

# CH. CHARAN SINGH UNIVERSITY, MEERUT



## SYLLABUS

For

**M. Sc. (Ag.) PLANT PATHOLOGY**

**(Under Self Finance Scheme)**

**Effective from**

**ACADEMIC SESSION 2017-2018**

**FACULTY OF AGRICULTURE**

**DEPARTMENT OF PLANT PROTECTION**

## OVERVIEW

The Department of Plant Protection was established in 1998 under the self-financed scheme (SFS) of the UP state government to meet the long-standing demand of students, farmers, pesticide companies and bio-control laboratories. The study of plant protection aims at developing strategies for overall improvement in crop production by minimizing crop losses due to insect-pests, diseases, weeds, nematodes, rodents, etc. The department has established well-equipped with modern laboratories for isolation, purification, identification and maintenance of cultures, mass rearing of natural enemies, mass production of bio-pesticides. Major equipments in the Department are BOD incubator, hot air oven, autoclave, Laminar air flow, GEL documentation system, deep freezer, high quality research microscopes, high quality inverted phase contrast microscopes, double distillation unit, bio-safety cabinets, pH meter, sprayers, etc. The department has its own departmental library, which consists of more than 600 books and journals. A computer lab with internet facility is also available.

**Course Structure: M.Sc. Ag. (Plant Pathology):** M.Sc. Ag. (Plant Pathology) is a two years (four semesters) full time course including the project work. There are four theory courses (only three in fourth semester) and one practical in each semester. Each student has to undertake a project work on any aspect related to the course of study and submit the Project Report at the end of fourth semester. The students also receive training during their project work in different research institutes, laboratories and other Universities.

**Examination and Evaluation:** The examination and evaluation patterns in each course will be according to the University norms. Each theory paper will carry 100 marks (50+50 marks of internal and external evaluation). Practical shall be of 100 marks in each semester. The project report in fourth semester shall be of 100 marks (50+50 marks of project report and viva – voce examination, respectively).

**Eligibility for Admission: M.Sc. Ag. (Plant Pathology) Programme:** Bachelor's degree in Agriculture/ Horticulture/ Forestry/ B.Sc. degree with Chemistry, Botany, Zoology/ Microbiology/ Biotechnology with 50% marks.

**Intake (Number of Seats):** M.Sc. Ag. (Plant Pathology) Programme: 20

**Department of Plant Protection**  
**Ch. Charan Singh University, Meerut**

**Syllabus for M Sc Ag (Plant Pathology) Effective from session 2017-18**

Sl. No.	Name of the Course	Course Code	Credits L+P	Maximum Marks			
				Internal	External	Practical	Total
<b>SEMESTER I</b>							
1.	Statistical Methods	PPA-1001	3+1	50	50		100
2.	Mycology	PPA-1002	3+2	50	50		100
3.	Principles of Plant Pathology	PPA-1003	3+0	50	50		100
4.	Detection and Diagnosis of Plant Diseases	PPA-1004	1+3	50	50		100
	Practical –I (Based on above courses)*	PPA-5001				100	100
	<b>Total</b>		16				<b>500</b>
<b>SEMESTER II</b>							
5.	Plant Virology	PPA-2001	3+1	50	50		100
6.	Diseases of Field and Vegetables Crops	PPA-2002	2+1	50	50		100
7.	Integrated Management of Plant Diseases	PPA-2003	3+2	50	50		100
8.	Principles of Nematology	PPA-2004	3+1	50	50		100
	Practical –II (Based on above courses)*	PPA-6001				100	100
	<b>Total</b>		16				<b>500</b>
<b>SEMESTER III</b>							
9.	Computer Applications and Bioinformatics	PPA-3001	3+1	50	50		100
10.	Plant Bacteriology	PPA-3002	2+2	50	50		100
11.	Chemicals in Plant Disease Management	PPA-3003	2+2	50	50		100
12.	Diseases of Fruits, Plantation and Ornamental Crops	PPA-3004	2+2	50	50		100
	Practical –III (Based on above courses)*	PPA-7001				100	100
	<b>Total</b>		16				<b>500</b>
<b>SEMESTER IV</b>							
13.	Plant Quarantine	PPA-4001	2+0	50	50		100
14.	Epidemiology and Forecasting of Plant Diseases	PPA-4002	2+1	50	50		100
15.	Seed Health Technology	PPA-4003	2+1	50	50		100
	Practical–IV (Based on above courses)*	PPA-8001				100	100
	Project Report Evaluation and Viva-voce	PPA-8002	6+0			50 + 50	100
	<b>Total</b>		14				<b>500</b>
	<b>Grand Total of Credits and Marks</b>		<b>62</b>				<b>2000</b>

