**Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore**
**Shri Vaishnav Institute of Agriculture**
**Ph.D. (Ag.) Genetics and Plant Breeding, I semester**

| Course Code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Credits | | |
| | | END SEM University Exam | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L | P | Total |
| PHDAS 101 | Research Methodology | 60 | 00 | 40 | 00 | 00 | 3 | 0 | 3 |

**1. Legends: L -** Lecture**; P –** Practical

**2. ***Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

## A1. Research Methodology (PHDAS101)

**Module 1**: Introduction to Research Methods: Role and objectives of research, types of research and various research design (exploratory, descriptive, experimental and diagnostic research), research process: Overview, Problems encountered by researcher. Experimental research design will comprise of Completely Randomized Design, Latin Square Design and Factorial Design. Limitations of RM: Ethics in Research, Philosophical issues in Research.

**Module 2:** Data and their Collection: Collection, Organization, Presentation, Analysis and Interrelation of Primary and Secondary Data. Measurement in research, measurement scales, sources of errors in measurement, Techniques of developing measurement tools, classification and testing (reliability, verification and validity) scales, Designing questionnaires and interviews Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions : Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors.

**Module 3:** Numerical Methods and Statistical Analysis Curve fitting (least square), solution of polynomial equation, numerical integration (Trapezoidal rule, Simpson's rule, Gaussian qudrature), solution of ordinary differential equations (Euler's method, Runge-Kutta method, predictor-corrector method), matrix multiplication, inversion and diagonalisation.

### References


- Kumar,R.(2006).Research Methodology-A Step- By- Step Guide for Beginners, Delhi: Pearson Education.
- Montgomery, D. C. (2007). Design & Analysis of Experiments. India: Wiley.
- Kothari, C. R. (2004). Research Methodology: Methods and Techniques. New Delhi: New Age International


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|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Credits | | |
| | | END SEM University Exam | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L | P | Total |
| PHDA 102 | Review of literature | 60 | 00 | 40 | 00 | 00 | 2 | 0 | 2 |

**1. Legends: L -** Lecture**; P –** Practical

**2. ***Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

### A.2. Review of Literature (PHDA102)

**Course Overview:** The objective of this course is to help the candidate to comprehend his/her broad field of research and be academically sound to carry out his research work. Understand the basic philosophical assumptions underlying research literature reviews for different purposes, including what, why, when, for whom, and how? Be able to manage the process of conducting a literature review, including reading, note taking strategies, coding/reference management, synthesizing and writing literature results. Be able to write a quality literature review with variations in references

**Examination Scheme:**
The candidate is required to write a Review paper based on the review of literature on his/her area of research in consultation with his supervisor. The paper has to be evaluated and approved by the panel constituted by Faculty of Doctoral studies and Research besides the assignments.

**Course Content**

**Module 1**: **Understanding Review of literature:** Relevance, Approach and Applications; Developing an outline for the literature review; Formulate key questions for a review. Organizing a literature search**:** Identify which literature bases to search; Developing the theoretical basis for the Research Question; Searching for, locating and organizing relevant professional literature

**Module 2**: **Conducting the Review:** Abstract relevant information from appropriate studies in a systematic manner; critically reviewing the literature; Rate the scientific quality of each study and the level of evidence for each question;

**Module 3**: **Synthesizing the Review:** Create evidence tables and summary tables; interpret the pattern of evidence interms of strength and consistency; Summarize the studies' findings. Writing the review: Writing a first draft; Writing references and citations; Obtaining, giving, and making productive use of feedback; the redrafting process; Professional formatting.

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| Course Code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Credits | | |
| | | END SEM University Exam | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L | P | Total |
| PHDA 103 | Computer Application | 60 | 00 | 40 | 00 | 00 | 2 | 0 | 2 |

**1. Legends: L -** Lecture**; P –** Practical

**2. ***Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

## A.3. Computer Applications (PHDA103)

**Course Overview:** The candidate should gain sufficient practical knowledge for use of computer and computer software for use in research work.

**Examination Scheme:**
The faculty member will award internal marks out of 40 based on the assignments and minor project.The end semester examination will be 60 marks with weightage of (online exams 40% + practical 60%)

**Contents**
**Module 1**: Basic knowledge of application software's in MS- Office with focus on MS-Word- its features and applications related to presentation of text in decent format and saving the same for further use. The practical knowledge of this software should enable the candidate to type and prepare the thesis
in a presentable format.MS-Excel- construction of worksheet and inserting data according to its characteristics, use of statistical tools and their presentation in the form of charts and graphs.

