

# 19 Plant Pathology

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## TRIMESTER WISE DISTRIBUTION OF COURSES

### I TRIMESTER

		L	P
PL PATH 501	MYCOLOGY	2	1
PL PATH 502	PLANT VIROLOGY	2	1
PL PATH 503	PLANT BACTERIOLOGY	2	1
PL PATH 505	DETECTION AND DIAGNOSIS OF PLANT DISEASES	1	2
PL PATH 507	DISEASES OF FIELD AND MEDICINAL CROPS	2	1
PL PATH 508	DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS	2	1
PL PATH 510	SEED HEALTH TECHNOLOGY	2	1
PL PATH 511	CHEMICALS IN PLANT DISEASE MANAGEMENT	2	1
PL PATH 516	PRINCIPLES AND PRACTICES OF IDM/IPM	3	2
PL PATH 691	SEMINAR	1	0

### II TRIMESTER

AGR 011	CROP DISEASES AND THEIR MANAGEMENT	1	1
PL PATH 504	PRINCIPLES OF PLANT PATHOLOGY	3	0
PL PATH 506	PRINCIPLES IN PLANT DISEASE MANAGEMENT	2	1
PL PATH 509	DISEASES OF VEGETABLES AND SPICE CROP	2	1
PL PATH 521/ AC 512/ ENT 512/ NEMA 513/ MB 512	NANOTECHNOLOGY IN CROP PROTECTION	2	1
PL PATH 515	BIOCONTROL OF PLANT DISEASES	2	1
PL PATH 517	MUSHROOM PRODUCTION TECHNOLOGY	2	1
PL PATH 601	ADVANCED MYCOLOGY	2	1
PL PATH 602	ADVANCED VIROLOGY	2	1
PL PATH 603	ADVANCED BACTERIOLOGY	2	1
PL PATH 607/ ENT 611	PLANT HEALTH DIAGNOSTICS AND MANAGEMENT	2	2
PL PATH 691	SEMINAR	1	0

### III TRIMESTER

<b>PL PATH 512</b>	ECOLOGY OF SOIL BORNE PLANT PATHOGENS	2	1
<b>PL PATH 513</b>	DISEASE RESISTANCE IN PLANT	2	0
<b>PL PATH 514</b>	INSECT VECTOR OF PLANT VIRUSES AND OTHER PATHOGENS	1	1
<b>PL PATH 518</b>	EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES	2	1
<b>PL PATH 519</b>	POST HARVEST DISEASES	2	1
<b>PL PATH 520</b>	PLANT QUARANTINE	2	0
<b>PL PATH 604</b>	MOLECULAR BASIS OF HOST PATHOGEN INTERACTION	2	1
<b>PL PATH 605</b>	PRINCIPLES AND PROCEDURES OF CERTIFICATION	1	0
<b>PL PATH 606</b>	PLANT BIOSECURITY AND BIO SAFETY	2	0
<b>PL PATH 691</b>	SEMINAR	1	0

#### Core Courses

**M.Sc.:** PL PATH 501, PL PATH 502, PL PATH 503, PL PATH 506

**Ph.D.:** PL PATH 601, PL PATH 602, PL PATH 603

# PLANT PATHOLOGY

**Major Fields :** Mycology  
Fungal Pathology  
Plant Bacteriology  
Plant Virology

**Minor Fields :** Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.

M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

## DESCRIPTION OF COURSES

### AGR 011 CROP DISEASES AND THEIR MANAGEMENT

(1L+1P) II

#### Objective

To provide basic knowledge on the plant diseases and their management caused by fungi, bacteria and viruses.

#### Theory

##### UNIT I

Milestones in Plant Pathology and common terminology, Economic importance and classification of plant diseases, Symptoms produced by plant pathogens, Koch's postulates and epidemiology

##### UNIT II

Historical development in Plant Bacteriology, Structure and classification of phytopathogenic bacteria

##### UNIT III

Mile stone in Plant Virology and symptoms of plant virus infections, Morphology and transmission of plant viruses

##### UNIT IV

Fungal diseases of wheat and rice and their management, Fungal diseases of maize and their management, Fungal diseases of pulses and oilseeds and their management, Fungal diseases of vegetables and fruits and their management

##### UNIT V

Diseases caused by bacteria in rice, mango, citrus, and their management, Diseases caused by bacteria in cotton and temperate fruits and their management

##### UNIT VI

Detection of plant viruses. Viral diseases and their management, Important viral diseases of plant and their management

#### Practicals

Identification of fungi, bacteria, fungal diseases, bacterial diseases, Isolation of fungi, bacteria

## Suggested Readings

- Agrio, G.N. 2004. Plant Pathology, Fifth Edition, Academic Press, USA.  
Boss, L. 1999. Plant Viruses, Unique and Intriguing Pathogens, a text book of plant virology.  
Verma, J.P. 2006. The Bacteria, Malhotra Publishing House, New Delhi.

## PL PATH 501 MYCOLOGY

(2L+1P) II

### Objective

To provide basic information regarding, nomenclature, historical development, classification of fungi. Different structures produced by fungi and their identification.

### Theory

#### UNIT I

Historical introduction to Mycology, definition of different terms, basic concepts.

#### UNIT II

Importance of Mycology in Agriculture, relation of fungi to human affairs, history of mycology.

#### UNIT III

Morphology of reproductive structures and conidiogenous cells, Spore types, Saccardo's spore grid, groups and its taxonomic bearing, Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

#### UNIT IV

The comparative morphology, ultrastructure, characters of different groups of fungi up to generic level: (a) Myxomycota and (b) Eumycota- i) Mastigomycotina ii) Zygomycotina, iii) Ascomycotina, iv) Basidiomycotina, v) Deuteromycotina. Lichens types and importance, fungal genetics and variability in fungi

### Practicals

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

## Suggested Readings

- Agrios, G.N. 2004. *Plant Pathology*. Fifth Edition, Academic Press, USA.  
Alexopoulos, J., Mims, C.W. and Blackwell, M. 1996. *Introductory Mycology* (Fourth Edition), J. Wiley & Sons, New York.  
Barnet and Hunter. 1972. *Illustrated Genera of Imperfect Fungi*. Burgess Publishing Company, Minneapolis, Minnesota, U.S.A.  
Gilmen, J.C. 1957. *A manual key of soil fungi*. Ames, IA, USA: Iowa State University Press. USA.  
Mehrotra, R.S. and Aneja, K.R. 1998. *An Introduction to Mycology*. New Age International, New Delhi.  
Mehrotra, R.S. 1991. *Plant Pathology*. Tata McGraw Hill Publishing Company Ltd. New Delhi.  
Nagamani, Kunwar and Manoharchary. 2006. *Handbook of soil fungi*. IK International Pvt. Ltd., New Delhi.  
Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*, Oxford and IBH Publishing Co Pvt. Ltd., New Delhi.  
Tsuneo, Watanable. 2002. *Pictorial Atlas of Soil and Seed Fungi*. CRC Press, USA.

