

New and Restructured Curriculum & Syllabus
Implemented from Academic Session 2020-2021



M.Sc. Ag. (Genetics & Plant Breeding)

Approved by:
Board of Studies –Agriculture
School of Agriculture & Allied Science

Hemvati Nandan Bahuguna Garhwal University
(A Central University)
Srinagar Garhwal, Uttarakhand (India)-246 174

www.hnbggu.ac.in

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Course Curriculum

PAPER CODES	COURSE TITLE	Total Marks	Sessional Marks	External Marks	Credits
Semester - I			(I + II)		
SOA/GPB/C-501	Statistical Methods and Experimental Design	100	40	60	3
SOA/GPB/C-502	Principles of Genetics	100	40	60	3
SOA/GPB/C-503	Principles of Plant Breeding	100	40	60	3
SOA/GPB/C-504	Cytology and Cytogenetics	100	40	60	2
SOA/GPB/C-505	Principles of Seed production	100	40	60	2
SOA/GPB/C-506	Laboratory course - I	100	40	60	5
	Total	600	240	360	18
Semester - II					
SOA/GPB/C-507	Advance Plant Breeding	100	40	60	3
SOA/GPB/C-508	Cell Biology and Molecular Genetics	100	40	60	3
SOA/GPB/C-509	Seed Production in Field Crops	100	40	60	2
SOA/GPB/C-510	Crop Physiology - I	100	40	60	3
SOA/GPB/C-511	Breeding Field crops (Rabi)	100	40	60	2
SOA/GPB/C-512	Laboratory course - II	100	40	60	5
	Total	600	240	360	18
Semester - III					
SOA/GPB/C-513	Biotechnology for crop Improvement	100	40	60	4
SOA/GPB/C-514	Population and Biometrical Genetics	100	40	60	3
<i>In addition to SOA/GPB/C&E-519, Students may choose any Three out of the following four elective courses</i>					
SOA/GPB/C-515	Breeding Field Crop (Kharif)	100	40	60	2
SOA/GPB/E-516	Plant Genetic Resources and their Utilization	100	40	60	2
SOA/GPB/E-517	Crop Physiology - II	100	40	60	2
SOA/GPB/E-518	Maintenance breeding, concept of Variety Release & Seed Production	100	40	60	2
*SOA/GPB/ C&E-519	Laboratory course - III	100	40	60	5
	Total	600	240	360	18
**SOA/GPB/SS01	Self Study course to be decided by concerned department/college & to be evaluated by themselves.	100	40	60	3

	It is only a qualifying course.				
Semester - IV					
SOA/GPB/C-520 OR SOA/GPB/C-521	Thesis	100	40	60	8
	Project Based on seed production of Field Crops / Vegetable Crops	100	40	60	8
SOA/GPB/C-522	Seminar	100	40	60	1
<i>In addition to SOA/GPB/E-528, Students may choose any three out of the following four elective courses.</i>					
SOA/GPB/E-523	Breeding of Vegetable Crops	100	40	60	2
SOA/GPB/E-524	Seed Production Technology of Vegetable Corps	100	40	60	2
SOA/GPB/E-525	Stress Physiology of Field Crops	100	40	60	2
SOA/GPB/E-526	Germ Plasm collection, Exchange and Quarantine	100	40	60	2
SOA/GPB/ E-527	Laboratory course - IV	100	40	60	3
	Total	600	240	360	18
Grand Total of all semesters		2400	960	1440	72

SUMMARY OF CREDITS

Semester	Core Credits	Elective Credits	Total Credits
1st	18	--	18
2nd	18	--	18
3rd	09	09	18
4th	09	09	18
	54	18	72

*SOA/GPB/C&E-520 - This is a practical course combining of both core and elective courses in third semester.

**SOA/GPB/SS01 Self Study course will be provided to the students by the concern Department/College and after evaluation at the Department, theory and Sessional marks shall have to be submitted to the University.

The distribution of marks for the Thesis or Project based on Seed production of field/Vegetable Crops will be as below:

Thesis or Project based on Seed production of field/Vegetable Crops (External Evaluation)	-	-	-	-	60 Marks
Periodical presentation	-	-	-	-	20 Marks
Viva-Voce	-	-	-	-	20 Marks
Total - - - - -					100 Marks

MASTER OF SCIENCE (AGRICULTURE)

GENETICS AND PLANT BREEDING

DESCRIPTION OF COURSES

SOA/GPB/C-501 STATISTICAL METHODS AND EXPERIMENTAL DESIGNS (3)

UNIT I

Processing of data: - Classification & Tabulation of data, Graphical and Diagrammatic presentation of data by histogram, frequency polygon, frequency curve & cumulative frequency curve.

UNIT II

Measures of Central Tendencies and Dispersion: - Mean, Median, Mode, Partition values, Range, Quartile deviation, Mean deviation, Standard deviation, Coefficient of variation.

UNIT III

Probability and Distribution:- Definition of Probability, Random distribution, Binomial distribution, Poisson distribution and Normal distribution, simple properties of the above distribution (without derivation).

UNIT IV

Correlation & Regression:- Bivariate data, Bivariate frequency distribution, Simple correlation coefficients, Regression line, Regression coefficients & their relation with correlation coefficient, Multiple regression multiple & Partial correlation coefficients.

UNIT V

Sampling: Concept of population and sample; random samples; methods of taking a simple random sample.

UNIT VI

Tests of significance: Sampling distribution of mean and standard error; z and t-test (equality of means: paired and unpaired t-test); t-test for comparison of means when variances of two populations differ: Chi-square test for goodness of fit: independence of attributes, and homogeneity of samples, interrelation between t-test and F-Test

UNIT VII

Experimental Designs: Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); Latin square designs; augmented block design, simple factorial experiments (mathematical derivations not required): analysis of variance (ANOVA) and its use including estimation of LSD (CD)

Suggested Readings

1. Goulden, C.H. (1952). *Methods of Statistical Analysis*. 2/e, John Wiley, New York
2. Liohmand A. Reza 1988. *Statistical Methods for Agricultural Sciences*, Timber Press, Portland, Oregon, USA.
3. Kempthorne, O. (1957). *An Introduction to Genetic Statistics*, John Wiley, New York.
4. Kempton RA and Fox PN (1997). *Statistical Methods for Plant Variety Evaluation*. Chapman and Hall
5. Panse, V.C. and Sukhatme, P.V. (1967). *Statistical Methods for Agricultural Workers*, I.C.A.R., New Delhi.
6. Snedecor, G.W. and Cochran, W.G. (1980). *Statistical Methods*, 7le. Iowa State Univ. Press. Ames, Iowa.
7. Steel, R.G.D. and Torrie , H.II. (1960). *Principles and Procedures of Statistics*. McGrawHill, New York
8. Gomez, AG and Gomez, AA (1994). *Statistical Procedures for Agricultural Research*, 2/e. John Wile & Sons, New York.

