U.P. HIGHER EDUCATION SERVICES COMMISSION, PRAYAGRAJ

Syllabus

Genetics & Plant Breeding

(Assistant Professor-Higher Education)

(Subject Code-85)

Unit 1: General Genetics and Plant Breeding.

Mendelian inheritance, cell structure, cell division, linkage, its detection and estimation.Epistasis. Gene concept, allelism and fine structure of gene.Sex determination, differentiation and sex linkage. Extra chromosomal inheritance DNA - structure, function, replication and repair.Organization of DNA in chromosome. Genetic code. Gene enzyme, relationship. Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.Replication, Transcription and Translation. Gene regulation in prokaryotes and eukaryotes. Transposable genetic elements.Crop Improvement. Spontaneous and induced mutations and their molecular mechanisms. Crop domestication, evolution of crops and centres of diversity. Emergence of scientific plant breeding. Objective and accomplishments in plant breeding and the role of National and International Institutes. Gametogenesis and fertilization. Modes of sexual and asexual reproduction and its relation to plant breeding methodology. Mating system and response to selection.Apomixis incompatibility and male sterility systems and their use in plant breeding.

Unit 2: Crop Improvement

Origin, distribution and floral biology of cereals, wheat, rice, maize,sorghum, pearl millet, minor milletspulses pigeonpea, chickpea, black gram, green gram, pea, lentil, oilseeds, groundnuts, sesamum, rapeseed mustard, soybean, linseed; fibers and sugar crops, fodder and green manures. Breeding methods for self-pollinated, cross-pollinated, and clonally propagated crops. Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance multiline approval. Ideotype breeding. Mutation breeding. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding.

Unit 3: Cytogenetics of Crop Plants

Chromosome structure, function and replication. Recombination and crossing over, karyotype analysis.Structural and numerical variations of chromosomes and their implications. Chromosome banding and painting techniques. In situ hybridization. Special types of chromosomes. Chromosomal interchanges, inversions, duplications and deletions. Polyploids, haploids aneuploids and their utility. Alien addition and substitution lines. Apomixis. Wide hybridization and chromosomal manipulations

for alien gene transfer. Pre-and post- fertilization barriers in wide hybridization and techniques to overcome the fertilization barriers in crops. Genome organization and cytogenetics of important crop species- wheat, maize, rice, Brassica, cotton, Vigna, potato and sugarcane.Bridge species. Principles and procedures of genome analysis. Cytogenetic techniques for gene location and gene transfer, somatic hybridization soma clonal variation.Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Unit 4: Quantitative genetics

Introduction and historical background of quantitative genetics. Quantitative characters. Multiple factors inheritance. Genetic control of polygenic characters.Analysis of continuous variation mean, range, SD, CV. Genetic advance and types of selection and correlated response. Hardy Weinberg law. Linkage disequilibrium. Genetic load. Polymorphism. Breeding value heritability. Response to selection, correlated response. Estimates of variance components and covariance among relatives. Estimation of gene effects and combing ability. Effects of linkage and epistasis on estimation of genetic parameters. Maternal effects.

Unit 5: Biometrical Genetics

Genotype environment interactions and stability of performance. Mating system and mating design diallel, partial diallel, line × tester, NC-1, NC-II and NC-I designs and Triple Test Cross, approaches to estimate and exploit component of self and cross pollinated crops. Genotype × environment interaction, adaptability and stability and models of stability analysis. Generation mean analysis, concept of combing ability & gene action. QTL mapping, strategy andstatistical methods in QTL mapping.Markers, Marker assisted selection and factors influencing the MAS.

Unit 6: Heterosis Breeding

Concept and types of heterosis. Genetic, physiological, biochemical, molecular, and biometrical basis or approaches of heterosis. Development of heterotic pools for increasing heterosis.Male sterility and use in heterosis breeding.Two and three line approaches of heterosis exploitation. Development of inbreds and parental lines- A, B and R lines. Synthetic and composite varieties. Role of genetic engineering in heterosis breeding.Fixation of heterosis Apomixis in fixing heterosis-concept of single line hybrid. Hybrid breeding in wheat, rice, cotton, maize, pearl millet, sorghum and rapeseed mustard, sunflower, safflower and castor oilseed crops and pigeon pea.

Unit 7: Molecular Breeding

Artificial synthesis of gene. Genetic and molecular markers, generations of molecular markers and their application in genetic analyses and breeding. Molecular markers in genetic diversity analysis and breeding for complex characters.Mapping populations. Gene tagging, marker aided selection.Marker-assisted backcross breeding. Gene pyramiding. Genome projects and utilization of sequence formation. Vectors. DNA libraries, DNA finger printing, DNA sequencing. Nucleic acid hybridization and immunochemical detection. Chromosome walking. Recombinant DNA technology. Gene editing, Gene cloning strategies. Genetic transformation and transgenic. Antisense RNA, RNAI and micro-RNA techniques in crop improvement.International regulations, biosafety issues of GMOs. Bioinformatics tools.

Unit 8: Plant Breeding for Stress Resistance and Nutritional Quality

Genetic basis and breeding for resistance to diseases and insect pests. Breeding for vertical and horizontal resistance to diseases.Host-pathogen interaction and gene-for-gene hypothesis. Genetic and physiological basis of abiotic stress tolerance. Breeding for Climate resilient crops. Breeding for resistance to heat frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits, Role of molecular markers in stress resistance breeding: MAS, MARS and MABB. Breeding for bio-fortification.

Unit 9: Plant Genetic Resources and their Regulatory Systems; Varietal Release and Seed Production

Concepts of gene pools.Genetic enhancement, Use of plant genetic resources for crop improvement.Pre-breeding.Plant exploration, germplasm introduction, exchange, conservation, evaluation and utilization of plant genetic resources. Convention on Biological Diversity and International Treaty on Plant Genetic Resources for Food and Agriculture. Intellectual Property Rights, Biodiversity Act. Plant Variety Protection and Farmers Rights Act. System of variety release and notification. Types of seeds and seed chain. Seed production and certificate.

Unit 10: Statistical Methods and Field Plot Techniques

Frequency distribution. Measures of central tendency, probability theory and its applications in genetics. Probability distribution and tests of significance. Correlation. Linear, partial and multiple regression. Genetic divergence. Multivariate analysis. Principles of analysis of variance.Design of experiment- basic principles, completely randomized design, randomized block and split plot design. Complete and incomplete block designs. Augmented design, Alpha lattice design, Grid and honeycomb design. Hill plots, unreplicated evaluation. Data collection and interpretation.

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