Experiment: Handing of segregation populations: Pedigree method

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

Mass selection and pure line selection cannot be applied to segregating population E.g. F_2, F_3 etc. because in these methods selection made from the existing variability present in the population. However, when there is limited genetic variability in a species than hybridization acts as an important tool to create additional genetic variability for further improvement of the species. The methods generally used for handling of segregation generation may be grouped into following three categories.

a) Pedigree Method
b) Bulk Method and
c) Back Cross Method

The objectives of all these methods are to

1. Develop pureline
2. Develop new varieties.
3. Develop inbred line
4. Improve specific character of a well-adapted variety for which it is deficient.

Pedigree method

In pedigree method, individual plants are selected from F_2 and the subsequent generation and their progenies are tested. During the entire operation, a record of the entire parent's offspring relationship is kept, is known as pedigree record. The selection of individual plant is continued till the progenies show no segregation. At this stage, selection is done among the progenies, because there would be no genetic variation within progenies.

Pedigree record

The pedigree may be defined as a description of the ancestors of an individual and it generally goes back to some distant ancestors. Thus, it describes the parents grandparents, great grandparents so on of an individual.

Maintenance of pedigree record

Pedigree record may be kept in several ways, but it should be simple and accurate. Generally, each cross is given a number. The first two digits of this number refer to the year in which the cross was made, and the remaining digits denote the serial number of the cross in that year. For example, the number 7911, denotes the cross number 11 of the year 79. In the segregating generation one of the two systems of designation may be followed.

i) System I

In this system, the individual plant progenies in each generation are assigned row number, corresponding to their location in the plot. In addition each progeny in F_4 and the subsequent generation is assigned the row number of the progeny in the previous generation from which it was derived.

Table 9.1: Description of maintenance of pedigree record by System I

Generation	Number	Description
F_3	7911-7	Progeny in the 7th row in the F_3 plot.
F_4	7911-7-4	Progeny in the 4th row in the F_4 plot, selected from the progeny in the 7th row of the F_3 plot.
F_5	7911-4-14	Progeny in the 14th row in the F_5 plot selected from the progeny in the 4th row of the F_4 plot.
F_6	7911-14-3	Progeny in the 3rd row in the F_6 plot selected from the progeny in the 14th row of the F_5 plot.

ii) System-II

In this system, in each generation the selected plants are assigned serial numbers within individual progenies. Each progeny or selected plant bear the serial number of all the plants in the previous generation, related to it by direct descent. Thus, the plants selected in F_2 are given serial numbers of their parents (F_2 plants). The plants selected from a progeny in F_3 are given the number of that progeny and in each generation the selected plant also given a serial number.

Table 9.2: Description of maintenance of pedigree record by System II

Generation	Number	Description
F_3	7911-7	Progeny obtained from plant number 7 selected in F_2
F_4	7911-7-4	Progeny from plant No.4 selected from F_3 progeny , derived from the plant No.7 selected in F_2
F_5	7911-7-4-2	Progeny from plant No.2 selected from the F4 progeny derived from plant no.4 , selected from the F_3 progeny, obtained from the plant No.7 selected in F_2.
F_6	7911-7-4-2-8	Progeny from plant No 8, selected from the F_5 progeny, derived from the plant N0.2 selected from the F_4 progeny of the plant No.4 selected from F_3 progeny of the Plant No.7 selected in F_2.

Procedure for pedigree method

1. Hybridization

Selection of parents to be used in a cross is the most important step in breeding program based on hybridization. The selected parents are crossed to produce a simple or a complex cross. For convenience we shall refer to the seed obtained from the width simple/complex crosses as F1 seed.

2. F_1 Generation

F1 seeds are space planted so that each F_1 plant produces the maximum number of F_2 seed ordinarily, 15-30 F_1 plants should produce enough seeds for a good F_2 population size.

3. F_2 Generation

In F_2, 2000-10000 plants are space-planted to facilitate selection. About 100-500 plants are selected & their seeds are harvested separately. Usually the F_2 population size should be 10-100 times the member of F_2 plants that would be selected in the number may vary from 100-500 depending on the facilities available and objectives of the breeding program. When the objective of breeding is to improve yield, a relatively large no of F_2 plants would be selected. Selection in F_2 is based on characteristics that are simply inherited, e.g. plant height, head type, seed colour, disease resistance, presence of awns etc. Selection of vigour is generally useless because vigour may be due to heterozygosis or environment or G×E interaction.

