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# FACULTY OF AGRICULTURAL SCIENCES AND ALLIED INDUSTRIES

## Pure line selection, Johannson's pure line theory, Mass selection and genetic basis of selection.

Selection in Self-Pollinated Crops

To get successful results by selection there are two pre-requisites.

a) Variation must be present in the population.

b) The variation must be heritable.

**History of selection**

Selection was practiced by farmers from ancient times. During 16th century Van Mons in Belgium, Andrew knight in England and Cooper in USA practiced selection in crop plants and released many varieties. Le coutier, a farmer of island of New Jersey published his results on selection in wheat in the year 1843. He concluded that progenies from single plants were more uniform. During the same period Patrick Shireff, a scotsman practiced selection in wheat and oats and developed some valuable varieties.During 1857 Hallet in England practiced single plant selection in wheat, oats and barley and developed several commercial varieties.

About this time Vilmorin proposed individual plant selection based on progeny testing. This method successfully improved the sugar content in sugar beet. His method was called as vilmorin isolation principle. He emphasized that the real value of a plant can be known only by studying the progeny produced by it. This method was successful in sugar beet but not in wheat. This shows the in-effectiveness of selection in cross pollinated crops. Today progeny test is the basic step in every breeding method.

## Pureline theory:

A pure line is the progeny of a single self fertilized homozygous plant. The concept of pureline was proposed by Johannsen on the basis of his studies with beans (Phaseolus vulgaris) variety called Princess. He obtained the seeds from the market and observed that the lot consisted of a mixture of larger as well as smaller size seeds. Thus there was variation in seed size.

Johannsen selected seeds of different sizes and grown them individually. Progenies of larger seeds produced larger seeds and progenies from smaller seeds produced small seeds only. This clearly showed that there is variation in seed size in the commercial lot and it has a genetic basis. He studied nineteen lines al together. He concluded that the market lot of the beans is a mixture of purelines. He also concluded whatever variation observed with in a pureline is due to environment only. Confirmatory evidence was obtained in three ways. In line 13 which is having 450 mg seed wt he divided the seeds on weight basis. He divided the line into seeds having 200, 300, 400 and 500 mg weights and studied the progenies.

Ultimately he got lines having weight ranging from 458 to 475. Thus the variation observed is purely due to environment. The second evidence was that selection with in a pureline is ineffective.

From a pure line having 840 mg selection was made for large as well as small seeds. After six generations of selection the line for large seed as well as for small seed gave progenies having 680-690 mg. Thus it was proved that selection within a pureline is ineffective. In third evidence when parent - offspring regression was worked in line thirteen. It worked to zero indicating that variation observed is non heritable and it is due to environment only.

**Sources of variations in pure lines:**

1. Mechanical mixtures.
2. Natural hybridization.
3. Chromosomal aberrations.
4. Natural mutation or spontaneous mutation.
5. Environmental factors.

**Effect of self-pollination on genotype**

- Self-pollination increases homozygosity with a corresponding decrease in heterozygosity. For example an individual heterozygous for a single gene Aa is self pollinated in successive generations, every generation of selfing will reduce the frequency of heterozygote Aa to 50 percent of that in the previous generation. There is a corresponding increase in homozygotes AA and aa. As a result, after 10 generations of selfing virtually all the plant in the population will be homozygous AA and aa.
- This can be calculated by the formulae [2m - 1) / 2m ]" where m = No. of generations of self-pollination and n = No. of genes segregating. When number of genes are segregating together, each gene would become homozygous at the same rate as Aa. Thus the number of genes segregating does not affect the percentage of homozygosity.
- Similarly linkage between genes does not affect the percentage of homozygosity in the population. Genetic advance under selection Normally selection is practiced based on the phenotype of the individual plant. The phenotype in turn is the result of joint action of genotype and environment i.e.,

- VP=Vg +VE Where P= phenotype; G = genotype; E = Environment The genetic advance is calculated by the following formula.