SOA/GPB/C-502 PRINCIPLES OF GENTICS

(3)

UNIT I

Introduction: History of genetics, its scope and significance, brief idea of Mendel's laws and physical basis of heredity (chromosome theory of inheritance), forward vs. reverse genetics.

UNIT II

Modification of F₂ ratios: Epitasis (non-allelic interactions), segregation distortion and selfish genes; penetrance and expressivity; modifiers and suppressors; pleiotropic **genes**.

UNIT III

Linkage and crossing over: Coupling and repulsion hypothesis; theories of crossing over; three point test cross (interference and coincidence; calculation of recombination frequencies from F₂ data; brief idea about mapping function; cytological basis of crossing over (experiments of Stern in *Drosophila* and that of McClintock in corn).

UNIT IV

Multiple alleles: Concept of multiple alleles; self incompatibility alleles in *Nicotiana* and *Brassica*; coat colour in rodents; blood groups in humans, antigen-antibody interaction in inheritance of A, B, AB and O blood groups; H – antigens, MNS system, Rh factor. Epitasis and multiple allelism (e. g. Bombay blood groups).

UNIT V

Quantitative inheritance: Multiple factor hypothesis (a brief introduction); concept of gene effects (additive, dominance, over-dominance and epitasis); polygenes and quantitative trait loci (QTL).

UNIT VI

Sex linked inheritance: Sex linked, sex limited and sex influenced traits with suitable examples.

UNIT VII

Sex determination and differentiation: Theories of sex determination -- chromosome theory and genic balance theory of sex determination, sex determination in dioecious plants {Marchantia, Ceratopteris, Silene (Melandrium), Humulus, Coccinia, Rumex, Papaya}, mouse and in man; genetic basis of sex differentiation (genes located on sex chromosomes and autosomes), single gene control of sex. Hormonal control of sex, sex reversal and gynandromorphy, human sex anomalies (Klinefelter's syndrome and Turner's syndrome); brief idea of dosage compensation and Lyon's hypothesis.

UNIT VIII

Extrachromosomal inheritance: Criteria for extra chromosomal inheritance; plastid inheritance in *Mirabilis*, iojap in corn, Kappa particles in *Paramecium*, coiling in snails, brief idea of mitochondrial (male sterility in plants) and chloroplast genetics, paternal inheritance.

UNIT IX

Mutations and mutagenic agents: Brief history of mutations; types of mutations; rate and frequencies of mutations; physical and chemical mutagens and deletogens; detection of mutations in *Drosophila* (CIB method, Muller-5 method, attached X method), detection of mutations in plants and their practical application in crop improvement. (molecular basis of mutations are included in another course).

UNIT X

Biochemical genetics: Inborn errors of metabolism in man; eye transplantation in *Drosophila*; biochemical mutations in *Neurospora*; biosynthetic pathways and biochemical mutations.

UNIT XI

Fine structure of gene: Classical and modern gene concepts; pseudoallelism, position effect; intragenic crossing over and complementation (cistron, recon, muton), Benzer's work on r_{II} locus in T_4 phage.

UNIT XII

Epigenetics: Paramutation; DNA methylation and histone modification; genome imprinting (IGF₂ in mammals) 'Solid gold' or Callipyge in sheep; epigenetic in *Arabidopsis* and *Linaria*; histone code.

Suggested Readings:

1. Gupta P K (2009). Genetics, 4/e. Rastogi Publications, Meerut.
2. Gupta P K (2007). Genetics: Classical to modern. Rastogi Publications, Meerut.
3. Griffith et al (2008). An introduction to Genetic Analysis. Freeman & Co.
4. Hartl DL and Jones EW (1997). Genetics: Principles and Analysis 4th Ed. Jones & Bartlett Publishers, Inc
5. Hartwell L et al (2000). Genetics: From genes to genomics. McGraw Hill, New Delhi.
6. Lewin B. (2007). Genes IX. Wiley Eastern Ltd., New Delhi.
7. Pierce, B. (2005). Genetics: A conceptual Approach 2nd Ed. WH Freeman.

8. Snustad D P , Simmons NJ and Jenkins JB (2003). Principles of Genetics. John Wiley& Sons, New York.
9. Strickberger, N.W. (1985). Genetics 3rd Ed. Macmillan Co. New York.

SOA/GPB/C-503 PRINCIPLES OF PLANT BREEDING

(3)

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centers of Origin-biodiversity and its significance.

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; Plant introduction and role of plant genetic resources in plant breeding.

UNIT III

Self-incompatibility and male sterility in crop plants and their commercial exploitation.

UNIT III

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self-pollinated crops (diallel selective mating approach).

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 interpopulation improvement and development of synthetics and composites Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V

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

UNIT VI

Self-incompatibility and male sterility in crop plants and their commercial exploitation; Concept of plant ideotype and its role in crop improvement; Transgressive breeding.

UNIT VII

Special breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses.

UNIT VIII

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

Suggested Readings

1. Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.
2. Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.
3. Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.
4. Gupta SK. 2005. *Practical Plant Breeding*. Agribios.
5. Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.
6. Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.
7. Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
8. Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.
9. Singh BD. 2006. *Plant Breeding*. Kalyani.
10. Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.
11. Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.
12. Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

SOA/GPB/C-504 CYTOLOGY AND CYTOGENETICS (2)

UNIT I

Historical perspectives

UNIT II

Cell-cell structure and functions

UNIT III

Cell division: Cell cycle (genetics, biochemistry and cell cycle mutants), differences between mitosis and meiosis; mechanism of chromosome movement; meiosis division and mitosis division; double reduction.

