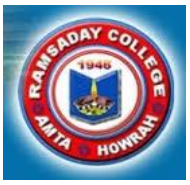


## Methods of Plant breeding


1. Mass selection:-

In mass selection, a large number of plant are selected with similar phenotype and their seeds are mixed together to constitute the new variety. The plants are selected on the basis of their appearance or phenotype Therefore , Selection is done for easily work character is like- Plant height, ear type, grain colour, grain size, disease resistance, tillering ability, loading resistance, shattering resistance sometimes yield of the plants may be used as a criterion of selection.

Application of mass selection:

1. Improvement of local varieties.
2. Purification of existing pure line varieties.

*Merits:

i) Since a large number of plants are selected, the adaptation of the original varieties is not change.

ii) Mass selection retains considerable genetic variability in the new variety.

*Demerits:

i) The varieties developed through mass selection show variation and are not as uniform as pureline varieties.

ii) The improvement of mass sely is generally less than that could be achieved through pure line selection.

2. Pure line selection:

A pure line is a progeny of a single, homozygous, self-pollinated plant. As a result all the individuals within a pureline have identical genotype, and any variation present within a pureline is solely due to the environment.In a seki pollinated species , all the plants in a population are expected to be homozygous because of continued self-fertilization. Thus progeny of a single plant isolated from a population of a self-pollinated crop would be a pureline.

In pureline selection a large number of plants are selected from a self-pollinated crops and are harvested individually, individual plant progeny from them are evaluated, and the best progeny is released as a pure line varieties.

**Application of pure line selection:**

1. Improvement of local varieties.

2. Improvement of old pureline varieties.

3. Selection for a new characteristic in a pureline.

***Merits:**

1. Pureline selection achives the maximum possible improvement over the original varieties.

2. Pureline varieties are extremely uniform since all the plants in the variety have been same genotype.

***Demerits:**

1. The procedure of pureline selection requires more time, space and more expensive yield trials than mass selection.

2. The upper limit of improvement is set by the genetic variation present in the original population.

**Comparison between pure line selection and mass selection**

| Pure line selection | Mass selection |
|---|---|
| **A. Procedure**<br>1. The plants are selected for their desirability of characters that may not be of similar phenotype.<br>2.The selected plants are subjected to progeny test.<br>3. The procedure is more effective as careful progeny test and yield trials are conducted.<br>4. Generally 9-10 years are required to develop a new variety.<br>5. This method is used in self pollinated crops only.<br>**B. Product**<br>6.The new variety is a pure line.<br>7. The new variety is highly uniform, genetic variation is very less.<br>8. Pure line variety is expected to have a narro- wer adaptation and lower stability in perfor- mance as there is less genetic variation.<br>9. The variety is easily identified in seed certification programmes.<br>**C. Quality of improvement**<br>10. The improvement of quality of the variety is generally the best which is present within the existing variety of the original population, i.e., this method brings about the best improve- ment over the original variety. | 1.The selected plants should be of similar phenotype as the seeds are mixed together<br>2. In normal mass selection progeny test is not performed.<br>3. As a large number of plants are selected, extensive yield trials are not necessary; less demanding process<br>4. Generally 5-7 years are required to develop a new variety.<br>5. This method is used in both self and cross crops pollinated crops.<br>6.The new variety is a mixture of pure lines.<br>7.The variety has genetic variation, so in gêneral appearance it is less unifom.<br>8. The variety has wider adaptation and greater stability than pure line varieties.<br>9. The variety is relatively more difficultto identify in seed certification programme.<br>10. The variety is inferior to the best pure line because most of the lines included within it will be inferior to the best pure line. |

(B) **Procedure of Back Cross Method of Breeding in Self Pollinated Crops**

The plan of back cross method depend upon whether the gene being transferred is recessive or dominant. The plan for transfer of a dominant gene is quite simple than for recessive gene.

**Transfer of Dominant Gene:**

Let us suppose that a high yielding and widely adopted variety 'a' is susceptible to stem rust (rr) and another variety b is poor yielding but resistant to stem rust (RR) i.e dominant to susceptibility. In this back cross programme rust resistance trait is transfer from donor parent into a recurrent parent.

