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7. Breeding Methods in Self-Pollinated Crops

Richa Panwar

Research Scholar,
Genetics & Plant Breeding,
SGT University,
Gurugram, Haryana.

Khushboo Chandra

Assistant Professor,
Plant Breeding & Genetics,
BAU, Sabour, Bihar.

Abstract:

Breeding is a crucial aspect of the agriculture industry as it helps to ensure a steady food supply for the world. Plant breeders can utilize breeding principles and advanced technologies in the field of agriculture to enhance crop yield and performance. Self-pollinated crops have shown successful outcomes through various breeding methods. The ultimate goal of a breeder is to develop new varieties that exhibit improved performance characteristics. This chapter will delve into the different breeding methods utilized in self-pollinated species.

Keywords:

Breeding, breeding methods, self-pollinated crops, yield.

7.1 Introduction:

Plant breeding is about the genetic improvement of crops by creating genetic variability and selecting elite genotypes from that variability for desirable traits. The breeding method aims to improve the genetic potential of the plant population and increase yield.

7.2 Breeding Methods in Self-Pollinated Crops:

7.2.1 Pedigree Method:

This method develops pure lines in self-pollinated crops and inbred lines in cross-pollinated crops. It is one of the most common methods used in plant breeding. The initial step is hybridization between the chosen homozygous parental lines, and segregating F2 populations are obtained by selfing the heterozygous F1s. Individual plants are selected from the F2 population and subsequent generations. Selected Progenies are tested and evaluated with repeated selection until the F6 or F7 generation progeny shows no segregation.

At this stage, when segregation stops, the homozygous progenies selected from the F6 generation are placed in multi-location yield trails in the F7 generation for further selection based on yield performance.

The record of the entire parent-to-offspring relationship is maintained, and this record is known as the pedigree record. The pedigree record is known as pedigree and helps provide information about the two individual plants that may share some allele in common if they are related by descent.

A. Procedure:

A. Hybridization - The desirable parents are crossed to produce a single or complex cross.
B. F1 generation – F1 seeds are space-planted to produce a higher yield.
C. 3 F2 generation – F2 seeds are space-planted to facilitate selection. Usually, 1-10 % selection intensity is practiced. When the objective is to breed for quantitative traits, a relatively more significant number of F2 plants would be selected. Selection in F2 is based on the traits that are inherited.
D. F3 – F5 generation – Individual plant progenies are space planted in F3 and F4 generation. Selection is practiced from within and between the progeny row. If two or more progenies from the same progeny row are similar, only one may be retained. In the F5 generation, variation within the progeny row vanishes, and the focus for the section should be between the progeny row.
E. F6 generation – Individually selected progenies in F5 are planted in multi-row for visual comparison among progeny rows. Superior progenies are bulk harvested as they have become homozygous. Progenies showing segregation are discarded unless the segregants are exceptional. In such a situation, an individual plant is selected.
F. F7 generation – PYT with three replications is conducted along with the standard check. Progenies concerning the check are assessed for plant height, disease resistance, flowering and maturity date, yield, and quality traits.
G. F8 – F10 generation – The superior lines are tested in replicated yield trials at several locations. These are evaluated for plant height, lodging and disease resistance, flowering and maturity date, yield, and quality traits. A line superior to the best commercial variety included in the trial as check-in yield and other traits is identified as a new variety.
H. F11 generation – when the strain is likely to be released as a variety, the breeder usually multiplies its seed during the last year in trial. The breeder is responsible for supplying the breeder seed to produce foundation seed. Thus, in F11 to F12, the seeds of the new variety will be multiplied for distribution to the farmers.

B. Merits of Pedigree Method:

- Provides maximum opportunity for the breeder to use his skill and judgment to select plants.
- Well-suited for characters that are inherited
- Transgressive segregants can be easily identified through records.
- Information about inheritance is precisely obtained.

C. Demerits

- Maintenance of pedigree records is time-consuming and limits the handling of the larger population.
- The success of this method mainly depends on the breeder's skill. There is no opportunity for natural selection
- Selection for yield in F2 and F3 is ineffective. Without care to maintain a larger population, valuable materials may be lost.

