VIDYASAGAR UNIVERSITY

Regulations, Curriculum & Syllabus

For

M. Sc (Agriculture) in Genetics & Plant Breeding

[w.e.f.: 2021-2022]

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VIDYASAGAR UNIVERSITY

Common Academic Regulations for PG Programme
in
M. Sc. (Agriculture) in Agronomy &
M. Sc. (Agriculture) in Genetics & Plant Breeding

[w.e.f.: 2021-2022]

Common Academic Regulations for PG Programme

This regulation framed by the board of studies meeting which was held on 13.05.2022 at Midnapore City College as per the guidelines of ICAR & Vidyasagar University for running M.Sc. (Agriculture) in Agronomy and M.Sc. (Agriculture) in Genetics & Plant Breeding. This regulation may change as per requirement deemed to be fit at any BOS Meeting under the prior approval as framed time to time by the ICAR & Vidyasagar University. The details of the rules & regulations as mentioned herein below:

1. Eligibility for Admission

The students who have passed Bachelor's degree in Agricultural / Botany / Horticulture or Forestry with 50% marks for General and 45% marks for SC/ST category.

2. Academic Year and Registration

a. An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. Dates of registration, commencement of instructions, semester end examination, end of semester and academic year, etc. will be implemented as per the Vidyasagar University norms.

b. The students shall register to the Vidyasagar University after the admission in the said course and the registration number will be issued by the Vidyasagar University.

3. Evolution System

a. Credit requirements

i. Framework of the courses

The following nomenclature and Credit Hrs need to be followed while providing the syllabus for all the disciplines:

Masters' Programme (Minimum credits)	
(i) Course work	
Major courses	20
Minor courses	06
Supporting courses	03
Common courses	06
Seminar	02
(ii) Thesis Research	20

Major courses: From the Discipline in which a student takes admission. Amongthe listed courses, the core courses compulsorily to be taken may be given *mark.

Minor courses: From the subjects closely related to a student's major subject.

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

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

- Library and Information Services
- Communicative English and thesis writing
- Intellectual Property and its management in Agriculture
- Basic Concepts in Laboratory Techniques
- Research Value and Ethics

Supporting Courses: The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. The syllabi of these courses are available in therespective disciplines. If required, the contents may be modified to suit the individualdiscipline with approval of the concerned BoS:

Course Title	Credit Hours
Mathematics for Applied Sciences	2+0
Statistical Methods for Applied Sciences	2+1
Experimental Designs	2+1

b. Mandatory requirement of seminars

- It has been agreed to have mandatory seminars one in Masters (Two Credits).
- The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.

c. Minimum Eligibility for Appearance in Examination

A regular student i.e. a student who has undergone a regular course of study in a college for the period specified for that course of study by having been on the rolls of the college immediately preceding the examination and has his/her name submitted to the Controller of Examinations by the college Principal where he/she has pursued the course for the examination and has fulfilled the following conditions to be certified by the college Principal concerned:

- He/she has been a student of good conduct.
- He/she has attended not less than 75% of the lecture delivered including seminars, tutorials etc. in each course opted by him/her in that semester.
- He/she has passed in previous semester.
- In the case of laboratory course/practical, he/she has attended not less than 75% of the practical classes conducted (practical include field studies, workshop practice, surveying etc.).

- He/she has paid the prescribed fee.

d. Scheme of Examination:

The evaluation of M.Sc. (Agriculture) in Agronomy and M.Sc. (Agriculture) in Genetics & Plant Breeding course contains two parts: Internal Assessment (IA) and End Semester Assessment (EA). The internal grade awarded to the students in the course in a semester shall be published on the notice board at least one week before the commencement of end semester examination. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course. There will be University Examinations at the end of each semester for both Theory and Practical. Semester End Examinations for all theory papers shall be set/prepared by the Controller of Examinations as per existing norms and evaluation of all theory papers courses shall be done by eligible faculty members set in the Board of Studies meeting held before the examination and under the supervision and coordination of the Chairman of BOS.

