BOS Meeting held on 2.4.22

University of Lucknow
M.Sc. (Ag.) GENETICS AND PLANT BREEDING
Programme
Regulations....2022-23
(As Per Education Division
Indian Council of Agricultural Research
New Delhi, BSMA Committee on Plant Science, April 2009)

1. Applicability

These Regulations shall apply to the M.Sc. (Ag.) Genetics and Plant Breeding programme from the session 2022-23

2. Minimum Eligibility for Admission

i) Bachelor's degree in respective/ related subjects.
ii) 7.0/10 or equivalent OGPA/equivalent percentage of marks at Bachelor's degree.

3. Objective :

i. Analyzes the historical evolution of plant breeding, knowing which have been the key scientific and technical advances that have influenced its development or accelerated its results.
ii. Knows the different plant reproduction systems, how they affect genetic variability and how they condition the strategies and processes of selection and breeding.
iii. Has a deeper insight into the genetic basis supporting plant breeding, from the individual gene to the complete genome.
iv. Knows the aim of the genome analysis projects of certain model plant species and the possibilities offered by their comparison with the genomes of other species of agronomic interest.
v. Understands the importance of identifying genes, isolating them, determining their function and controlling their expression.
vi. Can identify genetic variability, locating the genetic regions associated with traits of interest for breeding, and determining the connection between phenotypic and genetic variability.
vii. Considers the importance of plant genetic resources as a source of variability in plant breeding programmes, and knows the appropriate processes for their collection, conservation, evaluation and use.

(Dr. Pradeep Kumar Singh)

(Dr. Satyendra K Singh)

Program Outcome

Genetics and Plant breeding aims to improve the characteristics of plants so that they become more desirable agronomically and economically. To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement. The specific objectives may vary greatly depending on the crop under consideration. From times immemorial, the plant breeding has been helping the mankind. With knowledge of classical genetics, number of varieties have been evolved in different crop plants. Since the population is increasing at an alarming rate, there is need to strengthened the food production which is serious challenge to those scientists concerned with agriculture. Advances in molecular biology have sharpened the tools of the breeders, and brighten the prospects of confidence to serve the humanity. The application of biotechnology to field crop has already led to the field testing of genetically modified crop plants. Genetically engineered rice, maize, soybean, cotton, oilseeds rape, sugar beet and alfalfa cultivars are expected to be commercialized before the close of 20th century. Genes from varied organisms may be expected to boost the performance of crops especially with regard to their resistance to biotic and abiotic stresses. In addition, crop plants are likely to be cultivated for recovery of valuable compounds like pharmaceuticals produced by genes introduced into them through genetic engineering. It may be pointed out that in Europe hirudin, an anti-thrombin protein is already being produced from transgenic Brassica napus.

M.Sc. (Ag.) GENETICS AND PLANT BREEDING
NAME OF DEPARTMENT: GENETICS AND PLANT BREEDING

Course No.		Course Title	Credit(s) T	P
SEMESTER I				
1	GPMA-101	PRINCIPLES OF GENETICS	2	1
2	GPMA-102	PRINCIPLES OF CYTOGENETICS	2	1
3	GPMA-103	PRINCIPLES OF PLANT BREEDING	2	1
4	GPMA-104	PRINCIPLES OF QUANTITATIVE GENETICS	2	1
5	GPSS-101	ESSENTIAL STATISTICAL METHOD	2	1
6	GPNC-101	LIBRARY AND INFORMATION SERVICES	-	-
7	GPNC-102	BASIC CONCEPTS IN LABORATORY TECHNIQUES	-	-
8	GPRES-101	RESEARCH WORK	0	2
			10	7
		Total Credit	**17**	
SEMESTER II				
1	GPMA-201	CELL BIOLOGY AND MOLECULAR GENETICS	2	1
2	GPMA-202	BIOTECHNOLOGY FOR CROP IMPROVEMENT	2	1
3	GPSS-201	BREEDING CEREALS FORAGES AND SUGARCANE	2	1
4	GPMI-202	MAINTENANCE BREEDING, CONCEPT OF VERITIES AND SEED PRODUCTION	2	1
5	GPNC-201	DISASTER MANAGEMENT	-	-
6	GPNC-202	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	-	-
7	GPRES- 201	RESEARCH WORK	0	4
			8	8
		Total Credit	16	
SEMESTER III				
1	GPMA-301	BREEDING LEGUMES , OIL SEEDS AND FIBER CROPS	2	1
2	GPMI-301	SEED PRODUCTION IN FIELD CROPS	2	1

