COURSE CURRICULUM

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

A. Core Courses			
S. No.	**Course Code**	**Name of the Courses**	**Credit Hours**
1.	MGPC- 101	Principles of Genetics	3 (2-0-1)
2.	MGPC-102	Principles of Plant Breeding	3 (2-0-1)
3.	MGPC-103	Principles of Cytogenetics	3 (2-0-1)
4.	MGPC-201	Crop Breeding I (*Kharif* Crops)	3 (2-0-1)
5.	MGPC-202	Fundamentals of Quantitative Genetics	3 (2-0-1)
6.	MGPC-301	Crop Breeding II (*Rabi* Crops)	3 (2-0-1)
7.	MGPC-302	Molecular Breeding & Bioinformatics	3 (2-0-1)
8.	MGPS-401	Master's Seminar	1(0-0-1)
Total			22
B. Basic Supporting Courses			
9.	MGPB-104	Statistical Methods and Experimental Design	4(3-0-1)
10.	MGPB-203	Seed Production and Certification	2(1-0-1)
C. Research			
11.	MGPT-402	Master's Thesis Research	30
D. Elective Courses			
12.	-	From the list of elective courses	08 (Minimum)

List of Elective courses:

S. No.	**Course Code**	**Name of the course**	**Credit Hours**
1.	MGPE-105	Breeding for Stress Resistance and Climate Change	3(2-0-1)
2.	MGPE-106	Mutagenesis and Mutation Breeding	3(2-0-1)
3.	MGPE-204	Hybrid Breeding	3(2-0-1)
4.	MGPE-205	Genetic Enhancement for PGR Utilization	3(2-0-1)
5.	MGPE-303	Breeding for Quality and Special Traits	2 (1-0-1)
6.	MGPE-304	Breeding Vegetable Crops	2 (1-0-1)

SEMESTER WISE DISTRIBUTION OF COURSES

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

SEMESTER-I

S. No.	Course Code	Course Title	Periods				MM
			L	T	P	C	
Core Courses							
1.	MGPC- 101	Principles of Genetics	**2**	**0**	**1**	**3**	**100**
2.	MGPC- 102	Principles of Plant Breeding	**2**	**0**	**1**	**3**	**100**
3.	MGPC-103	Principles of Cytogenetics	**2**	**0**	**1**	**3**	**100**
Basic Supporting Courses							
4.	MGPB-104	Statistical Methods and Experimental Design	**3**	**0**	**1**	**4**	**100**
Elective Course- (Students can select any one elective course)							
5.	MGPE-105	Breeding for Stress Resistance and Climate Change	**2**	**0**	**1**	**3**	**100**
6.	MGPE-106	Mutagenesis and Mutation Breeding	**2**	**0**	**1**	**3**	**100**
		Total	**11**	**0**	**5**	**16**	**500**

Semester-II

S. No.	Course Code	Course Title	Periods				MM
			L	T	P	C	
Core Courses							
1.	MGPC- 201	Crop Breeding I (*Kharif* Crops)	**2**	**0**	**1**	**3**	**100**
2.	MGPC- 202	Fundamentals of Quantitative Genetics	**2**	**0**	**1**	**3**	**100**
Basic Supporting Courses							
3.	MGPB-203	Seed Production and Certification	**1**	**0**	**1**	**2**	**100**
Elective Course- (Students can select any one elective course)							
4.	MGPE-204	Hybrid Breeding	**2**	**0**	**1**	**3**	**100**

5.	MGPE-205	Genetic Enhancement for PGR Utilization	**2**	**0**	**1**	**3**	**100**
		Total	**7**	**0**	**4**	**11**	**400**

Semester-III

S. No.	**Course Code**	**Course Title**	**Periods**				**MM**
			L	**T**	**P**	**C**	
Core Courses							
1.	MGPC-301	Crop Breeding II (*Rabi* Crops)	**2**	**0**	**1**	**3**	**100**
2.	MGPC- 302	Molecular Breeding & Bioinformatics	**2**	**0**	**1**	**3**	**100**
Elective Course- (Students can select any one elective course)							
3.	MGPE-303	Breeding for Quality and Special Traits	**1**	**0**	**1**	**2**	**100**
4.	MGPE-304	Breeding Vegetable Crops	**1**	**0**	**1**	**2**	**100**
Total			**5**	**0**	**3**	**8**	**300**

Semester-IV

S.No.	**Course Code**	**Course Title**	**Periods**				**MM**
			L	**T**	**P**	**C**	
1.	MGPS-401	Master's Seminar	**0**	**0**	**1**	**1**	**100**
Total			**0**	**0**	**1**	**1**	**100**

L-Lecture-Tutorial-Practical-Credit

MGPT-402: Master's Thesis Research: Students may register up to 30 credits from first to fourth Semester during M. Sc. (Ag.) Genetics and Plant Breeding programme.

DESCRIPTION OF COURSES

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

Programme Name	**M.Sc. (Ag.) Genetics & Plant Breeding**	**Programme Code**	GPB01
Course Code	**MGPC- 101**	**Credit**	**3(2+1)**
Year/Sem	**1/I**	**L-T-P**	**2-0-1**
Course Name	**Principles of Genetics**		

Course Objectives: The objectives of this course are

1. To impart the knowledge about the chemical and physical nature of gene and their inheritance.
2. To develop understanding of the basic concept of inheritance of genetic traits.
3. To develop the problem solving skills from classical to modern genetics.
4. To develop the ability to identify desired traits.

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

UNIT-V

Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

UNIT-VI

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 considerations.