The students will learn 15 theory papers (Full Marks 50) and 15 practical papers (Full Marks 30) excluding Research paper (Full Marks 200) in total semester (it may be changed as per the recommendation of Board of Studies members and approved by the Hon'ble Vice Chancellor). The details of the syllabus should be approved by the Board of Studies members and or syllabus committee made for the course. The evaluation of a candidate shall be awarded and record thereof maintained in accordance with the Regulations prescribed:

Paper	Internal Assessment	End Semester	Total Marks
Theory	20	50	**100**
Practical	00	30	

Internal Assessment:

Categories	Class Assignment	Class Attendance	Internal exam*(IE)	Total
Number Distribution	05	05	10	**20**

*IE should be held two times. Best of the two should be awarded.

The questions pattern of theory will be as follows:

Component	Marks
05 Short Answer Type Questions out of 08 Questions. Each carries 02 marks.	**05×02=10**
05 Medium Answer Type Questions out of 08 Questions. Each carries 04 marks.	**05×04=20**
02 Long Answer Type Questions out of 05 Questions. Each carries 10 marks.	**02×10=20**

The questions pattern of practical will be as follows:

Component	**Marks**
2 experimental questions carries 5 marks each	**05×02=10**
Laboratory Note Book & Class Attendance	**10**
Viva-voce	**10**

e. Grading System:

Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) Based on the performance of the students, each student will be awarded Grade in each subject at the end of the semester following grading system on the base of 10 (ten). The letter grades and the corresponding grade points are as shown below:

Qualitative Evaluation	**Grade**	**% Scored in 100 Point Scale**	**Grade Points**
OUT STANDING	O	90 - 100	10
EXCELLENT	A	80 - 89	9
GOOD	B	70 - 79	8
AVERAGE	C	60 - 69	7
SATISFACTORY	D	50 - 59	6
FAILED	F	Below 50	0
ABSENT	Ab	0	0

Further there shall be another grade 'I' (with Point 0) for students for whom disciplinary actions remain pending. The Semester Grade Point Average (SGPA) will be computed in each semester as per the following formula:

SGPA (Si) = $\frac{\sum (Ci \times Gi)}{\sum Ci}$ Where Ci= Credit Point, Gi= Grade Point

C = The number of credits allotted for particular course. G = is the Grade points corresponding to the grade awarded for the course. i = 1,2,……., n represent the number of courses in which a student is registered in the concerned semester. The SGPA is rounded off to two decimal places. The Cumulative Grade Point Average (CGPA) will be computed at the end of each Semester as per the following formula:

CGPA=$\frac{\sum (Ci \times Si)}{\sum Ci}$

*C is the total credits of the corresponding semesters. S is the SGPA of the corresponding semesters. I = 1, 2… n represent the number of courses in which a student is registered in the concerned Semester. The CGPA is rounded off to two decimal places.

f. Rules for the Guidance of Candidates:

i. The final performance in a paper shall be taken as the total or aggregate of the marks obtained in internal assessment evaluation and the marks obtained at the End Semester Examinations.

ii. The qualifying marks for each theory paper shall be 50% and in the aggregate in each Semester it shall be 50%.

iii. A student who secures 50% in aggregate in a Semester but scores less than 50% in not more than two theory papers (Theory / Practical) shall be provisionally promoted to the next Semester, but declared failed in the papers in which he / she scores less than 50%. He / she shall be required to clear these back papers in next two chances. For these papers the qualifying marks shall be 50%.

iv. A student who does not secure 50% in aggregate in the Semester but secures 50% in all but two theory papers in the Semester, shall provisionally be promoted to the next Semester but declared failed in the papers in which he / she secured less than 50%. He / she shall be required to clear these back papers in next two chances subject to the condition stipulated in (h).

v. If students fail to qualify in more than two papers in a semester, he/she will have to repeat the semester in next academic session.

vi. A student may have a maximum of 4 back papers at any time of his/ her tenure.

vii. The back papers of the first, second and the third semester shall only be cleared with regular semester examination in the next academic session.

viii. The back papers of fourth semester shall be cleared in a special examination to be conducted within six weeks of the publication of the results or in the regular examination in the next academic session, to be decided by the Controller of Examination.

ix. A student shall have to qualify in all semester to qualify for the degree.

x. A student shall be allowed a maximum of consecutive four years to complete the two year Post-Graduate Programme of the University.

xi. Class/ Division will be awarded only in the Final Semester Examination.

