HORTICULTURE AND PLANT BREEDING

III B.Sc., BOTANY
Subject code:18K5BO8
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UNIT – I

- **INTRODUCTION**
- **HISTORY OF HORTICUTURE**
- **SCOPE**
- **DIVISIONS OF HORTICULTURE**
- **IMPORTANCE**

INTRODUCTION

- Horticulture is the science of growing flowers fruits, vegetables and ornamental plants especially in gardens and orchards.
- It differs from agriculture and forestry specializing the cultivation of garden crops.
- Garden crops includes fruits, vegetables, flowers plantation crops, spices and aromatic plants.
- Horticulture is one of the branches in botany.
- The term ‘horticulture ‘ is derived from two Latin words, hortus meaning garden and culture means cultivation.

HISTORY OF HORTICULTURE

- The separation of horticulture from agriculture as a distinct activity is usually dated from the Middle Ages in Europe.
- Long after Mughal Emperors practised horticulture in the country, Rev William Carey, an English Baptist Missionary, founded the Agri-Horticultural Society in India in 1820 for the promotion and development of agriculture in the country.
- Before the formation of the society, good vegetables were scarcely possible to be procured.

- In 1820, Carey published an essay presenting reasons for the establishment of an Agricultural Society in India.

Carey'As essay on supporting the formation of an agricultural and horticultural society in India states the following grounds Carey predicted for the society:

- Introduction of useful and new types of plants.
- Improvement in the implementation of husbandry practices.
- Improvement in animal husbandry.
- Inclusion of wastelands into a state of cultivation.

SCOPE OF HORTICULTURE

- India has great variety of climate and edaphic conditions which can be exploited by growing horticultural crops.
- Climates are varying from tropical, subtropical and temperate regions. From this humid, semi- arid, arid and varying temperature trees arealso grown.
- Likewise soils like loamy, alluvial, laterite, medium black, rocky shallow heavy black sandy etc are also available. From this, large crop areas can be grown with very high level of adaptability.

For providing raw material to small scale industries like silkworm, lack, honey, match, paper, canning, and dehydration etc. horticulture has wide scope.

In India larger area of lands are waste land, problematic soil, desert land which can be utilized for hardy fruits and medicinal plants.

and transport system create wide scope for horticulture development particularly in transporting the perishable commodities and products.

DIVISIONS OF HORTICUTURE

- The cultural operations are unique to each and every group o horticultural plants. Based upon the method of cultivation, horticulture has been grouped into following divisions.

POMOLOGY

- The term Pomology is derived from the Latin word ‘pomum’ meaning ‘fruits’ and the Greek term ‘logy’ meaning Science. Thus, pomology is the science of production of fruit crops. OR The science of growing fruit crops.
- (a) Tree fruits: Fruits are produced on tree e.g. Mango, Chiku, Citrus etc.
- (b) Small fruits: Fruits are produced on shrubs or vines e.g. Phalsa, Raspberry, Mulberry, Grapes, Gooseberry, Strawberry

OLERICULTURE

- The term Olericulture is originated from Latin word ‘oleris’ meaning pot herb and the English word culture meaning raising of plants.
- Thus, olericulture is the science of vegetable crops. OR The cultivation of vegetable crops.
- e.g. brinjal, tomato, potato, radish, carrot, chilli, bottle gourd.

FLORICULTURE

- It is a science of cultivation of flowers and ornamental plants for commercial purposes or merely for getting pleasure and as a hobby.
- Due to increase in domestic need of flowers, the career scope in the field of floriculture is also increasing . Nowadays, demanding of flowers like roses, gerbera, carnation, gladiolus, Orchids, and lilies is increasing day by day.

GARDENING

- It is a science of designing and laying out home gardens, public gardens, parks, road side plantation, avenues.
- Living elements, such as flora or fauna; or what is commonly called gardening, the art and craft of growing plants with a goal of creating a beauty within the landscape.

ARBORICULTURE

- Cultivation and management of forest tree e.g. teak wood, neem, ficus, eucalyptus etc.
- Control of crop composition and production of species of more economic value.

