

## **Alien-gene transfer through chromosome manipulations in wheat 4x and 6x**

### **Techniques for gene Transfer**

- Transfer of whole genome
- Transfer of individual whole chromosome
- Substitution of alien chromosome arms
- Interchanges
  - a) Through irradiation
  - b) Through recombination
    - i. Manipulation of diploidizing system
    - ii. Without manipulation of diploidizing system

The success of introducing alien variation into crop species from related species depends on the cytogenetic relations between the species. If there are no restrictions on chromosome pairing and recombination in species hybrids, a backcrossing programme can be used to obtain the desired gene transfers. However, when there is a failure of adequate chromosome pairing in species hybrids, techniques of chromosome manipulation have to be used to obtain alien gene transfers. In polyploid crop species it is possible to introduce appropriate single chromosomes of the alien species into the genotype of the recipient species, but the failure of the alien chromosome to become integrated into the genotype of the recipient species often leads to meiotic instability. The introduction of segments of alien chromosomes has been successful through the use of irradiation-induced translocations. The deletions/duplications that are a consequence of such translocations do limit the usefulness of this approach. In a number of allopolyploid crop species, regular bivalent pairing behaviour has been shown to be genetically controlled. By interfering with the genetic system controlling the diploid-like pairing it is possible to induce pairing between the alien chromosomes and its corresponding chromosomes in the crop species. Gene transfers based on this method involve exchanges between chromosomes of similar gene sequences.

#### **Genetic-induced gene transfers**

The failure of alien chromosomes to pair with their corresponding chromosomes in the cultivated species is not always associated with structural differentiation of the chromosomes but with the genetic control of chromosome pairing. In wheat, regular bivalent pairing is controlled by the Ph gene on the long arm of chromosome 5B. The Ph gene restricts pairing to homologous chromosomes and the homoeologues of the three constituent genomes synapse and form chiasmata associations only when chromosome 5B is deleted. The presence of such a genetic system in natural allopolyploids is also responsible for minimizing pairing between alien chromosomes and their homoeologues in the crop species. The relaxation of the control mechanism leads to pairing between alien chromosomes and the corresponding wheat chromosomes. By manipulating the control mechanism to allow homoeologous chromosomes to pair have been able to induce alien chromosomes to pair with their homoeologues in wheat and isolate recombinants including genes located on the alien chromosome. Riley et al.(1968) used genotypes of *Aegilops speltoides*, which suppresses the activity of the Ph gene, while Sears (1973), using the appropriate aneuploid lines, deleted chromosome 5B to induce pairing between alien chromosomes and their homoeologues in wheat.

#### **Irradiation -induced translocations:**

Sears (1956) was the first to use irradiation-induced translocations to transfer resistance to brown rust from *Aegilops umbellulata* to bread wheat. The technique relies on chromosomes rejoining in novel combinations after chromosome breakage induced by the irradiation treatment. Sears (1956) irradiated spikes, just before anthesis, of plants with additions of isochromosomes of *Aegilops umbellulata* carrying a gene for resistance to brown rust, and isolated gene transfers in subsequent progeny. Irradiation of dry seeds of the disomic alien addition can also be successfully used to induce translocations (Driscoll & Jensen 1963). In gene transfers based on irradiation-induced translocations there is a deletion of part of the genome of the recipient species and a duplication arising from the alien segment introduced. The usefulness of the gene transfers will depend on the ability of the genotype to tolerate such deletions and duplications.

## Interchanges through recombination

- Through manipulation of diploidizing system
  1. Removal of 5B chromosome
  2. Suppression of 5B effect by genome of *Ae. speltooides* or *Ae. mutica*
  3. Utilizing recessive mutant of Ph1 locus on 5B
- Without manipulation of diploidizing system