

Lecture: - 13

Population Improvement

- Cross pollinated crops are highly heterozygous and heterogeneous. Consequently, they show varying degrees of inbreeding depression. Therefore, inbreeding should be avoided or kept to a minimum in cross pollinated crops. Individual plants are heterozygous and their progeny would be heterogeneous and usually different from the parent, due to segregation and recombination. Therefore, desirable genes can be seldom fixed through selection in cross pollinated crops except for highly heritable qualitative characters.
- Hence, the breeder aims of increasing the frequency of desirable alleles in the population. In cross pollinated crops, the genotype of the individual plants is generally of little importance, especially in population improvement programmes but, the frequency of desirable alleles or genes in the population as a whole is more important.

The population improvement methods may be grouped into two general classes.

- **Selection without progeny testing** : Plants are selected on the basis of their phenotype, and no progeny test is carried out. e.g. : **Mass selection.**
- **Selection with progeny testing** : The Plants are initially selected on the basis of their phenotype, but the final selection of the plants that contribute to the next generation is based on progeny testing. The methods are e.g. : **A. Progeny selection or ear to row method, B. Line breeding and C. Recurrent selection**

13.1 Progeny selection:

This method was developed by Hopkins in 1908 and used extensively in maize. In its simplest form the ear-to-row method of selection is as follows:

- Number of plants (50-100) are selected on the basis of phenotypic superiority. They are allowed to open pollinate and the seed is harvested separately.
- Progeny rows are grown (each 10-50 plants) from the selected plants. They are evaluated for desirable characters and superior progenies are identified.
- From the superior progenies several superior plants are selected based on phenotypic characters. Plants are allowed to open pollinate. Plants are harvested separately.

- Small progeny rows are grown and the process of selection and raising progeny rows is repeated till superior population is obtained. May be for 2 or 3 selection cycles. At the end superior plants from superior families are selected and composited to produce a new variety.

Several modifications of ear to row method are available and many more may be developed to suit the needs of the breeder.

❖ **Modified ear to row method:-**

- **First year:** Plants selected on the basis of phenotype. Open pollinated seed from each plant harvested separately.
- **Second year:** Small progeny rows are grown and evaluated. The remaining seed from the plants producing superior progenies bulked to raise the next generation.
- **Third year:** The bulked seed of 2 year planted and allowed to open pollinate. Plants with superior phenotype selected and seed harvested separately. The selection cycle may be repeated one or more times.

Merits of progeny selection:

- Selection is based on progeny test and not phenotype as in mass selection. 3-8% improvement is possible per each selection cycle.
- Inbreeding is avoided by selection of large number of plants.
- Method is relatively simple and easy.

Demerits of progeny selection:

- No. control on pollination and thus selection is based on maternal parent only.
- Each selection cycle takes 2 years in many cases.

13.2 Line breeding:

- It is a variation of progeny selection in which one or several cycles of selection is carried out on the basis of progeny tests. At the end of the selection process i.e. in the last selection cycle, the superior lines or progenies are composited to produce a new variety.

- Hence, it is known as line breeding in contrast to progeny selection where superior plants from superior progenies are composited at the end. The merits and demerits are almost same in the case of progeny selection.

Achievements:

- Mass and progeny selections have been extensively used for the improvement of cross – pollinated crops.
- The early varieties of bajra were developed through mass selection; some of the examples are; Bajapur i, Jamnagar Giant, AF 3, S 530 and Pusa Moti; all these varieties were isolated from African introductions. Mass selection improved the yielding ability of toria by 30% and oil content by 56%; a further increase of 16% in yield was obtained by using mass- pedigree method.

Recurrent Selection

History: Breeding schemes similar to recurrent selection were first suggested in 1919 by Hayes and Garber and independently by East and Jones in 1920. Critical data were not given by the above scientist. First detailed description of this type of breeding method was published by Jenkins in 1940 as a result of his experiments with early testing for GCA in maize.

- The method acquired its name in 1945 when Hull suggested detailed scheme of recurrent selection for SCA, Hull (1952) defined recurrent selection as “Method which involves reselection generation after generation with interbreeding of selects to provide for genetic recombination”.
- The advantages of recurrent selections are
 - The rate of inbreeding can be kept at low level
 - The frequency of favourable genes in the population will be increased and so
 - The chance of obtaining satisfactory individuals from the population will be increased because greater opportunity for recombination is present.

There are four types of recurrent selections.