\*Practical exam of all the courses of a semester shall be conducted together/jointly.

**Course – 1: Statistical Methods  
(Credits: 3+1)**

**Teaching hours: 50**

**UNIT-I: Statistics:** Definition and its scope. 2

**UNIT-II: Presentation of data:** Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves. 6

**UNIT-III: Measures of locations and dispersion:** Mean, mode, median and their simple properties (with-out derivation) and calculation of median by graphs; range, mean deviation, standard deviation, standard error and coefficient of variation. 6

**UNIT-IV: Probability and distributions:** Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson and normal distributions; and simple properties of the above distributions (without derivation). 4

**UNIT-V: Correlation and regression:** Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes. 8

**UNIT-VI: Sampling:** Concept of population and sample; random samples; methods of taking a simple random sample. 4

**UNIT-VII: Tests of significance:** Sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi- square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-test. 10

**UNIT-VIII: Experimental designs:** Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; simple factorial experiments (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD). 10

**Practical:**

Measurement of central tendency and dispersion, standard deviation and standard error, principle uses of  $X^2$ , F and 't, test, Correlation Coefficient, Regression coefficient and Regression equation. Analysis of data obtained from CRD, RBD & LSD.

**Suggested Readings:**

1. Goulden, C.H. (1952). Methods of Statistical Analysis. 2/e, John Wiley, New York.
2. Hoshmand, A. Reza. (1988). Statistical Methods for Agriculture Sciences. Timber Press, USA.
3. Hogg, R.V and Carig, A.T. (2004). Introduction to Mathematical Statistics. Mac-Millan Publication Ltd., New York.
4. Gomez, A.G. and Gomez, A.A. (1994). Statistical Procedures for Agriculture Research, Second edition, John Wiley & Sons, New York.
5. Panse, V.C. and Sushatme, P.V. (1967). Statistical Methods for Agriculture Workers. I.C.A.R., New Delhi.
6. Snedecor, G.W. & Cochran, W.G. (1980). Statistical Methods. Iowa State Univ. Press, Iowa.

**Course – 2: Mycology**  
**(Credits: 3+2)**

**Teaching hours: 50**

**UNIT-I: Introduction:** General introduction, basic concept and definition of different terms. 8

**UNIT-II: Historical development:** Importance of mycology in agriculture, relation of fungi to human affairs and history of mycology. 10

**UNIT-III:** Fungal biodiversity, reproduction in fungi, Concepts of nomenclature and classification. 12

**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. Fungal genetics and variability in fungi. 20

**Practical:**

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

**Suggested Readings:**

1. Agrios, N. George (2009). Plant Pathology. 5<sup>th</sup> Ed., Academic press publishers, U.K.
2. Arora, Rai, Mukerji and Knudsen (2008). Hand Book of Applied Mycology. Volume-I, 1<sup>st</sup> Ed., Academic press publishers, U.K.
3. Ainsworth, G.C., Sparrow, F.K. and Susman, H.S. (1973). The Fungi: An Advanced Treatise. Vol. IV (A & B). Academic Press, New York.
4. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (2000). Introductory Mycology. 5<sup>th</sup> Ed., John Wiley & Sons, New York.
5. Mehrotra, R.S. and Arneja, K.R. (1990). An Introductory Mycology. Wiley Eastern, New Delhi.
6. Sarbhoy, A.K. (2000). Text book of Mycology. ICAR, New Delhi.
7. Singh, R.S. (1982). Plant Pathogens: The Fungi. Oxford & IBH, New Delhi.
8. Webster, J. (1980). Introduction to Fungi. 2<sup>nd</sup> Ed., Cambridge Univ. Press, Cambridge, New York.