4. F_3 Generation

Medical plant progenies having 30 or more plants each are space-planted. Medicinal plants with desirable characteristics are selected, particularly from superior progenies may also be selected. Diseased and lodging susceptible progenies are eliminated. The no of plants selected in F_3 should preferably be less than that at the F_3 progenies. If the no of superior progenies is small, the whole cross may be rejected.

5. F_4 Generation

Individual plant progenies are space planted and desirable plants are selected mainly from superior progenies. The no of plants selected in F_4 is generally much smaller than that in F_3 progenies with defect and undesirable characteristics are rejected. If two or more progenies coming from the same F3 progeny are similar and comparable, only on selection of desirable plants from superior progenies.

6. F_5 Generation

Individual plant progenies are generally planted according to the recommended commercial seed rate. Often there are more rows grown for each progeny to facilitate compression among many progenies would have in bulk. In progenies showing segregation, individual plants may be selected. The no of progenies meant be reduced to a size manageable in preliminary yield trials about 25-100 progenies.

7. F_7 Generation

Individual plants are planted in multi row plots and evaluated visually; progenies are harvested than bulk since they would have become almost homozygous. Progeny showing outstanding, in such progenies individual plants may be selected, preliminary yields trait is usually planted in F_6 for those progenies, which are reasonably homozygous and have enough seed, inferior progenies are eliminated based on yield from preliminary yield trial.

8. F_8-F_{10} Generation

The superior lines are tested in replicated yield trails at several locations. These lines are evaluated for yield diseases and lodging resistance, maturity time and quality etc. A line that is superior to the test commercial variety, included in the trials as check. Yield & other characteristics will be identified for release as a new variety.

9. F_{11} Generation

When a strain is likely to be released as a variety, the breeder usually multiplied its seed during its last year in trail. The breeders have responsibility to supply the breeder seed for production of foundation seed. Thus F_{11} to F_{12} the seed of the new variety will be multiplied for distribution to the farmer.