UNIT IV

Duplications and deficiencies: Classification, methods of production, meiotic pairing, phenotypic effects and breeding behavior.

UNIT V

Translocations: Classification, methods of production, identification, meiotic pairing (alternate and adjacent disjunction), crossing over in interstitial region, breeding behavior of translocation heterozygote, role in evolution (balanced lethal- *Oenothera* cytogenetics), A-B translocations.

UNIT VI

Inversions: Classification (paracentric and pericentric inversions), methods of production, identification, meiotic pairing and crossing over in different regions, anaphase I and anaphase II

configurations in paracentric inversions, breeding behavior of inversion heterozygote, role in evolution.

UNIT VII

Haploidy: Classification (monoploids, polyhaploids and aneuhaploids), methods of production (anther culture and chromosome elimination), identification, androgenic and gynogenetic, and parthenogenic haploids, meiotic pairing, utility (hybrid sorting and DH breeding).

UNIT VIII

Polyploidy: Classification (autopolyploid, allopolyploids), methods of production, cytological and genetic methods for identification, polyploidy genetics (chromosome and chromatid segregation), meiotic pairing (autotetrasomes and allotetrasomes), diploidizing system (Ph1 locus) and role in evolution, utility in crop improvement, segmental polyploidy, synthetic polyploids, brief idea of ancient polyploidy.

UNIT IX

Trisomics and tetrasomics (Hyperploids): Classification (primary, secondary and tertiary trisomics), methods of production, identification, meiotic pairing, breeding behavior of trisomics, trisomic and tetrasomic ratios, utility in chromosome mapping.

UNIT X

Monosomics and nullisomics (Hypoploids): Methods of production (particularly in wheat), identification, meiotic behavior; breeding behavior of monosomics, monosomic analysis (monogenic characters only); alien addition/substitution lines.

UNIT XI

Apomixis: Cytogenetic basis of apomixis, meiotic behavior in apomicts, autogamy and pseudogamy, agamospermy (apospory and diplospory) and other modes of apomixis.

Suggested Readings:

1. Burnham, C.R. (1962). *Discussions in Cytogenetics*: Burgers, Minneapolis.
2. Fukui K and Nakayama S (eds.) (1996). *Plant Chromosomes-Laboratory Methods*. CRC Press, London
3. Gupta, P.K. (1999). *Cytogenetics*. Rastogi & Co., Meerut.
4. Gupta, P.K. and Tsuchiya, T. 1991. *Chromosome Engineering in Plants: Parts A & B*, Elsevier Publishers, the Netherlands.
5. Gupta PK, Singh SP, Balyan HS, Sharma PC and Ramesh B (1998). *Genetics and Biotechnology in Crop Improvement*. Rastogi Publications, Meerut.
6. Hawes C and Satiat-Jennemaitre (eds.). (2001). *Plant Cell Biology* 2nd Ed. Oxford University Press, New York
7. Khush GS (1973). *Cytogenetics of Aneuploids*. Academic Press, New York
8. Singh RJ (2003). *Plant Cytogenetics (Second Edition)*. CRC Press, Taylor & Frances group.
9. Singh RJ and Prem P. Jauhar (Eds.) (2005). *Genetic Resources, Chromosome Engineering, and Crop Improvement: Grain Legumes, Volume I*. CRC Press, Taylor & Frances group
10. Swaminathan, M.S., Gupta, P.K. and Sinha, U. (1983). *Cytogenetics of Crop Plants*. Macmillan India, New Delhi.

11. Swanson, C.P., Merz, T. and Young, W.J. (1982). Cytogenetics. Prentice-Hall of India (Pvt.) Ltd., New Delhi.
12. Sybenga, J. (1972). General Cytogenetics. North-Holland publishing Co. Amsterdam.
13. Sybenga, J. (1992). Cytogenetics in Plant Breeding. Springer-verlag, Berlin.

SOA/GPB/C-505 PRINCIPLES OF SEED PRODUCTION

(2)

UNIT I

Introduction : Seed as basic input in agriculture; seed development in cultivated plants; seed quality concept and importance of genetic purity in seed production; types of cultivars, their maintenance and factors responsible for deterioration; seed production in self and cross pollinated crops.

UNIT II

Mode of pollination and reproduction in crop plants and their modification in relation to hybrid seed production. Principles of hybrid seed production, isolation distance, synchronization of flowering, rouging etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management.

UNIT III

Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production – agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of Nucleus seed, production of Breeder, Foundation and Certified seed– criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.

UNIT IV

Hybrid Seed - Methods of development of hybrids; use of male sterility and self-incompatibility and CHA in hybrid seed production; one, two and three line system; maintenance of parental lines of hybrids; planning and management of hybrid seed production technology of major field crops and vegetables.

UNIT V

Planning of seed production for different classes of seeds for self and crosspollinated crops, Seed quality control system and organization, seed village concept; Seed production agencies, seed industry and custom seed production in India.

Suggested Readings

1. Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
2. Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*. Dept. of Plant Breeding CCS HAU, Hisar.
3. Desai BB. 2004. *Seeds Handbook*. Marcel Dekker.
4. Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.
5. McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
6. Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA,

Washington, DC, USA.

7. Poehlman JM & Sleper DA. 2006. *Breeding Field Crops*. Blackwell.
8. Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
9. Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.
10. Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.
11. Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. CSCB, GOI.

SOA/GPB/C-506 LABORATORY COURSE (5)

UNIT I

Statistical Methods and Experimental Designs)

Presentation of data- tabulation, Histograms and frequency polygons, calculations of mean, median, mode, standard deviation, calculations of expected frequencies in binomial, Poisson & normal distributions, test of significance, correlation & regression coefficients and their significance, analysis of variance for RBD and LSD.

UNIT II

Principles of Genetics)

Analysis of Chi-Square in grouped data and for detection linkage, calculation of recombination frequencies from three point test cross data and F₂ data, Study of male sterility in Onion, Bajra and Wheat

UNIT III

Principles of Plant Breeding)

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.