Syllabus for M. Sc (Agriculture) in Genetics & Plant Breeding

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	Theory	Practical	Total
#GPB-101	Principles of Genetics	2		1	3	3	20	50	30	100
#GPB-102	Cell Biology and Cytogenetics	2		1	3	3	20	50	30	100
#GPB-103	Principles of Plant Breeding	2		1	3	3	20	50	30	100
#GPB-104	Principles of Quantitative Genetics	2		1	3	3	20	50	30	100
#GPB-105	Breeding for Biotic and Abiotic Stress Resistance	2		1	3	3	20	50	30	100
#GPB-201	Molecular Genetics	2		1	3	3	20	50	30	100
*AGR-202	Agronomy of Major *rabi* Cereals and Pulses	2		1	3	3	20	50	30	100
#GPB-203	Biotechnology for Crop Improvement	2		1	3	3	20	50	30	100
#GPB-204	Breeding Cereals, Forages and Sugarcane	2		1	3	3	20	50	30	100
#GPB-205	Breeding Legumes, Oilseeds and Fibre Crops	2		1	3	3	20	50	30	100
*GPB-206	Maintenance Breeding and Concepts of Variety Release and Seed Production	2		1	3	3	20	80	-	100
GPB- 207	Seminar I	0		1	1	1			100	100
**AST -101	Statistical methods for applied sciences	2		1	3	3	20	50	30	100
**PPH-301	Physiological and Molecular Response of Plants to Abiotic Stress	2		1	3	3	20	50	30	100
***PGS-302	Communicative English and thesis writing	1		1	2	2	20	50	30	100
***PGS-303	Basic Concepts of laboratory techniques	0		2	2	2	-	-	100	100
***PGS-304	Research value and ethics	2		0	2	2	20	80	-	100
##GPB-305	Research: Literature & Review	4				4				100
##GPB-401	Research	16				16				100
GPB-402	Seminar II	0		1	1	1	-	-	100	100
TOTAL THEORY					**29**	**29**				**2000**
TOTAL PRACTICAL					**18**	**18**				
RESEARCH					**20**	**20**				
TOTAL					**67**	**67**				

FIRST SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	Theory	Practical	Total
GPB-101	Principles of Genetics	2		1	3	3	20	50	30	100
GPB-102	Cell Biology and Cytogenetics	2		1	3	3	20	50	30	100
GPB-103	Principles of Plant Breeding	2		1	3	3	20	50	30	100
GPB-104	Principles of Quantitative Genetics	2		1	3	3	20	50	30	100
GPB-105	Breeding for Biotic and Abiotic Stress Resistance	2		1	3	3	20	50	30	100
TOTAL THEORY					**10**	**10**				**500**
TOTAL PRACTICAL					**5**	**5**				
TOTAL					**15**	**15**				

SECOND SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	Theory	Practical	Total
GPB-201	Molecular Genetics	2		1	3	3	20	50	30	100
AGR-202	Agronomy of Major *rabi* Cereals and Pulses	2		1	3	3	20	50	30	100
GPB-203	Biotechnology for Crop Improvement	2		1	3	3	20	50	30	100
GPB-204	Breeding Cereals, Forages and Sugarcane	2		1	3	3	20	50	30	100
GPB-205	Breeding Legumes, Oilseeds and Fibre Crops	2		1	3	3	20	50	30	100
GPB-206	Maintenance Breeding and Concepts of Variety Release and Seed Production	2		1	3	3	20	80	-	100
GPB- 207	Seminar I	0		1	1	1			100	100
TOTAL THEORY					**12**	**12**				**700**
TOTAL PRACTICAL					**7**	**7**				
TOTAL					**19**	**19**				