3	GPSS-302	BREEDING FOR BIOTEC AND ABIOTEC STRESS RESISTANCE	2	1
4	GPSEM-301	MASTERS' SEMINAR	0	1
5	GPNC- 301	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	-	-
6	GPRES-301	M.Sc.(AG.) RESEARCH	0	6
			6	10
		Total Credit	16	
SEMESTER IV				
1	GPNC-401	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	-	-
2	GPRES-401	RESEARCH WORK, RESEARCH REPORT AND VIVA-VOCE	-	8
		Total Credit		8
Grand Total Credits			57	

DEPARTMENT OF GENETICS AND PLANT BREEDING
M.Sc. (Ag.) GENETICS AND PLANT BREEDING

Course Contents

GPMA- 101 PRINCIPLES OF GENETICS 2+1

Objective

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

Program Outcome

After completing the course, the students will be equipped with the basic concepts of genetics, their analytical, quantitative and problem solving skills from classical to molecular genetics.

THEORY

UNIT I

Beginning of genetics; Cell structures and cell division; 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

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; 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, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT III

Regulation of gene activity in prokaryotes;Molecular mechanisms of mutation, repair and suppr ession; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing. Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR- based cloning, positional cloning; Nucleic acid hybridization and immune-chemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes ; Micro-RNAs (miRNAs).

UNIT IV

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics. Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; geneti cs of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics ,Genetic disorders and Behavioural genetics.

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Practical

1. Laboratory exercises in probability and chi-square.
2. Demonstration of genetic principles using laboratory organisms;
3. Chromosome mapping using three point test cross; Tetrad analys is;
4. Induction and detection of mutations through genetic tests;
5. DNA extraction and PCR amplification -
6. Electrophoresis – basic principles and running of amplified DNA -
7. Extraction of proteins and isozymes
8. use of Agrobacterium mediated method and Biolistic gun; practical demonstrations
9. Detection of transgenes in the exposed plant material;
10. Visit to transgenic glasshouse and learning the practical considerations.

Text Books

- Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India
- Singh BD . 2009. *Genetics*. Kalyani Publishers (2nd Revised Edition)
- Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.

Suggested Readings

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

GPMA- 102 PRINCIPLES OF CYTOGENETICS 2+1

Objective

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

Program Outcome

After completing the course, the students will be equipped with the structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

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. Chromosomal theory of inheritance – 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

UNI-II II

Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - in situ hybridization and various applications. 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. Inter-varietal chromosome substitutions;

UNIT III

Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploids vs allopolyploids — Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition a nd substitution lines – creation and utilization; Apomixis – Evolutionary and genetic problems in crops with apomixes.

UNIT IV

Reversion of autopolyploids to diploids; Genome mapping in polyploids - Interspecific hybridization and all opolyploids; Synthesi s of new crops (wheat, triticale and brassica) – H ybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species. Fertilization barriers in crop plants at pre-and postfertilization levels- In vitro techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

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1. **Practical**
   Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, stain ng, cleaning etc.
2. Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope;
3. Preparing specimen for observation
4. Fixative preparation and fixing specimen for light microscopy studies in cereals –
5. Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and Aloevera
6. Smdies on the course of meiosis in cereals, millets and pulses –
7. Studies on the course of meiosis in oilseeds and forage crops –
8. Using micrometers and studying the pollen grain size in various crops
9. Various methods of staining and preparation of temporary and permanent slides –
10. Pollen germination in vivo and in vitro;
11. Microtomy and steps in microtomy;
12. Agents employed for the induction of various ploidy levels;
13. Solution preparation and application at seed, seedling level –
14. Identification of polyploids in different crops –
15. Induction and identification of haploids;
16. Anther culture and Ovule culture –
17. Morphological observations on synthesized autopolyploids
18. Observations on C-mitosis, learning on the dynamics of spindle fiber assembly
19. Morphological observations on alloployploids
20. Morphological observations on aneuploids –
21. Cytogenetic analysis of interspecific and intergeneric crosses –
22. Maintenance of Cytogenetic stocks and their importance in crop breeding –
23. Various ploidy levels due to somaclonal variation ;
24. Polyploidy in ornamental crops.
25. Fluorescent in situ hybridization (FISH)-
26. Genome in situ hybridization GISH.

