## PLANT PATHOLOGY
### Course Structure – at a Glance

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*Compulsory for Master’s programme; ** Compulsory for Ph. D. programme; $ Cross-listed with Entomology
PLANT PATHOLOGY

Course Contents

PPA 501 INTRODUCTORY MYCOLOGY 2+1
Objective
To study the nomenclature, classification and characters of fungi.

Theory
UNIT I
Introduction, definition of different terms, basic concepts.
UNIT II
Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology.
UNIT III
Fungal biodiversity, reproduction in fungi, Concepts of nomenclature and classification
UNIT IV

Practical
Detailed comparative study of different groups of fungi; collection, identification and preservation of specimens. Identification of plant pathogenic fungi.

Suggested Readings

PPA 502 INTRODUCTORY PLANT VIROLOGY 2+1
Objective
To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Theory
UNIT I
History of plant viruses, shape, size, composition, structure and physical properties of viruses.
UNIT II
Symptomatology of important plant viral diseases, transmission, virus vector relationship.
UNIT III
Virus nomenclature and classification, genome organization, replication and movement of viruses.
UNIT IV
Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

UNIT V
Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions.

UNIT VI
Mechanism of resistance, genetic engineering and management of plant viruses.

Practical
Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, serological tests

Suggested Readings

PPA 503   INTRODUCTORY PLANT BACTERIOLOGY              2+1

Objective
To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Theory
UNIT I
History and introduction to phytopathogenic prokaryotes, viz., bacteria, MLOs, spiroplasmas and other fastidious prokaryotes. Importance of phytopathogenic bacteria

UNIT II
Bacterial cell structure, shape, size, flagellation, etc

UNIT III
Classification and nomenclature of phytopathogenic prokaryotes

UNIT IV
Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic bacteria.

UNIT V
General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT VI
Prokaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT VII
Survival and dissemination of phytopathogenic bacteria.

Practical:
Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical characterization, use of antibacterial chemicals/antibiotics.

Suggested Readings

**PPA 504 PRINCIPLES OF PLANT PATHOLOGY 3+0**

**Objective**
To introduce the subject of Plant Pathology, its concepts and principles.

**Theory**

**UNIT I**
Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases.

**UNIT II**
Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

**UNIT III**
Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

**UNIT IV**
Genetics of resistance; ‘R’ genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

**Suggested Readings**

**PPA 505 DETECTION AND DIAGNOSIS OF PLANT DISEASES 0+2**

**Objective**
To impart training on various methods/techniques/instruments used in the study of plant diseases/pathogens.

**Practical:**

**UNIT I**
Methods to prove Koch’s postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens.

**UNIT II**
Preservation of disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

**UNIT III**
Microscopic techniques and staining methods, phase contrast system, spectrophotometer. *In vitro* evaluation of fungicides, bactericides etc.

**Suggested Readings**

**PPA 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT 2+1**

**Objectives**
To acquaint with different strategies for management of plant diseases.

**Theory**

**UNIT I**
Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanical methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.

**UNIT II**
History of fungicides, bactericides, concepts of pathogen immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

**UNIT III**
Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

**Practical**
*In vitro* and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

**Suggested Readings**
PPA 507 DISEASES OF FIELD CROPS 2+1

Objective
To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases.

Theory
UNIT I
Diseases of Cereal crops- wheat, rice, pearl millet, sorghum and maize.
UNIT II
Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean.
UNIT III
Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut.
UNIT IV
Diseases of Cash crops- cotton, sugarcane, jute.
UNIT V
Diseases of Fodder legume crops- berseem, lucerne, cowpea.

Practical
Detailed study of symptoms of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops. Microscopic study of important pathogens.

Suggested Readings

PPA 508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS 2+1

Objective
To acquaint with diseases of fruits, plantation, ornamental plants and their management.

Theory
UNIT I
Introduction, symptoms, etiology, perpetuation and management of different fruit diseases like apple, pear, strawberry, citrus, mango, grapes, guava, banana, pineapple, papaya.
UNIT II
Introduction, symptoms, etiology, perpetuation and management of diseases of plantation crops such as tea, coffee, rubber and coconut.
UNIT III
Introduction, symptoms, etiology, perpetuation and management of ornamental plants such as roses, gladiolus, carnation, marigold, chrysanthemum.

