DDU Gorakhpur University, Gorakhpur 273009

Department of Genetics and Plant Breeding

COURSE CURRICULUM AND SYLLABUS
OF
M. SC. (AG.) IN GENETICS AND PLANT BREEDING

Nomenclature and Credit hour

(On the recommendations of the members of National Core Group, 19 Broad Subject Matter Area (BSMA), ICAR)

Nomenclature	**Credit hours**
Major Courses	20
Minor Courses	08
Supporting Course	06
Common Courses	05
Credit Seminar	01
Research work or Research Methodology	30
Total	**70**

Major courses: From the discipline in which a student takes admission.

Minor courses: From the subjects closely related to a student's major subject. It is suggested that the student may choose minor courses as these are related to policy advocacy and aim to build larger understanding of the subject. The final choice of the minor courses should be mandatorily approved by the Student Advisory committee/HOD.

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its Management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HoD)/ Board of Studies (BoS).

List of course offered in M.Sc. (Ag.) Genetics and Plant Breeding

Curriculum and Syllabus

Course Code	Course Title	Credit Hours
	Major Courses	**51**
GPB 501*	Principles of Genetics	3 (2+1)
GPB 502*	Principles of Plant Breeding	3 (2+1)
GPB 503*	Fundamentals of Quantitative Genetics	3 (2+1)
GPB 504	Varietal Development and Maintenance Breeding	2 (1+1)
GPB 506*	Molecular Breeding and Bioinformatics	3 (2+1)
GPB 511	Crop Breeding-I (Kharif Crops)	3 (2+1)
GPB 512	Crop Breeding-II (Rabi Crops)	3 (2+1)
GBP 591	Seminar	1
GPB 599	Master's Research (Thesis) or Research Methodology	30
Minor		**8**
ENT 507**	Host Plant Resistance	2 (1+1)
GPB 509	Hybrid Breeding	3 (2+1)
GPB 510	Seed Production and Certification	3 (2+1)
Supporting		**6**
STAT 502	Statistical Methods for Applied Sciences	3 (2+1)
STAT 511	Experimental Designs	3 (2+1)
Common		**5**
PGS 501	Library and Information Services	1 (0+1)
PGS 502	Technical Writing and Communications Skills	1 (0+1)
PGS 503	Intellectual Property and its Management in Agriculture	1 (1+0)
PGS 504	Basic Concepts in Laboratory Techniques	1 (0+1)
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1 (1+0)
	Total Credit	**70**

*Compulsory major courses

**Minor course covered by Department of Entomology

Semester Wise Course Distribution

Course Code	Course Title	Credit Hours
	Semester I	
GPB 501	Principles of Genetics	3 (2+1)
GPB 502	Principles of Plant Breeding	3 (2+1)
GPB 509	Hybrid Breeding	3 (2+1)
STAT 502	Statistical Methods for Applied Sciences	3 (2+1)
PGS 501	Library and Information Services	1 (0+1)
PGS 502	Technical Writing and Communications Skills	1 (0+1)
	Total	**14**
	Semester II	
GPB 503	Fundamentals of Quantitative Genetics	3 (2+1)
GPB 504	Varietal Development and Maintenance Breeding	2 (1+1)
GPB 511	Crop Breeding-I (Kharif Crops)	3 (2+1)
ENT 507*	Host Plant Resistance	2 (1+1)
STAT 511	Experimental Designs	3 (2+1)
PGS 503	Intellectual Property and its Management in Agriculture	1 (1+0)
PGS 504	Basic Concepts in Laboratory Techniques	1 (0+1)
	Total	**15**
	Semester III	
GPB 506	Molecular Breeding and Bioinformatics	3 (2+1)
GPB 512	Crop Breeding-II (Rabi Crops)	3 (2+1)
GPB 510	Seed Production and Certification	3 (2+1)
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1 (1+0)
	Total	**10**
	Semester IV	
GBP 591	Seminar	1 (0+1)
GPB 599	Master's Research (Thesis)** Or Research Methodology (Special Paper)**	30 (0+30) 30 (30+0)
	Total	**31**
	Grand Total of Credit	**70**

***This course will be covered by Department of Entomology**

****Satisfactory/Non-Satisfactory**

Course Title : Principles of Genetics*

Course Code : GPB 501

Credit Hours : 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; Micro-RNAs (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; Detection of transgenes in the exposed plant material; Visit to transgenic glasshouse and learning the practical consideration

Suggested reading

Daniel LH and Maryellen R. 2011. Genetics: “Analysis of Genes and Genomes”.
Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006
Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition
Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018
Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co
Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)
Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition International Student Version edition
Stansfield WD.1991. Genetics.Schaum Outline Series Mc Graw Hill
Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015
Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7 edition
Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

Course Title : Principles of Plant Breeding*

Course Code : GPB 502

Credit Hours : 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 in plant 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, single seed 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; S1 and S2 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 variety protection 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.