Upon successful completion of the course a student will be able to:

CO1	Define the pre mendelian concept of the genetics and nature of gene inheritance
CO2	Understanding of mendelian population nature, structure, function of genes and genetic material and their role in crop evolution.
CO3	Illustrate nature, structure and expression of genetic material.
CO4	Explain gene isolation, synthesis and cloning.
CO5	Evaluate techniques of nucleic acid hybridization and immunochemical detection.
CO6	Construct and design effective approaches at genomics, proteomics for treatment of genetic disorders

Suggested Readings

- Daniel L H and Maryellen R. 2011.*Genetics:*"*Analysis of Genes and Genomes*".
- Gardner E J and Snustad D P.1991.*Principles of Genetics*. JohnWiley and Sons. 8th ed. 2006
- Klug W S 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; 7th edition.
- Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manualon Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

CO-PO/PSO Mapping

COs / POs/PSOs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PS O3	PSO 4
CO1	2	1	2	-	-	-	-	-	-	1	1	1	2	3	2	3
CO2	2	2	1	1	1	2	-	-	-	-	1	1	2	2	1	2
CO3	1	1	2	-	-	1	-	-	-	-	1	1	3	1	2	1
CO4	3	-	1	3	2	2	-	-	-	-	1	1	3	2	3	1
CO5	2	1	1	2	2	1	-	-	-	-	1	1	2	2	2	2
CO6	2	1	1	2	1	1	-	-	-	-	2	2	2	2	2	2
Average	2	1.2	1.3	2	1.5	1.4	-	-	-	1	1.2	1.2	2.3	2	2	1.79

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPC- 102	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Principles of Plant Breeding		

Course Objectives: The objectives of this course are

1. To impart theoretical knowledge and practical skills about plant breeding objectives, genetic consequences, breeding methods for crop improvement.
2. To develop understanding of the basic concept of population improvement.
3. To develop skills for the development of new variety.
4. To develop the ability to identify the need for development of novel varieties.

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

UNIT-V

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-VI

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

Practical

- Floral biology in self and cross pollinated species;
- Selfing and crossing techniques;
- Selection methods in segregating populations and evaluation of breeding material;
- Analysis of variance (ANOVA);
- Estimation of heritability and genetic advance;
- Maintenance of experimental records;

Upon successful completion of the course a student will be able to:

CO1	Memorize principles and objectives of plant breeding, and state pattern of crop evolution and their role in crop improvement.
CO2	Explain genetic basis of breeding of agricultural crops.
CO3	Apply different breeding methods for solving breeding objectives in self pollinated crops.
CO4	Compare population improvement schemes for handling segregating generations.
CO5	Select special breeding techniques for varietal development.
CO6	Invent and apply participatory plant breeding approaches for variety protection.

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.
- 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.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3	PSO 4
CO1	2	1	2	-	-	-	-	-	-	-	1	1	2	2	-	3
CO2	3	2	2	3	2	2	-	-	-	-	-	-	3	3	3	2
CO3	2	2	2	3	2	2	-	-	-	-	2	2	2	2	2	3
CO4	2	1	2	1	1	1	-	-	-	-	-	-	3	1	1	3
CO5	2	2	2	2	2	1	-	-	-	-	2	2	3	2	2	2
CO6	2	2	2	2	2	1	-	-	-	-	2	2	3	2	2	2
Average	2.1	1.6	2	2.2	1.8	1.4	-	-	-	-	1.75	1.75	2.6	2	2	2.5

Programme Name	**M.Sc. (Ag.) Genetics & Plant Breeding**	**Programme Code**	GPB01
Course Code	**MGPC-103**	**Credit**	
Year/Sem	**1/I**	**L-T-P**	
Course Name			
1.			
•			

- Demonstration of polyploidy.

Upon successful completion of the course a student will be able to:

CO1	Define chromosomes architecture in prokaryotes and eukaryotes and their role in evolution.
CO2	Compare structural and numerical chromosome variation and relate their evolutionary significance
CO3	Identify invitro techniques to overcome pre and post fertilization barriers in crop plants.
CO4	Classify role of polyploidy in crop breeding.
CO5	Determine different techniques of genome mapping of polyploids.
CO6	Construct and develop methods for the production of wide hybrids through chromosome manipulation.

Suggested Readings

- Becker K and Hardin J. 2004. *World of the Cell*. 5th Ed. Pearson Edu. 9th edition. Carroll M. 1989. *Organelles*. The Guilford Press.
- Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall Publications.
- Darlington CD and La Cour LF. 1969. *The Handling of Chromosomes*. George Allen & Unwin Ltd.
- Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press, Oxford.
- Gupta PK and Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A.
- Gupta PK. 2010. *Cytogenetics*. Rastogi Publishers. Johannson DA. 1975. *Plant Micro technique*. McGraw Hill.
- Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons. Khush GS. 1973. *Cytogenetics of aneuploids*. Elsevier. 1 edition.
- Roy D.2009. *Cytogenetics*. Alpha Science Intl Ltd.
- Schulz SJ.1980. *Cytogenetics- Plant, animals and Humans*. Springer.
- Sharma AK and Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth-Heinemann publisher 2014.3rd edition
- Singh RJ. 2016. Plant *Cytogenetics* 3rd Edition. CRC Press.
- Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ. 1 edition, Springer pub. Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