SPICES

- Spices are plant products used in cookery to season or flavour the food.
- Cultivation of crops which products are used as adjunct in food for flavor, aroma and taste.
  e.g cardamom, clove, nutmeg, coriander, cumin etc.
- It is low volume , high value crop.

PLANTATION CROPS

- Cultivation of tea, coffee, coconut, arecanut, rubber, oil palm etc.
- 1)Expansion in non-traditional areas
- 2)Export potential :Plantation crops earn foreign exchange. Eg. Coir based products ,Coir export and Coffee .

AROMATIC AND MEDICINAL PLANTS

- Cultivation of aromatic and medicinal plants like gugal, aonla, beheda, harde, lucorice, lemon grass etc.
- The magical compound of medicinal and aromatic plants keeps saving human until present, such as medicine, food, healing, and recreation.

IMPORTANCE OF HORTICULTURE

- Fruits and vegetables play an important role in the balance diet of human being by providing vital protective nutrients.
- They not only adorn the table but also enrich health from the most nutritive menu and tone up the energy and vigour of man.
- Fruits and vegetables have a key role in neutralizing the acid produced during digestion of protein rich and fatty foods.
- They provide valuable roughages which promote digestion and helps in preventing constipation.

- The fruits and vegetables are chief source of vitamins and minerals which help in proper health and resistant to disease.
- The flowers, ornamental plants and gardens play a very important role in refreshing the minds of people and reducing air pollution.
- The growing of horticultural crops also contributes to the aesthetic side of rural and home life of community.

Thank you

Semester	Course	Hours	Credit	Sub. Code	Marks
V	CC8	5	5	18K5BO8	25+75=100

HORTICULTURE AND PLANT BREEDINGS

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UNIT IV.

PLANT BREEDING.

Principles and objectives of plant breeding, plant introduction and acclimatization. Selection methods and their advantages and disadvantages of Mass, Pure Line and Clonal selection.

INTRODUCTION OF PLANT BREEDINGS

Human being is almost dependent on plants for his food and all other needs. Plants are major source directly or indirectly of most food, fodder clothing, fuel, drugs etc. Considering the prime importance of plants, human being have long been concerned with developing plant types better suited to satisfying their needs.

Art: Before the rediscovery of Mendelism plant breeding was the result of visual selection of material practiced on a trial and error basis by untrained people. Skill and proper judgment coupled with common sense formed the basis of success. Selection was the only practice of plant breeding which resulted in development of many varieties developed before 20thcentury. This art depends on breeder to assess the difference of economic values between the plants.Now with the growth of genetics, these practices are systematic to the point, where they can be called as a science.

Smith defined plant breeding as the art and science of improving the genetic pattern of plants in relation to their economic use. It is a science which uses the knowledge and techniques from many basic science areas. As a continuation of natural evolution plant breeding is an ancient discipline.

It is not only contributes to agriculture progress by information, but also by material products such as crop varieties, hybrids, composite/ synthetics, which are suited to human needs in one or more aspects. Earliest success were chance affair largely depended upon the breeder's skill.

Thomas Robert Malthus 1798 postulated that human populations, unless checked by wars or disasters, increase under hunger. He foresaw catastrophe because he believed that population was capable of increase at a geometric rate and food supply at arithmetic rate. He predicted that Britain would be in disaster by the midnineteenth century. Fortunately his prediction was falsified. Due to tremendous increase in food supplies due to better method of production and improved varieties of plants and breeds of live stock.

Finally we can expect plant breeding to contribute substantially to greater agriculture production. It was not only by breeding high yielding varieties, but also by stabilizing production through developing resistance to diseases, pests, drought, heat and cold etc.

Objectives of Plant Breeding:

To develop varieties with better characteristics, such as:

. Higher yield

Disease resistance

Flood resistance

Early to mature

Adaptability to wide range of habitats

Resistance to alkaline and saline soil conditions

Better quality

Drought resistance

Response to manuring

Insect and pest resistance

Institutes Engaged in Plant Breeding at National and International Level:

International Rice Research Institute (IRRI), Philippines.

. International Maize and Wheat Improvement Centre (CIMMYT), Mexico.

International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad.

International Potato Centre (CIP), Peru.