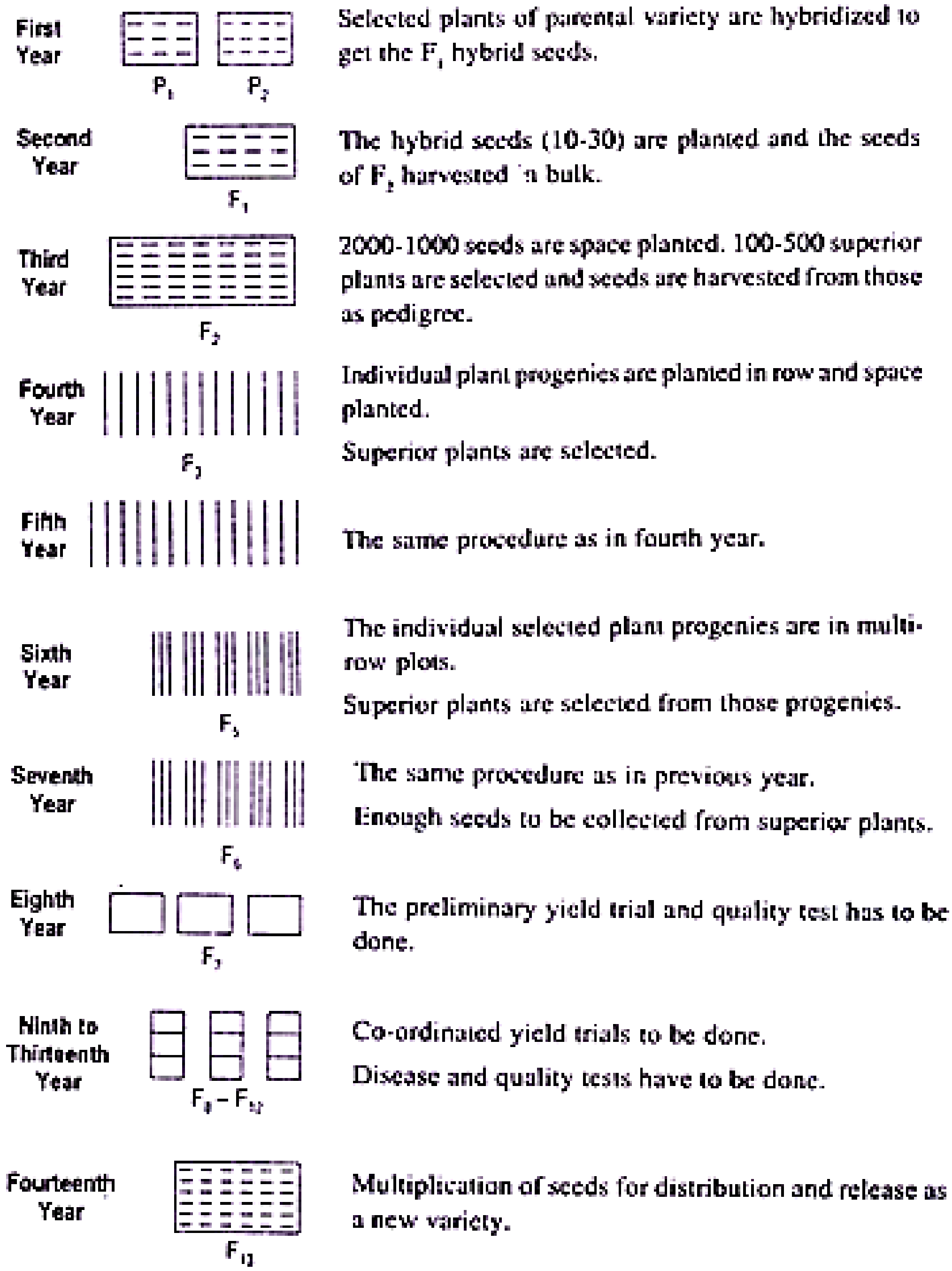

Fig.9.1: Breeding procedure of pedigree method

Application of Pedigree Method:

1) Selection of desirable plants from the segregating population in self- pollinated crops.
2) This method is commonly used to correct some specific weaknesses of an established variety (Combination breeding).
3) It is also used in the selection of new superior recombinant type's i.e. Transgressive breeding.
4) This method is suitable for improving specific characteristics such as disease resistant, plant height, maturity etc.

Experiment: Handing of segregation populations: Bulk method

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

Bulk population method

Bulk population method of breeding in self –pollinated crop is also known as mass method or population method of breeding. It was first used by Nilsson Ehle in 1908. It refers to a species is grown in bulk plot (from F1 to F5) with or without selection, a part of the bulk seed is used to grow the next generation and individual plant selection is practised in F6 or later generation. In this method duration of bulking may vary from 6-7 to 30 generation.

Procedure of Bulk Population Method:

1) Hybridization:

Parents are selected according to the objective of the breeding programmer and crossed.

2) F_1 Generation

The F_1 generation (10 to 25 F_1) is space planted and harvested in bulk.

3) F_2-F_6 – Generation

F_2 to F_6 generations are planted at commercial seed rate and spacing. These generations are harvested in bulk. During these generations the population size should be as possible, preferably 30 to 50 thousand plants should be grown in each generation.

4) F_7 Generation

About 30 to 50 thousand plants are space planted and out of this only 1000 to 5000 plants with superior phenotypes are selected and their seeds harvested separately. Selection is made on the basis of phenotypes of plants, grain characteristics etc.

5) F_8 Generation

Individual plant progenies are grown in single or multi row plots. Most of the progenies would be homozygous and are harvested in bulk. Weak and inferior progenies are rejected and only 100- 300 individual plant progenies with desirable characters are selected.

6) F_9 Generation

Preliminary yield trial is conducted along with standard variety as check. The evaluation of progeny is done for important desirable characteristics. Quality test may be conducted to reject the undesirable progenies.

7) F_{10}- F_{12} Generation

Replicated yield trails are conducted at several locations using standard commercial varieties as check. The lines are evaluated for important agronomic characteristics. If lines are superior to the standard check than it is released as new variety.

