Ph.D. in Plant Pathology

Re-Structured syllabus as BSMA recommendations 2021-22

[Applicable w.e.f. Academic Session 2024-2025]

TEERTHANKER MAHAVEER UNIVERSITY

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Program Summary

Institute Name	Teerthanker Mahaveer College of Agriculture Sciences
Program	Ph.D. in Plant Pathology
Duration	Three years full time (Six Semesters)
Medium	English
Credits	
Minimum Credits Required for Degree	105

About The Program

Ph.D. in Plant Pathology is a three-year Ph.D. program meticulously crafted to furnish students with an advanced comprehension of plant pathology. A Ph.D. program in Agricultural Sciences, specializing in Plant Pathology, provides students with a comprehensive and rigorous course of study that equips them with advanced knowledge and research skills in the field of plant health and disease management. The program typically spans four to six semesters, depending on the student's progress and the specific requirements of the institution.

The curriculum reveals a complex and advanced topic that has been thoughtfully constructed to provide students a comprehensive understanding of plant diseases and their complex management. Thorough investigation of the microorganisms that infect plants, such as nematodes, bacteria, viruses, and fungi, illness epidemiology, host-pathogen interactions, illness cycles, and pathogen biology are all covered. Investigation of the molecular processes that control how diseases and plants interact. This comprises genetic resistance, pathogen virulence factors, and signal transduction pathways. Techniques for identifying diseases in plants and creating comprehensive plans for managing illnesses. Using resistant cultivars is one aspect of this, along with biological, chemical, and cultural control techniques. Examination of the taxonomy, physiology, and roles that bacteria and fungus play in plant disease in detail. The use of contemporary methods helps students recognize and describe these infections. Use of biotechnological and genomic technologies in plant pathology. Molecular markers are used in disease resistance breeding, gene editing, and genetic engineering are examples of this.

Beyond the realms of academia, Ph.D. in Plant Pathology equips students with the practical acumen required to navigate the complexities of laboratory research and fieldwork trial. An essential component of the curriculum is practical training. Students obtain practical experience by using sophisticated methods in molecular biology, microbiology, and biotechnology to conduct studies. Putting disease control measures into place and keeping an eye on them in agricultural settings, taking part in plant disease diagnosis services to obtain practical problem-

solving expertise. Regular lectures and workshops with specialists in plant pathology and related topics are part of the program. Students can present their own research, network with professionals, and learn about the most recent advancements in the field at these sessions. Regular lectures and workshops with specialists in plant pathology and related topics are part of the program. Students can present their own research, network with professionals, and learn about the most recent advancements in the field at these sessions.

A Ph.D. in Plant Pathology will enable you to advance your understanding of plant health and disease prevention. The program offers opportunities to make significant contributions to food security and sustainable agriculture through cutting-edge research and innovation. It's a challenging yet rewarding program that equips students with the knowledge and skills needed to make a meaningful impact in the field of agriculture.

Program Outcomes (POs)

The Program Outcomes (POs) for a Ph.D. in Plant Pathology typically encompass a range of advanced skills and knowledge areas that students are expected by the completion of their program. These POs include:

PO1	Demonstrate in-depth understanding of plant pathology, including the biology, ecology, and epidemiology of plant pathogens. Master advanced techniques and methodologies for diagnosing and managing plant diseases.
PO2	Conduct original research that contributes new knowledge to the field of plant pathology. Develop and execute experimental designs, and analyse and interpret data using appropriate statistical tools.
PO3	Critically evaluate existing literature and identify gaps in current knowledge. Develop innovative solutions to complex problems in plant pathology and plant health management.
PO4	Gain proficiency in modern laboratory techniques, molecular biology tools, and bioinformatics relevant to plant pathology. Utilize advanced technologies for disease diagnosis and pathogen identification.
PO5	Effectively communicate research findings and complex concepts in plant pathology to both scientific and non-scientific audiences. Publish research results in peer-reviewed journals and present at national and international conferences.
PO6	Acquire skills to teach and mentor undergraduate and graduate students in plant pathology. Develop educational materials and deliver lectures or practical sessions.
PO7	Develop and implement extension programs to disseminate research findings and best practices to farmers, agricultural professionals, and the general public. Utilize

	various media and platforms for effective outreach.
PO8	Engage in interdisciplinary research and collaborate with experts in related fields such as agronomy, entomology, microbiology, and environmental science. Participate in collaborative projects to address complex agricultural problems.

Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) for a PhD in Plant Pathology focus on the specialized skills and knowledge that graduates are expected to acquire in this field. Here are four PSOs for such a program:

PSO1	Develop expertise in the identification, characterization, and classification of plant pathogens including fungi, bacteria, viruses, and nematodes. Design and implement integrated disease management strategies that combine cultural, biological, and chemical control methods to mitigate plant diseases.
PSO2	Conduct epidemiological studies to understand the dynamics of disease outbreaks and the factors influencing pathogen spread and survival. Develop and use disease forecasting models and decision support systems to predict disease outbreaks and guide timely intervention measures.
PSO3	Promote sustainable agriculture by researching and developing environmentally friendly disease control methods, such as biocontrol agents and organic amendments. Investigate the role of plant health in agroecosystem sustainability and resilience, emphasizing the importance of maintaining biodiversity and ecological balance in disease management practices.

SEMESTER-WISE COURSE STRUCTURE AND EVALUATION SCHEME

Ph.D. in Plant Pathology

Semester- I

S.No.	Course Code	Category	Title of course	L	P	Credit	Evaluation Scheme	
							Min Qualifying Marks	Max Marks
1	RRMD101*	Supporting Course	Research Methodology	4	0	4	60	100
2	RRMD102*	Supporting Course	Quantitative Methods & Computer Applications	2	0	2	60	100
3	RMGT171*	Supporting Course	Review of Literature**	2	0	2	-	-
4	CPE-RPE101*	Supporting Course	Research & Publication Ethics	2	0	2	60	100
5	PDS240159	Major	Advances in Mycology	2	2	3	60	100
Total				12	02	13	240	400

- ***University common supporting course work.**
- **** Prepare title and review for gap in research**

Semester- II

S.No.	Course Code	Category	Title of course	L	P	Credit	Min Qualifying Marks	Max Marks
1	PDS240160	Major	Advances in Virology	2	2	3	60	100
2	PDS240161	Major	Advances in Plant Pathogenic Prokaryotes	2	2	3	60	100
3	PDS240162	Major	Molecular Basis of Host-pathogen Interaction	2	2	3	60	100
4	PDS240163	Minor	Insect Vectors of Plant Pathogens	1	2	2	60	100
5	PDS240164	Minor	PGR Exchange and Quarantine	1	2	2	60	100
6	PDS240165	Minor	Seed Health Testing and Management	2	0	2	60	100
Total				10	10	15	360	600

Semester- III

S.No.	Course Code	Category	Title of course	L	P	Credit	Min Qualifying Marks	Max Marks
1	PDS240166	Major	Seminar	-	-	1	Satisfactory/Non-Satisfactory	
2	PDS240167	Major	Thesis Research	-	-	15	Satisfactory/Non-Satisfactory	
Total:				-	-	16	-	-

Semester- IV

Sl. No.	Course Code	Category Major	Title of course	L	P	Credit	Evaluation Scheme	
							Min Qualifying Marks	Max Marks
1	PDS240166	Major	Seminar	-	-	1	Satisfactory/Non-Satisfactory	
2	PDS240167	Major	Thesis Research	-	-	20	Satisfactory/Non-Satisfactory	
Total:				**-**	**-**	**21**	-	

Semester- V

No.	Course Code	Category	Title of course	L	T	P	Credit	Evaluation Scheme
	PDS240167	Major	Thesis Research	-	-	-	20	-
Total:							**20**	

Semester- VI

No.	Course Code	Category	Title of course	L	P	Credit	Evaluation Scheme
1	PDS240167	Major	Thesis Research	-	-	20	Satisfactory /Non-Satisfactory
Total:				**-**	**-**	**20**	-

Framework of the courses

Major courses: From the Discipline in which a student takes admission.