UNIT IV

Cytology and Cytogenetics)

Preparation of stains and fixatives, Study of various stages of mitosis in Onion root tips, Study of various stages of Meiosis, particularly pachytene, diplotene, diakinesis, Metaphase-I and Anaphase-II in available material like buds of Onion, Bajra, Maize, Wheat. Preparation of permanent slides.

UNIT V

Principles of Seed Production

Estimation of seed purity, germination, viability & moisture test, Seed Sampling and preparation of Samples for seed testing, Evolution of Seed tests and writing of seed testing reports, laboratory Layout and laboratory equipment for Seed Testing.

SEMESTER-II

SOA/GPB/C-507 ADVANCE PLANT BREEDING

(3)

UNIT I

Plant ideotype: Ideotype concept, ideotypes of wheat, rice, maize, Brassica species, cotton, pigeon pea, mung bean and chickpea, super plant types, green revolution -treasures and liabilities, breeding for evergreen revolution including gene revolution.

UNIT II

Introduction: Mutation, Mutagenesis & Mutants selection of desirable mutants in Autogamous, Allogamous and negatively propagated crops, Directed mutation, Achievements through mutation breeding in different crops.

UNIT III

Distance hybridization (Poly ploidy breeding): Interspecific, Inter generic and Somatic hybrids

UNIT IV

Breeding for biotic stress resistance: Introduction to biotic stresses, sources of variability in pathogens/insects, inheritance of disease/insect resistance, gene-for-gene relationship, molecular basis of host-pathogen interaction, vertical and horizontal resistance, durable resistance, breeding methodology (gene pyramiding, gene deployment, multiline varieties), insect resistant transgenic plants based on Bt, cowpea trypsin inhibitor (CpTI), alpha amylase inhibitor (α -AI-Pv), phytocystatins, cysteine proteinase inhibitor genes ,etc.

UNIT V

Breeding for abiotic stress (drought, salt and temperature) tolerance: Introduction, genetics of abiotic tolerance, mechanisms of stress tolerance (role of proline, glycine betaine, dehydration response elements, and trehalose) screening for tolerance, sources of tolerance, breeding approaches for improved tolerance to abiotic stresses.

UNIT VI

Breeding for nutritional quality traits (protein, oil, vitamins and iron): Breeding for improved protein content and quality in cereals and legumes, sources of quality traits, breeding approaches, achievements; breeding for improved oil content and quality, breeding approaches and achievements; biofortification including Fe (rice) and Zn, vitamins (golden rice and maize); quality protein maize (QPM).

Suggested Readings

1. Singh, B. D. (2007). Plant Breeding. Kalyani Publishers, New Delhi
2. Chahal, G. S. and Gosal, S. S. (2003). Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi
3. Simmonds, N. W. (1979). Principles of Crop Improvement. Longman, London
4. Poehlman, J. M. and Sleper, D. A. (1995). Breeding Field Crops, 4/e. Iowa State Univ. Press, Ames, Iowa
5. Gupta, P. K. (2003). Biotechnology and Genomics. Rastogi Publications, Meerut

6. Chopra, V. L. (ed.) (2000). Plant Breeding: Theory and Practice, 2/e. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
7. Hayward, M. D., Bosemark, N. O. and Romagosa, I. (eds.) (1993). Plant Breeding: Principles and Prospects. Chapman & Hall, London
8. Briggs, F. N. and Knowles, P. F. (1967). Introduction to Plant Breeding. Reinhold Company, New York
9. Simmonds, N. W. and Smartt, J. (2000). Principles of Crop Improvement, 2/e. Blackwell Science, Malden, MA
10. Fehr, W. R. (1987). Principles of Cultivar Development. Vol. 1. Theory and Technique. Macmillan Pub. Co., New York
11. Fehr, W. R. (1987). Principles of Cultivar Development. Vol. 2. Crop Species. Macmillan Pub. Co., New York
12. Fehr, W. R. and Hadley, H. H. (1980). Hybridization of Crop Plants. American Society of Agronomy, Madison, WI
13. Schlegel, R. J. (2003) Encyclopedic Dictionary of Plant Breeding. Food Products Press
14. Peleman, J. D. and van der Voort, J. R. (2003). Breeding by design. Trends in Plant Sci 8: 330-334
15. Nguyen, H. T. and Blum, A. (2004). Physiology and Biotechnology Integration for Plant Breeding. Marcel Dekker
16. Singh, D. P. and Singh, A. (2005). Disease and Insect Resistance in Plants. Science Publishers, Enfield (NH), USA, pp. 417.
17. Carena, M. J. (ed) (2009). Handbook of Plant Breeding: Cereals. Springer, USA

SOA/GPB/C-508

CELL BIOLOGY AND MOLECULAR GENETICS

(3)

UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastids/chloroplast, mitochondria, endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

UNIT II

Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division.

UNIT III

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences;

organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

Suggested Readings

1. Bruce A.2004. *Essential Cell Biology*. Garland.
2. Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.
3. Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.
4. Lewin B. 2008. *IX Genes*. John Wiley & Sons
5. Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.
6. Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.
7. Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ. Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

SOA/GPB/C-509 SEED PRODUCTION IN FIELD CROPS

(2)

UNIT I

Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, barley, paddy etc.

UNIT II

Floral structure, breeding and pollination mechanism in cross-pollinated cereals and millets viz maize, sorghum, bajra etc; methods and techniques of quality seed production in cross-pollinated cereals and millets.

UNIT III

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green gram, black gram, peas etc.).

UNIT IV

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, sunflower, rape seed and mustard, linseed, sesame etc.).

UNIT V

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, etc) and vegetatively propagated crops like sugar cane, potato etc.

Suggested Readings

1. Kelly AF. 1988. *Seed Production of Agricultural Crops*. John Wiley.
2. McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
3. Singhal NC. 2003. *Hybrid Seed Production in Field Crops*. Kalyani.
4. Agarwal, R.L. 1997, *Seed Technology*, 2nd Ed. Oxford & IBH

UNIT I

Some basic aspects of biochemistry, Structure, classification and properties of carbohydrates, proteins, fat & lipids and nucleic acids.

