Model Answers

FORESTRY

M.Sc.IInd Semester, Examination-2013.

PAPER: Forest Tree Improvement and Biotechnology

Note: Attempt any five questions. Question No. 1 is compulsory

Q.1.

i. The Phenotypic difference between males and females of the same species is called

- Dimorphism b. Polymorphism
- Phenocopies d. All of above.

Ans:- **a. Dimorphism**

ii. Crossing an offspring (usually hybrid) to either one of its parental types is

a. Test crossing b. Back crossing

c. Forward crossing d.Hybrid crossing

Ans:- **b. Back crossing**

iii. Plant that produce only ovules or pollen are called

- Dioecious b. Monoecious

c. Dichogamous d. Manogamous.

Ans:- **a. Dioecious**

iv. Alternative forms of a gene are called...

- Loci b. Multiples

c. Chromosomes d. Alleles

Ans:- **d . Alleles**

v. A forest tree population is said to be sympatric when…

- Two populations are physically isolated by natural barriers
- Two populations live together and freely interbreed to produce sterile offsprings.
- Two populations share the same environment but cannot interbreed.
- Two populations are isolated but occasionally come together to interbreed.

Ans:- **c. Two populations share the same environment but cannot interbreed**

vi. A DNA sequence is polymorphic if:

A. The carrier frequency is less than 2 percent

B. It can be cut with a restriction enzyme

C. A variant sequence occurs in at least 1 percent of the population

D. It is present in more than 100 genes

Ans:- **C. A variant sequence occurs in at least 1 percent of the population**

vii. Which vector is mostly used in forest tree improvement

A. Plasmid B. Cosmid C. Phasmid D. Agrobacterium

Ans:- **D**. **Agrobacterium**

viii. The movement of alleles among the population is called;

- Migration b. Selection

c. Deployment d. Inbreed depression

Ans:- **a. Migration**

ix. A continuous genetic gradient in a single measurable trait that is associated with Environmental gradient is called a ;

- Cline b. Ecotype

c. Ecad d. Land race

Ans:- **a. Cline**

x. A population tends towards dissimilarity when;

- There is no migration
- Mutation rates are elevated
- Population size are small
- All of above

Ans:- **d. All of above**

Q.2. How Mendel's law helps to understand the phenotypes, genotypes of forest tree in F_1 and F_2 generations when monohybrid and dihybrid crosses are made. Explain with suitable examples.

Ans:-

Mendel's laws form the theoretical basis of our understanding of the genetics of inheritance of forest tree species. The phenotype and genotype of an organism arises from the complex interactions of many character traits. In a monohybrid cross a single character trait and in dihybrid cross two character traits can segregate in several ways, resulting in different phenotypes and genotypes of forest tree species. Mendel's Second Law, the Law of Segregation, asserts that the factors that come together when an egg is fertilized, will separate again, unaffected by their mixture in the developed organism and unaffected by their physiological interaction that produces the phenotype of the adult. Mendel's Third Law, the Law of Independent Assortment asserts that when there are factor pairs for different characteristics, say a factor pair for flower color and a factor pair for plant height, that the segregation of the flower color factors when gametes are formed is causally independent of the segregation of the factor pair for plant height. The Second and Third Laws are then descriptions of regularities in inheritance. Mendel's First Law, the Law of Dominance, in contrast is a developmental law, asserting that when the two factors of a factor pair in an individual organism differ in their physiological effect, one will dominate the

other in the final result of development.

The phenotypic Ratio in monohybrid cross is all tall in F_1 and in F_2 is 3:1(3 Tall, 1 Dwarf),But the Genotypic ratio in F_1 is Tt (Heterozygous tall) and in F_2 is 1:2:1(1 pure Tall TT, 2 heterozygous Tall Tt, 1 pure Dawrftt).While In a dihybrid cross two character traits can segregate in several ways, with each leading to a different phenotype and genotype such as the phenotypic ratio in F_2 is 9:3:3:1 while genotypic ratio is 1:2:1:2:4:2:1:2:1.

From the above given ratio's this becomes relatively straightforward, providing each character trait behaves in a Mendelian fashion; that is, a simple dominant-recessive expression pattern. If the character traits are located on different chromosomes, they will segregate independently from each other. This means that the separate probabilities of each character trait can be predicted in case of forest tree species, as with a monohybrid or dihybrid cross. It follows then that the probabilities of these different phenotypes and genotypes occurring simultaneously in the same forest tree species will be the product of their probabilities occurring alone.