**Course – 3: Principles of Plant Pathology  
(Credits: 3+0)**

**Teaching hours: 50**

**UNIT-I: History and Introduction:** Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. 10

**UNIT-II:** Growth, reproduction, survival and dispersal of important plant pathogens; role of environment and host nutrition on disease development. 8

**UNIT-III: Host parasite interaction:** A brief idea of recognition concept and infection, symptomatology, Disease development: Role of enzymes, toxins, growth regulators. Defense strategies: Oxidative burst; Phenolics, Phytoalexins, PR proteins and elicitors. Altered plant metabolism as affected by plant pathogens, molecular basis of host plant interaction. 14

**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, physiology specialization – race identification. 12

**UNIT-V:** Disease management strategies. 6

**Practical:**

Acquaintance to plant pathology laboratory and equipments; Preparation of culture media for fungi and bacteria; Isolation techniques, preservation of disease samples.

**Suggested Readings:**

1. Agrios, N. George (2009). Plant Pathology. 5<sup>th</sup> Ed., Academic press publishers, U.K.
2. Heitefuss, R. and Williams, P.H. (1976). Physiological Plant Pathology. Springer Verlag, Berlin, New York.
3. Mehrotra, R.S. and Aggarwal, A. (2003). Plant Pathology. 2<sup>nd</sup> Ed., Oxford & IBH, New Delhi.
4. Singh, R.S. (2002). Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
5. Singh, D.P. and Singh, A. (2007). Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.
6. Upadhyay, R.K. and Mukherjee, K.G. (1997). Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi.

**Course – 4: Detection and Diagnosis of Plant Diseases  
(Credits: 1+3)**

**Teaching hours: 50**

**UNIT-I: Methods of studying plant disease:** Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques and use of selective media to isolate pathogens. 6

**UNIT-II:** Fungal and bacterial disease diagnosis: Symptomatology, collection of samples and their preservation, isolation techniques, purification and single spore isolation, inoculation technique and creation of artificial epiphytotics of fungal and bacterial pathogens, long term storage and preservation of fungal and bacterial cultures and disease specimens. 12

**UNIT-III: Micrometry, pH meter and Camera-Lucida:** Use of haemocytometer, micrometer, centrifuge, pH meter and camera lucida. 4

**UNIT-IV: Microscopy:** Microscopic techniques and staining methods, phase contrast system and use of electron microscope. 8

**UNIT-V: Modern analytical techniques:** Chromatography, spectrophotometer, ultracentrifuge and electrophoretic apparatus, ELISA and PCR-based diagnosis. 10

**UNIT-VI:** Disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references. 10

**Practical:**

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. Microscopic techniques and staining methods, phase contrast system, chromatography, use of spectrophotometer and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens.

**Suggested Readings:**

1. Aneja, K.R. (2001). Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom production technology. 1<sup>st</sup> Ed., New Age International publishers, New Delhi.
2. Baudoin, A.B.A.M., Hooper, G.R, Mathre, D.E. and Carroll, R.B. (1990). Laboratory Exercises in Plant Pathology: An Instructional Kit. 1<sup>st</sup> Ed., Scientific publishers, Jodhpur, India.
3. Freeman, S. and Herron, J.C. (1998). Evolutionary Analysis. Prentice Hall, New Delhi.
4. Fox, R.T.V. (1996). Principles of Diagnostics Techniques in Plant Pathology. 1<sup>st</sup> Ed., International Mycological Institute, CABI International publishers, Wallington, U.K.
5. Dhingra, O.D. and Sinclair, J.B. (1986). Basic Plant Pathology Methods. CRC Press, London, Tokyo.
6. Pathak, V.N. (1984). Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi.
7. Vishunavat, Karuna and Kolte, S.J. (2005). Essentials of Phytopathological Techniques. 1<sup>st</sup> Ed., Kalyani Publishers, New Delhi.

