Editorial Article

Conventional and Modern Plant Breeding Methods for Development of New Varieties/Hybrids

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Abstract

Plant breeding is an art, science and technology in which we can change genetic makeup of the in plants for human mankind. For improvement in plants different breeding methods can be used. On the basis of mode of pollination and propagation different breeding methods were developed. The continuous application of traditional breeding methods in a different species could lead to the narrowing of the gene pool from which cultivars are drawn, rendering crops vulnerable to biotic and abiotic stresses and hampering future progress. Several modern breeding methods are available for development of high yield varieties. At present development of hybrid varieties is a future need to increase production and feed growing population. Genetic engineering, mutation breeding and polyploidy have significant potential to improve crops.

Keywords: breeding method, yield, mutation, transgenic plant

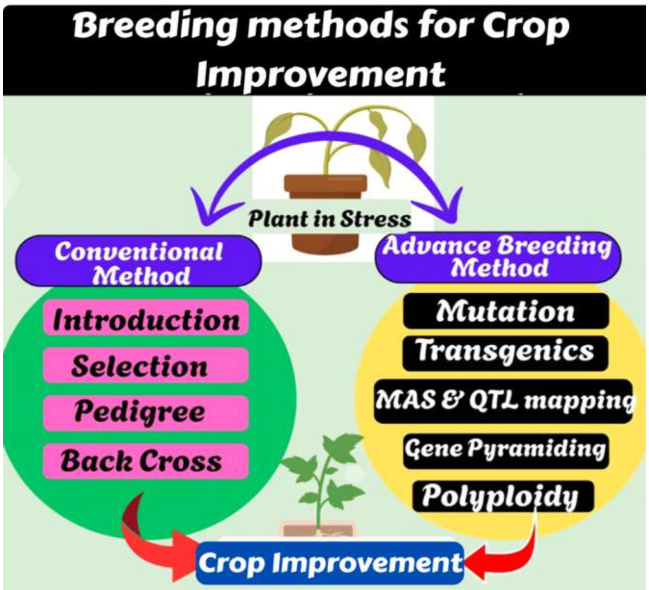
Introduction

The genetic improvement of crops can play a critical role in mitigating climate change and enhancing productivity in crops [(1)]. World has immense pressure for food production, due to increasing global population and developing countries playing an important role for minimizing food pressure by increasing area and production[(2)]. Climate change is a most important factor for low productivity in crops, genetic improvement in genotypes plays a critical role in mitigating climate change and enhancing agricultural systems. For genetic improvement and development of traits in plants modern breeding methods needs to be implemented. Before development of any variety, breeder requires to set their breeding objectives to improve according to future needs and environmental challenges.

Breeding strategies for development of New Varieties / Hybrids

Selection of desirable genotypes and use in breeding methods to get good genetic recombination or hybrid. In plant breeding two types of methods can be used for genetic improvement *i.e.* conventional and advance breeding method. Conventional breeding methods are mass selection, pure line selection, pedigree method, bulk selection, Single Seed Decent method, back cross method etc., whereas modern breeding method are mutation, polyploidy, transgenic, MAS & QTL mapping and gene pyramiding. Pedigree method is a commonly using breeding method in crops for development of new varieties. (Figure 1)

Figure 1: Breeding Methods for Crop Improvement



The core of plant breeding is the selection of better types among variants, in terms of yield and quality of edible parts; ease of cultivation, harvest, and processing; tolerance to environmental stresses; and resistance against pests. Each of these aspects of agronomic or food value can be dissected in many specific traits, each presenting its own range of variation[3].

1. Genetic Variability: The Starting Point

The basis of any breeding program lies in the creation or identification of genetic variation. Genetic diversity can be introduced through natural variation, induced mutations, or hybridization between genetically diverse parents[4]. Wild relatives and landraces are often tapped as reservoirs of untapped traits such as drought tolerance, pest resistance, and grain quality[5].

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2. Hybridization and Segregation

Hybridization involves crossing selected parental lines to combine desirable traits. The hybrids often exhibit heterosis or hybrid vigor, outperforming both parents in yield, vigor, and stress tolerance[6]. Following hybridization, segregation in the and subsequent generations allows the expression and recombination of traits, creating a wide array of genetic possibilities for selection[7].

3. Selection Techniques in Conventional Breeding

Selection is the process of identifying and advancing individuals with superior traits. Several conventional methods are employed depending on the crop type:

- Pedigree Selection tracks the inheritance of traits from parent to offspring and is commonly used in self-pollinated crops like wheat and rice[8].
- Bulk Selection allows natural and artificial selection to act on large populations over multiple generations before selection of individual plants[9].
- Mass Selection involves choosing superior phenotypes and bulking their seeds, effective in cross-pollinated crops[10].
- Recurrent Selection improves populations by repeated cycles of selection and recombination, often used to enhance complex traits[11].

4. Backcross Breeding

Backcrossing is a powerful method to introduce one or a few specific traits (e.g., disease resistance) into an elite variety while retaining its overall genetic makeup. This involves repeated crossing of the hybrid with one of its parents (recurrent parent) and is especially valuable in trait-specific improvements[12].

5. Doubled Haploids and Single Seed Descent (SSD)

Accelerating the breeding cycle is crucial. Doubled haploid (DH) technology allows breeders to develop completely homozygous lines in one generation, significantly reducing time and effort[13]. Single Seed Descent (SSD) is another rapid method where one seed per plant is advanced through generations without selection until homozygosity is achieved[14].

6. Hybrid Breeding

Hybrid breeding aims to exploit heterosis. In crops like maize and rice, hybrid varieties are developed using cytoplasmic male sterility (CMS) systems and inbred lines to ensure genetic purity and high performance[15]. These hybrids often yield 15–25% more than conventional varieties and are a major driver of agricultural productivity[16].

7. Field Evaluation and Multi-Location Trials

Before release, breeding lines undergo rigorous multi-environment testing to evaluate performance stability, adaptability, and resistance to biotic and abiotic stresses. These trials are vital to ensure that new varieties meet farmers' and market expectations under real-world conditions[17].

8. Integration with Modern Tools

Though fundamentally conventional, many breeding programs now incorporate Marker-Assisted Selection (MAS) and Genomic Selection (GS) to improve efficiency and precision. These tools complement traditional methods by allowing breeders to select traits based on genetic markers rather than solely on phenotypic performance[18].

Conclusion

Speed breeding is tool to reduce the duration of new genotype development. Increase of productivity in different crops is one of the challenging task for breeder and government. Due to increasing world population, needs to improve productivity in all cultivating crops. If we will success to induces stress tolerance in crops by using different modern breeding methods then, we will able to full-fill our food requirement without importing single grain from another countries. Even breeders are not successful in heterosis breeding, so needs more effort for induce of male sterile gene in different crops to develop hybrid seed.

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Conflict of Interest: Nil

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