Ph.D. in Plant Pathology

Courses and Syllabus

of

Plant Pathology

Palli Siksha Bhavana

(Institute of Agriculture)

Visva-Bharati, Sriniketan

Restructured and Revised Syllabi of Ph.D. Programme

Course and Credits Allocation

Course Code	Course Title	Credit Hours
PLPATH 601	Research Methodology and Techniques in Plant Pathology	4+0
PLPATH 602	Molecular Basis of Host-Pathogen Interaction	3+1
PLPATH 603	Review of literature and synopsis presentation	0+4
RPE	Research and publication ethics	2+0
PLPATH 604	Advances in Mycology	2+1
PLPATH 605	Advances in Plant Virology	2+1
PLPATH 606	Advances in Plant Pathogenic Prokaryotes	2+1
PLPATH 607	Principles and Procedures of Certification	1+0
PLPATH 608	Plant Biosecurity and Biosafety	2+0
PLPATH 691	Doctoral seminar-I	0+1
PLPATH 692	Doctoral seminar-II	0+1

Detailed Course Syllabi

CourseTitle : Research Methodology and Techniques in Plant Pathology

CourseCode :PL PATH 601

CreditHours :4+0

Aim of the course

To provide fundamental knowledge about the dimension of agricultural research, methodology, data analysis and interpretations, pathometry, maintenance of plants pathogens and their management

Learning Outcome: Help the researcher to understand the basic techniques required for plantpathological research, help them to identify the niche areas of research and make them competent enough for individual research.

Theory

UnitI

Research Concept and Classification; Categories of research and Social needs; Agricultural Research systems in India as well as other developing countries; Plant Pathological Societies and International Plant Pathology, Methodologies for recording and collection of data, data sis and interpretation of data; graphical representation of data; Use of mathematical and statistical tools for analysis of data; Maintenance of pathogen cultures and pests, vectors etc. ;Statistical methods relevant to plant pathological experiments

Unit II

Study of plant growth and crop growth parameters and modeling; Loss assessment in crops and cropping system; Pathometry; Study of growth of plant pathogens and some basic techniques essential for Plant Pathology; Basic knowledge on different groups of plant pathogens; Management of Plant Pathogens for sustainable production of crops; Practicals relevant to collection of data, data analysis and interpretation of data; Use of mathematical tools and statistical package; Pathometry and loss assessment by different techniques; Selected exercise on plant pathogens; Basic laboratory techniques

Course Title :Molecular Basis of Host-pathogen Interaction

Course Code :PL PATH 602

Credit Hours :3+1

Aim of the course

Tounderstandtheconceptsofmolecularbiologyandbiotechnologyinrelationtohostplant-pathogeninteractions.

I. Theory

UnitI

HistoryofhostplantresistanceandimportancetoAgriculture.Importanceandroleofbiotechnologicaltoolsinplantpathology.Basicconceptsandprinciplestostudyhostpathogenrelationship.Molecular genetics,imagingandanalyticalchemistrytoolsforstudyingplants,microbes,andtheirinteractions.

UnitII

Differentformsofplant-microbeinteractionsandnatureofsignals/effectorsunderpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecularbasis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognitionsystem,signaltransduction.

UnitIII

Induction of defence responses- HR, Programmed cell death, reactive oxygenspecies,systemicacquiredresistance,inducedsystemicresistance,pathogenesisrelatedproteins,phytoalexinsandvirusinducedgenesilencing.Molecularbasisofgene-for-genehypothesis;R-geneexpressionandtranscriptionprofiling,mappingandcloningofresistancegenesandmarker-aidedselection,pyramidingofRgenes.Geneforgenesystems:Background,genetics,phenotypes,molecularmechanisms,races,breakdownofresistance(boom-and-bustcycles),Coevolution-armsraceandtrenchwarfaremodels,Metapopulations,costofresistance,costofunnecessaryvirulence, GFG in agricultural crops vs. natural populations, Durability of resistance,erosionofquantitativeresistance.

UnitIV

Pathogen population genetics and durability, virusesvs cellular pathogens.Genedeployment, cultivar mixtures. Disease emergence, host specialization.Circadianclockgenesinrelationtoinnateimmunity.Biotechnologyanddisease management;developmentofdiseaseresistanceplantsusinggeneticengineeringapproaches,different methodsofgenetransfer,biosafetyissuesrelatedtoGMcrops.

II. Practical

- Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA andProteinelectrophoresis,bacterialtransformation;
- Genemappingandmarkerassistedselection;
- Development and use of molecular markers in identification and characterizationofresistancetoplantpathogensandtheirmanagement.