International Board of Plant Genetic resources (now International Plant Genetic Resources Institute; IBPGR, now IPGRI).

Central Potato Research Institute (CPRI), Kufri (Shimla).

. Indian Agricultural Research Institute (IARI), New Delhi.

Sugarcane Breeding Institute (SBI), Coimbatore.

Jute Agriculture Research Institute (JARI), Barackpore.

Indian Grassland and Fodder Research Institute (IGFRI), Jhansi.

Forest Research Institute, Dehradun.

Central Arid Zone Research Institute (CAZRI), Jodhpur.

Plant Introduction and Acclimatization

- Plant introduction can be defined as process of introducing plants from their growing locality to a new locality.

TYPES OF PLANT INTRODUCTION -

Plant introduction may be of following types:

(i) Intercontinental plant introduction

(ii) Intracontinental plant introduction

(iii) Interstate plant introduction

(iv) Intrastate or Inter-district plant introduction

PURPOSE OF PLANT INTRODUCTION

- For use in agriculture, forestry and industry
- For studying origin, distribution, classification and evolution in plants
- For aesthetic value
- For genetic improvement of economical crops
- To save the crop from disease and pests

PROCEDURE OF PLANT INTRODUCTION

- Procurement of germplasm: The new germplasm is procured through NBPGR, New Delhi.
- Quarantine: It is to keep the material in isolation to prevent spreading of diseases etc.
- Cataloging: All the plant material which is introduced is given an entry number and information regarding agency, place of origin, adaptation etc. and is well documented.
- Evaluation: The plant material is sent to sub stations of the bureau and evaluated with respect to various characters to assess the potential of new introductions.
- Multiplication and distribution: Plant material which is introduced is to be multiplied and further tested at various locations. The suitability of cultivation in different regions of the country should be assessed before using it as a commercial variety.

MERITS OF PLANT INTRODUCTION

- It is the easiest method of crop improvement.
- It helps in obtaining quickly and at low cost, the best variety available.
- Crops may be introduced into disease free areas to protect their damage.

Acclimatization

Generally, the introduced varieties perform poorly because they are often not adapted to the new environment. Sometimes, the performance of a variety in the new environment improves with a number of generations grown there. *The process that leads to the adaptation of a variety, line or population to a new environment in known as acclimatization*. Acclimatization is brought about by a faster multiplication of those genotypes (present in the original population) that are better adapted to the new environment. Thus acclimatization is essentially a consequence of natural selection. Genetic variability must be present in the original population for acclimatization to occur. Therefore, land varieties are likely to get acclimatized, while purelines are not likely to do so.

Acclimatization When superior cultivars from neighbouring or distant regions are introduced in a new area, they generally fail initially to produce a phenotypic expression similar to that in their place of origin. But later on they pickup and give optimal phenotypic performance, in other words they become acclimatized to the new ecological sphere. Thus acclimatization is the ability of crop variety to become adapted to new climatic and edaphic conditions. The process of acclimatization follows an increase in the frequency of those genotypes that are better adapted to the new environment. The success of acclimatization depends upon two factors i) Place effect ii) Selection of new genotypes.

SELECTION METHODS

1. Mass Selection:

When a large number of plants of similar phenotype are selected and their seeds are mixed together to constitute a new variety is called mass selection. The population obtained from the selected plants would be more uniform than the original population.

In case of self-pollinated crops, mass selection procedure has following objectives:

(a) Improvement of Local Varieties:

In local varieties sometimes there are mixtures of several types which may differ in flowering maturity time, disease resistance, plant height, etc. Elimination of poor quality plants help to get uniform performance of the variety.

(b) Purification of Existing Pure-Line Varieties:

Maintenance of purity of the existing pure line varieties is done through this method. The pure line varieties sometimes tend to become variable with time due to mechanical mixtures, natural hybridisation and mutation. Through regular mass selection the purity of the pure line varieties is maintained.

(c) Production of New Varieties from Heterogeneous Local Land Races:

By increasing the frequency of superior genotype, the population character can be changed. This change is a function of heritability and the number of genes conditioning the trait under selection.

