

Lecture: - 9

HYBRIDIZATION: TECHNIQUES AND CONSEQUENCES

9.1 Introduction:-

- The mating or crossing of two plants or a line of dissimilar genotype is known as hybridization.
- In plants, crossing is done by placing pollen grains from one genotype, the male parent, on to the stigma of flowers of the other genotype, the female parent.
- It is essential to prevent self-pollination as well as chance cross-pollination in the flowers of the female parent. At the same time, it must be ensured that the pollen from desired male parent reaches the stigma of female flowers for successful fertilization.
- The seeds as well as the progeny resulting from the hybridization are known as hybrid or F1. The progeny of F1 obtained by selfing or intermating of F1 plants, and the subsequent generations are termed as segregating generations. The term cross is often used to denote the products of hybridization, i.e. the F1 as well as the segregating generations.

9.2 Objectives of Hybridization:-

- The chief objective of hybridization is to create genetic variation by producing the segregating generations.
- The aim of hybridization may be the transfer of one or few qualitative characters, the improvement in one or more quantitative characters, or use to produce hybrid variety.
- **Combination Breeding:** The main aim of combination breeding is the transfer of one or more characters into a single variety from other varieties. These characters may be governed by oligo-genes or polygenes. The intensity of the character in the new variety is either comparable to or, more generally, lower than in the parent variety from which it was transferred. In this approach, increase in the yield of a variety is obtained by correcting the weaknesses in the yield contributing traits, e.g., tiller number, grains per spike, test weight is that for disease resistance.
- **Transgressive Breeding:** Transgressive breeding aims at improving yield or its contributing characters through transgressive segregation. Transgressive segregation is

the production of plants in an F₂ generation that are superior to both the parents for one or more characters. The pedigree method of breeding and its modifications, particularly the population approach, are designed for the production of transgressive segregants.

- **Hybrid Varieties:** In most self-pollinated crops, F₁ is more vigorous and higher yielding than the parents. Wherever it is commercially feasible, F₁ may be used directly as a variety. In such cases, it is important that the two parents should produce an outstanding F₁.

9.3 Types of Hybridization: - The plants or lines involved in hybridization may belong to the same variety, different varieties of the same species, different species of the same genus or species from different genera. Based on the taxonomic relationship of the two parents, hybridization may be classified into two broad groups: Intervarietal and Distant hybridization

Intervarietal Hybridization: The parents involved in hybridization belong to the same species; they may be two strains, varieties or races of the same species. It is also known as intraspecific hybridization. In crop improvement programmes, Intervarietal hybridization is the most commonly used. an example would be crossing of two varieties of wheat, rice or some other crop. The Intervarietal crosses may be simple or complex depending upon the number of parents involved.

- **Simple Cross:** In a simple cross, two parents are crossed to produce the F₁. The F₁ is selfed to produce F₂ or is used in a backcross programme, e.g., A X B → F₁ (A X B)
- **Complex Cross:** more than two parents are crossed to produce the hybrid, which is then used to produce F₂ or is used in a backcross. Such a cross is also known as convergent cross because this crossing programme aims at converging, i.e., bringing together, gene from several parents into a single hybrid.

Distant Hybridization: Distant hybridization includes crosses between different species of the same genus or of different genera. When two spp. belong to two different genera, it is termed as intergeneric hybridization.

- Generally, the objective of such crosses is to transfer one or few simply inherited characters like disease resistance to a crop species. Eg:-CO 31 rice variety was developed from the cross *Oryza sativa* var. indica x *O. perennis*.
- Almost all the present-day sugarcane varieties have been developed from complex crosses between *Saccharum officinarum* (noble canes), *S. barberi* (Indian canes) and other *Saccharum* species, e.g., *S. spontaneum* (Kans.).
- The improvement in fiber length of Indian Cotton (*Gossypium arboreum*) has been brought about by crossing it with American cultivated Cotton ; many improved varieties have resulted from such crosses.
- Intergeneric hybridization may also be used to develop a new crop species, e.g., *Triticale* from a cross between *Triticum* sp. And *Secale cereale* (rye). Wild species often provide genes which are not present in the cultivated species. For example, many of the genes for rust resistance in wheat are derived from related wild species.

Hybridization procedure: Choice or selection of parents, Evaluation of parents
i.e. by selfing and studying the progeny, Emasculation, Crossing or pollination, Bagging & labeling, Harvesting of F1 seed and Raising of F1 generation.