THIRD SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
AST -101	Statistical methods for applied sciences	2		1	3	3	20	50	30	100
PPH-301	Physiological and Molecular Response of Plants to Abiotic Stress	2		1	3	3	20	50	30	100
PGS-302	Communicative English and thesis writing	1		1	2	2	20	50	30	100
PGS-303	Basic Concepts of laboratory techniques	0		2	2	2	-	-	100	100
PGS-304	Research value and ethics	2		0	2	2	20	80	-	100
GPB-305	Research: Literature & Review	4			4					100
TOTAL THEORY					**7**	**7**				**600**
TOTAL PRACTICAL					**5**	**5**				
RESEARCH					**4**	**4**				
TOTAL					**16**	**16**				

FOURTH SEMESTER

COURSE CODE	COURSE TITLE	CONDUCT HOURS PER WEEK				TOTAL CREDITS	MARKS DISTRIBUTION			
		L	T	P	TOTAL		Int Asst.	End Sem	Practical	Total
GPB-401	Research	16				16				100
GPB -402	Seminar II	0		1	1	1	-	-		100
TOTAL					**17**	**17**				**200**

##Research work for master's dissertation- 20

#Major course - 27

*Minor course - 6

**Supporting course- 6

***Compulsory course-6

GENETICS AND PLANT BREEDING
FIRST SEMESTER

Principles of Genetics

Code: GPB-101 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

This course is aimed at understanding the basic concepts of genetics, helping studentsto develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

Theory

UNIT I

Beginning of genetics; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

UNIT II

Multiple alleles.Multiple Factor hypothesis.Geneinteractions.Lethal genes, Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; intergenic and intragenic complementation and recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

UNIT III

Population - Mendelian population – Random mating population -Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT IV

Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis. 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 V

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT VI

Mutation induction and detection, Molecular mechanisms of mutation, repair and suppression

UNIT VII

Regulation of gene activity in prokaryotes and eukaryotes; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

UNIT VIII

Concepts of Eugenics, Epigenetics, Genetic disorders and Behaviouralgenetics.Humangenetics and Gene therapy.Intrduction to recombinant DNA technology-restriction enzymes, vectors, genetic transformation and genomics.

Practical

Numerical exercises related to mendalian principles and gene interactions.Multiplealleles ABO blood group system.Analysis of penetrance and expressivity (PTC test).

Laboratory exercises in probability and chi-square; Demonstration of genetic principles Musing laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests;

Suggested Readings

1. Gardner EJ &Snustad DP. 1991. *Principles of Genetics*. John Wiley &Sons. 77
2. Klug WS & Cummings MR. 2003. *Concepts of Genetics*.Peterson Edu.Lewin B. 2008.*Genes IX*. Jones & Bartlett Publ.
3. Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.
4. Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.
5. Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India
6. Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.
7. Uppal S, Yadav R, Subhadra& Saharan RP. 2005. *Practical Manual onBasic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

Cell Biology and Cytogenetic

Code: GPB-102 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To provide insight into structure and functions of Cell, chromosomes, chromosomemapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

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, plastidschloro/chromoplast, 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 I

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix,chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II

Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, -

Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting

UNIT III

Structural and Numerical variations of chromosomes and their implications- Symbols and terminologies for chromosome numbers - euploidy -haploids, diploids and polyploids ; Utilization of aneuploids in gene location - Variation in chromosome behaviour - somatic segregation and chimeras – endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploidsvs allopolyploids –- Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and nutilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization;

UNIT V

Reversion of autopolyploids to diploids; Genome mapping in polyploids –Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica)

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– Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids – Bridge species.

UNIT VI

Fertilization barriers in crop plants at pre-and postfertilization levels- ;Chromosome manipulations in wide hybridization ; case studies –Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on thecourse of mitosis in onion and *Aloe vera***-** Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds andforage crops - Using micrometers and studying the pollen grain size in various crops - Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro;* Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level.Identification of polyploids in different crops - Induction and identification of haploids; Morphological observations on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibreassembly – Morphological observations onalloployploids – Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergenericcrosses -Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops.

Suggested Readings

1. Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.
2. Carroll M. 1989. *Organelles*.The Guilford Press.