Suggested Reading

Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.

Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.

Chopra VL. 2004. Plant Breeding. Oxford & IBH.

George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons. Gupta SK. 2005. Practical Plant Breeding. Agribios.

Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi

Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.

Sharma JP. 2010. Principles of Vegetable Breeding. Kalyani Publ, New Delhi.

Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.

Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.

Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

Course Title : Fundamentals of Quantitative Genetics*

Course Code : GPB 503

Credit Hours : 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 variance and 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 D2, Generation mean analysis, Parent progeny regression analysis

Unit IV

Mating designs- classification, Diallel, partial diallel, L × T, NCDs, and TTC; Concept of combining ability and gene action, G × 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 D2 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 × T analysis and interpretation, QTL analysis; Use of computer packages; Diallel analysis; G × E interaction and stability analysis.

Suggested Reading

Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall.

Falconer DS and Mackay J. 1998. Introduction to Quantitative Genetics (3rd Ed.).ELBS/ Longman, London.

Mather K and Jinks JL.1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London.

Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Roy D. 2000. Plant Breeding: Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.

Sharma JR. 2006. Statistical and Biometrical Techniques in Plant Breeding. New Age International Pvt. Ltd.

Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Singh RK and Chaudhary BD. 1987. Biometrical Methods in Quantitative Genetic analysis.

Kalyani Publishers, New Delhi.

Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.

Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.

Course Title : Varietal Development and Maintenance Breeding

Course Code : GPB 504

Credit Hours : 2(1+1)

Theory

Unit I

Variety Development systemsand Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, landraces, hybrid, and population; Variety testing, release and notification systems and norms in India and abroad.

Unit II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production.

Unit III

Maintenance of varieties in self and cross pollinated crops, isolation distance; Principles of seed production; Methods of nucleus and breeder seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified.

Unit IV

Quality seed production technology of self and cross-pollinated crop varieties, viz., cereals and millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi, etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton/ jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).

Unit V

Seed certification procedures; Seed laws and acts, plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/ locations for seed production; Ear-to-row method and nucleus seed production; Main characteristics of released and notified varieties, hybrids and parental lines; PGMS and TGMS; Identification of important weeds/ objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops; DUS testing and descriptors in major crops; Variety release proposal formats in different crops.

Suggested Reading

Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.

McDonald MB Jr and Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.

Poehlman JM and Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH. Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani. 2015 Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.

Course Title : Molecular Breeding and Bioinformatics*

Course Code : GPB 506

Credit Hours : 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 (F2s, 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; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and 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 of gene 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 Tissue culture 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 and 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 in media, 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 and data 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 and PMC, OMIM and OMIA, ORF finder; Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl); Primer designing- Primer 3/ Primer BLAST.

Suggested Reading

Azuaje F and Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics.

John Wiley and Sons.

Brown TA. 1991. Essential Molecular Biology: a practical Approach. Oxford university press, 2002, 2nd edition

Chawala HS. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt.

Ltd.

Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.

Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.

Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.

Lewin B. 2017. Genes XII. Jones & Bartlett learning, 2017.

Robert NT and Dennis JG. 2010. Plant Tissue Culture, Development, and Biotechnology. CRC Press.

Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.

Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, New Delhi. Watson J. 2006. Recombinant DNA. Cold Spring harbor laboratory press.

Course Title : Hybrid Breeding

Course Code : GPB 509

Credit Hours : 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 F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies.; Relationship between genetic 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 diversification in 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 inbreeds and 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, problems and 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 and Pigeon 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, their potential, problems and ways of overcoming it; Hybrid breeding at National and International level, opportunities ahead.

Suggested Reading

Agarwal RL. 1998. Fundamental of Plant Breeding and hybrid Seed Production. Science Publisher London.

Akin E. 1979. The Geometry of Population Genetics. Springer-Verlag.

Ben HL. 1998. Statistical Genomics – Linkage, Mapping and QTL Analysis. CRC Press.