CO-PO/PSO Mapping

COs / POs/PSOs	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	1	-	1	1	-	-	-	1	-	-	2	2	1	1
CO2	1	1	1	-	1	2	-	-	-	1	-	-	2	2	2	1
CO3	2	1	1	2	1	1	-	-	-	1	2	2	2	2	2	3
CO4	1	1	1	1	1	1	-	-	-	1	-	-	1	2	2	3
CO5	3	2	2	2	2	-	-	-	-	1	2	2	3	2	2	2
CO6	3	2	2	2	2	-	-	-	-	1	2	2	3	2	2	2
Average	2	1.3	1.3	1.75	1.3	1.25	-	-	-	1	2	2	2.1	2	1.8	2

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programe Code	GPB01
Course Code	MGPB-104	Credit	4(3+1)
Year/Sem	1/I	L-T-P	3-0-1
Course Name	Statistical Methods and Experimental Design		

Course Objectives: The objectives of this course are

1. To impart theoretical knowledge about statistical procedures and techniques that is being utilized for varietal development.
2. To develop understanding of the basic principles of experimental design to be utilized for varietal performance and development.
3. To develop skills for the analysis of data using statistical procedures.
4. To develop the ability to assess test of significance.

UNIT- I

Presentation of Data: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves.

UNIT- II

Measures of Locations and Dispersion: Mean, median, mode and their simple properties (with-out derivation) and calculation of median by graphs; range, mean deviation, standard deviation, standard error, coefficient of variation.

UNIT- III

Probability and Distributions: Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson and normal distributions; and simple properties of the above distributions (without derivation).

UNIT- IV

Correlation and Regression: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.

UNIT- V

Sampling: Concept of population and sample; random samples; methods of taking a simple random sample. 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 12.

UNIT-VI

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).

Practical

- Presentation of data-tabulation, histograms and frequency polygons.
- Calculation of mean, mode, standard deviation, skewness and kurtosis.
- Calculation of expected frequencies in binomial, poison and normal distributions testing the observed results against expected frequencies.
- Tests of significance as prescribed in theory.
- Regression and correlation coefficients and their significance.
- Analysis of variance for different designs prescribed. Analysis of covariance.

Upon successful completion of the course a student will be able to:

CO1	Define methods of presenting data for statistical analysis.
CO2	Compare different methods of measurement of location and dispersion.
CO3	Apply statistical methods of probability and distribution for data analysis.
CO4	Analyze relationship between correlation and regression.
CO5	Determine different methods of data sampling of plant population.
CO6	Choose appropriate experimental design for varietal development and evaluation.

Suggested Readings

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

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO3	PSO 4
CO1	2	-	2	3	-	-	-	-	-	-	-	-	2	2	-	-
CO2	-	2	1	3	-	2	-	-	-	-	-	-	-	1	-	-
CO3	1	1	2	3	-	1	-	-	-	-	-	-	2	-	-	2
CO4	1	1	1	3	-	1	-	-	-	-	-	-	2	-	-	1
CO5	2	1	1	2	-	1	-	-	-	-	1	1	2	1	-	2
CO6	2	1	1	2	-	1	-	-	-	-	2	2	2	1	-	2
Average	1.6	1.2	1.3	2.6	-	1.2	-	-	-	-	1.5	1.5	2	1.25	-	1.75

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programe Code	GPB01
Course Code	MGPE-105	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Breeding for Stress Resistance and Climate Change		

Course Objectives: The objectives of this course are

1. To make student capable of well verse with the stressand its causes.
2. To develop understanding of the basic concept of MAS.
3. To develop skills among student to develop RIL and NIL.
4. To develop the ability to develop tolerant varieties against biotic stress.

UNIT- I

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

UNIT- II

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

UNIT- III

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

UNIT- IV

Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT- V

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

UNIT-VI

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

Practical

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

Upon successful completion of the course a student will be able to:

CO1	Define stress and climate change and concept of resistant against insect and pathogens.
CO2	Summarize various abiotic and biotic stresses influencing crop yield.
CO3	Identify the mechanisms and types of genetics of resistance in plants against biotic stresses.
CO4	Classify abiotic stress and gave emphasis in developing breeding methodologies.
CO5	Determine role of genomics in development of abiotic stress resistance cultivars.
CO6	Design and construct transgenics for management of biotic and abiotic stresses.

Suggested Readings

- Blum A. 1988. *Plant Breeding for Stress Environments*. CRC Press.
- Christiansen MN and Lewis CF. 1982. *Breeding Plants for Less Favorable Environments*.
- Wiley International.
- Fritz RS and Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics*. The University of Chicago Press.
- Li PH and Sakai A. 1987. *Plant Cold Hardiness*. Liss, New York Springer
- Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects*. USDA, ARS, Washington DC.
- Maxwell FG and Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons. Wiley-Blackwell.
- Roberto F. 2018. *Plant Breeding for Biotic and Abiotic Stress Tolerance*. Springer. Russel GE. 1978. *Plant Breeding for Pest and Disease Resistance*. Butterworths. Sakai A and Larcher W. 1987. *Frost Survival in Plants*. Springer-Verlag.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	2	1	-	-	-	-	-	-	2	2	2	2	1	1
CO2	1	2	1	-	-	2	-	-	-	-	2	2	1	1	1	-
CO3	1	1	2	-	-	1	-	-	-	-	1	1	2	2	-	1
CO4	1	1	1	1	1	1	-	-	-	-	1	1	2	1	1	3
CO5	2	2	1	1	2	1	-	-	-	2	2	2	2	1	2	2
CO6	2	2	2	1	1	2	-	-	-	2	1	1	2	1	1	1
Average	1.5	1.5	1.5	1	1.3	1.4	-	-	-	2	1.5	1.5	1.8	1.3	1.2	1.6

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPE-106	Credit	3(2+1)
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Mutagenesis and Mutation Breeding		

Course Objectives: The objectives of this course are

1. To impart the knowledge about mutation, various methods of inducing mutations and their utilization in plant breeding
2. To give depth knowledge about genomics, allele mining, TILLING, etc. and their utilization in crop improvement program.
3. To develop ability to detect useful mutants to be utilized in crop improvement program.
4. To develop skills for the development of mutant varieties.

