

## Seed vigour and seedling establishment a lever to increase yields

- > Seed development
- > Germination vigour
- > Seedling establishment
- > Seed production



- > Genetic determinism
- > Varietal selection
- > Environmental impact  
(biotic/abiotic stresses) on seed  
development and seed(ling) vigour

### Editorial



**Olivier Leprince,**  
Head of the Seed Pole of [IRHS](#)

Germinative quality is a key factor for successful crop establishment. Defects in germination or seedling establishment have dramatic consequences on yield. Europe remains highly dependent on importations of plant proteins essentially on South-American soybean. The adaptation of legumes by French and European farmers is still strongly constrained by yield instability.

The challenge is thus to **select varieties that guarantee a good crop establishment even in the current context of climate change and input reduction.** This is one of the focuses of research of the Research Institute in Horticulture and Seeds ([IRHS](#)): experts of seed physiology and genetics investigate the molecular and environmental factors that determine seed storability, germination and seed(ling) vigour.

### Looking for partners?

Two contacts to support your projects:



**Aurore Gauthier**, contact to support your R&D projects and to put you through  
[aurore.gauthier@vegepolys.eu](mailto:aurore.gauthier@vegepolys.eu)



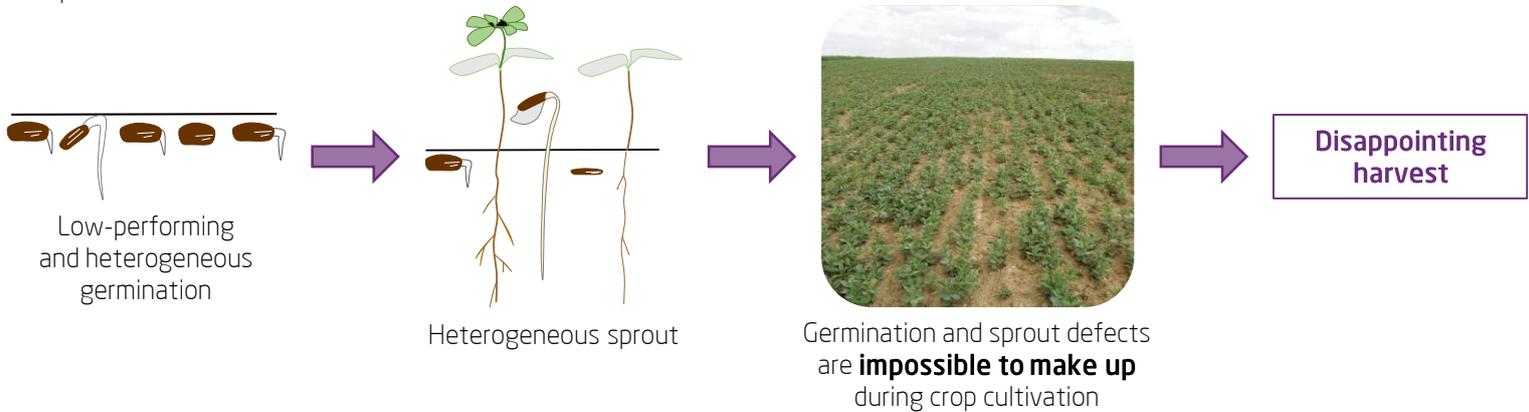
**Tanegmart Redjala**, close interface with the laboratories of the Research Federative Structure Quasav.  
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Last update: August 2017

