Crop Genetic Improvement Techniques
Fact sheet

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Reverse breeding

'Meet the parents'

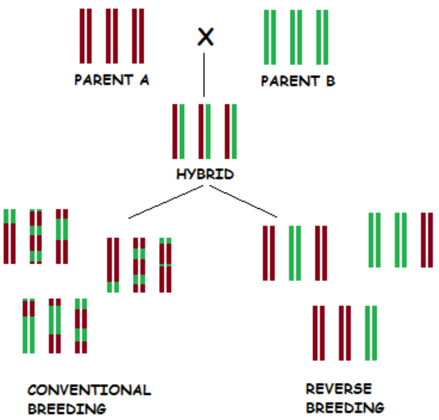
Hybrid plants are often superior in size, growth and yield compared to the parent plants. This phenomenon, called heterosis, has been exploited in plant breeding since the early 20th century. However, hybrid breeding has always been more or less based on a trial-and-error approach, since it is difficult to predict which parental lines will give the best possible progeny. Many pairs of parents then need to be crossed and their progeny tested. *Reverse breeding* puts this century-long endeavour up-side-down by starting with superior hybrid selection followed by recovery of the parental lines. This is an excellent tool in the plant breeder's toolbox, as it allows for a much more efficient and targeted hybrid plant production.

Benefits

The main advantage of reverse breeding is that it facilitates selection of superior hybrid plants. Large populations of plants can be generated and screened, and well performing plants can be regenerated indefinitely without prior knowledge of their genetic constitution. This essentially removes the elements of randomness in earlier hybrid breeding. The technique will be particularly important for crops lacking large existing collections of breeding lines. However, reverse breeding is currently limited to crops with a relatively small, diploid genome and is still difficult to carry out in crops with large, or polyploid, genomes such as wheat and oat.

Scientific description

To multiply a highly heterozygous hybrid plant, you need homozygous parental lines. The reason is that all the gene varieties – called alleles – and their corresponding traits get shuffled around randomly in the progeny seeds if you multiply a hybrid plant by itself. You will then lose the particular allele combination that made the hybrid plant successful. Reverse breeding starts by selecting a superior hybrid plant. This plant is then transformed with a gene that will prevent recombination – or shuffling – of genes during meiosis, thus leaving the individual chromosomes exactly as they were in the homozygous parental lines, rather than reshuffled. There will still be many new combinations of entire chromosomes though, but it is relatively easy to select for the "parental" combinations as long as the number of chromosomes in that species is not too large. The transgene is also removed by selection in these reconstituted "parental" lines, which are then maintained for indeterminate hybrid production.



Applications

Proposed in 2009, reverse breeding by engineered meiosis has not yet reached commercial application, though it has already been adopted at a research stage by many breeders. The potential is enormous – and so is also the growing interest in this technique – as breeders for many decades have sought after a reliable method to maintain superior hybrid crop plants independent of access to the parental lines. It is expected to benefit breeding of important agricultural crops such as maize, rice, pea, sorghum and sugar beet as well as horticultural crops such as cucumber, onion, broccoli, cauliflower, watermelon, tomato, eggplant and many others.

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