Text Books

- Gupta PK. 2010. *Cytogenetics*. Rastogi Publishers.
- Schulz SJ 1980. Cytogenetics – Plants, Animals and Humans. Springer.

Suggested Readings

- Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.
- Carroll M. 1989. Organelles. The Guilford Press.
- Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.
- Darlington CD & La Cour LF. 1969. The Handling of Chromosomes. Georger Allen & Unwin Ltd.
- Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRL Press.
- Gray P. 1954. The Mirotomist's Formulatory Guide. The Blakiston Co.
- Gupta PK & Tsuchiya T. 1991. Chromosome Engineering in Plants: Genetics, Breeding and Evolution. Part A. Elsevier.
- Johannson DA. 1975. Plant Microtechnique. McGraw Hill.
- Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.

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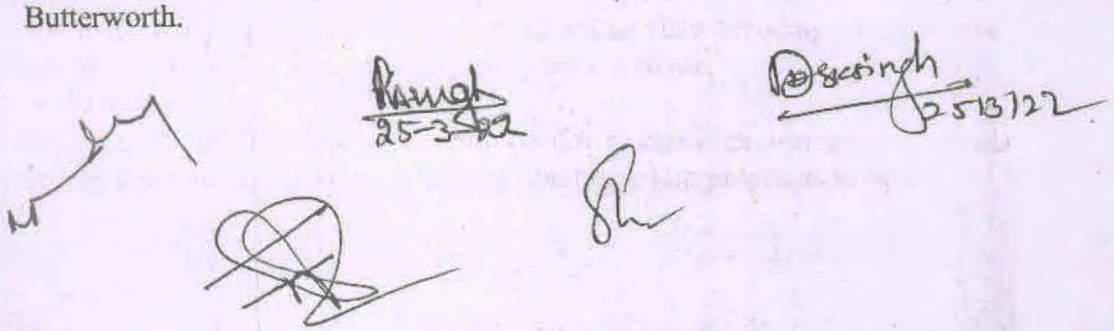
- Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.
- Sharma AK & Sharma A. 1988. Chromosome Techniques: Theory and Practice. Butterworth.



GPMA- 103 PRINCIPLES OF PLANT BREEDING 2+1

Objective

To provide understanding of principles and methods of plant breeding to enable the students to become capable of handling plant breeding programs in future.

Program Outcome

After completing the course, the students will be able to know the principles and methods of plant breeding and will be capable of handling plant breeding programs in future.

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.

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 plan t breeding;

UNIT II

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

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

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 III

Breeding methods in cross pollinated crops; Population breeding-mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter- population improvement and development of synthetics and composites;

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

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

UNIT IV

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

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

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

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Practical

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

Text Books

- Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.
- Singh BD. 2006. *Plant Breeding*. Kalyani Publishers, New Delhi.
- George A . 2012. *Principles of Plant Genetics and Breeding*.John Wiley & Sons.

Suggested Readings

- Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
- Chopra VL. 2004. Plant Breeding. Oxford & IBH.
- Gupta SK. 2005. Practical Plant Breeding. Agribios.
- Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
- Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
- Patra JK, Shukla AC and Das G. (2020). Advances in Pharmaceutical Biotechnology (Eds.), Springer Nature Publications [ISBN 978-981-15-2194-2], pp 478.
- Shukla, AC and Dikshi, A. (2016). Protocols in Medicinal and Aromatic Plants (Eds.), Today and Tomorrow's Printers and Publisher, New Delhi, IN [ISBN 81-7019-542-6 (IN); ISBN 1-55528-397-7 (USA)], pp 448.
- Shukla, A.C. (2014). Advances in Medicinal and Aromatic Plants (Vol-1), (Eds.), Agrobios (India) Pub, Jodhpur [ISBN No. 978-81-7754-525-8], pp 244.
- Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
- Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
- Singh P. 2006. Essentials of Plant Breeding. Kalyani.
- Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