Course Title **:Review of literature and synopsis presentation**
Course Code **:PL PATH 603**
Credit Hours **:4+0**

Aim of the course

To provide fundamental knowledge about the collection of literature and reviews, arrangements of data, analysis and their interpretation, preparation of dissertation and research articles

I. Learning Outcome: Help the researcher to understand the basic principles for writing experimental findings, dissertation, research articles etc.

II. Theory

Collection of literature and preparation of two review articles: Collection of thesis related review articles (2 objectives) from various sources, system of collection, processing of reviews, compilation, arrangement of reviews arrangement of references in bibliography.

P**reparation of synopsis of research topic:** Collection of background history, selection of methodology, setting and arrangement of experiments. Making of time frame of research, probable outcome of research and compilation of whole experiments with proper objectives.

Final Registration Seminar (including methodology of trial and experiments): Preparation of Power Point (ppt) slides, content compilation, methods of presentation, question answering etc.

Data analysis and preparation of MS for Thesis: Analysis of data, tabulation, preparation of manuscript by experimental findings and discussions. Preparation of short abstract.

Course Title :Advances in Mycology
Course Code :PL PATH 604
Credit Hours :2+1

Aim of the course

Toacquaintwiththeadvancesinmycology

I. Theory

UnitI

Generalintroduction,historicaldevelopmentandadvancesinmycology.Recent taxonomic criteria,morphologicalcriteriaforclassification.Serological,chemical(chemotaxonomy), molecular and numerical (computerbased assessment) taxonomy.Interactionbetweengroups:Phylogeny,Microconidiation,conidiogenesisandsporulatingstructuresoffungiimperfecti.

UnitII

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

UnitIII

Ultra structures and chemical constituents of fungal cells, functions of cell organelles.Mitosis, meiosis, gene action and regulation.Effects of fungal interaction with hostplantsandothermicroorganisms;parasitism,symbiosisandcommensalism.

UnitIV

GeneticImprovementofFungalstrains.Fungalbiotechnology.Fungimediatedsynthesis of nano particles – characterization process and application. Mycotoxinsproblemsanditsmanagement.

II. Practical

a. Isolation,purificationandidentificationofcultures,sporesandmatingtypedetermination;
b. Studyofconidiogenesis-Phialides,porospores,arthospores;

c. Studyoffruitingbodiesin Ascomycotina;
d. Identificationoffungiuptospecieslevel;
e. Studyofhyphalanastomosis;
f. Morphologyofrepresentativeplantpathogenicgenerafromdifferentgroupsoffungi;
g. Molecularcharacterizationoffungi.

CourseTitle : Advances in Plant Virology
Course Code : PL PATH 605
Credit Hours : 2+1

Aim of the course

Toeducateabouttheadvancedtechniquesandnewdevelopmentsinplantvirology.

I. Theory

UnitI

Origin,evolutionandinterrelationshipwithanimalviruses.Virusmorphology,structure,architecture,replication(overviewofhostandviralcomponentsrequired),assembly and virus specific cytological effects in infected plant cells. Mechanismsleading to the evolution of new viruses/ strains: mutation, recombination, pseudo-recombination,componentre-assortment,etc.

UnitII

Major vector groups of plant viruses and their taxonomy, virus-vector relationship,molecularmechanismofvirustransmissionbyvectors.Terminologiesusedinimmunologyandserology.Classification,structureandfunctionsofvariousdomainsof Immunoglobulins.Production of Polyclonal and monoclonal antibodies for detectionofviruses.Immuno/serologicalassays(Slideagglutinationtests,Testtubeprecipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot ImmunoBindingAssay,andnucleicacidbasedassaysfordetectionofplantviruses.

UnitIII

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),dotblothybridization.Plantvirusgenomeorganization(General properties of plant viral genome- information content, coding and non-codingregions),replication,transcriptionandtranslationalstrategiesofpararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses,satellitevirusesandsatelliteRNA.

UnitIV

Gene expression, regulation and viral promoters.Genetic engineering with plantviruses, viral suppressors, RNAi dynamics and resistant genes.Virus potential asvectors,geneticallyengineeredresistance,transgenicplants.Techniquesandapplicationoftissueculturefor productionofvirusfreeplantingmaterials.Phylogenetic grouping system based on partial/ complete sequences of virus genomesandusingof next generationsequencingtechnologyinplantvirusdiscovery.