Q.3. Define pollination. How pollination takes place in forest tree species. Mention the detailed role of pollinators in pollination, How pollinators influence the forest population genetics.

Ans:-

Pollination is transfer of pollen from the anther (the male part of the flower) to the stigma (the female part of the flower). Some plants can pollinate themselves: in this case, the pollen passes from the anther to the stigma inside the same flower, and this is called self-pollination. Other plants need pollen to be transferred between different flowers or different individuals of the plant. This is cross-pollination. Many plants can be pollinated both ways.

Pollination occurs in several ways. The transfer of pollens from anther to stigma is carried out by wind, water, animals, birds or insects. Usually forest tree species rely on animals, insects or the wind to pollinate them.When animals such as bees, butterflies, moths, flies, and hummingbirds pollinate plants, it's accidental. They are not trying to pollinate the plant. Usually they are at the plant to get food, the sticky pollen or a sweet nectar made at the base of the petals. When feeding, the animals accidentally rub against the stamens and get pollen stuck all over themselves. When they move to another flower to feed, some of the pollen can rub off onto this new plant's stigma.Another way plants are pollinated is by the wind. The wind picks up pollen from one plant and blows it onto another.In this way pollination occurs in forest trees.

A pollinator is the biotic agent (vector) that moves pollen from the male anthers of a flower to the female stigma of a flower to accomplish fertilization or syngamy of the female gamete in the ovule of the flower by the male gamete from the pollen grain. Plants fall into pollination syndromes that reflect the type of pollinator

being attracted. Essentially, it is what allows a plant to reproduce and to produce fruit. Pollination is necessary for fertilization. A single flower may need multiple pollinator visits to ensure that it will produce full-bodied fruit and a full set of seeds capable of producing new plants of that species. So the main role of apollinator in pollination is the movement of pollen from anther to stigma for fertilization.

The pollinators influence the forest population genetics by following ways;

- Pollinator-mediated selection plays a major role in floral evolution and speciation.
- Pollinators are the sources for the genetic diversity and genetic variation in forest tree populations.
- Pollinators architect the genetic structure of forest tree populations.
- Pollinators can be a cause for the development of noval forest tree species in case of Disease resistance, salt resistance, drought & frost resistance, better growth and high yield.

Q.4. Explain the following.

- **Provenance and its role in forest tree improvement.**

Ans:-

The term "provenance" refers to a specific geographical location within the natural range of a tree species. Natural selection during the course of evolution has adapted each provenance to its particular local environment. This means that there are large genetic differences among provenances growing in different environments. Provenance research defines the genetic and environmental components of phenotypic variation associated with geographic source. Information on provenance is important for tree improvement programmes.once a suitable provenence identified and selected for any tree improvement programme can give the success for that vary programme.The study of provenence helps in assuring sources of seed to give well-adapted, afforestation and reforestation programmes of tree improvement,To develop productive trees, directing breeding of interracial and interspecific hybrids toward adaptation to particular localities and to observe inherent adaptive variation and inherent nonadaptive differences of a forest tree species.

- **Pollinators and there energetic**

Ans:-

An agent that moves pollen from the anthers to the stigmas of flowers, thus effecting pollination are called pollinators. Animals that are known to be good pollinators of flowers include bees, butterflies, hummingbirds, moths, some flies, some wasps, and nectar feeding bats.Plants benefit from pollinators because the movement of pollen allows them to reproduce by setting seeds. However, pollinators don't know or care that the plant benefits. They pollinate to get nectar and/or pollen from flowers to meet their energy requirements and to produce offspring ie pollinator energetic. In the economy of nature, the pollinators provide an important service to flowering plants, while the plants pay with food or energy in form of nectar, pollen, waxes, pheromones, chemicals etc for the pollinators and their offspring.

Classical pollination studies focused on flower morphology relative to morphology and behavior of

pollinators . More recent studies have emphasized pollinator foraging behavior as a key to understanding inter-plant gene flow.Foraging energetics as a unifying approach to pollination ecology and ecosystem perspectives. Unlike morphological coadaptations between flowers and pollinators, the "fit" between caloric food rewards of flowers and energy expenditures of their pollinators is often not readily apparent, except grossly. However, some precision has been demonstrated using time-energy budgets in territorial species . Apparent "sloppiness" of energy fit may result from viewing pollinator-plant interactions on a one-to-one basis rather than from an ecosystem perspective. In addition, many flowers are utilized by foragers of both high and low energy expenditure.

