RNA-directed DNA Methylation

'Wrap it up'

The breeder who wants to alter a particular trait in a crop may attempt to modify the gene, or group of genes, controlling that trait. Another way to do it though, is to modify the way the genes are expressed. The result of these so-called epigenetic changes is a change in phenotype whereas the gene sequences are left untouched. This is exploited in a method called *RNA-directed DNA methylation (RdDM)*. Technically speaking a genetically modified organism, or GMO, during the initial stage of development, the resulting plants do not carry any introduced foreign DNA or new combinations of genetic material.

Benefits

RdDM allows highly targeted gene silencing in plants. The end result with a modified trait is similar to plants with a stable gene transformation or an induced mutation, but with the difference that the nucleotide sequence of the gene is not affected in any way. The technique is applicable to a number of crops and traits, and it is a very useful tool for both researchers and plant breeders.

Scientific description

The expression of genes can be influenced by a number of molecular processes, referred to as epigenetics. One common example is DNA methylation, which wraps the DNA in methyl molecules to block transcription of – and effectively silencing – the gene. This process is required for normal development and plays an important role in stress responses and virus protection. Small RNA molecules can be used in the laboratory to trigger DNA methylation at specific locations. The introduced methylation pattern is meiotically stable, which means it will be inherited by the next generation. However, the transgene expressing the RNA can be removed by segregation, resulting in a non-transgenic plant with an altered trait. The methylated status is thought to continue for a number of generations before eventually fading out.

Applications

This versatile and specific technique has been used both in basic research and in trait modification of crop plants. Biochemical pathways have been elucidated and marker genes have been silenced in model plants such as Arabidopsis and tobacco. In maize, RdDM has been used to introduce male sterility in order to facilitate hybrid breeding, and in potato to modify the starch content. Ornamental petunias have had their flower pigmentation modified, and RdDM-altered maize and rapeseed are currently waiting in the breeder's pipeline.

Contact: dennis.eriksson@slu.se joachim.schiemann@jki.bund.de epso@epsomail.org