8) F_{13} Generation

Seed multiplication of the newly released variety has done for distribution to the farmers.

Application of Bulk Population Method

This method is suitable and most convenient for handling the segregating generation of cereals, smaller millet, grain legume and oilseeds. This may be used for three different purposes.

1) Isolation of homozygous lines.
2) Waiting for the opportunity of selection.
3) Opportunity for natural selection to change the composition of the population.

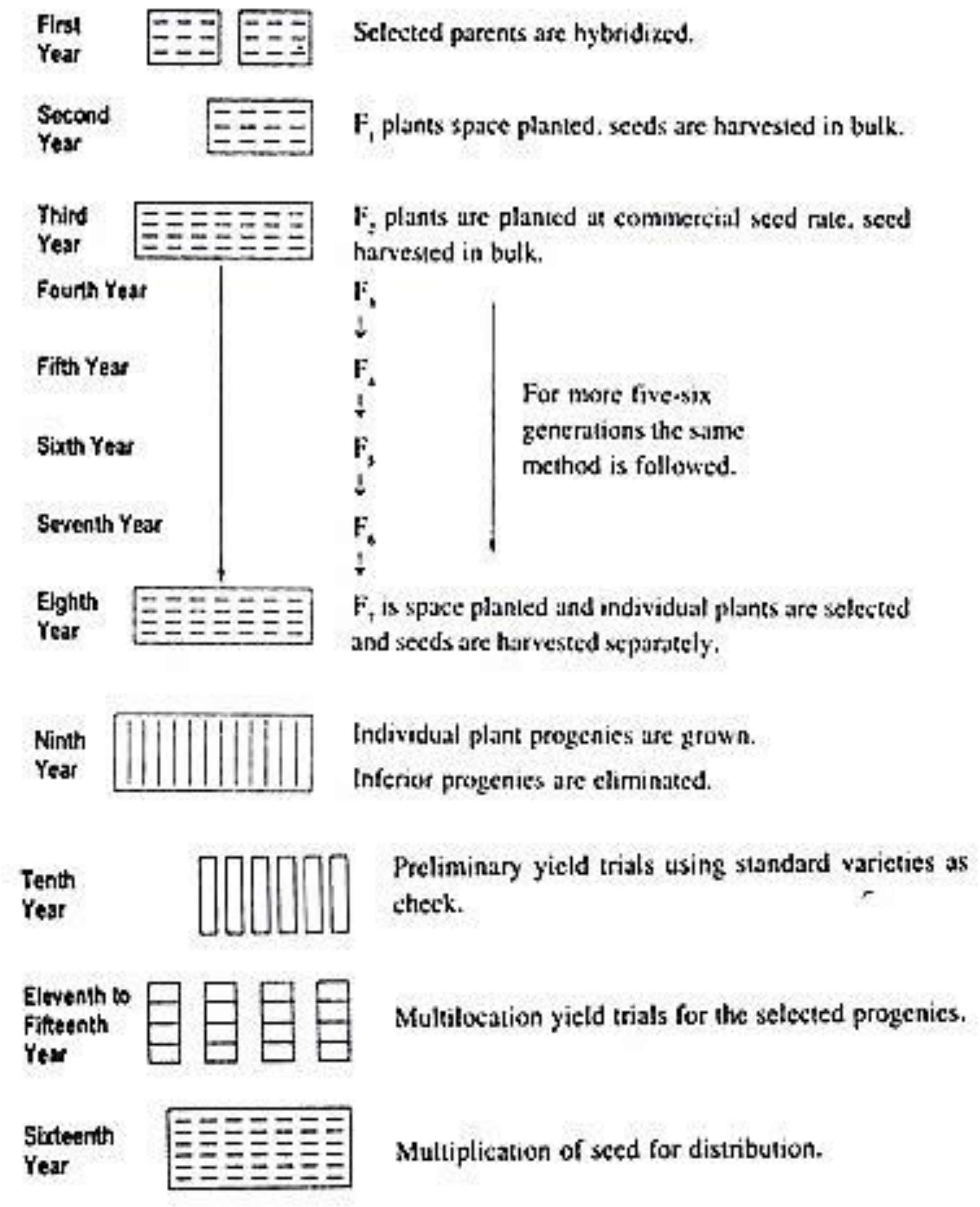

Fig.10.1: Breeding procedure of bulk population method

Experiment: 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

1. Existence of a good recurrent parent variety which requires improvement is some qualitatively inherited character or a quantitative character with high heritability.
2. A suitable donor parent must be available possessing the character or characters to be transferred in a highly intense form.
