MODEL ANSWERS
MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END EXAMINATION
B. Sc. (Hort.)

Semester : V (Old) **Academic year**: 2019-20
Course No. : H/VS-353 **Title** : Breeding of vegetable crops
Credits : 3(2+1) Time: **Total marks** : 80

Note: 1. Solve **ANY EIGHT** questions from **SECTION 'A'**
2. All questions from **SECTION 'B'** are compulsory
3. All questions carry equal marks.
4. Draw neat diagram wherever necessary

SECTION 'A'

Q. 1 Which are the breeding objectives in brinjal? Enlist the brinjal varieties released by selection and hybridization.

Ans: **Breeding objectives**

1. High yield and quality
2. To evolve shoot and fruit borer resistant variety
3. To evolve little leaf and mosaic resistant variety

Varieties developed through selection:

i. Pusa Purple Long ii. Pusa Purple Cluster iii. Arka Kusumakar iv. Arka Sheetal
v. Arka Shirish vi. Manjari Gota vii. Phule Harit viii. Anuradha ix. ABV -1 x. Aruna

Varieties developed by hybridization:

Pusa Kranti, Pusa Bindu,Vaishali,Pragati,Krishna, Arka Navneet,Pusa Hybrid 9,NDBH 6 ABH -1 and ABH-2

Q. 2 Define self pollination. Explain in short mechanisms that facilitate self pollination.

Ans: Self Pollination (Autogamy): Pollen from an anther may fall on the stigma of the same flower is known as self pollination.

Many cultivated plant species reproduce by self pollination. These species as a rule must have hermaphrodite flower. In most of these species cross pollination may occur up to 5%.

e. g. Bean, cluster bean, cowpea, garden pea, fenugreek, tomato, lettuce, chilli, potato.

Various mechanisms that promotes self pollination

1. **Cleistogamy**: Flower does not open at all. This ensures complete self pollination. Foreign pollens cannot reach the stigma of a closed flower.
2. **Chasmogamy**: Flower open but only after pollination has taken place. Since the flower opens some cross pollination may occur.
3. **Homogamy**: The anther and stigma mature at the same time resulting self pollination.
4. In tomato, brinjal the stigmas are closely surrounded by anthers. Pollination generally occurs after the flower open, but the position of anthers in relation to stigmas ensures self pollination.
5. In some species flower open but the stamens and the stigma are hidden by other floral organs (petals forming a keel) e.g. Pea.

6. In few species stigma becomes receptive and elongates through staminal columns. This ensures self pollination.

Self pollinated species are highly homozygous; do not show inbreeding depression but exhibit considerable heterosis. The aim of breeding methods is to develop homozygous varieties.

Q. 3 Which are the breeding objectives in cucumber? Enlist the cucumber varieties released by introduction and selection.

Ans: Objectives of breeding

i. To develop an early fruiting variety uniform cylindrical shape, soft seeds at edible maturity.
ii. High proportion of female flowers. iii. Attractive green colour with smooth surface.
iv. Long green fruits for slicing having white spines.v. Short fruits with thin skin for pickling. For pickling – a thin skin with lighter colour, have black spine colour.
vi. Resistance to powdery mildew, downy mildew, anthracnose and insect pests and abiotic stresses.vii. Fruits free from bitterness. viii. Without crook neck.

Breeding Methods

1. **Introduction:**
   Japanese Long Green, Straight Eight, Poinsette
2. **Selection:**
   i. Sheetal, ii. Poona Khira , iii. Khira 90 & Khira 75, iv. Himangi
   v. Phule Shubhangi

Q. 4 Enlist various methods of breeding used in vegetable crops and discuss about bulk method.

Ans: Breeding methods in improvement of vegetable crops

I. Plant introduction

II. Selection: A. Pure line selection B. Single plant selection C. Clonal selection

III. Hybridization: A.Pedigree selection B. Bulk method C. Pure line family method
D. Single seed descent method
E. Testing of breeding material
   1. Early generation testing 2. Advanced generation testing
F. Modified pedigree, bulk and SSD method
G. Backcross method
   1. Double back cross method 2. Backcross pedigree method
H. Asexually propagated crops

IV. Population Improvement

A. Mass selection B. Progeny testing and line breeding
C. Family breeding D. Recurrent selection
   1. Simple recurrent selection
   2. Recurrent selection of GCA & SCA
   3. Reciprocal Recurrent selection
E. Selfing and Massing

V. **Mutation.**

VI. **Polyploidy.**

Bulk Method

In this method, F_2 and the subsequent generations are grown in bulk, usually without artificial selection. In the end pure line varieties are developed through individual plant selection.