**Module 2:** Use of Internet for research work and exploring various websites and search engines for collecting quality literature review and secondary data etc. related to thesis work.

**Module 3**: MS- Power point – create power point presentation on a topic related to the theme of thesis and use of different presentation techniques. Use of SPSS – method of preparing data sheet and entering data according to its characteristics, use of various statistical tools on SPSS.

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| Course Code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Credits | | |
| | | END SEM University Exam | Mid term exam | Teachers Assessment* | END SEM University Exam | Teachers Assessment* | L | P | Total |
| PHDA 104 | Research and Publication Ethics | 60 | 00 | 40 | 00 | 00 | 2 | 0 | 2 |

**1. Legends: L -** Lecture**; P –** Practical

**2. ***Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class.

## A.4. Research and Publication Ethics (PHDA104)

**Module 1: Philosophy and Ethics-**Introduction to philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions.

**Scientific Conduct-** Ethics with respect to science and research. Intellectual honesty and research integrity. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publications: duplicate and overlapping publications, salami slicing. Selective reporting and misrepresentation of data

**Module 2: Publication Ethics-**Publication ethics: Definition, introduction and importance.
Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest.
Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.

**Open Access Publishing-** Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

**Module 3: Publication Misconduct, Group Discussions-**Subject specific ethical issues, FFP, authorship. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad. Software tools- Use of plagiarism software like Tumitin, Urkund And Other Open Source Software Tools. Data Bases And Research Metrics, Databases- Indexing databases Citation databases: Web of Science, Scopus, etc. Research Metrics- Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics

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## GPB 601: ADVANCES IN PLANT BREEDING SYSTEMS (3+0)

| Course code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | L | P | CREDITS |
| | | End Sem University Exam | Mid Term Exam | Teachers Assessment* | End Sem University Exam | Teacher's Assessment* | | | |
| GPB 601 | Advances In Plant Breeding Systems | 50 | 40 | 10 | 00 | 00 | 3 | 0 | 3 |

**Legends: L** - Lecture; **P** – Practical;

*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To impart theoretical knowledge about advances in plant breeding.

**Theory**

**Unit I**

Advances in reproductive biology of crops; Genes governing the whorls formation and various models proposed; Pollen pistil interaction: biochemical and molecular basis, environmental factors governing anthesis and bottlenecks for gene transfer. Plant Breeding methodologies: Classic versus modern; Over view of Pre and Post Mendelian breeding methods in self and cross pollinated crops; Molecular and transgenic breeding approaches; doubled haploid breeding, shuttle breeding, forward and reverse breeding, speed breeding, participatory plant breeding, breeding for organic situations.

**UNIT II**

Principles and procedures in the formation of a complex population; Genetic basis of population improvement in crop plants; Recurrent selection methods in self and cross pollinated crops and their modifications; Convergent selection, divergent selection; Recurrent selection, usefulness in hybrid breeding programs; Reciprocal recurrent selection; Selection in clonally propagated crops – Assumptions and realities.

**UNIT III**

Choice of molecular markers for plant breeding efficiency, fingerprinting and genetic diversity assessment, application of MAS for selection of qualitative and quantitative traits; Gene pyramiding, accelerated backcrossing, marker-based utilization of exotic germplasm, introgression libraries. Genetic resources: primary, secondary, tertiary and alien trans gene pool; Molecular and biochemical basis of self-incompatibility and male sterility, nucleocytoplasmic interactions with special reference to male sterility – genetic, biochemical and molecular bases.

**UNIT IV**

Genetic engineering technologies to create male sterility, prospects and problems, use of self-incompatibility and sterility in plant breeding – case studies; Fertility restoration in male sterile lines and restorer diversification programs; Conversion of agronomically ideal genotypes into male sterile: Concepts and breeding strategies; Case studies - Generating new cyto-nuclear interaction system for diversification of male sterile; Stability of male sterile lines – Environmental influence on sterility, Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding; Temperature sensitive genetic male sterility and its use heterosis breeding; Apomixis and its use in heterosis breeding; Incongruity: Factors influencing incongruity Methods to overcome incongruity mechanisms.

## UNIT V

Breeding for climate change -Improving root systems, abiotic stress tolerance, water use efficiency, flooding and sub-mergence tolerance; Biotic stress tolerance; Nutrient use efficiency, nitrogen fixation and assimilation, greenhouse gases and carbon sequestration; Breeding for bio-fortification.

