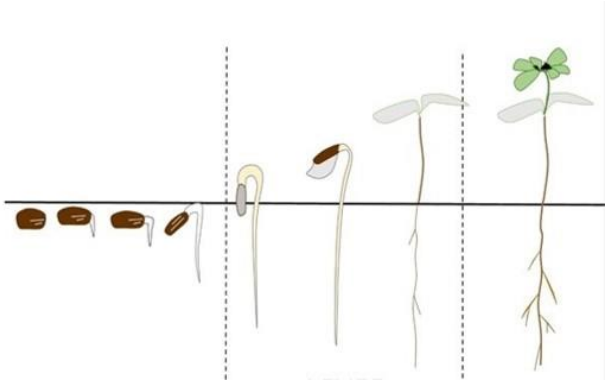
The innovation box of Objectif Végétal

Move closer to academic research to boost your potential of innovation!

n°6

Which methods to understand and assess seed quality?

- High throughput phenotyping
- Seed vigor
- Seed Conservation
- Biotic and abiotic stress



- X-ray tomography
- Multispectral analysis
- Spectrophotometry
- QTL and loci

Last update: August 2017

Editorial

Vincent Béguier
R&D Director
JOUFFRAY-DRILLAUD

« 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 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:

COMPANIES

Collaborative & innovative projects

EDUCATION

RESEARCH

Aurore Gauthier, contact to support your R&D projects and to put you through
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Tanegmart Redjala, close interface with the laboratories of the Research Federative Structure Quasav.
tanegmart.redjala@univ-angers.fr

This issue has been produced with the contribution of the organizing committee of the « Companies-Research day » held on december 15 2016 in Angers: O. Leprince et P. Grappin (AGROCAMPUS OUEST), J.P. Renou (INRA), A-M. Chèvre (IGEPP), S. Ducournau and J. Léchappé (GEVES), J.-A. Fougereux (FNAMS), J.-P. Guinebretière (Vilmorin), E. Lesprit (UFS), H. Ledeit (SATT Ouest Valorisation), A. Gautier (VEGEPOLYS), T. Redjala (RFI Objectif Végétal).

THIS PROJECT IS CO-FUNDED BY THE EUROPEAN REGIONAL DEVELOPMENT FUND

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.

Physical quality of seeds

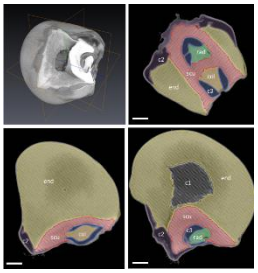
Seed internal morphology

→ 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

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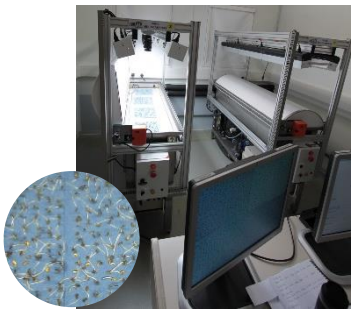
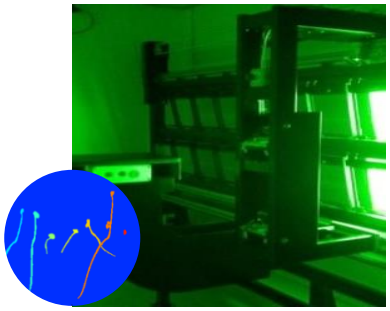


Automated monitoring of imbibition and germination rates on sprout beds Multicam®



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).

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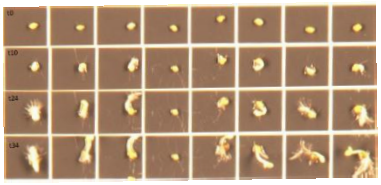
→ **To study the interactions between seeds and phytopathogenic agents during germination and seedling emergence.**



Patharaseed project (2014-2016) –*funded by Angers University*
associated with the thesis of **Elodie Belmas** (2014-2017)

Potential benefit:

Develop more effective treatment products at lower doses, identify disease-resistant varieties.

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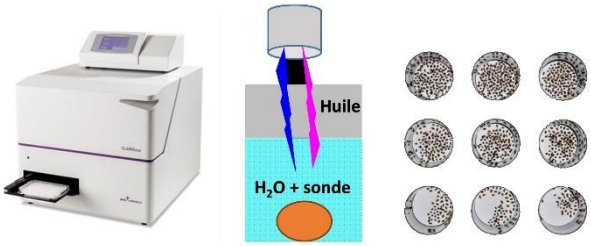
Measurement of seed metabolism

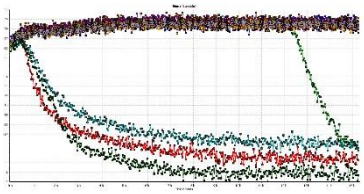
Mesurement of oxygen consumed with a spectrophotofluorometer



Multi-well plate | Seed at the bottom of the well | Wells containing one or more seeds

The O_2 consumption curves show the **heterogeneity of the imbibition** rates of the seed lots.

O_2 in the well



Time

Potential benefit:

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

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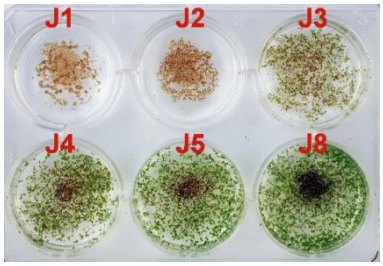
A simple and innovative method for high-throughput seedling phenotyping



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**

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

Potential benefit:

Propose solutions for the conservation of genetic resources or carry-over lots.

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Sanitary quality of seeds

VIDEOMETER: multispectral imaging

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.

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OFFERS TO COMPANIES

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

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

Bruno Desprez,
Chairman of the Coordinating Commitee of AKER programme

«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 the priority. INRA, GEVES and the University of Angers are 3 of the 11 partners particularly involved. »

Strenghten 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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Catalogue online of **Ecole Supérieure d'Agriculture**
› groupe-esa/formation-tout-au-long-de-la-vie

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› université-angers/formation-continue/Offre-de-formation

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 SEMENCES & PLANTES
phenotic@listes.univ-angers.fr

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

Need to manage the **conservation** of your postponed seed lots or your genetic resources for seed production?
IRHS
olivier.leprince@agrocampus-ouest.fr

Need to asses the impact of **treatments** on **seed quality**?
GEVES
contact@geves.fr

Need to **identify a bacteria**?
Cirm
Collection of bacteria : cfbp@inra.fr

Impression Service Reprographie UA

Objectif Végétal, 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.
Objectif Végétal 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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