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Pre-Breeding: Utilizing Crop Wild Relatives

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SUMMARY

Pre-breeding is most promising alternative to link genetic resources and breeding programmes, include activities related to identification of desirable genes from wild and weedy relatives, other unadapted materials and transfer these traits to an intermediate set of materials for further use in producing new varieties for farmers. Process focused to enhance genetic variability in the germplasm and to improved germplasm can be readily used in regular breeding programme for cultivar development. It 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. Pre-breeding should focus on the continuous supply of useful variability into the breeding pipeline to develop new high-yielding cultivars with a broad genetic base.

INTRODUCTION

Plant breeding is an art and science of improving plants genetically for the benefit of humankind. Plant breeding is devoted to develop or improve crop cultivars with economic benefits for small-scale and commercial farmers. The modern cultivation practices of uniform high yielding varieties (HYVs) had reduced crop genetic diversity and led the exposure of crop plants to disease and insect pest epidemics. To counter these effects, plant breeder need to make deliberate efforts to diversify the gene pools of their crop to reduce genetic vulnerability. Crop wild relatives (CWR) possess high level of genetic diversity that enabled them to survive in natural and adverse environments. The narrow genetic base of cultivars coupled with low utilization of genetic resources is the major factor limiting production and productivity globally. To exploit this genetic diversity pre-breeding offers a unique opportunity by introgression of desirable genes from wild germplasm into cultivated backgrounds readily used with minimum linkage drag.

What is pre-breeding?

Pre-Breeding is defined as transferring of useful genes from exotics or wild (unadapted sources) types into agronomical acceptable background / breeding material. Further, the Global Crop Diversity Trust defined pre-breeding as 'the art of identifying desired traits, and incorporation of these into modern breeding materials. It is a necessary first step in the "linking genetic variability to utilization" use of diversity arising from wild relatives and other unimproved materials. These activities are a collaboration between the germplasm curator and the plant breeder who need to work together to understand the scope and value of germplasm collections and how new traits from these collections can be bred into new varieties.

Why Pre-breeding is required?

Progress in breeding is limited from perceived lack of diversity:

- Current limited genetic base of agriculture today is apparent a threat to food security.
- Reduction of Biodiversity: genetically uniform modern varieties are replacing the highly diverse local cultivars and landraces in traditional agro-ecosystems.
- Genetic uniformity: Increases genetic vulnerability for pests and diseases.
- The effects of climate change: search for new genes/traits for better adaptation.
- Evolving pest and pathogen populations: motivating plant breeders to look for new sources of resistance in gene banks.

Activities Involved in Pre-breeding

1.Characterization of Germplasm

Characterization is the description of plant germplasm. It determines the expression of highly heritable characters ranging from morphological or agronomical features to seed proteins or molecular markers.
Value of Characterization in pre-breeding

- Adequate characterization of gene bank accessions is needed to facilitate the utilization of germplasm by end users
- Genetic diversity assessment of the variation among gene bank accessions is the main aim of germplasm characterization
- Systematic description of each accession should

–lead to classification in small and well organized groups
–will facilitate their enhanced utilization in pre-breeding

2.Creation of novel traits

Induced genetic variations have been used successfully in several crops to create useful mutants. The novel mutational events can either be directly developed as essentially derived varieties or novel genes introgressed into candidate parents through a backcross program.

3.Creation of new parent population

The success of a crop breeding program relies on choice of the best parents possessing complementary and desired traits. Thus, breeders continuously select potential parent populations from diverse sources including land races, modern cultivars, obsolete or primitive cultivars, wild or semi-wild species. Parents with high specific or general combining abilities are selected *via* progeny testing through well-designed recombination.

4.Creation of polyploid

Individuals with altered chromosome set (euploids) are developed by doubling the number of genome of a species or by crossing unrelated species followed by chromosome doubling of the inter-specific hybrid. Polyploids can be artificially induced by various means such as exposing plant materials to environmental shock (e.g. low or high temperature treatment, x-ray irradiation) or with chemicals (e.g. colchicine) that disrupt normal chromosome division.

5.Introgression of new traits from other useful sources, exotic germplasm or a land race or related species

The plant breeder transfers one or more desirable traits from unrelated, exotic or semi-exotic, landrace or related germplasm into an intermediate variety with good agronomic potential but lacking a specific trait. Thus, the new variety will be developed with the introduced novel gene(s) in the existing genetic background.

Methods of using crop wild relatives in crop improvement:

A. Classical approaches

1) Introgression: Also known as introgressive hybridization, in genetics is the movement of a gene (gene flow) from one species into the gene pool of another by the repeated backcrossing of an interspecific hybrid with one of its parent species.
2) Incorporation: Broadening of genetic base refers to a large scale programme aiming to develop locally adapted population using exotic / un-adapted germplasm. The objective of incorporation is to produce new breeding populations that have very high proportions of unique, exotic-derived alleles in order to broaden substantially the crop's genetic base
3) Wide crosses: synthesis of new base populations. A cross of two individuals belonging to different species or different genera is known as wide cross. Wide crosses usually employed to widen the gene pool of a crop practically, most often used to transfer genes for resistance to biotic/abiotic stress.

B.Modern approaches

The utility of molecular markers and genomic tools/techniques in the context of using PGR for crop improvement includes: (1) Diversity assessment (2) Somatic Hybridization (3) Anther culture (4) Embryo rescue (5)Marker assisted breeding (6) Mapping of quantitative trait loci (QTL) (7) Introgression libraries, association studies and (8) Genetic transformation.

Application of Pre-Breeding

1) Broadening the genetic base, to reduce vulnerability
2) Identifying traits in exotic materials and moving those genes into material more readily accessed by breeders
3) Moving genes from wild species into breeding populations when this appears to be the most effective strategy
4) Identification and transfer of novel genes from unrelated species using genetic transformation techniques.

Future Prospects

1) There is need for collection, characterization and documentation of wild species, including crop wild relatives, due to increased likelihood of extinction for narrowly adapted and endemic species. There is an increased demand for novel genes in germplasm/ genebanks collections for adapting agriculture to biotic and abiotic stresses, including the need of effective screening of germplasm for different characters like, quality traits and biofortification
2) The potential of genetic transformation technique could be exploited to transfer the desired gene(s) form the tertiary gene pool and/or beyond.
3) New breeding strategies and bioinformatics tools are required to use the information gathered from genetic and genome analysis programs for dealing with complex traits more effectively.

CONCLUSION

1.Genetic resource is a gold mine and we have to make substantial long term investment for exploiting its full potential
2.Without an intelligent and judicious use of PGR it will be difficult to achieve sustainable advances in agricultural production
3.Pre-breeding is an essential part of germplasm diversification strategies. It is the most promising alternative to link genetic resources and breeding programmes.
4.By exercising the pre-breeding procedure in crop improvement programme, the genetic vulnerability due to uniformity can be avoided in the population.

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