Wild relatives make a better wheat family

A CSIRO team, led by Dr Phil Larkin in Canberra, has developed the world's first trigenomic chromosome – a wheat chromosome that includes beneficial genes from three different grass species. The work is in collaboration with the International Maize and Wheat Improvement Center (CIMMYT) and Sydney University.

The development will greatly assist wheat breeders in their constant battle against two of the most damaging wheat diseases worldwide – leaf rust and Barley Yellow Dwarf Virus (BYDV).

BEATING DISEASE

Rusts are a range of fungal strains that can cause major crop losses. Rust strains continually mutate and evolve, with new strains appearing every year. Wheat breeders are therefore constantly searching for new sources of resistance to them.

BYDV is transmitted by aphids and found worldwide. BYDV is a disease for which there is no resistance known in the wheat gene pool.

CSIRO researchers have used innovative chromosome engineering to combine disease resistances from two wild wheat relatives in one wheat chromosome, helping plant breeders develop disease resistant wheat varieties.

To develop new disease resistant wheat varieties, plant breeders often use wild relatives of wheat as sources of resistance genes.

Genes from wild species are the only source of BYDV resistance for wheat.

Unfortunately resistance genes from wild relatives usually come in large blocks of hundreds of genes, often including undesirable genes.

Furthermore these blocks of genes stay tenaciously together during subsequent cycles of breeding. Plant breeders sometimes give up on promising resistance genes because they can not separate them from the undesirable genes.

The new technique pioneered by CSIRO offers new hope to revive the usefulness of these potentially valuable wild genes and illustrates the major genetic improvements possible without genetic modification (GM).

RECOMBINING RESISTANCE GENES

The CSIRO team began with two blocks of genes from two different Thinopyrum grass species, each positioned on the same wheat chromosome and with a number of resistance genes.

These two grasses contain genes that provide resistance to BYDV and effective protection against many global leaf rust strains.

Conditions were then created to 're-combine' the blocks to bring together the rust and BYDV resistances. In the process undesirable genes have been left behind.

The recombination is made possible by mutating a gene that normally prevents the three genomes in bread wheat from pairing and recombining. The gene also prevents wheat chromosomes pairing with introduced grass chromosomes.

Through the use of new DNA markers and careful testing, the team have developed a number of stable disease resistance 'packages' for wheat breeders without the associated undesirable genes – most notably those for yellow flour colour, an important quality characteristic in wheat.

An important part of the project was the development of DNA markers for the resistance genes. These markers allow breeders to see whether the genes are present in plants within the breeding program. Being able to track the traits ensures the right genes are present and speeds the process of breeding considerably.

The gene package will give breeders a distinct advantage, bestowing highly useful disease resistance traits in a stable package that can be easily moved and tracked by the breeders.

It is hoped other examples will follow and the genetic diversity available in wild species can be recruited more extensively for wheat improvement.

For more information contact Phil Larkin on 02 6246 5060 E: Philip.Larkin@csiro.au. ■

The project has the potential to considerably speed up the process of wheat breeding. (Photo Carl Davies, CSIRO Plant Industry)