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Upgraded New Era of Handling-Segregating Generations with Pedigree Method

Srikanth G. A., Basavaraj V.H., Rohan V.B., Nithin B.S. and Uttam G.
Assistant Professor, Department of Plant Physiology, Sampoorna International Institute of Agricultural Science and Horticultural Technology, Belekere, Channapatna, Karnataka

SUMMARY

The traditional methods of treating segregating populations, such as pedgree or bulk approaches, do not allow for gene reshuffling. A unfavourable connections discovered early in the segregating generation, such as in F2, are likely to remain across filial generations.

INTRODUCTION

In the pedigree method, individual plants are selected from F2 and subsequent generations, and their progenies are tested. During the entire operation a record of all parent off spring relationships is kept. This is known as pedigree record. Individual plant selection is continued till the progenies show no segregation. At this stage the selection is done among the progenies, multiplication tests are conducted and released as varieties.The pedigree may be defined as a description of the ancestors of an individual and it generally goes back to some distant ancestors. It is useful to know the relationship of two individuals and useful for selection of parents and prediction of outcome of the cross.

Procedure of pedigree method

1st year : cross is made between the parents possessing desirable characters.

2nd year : Sow the F1 seed giving wide spacing so that each F1 plant produces more seeds. Raise as many F1 plants as possible to produce large number of F2 seeds. Harvest in bulk.

3rd year : Grow 2000-10000 plants of F2 giving wide spacing for full expression of the characters in F2 generation plants. Grow parents for comparision. Depending upon the facilities and objectives of the programme about 100-500 superior plants are selected. The value of selection depend on the skill of the breeder. He has to judge which F2 plant will produce superior progeny for characters under consideration. The breeder develops this skill through close study of the crop for many generations. The selection in F2 is done for simply inherited characters like head type disease resistance etc. and selection for characters governed by many genes like yield will be reserved for later generations. The selected plants are harvested separately and given serial numbers and description entered in pedigree registers.

4th year : Progeny rows of F3 i.e. seeds of one selection plant in one row are space planted along with parents and checks. From superior progeny rows, individual plants with desirable characters are selected (about 50-100 families and about 5 plants in each family and harvested separately). Diseased, lodging and undersirable progenies are discarded.

5th year : F4 plants raised again as head to row. Desirable plants are selected from desirable rows and harvested separately.

6th year : F5 plants raised in 3 row plots i.e. seeds of each selected plant sown in 3 rows. By this time many families might have become reasonly homozygous. For comparision check variety is grown for every 3 or 5 block. Progenies are evaluated for yield and the inferior ones are rejected. The number should be reduced to 25-50. superior plants from superior progenies are selected. Plants from each progeny are bulked.

7th year : F6 individual plant progenies are grown in multi-row plots and evaluated. Inferior progenies are rejected and superior progenies are selected. Plants of each progeny are harvested in bulk. Diseased and inferior plants from the progenies are removed.

8th year : F7 preliminary yield trial with 3 or more replications ar conducted to identify superior lines. The progenies are evaluated for many characters including yield. Standard commercial varieties must be included as checks. Two to five outstanding lines are selected and advanced to coordinated yield trials.

9th, 10 th & 11th year : selected lines are tested in several localities for 2 or 3 years for adaptation tests. Lines are evaluated for all characters mainly yield and disease resistance. A line that is superior to commercial variety in yield and other characters is selected. 11th and

12th year : Selected superior lines is named, multiplied and released as a new variety. Number of year can be reduced if generations are advanced during off seasons either in green house or under irrigated conditions. Several modifications for the above described pedigree method are followed by breeders depending upon the crop, time and availability of funds and facilities like labour, land etc.

Early generation tests :

The objective of these test is to find out superior crosses and superior progenies in early generations i.e. in F2 and F3. we need not advance all the crossed and all selected progenies in each cross upto F8. much labour, time and cost would be saved by this early generation testing. A more reliable information about the potential crosses and progenies may be obtained by conducting replicated tests (preferably in more location) and evaluating them for yield and other characters in F2 or F3 itself. A desirable cross or progeny should have high mean yield, high genetic variance and high expected genetic advance under selection. Other crosses and progenies are rejected in the beginning i.e. F2 and F3 generations itself.

F2 progeny testing : Another modification for pedigree method. In F2 make as many single plants selections as possible. From F3 to F6 advance the progenies in bulk making selections of the progenies as a wholw and discarding the inferior progenies. Thus each of the progeny is derived from the single plant selected in F2 generation. In F6 make single plant selections in each of the progeny. Compare the yields of the single plants with progenies from which they are selected. Select superior single plant progenies and advance to preliminary yield trials, multilocation tests etc.

There are two advantages 1. No. of crosses can be handled simultaneously 2. Natural selection operates from F 3 to F6 since they are advanced in bulk.

Mass pedigree method :

This is another modified pedigree method. Crosses are made and further generations grown in bulk or as mass until suitable season occurs for making desirable selections against drought, insect and diseases etc. The population will be exposed to the natural conditions of vagaries. From the remaining population individual plants are selected and harvested progenies are evaluated for yield and other characters in preliminary yield trials and further generations are proceeded as in pedigree method till release of variety. The advantages of both bulk and pedigree methods can be obtained and large number of crosses can be handled at a time. The disadvantage is that it takes a bit longer time.

Merits of pedigree method :

- It gives maximum opportunity for the breeder to use his skill and judgement in selection of plants
- It is well suited for the improvement of characters which can be easily identified and are simply inherited.
- Transgressive segregation for yield and other quantitative characters may be recovered.
- Information about the inheritance of characters and pe digree of lines can be obtained.
- Inferior plants and progenies eliminated in early generations.
- It takes less time than bulk method to develop new variety are

.

