Course Name: Principles of Genetics
Course no.: GPB 501
Credits: 3 (2+1)

Theory

Unit I

Beginning of genetics, early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance; Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits;Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

Unit II

Mendelian population, Random mating population, Frequencies of genes and genotypes,Causes of change: Hardy-Weinberg equilibrium;

Unit III

Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis, Genetic fine structure analysis, Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Regulation of gene activity in prokaryotes and eukaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression, RNA editing.

Unit IV

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; MicroRNAs (miRNAs).

Unit V

Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders

Practical:

- Laboratory exercises in probability and chi-square;
- Demonstration of genetic principles using laboratory organisms;
- Chromosome mapping using three-point test cross;
- Tetrad analysis; Induction and detection of mutations through genetic tests;
- DNA extraction and PCR amplification
- Electrophoresis: basic principles and running of amplified DNA ,
- Extraction of proteins and isozymes
- Use of Agrobacterium mediated method and Biolistic gun; practical demonstrations:
- Detection of transgenes in the exposed plant material;
- Visit to transgenic glasshouse and learning the practical considerations.

Principles of Plant Breeding
Course no.: GPB 502
Credits: 3 (2+1)

Theory

UNIT I

Early Plant Breeding; Accomplishments through plant breeding; Objectives of plant breeding; Patterns of Evolution in Crop Plants: Centre of Origin, Agro-biodiversity and its significance. Pre-breeding and plant introduction and role of plant genetic resources inplant breeding.

UNIT II

Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection; Nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding.

UNIT III

Pure line theory, pure line and mass selection methods,; pedigree, bulk, backcross, singleseed descent and multiline breeding; Population breeding in self-pollinated crops with special reference to diallel selective mating; Transgressive breeding.

UNIT IV

Breeding methods in cross pollinated crops; Population breeding: mass selection and ear-to-row methods; S_1 and S_2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds, breeding approaches for improvement of inbreeds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreeds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.

UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection.

UNIT VI

Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy.

UNIT VII

Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant varietyprotection and farmers rights.

Practical:

- Floral biology in self and cross pollinated species,
- Selfing and crossing techniques.
- Selection methods in segregating populations and evaluation of breeding material;
- Analysis of variance (ANOVA);
- Estimation of heritability and genetic advance;
- Maintenance of experimental records;
- Learning techniques in hybrid seed production using male-sterility in field crops.
- Prediction of performance of double cross hybrid.

Fundamentals of Quantitative Genetics
Course no.: GPB 503
Credits: 3 (2+1)

Theory:

UNIT I

Introduction and historical background of quantitative genetics, Multiple factor hypothesis, Qualitative and quantitative characters, Analysis of continuous variation mean, range, SD, CV; Components of variation- Phenotypic, Genotypic, Nature of gene action- additive, dominance and epistatic, linkage effect. Principles of analysis of varianceand linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.

UNIT II

Designs for plant breeding experiments- principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA

UNIT III

Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysis- Metroglyph and D^2 , Generation mean analysis, Parent progeny regression analysis

UNIT IV

Mating designs- classification, Diallel, partial diallel, L x T, NCDs, and TTC; Concept of combining ability and gene action, G x E interaction-Adaptability and stability; Methods and models for stability analysis; Basic models- principles and interpretation, Bi-plot analysis.

UNIT V.

QTL mapping, Strategies for QTL mapping- Desired population and statistical methods,QTL mapping in genetic analysis; Markers, Marker assisted selection and factors influencing the MAS, Simultaneous selection based on marker and phenotype

Practical:

- Analysis and interpretation of variability parameters, Analysis and interpretation of Index score and Metroglyph,
- Clustering and interpretation of D^2 analysis.
- Genotypic and phenotypic correlation analysis and interpretation,
- Path coefficient analysis and interpretation, Estimation of different types of heterosis, inbreeding depression and interpretation.
- A, B and C Scaling test
- L x T analysis and interpretation, QTL analysis
- Use of computer packages.
- Diallel analysis
- G x E interaction and stability analysis

Principles of Cytogenetics
Course no.: GPB 505
Credits: 3 (2+1)

Theory:

Unit I

Cell cycle and architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes. Variation in chromosome structure: Evolutionary significance; Introduction to techniques for karyotyping; Chromosome banding and painting -in situ hybridization and various applications.