**Suggested Readings**


- Agarwal RL. 1996. Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford & IBH.
- Allard RW. 1966. Principles of Plant Breeding. John Wiley & Sons.
- Briggs FN and Knowles PF. 1967. Introduction to Plant Breeding. Reinhold.
- Fehr WR. 1987. Principles of Cultivar Development: Theory and Technique. Vol I. Macmillan.
- Hayes HK, Immer FR and Smith DC. 1955. Methods of Plant Breeding. McGraw-Hill.
- Kang MS and Priyadarshan PM (Edit.). 2007. Breeding Major Food Staples. Blackwell Publishing.
- Kole C. 2013. Genomics and Breeding for Climate-Resilient Crops. Springer. Volume 2-Target Traits.
- Mandal AK, Ganguli PK and Banerji SP. 1995. Advances in Plant Breeding. Vol. I, II. CBS.
- Richards AJ. 1986. Plant Breeding Systems. George Allen & Unwin.
- Sharma JR. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Simmonds NW. 1979. Principles of Crop Improvement. Longman.
- Singh BD. 1997. Plant Breeding: Principles and Methods. 5th Ed., Kalyani Publishers, New Delhi.
- Singh P. 1996. Essentials of Plant Breeding. Kalyani Publishers, New Delhi.
- Welsh JR. 1981. Fundamentals of Plant Genetic and Breeding. John Wiley


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## GPB 605: GENOMICS IN PLANT BREEDING (3+0)

| Course code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | L | P | CREDITS |
| | | End Sem University Exam | Mid Term Exam | Teachers Assessment* | End Sem University Exam | Teacher's Assessment* | | | |
| GPB 605 | Genomics in Plant Breeding | 50 | 40 | 10 | 00 | 00 | 3 | 0 | 3 |

**Legends: L** - Lecture; **P** – Practical;

*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

### Objective

To impart practical skills in advanced molecular techniques in genome mapping structural/ functional genomics.

### Theory

**UNIT I**

Introduction to the plant genomes: nuclear, chloroplast and mitochondrial genomes; Concept of genome size and complexity: C-value paradox, repetitive and unique DNA. Genome sequencing: Principles and techniques of conventional approaches and next generation sequencing including sequencing-by-synthesis/ ligation and single molecule real time (SMRT) technologies; Applications of sequence information: structural, functional and comparative genomics; Plant genome projects: Strategies for genome sequencing including shot gun and clone-by-clone method.

**UNIT II**

Molecular maps: Use of molecular markers/ SNPs for development of genetic and physical maps; Linkage and LD-based gene mapping approaches including gene/ QTL mapping, genome wide association studies (GWAS) and association analysis; Integration of genetic and physical map for map-based cloning of economically important genes. Concept of allele mining; Diversity array technology: concepts and applications.

**UNIT III**

Functional genomics: concept of reverse and forward genetics; Use of activation tagging, transposon tagging, insertional mutagenesis, TILLING and ecoTILLING for crop improvement; Genome-wide and gene-specific transcriptomics approaches: serial analysis of gene expression, massively parallel signature sequencing, next generation sequencing, microarray, northern hybridization, RT-PCR, qRT-PCR and molecular beacon.

**UNIT IV**

Development and management of database; Applications of bioinformatics tools/ software in genomics for crop improvement. Basic concepts of high-throughput proteomics, metabolomics and phenomics.

## UNIT V

Recent transgene free genome editing tools such as CRISPR-Cas9 system, TALENS and ZFNs for crop improvement. Cisgenesis and Intragenesis tools as twin sisters for Crop Improvement; Genomics-based plant breeding: Genome-Wide Genetic Diversity Studies, Identification of molecular markers linked to single Genes and QTL, Marker Assisted Selection (Marker Assisted Backcross Selection, Association mapping, Breeding by Design, Genome selection).

**Suggested Readings**


- Alonso JM, Stepanova AN. 2015. Plant Functional Genomics: Methods and Protocols. Springer.
- Chopra VL, Sharma RP, Bhat SR and Prasanna BM. 2007. Search for New Genes. Academic Foundation, New Delhi.
- Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology—Basic Experiments in Gene and Manipulation. 2nd Ed. Benjamin Publication Co.
- Primose SB and Twyman RM. 2006. Principles of Gene Manipulation and Genomics. 7th Ed. Wiley-Blackwell Publishing.
- Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Laboratory Press.
- Singh BD. 2005. Biotechnology: Expanding Horizons. Kalyani Publishers, New Delhi.
- Somers DJ, Langridge P, Gustafson JP. 2009. Plant Genomics: Methods and Protocols. Springer..