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GPMA- 104 PRINCIPLES OF QUANTITATIVE GENETICS 2+1

Objective

This course is designed to facilitate theoretical and practical understanding of quantitative genetic analysis which plays crucial role in the success of plant breeding work as majority of the important plant characters follow quantitative inheritance.

Program Outcome

After completing the course, the students will be able to know the theoretical and practical understanding of quantitative genetic analysis which plays crucial role in the success of plant breeding work.

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

UNIT II

Designs for plant breeding experiment s – principles and applications; Genetic diversity analysis – metroglyph, cluster and D analyses - Association analysis - phenotypic and genotypic correl ations; 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 III

Generation mean analysis; Mating designs - Diallel, partial diallel, line xtester 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 IV

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.

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Practical

1. Problems on multiple factors inheritance
2. Partitioning of variance - Estimation of heritability and gene tic advance
3. Covariance analysis
4. Metroglyph analysis
5. D analysis - Grouping of clusters and interpretation –Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation –
6. Correlation analysis - Path analysis - Parent-progeny regression analysis
7. Diallel analysis : Griffing's methods I and II
8. Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results NCD and their interpretations
9. Line x tester analysis and interpretation of results
10. Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression
11. Generation mean analysis: Analytical part and Interpretation - Estimation of different types of gene actions.
12. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions –
13. Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping;
14. Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation,
15. Biparental mating, Triallel analysis, Quadriallel analysis and Triple Test Cross (TTC) –
16. Use of software in analysis and result interpretation,
17. Advanced biometrical models for combining ability analysis,
18. Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model
19. Principal Component Analysis model - multiplicative model –
20. Analysis and selection of genotypes - Methods and steps to select the best model – Selection systems - Biplots and mapping genotypes.

Text Books

- Falconer DS & Mackay J. 1998. Introduction to Quantitative Genetics. Longman.
- Mather K & Jinks JL. 1983. Introduction to Biometrical Genetics. Chapman & Hall.
- Naryanan SS & Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani

Suggested Readings

- Bos I & Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall.
- Falconer DS & Mackay J. 1998. Introduction to Quantitative Genetics. Longman.
- Mather K & Jinks JL. 1971. Biometrical Genetics. Chapman & Hall.
- Mather K & Jinks JL. 1983. Introduction to Biometrical Genetics.
- Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.
- Singh P & Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani.
- Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.
- Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.

GPSS-101: ESSENTIAL STATISTICAL METHODS 2 +1

Objective

The subject of Agricultural Statistics revolves around crop statistics with crop area, reduction and yield as its main parameters. Since agriculture is a land based economic activity, the Land Use Statistics has a primacy in the agricultural statistics.

Program Outcome

After completing the course, the students will be able to know the technical know how various essential statistical methods.

UNIT I

Descriptive statistics: probability distributions, binomial, probability distributions of functions of random variables. Classification and tabulation of data. Diagrammatic and Graphical representations of research results.

UNIT II

Sampling distributions of sample mean and sample variance from Normal population, aim, method. Normal distribution - marginal and conditional distributions.

UNIT III

Distribution of quadratic forms. Regression and correlation rank correlation, Regression analysis, partial and multiple correlation and regression, linear and nonlinear relationship. Mechanical errors. Principles of experimental design, precision and accuracy, advantage of replication, experimental technique. Analysis of variance, fundamental principles of analysis of variance. Critical difference, limitations of the analysis of variance.

UNIT IV

Statistical analysis and advantage and disadvantage of basic design-completely randomized design, randomized block design, Latin square design. Factorial concept: simple effects, main effects and interaction, factorial experiments (without confounding), Yates method. Confounding, principles of confounding in a 2^3 factorial experiments. Split plot design.
Missing plot technique; Bartlett's techniques for missing plots, cross-overdesign or switch-over trials, Rotational experiments, progeny selection, compact family block design, uniformity trial, sire index, sampling in field experiments.