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

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

Break-up of the Courses

S. N.	Category	Total minimum number of credits to be earned
1	Major Courses	12
2	Minor	06
3	Supporting	10
4	Seminar	02
6	Research & Thesis	75
Total		**105**

List of Supporting Courses						
No.	Course Code	Title of course	L	T	P	Credit
1	RRMD101	Research Methodology	4	0	0	4
2	RRMD102	Quantitative Methods & Computer Applications	2	0	0	2
3	RMGT171	Review of Literature	2	0	0	2
4	CPE-RPE101	Research & Publication Ethics	2	0	0	2

List of Major Courses					
Course Code	Title of course	L	T	P	Credit
PDS240159	Advances in Mycology	2	0	2	3
PDS240160	Advances in Virology	2	0	2	3
PDS240161	Advances in Plant Pathogenic Prokaryotes	2	0	2	3
PDS240162	Molecular Basis of Host-pathogen Interaction	2	0	2	3
PDS240166	Seminar	0	0	2	2
PDS240167	Thesis Research	0	0	0	75

List of Minor Courses						
1	PDS240163	Insect Vectors of Plant Pathogens	1	0	2	2
2	PDS240164	PGR Exchange and Quarantine	1	0	2	2
3	PDS240165	Seed Health Testing and Management	1	0	2	2

SYLLABUS

Ph.D. in Plant Pathology
ADVANCES IN MYCOLOGY

Course type	Course code	L T P C
Major	PDS240159	2 0 2 3

Objective:

To acquaint with the advances in mycology

Theory

Unit I

General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, chemical (chemotaxonomy), molecular and numerical (computer-based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti.

Unit II

Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

Unit III

Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effects of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism.

Unit IV

Genetic Improvement of Fungal strains. Fungal biotechnology. Fungi mediated synthesis of nano particles – characterization process and application. Mycotoxins problems and its management.

Practical

- Isolation, purification and identification of cultures, spores and mating type determination;
- Study of conidiogenesis-Phialides, porospores, arthospores;
- Study of fruiting bodies in Ascomycotina;
- Identification of fungi up to species level;
- Study of hyphal anastomosis;
- Morphology of representative plant pathogenic genera form different groups of fungi;
- Molecular characterization of fungi.

Suggested Reading

Alexopoulos CJ, Mims CW and Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York

Dube HC. 2005. *An Introduction to Fungi.* 3rd Ed. Vikas Publ. House, New Delhi.

Kirk PM, Cannon PF, David JC and Stalpers JA. (Eds.). 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.

ADVANCES IN VIROLOGY

Course type	Course code	L T P C
Major	PDS240160	2 0 2 3

Objective:

To educate about the advanced techniques and new developments in plant virology.

Theory

Unit I

Origin, evolution and interrelationship with animal viruses. Virus morphology, structure, architecture, replication (overview of host and viral components required), assembly and virus specific cytological effects in infected plant cells. Mechanisms leading to the evolution of new viruses/ strains: mutation, recombination, pseudo-recombination, component re-assortment, etc.

Unit II

Major vector groups of plant viruses and their taxonomy, virus-vector relationship, molecular mechanism of virus transmission by vectors. Terminologies used in immunology and serology. Classification, structure and functions of various domains of Immunoglobulins. Production of Polyclonal and monoclonal antibodies for detection of viruses. Immuno/ serological assays (Slide agglutination tests, Test tube precipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot Immuno Binding Assay, and nucleic acid based assays for detection of plant viruses.

Unit III

Polymerase Chain Reaction based (PCR, reverse transcriptase PCR, multiplex PCR, Nested PCR, Real time/ q PCR) and non-PCR based: LAMP, Fluorescent *in situ* hybridization (FISH), dot blot hybridization. Plant virus genome organization (General properties of plant viral genome- information content, coding and noncoding regions), replication, transcription and translational strategies of pararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses, satellite viruses and satellite RNA.

Unit IV

Gene expression, regulation and viral promoters.Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes. Virus potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials. Phylogenetic grouping system based on partial/ complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery.