3. Charles B. 1993. *Discussions in Cytogenetics*.Prentice Hall.
4. Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*.Georger Allen &Unwin Ltd.
5. Elgin SCR. 1995. *Chromatin Structure and Gene Expression*.IRL Press.
6. Gray P. 1954. *The Mirotomist'sFormulatory Guide*. The Blakiston Co.
7. Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A. Elsevier.
8. Gupta PK. 2000. *Cytogenetics*.Rastogi Publ.
9. Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.
10. Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*.John Wiley &Sons.
11. Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.
12. Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory andPractice*. Butterworth.
13. Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

Principles of Plant Breeding

Code: GPB-103 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

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 - Centres 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 apomixisevolutionaryand genetic problems in crops with apomixis, 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.

Practical

Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops. 80

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. 2006. *Essentials of Plant Breeding*.Kalyani.
11. Singh S &Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

Principles of Quantitative Genetics

Code: GPB-104 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To impart theoretical knowledge and computation skills regarding component ofvariation and variances, scales, mating designs and gene effects.

Theory

UNIT I

Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Analysis of Variance (ANOVA) - Expected variance components, random and fixed models; MANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D2 analyses - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices – selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping -statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding – selection based on marker - simultaneous selection based on marker and phenotype – factors influencing MAS.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model – Principal Component Analysis model - Additive and multiplicative

model – Shifted multiplicative model - Analysis and selection of genotypes – Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

Suggested Readings

1. Bos I &Caligari P. 1995. *Selection Methods in Plant Breeding*.Chapman & Hall.
2. Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*.Longman.
3. Mather K &Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
4. Mather K &Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
5. Nadarajan N &Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*.Kalyani.
6. Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding.Kalyani.*
7. Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*.Kalyani.
8. Singh RK &Choudhary BD. 1987.*Biometrical Methods in Quantitative Genetics*.Kalyani.
9. Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*.Sinauer Associates.
10. Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

Breeding for Biotic and Abiotic Stress Resistance

Code: GPB-105 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

Theory

UNIT I

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 - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence 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 II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors –moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies. Pollution,heavy metal toxicity, Green house gases and its impact on crops

UNIT V

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

UNIT VI

Exploitation of 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, chitnases and Bt for diseases and insect pest management- Achievements.

Practical

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 combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating theavailable populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria;Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinitytheir effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and abiotic stress factors-ways of combating them.

Suggested Readings

1. Blum A. 1988. *Plant Breeding for Stress Environments*.CRC Press.
2. Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less FavourableEnvironments*.Wiley International.
3. Fritz RS & Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics*. The University of Chicago Press.
4. Li PH & Sakai A. 1987. *Plant Cold Hardiness*.Liss, New York
5. Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects*.USDA, ARS, Washington DC.
6. Maxwell FG & Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects*. John Wiley & Sons.
7. Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, New York.
8. Sakai A &Larcher W. 1987. *Frost Survival in Plants*.Springer-Verlag.
9. Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons. Van

SECOND SEMESTER
Molecular Genetics

Code: GPB-201 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To impart knowledge in theory and practice about DNA, molecules like proteins and nucleic acids.

Theory

UNIT I

Historical background of molecular genetics; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance;

UNIT II

Transposable elements; Mechanisms of recombination in prokaryote, DNA repair, RNA

UNIT III

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

UNIT IV

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics. proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging

UNIT V

Methods of studying polymorphism at biochemical and DNA level; Gene silencing; genetics of mitochondria and chloroplasts.

UNIT VI

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; 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 VII

Molecular mapping and tagging of agronomically important traits.Statistical tools inmarker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.genome mapping in polyploids.

UNIT VIII

Bioinformatics & Bioinformatics tools

Practical

Morphological and Gram staining of natural bacteria; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell;Quantitative estimation of DNA, RNA and protein in an organism;Fluorescent*in situ* hybridization (FISH)- Genome *in situ* hybridization GISH.DNA extraction and PCR amplification -Electrophoresis – basic principles and

running of amplified DNA -Extraction of proteins and isozymes – DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship,construction of genetic linkage maps using computer software.

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.
8. Schleif R.1986*. Genetics and Molecular Biology*. Addison-Wesley Publ.Co.

