Crop improvement through pre-breeding | RASHTRIYA KRISHI | Volume 12 | Issue 1 | June, 2017 | 29-30
e ISSN–2321–7987 | ●●● Article ●●● |Visit us : *www.researchjournal.co.in*|

Crop improvement through pre-breeding technologies

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ABSTRACT

Pre-breeding includes basic research to achieve wide crosses, and activities that facilitate the use of exotic materials or wild relatives. Pre-breeding consists of identifying a useful character, capturing its genetic diversity and putting those genes into usable form. Pre-breeding activities degined to transferring resistance gene(s) to major diseases and insects, and tolerance to abiotic stresses, from wild relatives into cultivated through using introgression and incorporation techniques.Pre-breeding aims to provide breeders ready to use materials with specific traits of interest as well as a means to broaden the diversity of improved germplasm. It does not differ significantly from general framework of plant breeding and is considered as prior step of sustainable plant breeding.

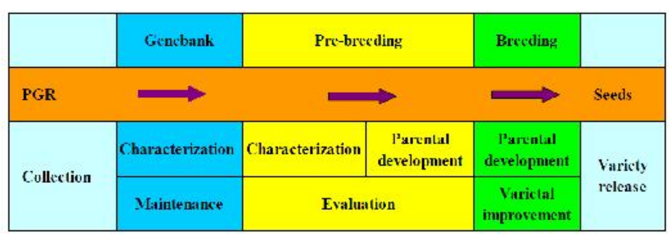
Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from un-adapted PGR and transfer them to an intermediate product that breeder can manipulate to any kind of selection for improvement.The Global Crop Diversity Trust defined pre-breeding as 'the art of identifying desired traits, and incorporation of these into modern breeding materials'.As pre-breeding is being carried out, the resulting materials are expected to have merit to be included in ordinary breeding programs. Pre-breeding aims to reduce genetic uniformity in crops through the use of a wider pool of genetic material to increase yield, resistance to pests and diseases, and other quality traits. It aims at base broadening or genetic enhancement which is achieved by either identification of genes that control traits of interest or moving these genes from un-adapted to adapted background. It also play an important role through genetically improving the yield performance, enhancement of agronomic, physiological and biotic stress tolerance in the germplasm.

Why pre-breeding is important : Pre-breeding programmes can generate new base populations for breeding programmes and also assist in identifying heterotic patterns for hybrid programmes. Lack of pre-breeding programmes is the most limiting factor for using landrace germplasms and un-adapted exotic lines from collections. It will also help in value addition of different genotypes through genetic enhancement In improving the level of resistance to biotic and abiotic stress. In improving quality characters such as fibre length, strength, fineness, maturity and uniformity.e.g., cotton. In developing early maturing genotypes, which can fit well in multiple cropping systems. Use of germplasm will help in broadening the genetic base of cultivars as well as in creating vast genetic variability.

Major approaches:

Introgression : It is transfer of one or more genes from exotic/un-adapted / wild stock to adapted breeding populations. This is achieved by making crosses between the donor and the recurrent parent. The concept of introgression through backcross was evolved by Dr. Edgar Anderson and in cotton it was first visualized by Knight (1945).

Incorporation: Incorporation refers to a large scale programme aiming to develop locally adapted population using exotic / un-adapted germplasm.



The following are the genetic principles of incorporation.

– Use of material covering wide range of variability

– Use of un-adapted introduced material

– The process is complementary to conventional breeding

– The breeding methods will depend on the biology of the crop, its breeding system and reproduction behavior

– Maximizing recombination through cyclic or recurrent crossing.

– Testing for adaptability under diverse agroclimatic conditions

– Local genetic adaptation - horizontal resistance (HR) to disease.

– The outcome of an effective base-broadening programme will be enhanced genetic variance in economic characters and either good materials *per se* or good parents for crossing into established programmes.

Other breeding approaches: They are: (i) convergent improvement, (ii) modified convergent improvement, (iii) decentralized breeding, and (iv) participatory plant breeding (v) Use of biotechnology in genetic enhancement through Marker-Assisted Selection, Somatic Hybridization and Doubled Haploids etc.

Successful examples :

Latin American Maize Project (LAMP): LAMP is a real example of pre-breeding program, which includes 12 countries (Argentina, Bolivia, Brazil, Colombia, Chile, U.S., Guatemala, Mexico, Paraguay, Peru, Uruguay and Venezuela). LAMP evaluated 15,000 accessions in the first stage, with close cooperation of the public and private sectors. Pioneer Hi-Bred International Company was decisive for the financial support of the project. The great genetic variability in Latin American maize is recognized, although there is much to be known, especially its potential and its significance for breeding approaches. Thus, maize breeders now have access to the most promising stocks identified by LAMP to expand the genetic base in maize.

Hierarchical Open ended Population Enrichment (HOPE) System: This system was first used by Kennenberg (1970) in maize. The main objectives of the HOPE system are: To provide a source of inbred lines that are genetically very different from those currently used in commercial breeding programmes, and the HOPE inbreds must be comparable in performance with current commercial inbreds both in *per se* performance and in hybrid combinations.

Recurrent Introgressive Population Enrichment (RIPE): RIPE was first adopted in 1990 by D.E. Falk in barley involving male sterile facilitated recurrent selection. The system consisted of one set of three hierarchical levels which like corn HOPE, was open-ended in that germplasm could move upward through the hierarchy and introductions could be added at the low level. However, the system was redesigned to intensify introgression at successive levels.

There are several problems that are associated with genetic enhancement programmes particularly when genes are introgressed from wild species. Some problems are listed below:

– Cross incompatibility in inter-specific crosses.

– Stability barriers and chromosome pairing in hybrids have restricted the access to genes from wild species into cultivated ones.

– Linkage drag.

– Hybrid inviability and sterility.

– Small sample size of inter-specific hybrid population.

– Restricted genetic recombination in the hybrid population.

– Lack of availability of donors for specific traits *viz.*, resistance to diseases and Insect and pests

– Exchange and accessibility of cultivated species germplasm material has become difficult due to legal restrictions like IPR.

Received : *20.01.2017* ***Revised :*** *13.04.2017* ***Accepted :*** *27.04.2017*