# REVIEW OF THE MAIN CONCEPTS

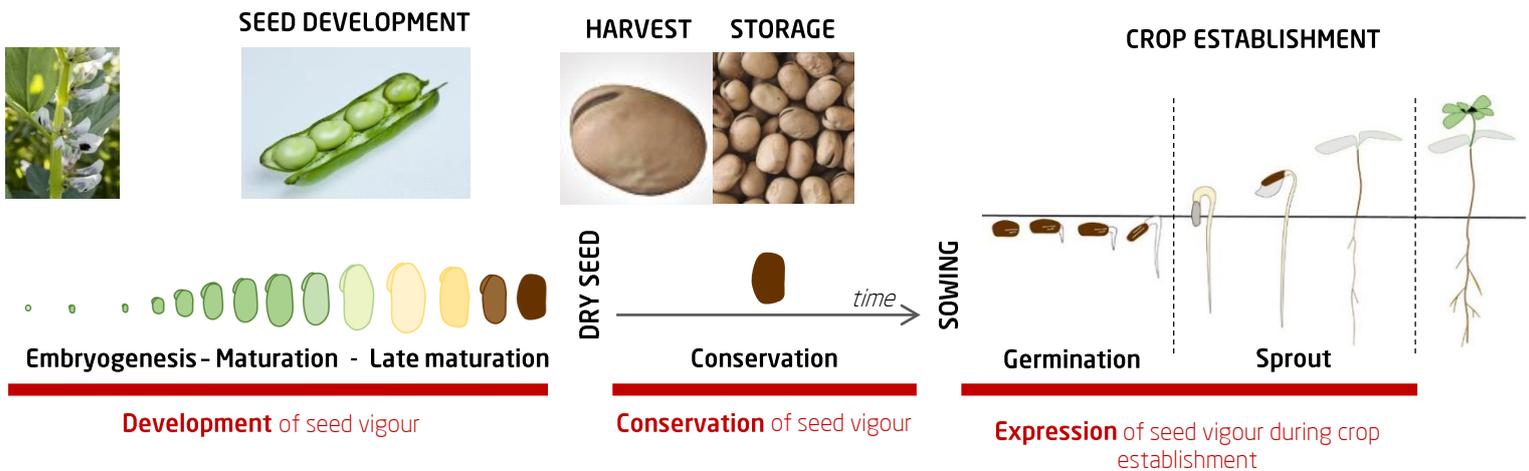
## Seed vigour, a lever to improve yields

It is essential, both **for plant protein production and for the development of sustainable agriculture**, to increase legume crop surfaces. Rapid and uniform seedling establishment of legume crops is a strong lever to **stabilise yields** and thus encourage legume crop cultivation.



**Seed vigour** (or germinative quality) represents the characteristics that allow a seed lot to germinate and emerge quickly and uniformly under (sub)optimal growth conditions.

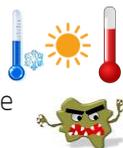
## Seeds must conserve this vigour until sowing



Even dry, seeds remain alive. However, **seed vigour** progressively diminishes during storage due to ageing.

Seed vigour depends on **genotype x environment interactions**, which is very important considering the stresses the plants/seeds are submitted to due to climate change:

- > Abiotic stresses (hydric, thermal, saline stresses)
- > Biotic stress (sanitary pressure in a context of pesticide reduction and global warming)



→ **Objective for the professionals of seed sector:**

Produce seed lots that :

- > properly **develop their germinative quality**
- > **conserve** this germinative quality until sowing
- > **express** this vigour to ensure correct seedling establishment settling down.

Seed experts of [IRHS](#) develop multidisciplinary approaches to decipher the mechanisms involved in:

- > **the development of the physiological quality** of seeds during their maturation,
- > **the impact of the environment** on this development,
- > **the expression of the germinative quality** during crop installation.

This research topic is essential for **varietal pre-selection** and **varietal creation** since it aims to identify the genes involved in the ability of seed lots to germinate and to emerge quickly in the field, which will be pivotal for high yield.

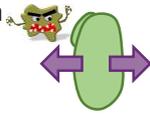
The researchers of [IRHS](#) regularly transfer their expertise to numerous species of interest that show difficulties in terms of the different seed quality parameters (seed stability, germination vigour, seedling emergence).

# RESEARCH RESULTS

## Seed maturation & conservation

When the seed perceives a pathogenic agent, there is a trade-off between the activation of its basal defences and its own development:

**Activation of genes** involved in the establishment of **defence** mechanisms

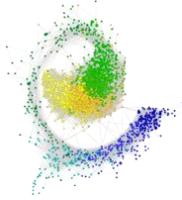


**Slowdown of seed maturation** process (reduction of the TKW and chlorophyll retention)

Some **genes involved in defence mechanisms** have been shown to **regulate seed longevity**.