## PL PATH 502 PLANT VIROLOGY

(2L+1P) I

### Objective

To provide knowledge in history of plant viruses, their biological properties, diagnostics and management

### Theory

#### UNIT I

History of plant viruses, composition and structure of viruses.

#### UNIT II

Symptomatology of important plant viral diseases, transmission, chemical and physical properties, host virus interaction, virus vector relationship.

#### UNIT III

Virus nomenclature and classification, Structure of plant virus, genome organization, replication and movement of viruses.

#### UNIT IV

Isolation and purification, estimation of virus titre and purity, electron microscopy, protein and nucleic acid based diagnostics.

#### UNIT V

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

#### UNIT VI

Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

### Practicals

Study of symptoms caused by viruses, transmission, assay of viruses, physical properties, purification, method of raising antisera, serological tests, electron microscopy, spectrophotometry and ultratomy, PCR, preservation of virus specimens, preparation of herbrium

### Suggested Readings

Agrios, G.N. 2004. *Plant Pathology*. Fifth Edition, Academic press, USA

Boss, L. 1999. *Plant Viruses*, Unique and Intriguing pathogens, a text book of plant virology. Backhuys Publishers, Leiden, The Netherlands

Roger, Hull. 2002. *Matthews' Plant Virology*. Fourth Edition, Academic press, USA

Walky, D.G.A. 1985. *Applied Plant Virology*. Longman, London, UK

## PL PATH 503 PLANT BACTERIOLOGY

(2L+1P) I

### Objective

To provide basic knowledge on biology, classification and nomenclature, survival, preservation of phytopathogenic prokaryotic bacteria, phytoplasma, bdellovibrions and bacteriophages.

## Theory

### UNIT I

History of bacteriology, nomenclature and classification of bacteria, bacteriophages-morphology, types and uses, mycoplasma and bdellovibrios

### UNIT II

Bacterial cell-morphology, organelles and their functions, cell wall structure and chemistry, endospore and its formation, composition and function, flagellar structure, arrangements, movements

### UNIT III

Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya.

### UNIT IV

Plasmids, bacterial conjugation, transduction and transformation

### UNIT V

Important bacterial diseases: Bacterial leaf blight of rice, bacterial blight of pomegranate, cotton bacterial blight, bacterial wilt of solanaceous vegetables, soft rot of vegetables and black rot of crucifers.

### UNIT VI

Management strategy for bacterial diseases, survival and dissemination of bacteria.

## Practicals

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological characterization, isolation of plasmid and use of antibacterial chemicals/antibiotics

## Suggested Readings

Bradbury, J.F. and Saddler, G.S. *A Guide to Plant Pathogenic Bacteria*. CABI.

Frobisher, M. 1944. *Fundamentals of Bacteriology*, W. B. Saunders Company.

Gerhardt, P., Murray, R.G.E., Wood, A.W. and Krieg, N.R. 1994. *Methods for Molecular Bacteriology*, American Society of Microbiology, Washington, DC

Jackson, R.W. 2009. *Plant Pathogenic Bacteria: Genomics and Molecular Biology*, Caister Academic Press, USA.

Salle, A.J. 1967. *Fundamental Principles of Bacteriology*, Mc Graw-Hill, Inc., New York.

Schaad, N.W., Jones, J.B. and Chun, W. 2001. *Laboratory Guide for Identification of Plant Pathogenic bacteria*, APS Press, St. Paul, Minnesota.

Verma, J.P. 2006. *The Bacteria*, Malhotra Publishing House, New Delhi.

Wistreich, G.A. and Lechtman, M.D. 1984. *Microbiology* (4th edit.). Mac Millan Publishing House, New York.

## PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY

(3L+0P) II

## Objective

To appraise the principles and methodologies used in Plant Pathology

## Theory

### UNIT I

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases, disease caused by phanerogamic parasites

### UNIT II

Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development, modern detection methods.

### 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, induced resistance, 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.

### UNIT V

Disease management strategies.

## Suggested Readings

Robert, D.A. and Boothroyd, C.W. 1984. *Fundamentals of Plant Pathology* (2<sup>nd</sup> edn), 432pp.

Schumann Gail, L. 1991. *Plant Diseases: Their Biology and Social Impact*. APS Press, USA. 397 pp.

Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*, 3<sup>rd</sup> edition, pp. 534. Oxford & IBH Publishing Co. (P) Ltd., New Delhi, Bombay, Calcutta.

Stakman, E.C. and Harrar, J.G. 1957. *Principles of Plant Pathology*, pp. 581. The Ronald Press Co., New York.

Strange, R.N. 1993. *Plant Disease Control-Towards environmentally accepted methods*. Chapman and Hall 2-6, London.

Strobel, G.A. and Mathre, D.E. 1970. *Outlines of Plant Pathology*, pp. 465, Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London, Melbourne.

Tarr, S.A.J. 1972. *Principles of Plant Pathology*. The Macmillan Press. London. pp. 632.

Vidhyasekharan, P. 1993. *Principles of Plant Pathology*, CBS Publishers & Distributors, Delhi. 166pp.