Agronomy of Major *rabi* Cereals and Pulses

Code: AGR -202 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To teach the crop husbandry of rabi cereals and pulse crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production**,** value addition and agro-based industries of:

UNIT I

Rabi cereals.

UNIT II

Rabi pulses.

Practical

Phenological studies at different growth stages of crop

Estimation of crop yield on the basis of yield attributes

Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities

Working out growth indices (CGR, RGR, NAR, LAD), LER, aggressiveness, relative crowding coefficient, monetary yield advantage and ATER (Area Time Equivalent Ratio) of prominent intercropping systems of different crops

Estimation of protein content in pulses

Planning and layout of field experiments

Judging of physiological maturity in different crops

Intercultural operations in different crops

Determination of cost of cultivation of different crops

Working out harvest index of various crops

Study of seed production techniques in various crops
Visit of field experiments on cultural, fertilizer, weed control and water management aspects
Visit to nearby villages for identification of constraints in crop production

Suggested Readings

1. Das, N. R. 2007. *Introduction to Crops of India*.Scientific Publ.
2. Hunsigi, G. and Krishna, K. R. 1998. *Science of Field Crop Production*.Oxford &IBH.
3. Jeswani, L.M. and Baldev, B. 1997. *Advances in Pulse Production Technology*.ICAR.
4. Khare, D. and Bhale, M. S. 2000. *Seed Technology*.Scientific Publ.
5. Kumar Ranjeet and Singh, N. P. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
6. Pal, M., Deka, J. and Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
7. Prasad, R. 2002(ed.). *Text Book of Field Crop Production*.ICAR.
8. Singh, C., Singh, P. and Singh, R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
9. Singh, S.S. 1998. *Crop Management*.Kalyani

Biotechnology for Crop Improvement

Code: GPB-203 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I

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

UNIT II

Tissue culture- History, callus, suspension cultures,organ culture, cloning; Regeneration;Somatic embryogenesis in vitro techniques to overcome the fertilization barriers in crops Anther culture; somatic hybridizationtechniques;Meristem, ovary and embryo culture; cryopreservation. Secondary metabolite production

UNIT III

Marker assisted selection and molecular breeding; Genomics and genoinformatics 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 IV

Recombinant DNA technology, transgenes, method of transformation,selectablemarkers and clean transformation techniques, Vectors, vector preparation and cloning, 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. Transgenic bacteria and bioethics

UNIT V

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

UNIT VI

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

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants ;observations on the contaminants occurring in media –interpretations - Inoculation of explants;anther culture and ovule culture. Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagationunit.Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. use of A*grobacterium* mediatedmethod and Biolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse andlearning the practical considerations.

Suggested Readings

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

Breeding Cereals, Forages and Sugarcane

Code: GPB-204 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To provide insight into recent advances in improvement of cereals and forage crops and sugarcane using conventional and modern biotechnological approaches.

Theory

UNIT I

Rice: Evolution and distribution of species and forms - wild relatives and germplasm; Genetics – cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc.* – Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding.New plant type concept.Genetic Engineering.

UNIT II

Wheat: Evolution and distribution of species and forms - wild relatives and germplasm; cytogenetics and genome relationship; Breeding objectivesyield, quality characters, biotic and abiotic stress resistance, exploitation of heterosisetc; Sorghum: 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; Pearl millet: Evolution and distribution of species and forms – wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectivesyield, quality characters, biotic and abiotic stress resistance etc.

UNIT III

Maize: 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 - QPM and Bt maize – strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets:

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

UNIT IV

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

UNIT V

Forage legumes: 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 - Tree fodders: 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*, palatability studies.

UNIT VI

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder SeedProduction.

Practical

Floral biology – emasculation - pollination techniques ; Study of range of variation for yield and yield components – Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance– Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.

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. Kannaiyan S, Uthamasamy S, Theodore RK &Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture*.Directorate of Extension Education, TNAU, Coimbatore.
7. Murty DS, Tabo R &Ajayi O. 1994. *Sorghum Hybrid Seed Production and Management*.ICRISAT, Patancheru, India.
8. Nanda JS. 1997. *Manual on Rice Breeding*. Kalyani.
9. Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.
10. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India*. International Book Distributing Co.
11. Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops*. Marcel Dekker.
12. Walden DB. 1978. *Maize Breeding and Genetics*. John Wiley & Sons.