Practical:

1.To the study about CRD, RBD and LSD designs.
2. Data analysis on co relation and regression on experimental data.
3.Data presentation in bar and pie diagram.

Text Books

- Chakrabarti MC. 1962. Mathematics of Design and Analysis of . Experiments.Asia Publ House.
- Cochran WG & Cox DR. 1957.Experimental Designs.2nd Ed. JohnWiley.

Suggested Reading

- Dean AM & Voss D. 1999.Design and Analysis ofExperiments.Springer.
- Dey A &Mukerjee R. 1999. Fractional Factorial Plans. JohnWiley.

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GPNC-101: LIBRARY AND INFORMATION SERVICES 0+1

Objective

The main objective of this paper is to keep as much information as possible about the literature coming in the library.

Program Outcome

After completing the course, the students will be able to know the literature available on various agricultural aspects as well as their information services.

UNIT I

To equip the library users with skills to trace information from libraries efficiently.

UNIT II

To apprise them of information and knowledge resources, to carry out literature survey.

UNIT III

To formulate information search strategies.

UNIT IV To use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

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

Text Books

- Radford, Marie L. 1999. The Reference Encounter: Interpersonal Communication in the Academic Library . Chicago: Association of College and Research Libraries.

Suggested Reading

- Bunge, Charles A. 1999. "Ethics and the Reference Librarian." The Reference Librarian , no. 66: 25–33.
- Connaway, Lynn S., and Marie L. Radford. 2011.
- Dublin, OH: OCLC Research. www.oclc.org/en/reports/synchronicity.html.Genz, Marcella D. 1998. "Working the Reference Desk." Library Trends 46, no. 3 (Winter): 505–525.
- Hernon, Peter, Ellen Altman, and Robert E. Dugan. 2015. Assessing Service Quality: Satisfying the
- Expectations of Library Customers. 3rd ed. Chicago: American Library Association.
- Katz, William A. 2001. Introduction to Reference Work. 2 vols. New York: McGraw-Hill.
- Radford, Marie L. 1999. The Reference Encounter: Interpersonal Communication in the Academic Library . Chicago: Association of College and Research Libraries.

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GPNC-102: BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1

Objective

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

Program Outcome

After completing the course, the students will be able to know the basics of commonly used techniques in laboratory.

Theory

UNIT I

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.

UNIT II

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.

UNIT III

Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing.

UNIT IV

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.

Practical

1. To the study about safety measures while in Lab.
2. Handling of chemical substances.
4. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware.
5. Drying of solvents/chemicals.
6. 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, sandbatb, waterbath, oilbath; Electric wiring and earthing.
7. Preparation of media and methods of sterilization.
8. Study about Seed viability testing, testing of pollen viability.
9. Study about tissue culture of crop plants

Suggested Readings

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

- Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
- Patra JK, Shukla AC and Das G. (2020). Advances in Pharmaceutical Biotechnology (Eds.), Springer Nature Publications [ISBN 978-981-15-2194-2], pp 478.
- Shukla, AC and Dikshi, A. (2016). Protocols in Medicinal and Aromatic Plants (Eds.), Today and Tomorrow's Printers and Publisher, New Delhi, IN [ISBN 81-7019-542-6 (IN); ISBN 1-55528-397-7 (USA)], pp 448.
- Shukla, A.C. (2014). Advances in Medicinal and Aromatic Plants (Vol-1), (Eds.), Agrobios (India) Pub, Jodhpur [ISBN No. 978-81-7754-525-8], pp 244.

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GPRES- 101 : Research Work **0+2**

The Masters in Agriculture course has 20 credits allotted for research work. In the first semester, the student will conduct trials related to his subject and collect data, this work will continue till the second year, will re-trial in the third semester and complete his thesis in the final year / iv semester. Examiners in thesis work will be appointed by Lucknow of University, Lucknow. The student's synopsis will be prepared by the student of the same subject/ minor subjects of the college and sent to the Dean, Lucknow University for final approval.