UNIT II

Photosynthesis: Ultrastructure, composition and function of chloroplast, Chlorophylls and carotenoids, Electromagnetic radiations and their qualities, Light reaction and photophosphorylation, Dark reaction and C-3 & C-4 pathways, Photorespiration (C-2 pathway), CO₂ compensation point and its relationship with crop productivity, Factors affecting rate of photosynthesis.

UNIT III

Respiration: Ultra structure, Composition and function of mitochondria, Aerobic and : anaerobic respiration, Glycolysis, Krebs's cycle, Hexose Monophosphate Shunt, Pentose Phosphate Pathways (PPP), Respiratory Quotient (RQ), Factors affecting respiration and its relationship with crop productivity

UNIT IV

4. Mineral nutrition: Absorption, Translocation, Role of minerals in plant nutrition and their deficiency symptoms.

UNIT V

Nitrogen metabolism: Source of nitrogen and its assimilation, Role of nitrite and nitrate reductases, Physiology of nodulation and nitrogen fixation.

UNIT VI

Water relations in plants and transpiration.

Suggested Reading:-

1. Malik, C.P. and Srivastava, A.K. (1985), Textbook of plant physiology, Kalyani Publishers,
2. Salisbury, F.B. and Ross. C. (1992), Plant Physiology. Prentice-Hall, New Delhi
3. Mehta, S.L. Lodha, M.L. and Sane, P.V. (Eds.) 1989. Recent Advances in Plant Biochemistry, ICAR Publication, New Delhi.
4. Zelitch, I. (1973), Photosynthesis, Photorespiration and Plant Productivity, Academic press, New York and London.

UNIT I

Major field crops of Rabi season: Cereals (Wheat, Barley), Pulses (Pea, chickpea & Lentil) and Oilseeds (Mustard & Rape Seed)

UNIT II

Wheat: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT III

Barley: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT IV

Pulses: Pea: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT V

Chickpea: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT VI

Lentil: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT VII

Oil Seeds: Rape Seed & Mustard: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

Suggested Readings

1. Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.
2. Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.
3. Chandraratna MF. 1964. *Genetics and Breeding of Rice*. Longmans.
4. Chopra VL & Prakash S. 2002. *Evolution and Adaptation of Cereal Crops*. Oxford & IBH.
5. Gill KS. 1991. *Pearl Millet and its Improvement*. ICAR.
6. IRRI. 1964. *Rice Genetics and Cytogenetics*. Elsevier.
7. IRRI. 1986. *Rice Genetics*. Proc. International Rice Genetics Symposium.
8. IRRI, Los Banos, Manila, Philippines.
9. IRRI. 1991. *Rice Genetics II*. Proc. International Rice Genetics
10. Symposium. IRRI, Los Banos, Manila, Philippines.
11. IRRI. 1996. *Rice Genetics III*. Proc. International Rice Genetics
12. Symposium. IRRI, Los Banos, Manila, Philippines.

13. IRRI. 2000. *Rice Genetics IV*. Proc. International Rice Genetics
14. Symposium. IRRI, Los Banos, Manila, Philippines.
15. Jennings PR, Coffman WR & Kauffman HE. 1979. *Rice Improvement*.
16. IRRI, Los Banos, Manila, Philippines.
17. Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*.
18. Directorate of Extension Education, TNAU, Coimbatore.
19. Murty DS, Tabo R & Ajayi O. 1994. *Sorghum Hybrid Seed Production and Management*. ICRISAT, Patancheru, India.
20. Nanda JS. 1997. *Manual on Rice Breeding*. Kalyani.
21. Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.
22. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994.
23. *Crop Breeding in India*. International Book Distributing Co.
24. Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops*. Marcel Dekker.
25. Walden DB. 1978. *Maize Breeding and Genetics*. John Wiley & Sons.

SOA/GPB/C-512 LABORATORY COURSE (5)

UNIT - I .

Advance Plant Breeding

Study of Morphological traits in various types of germplasm of Wheat, Rice, Pulses and Oil Seeds

UNIT II

Cell Biology and Molecular Genetics

Study of Ultrastructure of Plant cell and Animal cell, Eukaryotic and Prokaryotic cell, Major cell organelles (i.e. Nucleus, mitochondria, plastids, Cell wall, Golgi bodies etc.), Mitosis and Meiosis division, DNA and RNA, Chromosome ultrastructure.

UNIT III

Seed Production in Field Crops

Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate; Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony; supplementary pollination, pollen storage, hand emasculation and pollination in Cotton, detasseling in Corn, identification of rogues and pollen shedders; Pollen collection, storage, viability and stigma receptivity; gametocide application and visits to seed production plots etc.

UNIT IV

Crop Physiology-I

Demonstration and measurements of photosynthesis, respiration and transpiration: Preparation of stock solutions of different molarity, molality and normality. Finding out isotonic points of the various plant materials. Demonstration of exo- & endo-osmosis. Analysis of carbohydrates proteins and fats

UNIT V

Breeding Field Crop (Rabi)

Floral biology: Emasculation and pollination techniques. Study of range of variation for yield & yield related components. Study of regretting population. Germplasm maintenance

SEMESTER III

SOA/GPB/C-513 BIOTECHNOLOGY FOR CROP IMPROVEMENT (4)

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding.

UNIT II

Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR,SNPs, ESTs etc.), mapping populations (F₂s, back crosses, RILs, NILs and DH).

UNIT IV

Marker assisted selection and molecular breeding; Genomics and Geno informatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs

UNIT V

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. Commercial releases.

UNIT VI

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VII

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

UNIT VIII

Bioinformatics & Bioinformatics tools.

UNIT IX

Nanotechnology and its applications in crop improvement programmes.

Suggested Readings

1. Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.
2. Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.
3. Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation*. 2nd Ed. Benjamin Publ. Co.
4. Sambrook J & Russel D. 2001. *Molecular Cloning - a Laboratory Manual*. 3rd Ed. Cold Spring Harbor Lab. Press.
5. Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

SOA/GPB/C-514 POPULATION AND BIOMETRICAL GENETICS (3)

UNIT I

Population - Properties of population - Mendelian population – Genetic constitution of a population through time, space, age structure etc. Mating systems - Random mating population - Frequencies of genes and genotypes - Causes of change: population size, differences in fertility and viability, migration and mutation.