This is one of the most economical methods of handling the segregating population based on natural selection.

- In the case of natural selection, when two or more populations compete in different generations, the poorly adapted types are eliminated and superior types exists.
- This method consists of growing large populations in each generation and harvesting the seed in bulk and planting a sample of seeds in the following years.
- No selection is made in F_2 and bulk population grown upto F_5 or F_6.

In this case only natural selection operates.

- Generally there is no selection of plants on the phenotypic performance basis, but sometimes superior plants are selected and their seeds are composited.
- Selection of superior plants and their composition of seeds upto F_3 and after that pedigree method is very effective in tomato and egg plant.

-In F_6, single plants are selected and their progenies are grown in next generation.

- In F_7 and F_8 generations, superior families are selected on the basis of phenotypic performance, which are further evaluated against standard checks.
- In tomato, chilli, egg plant, pea and beans, this method can be adopted for handling large segregating populations.
- Now this method is being used as one of the economical and convenient methods for the improvement of vegetable crops.
- Bulk method is one of the effective methods for developing a new variety.

Merits of Bulk Method

1. Simple, convenient and inexpensive.
2. Artificial or natural epiphytotics (Epiphyte: Plant growing upon another plant but no parasite upon it), winter killing etc. eliminate undesirable types. Isolation of desirable plants thus becomes much easier.
3. Natural selection increases the frequency of superior types in the population. Progenies selected from long term bulks are likely to be far superior to those selected from F_2 or short term bulks.
4. Little work and attention is needed in F_2 and subsequent generations.
5. No pedigree record is to be kept, which saves time and labour.
6. Since large populations are grown, transgressive (Superior to both parents) segregants are more likely to appear and increase due to natural selection.
7. Artificial selection may be practiced to increase due to increase the frequency of desirable types.
8. It is suitable to studies on the survival of genes and genotypes in populations.

Demerits of Bulk Method

1.It takes much longer time to develop a new variety.
2.In short term bulks, natural selection has little effect on the genetic composition of population.
3.It provides little opportunities for the breeder to exercise his skill or judgment in selection.
4.A large number of progenies have to be selected at the end of bulking period.
5.Information on the inheritance of characters cannot be obtained.
6.In some cases, at least, natural selection may act against the agronomically desirable types.

Q. 5 Define genetic erosion. What are the causes of genetic erosion.

Ans: Genetic Erosion: The gradual loss of variability from cultivated species and their wild forms and wild relatives is called genetic erosion.

Genetic erosion is a creation of man since man's success in plant breeding is the chief cause of genetic erosion.

Main causes of erosion:

1.Replacement of genetically valuable land races (*desi* varieties) by the improved, genetically uniform pureline or hybrid varieties. This has caused disappearance of many land races, open pollinated varieties etc.
2.Improved crop management practices have virtually eliminated the weedy forms of many crops.
3.Increasing human needs have extended farming and grazing into forests. This led to extinction (No longer existing in living form) of many wild relatives of crops.
4.Developmental activities like hydroelectric projects, roads, industrial areas, railways, buildings etc. have also disturbed the wild habitat.
5. Sometimes introduction of a weedy species may result in the invasion of wild habitats by this species and lead to the elimination of the native wild relatives of crop plants.

Q. 6 Define hybridization. Enlist types of hybridization and explain any one.

Ans: Hybridization: The mating or crossing of two plants or lines of dissimilar genotypes are known as hybridization.

1.Inter-varietal hybridization

The parents involved belong to same species; they may be two strains, varieties or races of the same species. It is also known as **intra-specific hybridization.** In crop improvement intervarietal hybridization is most commonly used.

The inter-varietal crosses may be simple or complex.

a. **Simple cross**: Two parents are crossed to produce F_1 and F_1 is selfed to produce F_2 or used in backcross programme.

   A x B = F_1 (A x B) In case of hybrid variety such cross is called **single cross**.

b. **Complex cross**: More than two parents are crossed to produce the hybrid, which is then used to produce F_2 or used in back cross. Such crosses also known as

convergent cross because these cross bringing together genes from several parents into single hybrid.

