

Lecture: - 11

Back cross method

- ❖ **Harlan and Pope** (1922) suggested the back cross method by which an undesirable allele at a particular locus is replaced by the desirable allele in otherwise elite variety. In other words, B.C. procedure conserves all good characteristics of a popular adapted variety and incorporates a desirable character from another variety.
- ❖ **Back cross** : A cross between a hybrid (F1 or a segregating generation) and one of its parents is known as backcross.
- ❖ **Back cross method** : In the B.C. method, the hybrid and the progenies in the subsequent generations are repeatedly back crossed to one of their parents.
- ❖ **Objective** : To improve or correct one or two specific defects of a high yielding variety, which is well adapted to the area and has other desirable characteristics.
- ❖ **Recipient parent** : Well adapted, high yielding variety, lacking one or two characters and hence receives these genes from other variety.
- ❖ **Donor parent** : The variety which donates one or two useful genes.
- ❖ **Recurrent parent** : Since the recipient parent is repeatedly used in the backcross programme, it is also known as the recurrent parent.
- ❖ **Non-recurrent parent** : The donor parent, on the other hand, is known as the non-recurrent parent because it is used only once in the breeding programme (for producing the F1 hybrid).

11.1 Requirements of a back cross programme:

- Existence of a good recurrent parent variety which requires improvement is some qualitatively inherited character or a quantitative character with high heritability.
- A suitable donor parent must be available possessing the character or characters to be transferred in a highly in tense form.
- High expressivity of the character under transfer through several back crosses in the genetic back ground of the recurrent parent.
- The character to be transferred must have high heritability-preferably determined by one or few genes.
- Simple testing technique for detecting the presence of the character under transfer.
- Recovery of the recurrent genotype in a reasonable number of back cross generations.

11.2 Applications of Back Cross method:

- Back Cross method is applicable to both S.P. & C.P. crops.
- Inter varietal transfer of simply inherited characters: characters governed by one or two major genes – Eg. disease resistance, used color.
- **Linkage drag** : Failure of transfer of simply inherited characters like disease resistance by B.C. method due to a tight linkage between the gene being transferred and some other undesirable gene.
- Inter varietal transfer of Quantitative characters: Quantitative characters with high heritability can be transferred. Eg. Early ness, Pl. height seed size, seed shape.
- Inter specific transfer of simply inherited characters : Mostly disease resistance from related species into a cultivated species. Eg. **1.** Leaf and stem rust resistance from *Triticum timopheevii*, *T. monococcum*, *Aegilops speltoides* and rye (*S. cereale*) to *T. aestivum*. **2.** Black arm resistance from several *Gossypium* species to *G. hirsutum*
- **Transfer of cytoplasm:** Back Cross method used to transfer cytoplasm from one variety or species to another. This is especial desirable in cases of Cytoplasmic or Cytoplasmic-genetic male sterility. Transfer of *T. timopheevii* cytoplasm to *T. aestivum*
- **Transgressive segregation:** Back cross method may be modified to obtain transgressive segregants. It may be modified in one of the following two ways.
- The F1 may be Back crossed only 1 or at most 2 times to the recurrent parent leaving much heterozygosity for transgressive segregants to appear.
- Two or more recurrent parents may be used in the back cross programme to accumulate genes from them in to the back cross progeny. Such a modification of the back cross would produce a new variety that would not be exactly like any one of the recurrent parents.
- Production of Isogenic lines : Isogenic lines are identical in their genotype, except for one gene. Such lines are useful in studying the effects of individual genes on yield and other characteristics. Isogenic lines are easily produced using the back cross method.
- Germplasm conversion : Conversion of photosensitive germplasm lines (using as recurrent parent) to photo insensitive line (using a photo insensitive line as a donor or non-recurrent parent).

11.3 Transfer of a Dominant Gene:

Let us suppose that a high yielding and widely adapted variety A is susceptible to stem rust. Another variety B is resistant to stem rust, and that resistance to stem rust is dominant to susceptibility. A generalized scheme of the backcross programme for the transfer of rust resistance from variety B to variety A is given below.

- **Hybridization** : Variety A is crossed to variety B. Generally, variety A should be used as the female parent. This would facilitate the identification of selfed plants, if any F1 Generation: heterozygous for rust resistance, selection for rust resistance is not necessary.
- **First Backcross Generation (BC1)**: half of the plants would be resistant and the remaining half would be susceptible to stem rust. Rust resistant plants are selected and backcrossed to variety A. BC1 plants resistant to rust may be selected for their resemblance to variety A as well.
- **BC2-BC5 Generations**: In each backcross generation, segregation would occur for rust resistance. Rust resistant plants are selected and backcrossed to the recurrent parent A. Selection for the plant type of variety A may be practiced, particularly in BC2 and BC3.
- **BC6- Generation**: On an average, the plants will have 98.4 per cent genes from variety A.
- Rust resistant plants are selected and selfed; their seeds are harvested separately.
- **BC6 F2 Generation**: Individual plant progenies are grown. Progenies homozygous for rust resistance and similar to the plant type of variety A are harvested in bulk. Several similar progenies are mixed to constitute the new variety.
- **Yield Tests** : The new variety is tested in a replicated yield trial along with the variety A as a check. Plant type, date of flowering, date of maturity, quality etc. are critically evaluated. Ordinarily, the new variety would be identical to the var A in performance.