Handling of Segregating Population

Pedigree Method:

- In the pedigree method, individual plants are selected from F₂ and subsequent generations, and their progenies are tested. During the entire operation a record of all parent off spring relationships is kept. This is known as pedigree record. Individual plant selection is continued till the progenies show no segregation.
- At this stage the selection is done among the progenies, multilocation tests are conducted and released as varieties.
- Used for genetic improvement of self pollinated crops in which superior genotypes are selected from segregating generation.
- Here only artificial selection operates in pedigree method, there is no chance of natural selection to occur.
- Genetic constitution-homozygous and homogenous.

Procedure of pedigree method:-

- **1st year:** cross is made between the parents possessing desirable characters.
- **2nd year:** Sow the F₁ seed giving wide spacing so that each F₁ plant produces more seeds. Raise as many F₁ plants as possible to produce large number of F₂ seeds. Harvest in bulk.
- **3rd year:** Grow 2000-10000 plants of F₂ giving wide spacing for full expression of the characters in F₂ generation plants. Grow parents for comparison. About 100-500 superior plants are selected. He has to judge which F₂ plant will produce superior progeny for characters under consideration. The breeder develops this skill through close study of the crop for many generations. The selection in F₂ is done for simply inherited characters like head type disease resistance etc. and selection for characters governed by many genes like yield will be reserved for later generations. The selected plants are harvested separately and given serial numbers and description entered in pedigree registers.
- **4th year:** Progeny rows of F₃ i.e. seeds of one selection plant in one row are space planted along with parents and checks. From superior progeny rows, individual plants with desirable

characters are selected (about 50-100 families and about 5 plants in each family and harvested separately). Diseased, lodging and undersirable progenies are discarded.

- **5th year:** F4 plants raised again as head to row. Desirable plants are selected from desirable rows and harvested separately.
- **6th year:** F5 plants raised in 3 row plots i.e. seeds of each selected plant sown in 3 rows. By this time many families might have become reasonably homozygous. For comparison check variety is grown for every 3 or 5 block. Progenies are evaluated for yield and the inferior ones are rejected. The number should be reduced to 25-50. superior plants from superior progenies are selected. Plants from each progeny are bulked.
- **7th year:** F6 individual plant progenies are grown in multi-row plots and evaluated. Inferior progenies are rejected and superior progenies are selected. Plants of each progeny are harvested in bulk. Diseased and inferior plants from the progenies are removed.
- **8th year:** F7 preliminary yield trial with 3 or more replications are conducted to identify superior lines. The progenies are evaluated for many characters including yield. Standard commercial varieties must be included as checks. Two to five outstanding lines are selected and advanced to coordinated yield trials.
- **9th, 10th & 11th year:** selected lines are tested in several localities for 2 or 3 years for adaptation tests. Lines are evaluated for all characters mainly yield and disease resistance. A line that is superior to commercial variety in yield and other characters is selected. 11th
- **12th year:** Selected superior lines is named, multiplied and released as a new variety.

Merits of pedigree method:

- It gives maximum opportunity for the breeder to use his skill in selection of plants
- It is well suited for the improvement of traits which can be easily identified and inherited.
- Transgressive segregation for yield and other quantitative characters may be recovered.
- Information about the inheritance of characters and pedigree of lines can be obtained.
- Inferior plants and progenies are eliminated in early generations.
- It takes less time than bulk method to develop new variety

Demerits of pedigree method:

- Valuable genotypes may be lost in early generations, if sufficient skill and knowledge are lacking in the breeder, at the time of selection.
- No opportunity for natural selection
- Difficult to handle many crosses
- Maintenance of records, selections, growing progeny rows are time consuming and laborious.

Achievements:

Large number of varieties has been developed by pedigree method in many crops.

Wheat – NP -52, 120,125, **Rice** – ADT – 25, Jaya, Padma, **Cotton** – Lakshmi, Digvijay, **Sorghum** – Co 18, RS 610, **Tobacco** – NP 222, **Sorghum** – Co 18, Rs 610, **Tobacco** – NP 222.

Mass pedigree method: This is the modified pedigree method. Crosses are made and further generations grown in bulk or as mass until suitable season occurs for making desirable selections against drought, insect and diseases etc. The population will be exposed to the natural conditions of vagaries. From the remaining population individual plants are selected and harvested progenies are evaluated for yield and other characters in preliminary yield trials and further generations are proceeded as in pedigree method till release of variety. The advantages of both bulk and pedigree methods can be obtained and large number of crosses can be handled at a time. The disadvantage is that it takes a bit longer time.