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FACULTY OF AGRICULTURAL SCIENCES AND ALLIED INDUSTRIES

Aims, objectives, types of hybridization and clonal selection

Objective of hybridization

The chief objective of hybridization is to create variation. When two genotypically different plants are crossed, the genes from both the parents are brought together in Fl. Segregation and recombination produce many new gene combinations in F2 and subsequent generations. The degree of variation produced depends on the number of heterozygous genes in Fl. The number of heterozygous genes in F1 in turn depends on number of genes for which the two parents differ. If the parents are not related they may differ for several genes.

Combination breeding

The main aim of combination breeding is the transfer of one or more characters into a single variety from other varieties. These characters may be governed by oligogenes or polygenes. In this approach, increase in yield is obtained by correcting the weaknesses in the yield contributing traits like tiller number, grains per panicle, seed weight of the concerned variety. Example for combination breeding is disease resistance achieved by backcross breeding. Pedigree method is also another example.

Transgressive breeding

Transgressive segregation is the production of plants in F2 generation that are superior to both the parents for one or more characters. Such plants are produced by the accumulation of favourable genes from both the parents as a consequence of recombination. In this case the parents involved in hybridization must combine well with each other and preferably be genetically diverse. This way, each parent expected to contribute different plus genes which when brought together by recombination gives rise to transgresive segregation. The pedigree method as well as population approach are designed to produce transgresive segregants.

Procedure of hybridization

1. Set up your objective.
2. Selection of parents.
3. Evaluation of parents.
4. Sowing plan.
s. Emasculation and dusting.
6. Labelling and bagging.
7. Harvesting and storage of seeds.

1. **Objective:** Based on the requirement, set your objective. Because based on the objective only the selection of parents is done. If it is resistance breeding one of the parents must be a donor.

2**. Selection of parents** : Normal practice is, the female parent will be a locally adapted one in which we can bring in the plus genes. In case of intervarietal hybridization geographically diverse parents will be selected so as to get superior segregants.

3. **Evaluation of parents:** In case of parents which are new to the region they must be evaluated for their adaptability. Further to ensure homozygosity, they must be evaluated.

4. **Sowing plan**: If the flowering duration is same, simultaneous sowing of both the parents can be done. Otherwise staggered sowing is to be followed. The normal practice is to raise the ovule parent in the centre of the plot in rows and on the border pollen parent for each combination.

5. **Emasculation and dusting**: Emasculation is the removal of immature anthers from a bisexual flower. Depending on the crop the emasculation practice differs. Normal practice of hand emasculation and dusting of pollen is done. Depending on the time of anthesis the time of emasculation differs. For E.g. in rice the anthesis at Coimbatore takes place between 7.00 to 10.00 A.M. So the emasculation is done at around 6.30 A.M. and dusting of pollen is done immediately.

6**. Labelling and bagging**: Immediately after hybridization put a label indicating the parents and date of crossing. Put appropriate cover to prevent foreign pollen, contamination.

7. **Harvesting and storage of seeds:** Normally 15-20 days after crossing the seeds will be set. In the case of pulses the crossed pods can be easily identified by the shrunken nature of pod and seed set will be reduced. Harvest of crossed seeds must be done on individual plant basis. Seeds collected from individual plants are to be stored in appropriate containers with proper label and stored.

Distant Hybridization

When crosses are made between two different species or between two different genera, they are generally termed as distant hybridization (or) wide hybridization History Thomas Fairchild 1717 was the first man to do distant hybridization. He produced an hybrid between two species of Dianthus Dianthus caryophyllus (Carnation) x D. barbatus (Sweet william) Inter generic hybrid produced by Karpechenko, a Russian Scientist in 1928. Raphano brassica is the amphidiploid from a cross between Radish (Raphanus sativus) and cabbage (Brassica oleraceae). Triticale was produced by Rimpau in 1890 itself. Triticale is an amphidiploid obtained from cross between wheat and rye. Another example is Saccharum nobilisation involving three species.

Hybrids in self-pollinated crops - problems and prospects

Exploitation of heterosis through F I hybrids has hitherto been the prerogative of cross-pollinated crops, chiefly due to their breeding systems favouring allogamy. However, possibilities of working for such a proposition have recently been realized in self-pollinated corps also. Indeed, exploitation of hybrid vigour in autogamous crops is easy and less time consuming in that homozygous inbreds are already available. There is practically no difference with regard to hybrid breeding between self and cross-pollinated crops. But the prospects of hybrids in seIfers depends on three major considerations.