UNIT- I

Mutation and its history, nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations; Detection of mutations. Paramutations in crops plants. Mutagenic agents: physical – radiation types and sources: Ionizing and non-ionizing radiations. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships; Effect of mutations on DNA – repair mechanismsoperating at

UNIT- II

DNA, chromosome, cell and organism level to counteract the mutation effects; Dosimetry -Objects and methods of treatment; Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects; Radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.

UNIT- III

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

UNIT- IV

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

UNIT-V

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

Practical

- Precautions on handling of mutagens; Dosimetry-Studies of different mutagenic agents: Physical mutagens and Chemical mutagens;
- Learning on Radioactivity- Production source and isotopes at BRIT, Learning about gamma

chamber; Radiation hazards:

- Monitoring – safety regulations and safe transportation of radioisotopes,
- visit to radio isotope laboratory; learning on safe disposal of radioisotopes;
- Hazards due to chemical mutagens – Treating the plant propagules at different doses of physical and chemical mutagens;
- Procedures in combined mutagenic treatments;
- Raising the crop for observation; Mutagenic effectiveness and efficiency, calculating the same from earlier literature

Upon successful completion of the course a student will be able to:

CO1	Define general principles of mutagenesis for crop improvement.
CO2	Summarize types of mutagen and organism level to counteract mutation effect**.**
CO3	Choose different methods to detect mutation and study their effects.
CO4	Explain effects of mutation of mutagen on M1 and M2 generation.
CO5	Determine the role of mutation in creating oligogenic and polygenic variation.
CO6	Elaborate mutagens role in genomics, allele mining and tilling.

Suggested Readings

- Cotton R, Edkin E and Forrest S. 2000. *Mutation Detection: A Practical Approach*. Oxford Univ. Press.
- International Atomic Energy Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energy Agency, Vienna, Italy.
- Shu QY, Forster BP and Nakagawa N. 2012. *Plant Mutation Breeding and Biotechnology.*
- Gutenberg Press Ltd. Rome Italy ISBN:978-925107-022-2 (FAO).
- Singh BD. 2003. *Genetics*. Kalyani Publishers, New Delhi. Strickberger MW. 2005. *Genetics*. 3rd Ed. Prentice Hall.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	1	1	1	1	-	-	-	-	1	1	2	2	1	-
CO2	2	1	-	-	-	1	-	-	-	-	1	1	2	1	1	-
CO3	1	1	-	-	-	1	-	-	-	-	1	1	2	1	1	1
CO4	1	1	1	1	1	1	-	-	-	-	1	1	2	1	1	1
CO5	2	2	1	2	1	1	-	1	-	1	1	1	2	2	2	1
CO6	2	2	1	2	1	1	-	1	-	1	1	1	2	2	2	1
Average	1.6	1.3	1	1.5	1	1	-	1	-	1	1	1	2	1.5	1.3	1

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPC -201	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Crop Breeding I (Kharif *Crops*)		

Course Objectives: The objectives of this course are

1. To provide insight into recent advances in improvement of kharif cereals.
2. To give depth knowledge about advances in legumes, oilseeds, fiber, sugarcane and vegetative propagated crops.
3. To provide better understanding of the conventional and modern biotechnological approaches to be utilized for crop improvements.
4. To develop ability to to identify differences in botanical status, reproductive structures of crops and genetics of important kharif field crops.

UNIT- I

Rice: Origin, evolution, mode of reproduction, chromosome number; Genetics –Breeding for yield, quality, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding. Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications. Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc

UNIT- II

Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes. Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics– cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression ofalien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. Other pulses: Urd bean, mung bean, cowpea, Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT- III

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

UNIT-IV

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – 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-V

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

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

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;
- Visit to animal feed producing factories;
- Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

Upon successful completion of the course a student will be able to:

CO1	Define floral biology, genetics of *khari*f crops.
CO2	Express recent advances in improvement of *kharif* cereals and legumes.
CO3	Determine botany, genetics and breeding approaches of oilseeds, fibre, sugarcane and vegetative propagated crops
CO4	Illustrate conventional and modern biotechnological approaches for improvement of *kharif* crops.
CO5	Evaluate different breeding methods for the improvement of kharif crops.
CO6	Design and construct effective breeding approaches for the introgression of alien genes for biotic and abiotic stress resistance.

Suggested Readings

- 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 Palani swamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*. Directorate of Extension Education, TNAU, Coimbatore.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	1	1	1	1	-	-	-	-	1	1	3	2	1	1
CO2	2	1	1	1	1	1	-	-	-	-	1	1	1	1	2	2
CO3	1	1	2	1	1	1	-	-	-	-	1	1	2	2	2	2
CO4	1	1	1	1	2	1	-	-	-	-	1	1	2	1	2	2
CO5	2	2	1	1	1	1	-	-	-	1	1	1	2	1	2	2
CO6	2	2	1	1	1	1	-	-	-	1	1	1	2	1	2	2
Average	1.6	1.3	1.1	1	1.1	1	-	-	-	1	1	1	2	1.3	1.8	1.8

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPC- 202	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Fundamentals of Quantitative Genetics		

Course Objectives: The objectives of this course are

1. To impart theoretical knowledge and computation skills regarding components of variation and variances, scales, mating designs and gene effects.
2. To equipped with the knowledge of additive dominance and epistatic gene action.
3. To develop basic understanding of QTL mapping.
4. To develop ability to utilize markers for genotype and phenotype screening

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, ANOVA.

