© September 2021| IJIRT | Volume 8 Issue 4 | ISSN: 2349-6002

Distant Hybridization and Its Limitations

Shaik N Ameer Sohail[1], Ranjeet Singh Sran[2]

[1]*M.Sc. Student, Dept. of Genetics and Plant Breeding, Lovely Professional University, Phagwara, Punjab-144411*

[2]*Asst. Professor, Dept. of Genetica & Plant Breeding, Lovely Professional University, Phagwara, Punjab-144411*

***Abstract* - Mating between individuals of various species or genera that results in the merging of divergent genomes into a single nucleus is known as distant or wide hybridization. The species barrier to gene transfer is broken by this procedure. It allows the entire genome of one species to be transferred to another, causing changes in the progenies' genotypes and phenotypes. Natural remote hybridization and speciation have produced many of today's crop plants. Many allopolyploid species are the result of broad hybrids doubling their chromosomes. Backcrossing broad hybrids to their parents on a regular basis is another method of gene introgression. This occurs when chromosomes or chromosomal fragments from one species infiltrate into another.**

INTRODUCTION

Crop development has long relied on broad or distant hybridization as a key technique for chromosomal modification. The genetic underpinning for chromosomal manipulation is provided by the chromosome behaviours in F1 hybrids. Translocation lines are created by inducing homoeologous pairing in F1 hybrid plants and then incorporating a single-chromosome fragment from an alien or wild species into an established crop species using translocating chromosomes. Most attempts to transfer a beneficial feature from wild plants to crops have so far relied on alien chromosomal translocation lines to cross the species divide. Amphidiploids have been created by doubling chromosomes in somatic cells or F1 hybrid gametes, followed by the integration of all foreign chromosomes. Amphidiploidy can be utilised as a bridge to transfer a single chromosome from one species to another or to create new crops. In the generation of haploids, chromosome removal of a uniparental genome during the development of F1 hybrid embryos has been employed. Haploids are particularly helpful in the double-haploid breeding of a true-breeding crop like wheat or rice, since they can swiftly replace genetic recombination while improving breeding efficiency and enabling genetic research.

Distant or Wide Hybridization:

Distant hybridization occurs when two distinct species of the same genus or genera of the same family cross, and such crosses are referred to as distant crosses or broad crosses. In the genetic enhancement of various agricultural plants, wide crossing or remote hybridization has been utilised. It's an efficient way to get desired genes from related species and genera into cultivated plants. In more closely related species or genera, distant crosses are more effective than in less closely related species or genera.

Classification of Distant Hybridization:

It is broadly classified into tow main types:

1. Interspecific Hybridization:
    - Fully Fertile
    - Partially Fertile
    - Fully Sterile
2. Intergeneric Hybridization:

1. Interspecific Hybridization:

Interspecific hybridization, also known as intra-generic hybridization, occurs when two distinct species of the same genus cross. Interspecific crossings are the offspring of such crosses, while interspecific hybrids are the offspring of such crosses. Thomas Fairchild created the first interspecific hybrid between sweet William and Dianthus carnation species in 1717. (Dianthus barbatus x D. Canyophyllus). When a desirable trait is not found within a crop's species, interspecific hybridization is utilised. Karpechenko created the first intergeneric hybrid between radish and cabbage in Russia in 1928.

Raphanobrassica has radish (Raphanus stativus) and cabbage as parents (Brassica oleracea).

I. Fully Fertile:

Crosses of this type are made between animals that have full chromosomal homology. Interspecific crosses between individuals with perfect chromosomal similarity are completely viable. Because the chromosomes in such hybrids couple normally during meiosis, the F1 plants are totally fertile.

Example: Cotton

Cotton comes in four varieties: Gossypium hirsutum, G. barbadense, G. arboreum, and G. herbaceum. The first two New World species are diploid (2n – 26), while the latter two Old World species are tetraploid (2n = 52). Fully viable crosses exist between the tetraploid species G. hirsutum and G. barbadense, as well as between the diploid species G. arboreum and G. herbaceum.

G. hirsutum (2n = 52) x G. barbadense (In = 52) → F1 plants are fully fertile.

G. arboreum (2n = 26) x G. herbaceum (2n = 26) → F1 plants are fully fertile.

Partially Fertile:

These crosses are made between animals that have different ploidy levels yet share certain chromosomes. Interspecific crosses between individuals with different chromosomal numbers but some chromosomes in common are partly viable. The F1 plants are partly fertile and partially sterile in such conditions.

Example: Wheat:

Diploid (2n = 14), tetraploid (2n = 28), and hexaploid (2n = 42) are the three kinds of wheat species. Partially viable cross between common wheat (Triticum aestivum, 2n = 42) and durum wheat (T. durum, 2n = 28). Because A and B genome chromosomes are prevalent in both of these animals, F1 hybrids are only partly viable. During meiosis, F1 has 14 bivalents and 7 univalents. In this cross, there is some seed set.

Triticum aestivum (AA BB DD)× *Triticum durum* (AA BB)

(2n = 42) ↓ (2n = 28)

F1(AABBD)

(2n = 35)

Partially fertile

Fully Sterile:

These crosses are made between individuals with different chromosomes. Interspecific crosses that do not have chromosomal homology are completely infertile. The chromosomal number in these individuals may or may not be the same. During meiosis, the absence of chromosomal similarity prevents chromosome pairing between two species. As a result, the F1 plants are self-sterile to the fullest extent possible. Colchicine therapy can double the number of chromosomes in such hybrids, making them self-fertile. Tobacco, wheat, cotton, Brassica, Vigna, and a variety of other crops have all been documented to have fully sterile F hybrids.