1. Simple recurrent selection:-

I year :	Several phenotypically superior plants are selected selfed. Harvested separately and evaluated. Seed of superior plants retained and the rest are discarded.	Original selection cycle
II year :	Individual plant progeny rows are raised. The progeny rows are intercrossed in all possible combinations. Equal amounts of seed from each cross is taken and mixed. This forms the source for next selection cycle.	
III year :	Seed obtained in II year is planted Number of superior plants selection and harvested separately. Seed evaluated. Seeds of cycle superior plants retained and the rest discarded.	First selection
IV year :	Progeny rows are raised. Inter crossed in all possible ways.	

	Equal amount of seed from each cross is composited. This mixed seed forms the source for next selection cycle.	
--	--	--

The procedure may be repeated for another one or two selection cycles. The effectiveness of the simple recurrent selection was published with data by Sprague and Brimhall (1950). This is useful for characters that can be measured on individual plants and having high heritability. The procedure is to be modified suitably for characters which cannot be measured on individual plants.

Recurrent selection for general combining ability:

- Recurrent selection for GCA was first suggested by Jenkins in 1935. In this method a tester with broad genetic base i.e. open pollinated variety or a synthetic or segregating generations is used for evaluating the lines for GCA.

Procedure:

- **I year:** Several phenotypically superior plants are selected from source population. Each selected plant is selfed as well as crossed to a tester with broad genetic base. The selfed seeds are harvested separately and saved for planting in the third year. The test crossed seeds also harvested separately.
- **II year:** A replicated yield trial is conducted using the test crossed seeds. At the end the superior progenies are identified.
- **III year:** Selfed seed (from the first year) of the plants that produced superior progenies on the basis of yield trial of second year is planted in separate progeny rows. These progenies are inter crossed in all possible combinations. Equal amount of seed from each intercross is composited to raise the source population for next selection cycle.
- **IV year:** Source population is raised from the composited seeds. Several phenotypically superior plants are selected. They are selfed and crossed to a tester (broad genetic base) selfed seed harvested separately and saved for planting in
- **V year:** Test crossed seed also harvested separately. Year : Repeat as in second year.
- **VI year:** Repeat as in third year. This completes the first selection cycle.

The second and third selection cycle may be initiated if necessary.

- May be used for improving the yielding ability of the population and the end product may be released as a synthetic variety or
- May be used for increasing the frequency of desirable genes in the population and the population may be used for isolating superior inbreds.

Recurrent selection for specific combining ability:

- The recurrent selection for SCA was first proposed by Hull in 1945. the objective is the isolate from a population such lines that will combine well with a given inbred useful for selecting lines for SCA.
- The procedure for recurrent selection for SCA is identical with that of recurrent selection for GCA, expect that the tester used here is an inbred (narrow genetic base)

Reciprocal recurrent selection:

- Reciprocal recurrent selection was first proposed by Comstock, Robinson and Harvey in 1949. This would be useful.
 1. For selecting both for SCA and GCA
 2. For improving two source population simultaneously.

Procedure:

- **I year:** Two source populations (A & B) are taken, several phenotypically superior plants are selected from each population. Each of the selected plant is selfed. Each of the selected plant from source A is crossed with random plants from B. Similar each of the selected plants are crossed with random plants of A. plants of a will act as tester for B. The selfed seed is harvested separately and saved for planting in III year. Top crossed seed from each plant is also harvested separately.
- **II year:** Two replicated yield trials are conducted, progeny rows of Test cross seeds of population A in one plot and test cross seeds of population B in another plot are raised. Plants (I year) producing superior progenies (in II year) are identified.
- **III year:** Selfed seed (saved in I year) from plants selected on the basis of evaluation of progeny rows (in the II year) is planted in plant to row progeny in two cross in g plots. Seeds of selected plants from population A in one plot and that of the B in another plot. All possible intercrosses among the progeny rows in each plot are made. Equal amount of seed from all intercrosses from the crossing plot A is mixed to raise the source population of 'A'

next year. Similarly equal amount of seed from inter crosses of plot B is mixed to raise source population B next year. This completes original selection cycle.

- **IV year:** Source populations of A & B are raised from composited seeds of A & B (III year). Operations of the first year i.e. selection of plants, selfing and crossing with the plants of other population etc. are done.
- **V year:** operations as in second year are repeated.
- **VI year:** Operations as in third year are repeated. This completes first selection cycle. The populations may be subjected to further selection cycles, if necessary by repeating the procedure outlined above.

Conclusion on the efficiency of different Recurrent selection Schemes:

- If dominance is incomplete
- Recurrent selection for GCA and reciprocal recurrent selection are equal but both are superior to recurrent selection for SCA.
- If dominance is complete the three methods are equal
- If over dominance is present
- Reciprocal recurrent selection and recurrent selection for SCA are equally effective both are superior to recurrent selection for GCA.