UNIT-III

Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysis-Metro glyph and D^2,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 D^2analysis;
- 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.

Upon successful completion of the course a student will be able to:

CO1	Define the principle and concept of quantitative genetics
CO2	Summarize types of experimental design used in crop production and development.
CO3	Integrate different genetic analysis for varietal development.

CO4	Explain different mating designs used in varietal development and evaluation.
CO5	Choose and compare different models for stability analysis.
CO6	Construct and design different strategies for QTL mapping.

Suggested Readings

- Falconer DS and Mackay J. 1998. *Introduction to Quantitative Genetics* (3rdEd.). ELBS/Longman, London.
- Mather Kand Jinks JL.1985.*Biometrical Genetics* (3rdEd.).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, NewDelhi.
- Singh RK and Chaudhary BD.1987. *Biometrical Methods in Quantitative Genetic* analysis. Kalyani Publishers, NewDelhi.
- 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.

CO-PO/PSO Mapping

POs /PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	1	2	1	1	-	-	-	-	1	-	2	3	2	3
CO2	2	1	1	3	1	1	-	-	-	-	2	-	2	1	1	3
CO3	1	1	2	3	1	1	-	-	-	-	2	-	2	1	1	2
CO4	2	1	1	1	1	1	-	-	-	-	-	-	2	2	2	2
CO5	2	1	1	1	1	-	-	-	-	-	-	1	2	2	2	2
CO6	2	1	1	1	1	1	-	-	-	-	-	1	2	2	2	2
Average	1.8	1	1.1	1.8	1	1	-	-	-	-	1.6	1	2	1.8	1.6	2.3

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPB-203	Credit	2(1+1)
Year/Sem	1/II	L-T-P	1-0-1
Course Name	Seed Production & Certification		

Course Objectives: The objectives of this course are

1. To impart knowledge on the seed quality concept and importance.
2. To provide better understanding of seed production practices and seed certification procedures in different crops.
3. To give depth knowledge of seed laws.
4. To develop skills for quality seed production.

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 purityin 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; Organicseed production and certification.

UNIT- III

Principles of seed production in field crops; Floral structure, pollination mechanismand 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. Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibers. Hybrid-seed production techniques in major vegetative propagated crops.

UNIT-V

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 observationsrecorded 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.

Upon successful completion of the course a student will be able to:

CO1	Define the concept and importance of quality seed.
CO2	Summarize nucleus seed production and maintenance.
CO3	Utilize principle of hybrid seed production in field crops.
CO4	Compare techniques of seed production in pulses and oilseed crops.
CO5	Evaluate different phases of seed certification.
CO6	Develop and discuss minimum seed certification standards.

Suggested Readings

- 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.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	3	3	2	1	-	-	-	-	1	1	2	2	1	2
CO2	1	1	1	2	1	2	-	-	-	-	1	1	2	1	1	2
CO3	1	1	2	-	-	1	-	-	-	-	1	-	2	-	-	2
CO4	1	1	1	1	-	1	-	-	-	-	-	-	2	2	1	1
CO5	2	1	2	2	-	-	1	-	-	1	1	-	2	1	1	2
CO6	1	-	2	2	1	-	2	-	-	1	1	-	2	-	-	2
Average	1.3	1	1.8	2	1.3	1.25	1.5	-	-	1	1	1	2	1.5	1	1.8

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPE-204	Credit	3(2+1)
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Hybrid Breeding		

Course Objectives: The objectives of this course are

1. To help student in understanding of the basic concept of heterosis and its exploitation in varietal improvement.
2. To develop understanding of basic concepts of hybrid varieties and various techniques for development of hybrids in crop plants.
3. To develop skills for the utilization of male sterility system for hybrid seed production.
4. To develop the ability to exploit heterosis mechanism for yield improvement using conventional and biotechnological approaches.

UNIT- I

Historical aspect of heterosis, nomenclature and definitions of heterosis; Heterosis in natural population and inbreed 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 under lining heterosis; theories and their estimation; Biometrical basis of heterosis.

UNIT- II

Prediction of heterosis from various crosses, inbreeding depression, coefficient of inbreeding and its estimation, residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis–case studies.; Relationship 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 hybrid.

UNIT- IV

Hybrid seed production system: 3-line, 2-line and1-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 rape seed-mustard, sunflower, safflower and castor oil seed crops and pigeon pea.

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 there leased hybrids, their potential, problems and ways of overcoming it;
- Hybrid breeding at National and International level, opportunities ahead.

Upon successful completion of the course a student will be able to:

CO1	Define basic concept of heterosis and its historical aspect.
CO2	Summarize uses of heterosis in hybrid seed production.
CO3	Determine in the role of male sterility system in hybrid production.
CO4	Explain hybrid seed production system
CO5	Estimate difficulties in breeding apomicts
CO6	Discuss Hybrid breeding at National and International level, opportunities ahead.