Q.5.Explain heterosis. How vigor of a hybrid can be maintained through tree breeding. Give the suitable examples.

Ans:-

Heterosis, hybrid vigor, or outbreeding enhancement, is the improved or increased function of any biological quality in a hybrid offspring or The tendency of a crossbred individual to show qualities superior to those of both parents called heterosis. The increased vigor or general health in terms of disease resistance, drought & frost resistance, better yield and other superior qualities that are often manifested in hybrid organisms is called heterosis. Increased vigor or other superior qualities arising from the crossbreeding of genetically different forest tree species. Crosses between inbreds from different **heterotic groups** result in vigorous F1 hybrids with significantly more heterosis than F1 hybrids from inbreds within the same heterotic group or pattern. In forestry heterotic groups are created by forest tree breeders to classify inbred lines, and can be progressively improved by reciprocal recurrent selection.

Although species hybridization has proved to be a viable improvement strategy for some genera of forest tree species like *Eucalyptus, Populus, Salix, Pinus, Tectona*etc. Heterosis or hybrid vigour in these species have been developed through the technique of hybridization. The crossing of these species or populations resulted into the highly evolved, but different adaptive systems hybrids that are more fit than either parent species (heterosis).Once we got a hybrid of required characteristics like disease resistance, salt resistance, frost resistance, better growth, High yield, Herbicide resistance etc we can use these hybrids for many tree improvement programmes.once a hybrid of interest is produced can be conserved and utilized for a very long time.Tree breeding play an important role in the mentainance of these hybrid vigors.with the help of tree breeding we can mentain the hybrd vigor by following ways

- Making Artificial crosses between the selected genera and the hybrid of interest. So that the gene of interest can be conserved through a generation line.
- Through vegetative propagation like cutting, grafting, layering, budding and also through micropropagation.
- Through making isolated these hybrid groups from main population area,so that it couldn't receive pollen

from nearby population.

Q.6. **How the induction of polyploidy can be made in forest tree species. How much it will be significant for species improvement point of view.**

Ans:-

Polyploids are organisms with multiple sets of chromosomes in excess of the diploid number. Polyploidy is common in nature and provides a major mechanism for adaptation and speciation. Several cytological mechanisms are known to spontaneously induce polyploidy in plants .One such route involves non-reduction of gametes during meiosis a process called meiotic nuclear restitution. Another major route for polyploid formation is through somatic doubling of chromosomes during mitosis. Artificial inducement of polyploids through the inhibition of mitosis is routine in plant breeding. High temperatures above 40°C have been used to induce tetraploid and octoploid corn seedlings albeit with low success of 1.8% and 0.8% respectively. Currently, chemical mitotic inhibitory agents such as colchicines, oryzalin or dinitroanilines are used to induce polyploidy in forest tree species.Polyploidy can be induced in forest tree species by two methods ie

Physically induced polyploidy through heat/cold shocks, X-rays and through centrifugation.

Chemically induced polyploidy through the treatments of various chemials like colchicines, oryzalin or dinitroanilines.

The colchicines method is most commonly used method for the induction of polyploidy of forest tree species.The process was developed by Blackslee and avery in 1937.The alkaloid suppresses mitotic spindle fibre production during mitosis.The concentration of colchicines used depends upon the nature of the plant part used for regeneration.

Seeds- 0.001%(1-10 days)

Seedlings- 0.02-0.06%(3-24 hrs)

Shoot apices- 0.1-1.0% (few days)

Shoot buds- 0.05-0.15% (4-36 hrs)

colchicines is generally used as aqueous solutions at varying concentrations, in glycerine, or in agar gel. It can be used to generate fertile polyploids

The significance of inducing polyploidy in forest tree species has been well established with the past research. Following are some important credits of induction polyploidy for forest species point of view;

- Healthy and fertile forest tree species can be developed through induction polyploidy.
- It helps to evade inbreed depression among forest tree populations
- It alters gene expression and gene regulation for specific traits among forest tree species.
- It increases the vigor of the new developed polyploids with reference to disease resistance, salt resistance, drought & frost resistance, better growth, high yield etc.

Q.7. Write short notes of the following.

- **Null hypothesis**

Ans:-

The Null hypothesies is a particular hypothesies which is tested for its rejection under the assumption that its true. It assumes that there is no difference between hypothetical population and the one from which the sample under study has been drawn. Professor R.A.Fisher has given the name to such a hypothesies as Null hypothesies. These null hypotheses do not model reality, which is complex, but allow us to see how well real data conform or deviate from the model. Deviations from the null hypotheses provide information about processes that must therefore be operating in natural forest populations.