Proteic and **biochemical molecular** markers for seed **maturity** and **longevity** have been identified in field crop and vegetable crop species:

- > LEA proteins (Late Embryogenesis Abundant)
- > Sucrose/oligosaccharides ratio



**Approaches of gene co-expression networks** were developed to:

- > Decipher the molecular bases of **seed vigour acquisition**, and thus identify the key **regulator genes that have been conserved between species**
- > Better understand the **seed development dynamic** in optimal and stressful conditions

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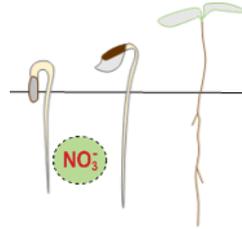


## Seedling establishment

Exploration of genetic diversity enabled to identify the **key physiological characteristics** of hypocotyl for successful sprout in abiotic stress conditions:

- > The **high number of cells in the embryo**
- > The **high ability for cell lengthening** in disadvantageous conditions

QTL were identified for these characteristics.



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Identification of a **membrane transporter** that regulates nitrate absorption and root architecture in seedlings.



These investigations are done thanks to the shared equipments of **SFR Quasav**:

SensoVeg

**PHENOTIC**  
SEMENCES & PLANTES

**PIAM** PHYTO

## RECENT PROJECTS

### RESEARCH PROJECTS

**ANR project Reguleg** (2015-2018) Identification of key regulators of legume seed adaptation to environmental fluctuations.

**RFI project Regulong** (2015-2018) Identification of key regulators of seed longevity.

**RFI project NPFun** (2016-2019). Involvement of nitrate transporter AtNPF6,3 in seedling resistance to biotic stress.

### NUMEROUS PROJECTS IN COLLABORATION WITH PRIVATE COMPANIES

- > seed producers
  - > input providers
- (confidential partners).



### PHD THESES



**Rubiana Falopa Rossi**. Impact of maturation and drying on gene expression during soya germination.

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**Juliana Pereira Lima**. Physiological and molecular characterization of longevity acquisition of soya seed.

[julia.buitink@inra.fr](mailto:julia.buitink@inra.fr)



**Julia Zinsmeister**. Characterization of the transcription factors that control germinative quality and longevity during seed development of *Medicago truncatula*.

[julia.buitink@inra.fr](mailto:julia.buitink@inra.fr)



**Chvan Youssef**. Genetic bases of heterotrophic growth of *Medicago truncatula* hypocotyl under optimal and abiotic stress conditions: contribution of cell number and length.

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**Denise Puntel Basso**. Physiological and molecular characterization of the acquisition of seedling establishment during soya seed maturation.

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# OFFERS TO COMPANIES

## Examples of topics for collaboration

- Identify the **factors that determine germinative quality** during seed development
- Control germinative quality during seed packaging **after harvest** and during **seed storage**
- Develop tools to characterize seed **longevity** and **germinative quality for seed technology** or **pre-breeding**
- Study the impact of **biostimulants** on seed ability to **germinate** and emerge under various environmental conditions (**biotic and abiotic stresses**)
- Study the role of **nitrate transport**, nitrate signalling and nitrogen metabolism in **seedling establishment** under abiotic and biotic **stress conditions**
- Solve the **genetic determinism** of physiologic traits associated to seedling establishment under **disadvantageous conditions** (cold, nitrogen...)



- ➔ **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

Modules offered by **Agrocampus Ouest** :

- Seed conservation and storage
- Plant genetic resources: genetic diversity and valorization
- Plant genetic resources: management of collections

[Catalogue online : agrocampus-ouest/formation-tout-au-long-de-la-vie](http://agrocampus-ouest/formation-tout-au-long-de-la-vie)

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[Catalogue online of Ecole Supérieure d'Agriculture](http://groupe-esa/formation-tout-au-long-de-la-vie)

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**or share your needs with us!**



**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.

Contact **The innovation box of Objectif Végétal** :

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