GPMA- 201 CELL BIOLOGY AND MOLECULAR GENETICS 2+1

Theory

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Program Outcome

After completing the course, the students will be able to know the theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, acromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular rganelles – 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 III

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

UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer & cell aging.

Practical

1. Morphological and Gram staining of natural bacteria
2. Cultivation of bacteria in synthetic medium
3. Determination of growth rate and doubling time of bacterial cells in culture
4. Demonstration of bacteriophage by plaque assay method
5. Determination of soluble protein content in a bacterial culture.
6. Isolation, purification and raising clonal population of a bacterium;
7. Biological assay of bacteriophage and determination of phage population in lysate
8. Study of lytic cycle of bacteriophage by one step growth experiment
9. Determination of latent period and burst size of phages per se
10. Quantitative estimation of DNA, RNA and protein in an organism Numerical problems and assignments.

Text Books

- Bruce A.2004. Essential Cell Biology. Garland.
- Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.

Suggested Readings

- Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.
- Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.

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- Lewin B. 2008. IX Genes. John Wiley & Sons
- Lodish H, Berk A & Zipursky SL. 2004. Molecular Cell Biology. 5th Ed. WH Freeman.
- Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman & Co.

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GPMA-202 BIOTECHNOLOGY FOR CROP IMPROVEMENT 2+1

Objective

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

Program Outcome

After completing the course, the students will be skilled to use biotechnological tools in crop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

UNIT II

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

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

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.Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT IV

Biotechnology applications in male sterility/hybrid breeding, molecular

farming.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 Bioinformatics & Bioinformatics tools.Nanotechnology and its applications in crop improvement programmes.

Practical

1. Requirements for plant tissue culture laboratory-Techniques in plant tissue culture
2. Media components and media preparation
3. Aseptic manipulation of various explants
4. Observations on the contaminants occurring in media interpretations
5. Inoculation of explants; Callus induction and plant regeneration
6. Plant regeneration; Standardizing the protocols for regeneration
7. Hardening of regenerated plants; Establishing a greenhouse and hardening procedures

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8. Visit to commercial micropropagation unit.
9. Transformation using *Agrobacterium* strains,
10. GUS assay in transformed cells / tissues.
11. DNA isolation, DNA purity and quantification tests
12. Gelelectrophoresis 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.

Text Books

- Chawala HS. 2000 Introduction To Plant Biotechnology . Oxford & IBH Publishing Co. Pvt. Ltd.
- Chopra VL & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.
- Gupta PK. 1997. Elements of Biotechnology. Rastogi Puhl.

Suggested Readings.

- Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Puhl. Co.
- Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual.
- 3rd Ed. Cold Spring Harbor Lab. Press. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani.

GPSS-201 BREEDING CEREALS, FORAGES AND SUGARCANE 2+1

Theory

Objective

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

Program Outcome

After completing the course, the students will be equipped with the recent advances in improvement of cereals and forage crops as well as sugarcane, using conventional and modern biotechnological approaches.

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.

Wheat: 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, exploitation of heterosis etc;

UNIT II

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 objectives- yield, quality characters, biotic and abiotic stress resistance etc.

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

UNIT III

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

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 IV

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. 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 Seed Production.

Practical

1. Floral biology – emasculation - pollination techniques
2. Study of range of variation for yield and yield components
3. Study of segregating populations and their evaluation
4. Trait based screening for stress resistance in crops of importance
5. Use of descriptors for cataloguing germplasm maintenance
6. Learning on the Standard Evaluation System (SES) and descriptors
7. Use of software for database management and retrieval.
8. Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability
9. Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes
10. 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.

Text Books

- Bahl PN & Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
- Ram H H and Singh HG. 1993 .Crop Breeding and Genetics, Kalyani Publishers

Suggested Readings

- Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
- Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.
- Chopra VL & 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 Geneties
- Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 1996. Rice Geneties 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 & Kauffman HE. 1979. Rice Improvement.
- IRRI, Los Banos, Manila, Philippines.
- Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. New
- Dimensions and Approaches for Sustainable A

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GPSS-202 MAINTENANCE BREEDING AND CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION

1+1

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & seed production.