Practical

- Purification of viruses, SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation.
- Acquaintance with different serological techniques (i) DAC- ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA. Nucleic acid isolation, DOT-blot, southern hybridization, probe preparation,and autoradiography.

- PCR application and viral genome cloning of PCR products, plasmid purification, enzyme digestion, sequencing, annotation of genes, analysis of viral sequences (use of gene bank, blast of viral sequences and phylogeny).
- Bioinformatics analysis tools for virology (ORF finder, Gene mark, Gene ontology, BLAST, Clustal X/W, Tm pred and Phylogeny programs).

Suggested Reading

Davies 1997. *Molecular Plant Virology: Replication and Gene Expression*. CRC Press, Florida.

Fauquet *et al*. 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.

Gibbs A and Harrison B. 1976. *Plant Virology – The Principles*. Edward Arnold, London.

Jones P, Jones PG and Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons, New York.

Khan J A and Dijkstra. 2002. *Plant Viruses as Molecular Pathogens*. Howarth Press, New York.

Maramorosch K, Murphy FA and Shatkin AJ. 1996. *Advances in Virus Research*. Vol. 46. Academic Press, New York.

Pirone TP and Shaw JG. 1990. *Viral Genes and Plant Pathogenesis*. Springer Verlag, New York.

Roger Hull. 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press, New York.

Thresh JM. 2006. *Advances in Virus Research.* Academic Press, New York.

ADVANCES IN PLANT PATHOGENIC PROKARYOTES

Course type	Course code	L T P C
Major	PDS240161	2 0 2 3

Objective:

To learn about the latest developments in all the plant pathogenic prokaryotes as a whole.

Theory

Unit I

Prokaryotic cell: Molecular basis for **o**rigin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition **(bacteria)** cell wall/ envelop, Types of secretion systems (TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterial chromosomes and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes (Embden-Meyerhof-Parmas (EMP) pathway, Phosphoketolase Pathway and Entner Doudoroff Pathway).

Unit II

Current trends in taxonomy and identification of phytopathogenic prokarya**:** International code of nomenclature, Polyphasic approach, New/ special detection methods for identification of bacterial plant pathogens. Taxonomic ranks hierarchy; Identification, Advances in classification and nomenclature.

Unit III

Bacterial genetics**:** General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome.

Unit IV

Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/ bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker, etc. Immunization, induced resistance/ Systemic Acquired Resistance, Quorum sensing. Bacterial pathogenicity and virulence**:** Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymes that degrade the cell walls, Role of hrp/ hrc genes and TALE effectors. Synthesis and regulation of EPSs.

Unit V

Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR cas9.

Practical

- Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using species/ pathovar specific primers.

- Basic techniques in diagnostic kit development, Molecular tools to identify phytoendosymbionts.
- Important and emerging diseases and their management strategies.

Suggested Reading

Dale JW and Simon P. 2004. *Molecular Genetics of Bacteria*. John Wiley & Sons, New York.

Garrity GM, Krieg NR and Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria.* Vol. II. Springer Verlag, New York.

Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag, New York.

Mount MS and Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.

Sigee DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge.

Starr MP. 1992. *The Prokaryotes*. Vols. I–IV. Springer Verlag, New York.

MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION

Course type	Course code	L T P C
Major	PDS240162	2 0 2 3

Objectives:
To understand the concepts of molecular biology and biotechnology in relation to host plant-pathogen interactions.

Theory

Unit I
History of host plant resistance and importance to Agriculture. Importance and role of biotechnological tools in plant pathology. Basic concepts and principles to study host pathogen relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions.

Unit II
Different forms of plant-microbe interactions and nature of signals/ effectors underpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecular basis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognition system, signal transduction.

Unit III
Induction of defence responses- HR, Programmed cell death, reactive oxygen species, systemic acquired resistance, induced systemic resistance, pathogenesis related proteins, phytoalexins and virus induced gene silencing. Molecular basis of gene for- gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. Gene for gene systems: Background, genetics, phenotypes, molecular mechanisms, races, breakdown of resistance (boom-and-bust cycles), Coevolution-arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, GFG in agricultural crops vs. natural populations, Durability of resistance, erosion of quantitative resistance.

