

Deliverable 7.4: Public Status Report on EcoSeed progress.

The EcoSeed project started in January 2013 with the main objective to assess the impact of environmental conditions on seed quality. The first year of the project was mainly dedicated to the production of biological material under selected environmental conditions and to carry out a range of pilot experiments. In 2014, key seed quality traits were assessed in the different seed lots and the first molecular analyses were conducted on selected samples. Progress has been made on each workpackage (WP) as follows:

- **WP1: Effects of the maternal environment on key seed quality traits**

Model and crop plants have been subjected to environmental stresses such as those predicted in climate change scenarios, i.e. drought and elevated temperature. In 2013, seeds from the four plant species selected for the project (*Arabidopsis thaliana*, *Brassica oleracea*, *Helianthus annuus* and *Hordeum vulgare*) were produced both with and without stress during grain filling. During the second year of the project, seed quality traits were assessed for each of the seed lots, revealing that the studied genotypes were differentially affected by the stresses applied to the mother plants. Elevated temperature and drought stress were found to impact on seed yield and quality. Based on these seed quality traits, samples were selected for further in-depth studies using –omics approaches (proteomics, transcriptomics, metabolomics) in order to unravel molecular changes underlying the stress-induced differences in seed quality. To date, -omics experiments have been carried out on *Arabidopsis thaliana* and *Brassica oleracea* and data are currently being analysed.

- **WP2: Molecular changes in the dry state**

Upon completion of seed production (WP1), seeds were stored under environmental conditions of contrasting temperatures and relative humidities ranging from conditions relevant to the seed trade and conservation projects alike. Seeds were also subjected to accelerated ageing following protocols developed for all four species. These experiments revealed that seeds produced under contrasting environmental conditions displayed a different sensitivity to ageing. To investigate how stresses to the mother plants influence the longevity of the seeds, non-aged and aged dry seeds are currently being analysed with a range of biochemical assays with a particular emphasis on the changes in the redox environment. The results are expected to deepen our understanding of the mechanisms contributing to seed storability.

- **WP3: Molecular changes during imbibition and germination**

WP3 is dedicated to studying the germination of seeds that had undergone different stresses during their development up to seed harvest (WP1) and during storage (WP2). Seeds from stressed and unstressed plants are now being investigated during the germination process using the –omics approaches (transcriptomics, proteomics and metabolomics) developed and optimized during the first year of the project. So far, functional genomics and metabolomics data have been generated from freshly harvested seeds of *Arabidopsis* produced under different environmental conditions. Our results highlight that pre-harvest stresses affected seed germination through modifications in gene expression and metabolic pathways. In addition, preliminary metabolomics results obtained on *Brassica oleracea* showed differential accumulation of specific metabolites. The effects of seed storage will also be examined for each species.

- **WP4: Biotechnology and innovative tools**

The goal of WP4 is to identify genes and technologies that contribute to the prediction of seed quality, storage and germination. During the first two years of this project, three genes regulating seed vigour have been identified in *Brassica oleracea* as well as one gene in *Arabidopsis thaliana*. Two candidate genes regulating seed longevity were found in barley and are being further characterised. In addition, transgenic plants have been produced to study the impact of known seed quality factors and transcription factors in Arabidopsis. Evaluation of novel technologies such as High Field EPR (HFEPR) and Activity-Based Protein Profiling (ABPP) revealed the potential of both methods to discriminate between seed lots with different quality. In particular, ABPP markers for two different protease activities have been identified that change in intensity during seed ageing. These markers will be further studied for their potential to evaluate the quality of harvested seeds at low cost.

- **WP5: Translational research from model to crop to wild species**

Workpackage 5 is dedicated to the translation of knowledge gained from the study of model and crop plants to wild species. We aim to model how environment affects a range of seed quality traits of importance to the seed trade and conservationists. In year 2, seeds of three barley and two *Brassica* species were regenerated from the collections of the Millennium Seed Bank (RBGK) and the Federal German Genebank at the IPK. Four wild sunflowers are proving difficult to multiply and a seed morphology assessment of failure to germinate has been undertaken. A meta-analysis (>200 species) of germination trait characteristics was published. It shows that, generally, the crops have been selected for rapid germination, with no apparent widening of the temperature range for germination. Our modelling studies are now focussing on phases of germination (root emergence and normal seedling growth) and seed ageing. The overall findings are to be used to validate the seed quality markers identified in other WPs in relation to natural adaptation to a changing environment.

- **WP7: Dissemination, Exploitation and Training**

Immediately after the start of the project a project website <http://www.uibk.ac.at/botany/ecoseed/> was created which serves as a direct portal to provide information to the public. It provides data about the members of the consortium, the scientific advisory board and the work packages of the project. A selection of press releases can also be downloaded. A restricted area enables a fast and efficient data exchange between the partners. Information about experimental procedures, dissemination activities, meetings and reports is available. This guarantees an efficient project management (WP6).

Posters describing EcoSeed activities were presented at European and International Conferences and meetings, the most important of which was the 11th *Conference of the International Society for Seed Science (ISSS)* in Changsha, China, September 15-19, 2014, which is the most significant meeting of seed scientists globally. It was also attended by many representatives of the seed industry. Moreover, partners of the EcoSeed consortium are members of the Scientific Organising Committee of an International conference entitled: *Seeds for future generations – Determinants of longevity*, which will be held in Wernigerode, Germany, July 5 – 8, 2015.

Five papers were published in peer reviewed journals, 29 oral and poster presentations delivered at scientific conferences, 7 articles published in the popular press and several contributions were published online. Furthermore, the consortium is dedicated to the training and knowledge transfer to early career scientists. Based on an inventory of training possibilities at all partner labs short-term exchanges of students between the project partners have been initiated. To date, eleven students were trained in the frame of the knowledge transfer programme.