Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

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Unit: Unit 09 - Methods of Crop Improvement

Module Name: Distant hybridization in Crop Improvement

Module No: 51

Name of the Presenter: Ms. Marina Janice Rodrigues

Notes

Distant hybridization is the crossing of individuals between species and genera that combine divergent genomes.

Wide crossing or distant hybridization has been used in the genetic improvement of some crop plants. It breaks the species barriers for gene transfer resulting in changes in genotypes and phenotypes of the progenies. It is an effective means of transferring desirable genes into cultivated plants from
related species and genera.
Distant crosses are more successful in more closely related species or genera than in less closely related species or genera

Distant hybridization is of two types, viz:

I. Interspecific Hybridization:

Crossing or mating between two different species of the same genus is referred to as interspecific hybridization. Because interspecific hybridization involves two species of the same genus, it is also termed as intrageneric hybridization.

Main features of interspecific hybridization are given below:

1. It is used when the desirable character is not found within the species of a crop.

2. It is an effective method of transferring desirable genes into cultivated plants from their related cultivated or wild species.

3. Interspecific hybridization is more successful in vegetatively propagated species like sugarcane and potato than in seed propagated species.

4. Interspecific hybridization leads to introgression which refers to transfer of some genes from one species into the genome of another species.

5. Interspecific hybridization gives rise to three types of crosses, viz.

a. Fully Fertile Crosses:

Interspecific crosses are fully fertile between those species that have complete chromosomal homology. Chromosomes in such hybrids have normal pairing at meiosis and as a result the F1 plants are fully fertile.Example: Cotton, Wheat, Oats, Soybean:

b. Partially Fertile Crosses:

Interspecific crosses are partially fertile between those species which differ in chromosome number but have some chromosomes in common. In such situations, the F1 plants are partially fertile and partially sterile. Wheat, Cotton,Tobacco:

c. Fully Sterile Crosses:

Interspecific crosses are fully sterile between those species which do not have chromosomal homology. In such species, chromosome number may or may not be similar. The lack of chromosomal homology does not permit pairing between the chromosomes of two species during meiosis.

As a result, the F1 plants are fully self-sterile. Such hybrids can be made self-fertile by doubling of chromosomes through colchicine treatment. Fully sterile F hybrids have been reported in tobacco, wheat, cotton, Brassica, Vigna and several other crops. Tobacco, Cotton, Brassica, Vigna:

II. Intergeneric Hybridization:

Intergeneric hybridization refers to crossing between two different genera of the same family. Such crosses are rarely used in crop improvement because of various problems associated with them.

The main features of intergeneric crosses are given below:

1. Intergeneric hybridization is used when the desirable genes are not found in different species of the same genus.

2. This method is rarely used in crop improvement programmes and that too for transfer of some specific characters into cultivated species from allied genera.

3. Intereneric hybridization has been generally used in asexually propagated species.

4. F1 hybrids between two genera are always sterile. The fertility has to be restored by doubling of chromosomes through colchicine treatment.

Some examples of intergeneric hybridization are given below:

i. Wheat-Rye Cross:

The first intergeneric cross was made in the family Gramineae between bread wheat (Triticum aestivum, $2n = 42$) and rye (Secale cereale $2n = 14$) by Rimpau around 1890 in Sweden. The F1 was sterile which was made fertile through colchicine treatment. The amphidiploid ($2n = 56$) was named as Triticale.

This combines yield potential and grain quality of wheat and hardiness of rye. Triticale is the best example of the practical achievements of intergeneric hybridization. Now Triticale is commercially grown in countries like Canada and Argentina. Several improved varieties of Triticale have been released for commercial cultivation. Research work on Triticale is in progress at CYMMIT, Mexico.

ii. Radish Cabbage Cross:

Intergeneric cross between radish (Raphanus sativus) and caage (Bassica oleracea) of the family Cruciferae was made by Karpechenko in 1928 in Russia. The main objective was to combine root of radish with leaves of cabbage. The F1 was sterile. e doubling of chromosome number by colchicine treatment resulted in development of fertile amphidiploid which was named as Raphanobrassica by Karpechenko. But the new species thus developed had roots like cabbage and leaves like radish, which was a useless combination.

