

Year of CfP: 2007

Project No: 07010 Completed

Project title: Genetic analysis of cadmium accumulation in lettuce (<i>Lactuca sativa</i>)

Unit managing the project: BPMP (Plant Molecular Physiology and Biochemistry) (CNRS, INRA, SupAgro, UMII)

Project leader: Pierre Berthomieu (berthomieu(a)supagro.inra.fr)

Country involved in the project: Tunisia

Other research units from the Foundation's scientific network involved: GAFL

Subthematic axes: IPB-1 (Integrative Plant Biology 1: *Genetics and genomics, plant breeding, ecophysiology*)

Objectives:

The goal of this project is to identify the genetic determinants controlling cadmium accumulation in lettuce as a first step towards the fine mapping of these determinants and the positional cloning of the genes underlying them.

Cadmium is a widespread metallic trace element whose concentration increases in cultivated soils. This has detrimental consequences in terms of food security. Genes proposed to control cadmium accumulation in plants have been identified mainly from functional studies performed in yeast up to now. The validation of the role of these genes in plants is still very limited. Very few (if any) mechanisms have been described as being possibly involved in the control of cadmium accumulation in plants in general. Lettuce (*Lactuca sativa*) can be characterised by a high ability to accumulate cadmium in its tissues. It is a good model both for studying the determinism of cadmium accumulation in plant tissues and for developing breeding strategies aimed at limiting cadmium accumulation in edible tissues of a crop species. The overall goal of this project is to characterise mechanisms underlying cadmium accumulation in lettuce and to identify the corresponding genetic determinants. The investigators have started to characterise the genetic diversity with respect to cadmium accumulation within the lettuce species, and this work has revealed a marked variability between lettuce varieties. The objective of this project is to further track the causes of the observed inter-varietal differences through physiological and molecular characterisations.

For this, genetic crosses between genotypes displaying extreme phenotypes to analyse the genetic bases of the character will be made. F2 populations from at least three different crosses are to be produced. Around 100 individual plants from each of these populations will be screened for cadmium accumulation following the standardised procedure established in the group. Genetic analysis of the data will be performed to characterise the cadmium accumulation character. The first steps towards the mapping of the character will be started. DNA extracts will be produced for the parent lines of the crosses and for the F2 analysed plants. Genetic markers already described in the literature will be tested on these parent lines, and then on the F2 population if they reveal polymorphism. This work will be pursued by a complete mapping experiment.

Action carried-out and results obtained:

Lettuce is a species that accumulates relatively significant quantities of cadmium in its tissues. In terms of food safety, it is interesting to breed varieties accumulating the lowest contents cadmium as possible. We work on the character of cadmium accumulation in the roots on the one hand, and on the character of translocation of cadmium from the roots towards the shoot on the other hand. From a diversity analysis, lines presenting extreme phenotypes for these two characters had been identified. Genetic crosses between these lines had been produced. The objective of the present work was to analyze the segregation of the two characters studied in the F2 progenies issued from

the crosses between the accessions presenting the extreme phenotypes for each character considered. Both characters proved to have a complex genetic determinism. No phenomenon of transgression was highlighted. We then wished to map the locus controlling the two studied characters. After several experiments aiming at allowing to combine phenotypical characterization and DNA extraction on a same plant, DNA extractions were performed on the 300 F2 plants that resulted from the two genetic crossed and that were phenotypically analyzed.

Publication:

Walid Zorrig, Aïda Rouached, Zaigham Shahzad, Chedly Abdelly, Jean-Claude Davidian, Pierre Berthomieu (Oct 2010) Identification of three relationships linking cadmium accumulation to cadmium tolerance and zinc and citrate accumulation in lettuce. *J. Plant Physiol.* 167(15):1239-1247

Prospects for the future:

The DNA samples were sent to Pr. R. Michelmore (UC Davis) who will carry out the genetic mapping of the locus controlling (i) the accumulation of cadmium in roots and (ii) the cadmium translocation from the roots towards the shoot. The awaited results are completely innovative, since no determinant controlling the accumulation of cadmium has to date been identified in any species through a direct genetics approach.

Total Agropolis Fondation funding: € 4,784 (predoctoral fellowship, travel expenses)

Funding categorie(s): Agropolis Fondation small grants (support to pre-doctoral students)

Project duration: 1 January 2008 – 31 August 2008

Keywords: cadmium accumulation – lettuce – *Lactuca sativa* – genetics – crosses – polymorphism - mapping