Chal GS and Gossal SS. 2002. Principles and procedures of Plant Breeding, Biotechnology and Convetional Approaches. Narosa Publishing House. New Delhi

De JG. 1988. Population Genetics and Evolution. Springer-Verlag. 30 January 2012 Hartl DL. 2000. A Primer of Population Genetics. 3rd Ed. Sinauer Assoc.

Mettler LE and Gregg TG. 1969. Population Genetics and Evolution. Prentice-Hall. 25 April 1988

Montgomery DC. 2001. Design and Analysis of Experiments. 5th Ed., Wiley & Sons. 2013 Mukherjee BK. 1995.The Heterosis Phenomenon. Kalyani Publishers, New Delhi.

Proceedings of Genetics and Exploitation of Heterosis in Crops – An International Symposium CIMMYT, 1998.

Richards AJ. 1986. Plant Breeding Systems. George Allen & Unwin. 30 May 1997 Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.

Srivastava S and Tyagi R. 1997. Selected Problems in Genetics. Vols. I, II. Anmol Publ. Virmani SS. 1994. Heterosis and Hybrid Rice Breeding. Monographs of ”Theoretical and Applied Genetics”, Springer-Verlag.

Course Title : Seed Production and Certification

Course Code : GPB 510

Credit Hours : 2(1+1)

Theory

Unit I

Importance of seed as basic input in agriculture; Seed quality concept and importance; Generation system of seed multiplication -Varietal replacement rate, Seed multiplication ratios, Seed replacement rate, Seed renewal period and seed demand and supply; Various factors influencing seed production –Physical and Genetic purity in seed production; Factors responsible for varietal and genetic deterioration.

Unit II

Nucleus seed production and its maintenance - Maintenance of parental lines of hybrids, Production of breeder, foundation and certified seed and their quality maintenance; Principles of seed production in self- and cross-pollinated crops; Hybrid seed production - system and techniques involved in Seed village concept; Organic seed production and certification.

Unit III

Principles of seed production in field crops; Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated cereals and millets.

Unit IV

Floral structure, pollination mechanism and methods and techniques of seed production in major pulses and oilseed crops; Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor and Sunflower.

Unit V

Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres. Hybrid-seed production techniques in major vegetatively propagated crops.

Unit VI

Seed certification - history, concept, objectives;Central seed certification board Seed certification agency/ organization and staff requirement; Legal status - Phases of seed certification, formulation, revision and publication of seed certification standards; Minimum Seed Certification Standards (MSCS) for different crops - General and specific crop standards, Field and seed standards; Planning and management of seed certification

programs; Eligibility of a variety for certification, area assessment, cropping history of the seed field.

Practical

Planting design for variety- hybrid seed production techniques, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; Identification of rogues and pollen shedders, supplementary pollination, detasseling, hand emasculation and pollination; Pollen collection and storage methods, pollen viability and stigma receptivity; Pre-harvest sanitation, maturity symptoms, harvesting techniques; Visits to seed production plots - visit to seed industries; Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate; General procedure of seed certification, identification of weed and other crop seeds as per specific crops, field inspection at different stages of a crop and observations recorded on contaminants and reporting of results, inspection and sampling, harvesting/ threshing, processing and after processing for seed law enforcement; Specifications for tags and labels to be used for certification purpose.

Suggested Reading

Agrawal PK and Dadlani M. 1987. Techniques in Seed Science and Technology, South Asian Publishers, Delhi.

Agrawal RL. 1997. Seed Technology, Oxford & IBH Publishing.

Anon, 1965. Field Inspection Manual and Minimum Seed Certification Standards, NSC Publication, New Delhi.

Anon. 1999. Manual of Seed Certification procedures. Directorate of Seed Certification, Coimbatore, Tamil Nadu.

Joshi AK and Singh BD. 2004. Seed Science and Technology, Kalyani Publishers, New Delhi. Kelly AF. 1988. Seed Production of Agricultural Crops. John Wiley, New York.

Mc Donald MB and Copeland LO. 1997. Seed Science and Technology, Scientific Publisher, Jodhpur.

Ramamoorthy K, Sivasubramaniam K and Kannan M. 2006. Seed Legislation in India. Agrobios (India), Jodhpur, Rajasthan.