Unit II

Structural and numerical variations of chromosomes and their implications; Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids; Utilization of aneuploids in gene location; Variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction; Evolutionary significanceof chromosomal aberrations, balanced lethal and chromosome complexes; Inter-varietal chromosome substitutions

Unit III

Fertilization barriers in crop plants at pre-and postfertilization levels; In vitro techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploids in crop breeding; Evolutionary advantages of autopolyploid vs allopolyploids; Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer ; Alien addition and substitution lines , creation and utilization; Apomixis , evolutionary and genetic problems in crops with apomixes.

Unit IV

Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale, brassica, and cotton); Hybrids between species with same chromosome number, alien translocations; Hybrids between species with different chromosome number; Gene transfer using amphidiploids, bridge species.

Unit V

Chromosome manipulations in wide hybridization; case studies; Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical:

- Learning the cytogenetical laboratory techniques, various chemicals to be used forfixation, dehydration, embedding, staining, cleaning etc.;
- Microscopy: various types of microscopes,
- Preparing specimen for observation;
- Fixative preparation and fixing specimen for light microscopy studies in cereals;
- Studies on mitosis and meiosis in crop plants.
- Using micrometres and studying the pollen grain size in various crops. Pollen germinationin vivo and in vitro;
- Demonstration of polyploidy

Molecular Breeding and Bioinformatics
Course no.: GPB 506
Credits: 3(2+1)

Theory:

UNIT I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), Functional markers;Mapping populations (F_2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.

UNIT II

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.

UNIT III

Introduction to Comparative Genomics; Large scale genome sequencing strategies;Human genome project; Arabidopsis genome project; Rice genome project; Comparativegenomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography & sequencing by Edman degradation & mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.

UNIT IV

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods ofgene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc and commercial releases; Biotechnology applications in male sterility/hybrid breeding, molecular farming; Application of Tissueculture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights ; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary & secondary), implications in crop improvement.

Practical:

- Requirements for plant tissue culture laboratory; Techniques in plant tissue culture; Media components and media preparation; Aseptic manipulation of various explants , observations on the contaminants occurring inmedia, interpretations; Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures; Visit to commercial micropropagation unit;
- Transformation using Agrobacterium strains, GUS assay in transformed cells / tissues
- DNA isolation, DNA purity and quantification tests,
- Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring anddata analysis for tagging and phylogenetic relationship,
- Construction of genetic linkage maps using computer software. NCBI Genomic Resources, GBFF, Swiss Prot, Blast n / Blast p, Gene Prediction Tool,Expasy Resources, PUBMED & PMC, OMIM & OMIA, ORF finder,
- Comparative Genomic Resources: - Map Viewer (UCSC Browser &Ensembl),
- Primer designing- Primer 3 / Primer BLAST.

Mutagenesis and Mutation Breeding
Course no.: GPB 508
Credits: 3 (2+1)

Theory:

UNIT-I

Mutation and its history, nature and classification of mutations: spontaneous and inducedmutations, micro and macro mutations, pre and post adaptive mutations; Detection of mutations. Paramutations in crops plants.

UNIT - II

Mutagenic agents: physical – radiation types and sources: Ionizing and non-ionizing radiations. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships; Effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects; Dosimetry -Objects and methods of treatment ; Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects ; Radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.

UNIT III

Chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action; Dose determination and factors influencing chemical mutagenesis; Treatment methods using physical and chemical mutagens, Combination treatments; other causes of mutation – direct and indirect action, comparative evaluation of physical and chemical mutagens.

UNIT IV

Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras etc.; Observing mutagen effects in M_2 generation ; Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations; Mutations in traits withcontinuous variation; Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage etc. ; Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation; Comparative evaluation of physical and chemical mutagens for creation of variability in the some species- Case studies.

UNIT- V

Use of mutagens in creating oligogenic and polygenic variations – Case studies ; In vitromutagenesis – Callus and pollen irradiation; Handling of segregating M_2 generations andselection procedures; Validation of mutants; Mutation breeding for various traits (diseaseresistance, insect resistance, quality improvement etc.) in different crops; Procedures for micromutations breeding/polygenic mutations; Achievements of mutation breeding-varieties released across the world, problems associated with mutation breeding. Use of mutagens in genomics, allele mining, TILLING