II. Practical

- Purificationofviruses,SDS-PAGEformolecularweightdetermination.
- Acquaintance with different serological techniques (i) DAC- ELISA (ii)

DAS-ELISA

- PCR application and viral genome cloning of PCR products, plasmid purification,enzyme digestion, sequencing, annotation of genes, analysis of viral sequences(useofgenebank,blastofviralsequencesandphylogeny);

Course Title : Advances in Plant Pathogenic Prokaryotes
Course Code : PL PATH 606
Credit Hours : 2+1

Aim of the course

Tolearnaboutthelatestdevelopmentsinalltheplantpathogenicprokaryotesasawhole.

I. Theory

UnitI

Prokaryoticcell:Molecularbasisfor**o**riginandevolutionofprokaryoticlife,RNAworld, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation.Structureandcomposition**(bacteria)**cellwall/envelop,Typesofsecretionsystems(TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterialchromosomesandplasmids,othercellorganelles.Growth,nutritionandmetabolisminprokaryotes(Embden-Meyerhof-Parmas(EMP)pathway,PhosphoketolasePathwayandEntnerDoudoroffPathway).

UnitII

Current trends in taXonomy and identification of phytopathogenicprokarya**:** International code of nomenclature, Polyphasic approach, New/ special detectionmethods for identification of bacterial plant pathogens. TaXonomic ranks hierarchy;Identification,Advancesinclassificationandnomenclature.

UnitIII

Bacterialgenetics**:**Generalmechanismofvariability(mutation),specializedmechanisms of variability. Transposable genetic elements in bacteria-integron andprophages,Mechanismofgenetransfer.Pathogenicityislands,horizontalgenetransfer,BacterialPan-Genome.

UnitI V

Bacteriophages:Composition,structureandinfection.Classificationanduseofphagesinplantpathology/bacteriology.Hostpathogeninteractions:Molecularmechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker,etc.Immunization,inducedresistance/SystemicAcquiredResistance,Quorumsensing. Bacterial pathogenicity and virulence**:** Molecular mechanism of virulenceand pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymesthatdegradethecellwalls,Roleofhrp/hrcgenesandTALEeffectors.Synthesisandregulationof EPSs.

UnitV

Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role indisease

management.Endosymbionts for host defence. Advances in management ofdiseasescausedbyprokaryotes:geneticengineering,RNAsilencing;CRISPRcas9.

II. Practical

- Pathogenic studies and race identification, Endospore,Flagellastaining,Testforsecondarymetaboliteproduction,cyanides,EPS,siderophore, specific detection of phytopathogenic bacteria using species/ pathovarspecificprimers;
- Basictechniquesindiagnostickitdevelopment,Moleculartoolstoidentifyphytoendosymbionts;
- Importantandemergingdiseasesandtheirmanagementstrategies.

Course Title : Principles and Procedures of Certification
Course Code : PL PATH 607
Credit Hours : (1+0)

Aim of the course

Toacquaintwiththecertificationproceduresofseedandplantingmaterial.

I. Theory

UnitI

Introductiontocertification.Internationalscenarioofcertificationandroleof ISTA, EPPO, OECD, etc. in certification and quality control. Case studies of certificationsystemsofUSAandEurope.NationalRegulatorymechanismandcertificationsystem including seed certification, minimum seed certification standards.Nationalstatusofseedhealthinseedcertification.Methodsfortestinggeneticidentity,physicalpurity,germinationpercentage,seedhealth,etc.Fixingtolerancelimitsfordiseasesandinsectpestsincertificationandqualitycontrolprogrammes.

UnitII

Methods used in certification of seeds, vegetative propagules and *in-vitro* cultures.Accreditation of seed testing laboratories.Role of seed/ planting material healthcertificationinnationalandinternationaltrade.

Course Title : Plant Biosecurity and Biosafety
Course Code : PL PATH 608
Credit Hours : 2+0

Aim of the course

Tofacilitatedeeperunderstandingonplantbiosecurityandbiosafetyissuesinagriculture.

I. Theory

UnitI

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine,InvasiveAlienSpecies,Biowarfare,Emerging/resurgenceofpestsanddiseases.IntroductionandHistoryofbiosecurityanditsimportance.

UnitII

National Regulatory Mechanism and International Agreements/ Conventions, viz.,Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World TradeOrganization(WTO),ConventiononBiologicalDiversity(CBD),InternationalStandards for Phytosanitary Measures, pest risk analysis, risk assessment models, pestinformationsystem,earlywarningandforecastingsystem,useofGlobalPositioningSystem (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associatedwithagroterrorismevent,mitigationplanning,integratedapproachforbiosecurity.

UnitIII

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety andits implications, Issues related to release of genetically modified crops. Emerging/resurgence of pests and diseases in the changing scenario of climatic conditions.