- **Wohlunds principles**

Ans:-

In population genetics, the **Wahlund effect** refers to reduction of heterozygosity (or when a organism has two different alleles) in a population caused by subpopulation structure. Namely, if two or more subpopulations have different allele frequencies then the overall heterozygosity is reduced, even if the subpopulations themselves are in a Hardy-Weinberg equilibrium. The underlying causes of this population subdivision could be geographic barriers to gene flow followed by genetic drift in the subpopulations.

The Wahlund effect was first documented by the Swedish geneticist StenWahlund in 1928.Suppose there is a population P, with allele frequencies of **A** and **a** given by p and q respectively ($p + q = 1$). Suppose this population is split into two equally-sized subpopulations, P_1 and P_2, and that all the *A* alleles are in subpopulation P_1 and all the *a* alleles are in subpopulation P_2 (this could occur due to drift). Then, there are no heterozygotes, even though the subpopulations are in a Hardy-Weinberg equilibrium.

- **Plus tree**

Ans:-

It has a superior phenotype for growth, form, wood quality, or other desired characteristics and appears to be adaptable. A tree that has been recommended for production or breeding orchards following grading. It has not yet been tested for its genetic worth.Different species have by nature different architecture. Selection for plus tree may vary between different species and improvement programmes. However, timber species to be cultivated in plantations share a number of desired features. The ideal plus tree has following characteristics:

- Straight, cylindrical, non-forking, non-twisting bole.
- Fast growth
- Narrow crown
- Thin branches with wide branch angles
- High wood density and long fibres
- Resistance to pest and diseases.
- Plus tree must be mature

STEPS IN PLUS TREE SELECTION

- Mapping of area and stand from where the plus tree is to be selected.
- Site description must be clearly identified for the selection of plus tree..
- Selection and marking of trees: plus trees are marked and graded. The mark should be distinct and conspicuous. The tree is marked with a number, which corresponds to that in the grading sheet and on the map. Yellow, red or white paint should be used for numbers. Paint or tape for bands

- **Aneuploidy**

Ans:-

Changes in chromosome number can occur by the addition of all or part of a chromosome (**aneuploidy**), the loss of an entire set of chromosomes (**monoploidy**) or the gain of one or more complete sets of chromosomes (**euploidy**).

Aneuploidy - the abnormal condition were one or more chromosomes of a normal set of chromosomes are missing or present in more than their usual number of copies

The different conditions of aneuploidy are:

- **Nullisomy** - the loss of both pairs of homologous chromosomes; individuals are called nullisomics and their chromosomal composition is 2N-2
- **Monosomy** - the loss of a single chromosome; individuals are called monosomics and their chromosomal composition is 2N-1
- **Trisomy** - the gain of an extra copy of a chromosome; individuals are called trisomics and their chromosomal composition is 2N+1
- **Tetrasomic** - the gain of an extra pair of homologous chromosomes; individuals are called tetrasomics and their chromosomal composition is 2N+2

In addition to these conditions, more than one pair of homologous chromosomes may be involved. For example, a**doublemonosomic** is missing one chromosome from each of two pair of homologous chromosome (designated**2N-1-1**), and a **double tetrasomic** contains an extra pair of two pairs of homologous chromosomes (**2N+2+2**).

Q.8.Define micropropagation. How this technique is utilized for the mentainance of propagation of forest tree species. Write about the merits and demerits of this way of propagation.

Ans:-

Micropropagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using modern plant tissue culture methods. Micropropagation is used to multiply novel plants,

such as those that have been genetically modified or bred through conventional plant breeding methods. It is also used to provide a sufficient number of plantlets for planting from a stock plant which does not produce seeds, or does not respond well to vegetative reproduction.