Practical

- Precautions on handling of mutagens; Dosimetry-Studies of different mutagenic agents: Physical mutagens and Chemical mutagens;
- Learning on Radioactivity- Production source and isotopes at BRIT, Trombay, Learning about gamma chamber;
- Radiation hazards: Monitoring – safety regulations and safe transportation of radioisotopes, visit to radio isotope laboratory; learning on safe disposal of radioisotopes;
- Hazards due to chemical mutagens – Treating the plant propagules at different doses of physical and chemical mutagens;
- Procedures in combined mutagenic treatments;
- Raising the crop for observation; Mutagenic effectiveness and efficiency, calculating the same from earlier literature;
- Study of M_1 generation – Parameters
- Study of M_2 generation – Parameters
- Mutation breeding in cereals and pulses-achievements made and an analysis

- Mutation breeding in oilseeds and cotton- achievements and opportunities;
- Mutation breeding in forage crops and vegetatively propagated crops;
- Procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

Hybrid Breeding
Course no.: GPB 509
Credits: 3 (2+1)

Theory:

UNIT-I

Historical aspect of heterosis, nomenclature and definitions of heterosis ; Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing, sibbing and crossing in self-and cross-pollinated and asexually propagated crops; Pre-Mendelian and Post-Mendelian ideas – Evolutionary concepts of heterosis; Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; Biometrical basis of heterosis.

UNIT-II

Prediction of heterosis from various crosses, inbreeding depression, coefficient of inbreeding and its estimation, residual heterosis in F_2 and segregating populations,importance of inbreeding in exploitation of heterosis – case studies.; Relationship betweengenetic distance and expression of heterosis, case studies; Divergence and genetic distance analyses, morphological and molecular genetic distance in predicting heterosis; Development of heterotic pools in germplasm/genetic stocks and inbreeds, their improvement for increasing heterosis.

UNIT-III

Male sterility and use in heterosis breeding; Male sterile line creation and diversificationin self-pollinated, cross pollinated and asexually propagated crops; Creation of male sterility through genetic engineering and its exploitation in heterosis; Maintenance,transfer and restoration of different types of male sterility; Use of self-incompatibility in development of hybrids.

UNIT-IV

Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreedsand parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis, maintenance breeding of parental lines in hybrids; Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops, problemsand prospects; Apomixis in fixing heterosis-concept of single line hybrid; Organellar heterosis and complementation.

UNIT-V

Hybrid breeding in wheat, rice, cotton, maize, pearl millet, sorghum and rapeseed- mustard, sunflower, safflower and castor oilseed crops and pigeonpea.

Practical:

- Characterization of male sterile lines using morphological descriptors;
- Restorer line identification and diversification of male sterile sources ;
- Male sterile line creation in crop plants , problems in creation of CGMS system,ways of overcoming them ; Diversification and restoration;
- Success stories of hybrid breeding in Maize, Rice, pearl millet, Sorghum andPigeon pea,
- Understanding the difficulties in breeding apomicts;
- Estimation of heterotic parameters in self, cross and asexually propagated crops ;
- Estimation from the various models for heterosis parameters ;
- Hybrid seed production in field crops – an account on the released hybrids, theirpotential, problems and ways of overcoming it;
- Hybrid breeding at National and International level,opportunities ahead

Crop Breeding I (Kharif Crops)
Course no.: GPB 511
Credits:: 3(2+1)

Theory:

UNIT-I

Rice: - Origin, evolution, , mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding.

Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, releasedvarieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications.

Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance etc.

UNIT-II

Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc; Breeding approaches, introgression of alien gene(s)(if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes.

Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc; Breeding approaches, introgression of alien gene(s)(if required), biotic and abiotic stress resistance, released varieties, examples of MAS usedfor improvement

Other pulses: Urdbean, mungbean, cowpea,: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasonsfor failure, ways of overcoming them.

UNIT-III

Soybean: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc; Breeding approaches, introgression of alien gene(s)(if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement

Castor and Sesame: Origin, evolution mode of reproduction, chromosome number;Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement ; Hybrid breeding in castor – opportunities, constraints and achievements.

