Oligonucleotide-Directed Mutagenesis

'Matchmaking and single mismatching'

Mutations are essential for life as we know it. Without mutations, there would be no evolution and no biodiversity. The variation created by natural mutations has also been the basis for all plant breeding since we started cultivating plants many thousand years ago. Then starting in the 1930s, scientific progress enabled us to use radiation and chemicals to induce mutations and thereby increase the genetic variation available for plant breeding. The more recent exploitation of *oligonucleotide-directed mutagenesis (ODM)* has now made mutation breeding more precise and efficient than ever before. Compared to the randomness of mutations induced by radiation or chemicals, this technique employs a complementary nucleotide sequence to introduce a mutation at a very specific location in the genome.

Benefits

ODM creates a mutation exactly where it is needed, greatly enhancing the precision, efficiency and speed of breeding. Earlier mutation breeding based on radiation or chemicals was essentially a random approach blasting thousands of seeds to induce countless mutations and then trying to cherry-pick the rare few mutations that were beneficial. A much smaller plant population is then sufficient to improve a particular trait with ODM. ODM also avoids the tedious 'cleaning up' procedure that is necessary in random mutation breeding to get rid of all the unwanted mutations through generations of backcrossing.

Scientific description

ODM was developed already in the 1970s and improvement over the years enabled the first application in plants in 1999. This tool for targeted mutagenesis takes advantage of hybridisation, which is the matching of complementary stretches of nucleotides, such as DNA. Short oligonucleotides are synthesized to match a corresponding sequence in the gene of interest – but with one or a few mismatches. When delivered to the plant cell, these oligonucleotides will hybridize to the gene and introduce the mutation. The induced mutation– often consisting of a single nucleotide – will be stably inherited whereas the oligonucleotides are degraded in the cells. With full control of the entire process, the result in the end is an improved trait in the plant.

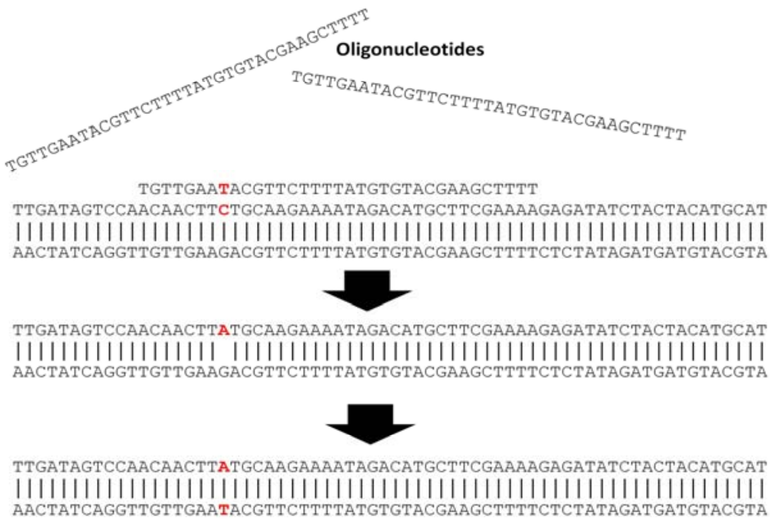

Image: Thorben Sprink, Julius Kühn-Institut

Applications

ODM has been applied extensively in plants, both in research and in commercial applications. As a research tool, it has greatly improved the capacity for reverse genetics, the approach where genes are knocked out to analyse their functions. The most common commercial applications so far have been to engineer herbicide tolerance in maize, wheat, rice, tobacco and rapeseed. As an example, the US based company Cibus is applying ODM in their Rapid Trait Development System (RTDS) and recently put forward a herbicide-tolerant rapeseed as a test case in several EU countries.

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About EPSO: EPSO, the European Plant Science Organisation, is an independent academic organisation that represents more than 220 research institutes, departments and universities from 31 countries. EPSO's mission is to improve the impact and visibility of plant science in Europe.