Suggested Readings

- 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.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	3	-	2	2	1	1	-	-	-	-	1	-	3	2	2	3
CO2	2	1	1	3	2	1	-	-	-	-	1	-	3	2	-	3
CO3	1	2	1	1	2	1	-	-	-	-	1	-	2	2	1	2
CO4	2	1	2	2	2	1	-	-	-	-	1	-	2	2	3	2
CO5	2	2	1	1	1	-	-	1	1	1	-	-	2	1	1	1
CO6	2	2	1	1	1	-	-	-	2	1	2	-	2	2	2	2
Average	2	1.6	1.3	1.6	1.5	1	-	1	1.5	1	1	-	2.3	1.8	1.8	2.1

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	**MGPE-205**	**Credit**	**3(2+1)**
Year/Sem	**1/II**	**L-T-P**	**2-0-1**
Course Name	**Genetic Enhancement for PGR Utilization**		

Course Objectives: The objectives of this course are

1. To provide theoretical and practical knowledge on the concept of gene pool.
2. To develop understanding on CWRs reproductive behavior, acclimatization and adaptation for utilization in prebreeding programs using advanced tools.
3. To make student conversant with handling of unadapted germplasm.
4. To develop ability to utilize plant genetic resource in crop improvement programs.

UNIT- I

Concepts of gene pools; Introduction, potential of pre-breeding. Role of crop wild relatives, semi exotics, creating and managing variation, basic concepts to set upa successful pre-breeding program.

UNIT- II

Understanding crop adaptation, handling and maintenance of CWRs, synchronization of flowering, overcoming impediments to flowering through photoperiodic adjustments, role of other barriers to flowering, role of amphidiploids, semi exotics and other un adapted germplasm, identifying desirable traits in natural populations, screening for biotic and abiotic stress resistance traits; screening of nutritionally important traits, genetic analysis to understand the inheritance of novel traits.

UNIT- III

Parental selection for prebreeding, search for superior genotypes, breeding methods for trait transfer; moving the genes - unadapted to adapted, wide hybridization, Incongruity and its management, modern tools for incongruity management, cytogenetical approaches for gene transfer such as alien addition and substitution, segregating populations and their management in wide crosses, purging the undesirable traits, testing and improving the adaptability of wide cross derivatives, cytological studies.

UNIT- IV

Florescence microscopy, embryo rescue methods, pollen physiology and storage, pollen storage methods to facilitate wide hybridization, pre- and post- zygotic barriers.

Practical

- Characterization of CWRs by visiting the fields;
- Screening methods for special traits-biotic and abiotic resistance;
- Screening for nutritional traits; Cross ability studies in CWRs of cereals, legumes, oilseeds, vegetables. Assessmentof pre and post-zygotic barriers in wide hybridization crosses;
- Pollen storage studies. Special l requirements for growing CWRs, inducing flowering by manipulating daylength, temperature, chemical spraying, etc

Upon successful completion of the course a student will be able to:

CO1	Define the concept of gene pool and its role in prebreeding program.
CO2	Explain CWRs reproductive behavior, acclimatization and adaptation for utilization in pre breeding programs using advanced tools.
CO3	Apply different screening methods for quality and resistant traits.
CO4	Classify parental selection for prebreeding.
CO5	Choose modern tools for incongruity management.
CO6	Elaborate pre and post-zygotic barriers in wide hybridization crosses.

Suggested Readings

- Andey Pereira. 2006. *Plant Reverse Genetics*, Methods and Protocols, Humana Press

- Bisht *et al*. 2004. Broadening the genetic base of sesame (*Sesamum indicum* L.) through genetic enhancement. *Plant Genetic Resources* **2**(3): 143–151.
- Dale JW and von Schantz M. 2007. *From genes to genomes. Concepts and applications of DNA technology*. John Wiley & Sons Ltd., Chichester, England.
- Duvick DN. 1990. Genetic enhancement and plant breeding. p. 90–96. In: J. Janick and J.E. Simon (eds.), Advances in new crops. Timber Press, Portland.
- Goodman, RM. 2004. *Encyclopedia of plant and crop science*. Marcel Dekker Inc., Switzerland.
Kimber, G and Feldman, M. 1987. *Wild Wheat: An introduction*. Special report 353, College of
- Agriculture, University of Missouri-Columbia.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3	PSO 4
CO1	2	1	2	1	1	1	-	-	-	-	1	-	2	1	1	1
CO2	1	2	1	1	1	1	-	-	-	-	1	-	2	1	1	1
CO3	1	1	2	1	1	1	-	-	-	-	1	-	2	2	-	2
CO4	1	1	1	1	1	1	-	-	-	-	1	-	2	1	-	1
CO5	2	1	2	2	-	-	2	1	1	1	1	-	2	1	1	1
CO6	2	1	-	2	-	-	-	1	-	1	1	-	2	2	2	1
Average	1.5	1.1	1.6	1.3	1	1	2	1	1	1	1	-	2	1.3	1.25	1.1

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPC-301	Credit	3(2+1)
Year/Sem	2/III	L-T-P	2-0-1
Course Name	Crop Breeding II (Rabi *Crops*)		

Course Objectives: The objectives of this course are

1. To provide insight into recent advances in improvement of rabi cereals.
2. To give depth knowledge about advances in legumes, oilseeds, fiber, forage crops and seed spices.
3. To provide better understanding of the conventional and modern biotechnological approaches to be utilized for crop improvements.
4. To develop ability to identify differences in botanical status, reproductive structures of crops and genetics of important rabi field crops.

UNIT- I

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

UNIT- II

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

UNIT- III

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

UNIT- IV

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

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

UNIT-V

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

Practical

- Floral biology, emasculation and pollination techniques in wheat, oats, barley, chickpea, rajma, rapeseed mustard, sunflower;
- 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.