1) **Hybridization:**

Variety 'A' is crossed with variety 'B' in which variety 'A' is used as female parent which is recurrent and variety 'B' is used as donor parent.

2) **F1 Generation:**

During the second year F1 plants are backcrossed to variety 'A' since all the F1 plants will be heterozygous for rust resistance. Selection for rust resistance is not necessary.

3) **First Back Cross Generation:**

In the third year half of the plant would be resistant and remaining half would be susceptible to stem rust, rust resistant plants are selected and backcross to variety 'A'.

4) **BC2 -BC6 Generation:**

In each backcross generation, segregation would occur for rust resistance. Rust resistant plant are selected and backcrossed to the variety A' selection for plant type of variety 'A' may be practised particularly in BC2 and BC3 generation.

5) **BC6 Generation:**

On an average the plant will have 98490 genes from variety A rust resistant plants are selected and selfed, their seeds are harvested separately.

6) **BC6 F2 Generation:**

Individual plant progenies are grown from the selected plants. Rust resistance once plant, which are sirmilar to variety 'A' are selected and selected plants are harvested separately.

7) **BC5 F3 Generation:**

Individual plant progenies are grown homozygous progenies resistant to rust and similar to piant type of variety 'A' harvested in bulk. Several similar progenies are mixed to constitute the new variety.

8) **Yield Test:**

The new variety is tested in R.Y.T i.e replicated yield trials along with the variety 'A' as a check.

Plant type dates of flowering date of maturity, quality, etc are critically evaluated. The new variety would be identical to variety 'A' in perfornance. Therefore detail yield test are not required, and the variety may be directly released for cultivation.

**Transfer of Recessive Gene:**

When rust resistant is due to a recessive gene, all the backcross cannot make one after other. After the first backcross and after every two backcrosses F2 must be grown to identity the rust resistant plants. The F1 and the back cross progenies are not inoculated with rust because they would be susceptible to rust. Only F2 is tested for rust resistant.

1) **Hybridization:**

The recurrent parent is crossed with rust resistant donor parent. The recurrent parent is generally used as female. i.e ( rr X RR).

2) **F1 Generation:**

F1 plants are backcrossed to the recurrent parent.

3) **BC1 Generation:**

If rust resistance is recessive all the plant will be rust susceptible. Therefore, there is no test for rust resistance. All the plants are self- pollinated.

4) **BC1 (F2) Generation:**

Rust resistance plants are selected and backcrossed with recurrent parent. i.e variety 'A'. Selection is made for the plant type and other characteristics of the variety 'A'.

5) **BC2 Generation:**

No rust resistance test, plants are selected, which is identical to the recurrent parent ( A) and backcrossed with the recurrent parent.

6) **BC3 Generation:**

No disease resistance test. The plants are self - pollinated to raise F2. selection is made for the plant type identical to variety 'A'.

7) **BC3 F2 Generation:**

Plants are inoculated with stem rust. Rust resistant plant, similar to 'A' are selected and backcrossed to variety 'A'.

8) **BC4 Generation:**

No rust resistance test plants are backcrossed to variety 'A'. 9) BC5 Generation:

No rust resistance test plants are self pollinated to raise F2 generation.

10) **BC5 (F2) Generation:**

Plants are subjected to rust epidemic, resistance plant for rust and having similar characteristic of variety. 'A' is selected and self seed are harvested separately.

11) **BC5 (F3):**

Individual plant progenies are grown and subjected to rust epiphytotic selection is done for rust resistance and for characteristics of variety 'A' seeds from several similar rust resistant homozygous progenies are mixed to constitute new variety.

12) **Yield Test:**

Same as in case of transfer of dominant gene.

(C) **Heterosis and Hybrid Vigour:**

Hybrid vigour has been used as a synonym of heterosis. It is generally agreed that hybrid vigour describes only the superiority of hybrids over their parents, while heterosis describes other situations as well. But a vast majority of the cases of heterosis are cases of superiority of hybrids over their parents. The few cases where F, hybrids are inferior to their parents may also be regarded as cases of hybrid vigour in the negative direction) For example, many F, hybrids in tomato are earlier than their parents. Earliness in many crops is agriculturally desirable. It may be argued that the earliness of F, hybrids exhibits a faster development in them so that their vegetative phase is replaced by the reproductive phase more quickly than in their parents.