11.4 Transfer of a Recessive Gene:-

- When rust resistance is due to a recessive gene, all the backcrosses cannot be made one after the other. After the first backcross, and after every two backcrosses, F₂ must be grown to identify rust resistant plants. The F₁ and the backcross progenies are not inoculated with rust because they would be susceptible to rust. Only the F₂ is tested for rust resistance. A generalized scheme for the transfer of a recessive gene for rust resistance is given below.
- **Hybridization:** The recurrent parent is crossed with the rust resistant donor parent. The recurrent parent is generally used as the female parent.
- **F₁ Generation:** F₁ plants are backcrossed to the recurrent parent.
- **BC₁ Generation:** Since rust resistance is recessive, all the plants will be rust susceptible. Therefore, there is no test for rust resistance. All the plants are self-pollinated.
- **BC₁ F₂ Generation:** Plants are inoculated with rust spores. Rust resistant plants are selected and backcrossed with the recurrent parent. Selection is done for the plant type and other characteristics of the variety A.
- **BC₂ Generation:** There is no rust resistance test. Plants are selected for their resemblance to the recurrent parent A, and backcrossed with the recurrent parent.
- **BC₃ Generation:** There is no disease test. The plants are self-pollinated to raise F₂. Selection is usually done for the plant type of variety A.
- **BC₃F₂ Generation :** Plants are inoculated with stem rust. Rust resistant plants resembling variety A are selected and bc to variety A. Selection for plant of A is generally effective.
- **BC₄ Generation:** There is no rust resistance test. Plants are back-crossed to variety A.
- **BC₅ Generation:** There
- is no rust test. Plants are self -pollinated to raise F₂ generation.
- **BC₅F₂ Generation:** Plants are subjected to rust epidemic. A rigid selection is done for rust resistance and for the characteristics of variety A. Selfed seeds from the selected plants are harvested separately.
- **BC₅F₃ Generation:** individual plant progenies are grown and subjected to rust epiphytotic. A rigid selection is done for resistance to stem rust and for the characteristics of variety A.

Seeds from several similar rust resistant homogeneous progenies are mixed to constitute the new variety.

- **Yield Tests:** It is the same as in the case of transfer of a dominant gene.

11.5 Merits:-

- The genotype of new variety is nearly identical with that of the recurrent parent, except for the genes transferred. Thus the outcome of a backcross programme is known beforehand and it can be reproduced any time in the future.
- It is not necessary to test the variety developed by the backcross method in extensive yield tests because the performance of the recurrent parent is already known. This may save upto 5 years' time and a considerable expense.
- The backcross programme is not dependent upon the environment, except for that needed for the selection of the character under transfer. Therefore, off -season nurseries and green-houses can be used to grow 2-3 generations each year. This would drastically reduce the time required for developing the new variety.
- Much smaller populations are needed in the backcross method than in the case of pedigree method.
- Defects, such as susceptibility to disease, of a well-adapted variety can be removed without affecting its performance and adaptability. Such a variety is often preferred by the farmers and the industries to an entirely new variety because they know the recurrent variety well.
- This is the only method for inter-specific gene transfers, and for the transfer of cytoplasm.
- It may be modified so that transgressive segregation may occur for quantitative characters.

11.6 Demerits:

- The new variety generally cannot be superior to the recurrent parent, except for the character that is transferred.
- Undesirable genes closely linked with the gene being transferred may also be transmitted to the new variety.
- Hybridization has to be done for each backcross. This often difficult, time taking and costly.
- By the time the backcross programme improves it, the recurrent parent may have been replaced by other varieties superior in yielding ability and other characteristics.

11.6 Achievements:

- Two cotton varieties 170-C o-2 and 134 – Co 2m were developed.
- Kalyana sona susceptible to leaf rust. Resistant has been transferred from several diverse sources i.e., Robin, K1, Blue bird, Tobari, Frecor and HS-19
- Tift 23A is susceptible to downy mildew. The line backcrossed with MS-521A, MS-541 A, MS-570A resistant hybrids were produced.

11.7 Multiline:-

- It is a mixture of isogenic lines, closely related lines or very rarely it is unrelated lines.
- For first time it is suggested by Jensen [1952] in oats and this method is outlined by N.E Borlaug and Gibler in 1953.
- Genetic constitution is homozygous and heterogenous.

11.9 Development of multiline varieties:

- A multiline variety is usually created by mixing the seeds of several lines that are similar in appearance but have different genes for resistance to a given disease. There are two main steps in the development of multilines:
 - Development of component lines
 - Evaluation and grouping of the components.

11.10 Development of component lines:-

- The resistance genes are incorporated in an elite variety or line to produce as many near-isogenic lines as there are distinct R genes.
- This is done through a conventional backcross programme (5-6 backcrosses), a limited backcrossing (2-3 backcrosses, followed by pedigree selection) or by making double or multiple crosses.
- The lines obtained from the last two approaches are likely to differ for agronomic and other features as well; therefore, a detailed evaluation of such lines is essential.

11.11 Evaluation and grouping of the components:-

- The number of component lines should be large, 15-20 according to Borlaug (1959), if durability of resistance is desired. But if a reduced level of disease is the objective, a rather small number of component lines would be adequate.

11.12 Characteristics of a good multiline:-

- Its genetic diversity for vertical resistance genes for the concerned disease.
- The vertical resistance genes should be strong enough.
- It should have normal resistance to other diseases.
- Components of multiline should be uniform for agronomic and other features.
- It should have yield advantage.

11.13 Achievements:-

- In India KSML3 developed by mixing 8 isogenic lines.
- MLKS 11 by 8 isogenic lines.
- KML by 9 isogenic lines.