Upon successful completion of the course a student will be able to:

CO1	Define major Rabi field crops
CO2	Summarize genetics and breeding approaches for Rabi field crops.
CO3	Determine factors affecting their crop production
CO4	Explain recent advances in improvement of Rabi cereals, legumes oilseeds, fiber and vegetative propagated crops.
CO5	Evaluate and utilize modern biotechnological approaches of crop improvement.
CO6	Choose effective breeding strategies for varietal development.

Suggested Readings

- 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.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3	PSO 4
CO1	2	1	1	-	1	-	-	-	-	-	2	-	2	1	1	1
CO2	2	2	1	-	1	2	-	-	-	-	2	-	1	1	2	2
CO3	1	1	2	1	1	1	-	-	-	-	2	-	1	1	2	2
CO4	1	1	1	1	1	1	-	-	-	-	2	-	1	1	2	2
CO5	1	2	1	1	2	1	-	1	-	-	1	1	2	2	2	2
CO6	1	2	1	1	2	1	1	1	-	-	1	1	2	2	2	2
Average	1.3	1.5	1.1	1	1.3	1.2	1	1	-	-	1.6	1	1.5	1.3	1.8	1.8

Programme Name	M.Sc.(Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPC- 302	Credit	3(2+1)
Year/Sem	2/III	L-T-P	2-0-1
Course Name	Molecular Breeding & Bioinformatics		

Course Objectives: The objectives of this course are

1. To provide depth knowledge about different tools of bioinformatics utilize in molecular breeding
2. To impart knowledge and practical skills to use innovative approaches in Plant Breeding.
3. To provide deep knowledge on genotyping and kinds of markers
4. To develop ability to develop superior varieties using marker assisted selection.

UNIT- I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F_2s, backcrosses, 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 genomic stools; 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; related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues.

UNIT-V

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 component sand 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 green house 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, gels Scoring and data analysis for tagging and phylogenetic relationship;
- Construction of genetic link age maps using computer software;
- NCBI Genomic Resources, GBFF, Swiss Prot, Blastn/Blastp, Gene Prediction Tool, Expasy Resources, PUBMED and PMC, OMIM and OMIA ,ORF finder; Comparative Genomic Resources:- Map Viewer (UCSC Browser and Ensembl); Primer designing-Primer3/Primer BLAST.

Upon successful completion of the course a student will be able to:

CO1	Define molecular markers and their role in varietal improvement and development.
CO2	Demonstrate technique of molecular mapping and allele mining.
CO3	Identify the role of comparative genomics in crop improvement.
CO4	Discover use of nanotechnology in crop improvement.
CO5	Evaluate application of recombinant DNA technology in molecular farming.
CO6	Elaborate bioinformatics implication in crop improvement.

Suggested Readings

- Azuaje Fand DopazoJ. 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..
- Jollès Pand Jörnvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis. Birkhäuser.
- 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.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	2	1	2	1	1	-	-	-	-	1	1	2	2	2	2
CO2	2	-	1	-	1	2	-	-	-	-	1	1	2	2	2	2
CO3	1	1	2	-	1	1	-	-	-	-	1	1	2	2	3	1
CO4	2	1	1	2	1	1	-	1	-	-	1	1	2	2	2	2
CO5	2	1	-	1	1	1	-	1	1	-	1	1	2	2	2	2
CO6	2	1	-	1	1	1	-	-	1	1	1	1	2	2	2	2
Average	2	1.2	1.25	1.5	1	1.1	-	1	1	1	1	1	2	2	2.1	1.8

Programme Name	**M.Sc. (Ag.) Genetics & Plant Breeding**	**Programme Code**	GPB01
Course Code	**MGPE-303**	**Credit**	**2(1+1)**
Year/Sem	**2/III**	**L-T-P**	**1-0-1**
Course Name	**Breeding for Quality and Special Traits**		

Course Objectives: The objectives of this course are

1. To provide insight into recent advances in improvement of quality traits in cereals, millets,
2. To give depth knowledge of recent advances in improvement of quality traits in legumes, oilseed crops
3. To provide better understanding the methods of improvement of forage and industrial crops using conventional and modern biotechnological approaches.
4. To develop ability to design varieties for quality parameters.

UNIT- I

Developmental biochemistry and genetics of carbohydrates, proteins, fats, vitamins, amino acids and anti-nutritional factors; Nutritional improvement - A human perspective.

UNIT- II

Breeding for grain quality parameters in rice and its analysis; Golden rice and aromatic rice: Breeding strategies, achievements and application in Indian context; Molecular basis of quality traits and their manipulation in rice; Post harvest manipulation for quality improvement; Breeding for baking qualities in wheat, characters to be considered and breeding strategies, molecular and cytogenetic manipulation for quality improvement in wheat.

UNIT- III

Breeding for quality improvement in Sorghum, pearl millet, barley and oats; Quality protein maize, specialty corns, concept and breeding strategies; Breeding for qualityimprovement in important forage crops for stay green traits; Genetic resource management for sustaining nutritive quality in crops.

UNIT-IV

Breeding for quality improvement in pulses – Chickpea, pigeonpea, green gram and black gram cooking quality; Breeding for quality in oilseeds -groundnut, mustard, soybean, sesame, sunflower and minor oilseeds; Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops; Genetic manipulation for quality improvement in cotton. Breeding for quality improvement in Sugarcane, potato.

UNIT-V

Genetic engineering protocols for quality improvement: Achievements made; Biofortification in crops; Classification and importance, Nutritional genomics and Second generation transgenics.

Practical

- Grain quality evaluation in rice;
- Correlating ageing and quality improvement inrice;
- Quality analysis in millets; Estimation of anti-nutritional factors like tannins in different varieties/ hybrids:A comparison;
- Quality parameters evaluation in wheat, pulses and oilseeds;
- Evaluation of quality parameters in cotton, sugarcane and potato;
- Value addition in crop plants.