UNIT-IV

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

Jute: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding,

released varieties, examples of MAS used for improvement

UNIT-V

Sugarcane: Evolution and distribution of species and forms , wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc. –

Forage crops: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc.,

Seed spices : Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc.,; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops

Practical:

- Floral biology, emasculation, pollination techniques in rice, maize, pigeon pea,soybean, sesame, cotton;
- Study of range of variation for yield and yield components;
- Study of segregating populations in cereal, pulses and oilseed crops;
- Learning on the crosses between different species; attempting crosses betweenblack gram and green gram;
- Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton;
- Visit to Cotton Technology Laboratory and Spinning Mills;
- Learning on the Standard Evaluation System (SES) and descriptors; Use ofsoftware for database management and retrieval;
- Practical learning on the cultivation of fodder crop species on sewage water,analysing them for yield components and palatability;
- Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes;
- Visit to animal feed producing factories;
- Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder

Crop Breeding-II (Rabi Crops)
Course no.: GPB 512
Credits: 3(2+1)

Theory:

UNIT-I

Wheat: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc., breeding approaches, introgression of alien gene(s)(if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Oats: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Barley: Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examplesof MAS used for improvement.

UNIT-II

Chickpea: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Other pulses: Lentil, field pea, Rajma, Horse gram: Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship; ; Breeding objectives : yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), , biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT-III

Rapeseed and Mustard: Origin, evolution, mode of reproduction, chromosome number; Genetics – Cytogenetics and genome relationship; Breeding objectives; yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), , biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality. Sunflower, Safflower: Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement

UNIT-IV

Mesta and minor fibre crops: Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc, breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Forage crops: Origin, evolution mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance

UNIT-V

Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding, released varieties, examples of MAS used for crop improvement.

Practical:

1. Floral biology, emasculation and pollination techniques in wheat, oats, barley, chickpea, rajma, rapeseed mustard, sunflower;
2. Study of range of variation for yield and yield components;
3. Study of segregating populations in cereal, pulses and oilseed crops;
4. Use of descriptors for cataloguing; Learning on the crosses between different species;
5. Trait based screening for stress resistance
6. Learning on the Standard Evaluation System (SES) and descriptors;
7. Use of software for database management and retrieval.

Breeding for Stress Resistance and Climate Change
Course no.: GPB 516
Credits: 3 (2+1)

Theory:

UNIT-I

Concept and impact of climatic change; Importance of plant breeding with special referenceto biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops

UNIT-II

Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical andmolecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria;

UNIT-III

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/adult plant resistance and slow rusting resistance; Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors, moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature,wind, etc; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT-IV

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable tolow water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc.; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT-V

Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management

Practical :

- Understanding the climatological parameters and predisposal of biotic and abiotic stressfactors- ways of combating them for diseases caused by fungi and bacteria;
- Symptoms and data recording; use of MAS procedures;
- Phenotypic screening techniques for sucking pests and chewing pests – Traits to beobserved at plant and insect level;
- Phenotypic screening techniques for nematodes and borers; Ways of combating them.Evaluating the available populations like RIL, NIL etc. for pest resistance;
- Use of standard MAS procedures. Breeding strategies - Weeds – ecological,environmental impacts on the crops;
- Breeding for herbicide resistance;
- Screening crops for drought and flood resistance; factors to be considered and breedingstrategies;
- Screening varieties of major crops for acidity and alkalinity- their effects and breedingstrategies.
- Screening forage crops for resistance to sewage water and tannery effluents; Qualityparameters

evaluation.

Germplasm Characterization and Evaluation
Course no.: GPB 517
Credits: 2(1+1)

Theory

Unit I

Understanding genetic diversity in crop plants; Crop descriptors, descriptor states; germplasm characterization/ evaluation procedures; evaluation of germplasm for specific traits; Measuring diversity using agro-morphological data, statistical procedures to measure population genetic variation, markers and their use in PGR, evaluation of biotic and abiotic stresses, Principles and methods for formulating core and mini core collections and their validation, Web based tools for management of data

Unit II

Principles and practices of germplasm regeneration and maintenance, breeding systems and mode of reproduction; maintaining sufficiently large populations for effective conservation of farmer landraces, evaluation and maintenance of wild relatives of crop plants. Genetic enhancement, Useof CWRs genetic resources for crop improvement.

Unit III

High throughput phenotyping systems- imaging & image processing concepts for automated germplasm characterization (phenotyping) – evaluation for nutritional traits, resistance traits - Biochemical and molecular markers for characterization.

Practical:

- Field layout and experimental designs;
- Recording field data on germplasm evaluation in different agri-horticultural crops,
- post harvest handling
- evaluating quality traits, biochemical and phyto-chemical evaluation of crop germplasm, data processing
- documentation, analysis of diversity and cataloguing, data analysis, viability equations,sampling strategies, data documentation, cataloguing, biochemical analyses of samples.