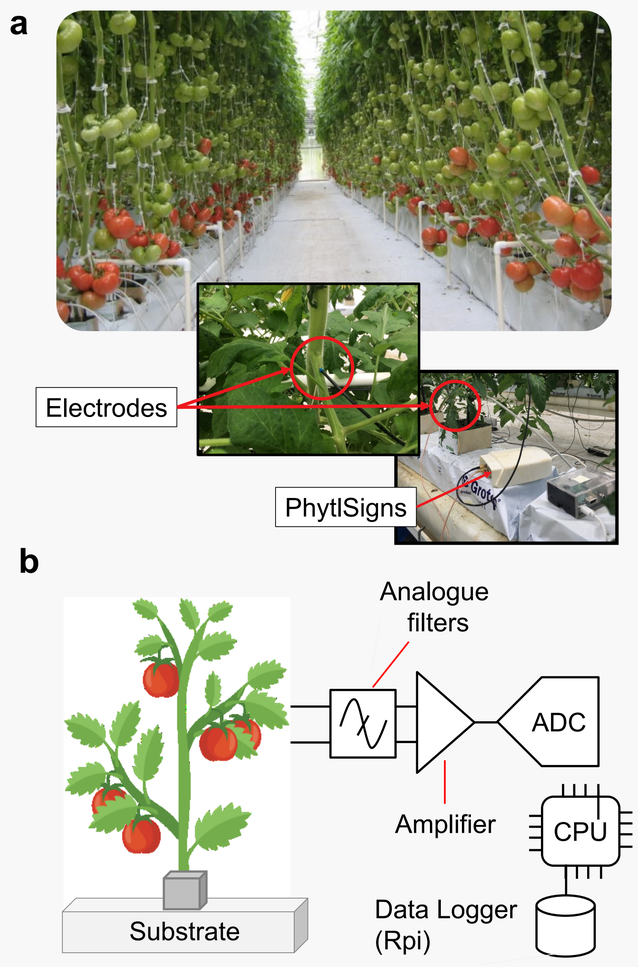
Context

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

Objectives

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

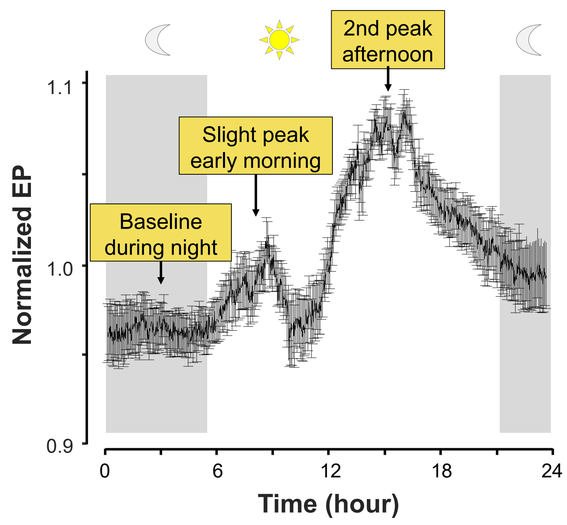
Monitoring electrical signals in a greenhouse...



Enabling electrophysiological recordings outside a Faraday cage
a, Experiments are performed on hydroponic tomatos grown in greenhouse. The PhytlSigns device allows monitoring of electric signal in 'real' environment without Faraday cage. 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. Digitized data are logged on a Raspberry Pi.

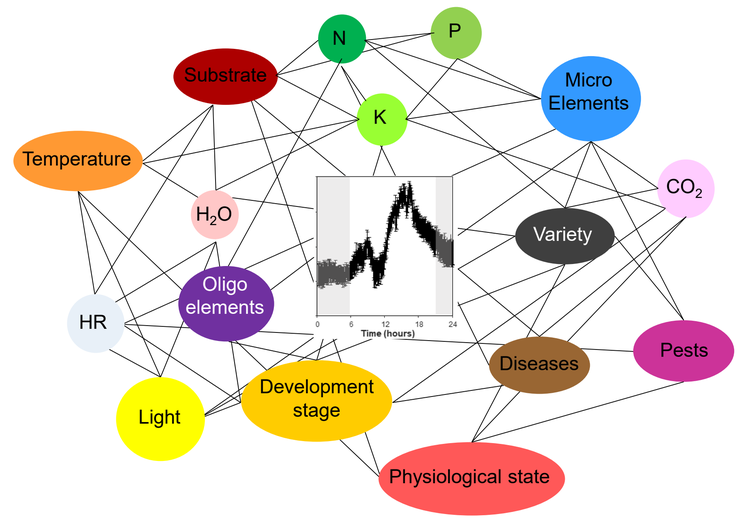
… as an agronomic tool to inform producers