**Course – 5: Plant Virology  
(Credits: 3+1)**

**Teaching hours: 50**

**UNIT-I: History and Introduction:** History of plant viruses, shape, size, composition, structure and physical properties of viruses. 6

**UNIT-II:** Symptomatology of important plant viral diseases, transmission of important plant viral diseases, chemical and physical properties of virus, host virus interaction and virus vector relationship. 10

**UNIT-III:** Virus nomenclature and classification, genome organization of viruses, replication and movement of viruses. 10

**UNIT-IV:** Isolation and purification of viruses, electron microscopy, protein and nucleic acid based diagnostics. 10

**UNIT-V:** Mycoviruses, phytoplasma arbo- and baculoviruses, satellite viruses, satellite RNAs, phages, viroids and prions. 8

**UNIT-VI:** Origin and evolution, mechanism of resistance, genetic engineering, ecology and management of plant viruses. 6

**Practical:**

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

**Suggested Readings:**

1. Bos, L. (1964). Symptoms of Virus Diseases in Plants. Oxford & IBH., New Delhi.
2. Brunt, A.A., Krabtree, K., Dallwitz, M.J., Gibbs A.J. and Watson, L. (1995). Virus of Plants: Descriptions and Lists from VIDE Database. CABI, Wallington.
3. Gibbs, A. and Harrison, B. (1976). Plant Virology: The Principles. Edward Arnold, London.
4. Hull, R. (2002). Mathew's Plant Virology. 4<sup>th</sup> Ed., Academic Press, New York.
5. Khan, A. Jawaid and Dijkstra, Jeannea. (2007). Hand Book of Plant Viorology. 1<sup>st</sup> Ed., Heritage Publishers, New Delhi.
6. Noordam, D. (1973). Identification of Plant Viruses, Methods and Experiments. Oxford & IBH, New Delhi.



**Course – 6: Diseases of Field and Vegetables Crops  
(Credits: 2+1)**

**Teaching hours: 50**

Introduction, nature, prevalence, etiology, factors affecting disease development and control measures of diseases of crops caused by fungi, bacteria, viruses, nematodes, etc.

**UNIT-I: Diseases of Cereal crops:** Wheat, barley, rice, pearl millet, sorghum and maize. 8

**UNIT-II: Diseases of Pulse crops:** Gram, urdbean, mungbean, lentil, pigeonpea and soybean. 6

**UNIT-III: Diseases of Oilseed crops:** Rapeseed and mustard, sesame, linseed, sunflower, groundnut and castor. 6

**UNIT-IV: Diseases of Cash crops:** Cotton and sugarcane. 6

**UNIT-V: Diseases of Fodder legume crops:** Berseem, oats, guar, lucerne and cowpea. 4

**UNIT-VI: Symptoms, etiology and management of diseases of root, bulb and leafy vegetables:** Beets, carrots, turnip, radish, sweet potatoes; onion, garlic; Brussels, sprouts, cabbage, lettuce and spinach. 10

**UNIT-VII: Symptoms, etiology and management of diseases of crucifers, cucurbits and solanaceous vegetable crops:** Broccoli, cabbage, cauliflower; Cucurbitaceous vegetables; Potato, tomato, brinjal and chilli. 10