In case of cross pollinated crops, inbreeding must be avoided as it leads to loss in vigour and yield. But in mass selection several plants are selected and their seeds are mixed together to raise the next generation, so inbreeding is avoided or kept minimum.

Procedure:

The process involves selection or retention of a large number of individual plants on the basis of superior phenotype, compositing the harvested seeds without progeny-testing, the mixture of seeds is sown in mass to raise the next generation. This process continues till the desired level of uniformity is achieved.

The procedure for mass selection may be outlined in brief as follows:

First Year:

A large number (200-2000) of plants are selected on their performance and phenotypic characters like vigour, plant type, disease resistance or other desirable characteristics. The seeds are composited together.

Second Year:

The composite seeds are planted in a preliminary yield trial along with standard varieties as checks as well as the variety from which the selection is made to determine whether there is any improvement or not.

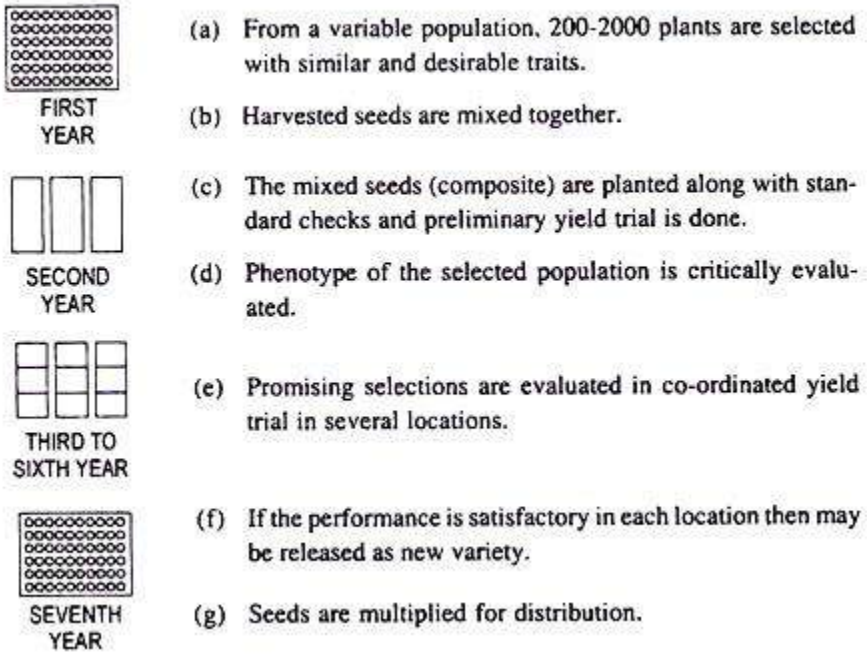
Third to Sixth Year:

The composite seeds from previous year collection are evaluated in coordinated yield trial in several locations within the same agro climatic zone. Initial evaluation trial for one year then uniformity regional trial for two or more years is done.

Seventh Year:

If the result is suitable for cultivation and performance is well then certification of seeds is necessary and released by central or state variety release committee.

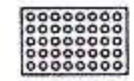
Schematic representation of mass selection in self-pollinated crops:



The procedure of mass selection whenever is coupled with progeny testing then that helps in maintaining the purity of pure line varieties. For this procedure, in the second year the individual plant progenies are planted individually and poor performers are rejected

The remaining progenies are mixed together to constitute the variety. The process may be repeated every few years to keep the variety pure as often as it is found necessary.

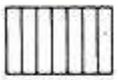
The modified procedure of mass selection is represented below schematically:



FIRST YEAR

(a) Similar and superior phenotypes are selected (200-2000 plants).

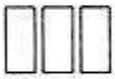
(b) The seeds are harvested from individual plant separately.



SECOND YEAR

(c) The harvested seeds from individual plant are sown in rows.

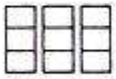
(d) The inferior or segregating progenies are rejected.



THIRD YEAR

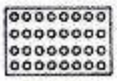
(e) The seeds from the remaining selected plants are harvested together.

(f) The composite seeds are used for preliminary yield trials along with standard checks.



FOURTH TO SEVENTH YEAR

(g) Multilocation co-ordinated yield trials are performed.