➢ Daily electrical potential (EP) variations



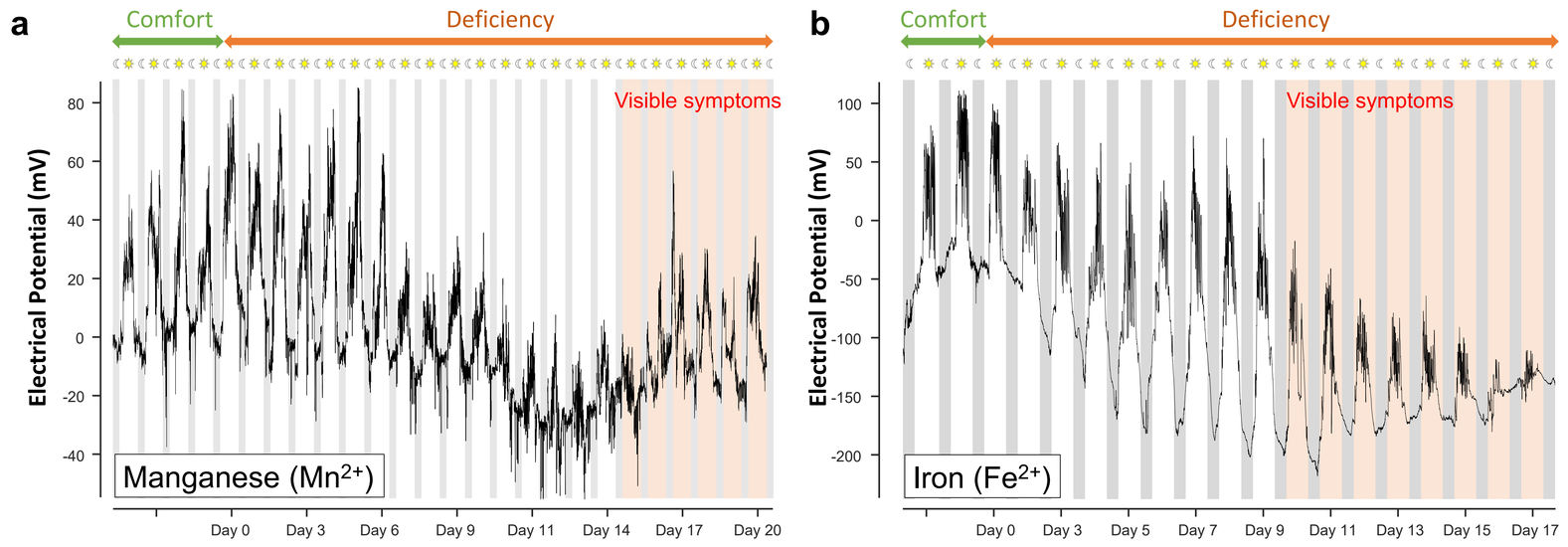
Hydroponic tomato plants in soilless culture are grown in the greenhouse and show cyclic variations of electric potential (EP) in controlled conditions. EP variations from tomato plants are split into 24 hours cycles and normalized to the mean during 24h. Results represent mean ± s.e.m, n=60.

➢ Different factors can affect plant's electrical potential



➢ Nutrient deficiencies affect plant metabolism

Does EP variations can inform about nutrient deficiency ?

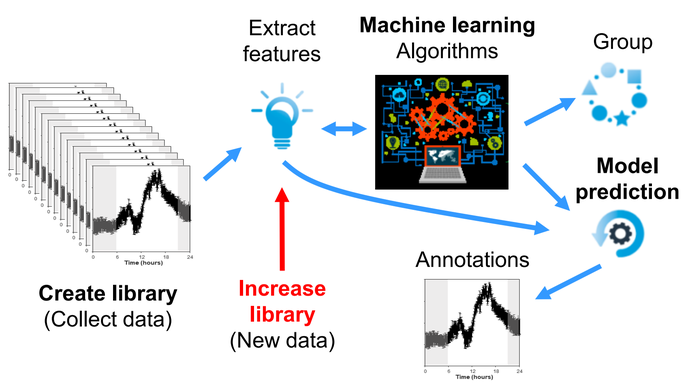


Hydroponic tomato plants in soilless culture grown in a greenhouse. Two examples of representative long-term monitoring of electric potential in response to **a,** manganese or **b,** iron deficit conditions.

➢ Nutrient deficiency modify electrical potential

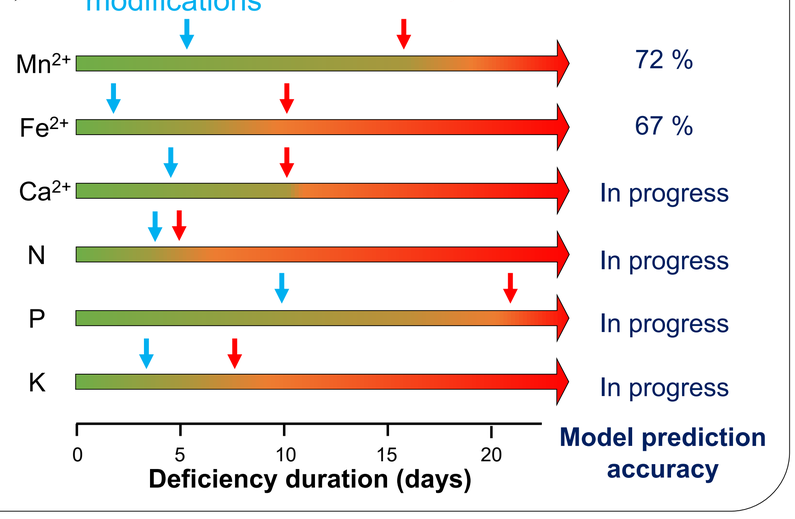
Machine learning to model electrical variations

➢ Create a database in order to predict crop health



➢ Model based on EP variations leads to good prediction

➢ Electrical signal modifications vs. Visible symptoms



Conclusions

→ Bioelectrical activity is modified prior to visible symptoms appearing due to nutrient deficiencies

→ Modelling based on EP variations yields good predictions

→ Agronomic tool for irrigation management according to actual plant needs/demands. Resources savings possible.

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

Agroscope good food, healthy environment

* 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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