## PL PATH 505 DETECTION AND DIAGNOSIS OF PLANT DISEASES

(1L+2P) I

### Objective

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

### Theory

#### UNIT I

Biological, serological and nucleic-acid based techniques for the detection of virus and virus like pathogens,

## UNIT II

Fungal disease diagnosis-symptomatology, collection of samples and their preservation, Koch's postulates, isolation techniques, purification and single spore isolation, inoculation technique and creation of artificial epiphytotics of fungal pathogens, long term storage and preservation of fungal cultures, molecular detection of fungal pathogens, data collection, compilation and scientific writing

## UNIT III

Symptoms of bacterial diseases and characteristics of phytopathogenic bacteria, isolation of phytopathogenic bacteria from rhizosphere and phyllospheres, bacterial stains and staining methods, techniques for purification and pathogenicity

### Practicals

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens, preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

### Suggested Readings

- Bahadur, P., Singh, R.H., Jain, R.K., Aggarwal, R. and Jayaraman, J. 2000. *Manual on diagnostic techniques in plant pathology*. Venus Printer and Publishers, New Delhi, 62pp.
- Dijkstra, J. and de Jager, C.P. 1998. *Practical Plant Virology: Protocols and Exercises*. Springer Lab Manual, New York, 459pp.
- Duncans, J.M. and Torrance, L. 1992. *Techniques for rapid diagnosis of plant pathogens*. Blackwell Scientific Publications, Oxford, U.K
- Facquet, C.M. 1999. *Taxonomy, classification and nomenclature of viruses*. In encyclopedia of virology (eds. Granoff & Webster), Academic Press, New York, USA, 1730-1756.
- Fox RTV. 1993. *Principles of diagnostic technique in plant pathology*. Cab International, Wallingford, U.K., 224pp.
- Hampton, R., Ball, E. and Bocr, S.D. 1990. *Serological methods for detection and identification of viral and bacterial plant pathogens- a laboratory manual*. APS publication, Minnocsota, USA, 389pp.
- Hull, R. 2002. *Matthews' plant virology*, 4th ed., Academic Press, New York, 1001pp.
- Jones, R.A.C. and Torrance, L. 1986. *Development and applications in virus testing*. AAB publication, Wellesbourne, U.K., 300pp.
- Kado, C.I. and Aggarwal, H.O. 1972. *Principles and techniques in plant virology*. Van Nostrand Reinhold Company, New York, 688pp.
- Martin, R.R., James, D. and Andre, L.C. 2000. *Impacts of molecular diagnostic techniques on plant disease management*. Ann. Rev. Phytopath. 38: 207-239.
- Matthews, R.E.F. 1993. *Diagnosis of plant virus diseases*. CRC press, Boca, Raton, Tokyo, 374pp.



- Noordam, D. 1993. *Identification of plant viruses: methods and experiments*. Cent Agric. Pub. Doc, Wageningen, 207pp.
- Trigiano, R.N., Windham, M.T. and Windham, A.S. 2004 (eds). *Plant Pathology- Concepts and Laboratory Exercises*. CRC Press, Boca Raton, Florida, USA, 413pp.
- Ward, E., Foster, S.J., Fraaije, B.A. and McCartney, H.A. 2004. *Plant pathogen diagnostics: Immunological and nucleic acid based approaches*. Ann. app. Biol. 145: 1-16.
- Webster, C.G., Wylie, S.J. and Jones, M.G.K. 2004. *Diagnosis of plant viral pathogens*. Current Science 86 (12): 1604-1607.

## PL PATH 506 PRINCIPLES IN PLANT DISEASE MANAGEMENT

(2L+1P) II

### Objective

To teach strategies and methods of plant disease management.

### Theory

#### UNIT I

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

#### UNIT II

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.

#### UNIT III

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

### Practicals

*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

- Agrios, G.N. 2004. *Plant Pathology*. Fifth Edition, Academic Press, USA.
- Chaube, H.S. and Pundhir, V.S. 2005. *Crop Disease and Their Management*. Prentice Hall of India Private Limited.
- Das Gupta, M.K. 1994. *Principles of Plant Pathology*. Published by Allied Publishers
- John, A.L. and Dickinson, C.H. 1998. *Plant Pathology and Plant Pathogens*. Wiley-Blackwell.
- Manners, J.G. 1993. *Principles of Plant Pathology*. Cambridge University Press, UK.
- Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*, Oxford and IBH Publishing Co Pvt. Ltd., New Delhi.
- William, E.F. 1982. *Principles of Plant Disease Management*. Academic Press, USA.

**Objective**

To provide knowledge on major diseases and management of field and medicinal crop diseases

**Theory**

UNIT I

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize-economic importance, symptoms and disease cycle, epidemiology and management

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, castor.

UNIT IV

Diseases of Cash crops- cotton, sugarcane.

UNIT V

Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea.

UNIT VI

Medicinal crops- plantago, liquorice, *mulathi*, rosagrass, sacred basil, mentha, *ashwagandha*, *Aloe vera*.

**Practicals**

Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops

**Suggested Readings**

Mishra, A. 2005. *Plant Pathology-Disease and Management*, Agrobios Publishers, India.

Paul Khurana, S.M. 1998. *Pathological Problems of Economic Crop Plants and their management*. Scientific Publishers, Jodhpur, India.

Shahid, Ahmad and Udit, N. 2007. *Eco friendly Management of Plant Diseases*. Daya Publishing House, Delhi, India.

Wang, Guo-Liang and Valent, B. 2009. *Advances in Genetics, Genomics and Control of Rice Blast Disease*, Springer Link, Netherland.

**PL PATH 508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS (2L+1P) I**

**Objective**

To provide knowledge on major diseases of fruits, plantation, ornamental plants and their management

**Theory**

UNIT I

Introduction, symptoms and etiology of different fruit diseases. Factors affecting disease development in fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry,

citrus, mango, grapes, guava, ber, banana, pineapple, papaya, fig, pomegranate, date palm and management of the fruits diseases, post harvest diseases of major fruits in storage and transit

#### UNIT II

Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management.

#### UNIT III

Symptoms and life cycle of pathogens. Factors affecting disease development of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum and their management, post harvest diseases of ornamentals in storage and transit.

### Practicals

Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops, fruits and ornamental plants Collection and dry preservation of diseased specimens of important crops.

### Suggested Readings

- Marshall, E.M., Alois, A.B. and Backman, C.H. 1981. *Fungal wilt diseases of plants*, Academic Press.
- Naqvi, S. and Kluwer. 2004. *Disease of Fruits and Vegetables Diagnosis and Management*. Academic publisher.
- Parvatha Reddy, P. 2010. *Fungal Diseases and Their Management in Horticultural Crops*. Scientific Publication.
- Saharan, G.S. and Metha, N. 2008. *Sclerotinia Disease of Crop Plants; Biology, Ecology and Disease Management*, Springer.
- Sharma, L.R., Sharma, R.C. and Gidwani, M. 1999. *Disease of Horticultural Crops Vegetables, Ornamental and Mushrooms*. Indus Publishing Co.
- Smith, I.M., Dunez, L., Lelliott, R.A., Phillips, D.H. and Archer, S.A. 1988. *European Handbook of Plant Disease*. Blackwell Scientific Publications.
- Steven, T.K., Peter, G. and Albert, O.P. 2007. *Vegetable Disease, A Color Handbook*. Manson Publishing Ltd. London,
- Sharma, Pratibha, Kandhari, J. and Sharma, R.C. 2007. "A practical manual on Diseases of Horticultural Crops.", PG school, IARI, Publication.