Unit IV
Pathogen population genetics and durability, viruses vs cellular pathogens. Gene deployment, cultivar mixtures. Disease emergence, host specialization. Circadian clock genes in relation to innate immunity. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

- Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.
- Gene mapping and marker assisted selection.
- Development and use of molecular markers in identification and characterization of resistance to plant pathogens and their management.

Suggested Reading

Chet I. 1993. *Biotechnology in Plant Disease Control.* John Wiley & Sons, New York.

Gurr SJ, McPohersen MJ and Bowlos DJ. (Eds.). 1992. *Molecular Plant Pathology – A Practical Approach.* Vols. I & II, Oxford Univ. Press, Oxford.

Mathew JD. 2003. *Molecular Plant Pathology*. Bios Scientific Publ., UK.
Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press,New Jersey.
Stacey G and Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. I-III. Chapman & Hall,New York; Vol. IV. APS Press, St. Paul, Minnesota.

INSECT VECTORS OF PLANT PATHOGENS

Course type	Course code	L T P C
Course Code :	PDS240163	**1 0 1 2**

Objectives:

To teach the students about the different groups of insects that act as vectors of plant pathogens, vector-plant pathogen interaction, and management of vectors for controlling diseases.

Theory

Unit I

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

Unit II

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

Unit III

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

Unit IV

Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

Unit V

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

VI. Practical

• Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, nematodes;

• Culturing and handling of vectors; demonstration of virus transmission through vectors- aphids, leafhoppers and whiteflies;

• Vector rearing and maintenance;

• Estimating vector transmission efficiency, studying vector-virus host interaction.

VII. Learning outcome

• Students are expected to be well versed with insect vectors of plant pathogens, acquire knowledge on disease transmission and vector management techniques.

VIII. Suggested Reading

Basu AN. 1995. *Bemisia tabaci* (Gennadius) – *Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford and IBH, New Delhi.

Harris KF and Maramarosh K. (Eds.). 1980. *Vectors of Plant Pathogens*. Academic Press, London.

Maramorosch K and Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*.

Academic Press, London.

Youdeovei A and Service MW. 1983. *Pest and Vector Management in the Tropics*. English

Language Books Series, Longman, London.

PGR EXCHANGE AND QUARANTINE

Course type	Course code	L T P C
Minor	PDS240164	1 0 2 2

Objectives:

To impart knowledge on safe exchange of germplasm nationally and internationally along with the quarantine related issues which are either legislative or technical.

Theory

Unit I

History, principles, objectives and importance of plant introduction, pre-requisite and conventions for exchange of PGR, national and international legislations and policies.

Unit II

Principles, objectives and relevance of plant quarantine, regulations and plant quarantine set up in India, pest risk analysis, pest and pathogen information database; quarantine in relation to integrated pest management, symptoms of pest damage, economic significance of seed-borne pests (insects, mites, nematodes, fungi, bacteria, viruses, phytoplasma, viroids, weeds, etc.), detection and identification of pests including use of recent techniques like ELISA, PCR, etc.

Unit III

Salvaging techniques for infested/ infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities, domestic quarantine; seed certification; international linkages in plant quarantine, weaknesses and future thrust. Symptoms of pest damage, pests of quarantine significance for India, sampling of bulk material for quarantine, Plant Quarantine/ biosecurity system in other countries, case histories of alien invasive species.

Unit IV

Genetically Modified Organisms (GMOs) or Genetically Engineered Plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical

• Joint inspection for pest detection

• Detection of pests of quarantine significance (Conventional, Electron microscopy, ELISA and molecular techniques)

• Primer designing;

• Pest risk analyses, quarantine in relation to integrated pest management; salvaging of infested/ infected germplasm

• Seed treatment and other prophylactic treatments and facilities; domestic quarantine; seed-health certification.

Learning Outcome

Knowledge gain on current national and international regulations related to germplasm exchange and plant quarantine, detection techniques for pests, salvaging methods, sampling techniques, biosafety of transgenics, etc.

Suggested Reading

Albrechsten SE. 2006. *Testing methods for seed-transmitted viruses: principles and protocols.*

UK: CAB International, Wallingford. 268 p.