Program Outcome

After completing the course, the students will be equipped with the variety deterioration and steps to maintain the purity of varieties & seed production.

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 otification systems in India and abroad.

UNIT II

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

UNIT III

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

UNIT IV

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, 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); fibers (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

1. Identification of suitable areas/locations for seed production
2. Ear-to-row method and nucleus seed production
3. Main characteristics of released and notified varieties, hybrids and parental lines
4. Identification of important weeds/objectionable weeds
5. Determination of isolation distance and planting ratios in different crops
6. Seed production techniques of varieties in different crops Hybrid seed production technology of important crops.

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Text Books

- Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.
- McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.

Suggested Readings

- Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants.
- Department of Plant Breeding. CCS HAU Hisar.
- Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.
- Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC.
- Poehlman JM & Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH.
- Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani.
- Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
- Tunwar NS & Singh SV. 1985. Handbook of Cultivars. ICAR.

GPNC -201: DISASTER MANAGEMENT **1+0**

(e-Course)

Objectives

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Program Outcome

After completing the course, the students will be equipped with the concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements.

UNIT IV

Role of NGOs, Comunity-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Practical

1.Pollution case studies. Case Studies- Field work.
2.Visit to a local area to document environmental assets river/ forest/ grassland,.
3.Visit to a local polluted site-Urban/Rural/Industrial/ Agricultural
4. Study of common plants and study of simple ecosystems-pond, river etc.

Text Books

- Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.

Suggested Readings

- Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

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GPNC-202 : AGRICULTURAL RESEARCH, RESEARCH ETHICS (E-COURSE) AND RURAL DEVELOPMENT PROGRAMMES 1+0

Objective

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

Program Outcome

After completing the course, the students will be able to know about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government of India.

Theory

UNIT I

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

UNIT II

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

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme.

UNIT IV

Integrated Rural Development Programme (IRDP), Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Practical

1. To the study about Global agricultural research system.
2. To the study about Regional Agricultural Research Institute.
3. Prepare reports Integrated Rural Development Programme (IRDP).
4. Visit agriculture research institute

Suggested Readings

- Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.

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- Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
- Singh K.. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

GPRES-201: Research Work **0+4**

Research continued.

The student's will prepare the synopsis on the same subject/ minor subjects of the college, and will be sent to the concerned Dean/ Coordinator (Agriculture) at the University of Lucknow, for final approval.

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GPMA- 301 BREEDING LEGUMES, OILSEEDS AND FIBER CROPS 2+1

Objective

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

Program Outcome

After completing the course, the students will be able to know about the recent advances in improvement of legumes, oilseeds and fiber crops 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 objectives- yield, quality characters, biotic and abiotic stress *etc* - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

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 II

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.

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 III

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

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.

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.

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UNIT IV

Castor: 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* - Hybrid breeding in castor – opportunities, constraints and achievements.

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 fiber 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.

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

Practical

1. Use of descriptors for cataloguing
2. Floral biology - emasculation – pollination techniques
3. Study of range of variation for yield and yield components
4. Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram.
5. Use of descriptors for cataloguing –
6. Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor,
7. Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species –
8. Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation
9. Trait based screening for stress resistance –
10. Cotton fiber quality evaluation – conventional and modern approaches; analysing the lint samples of different species, interspecific and interracial derivatives for fiber quality and interpretation –
11. Development and maintenance of male sterile lines
12. Evaluation of cotton cultures of different species for insect and disease resistance –
13. Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters
14. learning the procedures on development of Bt cotton
15. Visit to Cotton Technology

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Text Books

- Ram HH & Singh HG. 1993. Crop Breeding and Genetics. Kalyani
- Bahl PN & Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.

Suggested Readings

- Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
- Chahal GS & Ghosal SS. 2002. Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches. Narosa Publ.
- Chopra VL. 1997. Plant Breeding. Oxford & IBH.
- Nath V & Lal C. 1995. Oilseeds in India. Westvill Publ. House.
- Nigam J. 1996. Genetic Improvement of Oilseed Crops. Oxford & IBH.
- Singh DP. 1991. Genetics and Breeding of Pulse Crops. Kalyani.
- Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.