## PL PATH 509 DISEASES OF VEGETABLES AND SPICE CROPS

(2L+1P) II

### Objective

To impart knowledge about symptoms, epidemiology of different diseases of Vegetables and spices and their management.

### Theory

#### UNIT I

Nature, prevalence, factors affecting disease development of bulb, leafy vegetable, crucifers, cucurbits and solanaceous vegetables. Diseases of protected cultivation.

## UNIT II

Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceous vegetable crops.

## UNIT III

Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

### Practicals

Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

### Suggested Readings

Dixon, G.R. 1984. *Plant Pathogens and their control in Horticulture*. MacMillan, London

Dixon, G.R. 1981. *Vegetable crop diseases*. MacMillan Publishers Ltd, England.

Hooker, W.J. 1981. *Compendium on Potato diseases*. Minn, APS. USA.

Sherf, A.F. and Mc Nab, A.A. 1986. *Vegetable diseases and their control*. John Wiley and Sons, New York, NY.

Spencer, D.M. 1978. *The Powdery mildews*. Academic Press, New York.

Spencer, D.M. 1981. *The Downy mildews*. Academic Press, London.

Sharma, Pratibha. 2007. *Vegetables: Disease diagnosis and biomanagement*. Ppxii+218 (Aavishkar Publications, Distributors, Jaipur, 218 pp.

Sharma, Pratibha, Kandhari, J. and Sharma, R.C. 2007. "A practical manual on Diseases of Horticultural Crops.", PG school, IARI, Publication

## PL PATH 510/SST 510 SEED HEALTH TECHNOLOGY

(3L+2P) I

### Objective

To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/ losses 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, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. 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. Relationship between seed-borne infection and expression of the disease in the field.

#### Suggested Readings

Agarwal, V.K. and Sinclair, J.B. 1996. *Principles of Seed Pathology. edition*, CRC Press, Inc., Boca Raton, FL.

Karuna, V. 2007. *Seed Health Testing*. Kalyani.

Maude, R.B. 1996. *Seed borne Diseases and Their Control Principles and Practice*. CAB International, Wallingford, Oxon, UK.

Neergaard, P. 1979. *Seed Pathology* Vol. 1. The Macmillan Press. Ltd.

### PL PATH 511 CHEMICALS IN PLANT DISEASE MANAGEMENT

(2L+1P) I

#### Objective

To provide knowledge on the principles and use of chemicals in plant disease management in different crops

#### Theory

##### UNIT I

History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals.

##### UNIT II

Classification of chemicals used in plant disease control and their characteristics.

##### UNIT III

Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.

##### UNIT IV

Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.

##### UNIT V

Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides.

##### UNIT VI

General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

#### Practicals

Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, bactericides and nematicides; *in vitro* evaluation techniques, preparation of different

concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; persistence, compatibility with other agro-chemicals; detection of naturally occurring fungicide resistant mutants of pathogen; methods of application of chemicals

### Suggested Readings

- Farm Chemicals Handbook. (A global guide to crop protection produced yearly with information on all pesticides plus fertilizers, sources and regulatory information. Available at [www.meisterpro.com](http://www.meisterpro.com))
- Fry, W.E. 1982. *Principles of Plant Disease Management*. Academic Press, New York, NY
- Green, M.B. and Spilker, D.A. 1986. *Fungicide Chemistry: Advances and Practical Applications* (ACS Symposium Series, 304). American Chemical Society, Oxford University Press
- Hewitt, H.G. 1998. *Fungicides in Crop Protection* CABI Publishing, CAB International, Oxon, United Kingdom.
- Hutson, D. and Miyamoto, J. 1999. *Fungicidal Activity: Chemical and Biological Approaches to Plant Protection*, John Wiley & Sons. New York,
- Koller, W. 1992. *Target Sites of Fungicide Action* CRC Press. Boca Raton, FL
- Nene, Y.L. and Thapliyal, P.N. 1993. *Fungicides in Plant Disease Control*. Science Publishers, Inc. India.
- Page, B.G. and Thomson, W.T. 2003. *The 2003 Newly Revised Insecticide, Herbicide, Fungicide Quick Guide*. Kovak Books, Bakersfield, CA
- Smith, I.M. 1986. *Fungicides for Crop Protection: 100 Years of Progress*. International Specialized Book Service, Portland, OR.

## PL PATH 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS

(2L+1) III

### Objective

To impart 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. Types of biocontrol agents.

#### UNIT II

Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.

#### UNIT III

Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.

### Practicals

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. Isolation and identification of different biocontrol agents.

## Suggested Readings

- Frank, N.M. and Loper, J.E. 1999. *Soil borne Plant Diseases Caused by Pythium spp.: Ecology, Epidemiology, and Prospects for Biological Control*. Critical Reviews in Plant Sciences **18**: 111 – 181.
- Johnson, L.F. and Curl, E.A. 1971. *Methods for research on the ecology of soil-borne plant pathogens*. Burgess International Group Inc.
- Oort, A.J.P. 2008. *The Ecology of Soil-borne Pathogens*. EPPO Bulletin **2**:121-128.

## PL PATH 513 DISEASE RESISTANCE IN PLANTS

(2L+0P) III

### Objective

To impart knowledge on 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 infectious 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

- Agrios, G.N. 2005. *Plant Pathology*, Academic Press.
- Callow, J.A. and Green, J.R. 1992. *Perspectives in plant cell recognition*, Cambridge University Press.
- Dasgupta, M.K. 1988. *Principles of Plant Pathology*. Allied Publisher Private Limited. New Delhi, India.
- Dickinson, M. 2003. *Molecular Plant Pathology*, Taylor & Francis.
- Garraway, M.O. 1984. *Fungal nutrition and physiology*, Evans, Robert Church, Wiley,
- Gurr, S.J., McPherson, M.J., Bowles and Dianna, J. 1992. *Molecular Plant Pathology: A practical approach*. IRL Press at Oxford University Press.
- Gurr, S.J., McPherson, M.J. and Bowles, D.J. 1993. *Molecular Plant Pathology: A Practical Approach* Volumes I and II as a Set by Oxford University Press, USA
- Harshberger, J.W. 1917. *A text-book of Mycology and Plant Pathology*. P. Blakiston's Son & Co.

