Editorial

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« The French seed industry is recognized for the quality of its production. This key factor for non-cost competitiveness drove it to a major place in this industry in the world, as did the expertise of French seed growers and the quality of production areas. To be able to advance this quality but also to measure it is therefore a crucial stake for the future of our seed sector. The development within the competitiveness cluster Végépolys of research and resources dedicated to this research is therefore an investment that will have to bear fruit to enable the French seed industry to hold its rank and develop.

For my part, I hope that the discoveries resulting from seed phenotyping can both offer seeds that are even more effective for farmers, develop seed technologies that offer new agronomic opportunities, and contribute to the establishment of international standards allowing our seeds to conquer new markets. »

Looking for partners?

Two contacts to support your projects:

Aurore Gauthier contact to support your R&D projects and to put you through aurore.gautier@vegepolys.eu

Tanegmart Redjala close interface with the laboratories of the Research Federative Structure Quasav. tanegmart.redjala@univ-angers.fr

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**Seed high throughput phenotyping in Angers**

**High-throughput phenotyping of seeds** is essential to quickly measure the quality of large quantities of seeds in a very short time, which is impossible to do manually and with the naked eye. High-throughput seed phenotyping has many interests:

- Identify physiological traits of interest for seed selection,
- Selecting varieties adapted to penalizing environmental conditions,
- Look for appropriate technical itineraries,
- Establish varietal selection strategies.

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**Physical quality of seeds**

**Seed internal morphology**

→ Detection and measurement of the structure and internal organs of seeds by X-ray imaging

Example of use: **PeaMUST** project (2012-2020) - Funded by Programme d’Investissements d’Avenir

An analytical protocol is being developed for high-throughput detection of bruche damage on peas and faba beans by X-ray tomography.

**X-ray tomography room**

**Maize seeds by X-ray tomography**

**Potential benefit:**

Identify very quickly varieties of peas and faba beans that are not very palatable for bruches.

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**Seed vigour**

**Measurement of germinative quality and seedling growth**

Measurements under optimum or penalizing controlled conditions of:

- temperature,
- hygrometry,
- light

**Automated monitoring of imbibition and germination rates on sprout beds Multicam®**

**Automated monitoring of seedling growth under heterotrophic conditions on ElonCam**

→ Explore natural genetic diversity to identify physiological traits of interest under different temperature conditions.

This allowed for example to **identify QTL** that specifically control the rates of imbibition, germination and growth of the embryonic axis.

**Potential benefit:**

Assist breeders in obtaining leguminous plants able to sprout under penalizing growing conditions (deep sowing in arid zones, sowing under cold conditions).

→ Identify genes involved in the regulation of phenotypic plasticity of germinative quality.

**Reguleg** project (2016-2019) – funded by ANR

Seeds of 200 genotypes of truncated alfalfa, produced under optimum conditions and under water deficiency were screened to identify plastid loci by a genome-wide association (GWAS).

**Potential benefit:**

Produce legume varieties that are better adapted to climate change.

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Potential benefit:

- Identify very quickly varieties of peas and faba beans that are not very palatable for bruches.

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To study the interactions between seeds and phytopathogenic agents during germination and seedling emergence.

**Patharaseed project (2014-2016) – funded by Angers University**

**Potential benefit:**
Develop more effective treatment products at lower doses, identify disease-resistant varieties.

### Measurement of seed metabolism

Measurement of oxygen consumed with a spectrophotofluorometer

![Multi-well plate](multiwell_plate.png)

Seed at the bottom of the well

Wells containing one or more seeds

The O₂ consumption curves show the heterogeneity of the imbibition rates of the seed lots.

**Potential benefit:**
Use respiratory activity measurements as an indicator of the vigour and homogeneity of a seed lot.

