

Plant Breeding

Definition, Aim, Objectives and Scope of Plant Breeding

Definition :

Plant breeding can be defined as an art, a science, and technology of improving the genetic make up of plants in relation to their economic use for the man kind.

or

Plant breeding is the art and science of improving the heredity of plants for the benefit of mankind.

or

Plant breeding deals with the genetic improvement of crop plants also known as science of crop improvement.

or

Science of changing and improving the heredity of plants

Aim :

Plant breeding aims to improve the characteristics of plants so that they become more desirable agronomically and economically. The specific objectives may vary greatly depending on the crop under consideration.

Objectives of Plant Breeding :

1. Higher yield : The ultimate aim of plant breeding is to improve the yield of economic produce. It may be grain yield, fodder yield, fibre yield, tuber yield, cane yield or oil yield depending upon the crop species. Improvement in yield can be achieved either by evolving high yielding varieties or hybrids.

2. Improved quality: Quality of produce is another important objective in plant breeding. The quality characters vary from crop to crop. Eg. grain size, colour, milling and backing quality in wheat. Cooking quality in rice, malting quality in barley, size, colour and size of fruits, nutritive and keeping quality in vegetables, protein content in pulses, oil content in oilseeds, fibre length, strength and fineness in cotton.

3. Abiotic resistance : Crop plants also suffer from abiotic factors such as drought, soil salinity, extreme temperatures, heat, wind, cold and frost, breeder has to develop resistant varieties for such environmental conditions.

4. Biotic resistance : Crop plants are attacked by various diseases and insects, resulting in considerable yield losses. Genetic resistance is the cheapest and the best method of minimizing such losses. Resistant varieties are developed through the use of resistant donor parents available in the gene pool.

5. Change in maturity Duration / Earliness : Earliness is the most desirable character which has several advantages. It requires less crop management period, less insecticidal sprays, permits new crop rotations and often extends the crop area. Development of wheat varieties suitable for late planting has permitted rice-wheat rotation. Thus breeding for early maturing crop varieties, or varieties suitable for different dates of planting may be an important objective. Maturity has been reduced from 270 days to 170 days in cotton, from 270 days to 120 days in pigeonpea, from 360 days to 270 days in sugarcane.

6. Determinate Growth : Development of varieties with determinate growth is desirable in crops like Mung, Pigeon Pea (*Cajanus cajan*), Cotton (*Gossypium sp.*), etc.

7. Dormancy : In some crops, seeds germinate even before harvesting in the standing crop if there are rains at the time of maturity, e.g., Greengram, Blackgram, Barley and Pea, etc. A period of dormancy has to be introduced in these crops to check loss due to germination. In some other cases, however, it may be desirable to remove dormancy.

8. Desirable Agronomic Characteristics: It includes plant height, branching, tillering capacity, growth habit, erect or trailing habit etc., is often desirable. For example, dwarfness in cereals is generally associated with lodging resistance and better fertilizer response. Tallness, high tillering and profuse branching are desirable characters in fodder crops.

9. Elimination of Toxic Substances : It is essential to develop varieties free from toxic compounds in some crops to make them safe for human consumption. For example, removal of neurotoxin in Khesari (*Lathyrus sativus*) which leads to paralysis of lower limbs, erucic acid from *Brassica* which is harmful for human health, and gossypol from the seed of cotton is necessary to make them fit for human consumption. Removal of such toxic substances would increase the nutritional value of these crops.

10. Non-shattering characteristics: The shattering of pods is serious problem in green gram. Hence resistance to shattering is an important objective in green gram.

11.Synchronous Maturity : It refers to maturity of a crop species at one time. The character is highly desirable in crops like Greengram, Cowpea, and Cotton where several pickings are required for crop harvest.

12.Photo and Thermo insensitivity: Development of varieties insensitive to light and temperature helps in crossing the cultivation boundaries of crop plants. Photo and thermo-insensitive varieties of wheat and rice has permitted their cultivation in new areas. Rice is now cultivated in Punjab, while wheat is a major *rabi* crop in West Bengal.

13.Wider adaptability : Adaptability refers to suitability of a variety for general cultivation over a wide range of environmental conditions. Adaptability is an important objective in plant breeding because it helps in stabilizing the crop production over regions and seasons.

14.Varieties for New Seasons : Traditionally Maize is a *kharif* crop. But scientists are now able to grow Maize as *rabi* and *zaid* crops. Similarly, mung is grown as a summer crop in addition to the main *kharif* crop.

Scope of plant breeding (Future Prospects)

From times immemorial, the plant breeding has been helping the mankind. With knowledge of classical genetics, number of varieties have been evolved in different crop plants. In order to combat the global alarm created by population explosion, the food front has to be strengthened which is serious challenge to those scientists concerned with agriculture. Advances in molecular biology have sharpened the tools of the breeders, and brighten the prospects of confidence to serve the humanity. The application of biotechnology to field crop has already led to the field testing of genetically modified crop plants.

Genetically engineered Rice, Maize, Soybean, Cotton, Oilseeds Rape, Sugar Beet and Alfalfa cultivars are expected to be commercialized before the close of 20th century. Genes from varied organisms may be expected to boost the performance of crops especially with regard to their resistance to biotic and abiotic stresses. In addition, crop plants are likely to be cultivated for recovery of valuable compounds like pharmaceuticals produced by genes introduced into them through genetic engineering. It may be pointed out that in Europe hirudin, an anti-thrombin protein is already being produced from transgenic *Brassica napus*.

Undesirable effects

Plant breeding has several useful applications in the improvement of crop plants.

However, it has five main undesirable effects on crop plants.

1. Reduction in Diversity : Modern improved varieties are more uniform than land

racers. Thus plant breeding leads to reduction in diversity. The uniform varieties are more prone to the new races of pathogen than land races which have high genetic diversity.

2. Narrow genetic base : Uniform varieties have narrow genetic base. Such varieties generally have poor adaptability.

3. Danger of Uniformity : Most of the improved varieties have some common parents in the pedigree which may cause danger of uniformity.

4. Undesirable combinations : Sometimes, plant breeding leads to undesirable combinations. The examples of man made crops having undesirable combination of characters are *Raphanobrassica* and Pomato.

5. Increased susceptibility to minor diseases and pests : Due to emphasis on breeding for resistance to major diseases and insect pests often resulted in an increased susceptibility to minor diseases and pests. These have gained importance and, in some cases, produced severe epidemics. The epidemic caused by *Botrytis cinerea* (grey mold) in chickpea during 1980-82 Punjab, Haryana. The severe infection by Karnal bunt (*Tilletia sp.*) on some wheat varieties, infestation of mealy bugs in Bt cotton.

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