GPMI-301 SEED PRODUCTION IN FIELD CROPS 2+1

Objective

To impart a comprehensive knowledge of seed production in field crops with adequate practical training.

Program Outcome

After completing the course, the students will be able to know about the comprehensive knowledge of seed production in field crops.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, castor, sunflower, safflower, rape and mustard, linseed, sesame etc.).Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute, mesta etc) and vegetatively propagated crops like sugar cane, potato etc.

Practical

1. Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate
2. Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines
3. Synchronization of parental lines and methods to achieve synchrony
4. Supplementary pollination, pollen storage, hand emasculation and pollination in Cotton,
5. Detasseling in Corn, identification of rogues and pollen sbedders. Pollen collection, storage, viability and stigma receptivity.

Text Books

- Agrawal RL.1997. Seed Technology, Oxford and IBH Publishing
- Joshi AK and Singh BD. 2004. Seed Science and Technology, Kalyani Publishers.

Suggested Readings

- Kelly AF. 1988. Seed Production of Agricultural Crops. John Wiley.
- McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
- Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani.

GPMI -302 BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE 2+1

Objective

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

Program Outcome

After completing the course, the students will be equipped with 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.
Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT III

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.
25 Genetics of abiotic stress resistance;

UNIT IV

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. Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic andabiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management-Achievements.

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Practical

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

Text Books

- Blum A. 1988. Plant Breeding for Stress Environments. CRC Press.
- Christiansen MN & Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International.

Suggested Readings

- Fritz RS & Simms EL. (Eds.). 1992. Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics. The University of Chicago Press.
- Li PH & Sakai A. 1987. Plant Cold Hardiness. Liss, New York
- Luginpill P. 1969. Developing Resistant Plants - The Ideal Method of Controlling Insects. USDA, ARS, Washington DC.
- Maxwell FG & Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons.
- Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, New York.
- Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths.
- Sakai A & Larcher W. 1987. Frost Survival in Plants. Springer-Verlag.
- Turener NC & Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons. van der Plank JE. 1982.

GPMES-301 MASTERS SEMINAR 0+1

All P. G. agriculture students will prepare and deliver their seminar on any burning topic related to their subjects.

GPNC-301: INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (E-COURSE)

1+0

Objective

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

Program Outcome

After completing the course, the students will be able to know about the intellectual property rights (IPR) related protection systems, their significance and use of IPR.

Theory

UNIT I

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;.

Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks.

UNIT II

Protection of plant varieties and farmers' rights and biodiversity protection Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection;.

UNIT III

National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture

UNIT IV

Licensing of technologies, Material transfer agreements, Research collaboration Agreement, LicenseAgreement.

Practical

1. To the study about Indian Legislations for the protection of various types of
2. Intellectual Properties.
3. Study about Licensing of technologies.
4. Write the methods of Material transfer agreements

Text Books

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

Suggested Readings

- Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M & Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

25-3-22

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GPRES- 301 RESEARCH

0+6

The students of Agriculture will analyse the data, and compile the results.

GPNC-401: TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1

Objective

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

Program Outcome

After completing the course, the students will be able to know about the skills to write dissertations, research papers etc.

Theory

UNIT I

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)

UNIT II

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.

UNIT III

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:

UNIT IV

Participation in group discussion: Facing an interview; presentation of scientific papers.

Practical –

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

10. Methods 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
11. Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.
12. Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
13. To the study about 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.

25-3-22

Text Books

- James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.

Suggested Readings

- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India. Collins' Cobuild English Dictionary. 1995. Harper Collins.
- Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
- Mohan K. 2005. Speaking English Effectively. MacMillan India. Richard WS. 1969. Technical Writing. Barnes & Noble.
- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

GPRES-401: RESEARCH WORK, RESEARCH REPORT AND VIVA-VOCE

0+8

In the fourth semester of Masters Agriculture programme, the student will complete his research work and write the thesis and submit it to the college. The college will send the thesis to the Controller of Examinations, University of Lucknow, Lucknow for evaluation.

Further, in the IV semester; there will be oral viva- voce of the students by the examiners.