Lambert, M., Surhone, Miriam T. and Timpledon, S. 2009. *Plant Physiology: Plant, Plant Morphology, Ecology, Phytochemistry, Cell Biology, Molecular Biology, Photosynthesis, Herbivore, Plant Pathology, Plant Nutrition, Biological Pigment*. Betascript Publishers

Lucas, J.A. and Dickinson, C.H. 1997. *Plant Pathology and plant pathogens*, Wiley-Blackwell

Orcutt, D.M. and Nilsen, E.T. 2000. *The Physiology of Plants under Stress: Soil and Biotic factors*. John Wiley and Sons.

Singh, R.P. and Singh, U.S. 1995. *Molecular methods in plant pathology*. CRC press, London.

Strange, R.N. 2003. *Introduction to Plant Pathology*. John Wiley and Sons.

## **PL PATH 514 INSECT VECTOR OF PLANT VIRUSES AND OTHER PATHOGENS**

**(1L+1P) III**

### **Objective**

Provide knowledge on transmission of viruses by vectors, their biological & molecular interaction and management

### **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.

### **Practicals**

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**

Basu, A.N. and Giri, B.K. 1993. *Essentials of Virus, Vectors and Plant Diseases*. Wiley, Eastern Limited, New Delhi. 242 pp.

Harris, K.F. and Maramorosch, K. 1980. *Vectors of plant pathogens– Academic Press*.

Roger, Hull. 2002. *Mathew's Plant Virology*. Academic Press, London. 1001pp



**Objective**

To provide knowledge on principles, methods, mechanism of bio-control agents and their use against 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

Characterization and evaluation of bioagents, case example of successful bioagents (bacterial and fungal bioformulation), variability and characterization of bioagents important characteristics like competitive saprophytic ability, pesticide resistance

## UNIT IV

Commercial production of antagonists, Improvisation, genetic engineering, delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

**Practicals**

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

**Suggested Readings**

- Baker, E.F. and James, R.C. 1982. *Biological Control of Plant Pathogens*. American Phytopathological Society.
- Boland, G.J. and David, L. 1998. *Plant microbe interactions and Biological Control*. Kuykendall Marel Dekker, INC.
- Ciancia, A. and Mukerji, K.J. 2007. *General Concepts of Integrated Pest and Disease Management*. Edited Published by Springer.
- Cincholkar, S.B. and Mukherji, K.G. 2007. *Biological Control of Plant Diseases*. Hawarth Food and Agricultural products.
- Gnanamanickam, S.S. 2002. *Biological control of crop Disease*. Kuykendall Marel Dekker, INC.
- Ramanujam, B. and Rabindra, R.J. 2006. *Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India*. Precision Fototype Services Bangalore.
- Singh, S.P. and Hussanini, S.S. 1998. *Biological Suppression of Plant Disease, Phytoparasitic Nematodes and Weeds*. Precision Fototype Services Bangalore.

**Objective**

To impart knowledge to the students on principles and practices of integrated disease/ pest management in different crops.

**Theory**

## UNIT I

History, concept and philosophy of IDM/IPM, Current status (National and International) of IPM implementation.

Agricultural Pests of national importance, Major past epidemics, Survey and Surveillance and crop loss assessment; Important Weeds and their management, Agroecosystems, habitat management and conservation of natural enemies and their significance in IDM/IPM, Cultural, Mechanical and Physical Control Measures, genetic resistance / GM crops with special emphasis on cotton, rice, maize, soybean, tomato, canola etc. scouting / Economic Injury Levels / Action thresholds / Pheromone Monitoring and mass trapping of pests of rapeseed mustard, pearl millet, vegetable and fruits

## UNIT II

Bio-pesticides / bio-agents / botanicals / Quality parameters, registration, mass production and their integrated field use against different insect pests/diseases/nematodes etc.

## UNIT III

Chemical control: Major pesticides and their classification, Pesticide Acts, Registration, Growth of pesticide industry, dosage calculation, pest resurgence, Insecticide Resistance Management, IDM/IPM compatible Pesticides.

## UNIT IV

Concept of environmental Impact Quotient (EIQ), regulatory and Quarantine Measures, Quality control of IPM Inputs, forecasting of important pests in the country and Pest Risk Analysis

## UNIT IV

Base line studies for identification of crop based problems and socio-economic benchmarks; synthesis and development of IDM/IPM modules, data recording, on-farm validation and promotion of IPM, including important case studies and impact analysis, expert Systems in IDM/IPM, On-line Monitoring, role of media and information technology including Networking solutions; future trends in Pest management

**Practicals**

Diagnosis of key pests and their natural enemies, demonstration of field preparation, cultural practices such as solarization / mulching etc., pesticide dosage calculations and Economic threshold levels for major pests ; determination of Environmental Impact Quotient (EIQ), preparation methods for Neem based and other locally produced IPM inputs/formulations and their use, bioassay / field evaluation methods for major biocontrol agents and other eco-friendly inputs, Scouting/ Agroecosystem analysis and use of traps / lures mass production technologies for bioagents, exercises in synthesis of IDM/IPM modules, procedures and methodology for IDM/IPM validation/ implementation of IDM/IPM programmes: collection of baseline information, field Excursion to IDM/IPM validation sites/fields, rice, vegetables, cotton, statistical Procedures in IPM, Forecasting/

Forewarning / Simulation Models, use of Information Technology in IDM/IPM and decision support system, exercise in Pest Risk Analysis, GIS/GPS in digitization of hotspot maps

### **Suggested Reading**

- Ca, Romeno and Rehman. T. Elsevier. 2003. *Multiple criteria analysis for Agricultural decision*. NY.
- Claude Faurie et al. 2001. *Ecology: Science and Practice*. Oxford & IBM Pub. Co (P) Ltd.
- David Dent. Chapman and Hall, 1995. *Integrated Pest Management*, New York.
- Insect Ecology. Schowalter, T.D. Academic Press. USA. 2000.
- Marcel Dekker, J.R. 1999. *Handbook of Pest Management*. Ruberson Inc. USA.
- Koul, O., Dhaliwal, G.S. and Cuperus, G.W. 2004. *Integrated Pest Management*. CABI.
- Maredia, K.M., Aakono, V. and Mota, M. 2003. *IPM in the Global Arena*.– Sanchez (Eds.) CABI Publication.
- Nematology: Advances and Perspectives*. Vol.2. Nematode Management and Utilization CABI.
- Prem Kishore, 2004. *Dictionary of Integrated Pest Management*, Westville, New Delhi.
- Pullin, A.S. 2002. *Conservation Biology*. Cambridge University Press U.K.
- Quality Control and Production of Biological Control agents: Theory and Test Procedures*. CABI.
- Singh, Amerika, Sardana, H.R. and Sabir, N. 2004. *Validated IPM technologies*. NCIPM, (Eds.) New Delhi,
- Singh, Amerika, Sharma, O.P. and. Garg, D.K. 2005. *Integrated Pest Management: Principles and Applications Volumes I & II*. (Eds.) CBS Publishers & Distributors, New Delhi.
- Thomas S, Bellows and Fisher, T.W. 1999. *Handbook of Biological Control*, Academic Press, USA.