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**A simple and innovative method for high-throughput seedling phenotyping**

**Phenotyping of seedlings in multi-well plates in a non-sterile medium**

- An ideal method for evaluating the impact of abiotic stresses (temperature, salt stress, osmotic ...) on seedling germination and survival of the seedlings.
- Use in the framework of the ACCLIMHOT project including the thesis of Elise Réthoré – funded by RFI Objectif Végétal

With Evian water, no contamination or agglutination of *A. thaliana* after several weeks of culture.

- High through-put phenotyping of the quantity of chlorophyll by simple digital image analysis.

**Potential benefit:**
Screen high-throughput molecules for inhibitory / protective effects under abiotic stress conditions.

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**A simple and innovative method for high-throughput seedling phenotyping**

- Phenotyping of seed viability under controlled aging conditions to determine longevity of batches
- Different measures of deterioration of seed vigour to accurately predict the quality
- Use of modeling to estimate seed ability to conserve

**Potential benefit:**
Propose solutions for the conservation of genetic resources or carry-over lots.

**Use in projects:**

- **REGULONG** (2014-2017) – funded by RFI Objectif Végétal
  Identification of key regulator of seed longevity
- **REGULEG** (2016-2018) – funded by ANR
  Identification of key regulators of legume seeds adaptation to environmental fluctuations

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**Sanitary quality of seeds**

**Multispectral imaging** is used to evaluate the varietal resistance to *Fusarium* wilt on wheat ears.

Other cereals and other pathogens are also studied:

- **Microdochium** – funded by FSOV
- **Irigam** – funded by Ecophyto

**Potential benefit:**
Identify disease-resistant varieties.
Examples of topics for collaboration

- Using existing phenotyping tools to characterize genetic resources (seed vigor under optimal or penalizing conditions)
- to study the physiological and molecular determinism of seed quality
- Checking the correlation between respiration and seed vigor
- Checking the correlation between respiration and seed vigor

SUCCESS STORY - The collaborative project AKER - funded by Programme Investissements d'Avenir

<Of the 18.5 million budget allocated to the AKER sugar beet improvement programme, phenotyping accounts for more than 60% of the effort, in particular the phenotyping of seeds and seedlings. Two aspects are explored: one is descriptive (structural, physical and chemical analysis of the seed); the other one is physiological (germination, growth of the seedling under different conditions). The objective is to analyze and better “dissect” the variability observed and especially its dynamic, to associate it with the genetic variability produced in the other part of AKER. Non-destructive and, if possible, high-throughput equipment is preferred. The prediction of what happens in the field is of course of the priority. INRA, GEVES and the University of Angers are 3 of the 11 partners particularly involved.>

Strengthen your R&D team by recruiting a CIFRE PhD student (financial support by ANRT and CIR), a recent PhD graduate (financial support by CIR) or a working student (in contract of professionalization or apprenticeship)

Training for enterprises

- Seed storage and storage
- Plant genetic resources: genetic diversity and valorization
- Plant Genetic Resources: Collections Management

Catalogue online: agrocampus-ouest/formation-tout-au-long-de-la-vie

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or share your needs with us!

Services

Need to know the aggressiveness of a microorganism? Need to evaluate the impact of a bio-aggressor on germination and emergence?

phenotic@listes.univ-angers.fr

Need to assess the energy metabolism of your seeds, under penalizing or optimal conditions?
david.macherel@univ-angers.fr

Need to manage the conservation of your postponed seed lots or your genetic resources for seed production?

olivier.leprince@agrocampus-ouest.fr

Need to assess the impact of treatments on seed quality?

contact@geves.fr

Need to identify a bacteria?

Collection of bacteria: cfhp@irra.fr

ObjectifVégétal Research, Education & Innovation in Pays de la Loire is a regional program (2014-2019) established by the Pays de la Loire Regional Council and that involves the teaching and research institutions (Université d’Angers, leader of the program, Agrocampus Ouest, ESA, Inra, Université de Nantes) as well as the international French cluster Végépolys.
ObjectifVégétal program mainly aims to reinforce the visibility of the regional centre for education and basic research, to boost translational research and reinforce the processes of economic valorization of research findings, and to develop international partnerships.

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