Practical
Detailed study of symptoms of representative diseases of plantation crops. Collection and dry preservation of diseased specimens of important crops. Microscopic study of important pathogens.
Suggested Readings

PPA 509 DISEASES OF VEGETABLE, SPICES AND MEDICINAL CROPS          2+1
Objective
To impart knowledge about symptoms, etiology and management of different diseases of vegetables, spices and medicinal plants.

Theory
UNIT I
Symptoms, etiology and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceous vegetable crops.
UNIT II
Symptoms, etiology and management of diseases of different spice crops such as black pepper, cumin, coriander, turmeric, fennel, fenugreek and ginger.
UNIT III
Symptoms, etiology and management of diseases of Belladona, Cinchona, Plantago, Rauvolfia, Withania and Opium Poppy

Practical
Detailed study of symptoms of important diseases of vegetable and spice crops. Microscopic study of important pathogens.

Suggested Readings

PPA 510   SEED HEALTH TECHNOLOGY                                                 2+1
Objective
To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/loses and management.

Theory
UNIT I
History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.
UNIT II
Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III
Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV
Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical
Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses.

Suggested Readings
botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals, methods of application of chemicals.

**Suggested Readings**


**PPA 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS 2+1**

**Objective**
To provide knowledge on soil-plant disease relationship.

**Theory**

**UNIT I**
Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi, bacteria, actinomycetes, etc.

**UNIT II**
Relationship among soil microbes.

**UNIT III**
Suppressive soils, biological control, types of bio control agents, concepts and potentialities for managing soil borne pathogens.

**Practical**
Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; pathogenicity test by soil and root inoculation techniques, correlation between inoculum density of test pathogens and disease incidence, demonstration of fungistasis in natural soils; suppression of test soil-borne pathogens by antagonistic microorganisms. Identification of different biocontrol agents.

**Suggested Readings**


**PPA 513 DISEASE RESISTANCE IN PLANTS 2+0**

**Objective**
To acquaint with disease resistance mechanisms in plants.

**Theory**

**UNIT I**
Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.
UNIT II
Disease escapes, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT III
Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT IV
Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

Suggested Readings


PPA 514/ ENT 514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS

Objective
To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, 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.
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.

Suggested Readings

PPA 515 BIOLOGICAL CONTROL OF PLANT DISEASES 1+1
Objective
To study principles and application of ecofriendly and sustainable management strategies of plant diseases.

Theory
UNIT I
Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.
UNIT II
Types of biological interactions, competition, mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.
UNIT III
Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. Compatibility of different bioagents.
UNIT IV
Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

Practical
Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen in *in vivo* conditions. Study of cfu/g of formulated products.

Suggested Readings

**PPA 516 INTEGRATED DISEASE MANAGEMENT 2+1**

**Objective**
To emphasize the importance and need of IDM in the management of diseases of important crops.

**Theory**

UNIT I
Introduction, definition, concept and tools of disease management.

UNIT II
Development of IDM – basic principles, biological, chemical and cultural disease management, their implications and limitations.

UNIT III
IDM in important crops- rice, wheat, cotton, sugarcane, rapeseed, mustard, *kharif* pulses, vegetable crops and fruit crops.

**Practical**
Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM, demonstration of IDM in certain vegetable nursery.

**Suggested Readings**

**PPA 517 EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES 2+1**

**Objective**
To acquaint with the principles of epidemiology and its application in disease forecasting.

**Theory**

UNIT I
Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.

UNIT II
Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.

UNIT III
Survey, surveillance and vigilance, crop loss assessment and models.

UNIT IV
Principles and pre-requisites of forecasting, systems and factors affecting various components of forecastings, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.
Practical:
Measuring diseases, spore dispersal and trapping, weather recording, survey, computerized
data analysis, function fitting, model preparation and validation.

Suggested Readings
Campbell CL & Madden LV. 1990. *Introduction to Plant Disease Epidemiology*. John Wiley
& Sons. New York
Laurence VM, Gareth H & Frame Van den Bosch (Eds.). *The Study of Plant Disease
Epidemics*. APS, St. Paul, Minnesota.
Press, New York.
Press, London.

