

FOREST GENETICS

SECTION A: FOREST GENETICS

Basic principles – Introduction to forest genetics, tree breeding and its applications. Molecular basis of inheritance & genome organization

Variation: causes and kinds of variation, variation in natural and artificial stands, forces that shape variation, uses of variation. Estimates of variance components and covariance among relatives.

Population Genetics – Gene frequencies, Hardy-Weinberg law, evolution and migration.

Evolutionary Genetics – Natural selection, mutation, genetic drift, gene flow, speciation.

Quantitative Genetics – Heritability- broad and narrow sense, selection differential, selection intensity, response to selection, genetic gain and combining ability and their application. Genotype x environment interaction and stability of performance, Genetic correlation. Multiple factor inheritance. Linkage disequilibrium, genetic load. Mating system and mating design.

Conservation Genetics – Objectives in gene conservation, genetic structure, *In situ* and *ex situ* gene conservation, forest fragmentation, forest tree gene conservation methods. Molecular markers i.e. RAPD, ISSR, AFLP and SSR and their applications in forest conservation and tree improvement. Population and conservation genetics. Cryopreservation and plant regeneration for conserving and micropropagation of specific plant material for *ex situ* conservation.

Molecular Genetics: Inheritance of genetic information: Cell division, regulation of cell cycle, sexual reproduction and Mendelian genetics. The structure of the genome: chromosomes, chromosomal structure, extrachromosomal inheritance, organization of prokaryotic and eukaryotic genes and genomes including operon, exon, enhancer promoter sequences and other regulatory elements. The molecular basis of transmission of genetic information: nucleic acids and proteins. DNA replication, DNA damage and repair, mutations– spontaneous, induced and site-directed, recombination in bacteria, fungi and viruses, transformation, transduction, conjugation, transposable elements and transposition, recombination, transcription, and translation. Methods of gene isolation and identification, split gene, overlapping genes and pseudo gene. Restriction mapping, genetic libraries, cloning, DNA/RNA-sequencing, PCR.

Construction and use of molecular marker-based chromosome maps. MAS, comparative and association mapping and genome analysis.

SECTION B: FOREST TREE BREEDING

Techniques of tree breeding: Self- and cross-pollinated tree species, natives and exotics with their origin and distribution.

Definition and scope of tree breeding, its objectives and application. Multiple population and nucleolus breeding methods. Selective methods of breeding. Controlled pollination and development of hybrids in forestry. Apomixes, incompatibility and male sterility system.

Polyploidy and mutation breeding. Breeding for specific traits viz. wood properties, resistance to insect and diseases. Ideotype breeding. Genetic and physiological basis of abiotic stress tolerance.

SECTION C: APPLIED TREE IMPROVEMENT

Species and provenance testing, plus trees and their selection methods, progeny testing and identification of elite trees. Production of quality seeds and seed certification. Seed orchards and seed production areas their establishment and management. Advanced generation breeding/seed orchards. Layout and designing of experimental trials.

Vegetative propagation, principles, methods and applications in trees. Plant tissue culture-principles, history and development, field of application, progress and prospects with special reference to tree crops. Components and preparation of culture medium. Collection, handling and surface sterilization of explants. Inoculation and incubation. Culture conditions. Stages of Micro-propagation. Problems and progress of *in vitro* propagation in tree species. Production of virus free plants. Soma-clonal and gameto-clonal variation, factors influencing, exploitation for crop improvement. Anther and haploid culture and production of homo-diploids, protoplast isolation, culture and regeneration; hybrid embryo culture and embryo rescue, protoplast fusion for somatic hybridization, cybridization and its application. Techniques for direct gene transfer to protoplasts.

Clonal testing and clonal selection: Concept of juvenility. Establishment of VMGs and their management. Propagation structures and their management. Hardening of clonal plantlets. Development and deployment of clones. Clonal testing across the sites. Release and registration of clonal material.

Plant exploration, germplasm introduction, exchange, conservation, and evaluation of forest genetic resources. Intellectual property Rights, Plant Variety Protection and Farmers' Right Act. System of variety release and notification. Seed production and certification. Geographical Indicators.

SECTION D: STATISTICAL METHODS AND EXPERIMENTAL DESIGNS

Frequency distribution, measures of central tendency, probability theory and its application in genetics. Tests of significance, Null hypothesis, Z test, t- test, χ^2 (chi-square) test, F-test. Correlation- linear, partial multiple regression, Genetic divergence. Multivariate analysis, basic principles of design of experiment, RBD, CRBD, SPD, IRBD, Augmented design, Grid and honeycomb design.