Demerits of pedigree method :

- Valuable genotypes may be lost in early generations, if sufficient skill and knowledge are lacking in the breeder, at the time of selection.
- No opportunity for natural selection
- Difficult to handle many crosses
- Maintenance of records, selections, growing progeny rows etc are time consuming and laborious.

Achievements : Large number of varieties have been developed by pedigree method in many crops.
A few examples are
Wheat – NP-52, 120,125, 700 and 800 series
Rice – ADT – 25, Jaya, Padma
Cotton – Lakshmi, Digvijay, Sorghum – Co 18, RS 610 etc., Tobacco – NP 222
Sorghum – Co 18, Rs 610, Tobacco – NP 222

Population method of breeding-Bulk Method

The bulk method was first proposed by Nilsson Ehle in 1908 at Svalof. This method is also known as **mass method** ‘or’ **Population method of breeding**

- Isolation of Homozygus lines
- Waiting for the opportunity for selection
- Opportunity for natural selection.
- F2 and subsequent generations are harvested in mass as bulk to raise the next generation.
- At the end of the bulking period (after attaining homozygosity) individual plants are selected and evaluated similar manner as pedigree method of breeding.

The Procedure for Bulk Method

The exact procedure for the bulk method would vary depending upon the objective of breeder. The following procedure is described for the isolation of homozygous lines. The breeder may introduce various modifications in the scheme to suit his needs.

Hybridization : Parents are selected according to the objective of the breeding programme. A simple or a complex cross is then made depending upon the number of parents involved.

F1 Generation : F1 is space-planted and harvested in bulk. The number of F1 plants should be as large as possible ; usually more than 20 plants should be grown.

F2-F6 Generations : F2 to F6 generations are planted at commercial seed rates and spacings. These generations are harvested in bulk. During this period, environmental factors, disease and pest outbreaks would change, the frequencies of different genotypes in the population.

Artificial selection is generally not done. The population size should be as large as possible, preferably 30,000-50,000 plants in each generation.

F7 Generations : About 30-50 thousand plants are space-planted. 1000 to 5000 plants with superior phenotypes are selected and their seeds harvested separately. Selection is based on the phenotype of plants, grain characteristics, disease reaction, etc.

F8 Generation : Individual plant progenies are grown in single or multi-row plots. Most of the progenies would be reasonably homozygous and are harvested in bulk. Weak and inferior progenies are rejected on the basis of visual evaluation. Only 100-300 plant progenies with desirable characteristics are saved. Some progenies which

show segregation are generally rejected unless they are of great promise. In promising pr ogenies, individual plants may be selected ; preliminary yield trial will be delayed for one year in such cases.

F9 Generation : Preliminary yield trial is conducted by using standard commercial varieties as checks. The progenies which are superior than the check are advanced. Quality test may be conducted to further reject undesirable progenies. The progenies are evaluated for height, lodging resistance, maturity date, disease resistance and other important characteristics of the crop species.

F10-F13 Generations : Replicated yield trials are conducted over several locations using standard commercial varieties as checks. The lines are evaluated for important characteristics in addition to yield, disease resistance and quality. If a line is superior to the standard varieties in yield trials, it would be released as a new variety.

F14 Generation : Seed of the released variety is increased for distribution to the cultivators.

Merits of Bulk Method

- The bulk method is simple, convenient and less expensive.
- Since, each F2 plant is equally represented till F6, no chance of elimination of good genotypes in early generations.
- Artificial or natural disease epiphytics, winter killing high temperature etc. eliminates undesirable types and increases the frequency of desirable type. Thus isolation of desirable types becomes easier.
- Progenies select from long term bulks are superior than the selection from F2 or short
- term bulk.
- Since, little work and attention is needed in F2 and subsequent generation more no. of crosses can be handled.
- No pedigree records which saves time
- Since large population are grown, transgressive segregants are more likely to appear and increase due to natural selection. Hence, there is a greater chance to isolate good segregants than pedigree method.

Demerits oOf Bulk Method

- The major disadvantage of bulk method is that it takes a much longer time to develop a new variety. Natural selection becomes important only after F8 or F10, and bulking may have to be done upto F20 or more. Thus the time required is considerably longer, and most breeders do not use the bulk method simply for this reason.
- In short-term bulks, natural selection has little effect on the genetic composition of populations. But short - term bulks are useful for the isolation of homozygous lines and for specific objectives as in Harlan’s mass - pedigree method.
- It provides little opportunity for the breeder to exercise his skill or judgement in selection. But in the modified bulk method, the breeder has ample opportunity for practicing selection in the early segregating generations.
- A large number of progenies have to be selected at the end of the bulking period.
- Information on the inheritance of characters cannot be obtained which is often available from the pedigree method.
- In some cases, at least, natural selection may act against the agronomically desirable types.

Much improvement in crop plants could not be done through this method reason being.

- Long time required for Natural Selector
- Lack of opportunity for the breeder to use his skills
- Lack of facilities to raise large population

Handing of segregation populations: Backcross method

Aim: To know about how to handle segregating population of backcross method

Backcross method

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.

Requirements of a backcross 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 intense 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.
- Recoveries of the recurrent genotype in a reasonable number of back cross generations.

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 (B) into a recurrent parent (A).

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 practiced 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 similar 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 plant 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 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 performance. 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 dominant gene transfer.

CONCLUSION

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.

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