Therefore, the use of heterosis and hybrid vigour as synonym seems to be reasonably justified.

(D**) Manifestations of Heterosis:**

Heierosis is the superiority of a hybrid over its parents. This superiority may be in yield, quality, disease and insect resistance, adaptability, general size or the size of specific parts, growth rate, enzyme activity, etc. These various manifestations of heterosis may be summarised as follows.

1. **Increased yield:**

Heterosis is generally expressed as an increase in the yield of hybrids. Commercially, this phenomenon is of the greatest importance since higher yields are the most important objective of plant breeding. The yield may be measured in terms of grain, fruit, seed, leaf, tubers or the whole plant.

2. **Increased Reproductive ability:**

The hybrids exhibiting heterosis show an increase in fertility or reproductive ability. This is often expressed as higher yield of seeds or fruits or other propagules, e.g. tuber in potato (S.

tuberosum), stem in sugarcane (S. officinarum), etc.

3. **Increase in Size and General Vigour:**

The hybrids are generally more vigorous, i.e. healthier and faşter growing and larger in size than their parents. The increase in size is usually a result of an increase in the number and size of cells in various plant parts. Some examples of increased size are increases in fruit size in tomato, head size in cabbage, cob size in maize, head size in jowar ete

4. **Better Quality:**

In many cases, hybrids show improved quality. This may or may not be accompanied by higher yields. For example, many hybrids in onion show better keeping quality, but not yield, than open-pollinated varieties.

5. **Earlier Flowering and Maturity:**

In many cases, hybrids are earlier in flowering and maturity than the parents. This may sometimes be associated with a lower total plant weight. But earliness is highly desirable in many situations, particularly in vegetables. Many tomato hybrids are earlier than their parents.

6. **Greater Resistance to Diseases and Pests:**

Some hybrids are known to exhibit a greater resistance to insects or diseases than their parents.

7. **Greater Adaptability:**

Hybrids are generally more adapted to environmental changes than inbreds. In general, the variance of hybrids is significantly smaller than that of inbreds. This shows that hybrids are more adapted to environmental variations than are inbreds. In fact, it is one of the physiological explanations offered for heterosis.

8. **Faster Growth Rate:**

In some cases, hybrids show a faster growth rate than their parents. But the total plant size of the hybrids may be comparable to that of parents. In such cases, a faster growth rate is not associated with a larger size.

9. **Increase in the Number of a Plant Part:**

In some cases, there is an increase in the number of nodes, leaves and other plant parts, but the total plant size may not be larger. Such hybrids are known in beans (P. vulgaris) and some other crops.

These are some of the characteristics for which heterosis is easily observed. Many other characters are also affected by heterosis, e.g. enzyme activities, cell division, vitamin content (vit. C content in tomato), other biochemical characteristics, etc., but they are not so readily

observable.

(E) **Male Sterility and its use in Plant Breeding :**

Male sterility in plants is often cytoplasmically hased and maternally inherited. Male sterility is the faliure of plants of produce functional anthers, pollens or male ametes but do produce viable eggs.

Cytoplasmic male sterility is total or partial male sterility in plants as a result of specific nuclear and mitochondrial interactions (Gomez-Camp, 1999)

1. **Background :** The first documentation of male sterility was by Joseph Gottlieb Kölreuter who observed anther abortion within specific hybrids. Cytoplasmic male sterility has now been identified in ISO plant species (Schnable and Wise, 1998). It is more prevalent than female sterility either because the male sporophyte and gametophyte are less protected from the environment than the ovule or embryo sac or because it results from natural selection on mitochondrial genes which are maternally inherited and are thus not concerned with pollen production. Male sterility is easy to detect because a large number of pollen grains are produced and are easily studied. Male sterility is assayed through staining techniques (carmine, lactophenol or iodine), where detection of female sterility is by the absence of seeds. Male sterile plants may be propagated, since they can still set seed., while female-sterile plants cannot. Male sterility can be arise spontaneously via mutations in nuclear and/or cytoplasmic genes. Male sterility can be either cytoplasmic or cytoplasmic-genetic. Cytoplasmic male sterility (CMS) is caused by the extranuclear genome (mitochondria or chloroplast) and shows maternal inheritance. Manifestation of male sterility in CMS may be controlled either entirely by cytoplasmic factors or by interaction between cytoplasmic and nuclear factors.