UNIT II

Hardy-Weinberg equilibrium - Hardy-Weinberg law - Proof – Applications of the Hardy-Weinberg law - Test of Hardy-Weinberg equilibrium – Mating frequencies - Non-dominance - Codominance - Snyder's ratio, importance and its effect over random mating in succeeding generations.

UNIT III

Multiple alleles - More than one locus - Sex linked genes; Use of gene and genotypic frequencies evaluation in field population level; Interpretations - Changes of gene frequency - Migration – Mutation - Recurrent and nonrecurrent - Selection - Balance between selection and mutation – Selection favouring heterozygotes - Overdominance for fitness.

UNIT IV

Correlation studies: Genotypic, Phenotypic, Environmental Correlations and Path Coefficient Analysis in relation to crop improvement. Heritability and selection response: Methods of estimation and their application in plant breeding. Simultaneous selection models: Discriminant functions; Classical; Restricted and General Selection indices.

UNIT V

Combining ability and gene effects: General and specific combining abilities; Additive, Dominance and Epistatic gene effects; Line X Tester analysis, Diallel analysis (Hayman and Griffings approaches), Generation mean analysis (6, 5 and 3 parameters models). Genotype X Environment interaction and stability analysis: Varietal evaluation in multi-location / multiyear trials; Estimation G X E interaction and Stability parameters following the models of Finlay and Wilkinson, Eberhart and Russell, Perkins and Jinks, Freeman and Perkins.

UNIT I

Major Field crops of Kharif season: Cereals (Rice, Maize, Pearl Millet, Sorghum), Pulses (Arhar, Urd and Moong) and Oilseeds (Sunflower and Ground nut)

UNIT II

Rice: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters and Hybrid breeding.

UNIT III

Maize: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters and Hybrid breeding.

Pearl Millet & Sorghum: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters and Hybrid breeding.

UNIT IV

Pulses: Arhar : Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

Urd and Moong: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

UNIT V

Oilseed: Sunflower: Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters and Hybrid breeding. **Groundnut:** Evolution and distribution of species and forms –wild relatives and germ plasm, Cytogenetics and genome relationship, Breeding Objective yield & quality characters.

Suggested Readings

1. Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.
2. Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.
3. Chandraratna MF. 1964. *Genetics and Breeding of Rice*. Longmans.
4. Chopra VL & Prakash S. 2002. *Evolution and Adaptation of Cereal Crops*. Oxford & IBH.
5. Gill KS. 1991. *Pearl Millet and its Improvement*. ICAR.
6. IRRI. 1964. *Rice Genetics and Cytogenetics*. Elsevier.
7. IRRI. 1986. *Rice Genetics*. Proc. International Rice Genetics Symposium.
8. IRRI, Los Banos, Manila, Philippines.
9. IRRI. 1991. *Rice Genetics II*. Proc. International Rice Genetics
10. Symposium. IRRI, Los Banos, Manila, Philippines.
11. IRRI. 1996. *Rice Genetics III*. Proc. International Rice Genetics
12. Symposium. IRRI, Los Banos, Manila, Philippines.
13. IRRI. 2000. *Rice Genetics IV*. Proc. International Rice Genetics
14. Symposium. IRRI, Los Banos, Manila, Philippines.

15. Jennings PR, Coffman WR & Kauffman HE. 1979. *Rice Improvement*.
16. IRRI, Los Banos, Manila, Philippines.
17. Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*.
18. Directorate of Extension Education, TNAU, Coimbatore.
19. Murty DS, Tabo R & Ajayi O. 1994. *Sorghum Hybrid Seed Production and Management*. ICRISAT, Patancheru, India.
20. Nanda JS. 1997. *Manual on Rice Breeding*. Kalyani.
21. Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.
22. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994.
23. *Crop Breeding in India*. International Book Distributing Co.
24. Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops*. Marcel Dekker.
25. Walden DB. 1978. *Maize Breeding and Genetics*. John Wiley & Sons.

SOA/GPB/E-516 PLANT GENETIC RESOURCES & THEIR UTILIZATION (2)

UNIT I

A brief idea of modern system of classification (angiosperm phylogeny groups). Centres of diversity and origin: Brief account of domestication of important crop plants (wheat, maize, rice, potato, sorghum and brassica) and gene pools.

UNIT II

Biodiversity vs. genetic resources: Definition and explanation, alpha vs. beta biodiversity and methods of their study; present levels of biodiversity and rate of loss of biodiversity; causes for the loss of biodiversity; uses of biodiversity; extent of biodiversity in plants; exploration and germplasm collection, introduction and exchange of PGR.

UNIT III

Direct and indirect uses of plant genetic resources for human welfare: In plant breeding and agriculture, pharmaceuticals and in maintenance of ecosystem; Red Data books and endangered plant species.

UNIT IV

Plant genetic resources: Different kinds of PGR- basic, derived and molecular; core collections; principles of germplasm characterization, DNA fingerprinting and plant bar codes; germplasm evaluation, maintenance and regeneration; plant quarantine aspects sanitary and phytosanitary systems (SPS).

UNIT V

Techniques for conservation of plant germplasm: In situ and Ex-situ methods of conservation; cryopreservation of genetic materials; gene banks and cryobanks. Biodiversity International (IPGRI) and NBPGR: Their role in conservation of PGR.

UNIT VI

Role of FAO/CGIAR system for access to genetic resources: ITPGRFA (International treaty on plant genetic resources for food and agriculture) and global system of PGR; FAO's commission on PGR (CPGR); International code of conduct for PGR collection and transfer; multilateral system for access to PGR.