Singhal NC. 2003. Hybrid Seed Production in Field Crops, Kalyani Publications, New Delhi Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

Course Title : Crop Breeding I (Kharif Crops)

Course Code : GPB 511

Credit Hours : 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.

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.

Pearl 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.

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.

Other pulses: Urdbean, mungbean: 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.

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.

Unit IV

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – biotic and abiotic stress resistance, etc.; Breeding approaches, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

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 (Sorghum): 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.

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 between black 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 of software 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.

Suggested Reading

Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.

Bahl PN and Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.

Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.

Chopra VL and Prakash S. 2002. Evolution and Adaptation of Cereal Crops. Oxford & IBH. Gill KS. 1991. Pearl Millet and its Improvement. ICAR.

IRRI. 1964. Rice Genetics and Cytogenetics. Elsevier.

IRRI. 1986. Rice Genetics. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 1991. Rice Genetics II. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 1996. Rice Genetics III. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 2000. Rice Genetics IV. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

Jennings PR, Coffman WR and Kauffman HE. 1979. Rice Improvement. IRRI, Los Banos, Manila, Philippines.

Kannaiyan S, Uthamasamy S, Theodore RK and Palaniswamy S. 2002. New Dimensions and Approaches for Sustainable Agriculture. Directorate of Extension Education, TNAU, Coimbatore.

Murty DS, Tabo R and Ajayi O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru, India.

Nanda JS. 1997. Manual on Rice Breeding. Kalyani Publishers.

Parthasarathy VA. 2017. Spices and Plantation Crops Vol.1 (Part A) Breeding of Horticultural Crops Vol.1 (Part-B), Today and Tomorrow Printers and Publishers

Poehlman, JM. 1987. Breeding of Field Crops. AVI Publishing Co. Inc. East Post Connecticut, USA.

Ram HH and Singh HG. 1993. Crop Breeding and Genetics. Kalyani.

Sharma, AK. 2005. Breeding Technology of Crop Plant. Yesh Publishing House, Bikaner Slafer GA. (Ed.). 1994. Genetic Improvement of Field Crops. Marcel Dekker.

Singh HG, Mishra SN, Singh TB, Ram HH and Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.

Walden DB. 1978. Maize Breeding and Genetics. John Wiley & Sons.

Course Title : Crop Breeding-II (Rabi Crops)

Course Code : GPB 512

Credit Hours : 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.

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.

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.

Other pulses: field pea, lentil: 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.

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.

Unit IV

Potato: Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches.

Unit V

Tomato: 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.

Practical

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

Suggested Reading

Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.

Bahl PN and Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.

Gupta SK. 2012. Technological Innovations in Major World Oil crops. Vol. I. Springer, USA.

Gupta SK. 2012. Technological Innovations in Major World Oil crops. Vol. II. Springer, USA.

Gupta SK. 2016. Breeding of Oilseed Crops for Sustainable Production. Academic Press, USA.

Kannaiyan S, Uthamasamy S, Theodore RK and Palaniswamy S. 2002. New Dimensions and Approaches for Sustainable Agriculture. Directorate of Extension Education, TNAU, Coimbatore.

Parthasarathy VA. 2017. Spices and Plantation Crops Vol.1 (Part A) Breeding of Breeding and Genetics. John Wiley & Sons.

ENT 507: HOST PLANT RESISTANCE 2(1+1)

Objective: To familiarize the students with types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management.

Theory

UNIT I: History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT II: Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III: Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

UNIT IV: Factors affecting plant resistance including biotypes and measures to combat them.

UNIT V: Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

UNIT VI: Role of biotechnology in plant resistance to insects.

Practical

Screening techniques for measuring resistance. Measurement of plant characters and working out their correlations with plant resistance. Testing of resistance in important crops Demonstration of antibiosis, tolerance and antixenosis.

Suggested Reading

Dhaliwal GS and Singh R. (Eds). 2004. Host Plant Resistance to Insects -Concepts and Applications. Panima Publ., New Delhi.

Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, London.

Panda N and Khush GS. 1995. Plant Resistance to Insects. CABI, London.

Smith CM. 2005. Plant Resistance to Arthropods – Molecular and Conventional Approaches. Springer, Berlin.

STAT 502: Statistical Methods for Applied Sciences 3(2+1)

Aim of the course

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

Theory

Unit I

Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation.

Unit II

Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions.

Unit III

Introduction to theory of estimation and confidence-intervals, Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination, Fitting of quadratic models.