2. Distant hybridization

Distant hybridization includes crosses between different species of the same genus or of different genera.

a. **Interspecific hybridization**: When two species of the same genus are crossed.

b. **Intergeneric hybridization**: When the two species belong to two different genera.

Disease resistance is inherited character, can be brought in the required variety or this hybridization sometimes used to evolve new variety.

1. Intra varietal Hybridization	Same variety	Mixture of different genotypes
2. Inter-varietal or Intra-specific Hybridization	Different varieties Same species	
3. Inter-specific or Intra-generic* Hybridization	Different species Same genus	Disease/Insect/Drought
4. Inter-generic* Hybridization	Different genera	Disease/Insect/Drought from wild to cultivated
5. Introgressive		One species is Hybridization completely replaced by another in nature

*Intra-generic and Inter-generic crosses of parental plants are distinctly or widely related i.e. **Wide crosses** or **distant crosses**.

Q. 7 Enlist different breeding objectives of okra. What are the breeding methods used for okra improvement?

Ans:

Breeding objectives:

1. Improvement in yield and its contributing characters like fruit size, weight and number.
2. Resistance to YVMV / Fruit and shoot borer.
3. Fruits free from conspicuous (easily seen / attracting attention) hairs.
4. Fruits suitable for processing industry and export market.
5. Early and prolonged harvest.
6. Short plant with more number of nodes, short internodes.

Breeding methods:

1. Introduction:

i. Perkin's Long Green ii. Clemson's Spineless:

2. Selection:

i. Pusa Makhmali ii. Co 1

iii. Gujarat Bhendi 1

3. Hybridization:

i. Pusa Sawani ii. Selection 2-2

4. Inter-specific hybridization using back cross technique:

i.Parbhani Kranti iii. Arka Anamika (Sel.10) iv. Arka Abhay (Sel. 4)

5. Intervarietal crosses using pedigree selection:

i. Varsha Uphar ii. Phule Utkarsha iii. Hissar Unnat

6. Mutation:

i. MDU 1 ii. Punjab 8 (EMS 8)

7. F_1 Hybrid

i. Phule Kirti

Q. 8 Write short notes

1. Biodiversity

Ans:

Defination: The total diversity present within and among species of all living organisms and their habitats

OR

Biodiversity is totality of genes, species and ecosystems in a region.

Biodiversity is of three types

1. Genetic diversity: variation in genes within a species
2. Species diversity : the variation of species within a region
3. Ecosystem biodiversity: Variation in ecosystems in a country or nation

Diversity of species and ecosystems influence productivity and services provided by the ecosystem Genetic diversity is also a great significance. It provides an insurance against crop losses caused due to diseases and insects. Land races provide protection from biotic and abiotic stresses due to genetic diversity. Biodiversity is getting eroded due to factors responsible for getting erosion.

Loss of biodiversity invites dangers of uniformity and may lead to outbreak of diseases and insects. Hence, conservation of biodiversity is essential. Efforts for conservation of biodiversity are being made internationally. In 1992 the Convention on Biological Diversity (CBD) was assigned. The CBD became operational in December 1993 and has following three main objectives.

1.Conservation of biodiversity 2.Sustainable use of biodiversity

3.Fair and equitable sharing of genetic resources for benefits of all countries

2. Apomixis:

Ans: Apomixis: In apomixis seeds are formed but the embryo develops without fertilization i. e. an embryo that bypasses the usual process of meiosis and fertilization. The plants resulting from them are identical in genotypes to the parent plant. Sexual production is either suppressed (facultative) or absent referred as obligate.

Types of Apomixis

Recurrent apomixis: Complete meiosis does not occur. Embryo develops directly from egg nucleus without fertilization. Eggs remain in normal diploid condition. e.g. onion

Non-recurrent apomixis: Meiosis does occur. Embryo arises from egg nucleus without fertilization, since egg is haploid and hence resulting embryo is also haploid. It is very rare.

Classification of Apomixis

a. **Adventive embryony**: Embryo develops directly from vegetative cells of the ovules. e.g. mango, citrus.

b. **Apospory**: Some vegetative cells of the ovules develop into unreduced embryo sac after meiosis. e.g.species of *Malus*, *Crepis*.

c. **Diplospory**: Embryo sac is produced from the megasore. Diplospory leads to parthenogenesis or apogamy.

