Low-cost Near InfraRed (NIR) spectrometer measuring plant stress to design and steer agroecological systems

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Benefits of the measurement of Eh and pH of leaves

Work and a recent bibliographic study[1] have made it possible to correlate the development of pests and diseases with specific oxidation-reduction conditions (measured through the redox potential, Eh) and acid-base (pH) of plants, in relation to the conditions of soil, cultural practices, genotype and climatic conditions.

It would thus become possible to diagnose or even quantify the effect of certain stresses undergone by cultivation via these measurements. This opens up new perspectives on the management of practices for agro-ecological crop protection by regulation of Eh-pH conditions. Such a prophylactic approach would maintain the plant in good health, under conditions unfavourable to pests, rather than having to fight against these pests once they have developed, often by overoxidation.

Curent measurement issues

Conventional electrochemical measurements are very delicate and time-consuming, which makes them impractical for farmers. Due to these measurement difficulties, the number of references on the conditions of plant balance and the impact of practices remains very limited.

Figure 1. Characterization of the Eh-pH conditions for the development of different types of pests and the balance of different parts of plants. Oxidation of plants leads to favourable conditions for pests and diseases. *Husson et al, 2021.*
Pests and pathogens thrive in specific Eh-pH niches. Plants become susceptible to pest and pathogen attacks if their compartments are subjected to imbalanced Eh-pH conditions with specific Eh-pH values for each pest or pathogen to thrive

Figure 2: Eh-pH electrochemical measurement (left) and with NIR on wheat, rice and in vineyards (left to right)

The NIR spectroscopy innovation

Portable near infrared spectrometry (NIRS) would make it possible to overcome these difficulties, This has been shown for wheat and rapeseed first with measurement campaigns combining classic electrochemistry (Eh-pH, EC) and spectrometry with the spectrometer developed by the company Senseen during 2020 in collaboration with Ver de Terre production[5], and confirmed now for rice and grapevine in collaboration with French Rice Centre (CFR)[3] and Estandon[4]"

Senseen which was created in May 2020 brings the state-of-the-art of miniaturized spectrometers combined with AI-based chemometrics. With several thousands of electrochemical measurements and corresponding spectrums, the company succeed to develop models using neurons network and giving 87% to 95% accuracy of predictions[6]

Measure to progress for driving towards a sustainable planet.

Figure 3: Eh predictions using MLP on wheat (left) and grapevine (right)

Future

The simple, reliable, fast and inexpensive measurement by portable near infrared spectrometry of these plant health indicators should make it possible to develop a unique expertise on the effects of agricultural practices and thus to have practical tools for redox control of the plant health.
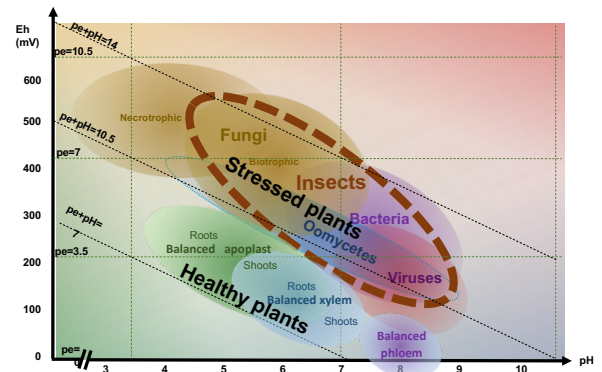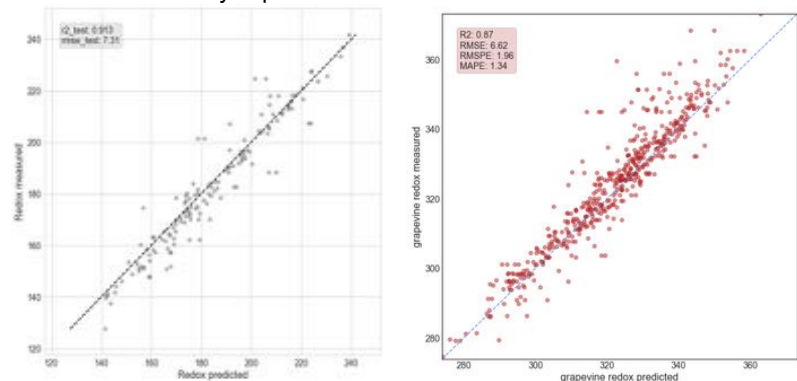
1. Husson et al. 2021. Soil and plant health in relation to dynamic sustainment of Eh and pH homeostasis: A review. *Plant & Soil. http://doi.org/10.1007/s11104-021-05047-z*
2. www.senseen.io   www.cirad.fr Contact: olivier.husson@cirad.fr; philippe.cousin@senseen.io ; 3. http://www.centrefrancaisduriz.fr/ 4 http://estandon.fr/en/ 5 https://www.verdeterreprod.fr/
6 Cousin et al. 2021 Innovative measurements to drive sustainable agriculture: the agroecology case (to be soon published in Journal of Advanced Agriculture Technologies)