Pre-Breeding and Its Importance in Crop Improvement Program

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Prebreeding – Effective Use of Plant Genetic Resources

Pre-breeding refers to the transfer of beneficial alleles from unused germplasm into elite breeding materials and the term "pre-breeding' was first used by Rick (1984). The other names for pre-breeding are genetic enhancement or developmental breeding. Pre breeding is very much needed

i) To meet food production demands, cultivars can be developed through utilizing elite breeding materials which is possible only through pre-breeding.

ii) Currently cultivating improved cultivars are becoming increasingly similar to each other cultivars due to commonness of parents. The required skills of the pre breeder includes identify the useful traits in unadapted germplasm and introduce the traits into elite breeding materials.

Usefulness of Germplasm in Pre-Breeding

Germplasm plays a vital role in improving crop cultivars utilizing the useful traits. Traits focussed in major food crops includes

- Broadening the genetic base
- Improving the level of resistance to biotic and abiotic stresses
- Improving the yield and grain quality traits
- Improving the biomass yield
- Developing short duration varieties

Use of exotic lines: The exotic lines defined as lines that do not have an immediate usefulness without selection for adaptation. Generally, the direct use of exotic lines limits the breeding activities in the breeding programmes:

i) More possibility for the introduction inferior alleles

ii) Negatively affect adaptedness and

iii) Linkage of undesirable genes with desirable traits (linkage drag).

Uses of Gene pool: The term gene pool concept was proposed by Harlan and deWet, 1971. The gene pool consists of all genes and their alleles of an individual. The gene pool is categorized into the three groups and was further expanded through genetic engineering.

- **Primary gene pool:** This includes both cultivated as well wild relative of the crop. Crossing among members of the group is possible to produce normal seed set, segregation and recombination through normal plant breeding methods.
- **Secondary gene pool:** The cross between primary gene pool and secondary gene pool produce partially sterile hybrids due to meiotic irregularities.
- **Tertiary gene pool:** Hybrids between the gene pools produce completely sterile. These crossability barriers could be overcome by specialized techniques such as embryo rescue, tissue culture, chromosome doubling and bridging species.
- **Quaternary gene pool:** The other name for quaternary gene pool as gene-ocean. Genes can be transferred not only from the species or genera of the organism but from the different organism through recombinant DNA technology.

Methods of pre breeding

Pre breeding can be successful with two approaches like introgression and incorporation. Introgression refers to transfer of one or more genes from unadapted germplasm (donor parent) to adopted elite breeding materials (recurrent parent). This can be achieved through repeated backcrossing and the introgression through back cross concept proposed by Dr Edger Anderson. The recombination frequency between the parents can be maximized by three ways of backcross methodologies:

Repeated backcross: This method involves repeated backcrossing (usually six) of the cross made between recurrent and donor parent with the recurrent parent with or without selection.

Inbred backcross: This method was originally proposed by Wehrhahn and Allard, 1965. This method involves limited number of backcrosses (usually three) followed by several generation of selfing.

Congruity backcross: In this method, backcrossing is done with both donor and recurrent parent in alternative generations. This method was proposed by Haghighi and Ascher, 1988.

There are several other conventional breeding methods to enhance the genetic potential of the unadapted germplasm.

Convergent Improvement: This method involves the resultant single cross hybrid backcrossing with both the parents independently. This was originally proposed by Richey (1927).

Development of Composites/Synthetics: In this method, crossing will be made among diverse group of germplasms/parents and create highly heterogeneous stocks with broad genetic base which serve as reservoir for the trait of interest.

Decentralized Breeding: The term "decentralized selection" was first used by Simmonds, 1984. This method mainly involves selection at the target site or environment.

Participatory Plant Breeding: This method of breeding involves both farmers and breeders, and interaction among them to improve locally adapted germplasm. The outline for this method was given by Witcombe et al., 1996.

Limitations of pre breeding

- Require longer time (5 to 10 years more)
- Accessibility and exchange of germplasm is difficult due to intellectual property rights (IPR)
- New types of production practices emerge
- Cross incompatibility through wide hybridization
- Linkage drag
- Low levels of recombination in the hybrids
- Evolve new pest or disease problems
- Needs establish new market demands
- Climate shock problems.

Achievements in crop plants

Pre breeding activities have been practised in several crops to enhance crop production. The few successful examples are given below

1) Hierarchical Open-ended Population Enrichment (HOPE) System
2) Recurrent Introgressive Population Enrichment (RIPE)
3) Latin American Maize Programme (LAMP).