Bhalla S, Chalam VC, Tyagi V, Lal A, Agarwal PC and Bisht IS. 2014. Teaching Manual on

Germplasm Exchange and Plant Quarantine. ICAR-NBPGR, New Delhi, India p. 340+ viii.

Bhalla S, Chalam VC, Lal A, and Khetarpal RK. 2009. *Practical Manual on Plant Quarantine*.

National Bureau of Plant Genetic Resources, New Delhi, India. 204p+viii.

Bhalla S, Chalam VC, Singh B, Gupta K and Dubey SC. 2018. Biosecuring Plant Genetic

Resources in India: Role of Plant Quarantine. ICAR-NBPGR, New Delhi vi+216 p.

Chalam VC, Dubey SC, Murali Krishna C, Bhalla S and Singh K (eds.). 2018. *Transboundary*

Movement of Living Modified Organisms: Strengthening Capacities of Enforcement

Agencies. ICAR-National Bureau of Plant Genetic Resources and Ministry of Environment,

Forest and Climate Change, New Delhi, India. vi+159 p. ISBN 978-81-937111-2-5

SEED HEALTH TESTING AND MANAGEMENT

Course type	Course code	L T P C
Minor	PDS240165	**1 0 2 2**

Objectives:

To acquaint the students with principle and practices of seed health testing and management of seed borne pathogens and storage insects.

Theory

Unit I

History and economic importance of seed health in seed industry and plant quarantine – important seed borne and seed transmitted pathogens – role of microorganisms in seed quality deterioration – storage and field fungi – effect of storage fungi on seeds – factors influencing storage fungi and management.

Unit II

Transmission of pathogens – mode and mechanism – seed certification standards; mycotoxins – types and its impact on plant, animal and human health; seed health testing methods – direct examination, incubation, serological and molecular methods.

Unit III

Production of disease free seeds in agricultural and horticultural crops; management of seed borne pathogens – plant quarantine – Indian system and networking, postentry quarantine and international systems – Pest Risk Analysis (PRA); Sanitary and Phytosanitary System (SPS) – certificates; International Seed Health Initiative (ISHI) on seed health standards.

Unit IV

Storage pests – insects, mites, rodents and their development – economic importance; insect infestation – factors influencing, sources and kinds, biochemical changes in stored seeds due to insect infestation; detection methods and estimation of storage losses; types of seed storage structures – domestic and commercial.

Unit V

Fumigation – principles and techniques – type of fumigants; preservatives and seed protectants on seed quality – non-chemical methods for managing seed storage pests – controlled and modified atmospheric storage – trapping devices – IPM for seed storage.

Practical

• Detection of seed borne pathogens – direct examination;

• Detection of seed borne pathogens – incubation methods;

• Detection of seed borne pathogens – serological methods;

• Detection of seed borne pathogens – molecular methods;

• Study on seed transmission of seed borne fungi, bacteria and viruses;

• Identification of storage fungi;

• Management of seed borne pathogens – seed treatment methods;

• Identification of storage insects – internal and external feeders influencing insects

• Study on the effect of pre harvest spray on field carryover storage pests;

• Estimation of storage losses due to pests;

• Methods of detection of insect infestation;

• Management of storage pests – pesticides, dose determination, preparation of

solution and application;

• Management of storage pests – non-chemical management methods;

• Demonstration of controlled atmospheric storage;

• Safe handling and use of fumigants and insecticides;

• Visit to seed storage godowns.

Learning outcome

Successful completion of this course will provide knowledge on production of healthy seeds by timely detection and management of seed borne pathogens and storage pests to meet phyto-sanitary requirements.

Suggested Reading

Agarwal VK and Sinclair JB. 1996. *Principles of Seed Pathology*. Edition, CRC Press Inc. Boca Raton, FL.

Athanassiou CG and Arthur FH. 2018. *Recent advances in stored product protection*. Springer-Verlag, Germany

Cotton, RT. 2007. *Insect Pests of Stored grain and Grain products*. Burgess Publ. Co.,

Minneopolis, Minn., USA

Karuna V. 2007. *Seed Health Testing*. Kalyani Publishers, New Delhi.