Forest trees are renewable sources of food, fodder, fuel wood, timber and other valuable non-timber products. The ever increasing human and livestock populations have put heavy demands for plant products, resulting in over exploitation of forest trees. Therefore, there is an urgent need for conservation of germplasm and also for propagation of a sustainable utilization of forest trees. Micropropagation of tree species offers a rapid means of producing clonal planting stock for afforestation, woody biomass production and conservation of elite and rare germplasm. success has been achieved on in vitrowork done for a number of important forest trees like *Albizia lebbeck*, *Leucaena leucocephala*, *Prosopis cineraria, Poplus species, Salix, Dalbergia sissoo* etc The technique of micropropagation which we use for multiplication and mentainance of forest tree species i.e,

- Micropropagation by axillary and apical buds
- Micropropagation by axillary shoots (buds, bulbs and protocorms)
- Micropropagation through callus culture
- Artificial seeds
- Somaclonal variations

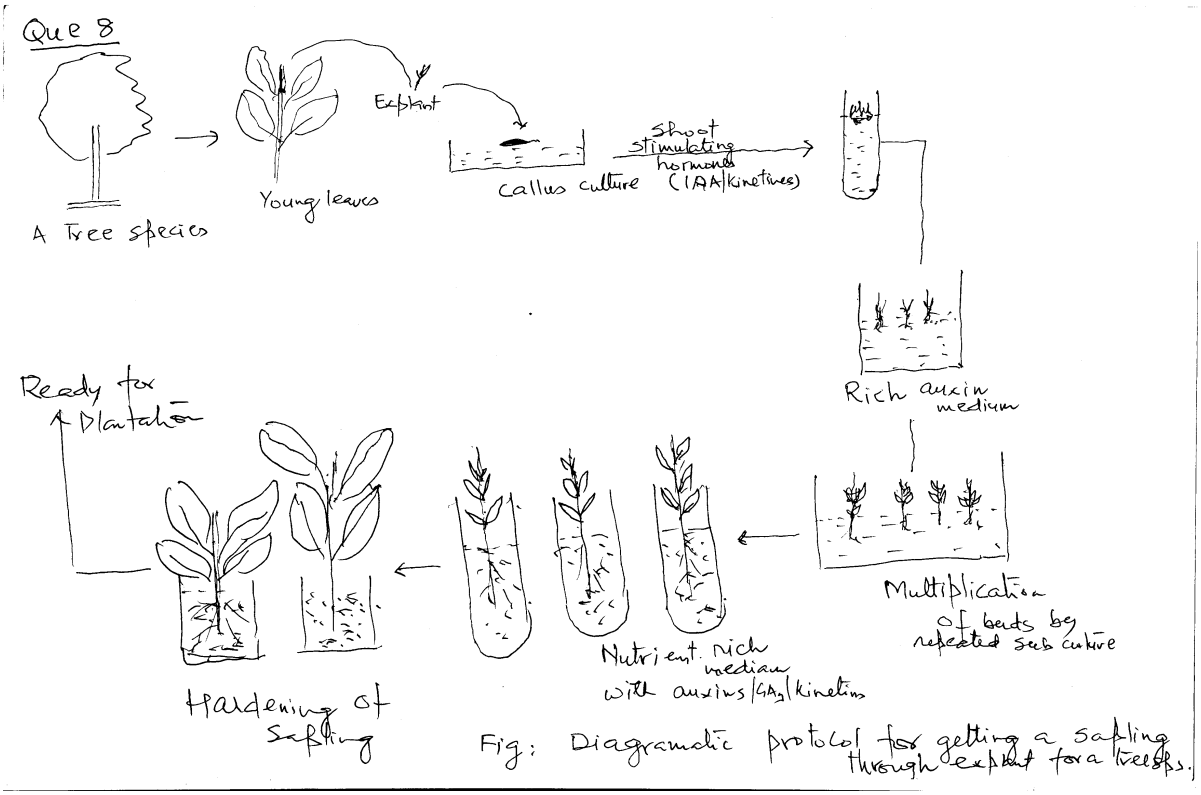

Fig: Diagramatic protocol for getting a sapling through explant for a tree sps.

Merits of Micro Propagation:

1. Tissue culture helps in rapid multiplication of forest trees throughout the year.
2. A new forest tree species can be regenerated from a miniature plant part, whereas in conventional methods a shoot of considerable length is required.
3. Large number of forest tree species can be produced in culture tubes in small space with uniform growth and productivity of growing them in large area in nursery.
4. Forest trees species raised by tissue culture are free from diseases.
5. Tissue culture coupled with somatic hybridization helps in evolving new cultivar in a short time.
6. Micro propagation facilitates long distance transport of propagation material and long term storage of clonal materials.

Demerits of Micro Propagation:

1. The cost involved in setting up and maintence of laboratory is very high .
2. Tissue culture techniques require skill and manpower.
3. Slight infection may damage the entire lot of plants.
4. Some genetic modification (mutation) of the plant may develop with some varieties and culture systems which may alter the quality of the produce.
5. The seedling grown under artificial condition may not survive when placed under environmental condition directly if thing is not given.