UNIT VII

IPRs in plant breeding: UPOV, plant breeders rights (PBRs); essentially derived varieties and farmers rights (FRs); protection of plant varieties and farmers rights act (PPV & FRA) 2001; intellectual property rights- patents, copyrights, trademarks; GATT and TRIPs, patents for higher plants; terminator and traitor techniques (v-GURT and t-GURT); biodiversity act 2002; geographical indications act 1999; amendments to patent act 1970

Suggested Readings

1. Engelmann F and Takagi H (eds). (2000). Cryopreservation of tropical germplasm. IPGRI, Rome
2. CGIAR Annual Reports. (<http://www.cgiar.org>)
3. Swaminathan MS (1996). Biodiversity. Konark Publications, New Delhi
4. Swaminathan MS (1996). Agrobiodiversity and Farmers Rights. Konark Pub, New Delhi.
5. Maxsted N, Ford-Lloyd BV and Hawkes JJ (eds) (1997). Plant Genetic Conservation. Chapman and Hall, London
6. Indian Framing Vol. 43 (7), October 1993
7. Negi SS (2003). Biodiversity and its Conservation in India, 2/e. Indus Books, New Delhi.
8. Anonymous (1995). Encyclopedia of Environmental Biology Vol. Academic Press
9. Rao RR (1994). Biodiversity in India. Bishen Singh Mahendra Pal Singh, New Delhi
10. Paroda RS and Arora RK (eds) (1991). Plant Genetic Resources: Conservation and Management. IPPGR, Rome
11. Swaminathan MS and Jana S (eds) (1992). Biodiversity- Implications for Global Food Security. McMillan India, New Delhi
12. Singh MP and Soma D (2004). Bioresources and Gene Pool Conservations. Biopublications, New Delhi

SOA/GPB/E-517: CROP PHYSIOLOGY-II

(2)

UNIT I

Growth and development: Concept; Biological & Economic yield, Harvest Index (HI), Leaf area index (LAI), Leaf area ratio (LAR), Net assimilation rate (NAR) and Relative growth rate (RGR); Applied aspects of growth and development in determining crop productivity potentials.

UNIT II

Source-Sink relationship: Importance in crops yields potentials and efficiency of energy use; Sink potential and its utilization in different crops.

UNIT III

Photoperiodism and Vernalization: Concept and role in crop productivity.

UNIT IV

Physiology of germination and dormancy. Applied aspects of phytohormones with special reference to auxins, gibberellins, cytokinins and abscisic acids.

UNIT V

Economic importance of phytohormones and growth regulators in agriculture.

Suggested Reading

1. Malik, C.P. and Srivastava, A.K. (1985), Textbook of plant physiology, Kalyani Publishers,
2. Salisbury, F.B. and Ross. C. (1992), Plant Physiology. Prentice-Hall, New Delhi

3. Mehta, S.L. Lodha, M.L. and Sane, P.V. (Eds.) 1989. Recent Advances in Plant Biochemistry, ICAR Publication, New Delhi.
4. Zelitch, I. (1973), Photosynthesis, Photorespiration and Plant Productivity, Academic press, New York and London.
5. Leopold, A.C. (1974). Plant Growth and Development. McGraw-Hill Book Co. Inc., New York.

SOA/GPB/E-518 Maintenance Breeding, Concepts of Variety Release and Seed Production (2)

UNIT I

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

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, paddy, sorghum, maize etc.); Pulses (green gram, black gram, pigeon pea, chickpea, field pea, lentil); Oilseeds (groundnut, soybean, rapeseed and mustard); fibers (cotton) and forages (forage sorghum, oats, berseem).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Suggested Readings

1. Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.
2. Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants*.
3. Department of Plant Breeding. CCS HAU Hisar.
4. Kelly AF. 1988. *Seed Production of Agricultural Crops*. Longman.
5. McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.
6. Musil AF. 1967. *Identification of Crop and Weed Seeds*. Handbook No. 219, USDA, Washington, DC.
7. Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops*. Oxford & IBH.
8. Singh BD. 2005. *Plant Breeding: Principles and Methods*. Kalyani.
9. Thompson JR. 1979. *An Introduction to Seed Technology*. Leonard Hill.
10. Tunwar NS & Singh SV. 1985. *Handbook of Cultivars*. ICAR.

UNIT- I : Biotechnology for Crop Improvement

Preparation Of Media For Organ And Tissue Culture, Practice Of Excision And Inculcation Of Tissues In Culture Medium, Developing Protocol for different type of plant tissues. Visit to advanced biotech and tissue culture laboratories.

UNIT- II: Population and Biometrical Genetics

Numerical examples on Generation mean analysis; D H and I component analysis; Diallel analysis (i) Component analysis (ii) Combining ability analysis; Line X Tester analysis; Character association, Path analysis, Correlation and regressions.

UNIT- III: Breeding Field Crop (Kharif)

Flood biology: Emasculation and pollination techniques. Study of range of variation for yield & yield related components. Study of regretting population. Germplasm maintenance

UNIT- IV: Plant Genetic Resources and their Utilization

Evaluation of available germ plasm of wheat, rice and other crops. Study of morphological characters of germplasm (varieties and available wild relatives).

UNIT -V: CROP PHYSIOLOGY-II

Practical exercise on the measurement and analysis of Biological & Economic yield, Harvest Index (HI); Leaf area index (LAI), Leaf area ratio (LAR), Net assimilation rate (NAR) and Relative growth rate (RGR), Bioassay methods of auxins, gibberellins cytokinins and abscisic acid.

UNIT- VI: Maintenance Breeding, Concepts of Variety Release and Seed Production

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; 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.

SEMESTER IV**SOA/GPB/E-523****BREEDING OF VEGETABLE CROPS****(2)****Theory**

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

UNIT I

Potato and tomato

UNIT II

Eggplant, hot pepper, sweet pepper and okra

UNIT III

Peas and beans.

UNIT IV

Gourds, melons, pumpkins.

UNIT V

Cabbage, cauliflower, carrot, radish.

Suggested Readings

1. Allard RW. 1999 *Principles of Plant Breeding*. John Wiley & Sons.
2. Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.
3. Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005 *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. Housse.
4. Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.
5. Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons.
6. Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*. McGraw-Hill.
7. Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding Principles and Prospects* Chapman & Hall.
8. Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.
9. Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.
10. Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.
11. Paroda RS & Kalloo G. (Eds.). 1955. *Vegetable Research with Special Reference to Hybrid Technology in Aisa-Pacific Region*. FAO.
12. Peter KV & Pradeep Kumar T. 2008. *Genetics and Breeding of Vegetables*. Revised, ICAR.
13. Rai N & Rai M. 2006. *Heterosis Breeding in Vegetables Crops*. New India Publ. Agency.
14. Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani.
15. Simmonds NW. 1978. *Principles of Crop Improvement*. Longman.
16. Singh BD. 1983. *Plant Breeding*. Kalyani.
17. Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.
18. Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

SOA/GPB/E-524 Seed Production Technology of Vegetable Crops (2)

UNIT-I

Introduction; modes of propagation in vegetables. Seed morphology and development in vegetable seeds. Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops.