**e-Resources**

http://gramene.org
https://www.arabidopsis.org
https://wheat.pw.usda.gov
http://ncbi.nlm.nih.gov
http://www.maizegenetics.net

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## GPB 609: IPR AND REGULATORY MECHANISM (E-COURSE) (1+0)

| Course code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | L | P | CREDITS |
| | | End Sem University Exam | Mid Term Exam | Teachers Assessment* | End Sem University Exam | Teacher's Assessment* | | | |
| GPB 609 | IPR and Regulatory Mechanism (e-course) | 50 | 40 | 10 | 00 | 00 | 1 | 0 | 1 |

**Legends: L** - Lecture; **P** – Practical;

*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**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 knowledgebased economy

**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.

**Unit II**

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

**Unit III**

Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.

**Unit IV**

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

**Unit V**

Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

**Suggested Readings**

- Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.

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## MBB 601: PLANT MOLECULAR BIOLOGY (3+0)

| Course code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | | | |
| | | End Sem University Exam | Mid Term Exam | Teachers Assessment* | End Sem University Exam | Teachers Assessment* | L | P | CREDITS |
| MBB 601 | Plant Molecular Biology | 50 | 40 | 10 | 00 | 00 | 3 | 0 | 3 |

**Legends: L** - Lecture; **P** – Practical;

*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

• To provide in depth knowledge of recent developments of plant molecular biology and applications

• To discuss case studies and success stories in agriculture and industry

**Theory**

**Unit I**

Model Systems in Plant Biology (Arabidopsis, Rice, etc.) Forward and Reverse Genetic Approaches. Organization expression and interaction of nuclear, Mitochondrial and Chloroplast Genomes. Cytoplasmic male sterility.

**Unit II**

Transcriptional and Post-transcriptional Regulation of Gene Expression, Isolation of promoters and other regulatory elements, RNA interference, Transcriptional Gene Silencing, Transcript and Protein Analysis.

**Unit III**

Plant Developmental Processes, ABC Model of Floral Development, Role of hormones (Ethylene, Cytokinin, Auxin and ABA, SA and JA) in plant development.

**Unit IV**

Regulation of Flowering, Plant photoreceptors and light signal transduction, vernalization, Circadian Rhythms. Abiotic Stress Responses: Salt, Cold, Heat and Drought.

**UNIT V** Biotic Stress Responses. Molecular Biology of Plant-pathogen Interactions, Molecular Biology of Rhizobium and Agrobacterium- Plant interaction. Role of programmed Cell Death in Development and Defense.

## Suggested Readings

• Buchanan, B.B., Gruissem, W. and Jones R. 2015. Biochemistry and Molecular Biology of Plants, 2nd edition, Wiley and Blackwell Publications.

• Slater, A., Scott, N.W., and Fowler, M.R. 2003. The Genetic Manipulation of Plants. Plant Biotechnology Oxford, England: Oxford University Press.

• Walker, J.M., Rapley, R. 2008. Plant Biotechnology and Genetics: Principles, Techniques and Applications.

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## SST 601: HYBRID SEED PRODUCTION TECHNOLOGY (2+1)

| Course code | Course Name | TEACHING & EVALUATION SCHEME | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | THEORY | | | PRACTICAL | | L | P | CREDITS |
| | | End Sem University Exam | Mid Term Exam | Teachers Assessment* | End Sem University Exam | Teacher's Assessment* | | | |
| SST 601 | Hybrid Seed Production Technology | 50 | 30 | 00 | 15 | 05 | 2 | 1 | 3 |

**Legends: L - Lecture; P – Practical;**

*Teacher Assessment shall be based on following components: Quiz / Assignment / Project / Participation in Class etc.

**Objective**

To provide students a comprehensive knowledge and practical exposure on hybrid seed production techniques in agricultural and horticultural crops

**Theory**

**UNIT I**

Introduction – history – scope – importance of hybrid development – national and international scenario of seed industry – popular public sector hybrids in various crops. Heterosis – definition – expression – types – utilization of heterosis in hybrid development, hybrid vigour and seed vigour.

**Unit II**

Types of hybrids – intra-specific, inter-specific hybrids, single, double, three way cross, top cross hybrids – apomixes; generation system of seed multiplication in different types of hybrids. Development and maintenance of inbred lines – male sterile – maintainer lines – fertility restoration – transgenic hybrids – principles and method of development.

**Unit III**

Breeding tools – genetic mechanism – male sterility – types: CMS, GMS, CGMS, TGMS, PGMS – barnase and barstar system – pistillateness – self incompatibility. Manual creation of male sterility – emasculation and pollination – gametocides – mode of action, mechanism. Synchronization of flowering – problems – methods to achieve synchrony – planting ratio and supplementary pollination methods.