3. High expressivity of the character under transfer through several back crosses in the genetic back ground of the recurrent parent.
4. The character to be transferred must have high heritability preferably determined by one or few genes.
5. Simple testing technique for detecting the presence of the character under transfer.
6. Recoveries of the recurrent genotype in a reasonable number of back cross generations.

I. 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.

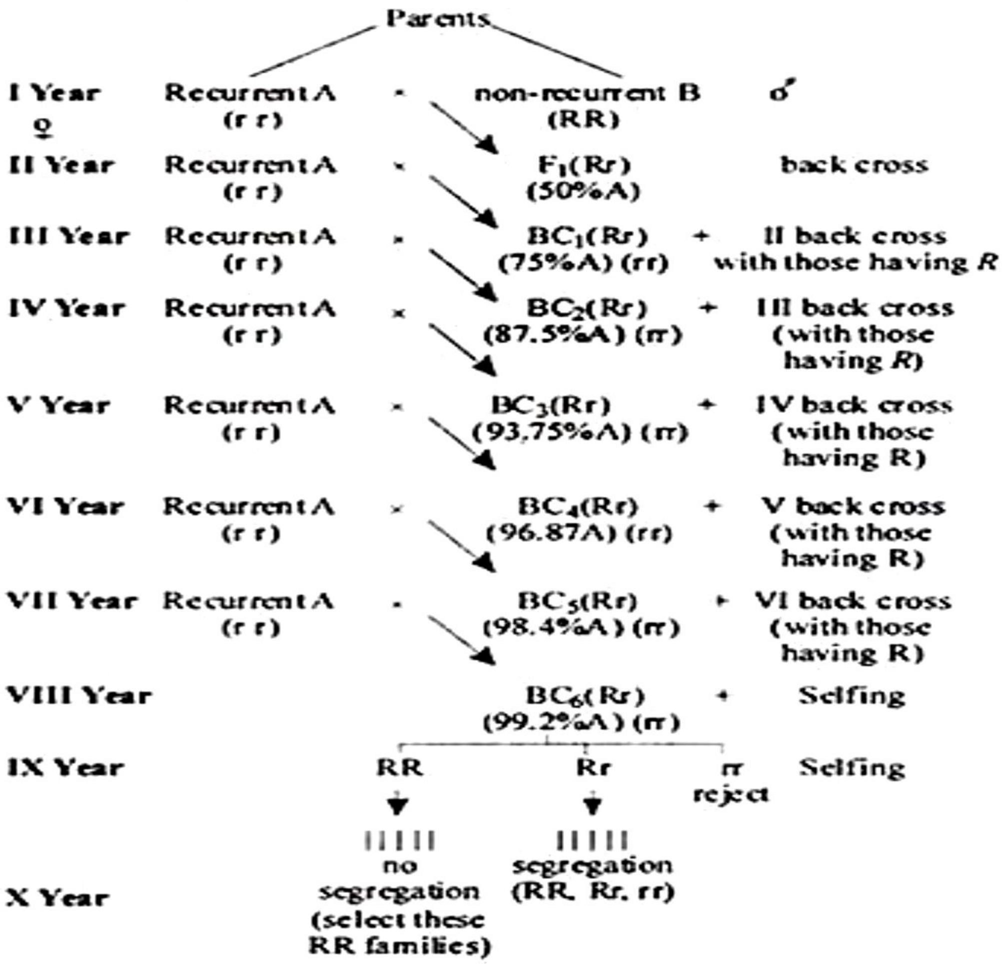

Fig. 11.1: Different steps involved in the back cross method when a dominant trait is transferred from variety B to an otherwise improved variety A

II. 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 F_2 must be grown to identity the rust resistant plants. The F_1 and the back cross progenies are not inoculated with rust because they would be susceptible to rust. Only F_2 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.