**Practical:**

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

**Suggested Readings:**

1. Chaube, H.S., Singh, U.S., Mukhopadhyay A.N. and Kumar, J. (1992). Plant Diseases of International Importance. Vol. II. Diseases of Vegetable and Oilseed Crops. Prentice Hall, Englewood Cliffs, New Jersey.
2. Gupta, V.K. and Paul, Y.S. (2001). Diseases of Vegetable Crops. Kalyani Publi., New Delhi.
3. Gupta, S.K. and Thind, T.S. (2006). Disease Problem in Vegetable Production. Scientific Publ., Jodhpur.
4. Joshi, L.M., Singh, D.V. and Srivastava, K.D. (1984). Problems and Progress of Wheat Pathology in South Asia. Malhotra Publ. House, New Delhi.
5. Ricanel, C., Egan, B.T., Gillaspie, Jr A.G. and Hughes, C.G. (1989). Diseases of Sugarcane, Major Diseases. Academic Press, New York.
6. Singh, R.S. (1998). Plant Diseases. 7<sup>th</sup> Ed., Oxford & IBH, New Delhi.
7. Khan, M.R. and Jairajpuri, M.S. (2010 & 2012). Nematology Infestation in Crop. Vol I, II & III. National Academy of Science, Allahabad, India.

**Course – 7: Integrated Management of Plant Diseases  
(Credits: 3+2)**

**Teaching hours: 50**

**UNIT-I:** 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. 10

**UNIT-II:** Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil-borne and foliar diseases. 10

**UNIT-III:** 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. 10

**UNIT-IV:** Commercial formulations 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. 10

**UNIT-V:** Development of IDM: Basic principles, biological, chemical and cultural disease management, their implications and limitations. 10

**Practical:**

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, and other quality parameters. Application of biological, cultural, chemical and bio-control agents, their compatibility and integration in IDM, demonstration of IDM in certain vegetable nursery.

**Suggested Readings:**

1. Baker, E.F. and James, R.C. (1982). Biological Control of Plant Pathogens. American Phytopathological Society.
2. Boland, G.J. and David, L. (1998). Plant microbe interactions and Biological Control. Kuykendall Marel Dekker, INC.
3. Campbell, R. (1989). Biological Control of Microbial Plant Pathogens. Cambridge Univ. Press, Cambridge.
4. Ciancia, A. and Mukerji, K.J. (2007). General Concepts of Integrated Pest and Disease Management. Edited Published by Springer.
5. Cincholkar, S.B. and Mukherji, K.G. (2007). Biological Control of Plant Diseases. Hawarth Food and Agricultural products.
6. Ramanujam, B. and Rabindra, R.J. 2006. Current Status of Biological Control of Plant Disease using Antagonistic Organisms in India. Precision Fototype Services Bangalore.

**Course – 8: Principles of Nematology**  
**(Credits: 3+1)**

**Teaching hours: 50**

**UNIT-I:** History and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry. 14

**UNIT-II:** Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology. 10

**UNIT-III:** Types of parasitism; nature of damage and general symptomatology; interaction of plant parasitic nematodes with other organisms. 10

**UNIT-IV:** Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes. 10

**UNIT-V:** Principles and practices of nematode management; integrated nematode management. 6

**Practical:**

Studies on kinds of nematodes- free-living, animal, insect and plant parasites; nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary endoparasites; examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

**Suggested Readings:**

1. Dropkin, V.H. (1980). An Introduction to Plant Nematology. John Wiley & Sons, New York.
2. Perry, R.N. and Moens, M. (2006). Plant Nematology. CABI, London.
3. Singh, R.S. and Sitaramaiah, K. (1994). Plant Pathogens – Nematodes. Oxford & IBH, New Delhi.
4. Khan, M.R. (2008). Plant Nematodes... Oxford & IBH, New Delhi.
5. Walia, R.K. and Bajaj, H.K. (2003). Text Book on Introductory Plant Nematology. ICAR, New Delhi.