Karuna V. 2009. *Fundamentals of Seed Pathology*. Kalyani Publishers, New Delhi.

Suggested e-books

https://link.springer.com/book/10.1007/978-1-349-02842-9

Research Methodology
COURSE CODE: RRMD101

1. Scientific Research: meaning and characteristics of scientific research, validity in research, phases/stages in research; types of research- qualitative, quantitative, exponential, exploratory, empirical, descriptive, ex-post facto, case studies, historical studies, philosophical studies, quasi-experimental; ethical problems in research; constructs and variables- nature of construct and variables, concept of constructs, type of variables, continuous and categorical, constructs, observables and intervening variables; Review of literature- purpose of the review, sources of the review, preparation of index card for reviewing and abstracting.
2. Problem Identification and Hypothesis Formation: problem- meaning and characteristics of a problem, types of problem, generality and specific of problem; hypothesis- meaning and characteristics of a good hypothesis, types of hypotheses, formulating a hypothesis, ways of stating a hypothesis; testing experimental hypothesis- standard error, test of significance, level of significance, degrees of freedom, errors in hypothesis- type I, type II errors.
3. Sampling and Research Design: meaning and types of sampling; probability and non probability sampling. methods of drawing samples, requisites of a good sampling method, sample size, sampling error; meaning and purpose of research design, types of research design, criteria of a good research design, basic principles of experimental design.
4. Introduction to MS-Office: MS-WORD, MS-EXCEL, MATLAB, LATEX.

Suggested Reading:

1. Cooper & Schindler, *Business Research Methods*, Tata McGraw Hill.
2. Saunders, *Research Methods for Business Students*, Pearson Education
3. Allen T Harrell, *New Methods in Social Science Researchs*, Praeger Publishers, New York
4. Beri, G.C., S*tatistics for Management*, Tata MacGraw-Hill
5. Chandan J. S., *Statistics for Business and Economics*, Vikas Publications.
6. Broota, K.D., *Experimantal Designs in Behavioural Research*, New Age International
7. Singh A. K., *Test Measurement and Research Methods in Behaviours Sciences*, Bharti Bhawan
8. Joyce Cox & Polly Urban, *Microsoft Office*, Galgotia Publishing
9. Sinha P.K., *Computer Fundamentals*, BPB Publishing.

Quantitative Methods and Computer Applications (RRMD102)

1. Measurement and Scaling Techniques: measurement in research, measurement scales sources of errors in measurement, tests of second measurement, techniques of developing measurement tools, meaning of scaling, scale classification bases, important scaling techniques, and scale construction techniques.
2. Data Collection, Processing and Analysis: methods of data collection – primary data,

secondary data; primary data collection – observation method, interview method, questionnaires, schedules, guideline for constructing questionnaires/schedules, secondary data collection of, selection of appropriate method of data collection; coding, editing and tabulation of data, charts and diagrams used in data analysis, bar and pie diagrams and their significance; measures of central tendency, measures of dispersion; correlation and regression analysis - meaning and uses, methods of calculation of coefficients and their analysis and implication. sampling distribution, sampling schemes and sample sizes, confidence interval for the mean, t-statistic, z-statistic, confidence interval for the population variances, hypothesis testing, test of hypothesis for the population mean, population variance and ratio of two population variances; applications of z-test, t-test, f-test and chi-square test, association of attributes and techniques of testing, ANOVA.

3. Report Writing: meaning and significance of report writing, types of report, steps in writing report, layout of the research report, precaution in writing research report, developing thesis report, formatting, inside citations, references and bibliography, knowledge of computer, statistical software and their application, application of statistical tests/techniques through the use of statistical software like SPSS, scientific packages like LISREL, AMOS, and SYSTAT for documentation and report generation.