Unit IV

Non-parametric tests – sign, Wilcoxon, Mann-Whitney U-test, Run test for the randomness of a sequence. Median test.

Unit V

Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques, Introduction to Multivariate Analysis, Transformation of Data.

Practical

Exploratory data analysis, fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval estimation and Correlation and regression analysis, fitting of Linear and Quadratic Model. Non-parametric tests. ANOVA: One way, Two Way, SRS.

Suggested Reading

Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. The World Press.

Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The World Press.

Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.

Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.

Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.

Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.

Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. John Wiley.

Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed . John Wiley.

http://freestatistics.altervista.org/en/learning.php.

http://www.statsoft.com/textbook/stathome.html.

STAT 511: Experimental Designs 3(2+1)

Aim of the course

This course is meant for students of agricultural and animal sciences other than Agricultural Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

Unit I

Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

Unit II

Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

Unit III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Unit IV

Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments. Analysis with missing data. Split plot and strip plot designs.

Suggested Reading

Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

PGS 501: LIBRARY AND INFORMATION SERVICES (0+1)

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/ Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 502: TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

Objective

To equip the students/ scholars with skills to write dissertations, research papers, etc. To equip the students/ scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical (Technical Writing)

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);

Writing of abstracts, summaries, précis, citations, etc.; Commonly used abbreviations in the theses and research communications; Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article; Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech; Participation in group discussion; Facing an interview; Presentation of scientific papers.

Suggested Readings

Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995.

Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.

Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.

James HS. 1994. Handbook for Technical Writing. NTC Business Books.

Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

PGS: 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.

Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.

PGS 504: BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/ chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

PGS: 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.

Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.

Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.

Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ

GPB 599 Research Methodology (30+0)

UNIT 1: Genetic diversity analysis- metroglyph, cluster and D^2 analysis. Association analysis- phenotypic and genotypic correlation, path analysis and parent-progeny regression analysis and genetic divergence. Selection indices- selection of parents, Simultaneous model, selection model, concept of selection, heritability and genetic advance. Selection differential and response to selection, correlated response, principal component and discriminant function analysis.

UNIT 2: Mating design, Diallel analysis- Griffin's method 1 and 2. Hayman's graphical approach, North Carolina Design (NCD) and their interpretation – Line X tester analysis and triple test cross. Estimation of heterosis and inbreeding depression, concept of combining ability analysis and nature of gene action- additive, dominance, epistasis and linkage. Treating the plant propagules at different doses of physical and chemical mutagens, visit to radio-isotope laboratory, Mutagenic effectiveness and efficiency, Mutation breeding in cereals and pulses.

UNIT 3: Basic principles of design of experiment, Analysis of variance and covariance, completely randomized design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Missing plot technique, Factorial experiment, Split plot and strip plot design. Preparation of layout plans, and field visits related to application of these designs. Null hypothesis, Alternate hypothesis, Test of significance, z-, t- & X^2 (Chi-square) tests, non-parametric tests.

UNIT 4: History of Cytology, cell structure, cell division. Nucleolus: Structure & Function; Basis of Heredity: Chemical and Physical; Basic knowledge of nucleic acids; Forms of Chromosomes, chromosomal aberrations, linkage, crossing over and gene mapping; Alleles and pleiotropism; Lethal genes; Mendelian principles and gene interaction; Multiple factor; Sex determination; Extracellular inheritance; Mutation: Nature & Causes. Transcription, Translation and gene-regulation. Population Genetics.

UNIT 5: Nature & scope of plant breeding, Plant Introduction & domestication. Reproductive systems; Genetic basis of breeding methods with self & cross pollinated crops; Introduction, Selection, Hybridization, Multiple crossing, Back cross and other approaches; Breeding methods for asexually propagated crops; Systems of mating with respect to selection, heterosis and inbreeding depression; Self-incompatibility and male-sterility; Hybrid, Synthetic and Composite varieties; Recurrent selection; Classes of quality seeds, maintenance & multiplication of Nucleus, Breeder, Foundation & Certified Seeds. Varietal deterioration and their control. Seed viability test (Tz test). Biotechnology in crop improvement.

Suggested Readings

Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.

Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.

Chopra VL. 2004. Plant Breeding. Oxford & IBH.

Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.

Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.

Federer WT. 1985. Experimental Designs. MacMillan.

Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.

Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi.

Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.

Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.

Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.

Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.

Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.

Singh RK and Chaudhary BD. 1987. Biometrical Methods in Quantitative Genetic analysis.

Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.