Plant Breeding

Plant breeding is the science driven creative process of developing new plant varieties that goes by various names including cultivar development, crop improvement, and seed improvement. Breeding involves the creation of multi-generation genetically diverse populations on which human selection is practiced to create adapted plants with new combinations of specific desirable traits.

Introduction

- G.J.Mendle is known as Father of Genetics
- Father of plant physiology is Stephen Hales.
- Father of Plant tissue culture: G. Haberland
- Babylonians and Assyrians artificially pollinated the date palm as early as 700 BC.
- Joseph Kolreuter, a German made extensive crosses in Tobacco and Solanum between 1760 and 1866 and studied the progenies in detail.
- Thomas Andrew Knight (1759-1835) was the first man to produce several new fruit varieties by using artificial hybridization.
- Johansen proposed the famous 'pure line theory' which states that a pure line is progeny of a single self-fertilized homozygous plant. He proposed this theory based on his studies in Phaseolus vulgaris
- G.H. Shull Played an important role in the development of hybrid maize which had a tremendous impact upon global agriculture.
- Nils Heribert-Nilsson (1883-1955) Published a paper demonstrating how results between crosses, or hybrids, yielded plants that outperformed either parent. This concept later came to be known as hybrid vigor, which formed the foundation of today's hybrid crop production programs.

Modes of Reproduction

Reproduction refers to the process by which living organisms give rise to the offspring of similar kind (species).

It is of two types:

1. **Sexual reproduction:** Multiplication of plants through embryos which have developed by fusion of male and female gametes is known as sexual reproduction.

- All the seed propagating species belong to this group.

Fertilization

- Fusion of one of the two sperms with the egg cell producing a diploid zygote is known as fertilization.
- Fusion of the remaining sperm with the secondary nucleus leading to the formation of a triploid primary endosperm nucleus is termed as **triple fusion**.

2. **Asexual reproduction**: Multiplication of plants without the fusion of male and female gametes is known as asexual reproduction

a) **vegetative reproduction**

- In nature, multiplication of certain plants occurs by underground stems, sub aerial stems, roots and bulbils.
- Rhizome: Turmeric (Curcuma domestica), Ginger (Zingiber officinale)
- Tuber: Potato (Solanum tuberosum)
- Corm: Arvi (Colocasia esculenta), Bunda (C. antiquorum)
- Bulb: Garlic (Allium sativum), onion (A. Cepa)

b) Artificial vegetative reproduction

Stem cuttings: Sugarcane (Saccharum sp.) grapes (Vitis vinifera), roses, etc

Root cuttings: Sweet potato, citrus, lemon, etc. Layering and grafting are used in fruit and ornamental crops.

Apomixis

- Development of seed without sexual fusion (fertilization). In apomixis embryo develops without fertilization.
- Reproduction in some species occurs only by apomixis. This apomixis is termed as obligate apomixis.
- Some species sexual reproduction also occurs in addition to apomixis. Such apomixis is known as facultative apomixes

Methods of breeding

1. Introduction

2. Selection

   a) Pure line selection
   b) Mass selection

3. Hybridization and selection

   i. Inter varietal
   a) Pedigree Method
   b) Bulk Method.
   c) Single Seed Descent Method.
   d) Modified Bulk Method
   e) Mass - Pedigree Method.

   ii. Interspecific hybridization

4. Back cross method

5. Multiline varieties

6. Population approach

7. Hybrids.

8. Mutation breeding

9. Polyploidy breeding

10. Innovative techniques

1. Plant introduction: Taking a genotype or a group of genotypes in to a new place or environment where they were not grown previously.

2. Pureline Selection: A large number of plants are selected from a self pollinated crop. The selected plants are harvested individually.

3. Mass Selection: A large number of plants having similar phenotype are selected and their seeds are mixed together to constitute a new variety. Thus the population obtained-from selected plants will be more uniform than the original population.

4. Pedigree method: In pedigree method individual plants are selected from F2 and their progenies are tested in subsequent generations. A record of the entire parent off spring relationship is maintained and known as pedigree record. The pedigree may be defined as a description of the ancestor of an individual and it generally goes back to some distant ancestor. So each progeny in every generation can be traced back to the F2 plant from which it is originated.

5. Bulk Method: It is a method which can handle segregating generations, in which F2 and subsequent generations are harvested in bulk to grow the next generation. At the end of bulking period, individual plant selection and evaluation is carried out in the similar fashion as in the pedigree method.

6. Backcross breeding: It is an effective method to transfer one or a few genes controlling a specific trait from one line into a second—usually elite—breeding line. The parent with the desired trait, called the donor parent, provides the desired trait and may not perform as well as an elite variety in other areas

7. Recurrent selection: It is a method which involves reselection generation after generation with interbreeding of selects to provide for genetic recombination

8. Mutation breeding: It is referred to as "variation breeding", is the process of exposing seeds to chemicals or radiation in order to generate mutants with desirable traits to be bred with other cultivars.

9. Ploidy breeding: The mitotic and meiotic divisions are very precise as a result of which the chromosome numbers of different species are highly stable. But a low frequency of irregularities do occur both during mitotic and meiotic divisions. These irregularities give rise to individuals with chromosome numbers different from the normal somatic chromosome number of the concerned species.

10. Recurrent selection: it is a method which involves reselection generation after generation with interbreeding of selects to provide for genetic recombination.