Suggested Reading:

1. Cooper & Schindler, *Business Research Methods*, Tata McGraw Hill.
2. Malhotra Naresh K., *Marketing Research*, Pearson Education
3. Power Analysis for experimental Research: A practical Guide for the Biological, Medical and Social Sciences by R. Barker Baushell, Yu-Fang Li Cambridge University Press
4. Chandan J. S., *Statistics for Business and Economics*, Vikas Publications.
5. Broota, K.D., *Experimantal Designs in Behavioural Research*, New Age International
6. Singh A. K., *Test Measurement and Research Methods in Behaviours Sciences*, Bharti Bhawan
7. Joyce Cox & Polly Urban, *Microsoft Office*, Galgotia Publishing
8. Sinha P.K., *Computer Fundamentals*, BPB Publishing.
9. Latex: A Document Preparation System, 2/E pearson low price edition by Lamport
10. MATLAB: An Introduction with Applications by Gilat Wiley India Pvt. Ltd.
11. Getting started with MATLAB by Rudra Pratap Oxford University Press.

EVALUATION OF REVIEW OF LITERATURE (RMGT171)

The research scholar will review the important studies conducted at the national and international level either by individuals or organizations including government agencies and present the methodology adopted and important findings emerged from these studies. Based

on this review of literature the researcher will identify the research gaps existing in the available literature and thus justifying the need for the present study.

The researcher is supposed to follow the pattern adopted in the standard national and international research journals. However, as an illustration the pattern for reporting review of literature is as under:

1. Tiwari and Sinha (1971) gave productivity trends and factor compensation in Indian textiles industry for the period 1946-65 comprising of two sub-periods (1946- 1955 and 1956-1965). The marginal productivity of capital on an average for the industry as a whole is found to be lower in the sub-period (1946-55) and higher during (1956-65). On the contrary, the estimates of the marginal productivity of labour again on average exhibit an actual decline from 2.9 percent to 2.5 percent.
2. Menon (1971) in his review article examines the concepts associated with measurement of productivity at various dimensions of output and input, which are the major elements involved in the exercise of measuring productivity.
3. Kumar, Anil and Khurana (2007) in their paper have examined trends in productivity of labour and capital in dairy industry in India during pre and post-reform periods. The results in the study conclude that labour productivity at national level has shown considerable improvement during post-reform period. But variations have been observed in case of growth rate of labour productivity at state-level. On the other hand, capital productivity has declined during post-reform period at national and state levels.
4. Kumar and Bala (2007) in their study on "An evaluation of the impact of economic reforms on the growth and productivity of Indian small scale sector" has concluded that economic reforms process initiated in the early nineties has had a downbeat impact on the growth and productivity of small scale sector.

Research & Publication Ethics (CPE-RPE101)

Theory

- **RPE 01: PHILOSOPHY AND ETHICS (3 hrs.)**
    1. Introduction to philosophy: definition, nature and scope, concept, branches
    2. Ethics: definition, moral philosophy, nature of moral judgments and reactions
- **RPE 02: SCIENTIFIC CONDUCT (5 hrs.)**
    1. Ethics with respect to science and research
    2. Intellectual honesty and research integrity
    3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
    4. Redundant publications: duplicate and overlapping publications, salami slicing
    5. Selective reporting and misrepresentation of data
- **RPE 03: PUBLICATION ETHICS (7 hrs.)**
    1. Publication ethics: definition, introduction and importance
    2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
    3. Conflicts of interest
    4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
    5. Violation of publication ethics, authorship and contributorship
    6. Identification of publication misconduct, complaints and appeals
    7. Predatory publishers and journals

Practice

- **RPE 04: OPEN ACCESS PUBLISHING (4 hrs.)**
    1. Open access publications and initiatives
    2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
    3. Software tool to identify predatory publications developed by SPPU
    4. Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.
- **RPE 05: PUBLICATION MISCONDUCT (4hrs.)**

Group Discussions (2 hrs.)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

Software tools (2 hrs.) :Use of plagiarism software like Tumitin, Urkund and other open source software tools

- **RPE 06: DATABASES AND RESEARCH METRICS (7hrs.)**

. Databases (4 hrs.)

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

Research Metrics (3 hrs.)

3. Impact Factor of journal as per Journal Citation Report, SNIP, SIR, IPP, Cite Score
4. Metrics: h-index, g index, i10 index, altmetrics.