Parthenogenesis: Embryo develops from egg cell. Depending upon embryo sac is haploid or diploid. Parthenogenesis is termed as haploid parthenogenesis and occur accidentally reported in *Solanum nigrum,* maize or diploid parthenogenesis occurs in many grasses e.g.*Taraxacum*.

Apogamy: Synergids or antipodal cells develop into an embryo without fertilization. Haploid or diploid occurs in *Allium* and many other species.

Significance of Apomixis

Apomixis is nuisance when the breeder desires to obtain sexual progeny i.e. self or hybrids. But it is great help when the breeder desires to maintain variety.

Though apomixis is categorized as abnormal sexual reproduction the progeny develops without fusion of both gametes and hence may be treated as asexual or vegetative reproduction.

3 Plant Introduction

It consists of taking a genotype or group of genotype of plant into new environment where they have not been grown before.

The main steps involves in introduction are –

i. Exploration (Careful search) ii. Collection iii. Purification
iv. Conservation v. Evaluation vi. Storage vii.Utilization

Types of introduction

1. **Primary introduction**:

When introduced variety is well suited to new environment, it is released for commercial cultivation without any alteration in the original genotype though it is brought from other countries.

2. **Secondary introduction**:

The introduced variety may be subjected to selection to isolate superior variety alternatively it may be hybridized with local variety to transfer one or few characters in local variety is known as secondary introduction.

Merits of Plant Introduction

1.Provide entirely new crop plant.
2.May provide superior variety directly or after selection or hybridization.
3.Introduction and exploration are the only feasible means of collecting germplasm and to protect variability from genetic erosion.

4.It is very quick and economical method of crop improvement, particularly when the introductions are released as varieties either directly or after selection.

5.Crop species may be introduced in new disease free areas to protect them from damage. e.g. Coffee and Rubber.

Demerits of Plant introduction

Plant introduction are associated with the entry into the country of weeds, diseases and pests along with the introduced material. In the past several such cases have occurred.

1.weeds:

Argemone mexicanan , Echornia aressipes, Phylaris minor,Parthenium are some of noxious weeds that entered India.

2. Diseases:

Late blight of potato from Europe.

Coffee rust from Ceylon

Bunchy top in Banana from Ceylon

3. **Insect pests:**Potato tuber moth from Italy,Wooly aphis of Apple, Fluted Scale of Citrus

4. Ornamentals turned weeds:

Water hyacinth and *Lantana camara* were both introduced as ornamental plants, but they are now noxious weeds.

5. Threat to ecological balance:

Eucalyptus spp. introduced from Australia, cause a rapid depletion of the sub soil water reserves. This is detrimental to the ecosystem.

Q. 9 Define self incompatibility. Write its classification and importance in vegetable improvement.

Ans: Self-Incompatibility

It refers to the failure of pollen from a flower to fertilize the same flower or other flowers on the same plant.

Self incompatible pollen grains fail to germinate on the stigma.

If some pollen grains do germinate, pollen tubes fail to enter the stigma.

Pollen tube enters the style, but they grow too slowly to effect the fertilization before the flower drops.

Fertilization is effected, but the embryo degenerates at a very early stage.

Classification of self incompatibility

Lewis (1954) suggested-

1. Heteromorphic system
2. Homomrphic system- a. Gametophytic
   b. Sporophytic

1. Heteromorphic system

Flowers of different incompatibility groups are different in morphology.

The incompatibility reaction of pollen is determined by the genotype of the plant producing them.

2. Homomrphic system-

a. Gametophytic self incompatibility

The incompatibility reaction of pollen is determined by its own genotype and not the genotype of the plant on which it is produced

Incompatibility reaction is determined by a single gene with multiple alleles.

E.g. *Beta vulgaris, Solanum*

b. Sporophytic self incompatibility

The incompatibility reaction of pollen is determined by genotype of plant on which the pollen is produced and not the genotype of the pollen

- There are frequent reciprocal differences.
- Incompatibility can occur with the female parent.
- A family consists of three incompatibility groups.
- Homozygous are normal part of the system.
- An incompatibility group may contain two genotypes.

e.g. Radish, diploid *Brassica* crops

Advantages of self incompatibility

1. Where male sterility is nonexistent, self incompatibility can alternatively facilitate the production of F_1 hybrids.
   a. Two self incompatible lines, but cross compatible lines are inter planted
   b. A self incompatible line and self compatible lines
2. Self fertility can be induced temporarily or permanently by mutation of S-allele to S_1 through artificial irradiation in clonally propagated species.
3. Seedless varieties, such as in watermelon, muskmelon etc. can be evolved if self incompatibility is present.

