Molecular Plant Breeding CRC

Fact Sheet

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Molecular markers and plant breeding

Breeding new varieties of cereal crops is time consuming and highly dependant on environmental conditions. On average, it takes 8-14 years to develop a new variety. Molecular markers allow plant breeders to speed up this process, even cutting the breeding time in half.

What are molecular markers?

A molecular marker is a 'genetic signpost' that identifies the location of a gene within a plant or animal's DNA. Molecular markers are naturally occurring sections of genetic code that are easily detected and whose inheritance can easily be monitored.

To be useful, markers must exist in different forms so that plants carrying one form of the gene can be distinguished from other plants carrying a different version of the gene. This is called 'polymorphism'.

What use are they?

All plant tissue contains DNA. So plants can be tested for the presence of a particular molecular marker at any age – as an adult plant, seedling or seed. Molecular markers are used in:

- testing genetic variability
- testing the degree of relatedness between different populations
- marker-assisted selection
- identifying genes useful to plant breeders.

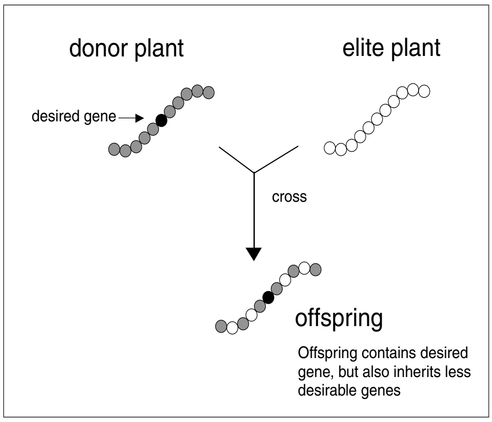
Plant breeding

The very first plant breeders collected wild seeds, grew them, and selected the best plants for further cultivation. Over the centuries, people developed cereals with high yields and different properties suitable for milling, baking and brewing. These highly cultivated lines are known as 'elite lines'.

Nowadays, plant breeding involves identifying valuable traits such as disease resistance in closely related plants, and breeding them into the elite lines.

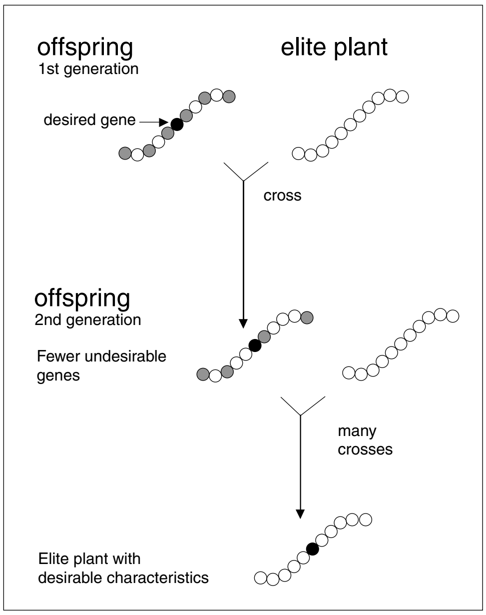
In all forms of sexual reproduction, half the genetic material comes from one parent, half from the other. This means that for any cross (mating), the offspring will have a random mixture of the genes of the two parents (see figure 1). This is a problem for breeders because they generally want only one gene from the 'donor' plant, with all the other genes of the elite plant. Unfortunately, many of the desirable genes of the elite plants can be lost, or worse, the offspring may not even contain the gene of interest.

figure 1



Breeders get around this problem by 'back-crossing' with the elite parent (see figure 2). After the first cross, the offspring are grown to maturity, and then tested to make sure they contain the gene of interest. Those plants that do not have it are discarded, and the remaining plants are back-crossed with the elite parent so that the next generation will have more of the elite genes. This process is repeated many times, until offspring with all the desired characteristics are produced.

This kind of plant breeding is very time consuming because each new cross takes an entire season to produce offspring. Each offspring plant needs to be tested which can figure 2



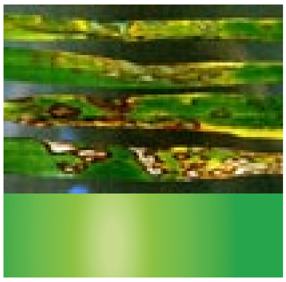
also be a lengthy process. Because a plant's performance is dependant on environmental conditions, potential new varieties need to be tested under different conditions, and in different locations.

Marker-assisted selection

Molecular markers allow us to screen the offspring of a given cross. By screening the DNA of a juvenile plant for a particular marker, breeders can quickly tell whether the adult plant will have the gene of interest. Unsuitable plants can be eliminated from the breeding program without the need for lengthy performance trials.

Case study: enhancement of disease resistance in elite malting barley

Baudin and WI3284 are elite malting barley lines that are severely affected by diseases such as leaf scald. Leaf scald is a common disease of barley, especially in cool moist areas of southern Australia. The disease causes lesions that develop into 'scalds' that affect the leaves, stems and heads of barley, lowering grain yields and reducing returns to growers.



Wheat infected with scald

Researchers at the Molecular Plant Breeding CRC have been working to breed resistance to leaf scald and other diseases into these elite lines. Using molecular markers for resistance to leaf scald, leaf rust, cereal cyst nematode and a number of other diseases, the researchers have been able to produce 200 lines with resistance to one or more of these diseases, while retaining the genes for high malting quality. All this in just three years!

This is an example of a breeding program that never would have been possible without the use of molecular markers. Normally, offspring from a cross would need to be exposed to a particular disease under field conditions, the plants examined, and then the plants affected by the disease discarded. Testing for resistance to even one disease is time consuming. Testing for six or seven would take decades. Testing for different genetic sources of resistance (ie making sure the plant has three different genes for resistance to a disease rather than one) would have been impossible.

Established and supported under the Australian Government's Cooperative Research Centre Program.

For further information visit www.molecularplantbreeding.com

Molecular Plant Breeding CRC

Melbourne P: +61 3 9479 1698 F: +61 3 9479 5022 E: mpb@molecularplantbreeding.com

Adelaide P: +61 8 8303 6539 F: +61 8 8303 6789