

INTRODUCTION TO PLANT BREEDING

Lecture: - 1

Definition, Concept, Nature and Role of Plant Breeding

1.1 Definition

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

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.

1.2 Nature of Plant Breeding:

1.2.1 Art:-In earlier days man depends on his skills and judgment in selecting better plants. He knew nothing about the inheritance of characters, role of environment in producing them and the basis of variation in various plant characters. His method of selection was designed without the understanding of principles of inheritance. Therefore during primitive time plant breeding was largely an art and very less science was involved in that. Even today success of selection depends upon ability of the person involved in the selection.

1.2.2 Science:-Plant breeding is considered as the current phase of crop evolution. As the knowledge of genetics and other related science progresses plant breeding become less art and more science. Especially, discovery of Mendel's work in 1900 added a lot to the knowledge of science. Selection of desirable plant even today is an art it depends on the skill of a person. But alone skill is not enough, modern plant breeding is a combined effort of art and understanding and use of genetic principles.

1.2.3. Technology: - Product of all plant breeding activities, whether dependent on the art or science, is improved variety, hybrids, synthetics and composites. This product is utilized by farmers for commercial cultivation. Therefore, plant breeding can be rightly viewed as a technology since it generates a useful product.

1.3 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. E.g. 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, and 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 pigeon pea, 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., Green gram, Black gram, 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 Green gram, 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.

1.4 Undesirable effects of Plant Breeding: -

Genetic erosion: Disappearance of land races due to introduction of high yielding varieties.

E.g. Introduction of IR 20 rice led to disappearance of land races of samba rice.

2. Narrow genetic base: Genetic vulnerability to pest and diseases.

Tift 23A - Bajra - Susceptible downy mildew

T cytoplasm - Maize - susceptible to *Helmintho sporium*

3. Minor disease and pest become major: Due to intensive resistance breeding.

RTV (Rice Tungro Virus)

Grey mold in Bengal gram

4. Attainment of yield plateau: No more further increase in yield

History of Plant Breeding

1.5 Important Historical Events:

- 700 BC - Babylonians and Assyrians pollinated date palm artificially
- 17th century - several varieties of heading lettuce were developed in France
- 1717 - Thomas Fair Child - produced the first artificial hybrid, popularly known as Fair Child's mule, by using carnation with sweet William.
- 1727 - The first plant breeding company was established in France by the vilmorins.
- 1760-1766 - Joseph koelreuter, a German, made extensive crosses in tobacco.
- 1759-1835 – Knight was perhaps the first man to use artificial hybridization to develop several new fruit varieties.
- Le couteur and Shireff used individual plant selections and progeny test to develop some useful cereal varieties.
- 1873 - Work of Patrick Shireff was first published.
- He concluded that only the variation heritable nature responded to selections, and that there variation arose through 'natural sports'
- 1856 - Vilmorin developed the progeny test and used this method successfully in the improvement of sugar beets.
- 1900 - Nilson-Ehle, his associates developed the individual plant selection method in Sweden.
- 1903 - Johanssen proposed the pureline theory that provided the genetic basis for individual plant selection.

- The science of genetics began with the rediscovery of Gregor Johan Mendel's paper in 1900 by Hugo de vries, Tshermak and Correns which was originally published in 1866.

1.6 History of plant breeding in India:

- 1871 – The Government of India created the Department of Agriculture.
- 1905 – The Imperial Agricultural Research Institute was established in Pusa, Bihar.
- 1934 – The buildings of the institute damaged in earthquake.
- 1936 – Shifted to New Delhi.
- 1946 – Name was changed Indian Agricultural Research Institute.
- 1901-05 – Agricultural Colleges were established at Kanpur, Pune, Sabour, Llyalpur, Coimbatore.
- 1929 – Imperial council of Agricultural Research was established.
- 1946 – Name was change to Indian Council Agricultural Research.
- 1921 – Indian Central Cotton Committee was established – Notable researches on breeding and cultivation of cotton. E.g.: 70 improved varieties of cotton.
- 1956 – Project for intensification of regional research on cotton, oilseeds and millets (PIRRCOM) was initiated to intensify research on these crops – located at 17 different centres through out the country.
- 1957 – All India Coordinated maize improvement project was started with objective of exploiting heterosis.
- 1961 - The first hybrid maize varieties released by the project.
- ICAR initiated coordinated projects for improvement of the other crops.
- 1960 – First Agricultural University established at Pantnagar, Nainital, U.P.