EIGHTH YEAR

(h) Superior phenotypes are released as new varieties.

(i) Seeds are multiplied and distributed.

Merits and Demerits :

1. Since a large number plant is selected, the variety is more stable in performance over different environments as it is more adapted than a single pure line. So the varieties developed through mass selection are more widely accepted than pure line.

2. Extensive and prolonged field trials are not necessary. This reduces the time and cost needed for developing a new variety. This method is also less labour consuming.

3. Mass selection retains considerable genetic variability, so another mass selection after few years improves the variety.

4. This method can be applied to cross pollinated crops.

Demerits:

1. The varieties developed through mass selection show variation and are not uniform as pure line varieties, and strict selection for uniformity would lead to inbreeding depression.

2. The improvement of variety through mass selection is poorer than through pure line selection.

3. When the mass selection is done without progeny test, the homozygosity of the selected plants is not assured. In the self-pollinating species as there are chances for cross pollination to some extent, some plants must be heterozygous. In this method the genetic superiority either may be due to environment or due to genotype.

4. Pure line selection is more used than mass selection, only improvements of local old varieties are done through this method.

5. In seed certification programme, it is more difficult to identify the mass selected variety than the pure line.

6. This method utilizes only the variability already exists in the population, improvement is done only through selection. So the limitation is that it cannot generate new genetic variability.

Achievements:

Mass selection is effective when the population has the following characters:
(a) High genetic variability for different traits.

(b) The characters should be highly heritable in nature.

(c) The crop is grown under low population density.

(d) If only one particular character is chosen.

At present use of mass selection is limited to purification of pure line varieties of self-pollinated crops, because the superiority of the pure lines would be lost quickly if their purity is not maintained through mass selection.

Pure Line Selection:

step number	Year	Details
One	First year	Many individual plants (about 200-3000) are selected from a local variety or some other mixed population based on phenotype. Any number of plants can be selected but importantly they should be homozygous. Seeds are harvested separately.
Two	Second year	Seeds from each plant are grown separately with proper spacing. Evaluated for characters under consideration. Probably in this first season it will not be possible to judge the value of separate lines well, but surely visually poor, weak and defective progenies can be rejected. Number of progenies is drastically reduced in this step, fewer are carried to step three.
Three	Third year	Seeds of second year crop are planted in a preliminary yield trial. Standard plots for comparison are introduced, undesirable progenies are rejected.
	Four to seven years	Replicated yield trials conducted at several locations. Standard plots for comparison are introduced, undesirable progenies are rejected. Tests are done for characters under consideration.
	Eighth year	Best progeny is released as a new pureline variety. Seed is multiplied for distribution

Advantages & Disadvantages of Pureline Selection

- Easy and cheap method of crop improvement
- Rapid method, lines are usually genetically fixed and yield trials can be immediately conducted.
- Plants in such variety react in similar fashion to environmental conditions, means they are uniform in performance and at the same time in appearance too.
- Maximum possible improvement over the original variety can be achieved
- Useful in improving low heritability traits as selection is based on progeny performance

Disadvantages of Pureline Selection

- Demerits of pureline selection are given below:
- Purelines have poor adaptability due to narrow genetic base, just opposite to mass selected variety
- Superior genotypes can only be isolated from the mixed population. This selection is powerless to bring changes in hereditary factors i.e. to develop new genotype.
- Mostly popular or in fact limited to self pollinated spp. only
- Time and space consuming
- More expensive yield trials have to be conducted than in mass selection

CLONAL SELECTION

Clone A clone is a group of plants produced exclusively from a single individual plant through asexual reproduction. Most of the fruit plants are propagated asexually which consist of large number of clones that is why these plants are known as a group of plants derived from a single plant by vegetative means.

In other words all the vegetative progenies of a single plant make a clone. Characteristics _ Clones are stable- They retain their original traits just like pure line variety _ Theoretically clones are immortal i.e. A clone can be maintained indefinitely by asexual reproduction.

However, these are very much susceptible to diseases or insect pests depending upon the species and cultivars. _ Homogeneous-Individual plant of a clone is a mitotic derivative of the same plant and therefore homogeneity in phenotype is the major feature of clones.