Breeding Legumes, Oilseeds and Fibre Crops

Code: GPB-205 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To provide insight into recent advances in improvement of legumes, oilseeds and fibrecrops using conventional and modern biotechnological approaches.

Theory

UNIT I

Pigeonpea: Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectivesyield, quality characters, biotic and abiotic stress *etc*- Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT II

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti-nutritional factors.

UNIT III

Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT V

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for yield andquality improvement, biotic and abiotic stress etc; Oil quality – characteristics indifferent oils; Evolution and distribution of species and forms; Wild relatives andgermplasm; Genetics, cytogenetics and genome relationship.

UNIT VI

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality – characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VII

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT VIII

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, breeding objectivesyield, quality characters, biotic and abiotic stress *etc* - Hybrid breeding in castor – opportunities, constraints and achievements.

UNIT IX

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc.

UNIT X

Distinguishing features of the released varieties in pulses, oilseeds and cotton; Maintenance of seed purity and seed production.

Practical

Use of descriptors for cataloguing – Floral biology - emasculation – pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation –conventional and modern approaches; analysing the lint samples of different species, interspecific

and interracial derivatives for fibre quality and interpretation – Development and maintenance of male sterile lines Evaluation of cotton cultures of

different species for insect and disease resistance – Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters – learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills – Learning on cotton yarn production, its quality evaluation and uses.

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. Chahal GS &Ghosal SS. 2002. *Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches*.Narosa Publ.
4. Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.
5. Nath V &Lal C. 1995. *Oilseeds in India*.Westvill Publ. House.
6. Nigam J. 1996. *Genetic Improvement of Oilseed Crops*.Oxford & IBH.
7. Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani.
8. Singh DP. 1991. *Genetics and Breeding of Pulse Crops*. Kalyani.
9. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India*. International Book Distributing Co.
10. Smartt J. 1994. *The Groundnut Crop - a Scientific Basis for Improvement*. Chapman & Hall

Maintenance Breeding and Concepts of Variety Release and Seed Production

Code: GPB-206 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

Theory

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 seedproduction.

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, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem,lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; 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.

Suggested Readings

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

SEMINAR-I

Code: GPB-207 **Full Marks - 100**

0L+1P=1

Credit-1

The seminar paper will be evaluated only by the internal.

THIRD SEMESTER

Statistical methods for applied sciences

Code: AST -101 **Full Marks - 100**

2L+1P=3

Credit-3

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. It would help them in understanding the concepts involved in data presentation, analysis and interpretation and also for taking other supporting courses on Agricultural Statistics. The course is useful to students of all other disciplines especially to students of social sciences.

Theory

UNIT I

Classification, tabulation and graphical representation of data.Box-plot, Descriptive statistics.Exploratory data analysis; Theory of probability.Random variable and mathematical expectation.

UNIT II

Discrete and continuous probability distributions: Binomial, Poisson and Normal distribution. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. Large sample theory.

UNIT III

Introduction to theory of estimation and confidence-intervals.Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination.Polynomial regression models and their fitting.

UNIT IV

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks.Kendall's coefficient of concordance.

UNIT V

Introduction to multivariate analytical tools- Classificatory problems and discriminant function, D2-statistic and its applications; Cluster analysis, Principal component analysis and factor analysis

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Normal; Large sample tests, testing of hypothesis based on exact sampling distributions chi square, t and F; Confidence interval, Interval estimation and point estimation of parameters of Binomial, Poisson and Normal distribution; Correlation and regression analysis, Non parametric tests, Discriminant function analysis, D2 analysis and factor analysis.

Suggested Readings

1. Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.