Q. 10 Differentiate between

1. Pedigree Method	**Backcross Method**
1. F_1 and the subsequent generations are allowed to self pollinate.	1. F_1 and the subsequent generations are backcrossed to the recurrent parent.
2. The new variety different from the parent.	2. The new variety is identical except for character under transfer.
3. Variety is to be extensively tested before release.	3. Usually extensive testing is not necessary before release.
4. The method aims at improving the yielding ability and other characters.	4. The method aims at improving specific defects of well adapted popular variety.
5. It is useful in improving qualitative and quantitative characters	5. It is useful for the transfer of both qualitative and quantitative characters provided they have high

heritability.

6. It is not suitable for gene transfer related species and producing substitution or addition lines.
6. It is the only useful method for from gene transfers from related species and for producing addition and substitution lines.
7. Hybridization is limited to the production of the F_1 generation.
7. Hybridization with the recurrent parent is necessary for producing every backcross generation.
8. Subsequent generations are much larger than those in backcross.
8. The backcross generations are small and usually consists of 20-100 plants in each generation.
9. The procedure is the same for both dominant and recessive genes.
9. The procedure for the transfer of dominant and recessive genes are different.

2. Pure line Selection | **Mass Selection**

1. New variety is pureline
2. Variety is highly uniform. Variation is purely environmental
3. Subjected to progeny test.
4. Brings about the greatest improvement.
5. Narrower adoption and lower stability.
6. It is not necessary that they should have similar phenotype.
7. Yield trials are to be conducted carefully.
8. 9-10 years are required
9. Selection within variety is ineffective.
10. Produce is uniform in quality.
11. Variety is easily identified.
12. Used in self pollinated and often cross pollinated crops.

1. New variety is mixture of pureline
2. Variety has genetic variation.
3. Progeny test generally not carried out.
4. Variety is inferior
5. Wider adaptation and greater stability.
6. Similar phenotypes.
7. Extensive yield trials are not necessary.
8. 5-7 years are required.
9. Selection within variety is effective.
10. Produce is not uniform.
11. Variety difficult to identify.
12. Used in both self and cross pollinated crops.

11 Define the following terms

Ans:

1. **Heterozygosity:** An individual having dissimilar alleles of a gene, the condition is known as heterozygosity.

2. **Vegetable Breeding:** It is the art and science of changing and improving the heredity of vegetable crops.
3. **Clonal Degeneration**: The loss in vigour and productivity of clones with time is known as clonal degeneration. It is the result of mutation, viral and bacterial disease.
4. **Isogenic line:** Lines are identical in genotype except for one gene.
5. **Germplasm:** The sum total of hereditary material i.e. all the alleles of various genes present in a crop species and its wild relatives
6. **Male sterility:** Absence of functional pollen grains, in otherwise hermaphrodite flower
7. **Polyploidy:** An individual with more than two identical or distinct genomes.
8. **Inbreeding depression:** Loss of vigour due to inbreeding.

Q. 12 Match the pair

'A'	'B'
1. *Luffa cylindrica*	h) a. Sponge gourd
2. *Luffa acutangula*	f) b. Ridge gourd
3. Phule Utkarsha	d) c. Parbhani Kranti x Varsha Uphar
4. *Cucurbita moschata*	b) d. Pumpkin
5. Pusa Sawani	g) e. Pusa Makhmali x Bengal Local
6. *Cucurbita pepo*	a) f. Summer squash
7. Sylvia	e) g. Pea
8. Pusa Himani	c) h. Radish

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Signature of the Course Instructor-

Name- Prof. S.U.Chalak

Phone No- ----- **Mobile- 9405854603**

Email:- sunilchalak@gmail.com

Signature of the Associate Dean& Principal, College of Horticulture, Pune

Name- Dr. S. D. Masalkar

Phone No- 020 25537646 **Mobile- 9422227195**

Email id :- princoh@gmail.com

Signature of the University Head of the Department-

Name- Dr. S. A. Ranpise

Phone No - 02426 243247 **Mobile-**

Email id :- hodhort2013@gmail.com