PPA 518    POST HARVEST DISEASES     1+1
Objective
To acquaint with post harvest diseases of agricultural produce and their ecofriendly
management.
Theory
UNIT I
Concept of post harvest diseases, definitions, importance with reference to environment and
health.
UNIT II
Types of post harvest problems both by biotic and abiotic causes.
UNIT III
Factors governing post harvest problems both as biotic and abiotic, role of physical
environment, agro-ecosystem leading to quiescent infection, operational mechanisms and
cultural practices in perpetuation of pathogens, pathogens and antagonist and their
relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases.
UNIT IV
Integrated approach in controlling diseases and improving the shelf life of produce with
special reference to mycotoxicogenic fungi, knowledge of Codex Alimentarius.
Practical:
Isolation characterization and maintenance of pathogens, role of different storage conditions
on disease development. Comparative efficacy of different chemicals, fungicides,
phytoextracts and bioagents.
Suggested Readings
New Delhi.

PPA 519/ ENT 520  PLANT QUARANTINE      2+0
Objective
To acquaint the learners about the principles and the role of Plant Quarantine in containment
of pests and diseases, plant quarantine regulations and set-up.
Theory
UNIT I
Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.
UNIT II
UNIT III
Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfection/salvaging of infected material.
UNIT IV
WTO regulations; non-tariff barriers; Pest risk analysis. Sanitary and Phytosanitary measures.
Suggested Readings

PPA 601     ADVANCED MYCOLOGY    2+1
Objective
To acquaint with the latest advances in Mycology.
Theory
UNIT I
General introduction, historical development and advances in mycology.
UNIT II
Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy.
UNIT III
Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.
UNIT IV
Population biology, pathogenic variability/vegetative compatibility.
UNIT V
Practical
Suggested Readings
Objective
To educate about the advanced techniques and new developments in the field of Plant Virology.

Theory
UNIT I
Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.

UNIT II
Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

UNIT III
Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty-, bromo, cucummo, ilar and tospoviruses.

UNIT IV
Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

UNIT V
Viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.

UNIT VI
Techniques and application of tissue culture.

Practical
Purification of virus(es), SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, PCR application.

Suggested Readings
Objective
To provide knowledge about the latest advances in phytobacteriology.

UNIT I

UNIT II
Current trends in taxonomy of phytopathogenic procarya.

UNIT III
Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*). UNIT IV
Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT V
Molecular variability among phytopathogenic procarya and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology. UNIT VI
Beneficial procaryotes - Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical
Pathogenic studies and race identification; Gram, Capsule, Endospore and Flagellar staining; test for secondary metabolite production, cyanides, EPS, siderophore; molecular tools to identify bacteria.

Suggested Readings
Theory

UNIT I
Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT II
Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

UNIT III
Induction of defense responses- pathogenesis related proteins, HR, reactive oxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

UNIT IV
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.

UNIT V
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, Plasmids extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

Suggested Readings

PLANT PATHOLOGY

List of Journals
- Annual Review of Phytopathology – Annual Reviews, Palo Alto, California
- Annual Review of Plant Pathology - Scientific Publishers, Jodhpur
- Canadian Journal of Plant Pathology - Canadian Phytopathological Society, Ottawa
- Indian Journal of Biotechnology - National Institute of Science Communication and Information Resources, CSIR, New Delhi
- Indian Journal of Mycopathological Research- Indian Society of Mycology, Kolkata.
- Indian Journal of Virology - Indian Virological Society, New Delhi
- Indian Phytopathology - Indian Phytopathological Society, New Delhi
- Journal of Mycology and Plant Pathology - Society of Mycology and Plant Pathology, Udaipur
- Journal of Phytopathology - Blackwell Verlag, Berlin
- Mycologia - New York Botanical Garden, Pennsylvania
- Mycological Research - Cambridge University Press, London
- Physiological Molecular Plant Pathology - Academic Press, London
Suggested Broad Topics for Master’s and Doctoral Research

- Pathogenesis and characterization of plant pathogens
- Survey and surveillance
- Induction of resistance using biotic and abiotic elicitors
- Variability in plant pathogens
- Plant-Virus-Vector relationships
- Genome organization of plant pathogens
- Dynamics of plant pathogen propagules and their biology
- Molecular tools in disease diagnosis
- Molecular mechanisms of pathogenesis in crops and seeds
- Rhizosphere in pathogenesis of seed-borne plant pathogens
- Transgenic resistance
- Development of disease prediction models in disease forecasting
- Integrated Disease Management
- Molecular Taxonomy of different plant pathogens
- Development of Rapid Diagnostic methods
- Development and Formulation of Improved Biocontrol Agent