**Course – 9: Computer Applications and Bioinformatics  
(Credits: 3+1)**

**Teaching hours: 50**

**UNIT-I: Introduction to computers:** General characteristics, generation, component, (input/output and memory unit) and classification of computer, internal representation of data (binary, octal and hexa-decimal system, bits and bytes). 4

**UNIT-II: Brief idea of operating systems:** Disc operating systems (DOS), UNIX/Linux, WINDOWS and its upgraded versions; Mobile operating system. 4

**UNIT-III: Introduction to networking:** Types of Networking (LAN: local area network, WAN: wide area network, MAN: metropolitan area network), Client-Server Architecture, Network topologies and Internet. 6

**UNIT-IV: Microsoft (MS) office and its applications:** Introduction to MS Excel and its applications for statistical analyses with particular reference to agricultural data (tabular and graphical representation of data, analyses of variance, regression and correlation); introduction to MS Word and its application for document preparation; power Point and its application for preparing presentations. 8

**UNIT-V: Introduction to statistical packages:** Introductory knowledge of SPSS (Statistical Package for the Social Sciences), SAS (Statistical Analysis Software) packages for statistical analysis of agricultural data, handling software for data analyses. 8

**UNIT-VI: An overview of bioinformatics:** Introduction, definition and scope of bioinformatics, kind of data used in bioinformatics; Biological databases (nucleic acid, protein sequence and protein structure database); multiplicity of data and redundancy, major bioinformatics websites; PubMed and other databases; on-line access to abstracts and full text of articles; online books; free and paid access. 10

**UNIT-VII: Sequence analysis:** Sequence Alignment, Introduction to sequence analysis, Sequence database similarity searching algorithms, local alignment, global alignment, FASTA, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX) and similarity searching scores. 10

**Suggested Readings:**

1. Gear, CW (1980). Computer Organization and Programming. McGraw-Hill Inc., New York.
2. Gotefried, B.S. (1986). Theories and Problems of Programming with BASIC. Schaum's Outline Series, McGraw-Hill Book Company, Singapore.
3. Lipschutz, M.M and Lipschutz, S. (1981). Theories and Problems of Data Processing. Schaum's Outline Series, McGraw-Hill Book Company, Singapore.
4. Subramanian, N. (1986). Introduction to Computer. Fundamentals of Computer Science. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Rajaraman, V. Fundamentals of Computers. Prentice-Hall of India (Pvt.) Ltd., New Delhi.
6. Mount, D.W. (2004). Bioinformatics: Sequence and Genome Analysis, 2/e. Cold Spring Harbor laboratory Press, USA.
7. Rastogi, S.C., Mendiratta, N. and Rastogi, P. (2003). Bioinformatics: Concepts, Skills and Applications. CBS Publishers, New Delhi.

**Course – 10: Plant Bacteriology**  
**(Credits: 2+2)**

**Teaching hours: 50**

**UNIT-I:** History of bacteriology, nomenclature and classification of bacteria, bacteriophages-morphology, types and uses, mycoplasma and bdellovibrios. 8

**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. 8

**UNIT-III:** Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. 8

**UNIT-IV:** Plasmids, bacterial conjugation, transduction and transformation. 6

**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. 14

**UNIT-VI:** Management strategy for bacterial diseases, survival and dissemination of bacteria. 6

**Practical:**

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

**Suggested Readings:**

1. Goto, M. (1990). Fundamentals of Plant Bacteriology. Academic Press, New York.
2. Frobisher, M. (1944). Fundamentals of Bacteriology, W. B. Saunders Company.
3. Gerhardt, P., Murray, R.G.E., Wood, A.W. and Krieg, N.R. (1994). Methods for Molecular Bacteriology, American Society of Microbiology, Washington, DC, USA.
4. Jackson, R.W. (2009). Plant Pathogenic Bacteria: Genomics and Molecular Biology, Caister Academic Press, USA.
5. Jayaraman, J. and Verma, J.P. (2002). Fundamentals of Plant Bacteriology. Kalyani Publishers, Ludhiana.
6. Mount, M.S. and Lacy, G.H. (1982). Phytopathogenic Prokaryotes. Vols. I, II. Academic Press, New York.
7. Salle, A.J. (1967). Fundamental Principles of Bacteriology, Mc Graw-Hill, Inc., New York.
8. Schaad, N.W., Jones, J.B. and Chun, W. (2001). Laboratory Guide for Identification of Plant Pathogenic bacteria, APS Press, St. Paul, Minnisota.
9. Verma, J.P. (1998). The Bacteria. Malhotra Publ. House, New Delhi.