Example: Tobacco

Clausen and Goodspeed (1928) crossed two wild diploid tobacco species, Nicotiana sylvestris (2n = 24) and Nicotiana tomentosa (2n = 24), to produce a hybrid. The F1 hybrid proved to be infertile. When the F1 plants were given colchicine, they produced a completely viable tetraploid (2n = 48) that looked like farmed species (N. tabacum).

Another hybrid was created between two wild diploid tobacco species, N. paniculata (2n = 24) and N. undulata (2n = 24). The F1 was sterile once more. Colchicine treatment of F1 resulted in the generation of viable amphidiploid (2n = 48) seeds that were comparable to those found in farmed N. rustica.

Main Features of Interspecific Hybridization:

- It's utilised when a desirable characteristic isn't found in a crop's species.
- It is a successful way of transferring beneficial genes from similar farmed or wild species into cultivated plants.
- In vegetatively propagated species like sugarcane and potato, interspecific hybridization is more effective than in seed propagated species.
- Introgression occurs when certain genes from one species are transferred to the genome of another species as a result of interspecific hybridization.

Intergeneric Hybridization:

Intergeneric hybridization occurs when two genera from the same family cross. Intergeneric crosses produced *Triticale* and *Raphanobrassica*.

Example: Radisg - Cabbage:
Karpechenko created an intergeneric hybrid between radish (Raphanus sativus) and caage (Bassica oleracea) of the Cruciferae family in Russia in 1928. The major goal was to mix radish roots with cabbage leaves. The F1 was found to be infertile. The creation of a viable amphidiploid, called Raphanobrassica by Karpechenko, came from the doubling of chromosomal number by colchicine therapy. However, the new species that resulted had roots similar to cabbage and leaves similar to radish, which was an ineffective combination.

Main Features of Intergeneric Hybridization:

- When the desired genes are not found in various species of the same genus, intergeneric hybridization is utilised.
- This approach is infrequently employed in crop development programs, and only for the transfer of particular characteristics from related taxa into cultivated species.
- In asexually propagated species, intereneric hybridization is commonly utilised.
- Sterility is usually present in F1 hybrids between two genera. The fertility must be restored by colchicine therapy, which involves doubling the chromosomes.
- Some researchers utilised intergeneric hybridization to create new crop species.

Difference Between Interspecific and Intergeneric Hybridization:

Sl. Number	Particulars	Interspecific	Intergeneric
1	Parents Involved	Involve two different species of same genes	Involve two different genera of the same family
2	Fertility	Such hybrid vary from completely fertile to completely sterile	Hybrids are always sterile
3	Seed Setting	More than intergeneric crosses	Low
4	Use in crop improvement	More than intergeneric crosses	Less than interspecific crosses
5	Release of hybrid variety	Possible in some crops	Not possible
6	Evolution of new crop	Not possible but evolution of new species is sometimes possible	Sometimes possible

Limitations of Distant Hybridization:

- Though remote hybridization offers a number of important uses in crop development, it has certain drawbacks that have limited its widespread adoption.
- Cross incompatibility, hybrid inviability, hybrid sterility, and hybrid breakdown are all difficulties connected with distant crossings. Interspecific or intergeneric gene transfer is complicated by these issues.
- To make distant hybrids effective in some situations, specific procedures like as ploidy modification, pistil manipulation, chemical (growth regulator) therapy, bridge crossing, grafting, embryo culture, and so on must be used. As a result, this is a difficult task.
- Desirable traits are frequently associated with unfavourable characters, making remote hybridization of desirable genes from wild species problematic. Several wheat chromosomal addition and replacement lines have been created, however because to the presence of some undesired genes, none of them could be employed for commercial production.
- Distant hybrids can exhibit a number of negative characteristics, including as non-flowering, late maturity, seed dormancy, and ineffective combinations, such as Raphanobrassica.
- Interspecific crossings make it harder to transfer recessive gene-controlled traits.
- Character transmission is not as straightforward in remote hybridization as it is in intervarietal crosses.

REFERENCES

[1] Allard, R. W. 1960, Principles of Plant Breeding, John Wiley, Inc, New York.
[2] Anderson E (1953) Introgressive hybridization. Biol Rev 28:280–307

[3] Arnold MA (1997) Natural hybridization and evolution. Oxford University Press, New York
[4] Cabral, J.B. and Crocomo, O.J. (1989) Interspecific hybridization of Phaseolus vulgaris, P. acutifolius and P. lunatus using in vitro technique. Turrialba 39, 243–246.
[5] Fratini, R. and Ruiz, M.L. (2006) Interspecific hybridization in the genus Lens applying in vitro embryo rescue. Euphytica 150, 271–280.
[6] Kaneko Y, Bang SW (2014) Interspecific and intergeneric hybridization and chromosomal engineering of brassicaceae crops. Breed Sci 64:14–22
[7] Knott, D. R. and Dvorak, J. 1976, Genetic resources in wild relatives of crops, Crops sci, 16; 329-333.
[8] Meyer, V. G. 1979, Principles of crop improvement. Longman, London and New York.