- Genetic advance (GS) = (K) (H) (SD P) or GS = (K) (VP) ½ (Vg / Vp), Where GS is the genetic advance under selection, K is the selection differential, SD P is the phenotypic standard deviation of base population and H is the heritability of the character under selection. The estimates of GS have the same unit as that of the mean.

## Pureline Selection:

A large number of plants are selected from a self pollinated crop. The selected plants are harvested individually. The selected individual plants are grown in individual rows and evaluated and best progeny is selected, yield tested and released as a variety.

**Characteristics of purelines**

1. All plants within a pure line have the same genotype.
2. The variation with in a pureline is environmental and nonheritable.
3. Purelines become genetically variable with time due to natural hybridization, mutation and mechanical mixtures.

**General steps for making a pureline selection**

**First Season**: From the base population select best looking plants having the desirable characters. Harvest them on single plant basis.

**Second Season**: The selected single plants are grown in progeny rows and estimate the performance. Reject unwanted progenies.

**Third Season**: Repeat the process of second season.

**Fourth Season:** Grow the selected single plants in replicated preliminary yield trial along with suitable check or control variety.

**Fifth Season:** Conduct regular comparative yield trial along with check variety and select the best culture.

**Sixth Season**: Conduct multilocation trial in different research stations along with local check.

**Seventh Season**: Conduct Adaptive Research Trial in farmer's field. Fix the best yielder and release it as a variety thro' Variety Release committee.

**Advantage of pure line selection**

1. Achieves maximum possible improvement over the original variety.
2. Extremely uniform in appearance.
3. Because of the uniformity, a variety is easily identified and seed certification is easy.

**Disadvantages**

1. It does not have wide adaptability because improvement is made only in the local variety.
2. Time required for developing a variety is more when compared to mass selection.
3. Depending on the genetic variability present in the base population only the improvement is made. If there is no genetic variability improvement cannot be made.

4. Breeder has to spend more time compared to mass selection.

## Mass Selection

Here a large number of plants having similar phenotype are selected and their seeds are mixed together to constitute a new variety. Thus the population obtained-from selected plants will be more uniform than the original population. However they are genotypically different.

Steps

**First season**: From the base population select phenotypically similar plants, which may be 200 2000. Harvest the selected plants as a bulk.

**Second season**: The bulk seed is divided into smaller lots and grown in preliminary yield trial along with control variety. Dissimilar phenotypes are rejected. Higher yielding plots are selected.

**Third to Sixth Season**: With the selected lots conduct yield trials along with appropriate check or control. Select the best one and release it as a variety.

**Merits of Mass Selection**

1. Varieties developed will be having more adaptability since each plant is genotypicaly not similar. They have buffering action against abnormal environment.
2. Time taken for release of a variety is less.
3. The genetic variability present in the original population is maintained.

**Demerits**

1. Compared to pure line variety they may not be uniform.
2. In the absence of progeny test we are not sure whether the superiority of selected plant is due to environment or genotype.
3. May not be as uniform as that of a pureline variety and certification is difficult.

## Comparison between pure line and mass selections

**Pureline selection**

1. The new variety is a pureline
2. The new variety is highly uniform. In fact, the variation within a pureline variety is purely environmental.
3. The selected plants are subjected to progeny test.
4. The variety is generally the best pureline present in the original population. The pure line selection brings about the greatest improvement over the original variety.
5. Generally, a pure line variety is expected to have narrower adaptation and lower stability in performance than a mixture of pure lines.
6. The plants are selected for the desirability. It is not necessary they should have a similar phenotype.

7. It is more demanding because careful progeny tests and yield trials have to be conducted.

**Mass selection**

1. The new variety is a mixture of purelines.
2. The variety has genetic variation of quantitative characters, although it is relatively uniform in general appearance.
3. Progeny test is generally not carried out.
4. The variety is inferior to the best pureline because most of the purelines included in it will be inferior to the best pure line.
5. Usually the variety has a wider adaptation and greater stability than a pureline variety.
6. The selected plants have to be similar in phenotype since their seeds are mixed to make up the new variety.
7. If a large number of plants are selected, expensive yield trials are not necessary. Thus it is less demanding on the breeder.