A group of individual plants derived from the same tissue of the original mother plant carries the same genotype. Phenotypic variation if any in clones is due to environmental impact. _ Continuous inbreeding of clones which are heterozygous might lead to severe loss in vigour _

The phenotype of a clone is due to effect of gene (G), environment (E) and GxE interaction over the population mean (h). Therefore P=h+G+E+GE _ Clones are maintained by asexual reproduction, but pure lines and inbreds are maintained by self-pollination or close inbreeding Genetic variation within clones Genetic variation within clones may be due to mutation, mechanical mixture and sexual reproduction.

a. Mutation Somatic mutations are also known as bud mutations. The frequency of mutations is generally very low. A mutant allele would be homozygous only when

(i) both the alleles in the cell mutate at the same time producing the same mutant allele, or

(ii) the mutant allele is already in the heterozygous condition in the original clone. Dominant bud mutations express themselves more frequently than the recessive ones, as recessive mutation get expressed only under homozygous conditions.

Bud mutations often produce chimeras, i.e., individuals containing cells of two or more genotypes. However, it is not a great problem because normal plants, i.e., non chimeras, may be produced from chimeras by several techniques.

b. Mechanical mixture Mechanical mixture produces genetic variation within a clone, similar to the manner as seen in pure lines.

c. Sexual reproduction Occasional sexual reproduction leads to segregation and recombination. The seedlings obtained from sexual reproduction are genotypically different from the asexual progeny. Clonal degeneration

The loss in vigour and productivity of clones with the passing of time is known as clonal degeneration and it may be due to mutation and infection of virus and bacteria. Clonal selection The phenotypic value of a plant or a clone is due to its genotype (G), the environment (E) and the genotype x environment interaction (GE). Of these, only the G effects are heritable and stable. Therefore, a selection for quantitative characters based on single plant observation may not hold good. A selection for polygenic characters like yield on the basis of unreplicated clonal plots would also often be misleading and unreliable. The value of clone can be reliably estimated only through replicated yield trials.

However, selection for highly heritable characters, such as plant height, days to flowering, colour, disease resistance, etc., is easy and effective even on the basis of single plant or plot. The various steps involved in clonal selection are briefly described below and are depicted.

First year: From a mixed variable population, a few hundred to few thousand desirable plans are selected. A rigid selection can be done for simply inherited characters with high heritability. Plants with obvious weakness are eliminated. In fruit plants, it is difficult to get large number of individual selections. In such case, few plants may be selected.

Second Year: Clones from the selected plants are grown separately, generally without replication. This is because of the limitation in propagation material in each clone, and also because of the large number of clones involved. The characteristics of clones will be clear now than in the previous generation when the observations were based on single plant. The inferior clones are eliminated at this stage. The selection is based on visual observation and on the breeder's judgment of the value of clones. Fifty to one hundred clones are selected on the basis of clonal characteristics.

Third year: Replicated preliminary yield trial is conducted. A suitable check is included for comparison. Few superior performing clones with desirable characteristics are selected for multi location trials. At this stage, selection for quality is done. If necessary, separate disease nurseries may be planted to evaluate disease resistance of the selected clones.

Fourth to Seventh years: Replicated yield trials are conducted at several locations along with a suitable check. The yielding ability, quality and disease resistance etc. of the clones are rigidly evaluated. The best clones that are superior to the check in one or more characteristics are identified for release as varieties.

Nineeth year: The superior clones are multiplied and released as varieties.

Advantages

i) Clonal selection is an easy and less time consuming method.

ii) Easy maintenance because there is no problem of out crossing and loss of seed viability. Variation occurs due to somatic mutation only which can be managed by removal of undesired plants.

iii) Heterotic clones on selection may be used as permanent hybrids. Heterosis can be exploited for longer time without production of hybrid seed every year (for vegetatively propagated vegetable crops).

iv) Clonal selection is the only method of breeding in vegetatively propagated fruit plants.

Disadvantages

There is limited chance of getting new and useful type of variability _ The multiplication rate is low. _ It is only useful for vegetatively propagated plants.