1. How high a heterotic effect can be gained under optimal production conditions.
2. In fact, a breeder's main concern is the magnitude rather than the frequency of occurrence of heterosis in crops. Thus the consideration is whether or not it is possible to obtain economically viable heterosis.
3. How much of the yield surplus due to high heterosis can offset the extra seed cost? In major self-pollinated crops like wheat, barley, rice, etc., the seed rate per unit area is exorbitant and hence the hybrid seed requirement is also more.
4. How efficient and effective is the mechanism of cross-pollination in seIfers? By nature, self-pollinated crops are shy pollinators with very poor pollen maneuverability (or movability to effect allogamy). Therefore, the efficiency (degree of allogamy) with which cross pollination can take place on a commercial scale is the true determinant of the success of a hybrid programme in seIfers.
5. Among self-pollinated crops, FI hybrids have been graduated into the farmer's field in barely, tomato, Sorghum (often-cross-pollinated) and wheat. Briggle (1963) presented a vivid account of heterosis in wheat. Work in rice is also most encouraging (IRRI, 1972).

Breeding Procedure for Hybridization (Clonal Selection)

Clonal crops are generally improved by crossing two or more desirable clones, followed by by selection in the F1 progeny and in the subsequent clonal generations. Once the F1 has been produced, the breeding procedure is essentially the same as clonal selection. The improvement through hybridization involves the following three steps:

1. Selection of parents,
2. Production of F1 progeny, and
3. Selection of superior cones.

Hybridization can be used only in such crops, which can reproduce sexually. In case of those crops where sexual reproduction is lacking, mutagenesis or biotechnological approaches can be applied.

Selection of Parents: Selection of the parents to be used in hybridization is very important since the value of F1 progeny would depend upon the parents used for producing the F1. Parents are generally selected on the basis of their known performance both as varieties and as parents in hybridization programmes. The performance of a strain in hybridization programmes depends on its prepotency and general combining ability. It would be highly desirable to know the relative values of CGA and SCA in the crop to be improved. If GCA is more important, a small number of parents with good should be used in hybridization programmes. On the other hand, when SCA is more important, a large number of parents should be used to produce a large number of F1 families, an effort to find some outstanding crosses.

A recent suggestion is to partially inbreed the parents to be used in hybridization programmes. Clonal crops show severe inbreeding depression, but it is expected that one generation of selfing or 2-3 generations of sib-mating may not reduce vigour and fertility too severely. Inbreeding may enable the breeder to identify plants that would have a greater concentration of desirable alleles. These plants may be more prepotent as parents than the highly heterozygous clones. The practice is gaining some favour with plant breeders.

Production of F1 progeny: Generally, clonal crops are cross-pollinated and they may show self-incompatibility. The selected parents may be used to produce single crosses involving two parents or an equivalent of a polycross involving more than two parents.

Selection among FI Families: When the breeding value of parents is not known, and the relative contributions of GCA and SCA is not available, a large number of crosses have to be made in order to ensure that at least some of the crosses would produce outstanding progeny in F,. This is particularly true in a species where crop improvement has not been done or has been done at a small scale. In such cases, it would be cumbersome to evaluate a large number of F, progeny is detail. To avoid this, generally small samples of several F, populations are grown. The general worth of individual F, populations is estimated visually. The presence of outstanding individuals in the F, populations is also noted, and inferior F1's are eliminated. Promising F1's with outstanding individuals are then grown at a much larger scale for selection. The procedure is designed to save time, space and labor by planting only small populations of a large number of crosses at the preliminary stage.

Selection within FI Families: The selection procedure within FJ populations is essentially the same as that in the case of clonal selection.

The various steps involved in the breeding of clonal crops through hybridization are briefly described below:

First Year: Clones to be used as parents are grown and crosses are made to produce F1 progeny.

Second Year: Sexual progeny from the cross, i.e., seedlings obtained from seeds, are grown. Undesirable plants are eliminated. Few hundred t9 few thousand desirable plants are selected.

Third Year: Clones from the selected individual plants are grown separately. Poor and inferior clones are eliminated. Up to 200 superior clones may be selected for preliminary yield trial.

Fourth Year: A replicated preliminary yield trial is conducted in which suitable checks are included for comparison. Few outstanding clones are selected for trials at several locations.

Fifth to seventh year: Replicated yield trials are conducted at several locations. Suitable checks are included for comparison. One or a few outstanding clones are identified and released as new varieties.

Eighth year: The clones released as varieties are multiplied and distributed among farmers.