UNIT-II

Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. seed-to-seed vs. root-to-seed method in radish; seed multiplication ratios in vegetables; pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage.

UNIT-III

Seed production technology of vegetables viz. Solanaceous, cucurbitaceous, leguminous, malvaceae, Cole crops, leafy vegetables, root, tuber and bulb crops and spices; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato, sweet

potato, colocasia, tapioca; seed-plot technique in potato tuber seed production; hybrid seed production technology of vegetable crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self incompatibility in hybrid seed production, environmental factors related to flowering/bolting in vegetable crops.

UNIT-IV

Share of vegetable seeds in seed industry; importance and present status of vegetable industry; intellectual property rights and its implications, impact of PVP on growth of seed industry.

Suggested Readings

1. Arora, S.K. Haryana Men Subjionki Utpadan Prodhyokiki. Scientific Pub. India. B.P. Ghildyal and R.P. Gupta, 2002. Soil Structure: problems and Management, ICAR, New
2. Delhi. Bassett, M.J. (1986) Breeding vegetable crops. AVI Publishing Comp.
3. Dennis R. Decoteau (2000) Vegetable Crops. Prentice Hall. Desai BB. Katecha, PM & Salunke DK.1997. Seed Hand Book: Biology, Production,
4. Processing and Storage. Marcel Dekker. Desai BB. 2004. Seeds Handbook. Marcel Dekker. George RAT. 1980. Vegetable Seed Technology. A Technical Guide to Vegetable Seed
5. Production, Processing, Storage and Quality Control. FAO, Rome. Harihar Ram. (1997). Vegetable Breeding: Principles and Practices.
6. Jagminder Hartman HT & Kester DE. 2000. Plant Propagation: Principles and Practices. Prentice
7. Hall. Inns, N.L. (1983). Breeding field vegetables, Asian vegetable Research and Development
8. Centre. Tainan...Taiwan ISTA (1983). Seed Technology in the tropic. The International Seed Testing Association,
9. reprinted by Scientific Publishers, India Kelly AF & George RAT. (Eds.).1998. Encyclopedia of Seed Production of World Crops.
10. John Wiley & Sons. Jeswani, L.M. and Baldev, B. (1997). Advances in pulse production technology, ICAR, New
11. Delhi. McDonald MB Jr & Copeland LO. 1997. Seed Production of Crops: Principles and Practices.
12. Chapman & Hall. Miller, B. McDonald and Lawrence O. Copeland, (1998). Seed Production: Principles and
13. Practices. CBS publishers and distributors, 11 Darya Ganj, New Delhi. Mini, C. and Krishnakumary, K. (2004). Leaf Vegetables: Agrotech Publishing Academy,
14. Sector-5, Hiranmagri, Udaipur. Prem Singh Arya, (2000) Off-Season Vegetable Growing In Hills. A.P.H. Publishing
15. Corporation, 5-Ansari Road, Daryaganj, New Delhi Salunkhe DK, Desai BB & Bhat RN. 1987. Vegetable and Flower Seed Production. Agricole
16. Publ. Academy. Singh SP. 2001. Seed Production of Commercial Vegetables. Agrotech. Suman Bhati and Uma Verma (1997). Fruits and vegetable processing. CBS. Publ. Book
17. Agency. New Delhi Work Paul (1997). Vegetable production and marketing. Daya Publ. House, Devram.

UNIT I

Basic Concepts of plants under stresses. Types of stresses; Biotic and Abiotic.

UNIT II

Effects of biotic and abiotic stresses on the physiology of various field crops e.g. Cereals, Pulses, Oilseeds, and Sugarcane and Vegetable crops.

UNIT III

Methods to overcome from stress. Concept of stress tolerance, resistance and avoidance.

UNIT IV

Plant modeling for the effective stress management.

Suggested Reading:-

1. Malik, C.P. and Srivastava, A.K. (1985), Textbook of plant physiology, Kalyani Publishers,
2. Salisbury, F.B. and Ross. C. (1992), Plant Physiology. Prentice-Hall, New Delhi
3. Mehta, S.L. Lodha, M.L. and Sane, P.V. (Eds.) 1989. Recent Advances in Plant Biochemistry, ICAR Publication, New Delhi.
4. Zelitch, I. (1973), Photosynthesis, Photorespiration and Plant Productivity, Academic press, New York and London.
5. Leopold, A.C. (1974). Plant Growth and Development. Mc Graw-Hill Book Co. Inc., New York.

SOA/GPB/E-526 Germplasm Collection, Exchange and Quarantine (2)

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

UNIT III

Ethnobotanical of PGR; Crop botany, farming systems, collecting wild relatives of plants;.

UNIT IV

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango etc; approaches for collection including indigenous knowledge.

UNIT V

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic

significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma etc.).

Suggested Readings

1. Briggs D. 1997. *Plant Variation and Evolution*. Science Publ.
2. Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants*. Columbia Univ. Press.
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SOA/GPB/E-527 LABORATORY COURSE (3)

UNIT- I: Breeding of Vegetable Crops

Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, paleontological studies, selfing and crossing techniques in vegetable crops in bulk. screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population;

UNIT- II: Seed Production Technology of Vegetable Crops

Selection of suitable areas/locations for high quality seed/planting material production; study of floral biology of vegetables, determination of planting ratios for hybrid seed production vegetables; use and maintenance of monoecious line in hybrid seed production of cucumber; exercises on emasculation and pollination; seed extraction methods and their effect on quality of vegetables; seed production technology of varieties and hybrids in vegetables,

UNIT - III: Stress Physiology of Field Crops

Conducting experiment to study the effect of various biotic and abiotic stresses on the physiology and morphology of common field crops under in vivo and in vitro conditions. Measurements of various plant growth characters under normal and different stress conditions.

UNIT-IV: Germplasm Collection, Exchange and Quarantine

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Example of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Preparation of Herbarium of crop varieties and their wild relatives.