Upon successful completion of the course a student will be able to:

CO1	Identifying developmental biochemistry and genetics of biomolecules.
CO2	Summarize breeding methods for grain quality parameters in field crops
CO3	Choose and select methods of quality analysis in millets.
CO4	Compare different breeding strategies for quality improvement in Sugarcane, potato.

CO5	Evaluate different breeding approaches for quality improvement in pulses.
CO6	Formulate genetic engineering protocols for quality improvement.

Suggested Readings

- Chahal GS and SS Ghosal. 2002. Principles and procedures of plant breeding - Biotechnological and Conventional approaches**,** Narosa Publications Chopra VL. 1997. Plant Breeding. Oxford & IBH. 2018.
- FAO 2001. Speciality Rices of the World - Breeding, Production and Marketing. Oxford & IBH,1 Nov 2001.
- Ghosh P. 2004. Fibre Science and Technology. Tata McGraw Hill.
- Gupta SK. 2007. Advances in Botanical Research Vol. 45 Academic Press USA. Hay RK. 2006. Physiology of Crop Yield. 2nd Ed. Blackwell.
- Nigam J. 1996. Genetic Improvement of Oilseed Crops. Oxford & IBH. Singh BD. 1997. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh RK, Singh UK and Khush GS. 2000. Aromatic Rices. Oxford & IBH.

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	-	1	1	-	-	-	-	2	-	2	2	1	1
CO2	2	2	1	1	1	2	-	-	-	-	2	-	2	2	1	2
CO3	1	1	1	1	1	1	-	-	-	-	2	-	2	1	1	1
CO4	1	1	1	1	1	1	-	-	-	-	2	-	2	1	2	2
CO5	1	2	2	2	1	1	-	-	-	1	2	-	2	2	2	2
CO6	1	2	2	2	1	2	-	-	1	1	2	-	2	2	2	2
Average	1.3	1.6	1.5	1.4	1	1.3	-	-	1	1	2	-	2	1.6	1.5	1.6

Programme Name	M.Sc. (Ag.) Genetics & Plant Breeding	Programme Code	GPB01
Course Code	MGPE-304	Credit	2(1+1)
Year/Sem	2/III	L-T-P	1-0-1
Course Name	Breeding Vegetable Crops		

Course Objectives: The objectives of this course are

1. To provide insight into principles and practices adopted for breeding vegetable crops
2. To give depth knowledge about breeding objectives, methodologies and genetics involved for the improvement of major vegetable crops
3. To provide better understanding of special breeding techniques for varietal improvement.
4. To develop ability to design varieties for biotic and abiotic stress.

UNIT- I

Breeding for Leafy vegetables: Amaranth, chenopods and lettuce.

UNIT- II

Breeding for Cucurbits: Gourds, melons, pumpkins and squashes.

UNIT- III

Breeding for Solanaceae: Potato and tomato, eggplant, hot pepper, sweet pepper

UNIT-IV

Breeding for Cole crops: Cabbage, cauliflower, broccoli and knolkhol.

UNIT- V

Breeding for Root vegetables: Carrot, beetroot, radish, sweet potato and tapioca.

Practical

- Selection of desirable plants from breeding population, observations and analysis of various qualitative and quantitative traits in germplasm;
- Hybridization and handling segregating generations; Induction of flowering, palanological studies, selfing and crossing techniques invegetable crops;
- Hybrid seed production of vegetable crops in bulk;
- Screening techniques for insect-pests, disease and environmental stress resistance in vegetable crops;
- Demonstration of sib-mating and mixed population;
- Molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques;
- Visit to breeding blocks, MAS for incorporating traits governed by major and polygenes.

Upon successful completion of the course a student will be able to:

CO1	Find principles and practices adopted for breeding of vegetable crops.
CO2	Summarize special breeding techniques for trait improvement in vegetable crops.
CO3	Determine different methodologies utilized for breeding vegetable crops.
CO4	Explain genetics involved for the improvement of major vegetable crops.
CO5	Evaluate different breeding approaches for improvement of vegetable crops.
CO6	Formulate effective molecular approaches for varietal development in vegetable crops.

Suggested Readings

- Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons.
- Fageria MS, Arya PS and Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani Publishers, New Delhi.
- Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.

- Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency. Peter KV and Pradeep KT. 2008. *Genetics and Breeding of Vegetables.* ICAR.
- Rai N and Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publication Agency. Ram HH. 2005. *Vegetable Breeding-Principles and Practices*. Kalyani Publishers
- Sharma JP. 2010. *Principles of Vegetable Breeding*. Kalyani Publishers, New Delhi.Singh BD. 1983. *Plant Breeding*. Kalyani Publisher

CO-PO/PSO Mapping

COs / POs/PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO 4
CO1	2	1	2	1	1	1	-	-	-	-	2	-	2	2	1	2
CO2	1	2	1	1	1	2	-	-	-	-	2	-	2	2	2	1
CO3	1	1	2	1	1	1	-	-	-	-	2	-	2	2	2	2
CO4	1	1	1	1	1	1	-	-	-	-	2	-	2	2	2	2
CO5	2	2	2	2	2	1	-	-	-	-	2	-	2	2	1	2
CO6	2	2	2	2	2	1	-	-	-	-	2	-	2	2	1	2
Average	1.5	1.5	1.6	1.3	1.3	1.1	-	-	-	-	2	2	2	2	1.5	1.8