**UNIT IV**

Techniques of hybrid seed production in major agricultural crops – cereals (wheat, rice), millets (maize, sorghum, bajra), pulses (red gram), oilseeds (sunflower, castor, mustard), cotton and forage crops

## UNIT V

Hybrid seed production techniques in horticultural crops – tomato, brinjal, chilli, bhendi, onion, bitter gourd, bottle gourd, ridge gourd, cucumber, melon, cabbage, cauliflower, potato, coconut and papaya

**Practical**

• Characteristics features of parental lines and their hybrids;

• Floral biology of rice, maize, pearlmillet, sunflower, castor and cotton;

• Study on floral biology of vegetable crops – solanaceous and other vegetables;

• Study on floral biology of cucurbitaceous crops;

• Production and maintenance of A, B and R lines;

• Practicing planting design and border rows – rice, maize, pearlmillet, sunflower and red gram; brinjal and chillies;

• Practicing planting design and border rows in tomato, cotton and cucurbitaceous vegetables;

• Manipulation for synchronization – rice, sunflower, pearlmillet and sorghum;

• Practicing supplementary pollination – rice and sunflower;

• Practicing field inspection in hybrid seed production plot – crops planted in ratio – sunflower, pearlmillet, sorghum, etc.;

• Practicing field inspection in hybrid seed production field – red gram, castor, cotton, cucurbits and tomato;

• Practicing roguing and identification of off-types – pollen shedders – shedding tassel – selfed fruits;

• Visit to hybrid seed production fields;

• Visit to potato seed production plots;

• Determination of cost benefit of hybrid seed production;

• Visit to seed Industry and assessing problems and perspectives in hybrid seed production.

**Suggested Readings**

- Agarwal RL. 2012. Seed Technology. 3rd Ed. Oxford & IBH Publishers, New Delhi.
- Basra A. 1999. Heterosis and Hybrid Seed Production in Agronomic Crops. CRC Press., Florida, United States.
- Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Department of Plant Breeding, CCSHAU, Hisar.
- Dar SH. 2018. Methods of Hybrid Seed Production in Major Crops. Educreation Publishing, Chhattisgarh.
- Frankel R and Galun E. 1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer Verlag, New York.
- Hebblethwaite PD. 1980. Seed Production. Butterworth Heinemann Ltd., London, UK.
- Joshi AK and Singh BD. 2004. Seed Science and Technology. Kalyani Publishers, New Delhi.
- Krishnan M. 2012. Plant breeding and Hybrid Seed Production. Domin and Publishers & Distributors, New Delhi, India.

- Kulkarni GN. 2011. Principles of Seed Technology. Kalyani Publishers, New Delhi.
- Maiti RK, Sarkar NC and Singh VP. 2006. Principles of Post Harvest Seed Physiology and Technology. Agrobios., Jodhpur, India.
- McDonald MF and Copeland LO. 2012. Seed Production: Principles and Practices. Springer Science and Business Media, Boston, United States.
- Mondal SS, Saha M and Sengupta K. 2009. Seed Production of Field Crops. New India Publishing Agency, New Delhi.
- Sen S and Ghosh N. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.
- Singhal NC. 2003. Hybrid Seed Production. Kalyani Publishers., New Delhi, India.
- Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani Publications, New Delhi.
- Singhal NC. 2010. Seed Science and Technology. Kalyani Publishers, New Delhi.
- Vanangamudi K, Prabhu M, Kalaivani S, Bhaskaran M and Manonmani V. 2010. Vegetable Hybrid seed Production and Management. Agrobios., Jodhpur, India.

**Suggested e-books**

https://www.springer.com/in/book/9780792373223

https://www.springer.com/in/book/9780412075513

https://www.nipabooks.com/info/9788190723763/seed-production-of-field-crops

https://www.kopykitab.com/Vegetable-Hybrid-Seed-Production-And-Management

https://www.researchgate.net/publication/229432295_Hybrid_Seed_Production_and Flowers

http://www.worldcat.org/title/seed-production-principles-andractices/oclc

https://libgen.is/search.php?req=Raymond+A++T+George&column=author

https://www.researchgate.net/profile/Gulzar_S_Sanghera/publication/236865752_Advances_in_Hybrid_Rice_Technology_through_Applications_of_Novel_Technologies/links/ 0deec519b46087d815000000.pdf

**Suggested websites**

www.agriquest.info

www.agriinfo.in

www.seedquest.com

https://agriinfo.in/botany/18/

http://www.fao.org/3/a-e8935e.pdf

http://www.agriquest.info/seed_production.php

http://agritech.tnau.ac.in/seed_certification/seedtech_index.html