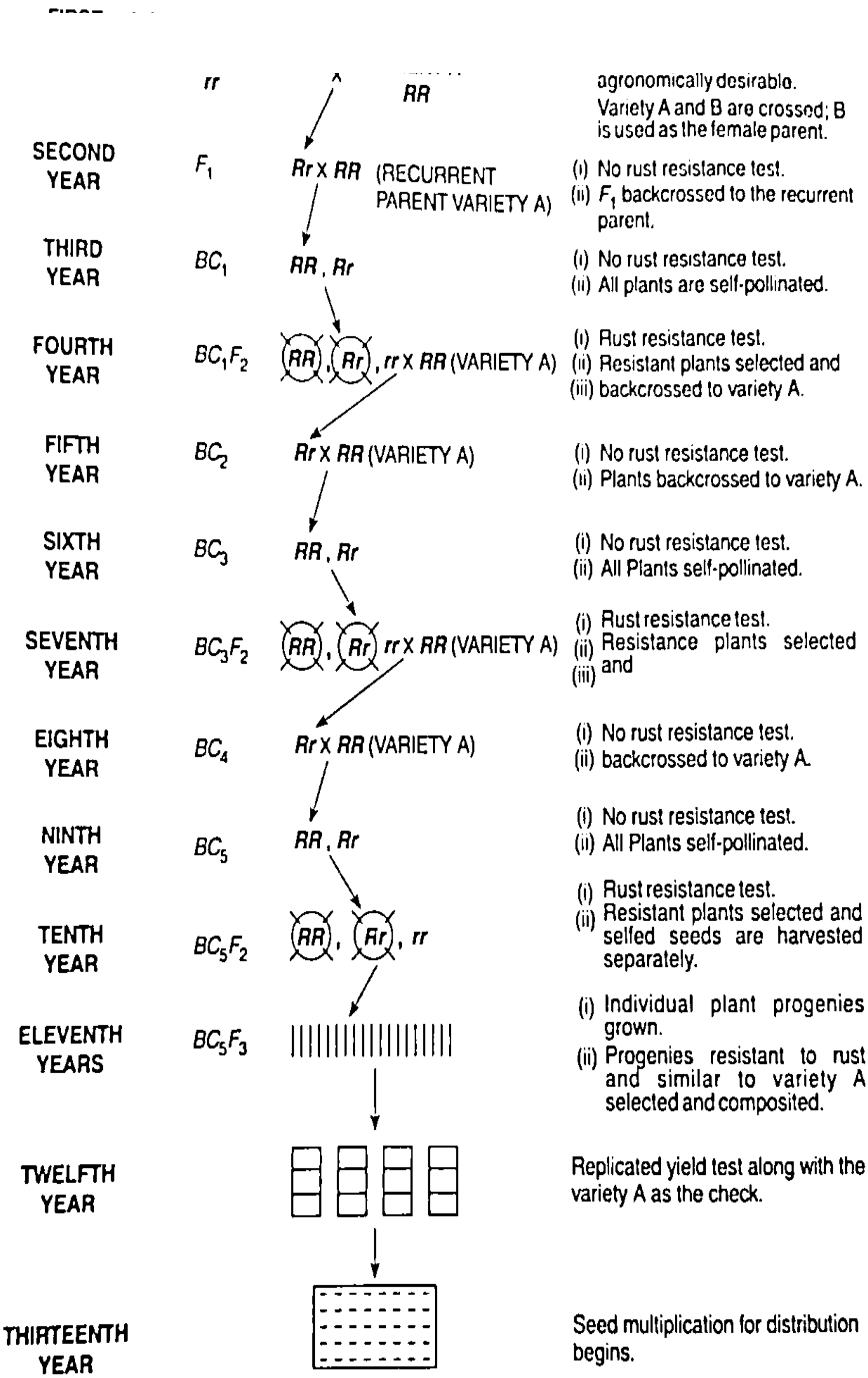

Fig. 11.2: A generalised scheme for the transfer a recessive gene for disease resistant (here rust resistance) through the backcross method in a self-pollinated crop.