**Course – 11: Chemicals in Plant Disease Management  
(Credits: 2+2)**

**Teaching hours: 50**

**UNIT-I:** History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals. 6

**UNIT-II:** Classification of chemicals based on chemical nature and mode of action used in plant disease control and their characteristics. 8

**UNIT-III:** Chemicals in plant disease control, viz., fungicides, bactericides, nematocides and botanicals. 8

**UNIT-IV:** Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of chemical pesticides. 10

**UNIT-V:** Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides. 10

**UNIT-VI:** General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management. 8

**Practical:**

Acquaintance with formulation of different fungicides and plant protection appliances, Formulation of fungicides and bactericides; *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; methods of application of chemicals.

**Suggested Readings:**

1. Bindra, O.S and Singh, H. (1977). Pesticides - An Application Equipment. Oxford & IBH, New Delhi.
2. Green, M.B. and Spilker, D.A. (1986). Fungicide Chemistry: Advances and Practical Applications (ACS Symposium Series, 304). American Chemical Society, Oxford University Press.
3. Hewitt, H.G. (1998). Fungicides in Crop Protection CABI Publishing, CAB International, Oxon, United Kingdom.
4. Hutson, D. and Miyamoto, J. (1999). Fungicidal Activity: Chemical and Biological Approaches to Plant Protection, John Wiley & Sons. New York.
5. Koller, W. (1992). Target Sites of Fungicide Action CRC Press. Boca Raton, FL.
6. Nene, Y.L. and Thapliyal, P.N. (1993). Fungicides in Plant Disease Control. 3rd Ed., Oxford & IBH, New Delhi.
7. Page, B.G. and Thomson, W.T. (2003). The 2003 Newly Revised Insecticide, Herbicide, Fungicide Quick Guide. Kovak Books, Bakersfield, CA.
8. Vyas, S.C. (1993). Handbook of Systemic Fungicides. Vols. I-III. Tata McGraw Hill, New Delhi.

**Course – 12: Diseases of Fruits, Plantation and Ornamental Crops  
(Credits: 2+2)**

**Teaching hours: 50**

Introduction, nature, prevalence, etiology, factors affecting disease development and control measures of diseases of crops caused by fungi, bacteria, viruses, nematodes, etc.

**UNIT-I:** Introduction, symptoms and etiology of different fruit diseases. Factors affecting disease development in fruits like apple, pear, peach, strawberry, citrus, mango, grapes, guava, ber, banana, pineapple, papaya, pomegranate and management of the fruits diseases. 20

**UNIT-II:** Introduction, symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management. 12

**UNIT-III:** Introduction, 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. 18

**Practical:**

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:**

1. Gupta, V.K. and Sharma, S.K. (2000). Diseases of Fruit Crops. Kalyani Publ., New Delhi.
2. Marshall, E.M., Alois, A.B. and Backman, C.H. (1981). Fungal wilt diseases of plants, Academic Press.
3. Naqvi, S. and Kluwer. (2004). Disease of Fruits and Vegetables Diagnosis and Management. Academic publisher.
4. Parvatha Reddy, P. (2010). Fungal Diseases and Their Management in Horticultural Crops. Scientific Publication.
5. Pathak, V.N. (1980). Diseases of Fruit Crops. Oxford & IBH, New Delhi.
6. Sharma, L.R., Sharma, R.C. and Gidwani, M. (1999). Disease of Horticultural Crops Vegetables, Ornamental and Mushrooms. Indus Publishing Co.
7. Singh, R.S. (2000). Diseases of Fruit Crops. Oxford & IBH, New Delhi.
8. Smith, I.M., Dunez, L., Lelliott, R.A., Phillips, D.H. and Archer, S.A. (1988). European Handbook of Plant Disease. Blackwell Scientific Publications.
9. Walker, J.C. (2004). Diseases of Vegetable Crops. TTPP, India.