Role of Distant Hybridization in Crop Improvement:

Wild species or wild genetic resources are the potential sources of desirable genes for various characters of crop plants. Wide crossing is an effective method of exploiting desirable characters from wild species for the improvement of cultivated crop plants. Thus the significance of wild species and distant hybridization are interlinked.

Distant hybridization has played significant role in:

i. Character Improvement:

(i) Disease and Insect Resistance:

Distant hybridization has been instrumental in transferring disease resistance from wild species into cultivated ones. For example, resistance to rust and black arm in cotton; mosaic virus, blue mould, black root rot, and Fusarium wilt diseases in tobacco , late blight, leaf roll in potato; rust and eye spot in wheat; and yellow mosaic virus in okra have been transferred from wild species of these crops into cultivated species

(ii) Improvement in Quality:

In some crops, wild species have been used to improve the quality of cultivated ones. For example, protein content in rice, oats and rye; fibre length in cotton; oil quality in oil palm; carotenoid content in tomato; starch content in potato; leaf quality in tobacco; and oil per cent in oats have been improved through the use of their wild species in the hybridization programme.

Wild tobacco has been utilised to reduce nicotin content in cultivated species and flavour of cultivated tea has been improved through the use of wild tea.

(iii) Improvement in Adaptation:

Adaptation to various environmental conditions has been improved through the use of wild species. For example, tolerance to cold in rye, wheat, onion, potato, tomato, grapes, strawberry and peppermints etc. has been transferred from wild species of these crops in Russia.

In grape, hardier vines have been developed through the use of wild species *Vitis amurensis* in the breeding programme.

(iv) Improvement in Yield:

Improvement in yield has also been achieved through the use of wild species in some crops. For example, in oat yield increase of 25-30% over the recurrent parent was obtained from a cross between Avena sativa x A. sterilis.

Increase in yield has been reported in several crops such as Vigna, Zea, Ribes, vanilla, Arachis, potato and tobacco through interspecific hybridization. In tobacco, yields were increased by the use of wild species Nicotianci debneyi. Yields of sugarcane and octaploid strawberries have been increased by the use of their wild species.

(v) Mode of Reproduction:

Use of wild species in the hybridization programmes sometimes leads to alteration in the mode of reproduction. The male sterility is the most common alteration in the mode of reproduction which results from interspecific hybridization.

CMS has been discovered in crosses between wild and cultivated species in wheat, cotton, barley, tobacco, potato, sunflower and ryegrass. The CMS has been transferred to cultivated species of these crops. Apomictic genes have been transferred from maize — *Tripsacum* cross to maize and from wild species of Beta to cultivated species. The cleistogamy and self-fertility traits of wild Secale have been transferred to cultivated rye (*secale cereale*).

(vi) Other Characters:

There are several other desirable characters which have been transferred from wild species to cultivated plants. For example, wild species have been used to transfer dark green colour and excellent leaf texture in lettuce and bright red thin flesh in red peppers. Semi-dwarf wheat has obtained from Triticum x Agropyron hybrid derivatives. Short statured oil palms resulted from interspecific hybrids. Earliness has been achieved from use of wild species in soybean.

ii. Hybrid Varieties:

Improved hybrid cultivars have been developed through the use of wild species mainly in sugarcane, potato and some forage crops. Most of the modem cultivars of sugarcane and potato are the derivatives of interspecific hybridization. In cotton, commercial interspecific hybrids have been developed both at tetraploid and diploid levels but between cultivated species only.

iii. New Crop Species:

Sometimes, distant hybridization and polyploidy lead to creation of new crop species. Nicotiana digluta has been synthesized from a cross between N. tabacum and N. glutinosa. Triticale is the example of new crop which has evolved from an intergeneric cross between Triticum aestivum and Secale sereale and combines good characters of both the species.