## **PL PATH 517 MUSHROOM PRODUCTION TECHNOLOGY**

**(2L+1P) II**

### **Objective**

Biodiversity in mushroom fungi, edible, poisonous and medicinal mushrooms. Structure and classification of mushrooms and their economic importance. Spawn production technology and cultivation of different types of mushrooms under seasonal and environmentally controlled conditions.

### **Theory**

#### UNIT I

Historical development of mushroom cultivation and present status, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms.

#### UNIT II

Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab.

#### UNIT III

Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate.

#### UNIT IV

Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO<sub>2</sub>, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus*, *Pleurotus* sp., *Calocybe indica*, *Lentinus edodes* and *Ganoderma lucidum*.

#### UNIT V

Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.

#### Practicals

Preparation of spawn, compost, spawning, casing, harvesting and post harvest handling of edible mushroom; identification of various pathogens, competitors of various mushroom

#### Suggested Readings

Chang, S.T. and Miles, P.G. 1989. *Edible Mushrooms and their cultivation*. CRC Press Boca Raton, 345 pp.

Kaul, T.N. 1997. *Introduction to Mushroom Science (Systematic)*. Oxford & IBM Publishing Co. Ltd. Calcutta

Kaul, T.N. 2002. *Biology and Conservation of Mushrooms*. Oxford & IBM Publishing Co. Ltd.

Kaul, T.N. and Dhar, B.L. 2007. *Biology cultivation and Edible Mushrooms*. Westville Publishing House, New Delhi.

### **PL PATH 518 EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES (2L+1P) III**

#### Objective

To provide knowledge 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.

## Practicals

Measuring diseases, spore dispersal and trapping, weather recording, survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

## Suggested Readings

- Campbell, C.L. and Madden, L.V. 1990. *Introduction to Plant Disease Epidemiology*. John Willey & Sons, New York.
- Cooke, B.M., Jones, D.G. and Kaye, B. 2006. (eds). *A textbook 'The Epidemiology of Plant Diseases*, Springer, pp 456.
- Davis, P.M. 1986. *Statistics for describing populations*. In : Handbook of Sampling methods for Arthropods in Agriculture (eds L. P. Pedigo and Buntin, G. D.) CRC Press, pp. 34-53.
- Gilligan, C.A. and Kleczkowski, A. 1997. *Population dynamics of botanical epidemics involving primary and secondary infection*. Phil Trans R Soc London B 352: 591-608.
- Gilligan, C.A., Gubbins, S. and Simons, S.A. 1997. *Analysis and fitting of an SIR model with host response to infection load for a plant disease*. Phil Trans R Soc London B 352: 353-364.
- Jeger, M.J. 1986. *The potential for an analytic compared with simulation approaches to modeling in plant disease epidemiology*. In: Plant Disease Epidemiology, vol I eds Leonard, K. J. and Fry, W. E., Mcmillan, NewYork, pp372.
- Madden, L.V. and Hughes, G. 1995. *Plant disease incidence: distributions, heterogeneity, and temporal analysis*. Annu Rev Phytopathol 33: 529-564.
- Nutter, F.W. Jr and Litrell, R.H. 1996. *Relationships between defoliation, canopy reflectance and pod yield in the peanut –late leaf spot pathosystem*. Crop Protection 15: 135-142.
- Nutter, F.W., Esker, Coelho, Netto, P.D. and Rosalee, A. 2006. *Disease assessment concepts and the advancements made in improving the accuracy and precision of plant disease data*. Euro J Plant Path 115: 95-103.
- Roelfs, I., Scherm, H. and Iersel, M.W. 2004. *Photosynthesis of Blueberry Leaves as Affected by Septoria Leaf Spot and Abiotic Leaf Damage*. Plant Dis. 88: 397-401.
- Teng, P.S.1981. *Construction of predictive models: II. Forecasting crop losses*. In: Advances in Plant pathology vol 3. Mathematical Modelling of Crop Disease ed Gilligan, C. A. Academic Press, pp 179-206.
- West, J.S., Bravo, C., Oberti, R., Lemaire, D., Moshou, D. and McCartney, H.A. 2004. *The potential of optical measurements for targeted control of field crop diseases*. Annu Rev Phytopathol 35: 593-615.
- Zhang, X.S., Holt, J. and Colvin, J. 2000. *A general model of plant-virus disease infection incorporating vector aggregation*. Plant Pathol 49: 435-444.

## PL PATH 519 POST HARVEST DISEASES

(2L+1P) III

### Objective

To provide knowledge on post harvest diseases, factors governing post harvest problems, stages of diseases development, integrated approach in disease management and quality control

## Theory

### UNIT I

Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as preharvest and post-harvest, merits and demerits of biological/phytoextracts in controlling post-harvest diseases.

### UNIT II

Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.

### 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, comparative approaches to control of plant pathogens by resident and introduced antagonists. Isolation, characterization and maintenance of pathogens, role of different storage.

### UNIT IV

Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarius for each product and commodity.

## Practicals

Isolation characterization and maintenance of pathogens, role of different storage conditions on disease development, application of antagonists against pathogens *in vivo* and *in vitro* conditions. Comparative efficacy of different chemicals, fungicides, phytoextracts and bioagents.

## Suggested Readings

- Benkeblia N and Shiomi N. 2006. *Advances in Post harvest Technology of Horticultural crops*. Research Signpost, India.
- Narayanasamy, P. 2005. *Post harvest pathogens and disease management*. John Wiley & Sons, Inc.
- Prusky, D. and Gullino, M.L. 2009. *Post harvest Pathology* Vol.2. Springer, New York, USA.
- Calderon, M. and Barkai-Golan, R. 1990. *Food preservation by modified atmospheres*. CRC Press, Boca Raton, FL.
- Sharma, N. 2005. *Post harvest diseases of Horticulturable perishables*. Indus seller.
- Snowdon, A. 1990. *A colour Atlas of Post harvest diseases and disorders* Vol. 1 & 2. CRC Press.