2. Dillon WR & Goldstein M. 1984.*Multivariate Analysis - Methods and Applications*.John Wiley.
3. Goon AM, Gupta MK &Dasgupta B. 1983. *Fundamentals of Statistics*.Vol. I.The World Press.
4. Hoel PG. 1971. *Introduction to Mathematical Statistics*.John Wiley.
5. Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.
6. Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.
7. Siegel S, Johan N &Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*.John Wiley.
8. Learning Statistics: http://freestatistics.altervista.org/en/learning.php.
9. Electronic Statistics Text Book: http://www.statsoft.com/textbook/stathome.html.

Physiological and Molecular Responses of Plants to Abiotic Stresses

Code: PPH-301

2L+1P=3

Credit-3 **Full Marks – 100**

Objective

This course is meant for students to study physiological responses in molecular level of plants in stressed condition, focusing on abiotic stress or adverse environmental condition and their effect. It would help them in understanding the concepts involved in plant responses to different environmental condition and their molecular basis. The course is useful to students of all other disciplines, especially to students of genetics and plant breeding.

Theory

UNIT I: Stress, strain concept and terminologies. Classification of different kinds of abiotic stresses.

UNIT II: General features of drought stress. Temporary and permanent wilting, Morphological and physiological responses to drough, Drought resistance mechanisms: Escape and dehydration postponement (Drought avoidance), Dehydration tolerance. Compatible solutes and osmotic adjustment, Osmoprotectants, Stress proteins. Water use efficiency as a drought resistant trait.

UNIT III: Molecular responses to water deficit: Signal perception and signal transduction in drought stress. Expression of regulatory and functional genes and significance of gene products.

UNIT IV: Stress and hormones: Stress signaling molecules. Role of ABA in stomatal closure. Oxidative stress : Reactive Oxygen Species (ROS) ; Generation of ROS in plants – Fenton reaction and Haber-Weiss reaction. Scavenging mechanisms: Enzymatic (SOD, catalase, peroxidase, ascorbate peroxidase, glutathione reductase etc) and non-enzymaticanti-oxidants [Ascorbate (Vit. C), Tocopherol (Vit. E), carotenoids, glutathione etc].

UNIT V: Salinity: Alkalinity and salinity. Salinity effects at cellular and whole plant level. Effects of salinity on growth, yield and some physiological processes of crop plants. Species and varietal variation in salt tolerance. Molecular mechanism of salt tolerance: Salt stress perception and signal transduction.

UNIT VI: Metal stress: Aluminium and cadmium toxicity. Physiological processes affected by aluminium and cadmium. Alleviation of heavy metal stress by various technologies. Role of Phytochelatins.

Practical

1. Measurement of Relative water content (RWC) in leaf, Measurement of Electrical
2. conductivity (EC) of different salt solutions, Determination of membrane injury (MI) and
3. Membrane stability index (MSI), Effect of moisture and salinity stress on seed germination

4. and seedling growth, Measurement of chlorophyll stability index (CSI) in response to drought
5. and salinity, Effect of ABA on stomatal closure, Measurement of proline, Measurement of
6. peroxidase and catalase activity, Screening techniques for salt tolerance, microscopic study of aerenchyma in *Nymphaea* sp.

COMMUNICATIVE ENGLISH AND THESIS WRITING

Code: PGS-302 **Full Marks – 100**
1L+1P=2
Credit-2

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article. Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

BASIC CONCEPTS OF LABORATORY TECHNIQUES

Code:PGS-303 **Full Marks – 100**
0L+2P=2
Credit-2

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

RESEARCH VALUE AND ETHICS

Code:PGS-304 **Full Marks – 100**
2L+0P=2

Credit-2

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

Research: Literature and Review

Code: GPB -305 **Full Marks - 100**

Credit-4

Project work should be defined and related literature review will be done and evaluated

FOURTH SEMESTER

Research

Code: GPB -401 **Full Marks - 100**

Credit-12

Objective

This course is meant for students who want to undertake research work in future and get training through this course. During their M.Sc. dissertation/project work students will be able to know the different aspects of a research work in nutshell. Besides experimental works, learners will learn how to write a M.Sc. thesis starting from introduction (including literature review), objectives of the work through material & methods, results, discussion, conclusion and lastly references.

Seminar II

Code: GPB -402 **Full Marks - 100**

Credit-2

The seminar paper will be evaluated only by the external