UMT CAPTE Workshop

Phenotyping for improving vegetal crops

Visit of the Arvalis research station in Gréoux-les-Bains (credits : Hiphen)

200 international specialists of sensors and phenotyping met in France

On the occasion of the UMT CAPTE international workshop, in Avignon and in webconference, more than 200 researchers, specialists and developers of sensor-based solutions exchanged on the latest technical advances and collectively drew the lines of work to improve plant phenotyping research under field conditions, mainly for whea, maize, sunflower and sugarbeet crops.

Organised by ARVALIS - Institut du végétal, INRAE and the company HIPHEN, the event took place over 3 days. The first two days were devoted to presentations and discussions covering different fields of study: structural and morphological traits; biochemical, sanitary and stress traits; dynamic and functional triats, and finally examples of the integration of phenotyping in the agricultural sector.

In line with the overall objective of the UMT CAPTE, the discussions focused on the development of tools and methods for the efficient, practical and profitable use of sensors in agriculture, particularly for research purposes.

These technologies are implemented at different scales: from the microplot to the field scale on farms. The services they offer are varied:

- Varietal selection via high-throughput phenotyping
- Assistance in conducting agricultural trials, by allowing rapid non-destructive observations
- Real-time crop management throughout the season, based on close observations and remote sensing

It should be noted that the nature of the sensors (Lidar, cameras, spectroradiometers, ultrasound, etc.) and measurement systems (drone, ground robot, portable or fixed system) depends on the desired use.

Another objective of the UMT CAPTE is to develop algorithms to analyse the data from the sensors and to integrate them into reliable, powerful and secure data management and processing systems. Sensors and crop models are highly complementary and must be processed in an integrative way to describe the state of crops, predict their growth and appropriate management practices.

Demonstration of phenotyping tools at the ARVALIS station in Gréoux-les-Bains.

Following the presentations given in the plenary sessions (more information here), the participants were able to take part in a visit to the ARVALIS - Institut du végétal experimental station in Gréoux-les-Bains (04), which has been implementing various high-throughput field phenotyping systems for several years.

This was an opportunity to see various phenotyping tools in action (see below)

LITERAL

This is a portable stick equipped with 3 high resolution cameras, allowing the automatic counting of the number of ears/m2 in experimental plots. The tool can be used quickly on medium-sized trials and does not require any particular authorisation. 30 seconds are enough to photograph 10m² of a micro plot, which represents a high throughput compared to manual counting.

PHENOMOBILE

This self-guided RTK machine scans the state of the plants as it moves, with a resolution of the order of a millimetre, thanks to three types of on-board sensors: cameras synchronised with flashes and scanning lasers make it possible to measure the architecture of the vegetation (height of the plants, position of the leaves and the ears). On the other hand, radiometers are used to measure the reflection of light by the vegetation in order to collect data on the biochemical composition of the plants. This tool allows a reliable, reproducible and rapid characterisation of the growth dynamics of many varieties.

MINIRHIZOTRON

The principle of minirhizotrons is to directly observe the root system through transparent tubes inserted from the surface. The roots in contact with the wall of the tube can then be observed and their morphological characteristics can be quantified. The manipulations required to install the minirhizotrons have been optimised to limit soil disturbance. The observation is carried out by a rotating scanner descending into the tube.

HIPHEN drones

The company was able to demonstrate image acquisition using connected sensors boarded on drones, as well as the processing of the data up to the analysis enabling a detailed assessment of the state of the crop.

Implementation in the European multi-stakeholder project H2020 INVITE

Several participants were also partners in the H2020 INVITE project, which supported the organisation of this event. For example, Fred Van Eeuwijk (Wageningen University) presented statistical methods for plant phenotyping, David Rousseau (INRAe) presented spectro-imaging techniques applied to the detection of plant diseases, and Benoît de Solan (Arvalis) highlighted the challenges of semantic segmentation for describing crop growth. They were able to report on the ambitions of the project, the progress made and the challenges ahead.

INVITE brings together 29 European partners and aims to improve the efficiency of varietal evaluation in Europe (DUS, VATE) and the information available to users (breeders, farmers) on the performance of varieties under various production conditions.

One focus of the project is the use and development of new phenotyping tools in the visible and non-visible domains to provide indicators of adaptation to stress and to improve the speed, precision and efficiency of variety evaluation. For arable crops, the tools available at the Arvalis station (e.g. Phénomobile, LITERAL) are mobilised to collect reliable data to feed phenotypic data processing models adapted to be integrated into the varietal examination for registration process in Europe.
At the end of the project, the most suitable tools and methods will be made available to variety examination offices in order to improve the efficiency and accuracy of DUS and VATE tests, particularly by integrating sustainability criteria.