## PL PATH 520 PLANT QUARANTINE

(2L+0P) III

(To be operated by NBPGR)

## Objective

To provide knowledge on the principles and the role of Plant Quarantine at National and International level.

## 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

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

### 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 disinfestation/salvaging of infected material.

### UNIT IV

WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

## Suggested Readings

Ebbels, D.L. 2003. *Principles of Plant Health and Quarantine* CABI, Wallingford, Oxon, UK.

Harber, R. 1983. *International Plant Quarantine Treatment manual*. Food and Agriculture Organization of the United Nations, Rome .

Sharp, J.L., Gaffney, J.J., Moss, J.I. and Gould, W.P. 1991. *Hot air treatment device for Quarantine research*. J. Econ. Entomol. 84: 520-527.

## PL PATH 521/AC 512/ENT 512/NEMA 513/MB 512 NANOTECHNOLOGY IN CROP PROTECTION (2L+1P) II

### Objective

To enable students to acquire expertise and skill to develop agrochemical formulations with nanoparticles and acquaint them with nanotechnology

## Theory

### UNIT I

Introduction: History of nanotechnology – Origin, fundamental concepts, and molecular perspective, Nanomaterials: formation, stability and quality. Application of nanotechnology in agricultural chemicals, bio-pesticides, carriers, surfactants, formulation auxiliaries plant nutrients and related materials

### UNIT II

Effect of bioactive nano-materials on insect pests and beneficial insects.

### UNIT III

Different types of nano compounds and their use in the management of plant disease incited by pathogenic fungi, bacteria and viruses with special reference to copper, sulfur etc, Interaction of bioactive nano- materials on plant pathogens including fungi, bacteria, virus etc

#### UNIT IV

Nematodes: Plant pathogenic and entomopathogenic nematodes, life cycle, Efficacy of nano chemicals against nematodes, Biotoxins from *Xenorhabdus* and *Photorhabdus* Identification and quantification of biotoxins effective in nano-doses.

#### UNIT V

Microbes: Microbes of agricultural importance. Life cycle: genesis, growth, reproduction, identification and quantification. Nanotechnological application in microbiology

#### UNIT VI

Nanomaterials: size, characterization, formation and stability. Tools for identification and quantitation: Particle size analyzers, nanosizers, scanning microscopes of different types. Development of nano-materials: Bottom-up and top-down approach: Chemical synthesis, sol-gel and emulsion polymerization techniques, wet milling, nano-milling. Stabilization of nanoparticles. Regulations and quality control.

### Practicals

Identifications, and quantification of agricultural chemicals in conventional and nano formulations, Size determination, Quality of nano-formulations: Cold test, emulsion stability test, and suspensibility tests

### Suggested Reading

Allhoff, Fritz and Lin, Patrick (Eds) 2009. *Nanotechnology and Society*, ISBN: 978-1-4020- 6208-7 Springer Publications, UK

## PL PATH 601 ADVANCED MYCOLOGY

(2L+1P) II

### Objective

To provide deep insight of fungal systematic, fungal structures and their role in identification. Recent developments in fungal classification including chemo and molecular taxonomy. Genetics and variability among fungi and their economic and industrial importance.

### 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

Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.



## Practicals

Study of conidiogenesis- phialides, porospores, arthospores. Study of fruit bodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi.

## Suggested Readings

Agrios, G.N. 2004. *Plant Pathology*. Fifth Edition, Academic Press, USA.

Bos, C.J. 1996. *Fungal Genetics: Principles and Practice*. Marcel Dekker, Inc.: New York.

Chawla, H.S. 2004. *Introduction of Plant Biotechnology*. Science publisher, Inc. Enfield, NH, USA.

Frisvad, J.C., Bridge, P.D. and Arora, D.K. 1998. *Chemical Fungal Taxonomy*. Marcel Dekker. Inc., New York.

Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1993. *Microbiology: Concept and Application*. McGraw-Hill, Inc. New York.

Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*, Oxford and IBH Publishing Co Pvt. Ltd., New Delhi.

## PL PATH 602 ADVANCED VIROLOGY

(2L+1P) II

### Objective

To provide knowledge in recent advancement in study of plant viruses and their management

### Theory

#### UNIT I

Introduction to Advanced Virology Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and 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

Production PAb and hybridoma, nucleo-based diagnostic technique, 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, Rolling Circle replication.

#### UNIT III

Genome organization, gene expression in Gemini viruses, mechanism of 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

Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.

#### UNIT VI

Techniques and application of tissue culture. Origin, evolution and interrelationship with animal viruses.

## Practicals

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, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

## Suggested Readings

Fauquet, C.M., Mayo, M.A., Maniloff, J., Desselberger, U. and Ball, L.A. 2005. *Virus Taxonomy:VIII*, Elsevier-Academic Press, London.

Mahy, B.W.J. and Van Regenmortel, M.H.V. 2008. *Encyclopedia of Virology*-Third edition, Elsevier-Academic Press, London.

Roger, Hull. 2004. *Matthews' Plant Virology* (II<sup>nd</sup> Edition). Academy Press, London, UK.

## PL PATH 603 ADVANCED BACTERIOLOGY

(2L+1P) II

### Objective

To provide advanced knowledge on characterization, identification of bacteria, pathogenesis, mechanism of disease development and recent approach in bacterial disease management.

### Theory

#### UNIT I

Nomenclature, characteristics and classification of bacteria, Ultrastructures and biology of bacteria.

#### UNIT II

Fastidious bacteria, mechanism of soft rot (*Erwinia* spp.) development, mechanism of crown gall formation (*Agrobacterium tumefaciens*), Mechanism of wilt (*Ralstonia solanacearum*) development.

#### UNIT III

Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development, epidemiology in relation to bacterial plant pathogens

#### UNIT IV

Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, effector protein, survival, colonization ability of bacteria, bacterial EPS and their role as disease determinant

#### UNIT V

Plasmid biology, 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

Polyclonal and monoclonal antibodies against phytopathogenic bacteria, PCR based detection of plant pathogenic bacteria, use of advanced techniques in quarantine, PRA, development of diagnostic kit.

#### UNIT VII

Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management, endosymbionts for host defence.

## Practicals

Pathogenic studies and race identification; plasmid profiling of bacteria; fatty acid profiling of bacteria; RAPD profiling of bacteria and variability status; Endospore, Flagiler staining; test for secondary metabolite production, cyanides, Extracellular Polymeric Substance, siderophore; specific detection of phytopathogenic bacteria using species/pathovar specific primers, basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts

## Suggested Readings

Bradbury, J.F. and Saddler, G.S. 1985. *A Guide to Plant Pathogenic Bacteria*, CABI.