II. **Cytoplasmic Male Sterility (CMS):**

Cytoplasmic male sterility, as the name indicates is under extranuclear genetic control (under control of the mitochondrial or plasmid genomes). It shows non-Mendelian inheritance with male sterility inherited maternally. In general, there are two types of cytoplasm : N (normal) and aberrant S (sterile). cytoplasms. These types exhibit reciprocal differences.

III. **Cytoplasmic-Genetic Male Sterility :**

While cytoplasmic male sterility is controlled by an extranuclear genome, nuclear genes may have the capability to restore fertility. When nuclear restoration of feritility genes (RP is available for a CMS system in any crop, it is cytoplasmic-genetic male sterility. The sterility is manifested by the influence of the influence of both nuclear (with Mendelian inheritance) and cytoplasmic (maternally inberitedy genes. There are also restorers of fertility (Rf) genes

that are distinct from genetic male sterility. Thus plants with N cytoplasm are fertile and S cytoplasm with genotype Rf-leads to fertiles while S cytoplasm with rf rf produces or male-steriles. Another features of these systems is that Rf mutation (i.e. mutations of rf or no fertility restoration) are frequent, so that N cytoplasm with Rf rf is best for stable fertility. Cytoplasmic-genetic male sterility systems are widely exploited in crop plants for hybrid breeding due to the convenience of controlling sterility expression by manipulating the gene-cytoplasm combinations in any selected genotypes. Incorporation of these system for male sterility evades the need for emasculation in cross-pollinated species, thus encouraging cross breeding producing only hybrid seeds under the natural conditions.

IV. **Cytoplasmic Male Sterility in Hybrid Breeding:**

Hybrid production requires a female plant in which a plant no viable male gametes are borne. Emasculation is done to prevent a plant from producing pollens so that it serves only as femal plant. Another simple way to establish a female line for hybrid seed production is to identify or create lines that is unable to produce male pollen. Since this male-sterile line can not self pollinate, seed formation is dependent upon pollen from male line. Cytoplasmic male sterility is used in hybrid seed production. In this case, the sterility is transmitted only through the female and all progeny will be sterile. This is not a problem for crops such as onions or carrots where the commodity is transmitted from the F, generations is produced during vegetative growth.

These CMS lines must be maintained by repeated crossing to a sister line (known as the maintainer line) that is genetically identical expect that it possess normal cytoplasm and is therfore male fertile. In cytoplasmic-genetic male sterility restoration of fertility is done using restorer lines carrying nuclear genes. The male sterile line is maintained by crossing with a maintainer line carrying the same nuclear genome as the male sterile line but with normal fertile cytoplasm.

V**. Cytoplasmic Male Sterility in Hybrid Maize Breeding :** Cytoplasmic male sterility is an important part of hybrid maize production. The first commercial cytoplasmic male-sterile, discovered in Texus is known as CMS-T. The use of CMS-T, starting in the 1950s eliminated the use of detasseling, In the early 1970s, plants containing CMS-T genetics were susceptible to Southern corn leaf blight and suffered from widespread loss of yield, Since then CMS types C and S are used instead (Weider et al, 2009). Unfortunately these types are prone to environmentally induced fertility restoration and must be carefully monitored in the field. Environmentally induced, in contrast to genetic, restoration occurs when certain

environmental stimuli signal the plant to bypass sterility restoration and produce pollen anyway.

The systematic sequencing of new plant species in recent years has uncovered the existence of several novel Rf genes and their encoded proteins. A unified nomenclature for the Rf defines protein families across all plant species and facilitates comparative functional genomics. This nomenclature accommodates functional Rf genes and pseudogenes and offers the flexibility needed to incorporate additional Rfs as they become available in future (Kotchoni et al, 2010).