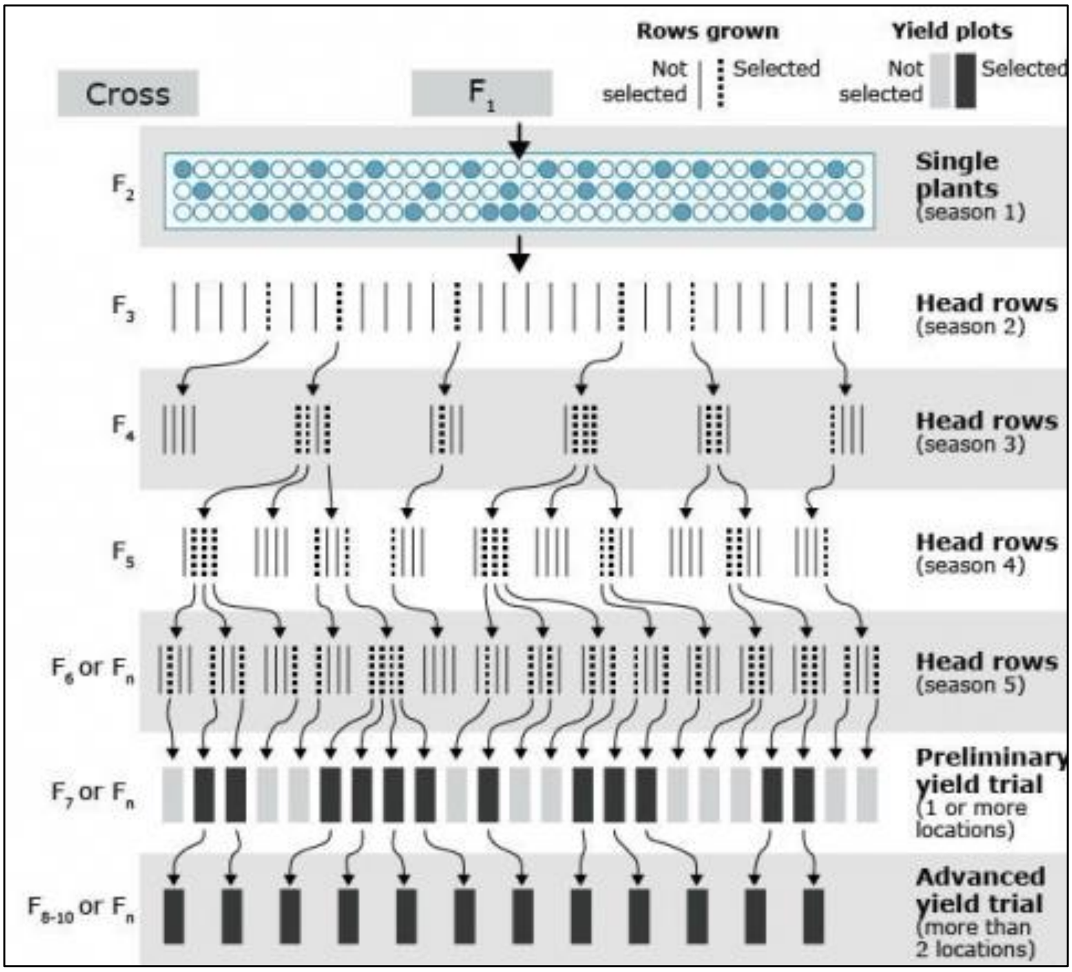

Figure 7.1: Pedigree Method

7.2.2 Bulk Method:

In this method, F2 generation and successive generations are harvested in bulk to grow the next generation. The duration of bulking may be 6 - 7 generations. Selection can be made in each generation, but harvest is done in bulk. This is similar to mass selection.

At the end of the bulking period, a single plant selection is made and tested for yielding ability. If the bulking period is extended, say 20 - 30 seasons, then natural selection acts on the homozygous lines. In this method, the breeder uses his skill for selecting the plants, and at the same time, there is no pedigree record. This saves much time and labor.

A. Merits of Bulk Method:

- Simple, convenient, and inexpensive
- Inducing artificial epiphytotic conditions, undesirable or weaker genotypes can be eliminated.
- If the bulking period is extended, natural selection operates, and desirable genotypes are selected.
- No pedigree record is maintained.
- Since a large population is growing, there is a chance for the appearance of transgressive segregants, which will be superior to parents or F2.

B. Demerits:

- It Takes a much longer time to develop a new variety.
- In short-term bulk, there is no chance for natural selection.
- Many progenies are to be selected in each generation, which requires much labor, time, and space.
- We cannot get information on inheritance.

7.2.3 Single Descent Method:

Single Seed-Descent Method It is the modification of the bulk method. In this method, a single seed from each of the F2 plants is collected and bulked to raise F3 generation. Similarly, a single seed from each F3 plant is organized and carried to F4. This procedure is followed till F6 or F7. Afterward, single plant selection is made and studied in progeny rows.

This Scheme's main features are:

A. Lack of selection till F6 or F7 when the population becomes homozygous.

B. Each F2 plant is represented till F6 or F7 generation.

C. In this method, there are chances for a reduction in population size due to pests, disease, or poor germination.

D. Rapid generation advancement (RGA) can be made using glass houses or off-season nurseries. Modified bulk method Here, selection can be practiced in F2 and F3 and subsequent generations. There will not be any pedigree record, but superior plants are selected, bulked, and carried forward. In F4, superior plants are selected and harvested on a single-plant basis.

In F5, these single plants are studied in progeny rows, and the best progenies are selected and harvested. In F6, PYT can be conducted to select the best families. In subsequent generations, regular trials can be conducted. This modification of the bulk method allows the breeder to exercise his skill and judgment in selection. Further, pedigree records are not maintained, which is another advantage. Mass pedigree method Harrington proposed this.

It is a solution to one of the deficiencies in the pedigree breeding method. For example, suppose the population is subjected to disease resistance screening like YMV, and there is no method to create artificial epiphytotic conditions.

In that case, studying the population using the pedigree method is wasteful. Instead, we can carry the population as a mass and test them when the disease occurs. When conditions favor the disease, we can terminate the bulking and resort to single plant selection.

Comparison Between Pedigree and Bulk Method:

Table 7.1: Comparison Between Pedigree and Bulk Method

Pedigree method	Bulk method
1. Individual plants are selected in F2, subsequent generations, and individual plant progenies are grown.	1. The F2 and the subsequent generations are maintained as bulks.
2. Artificial selection, artificial disease epidemics, etc., are integral to the method	2. 2. Artificial selection, artificial disease epiphytotic, etc., may be used to assist natural selection. In some instances, artificial selection may be essential.]
3. Natural selection does not play any role in the method	3. Natural selection determines the population's composition at the bulking period's end.
4. Pedigree records must be maintained, which is often time-consuming and laborious.	4. No pedigree record is maintained
5. Most widely used breeding method.	5. Used only to a limited extent
6. It demands close attention from the breeder from F2 onwards as individual plant selections must be made, and pedigree records must be maintained	6. It is simple, convenient, and inexpensive and does not require much attention from the breeder during bulking
7. The segregating generations are space planted to permit individual plant selection.	7. The bulk populations are generally planted at commercial planting rates.
8. The size of the population is usually smaller than that in the case of the bulk method.	8. Large populations are grown.

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