Boer, S.H.D. 2001. *Plant Pathogenic Bacteria*. Kluwer Academic Publishers, Netherlands.

Civerolo, E.L., Collmer, A., Davis, R.E. and Gillaspie, A.G. *Plant Pathogenic bacteria*, Martinus Nijhoff Publishers, Boston.

Gerhardt, P., Murray, R.G.E., Wood, W.A. and Krieg, N.R. 1994. *Methods for Molecular bacteriology*. American Society of Microbiology, Washington, DC.

Gnanamanickam, S.S. 2006. *Plant Associated Bacteria*. Springer.

Jackson, R.W. 2009. *Plant Pathogenic Bacteria: Genomics and Molecular Biology*. Caister Academic Press.

Schaad, N.W., Jones, J.B. and Chun, W. 2001. *Laboratory Guide for Identification of Plant Pathogenic bacteria*. APS, St. Paul, Minnisota.

## PL PATH 604 MOLECULAR BASIS OF HOST PATHOGEN INTERACTION (2L+1P) III

### Objective

To provide knowledge on host pathogen interaction and its application at molecular level.

### 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

Agrios, G.N. 1997. *Plant Pathology*. 4<sup>th</sup> Edition. Academic Press, New York.

Huang, J. 2001. *Plant Pathogenesis and Resistance- Biochemistry and physiology of plant-microbe interactions*. Kluwer Academic Publishers, pp. 691.

Osiewacz, H.D. 2002. *Molecular Biology of Fungal Development*, Marcel Dekker, USA, pp.607.

Singh, R.S., Singh, U.S., Hess, W.M. and Weber, D.J. 1988. *Experimental and Conceptual Plant Pathology*. Oxford and IBH publishing Co. Pvt. Ltd., pp. 599.

Vidhyasekaran, P. 1993. *Principles of Plant Pathology*. CBS Publishers and Distributors, New Delhi.

Vidhyasekaran, P. 2008. *Fungal Pathogenesis in Plants and Crops-Molecular biology and host defense mechanism*. CRC press, pp. 509.

## PL PATH 605 PRINCIPLES AND PROCEDURES OF CERTIFICATION

(1L+0P) III

*(Course to be taken in NBPGR)*

## Objective

To provide the information on regulation of pathogens for import/export as well as movement in the country

## Theory

### UNIT I

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control.

### UNIT II

Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc.

### UNIT III

Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade

## Suggested Readings

Andriole, S.J.1986. *Software Validation, Verification, Testing, and Documentation*, Princeton, NJ: Petrocelli Books.

Boston, M.A. 1997. *Embedded applications*, Kluwer Academics Publishers.

Kopetz, H. 1993. *Real-Time Systems: Design Principles for Distributed* Rushby, John, "Formal Methods and the Certification of Critical Systems," SRI-CSL Technical Report.

**Objective**

To provide knowledge on regulations of import /export of plant material, sanitary and phytosanitary issues, quarantine.

**Theory**

## UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

## UNIT II

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

## UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

**Suggested Readings**

Shantharam, S. and Montgomery, J.F.1999. *Biotechnology, Biosafety and Biosecurity*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi, 1999, pp 237.

**PL PATH 607/ENT 611 PLANT HEALTH DIAGNOSTICS AND MANAGEMENT (2L+2P) II****Objective**

To familiarize the students with different abnormalities caused by insect, pathogens, nematodes, weeds and imbalance use of plant nutrients. Also, develop the confidence in them to handle plant protection problems faced by the farmers/growers.

**Theory**

## UNIT I

Introduction to the plant health clinic: concept, importance, infrastructure etc. Identification of important beneficial insects (parasitoids, predators, pollinators and others of economic importance). Principles of pest management.

## UNIT II

Injury caused by different type of insects to the plants by feeding, oviposition, sheltering or any other means.

## UNIT III

Screening of damaged material for establishing the identity of casual agent viz.; insect, microbe, nematode, mites, rodents, vertebrates, competitive plant as well as nutritional or any other physiological disorders.

#### UNIT IV

Important Plant parasitic nematodes and their symptoms produced on major field, fruit, ornamental and plantation crops.

#### UNIT V

Damage caused by important nematodes causing root knot, ear-cockle and other diseases in different crops and their management.

#### UNIT VI

Molecular approaches for viral, bacterial and fungal diseases with regards to diagnostics and management.

#### UNIT VII

Symptoms of diseases caused by imbalances in plant nutrients

#### UNIT VIII

Identification of problematic weeds and their management.

### Practicals

Identification of symptoms caused by important insect pests. Preparation of pesticide stock solution and safe handling of agrochemicals. Disease diagnostic kit and related basic facilities. Identification of common diseases. Types of plant parasitic nematodes, demonstration of pathogenicity of root knot nematode on tomato and vegetables, Root knot index calculation. Symptoms of Molya disease and Ear-cockle disease of wheat. Management methods to manage nematode diseases in crop

### Suggested Readings

Chase, A.R. 1997. *Foliage plant diseases: Diagnosis and Control*, APS Press, St. Paul.

Ciancio, A. and Mukerji, K.G. 2008. *Integrated Management of Diseases by fungi, Phytoplasma and Bacteria*. Springer.

Malcolm, C., Shurtleff and Charles, W.A. 1997. *Plant Disease clinic and Field diagnosis of Abiotic diseases*, APS Press.

Nair, M.R.G.K. 1986. *Insect and mites of Crops in India*. ICAR, New Delhi.

Narayanasamy, P. 2001. *Plant pathogen detection and disease diagnosis*. Second Edition Marcel Dekker Inc, New York

Pradhan, S. 1969. *Insect Pests of Crops*. National Book Trust, India, pp 208.

Regupathy, A.N., Chandramohan, S., Palanisamy and Gunathilagaraj, K. 2003. *A guide on Crop Pests*. TNAU, Coimbatore, pp 276.

Robert, N., Trigiano, Mark, T.W., Slan, S. and Windham. 2007. *Plant Pathology Concepts and Laboratory Exercise* 2<sup>nd</sup> Edition. CPL Scientific Publishing Services Limited.

Schaad, N.W., Jones, J.B. and Chun, W. 2001. *Laboratory Guide for identification of plant pathogenic bacteria*. APS Press, St. Paul.