**Course – 13: Plant Quarantine  
(Credits: 2+0)**

**Teaching hours: 50**

**UNIT-I: Introduction:** 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. 12

**UNIT-II:** Plant protection organization in India. Acts related to registration of pesticides and transgenics. 6

**UNIT-III:** History of quarantine legislations, PQ Order 2003. Environmental acts, Industrial registration; APEDA, Import and Export of bio-control agents. 8

**UNIT-IV:** 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. 14

**UNIT-V:** WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures. 10

**Suggested Readings:**

1. Ebbels, D.L. (2003). Principles of Plant Health and Quarantine CABI, Wallingford, Oxon, UK.
2. Harber, R. (1983). International Plant Quarantine Treatment manual. Food and Agriculture Organization of the United Nations, Rome.
3. Rajeev, K. and Mukherjee, R.C. (1996). Role of Plant Quarantine in IPM. Aditya Books.
4. Rhower, G.G. (1991). Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2<sup>nd</sup> Ed., Vol. II. (Ed. David Pimental). CRC Press.
5. Saha, L.R. (2006). Handbook of Plant Protection. First edition, C.B.S. Publishers, New Delhi.
6. 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.
7. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2<sup>nd</sup> Ed., Volume-I and II, Kalyani Publishers, New Delhi.



**Course – 14: Epidemiology and Forecasting of Plant Diseases  
(Credits: 2+1)**

**Teaching hours: 50**

**UNIT-I:** Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis. 12

**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. 14

**UNIT-III:** Survey, surveillance and vigilance, crop loss assessment and models. 8

**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. 16

**Suggested Readings:**

1. Campbell, C.L. and Madden, L.V. (1990). Introduction to Plant Disease Epidemiology. John Willey & Sons, New York.
2. Cooke, B.M., Jones, D.G. and Kaye, B. 2006. A textbook 'The Epidemiology of Plant Diseases, Springer, pp 456.
3. Cowling, E.B. and Horsefall, J.G. (1978). Plant Disease. Vol. II. Academic Press, New York.
4. 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, New York, pp372.
5. Laurence, V.M., Gareth, H. and Frame Van den Bosch (Eds.). The Study of Plant Disease Epidemics. APS, St. Paul, Minnesota.
6. Nagarajan, S. and Murlidharan, K. (1995). Dynamics of Plant Diseases. Allied Publ., New Delhi.
7. Van der Plank, J.E. (1963). Plant Diseases Epidemics and Control. Academic Press, New York.
8. Zadoks, J.C. and Schein, R.D. (1979). Epidemiology and Plant Disease Management. Oxford University Press, London.

**Course – 15: Seed Health Technology  
(Credits: 2+1)**

**Teaching hours: 50**

**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. 10

**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. 10

**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. 16

**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. 14

**Suggested Readings:**

1. Agarwal, V.K. and Sinclair, J.B. (1996). Principles of Seed Pathology. 1<sup>st</sup> edition, CRC Press, Inc., Boca Raton, FL.
2. Hutchins, J.D. and Reeves, J.E. (1997). Seed Health Testing: Progress Towards the 21<sup>st</sup> Century. CABI, Wallington.
3. Karuna, V. (2007). Seed Health Testing. Kalyani Publishers, Ludhiana.
4. Maude, R.B. (1996). Seed borne Diseases and Their Control Principles and Practice. CAB International, Wallingford, Oxon, UK.
5. Neergaard, P. (1979). Seed Pathology Vol. 1. The Macmillan Press. Ltd.
6. Singh, Tribhwan and Triwedi, P.P (2005). Seed Pathology. Second edition, Daya Publishing House, New Delhi.
7. Suryanarayana, D. (1978). Seed Pathology. Vikash Publ., New Delhi.