



Swami Vivekanand University, Sagar (M.P.)



# SYLLABUS

**Master of Science in Agriculture**

(As per, 5<sup>th</sup> Dean Committee of ICAR)

**Faculty of Agriculture Science & Technology**

**Department of Agriculture Science**



**Study and Evaluation Scheme  
of**

**M. Sc. (Ag.) Plant Pathology**

(Applicable w.e.f. Academic Session 2018 to till revised)

**Duration of Course: 02 year  
Mode of Examination: Semester**

**SWAMI VIVEKANAND  
UNIVERSITY, SIRONJA, SAGAR,  
(M.P.)**

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## M. Sc. (Ag) Plant Pathology (Two Year Master Degree Programme)

### REQUIREMENT OF CREDIT HOURS FOR AWARD OF THE DEGREE

S. No.	Nature of Courses	Credit
1	Major Courses	22
2	Minor Courses	11
3	Supporting Courses	07
4	Masters Seminar	01
5	Masters Research	20
<b>Total Credits</b>		<b>61</b>

**Major Subject:** The subject (Department/Discipline) in which a student takes admission.

**Minor Subject:** The subject closely related to a student's major subject.

**Supporting Subject:** The subject not related to the major subject. It could be any subject considered relevant for student's research work or necessary for building his overall competence.

**Non-Credit Compulsory Courses:** Six courses are of general nature and are compulsory for Master's programme.



M.Sc. (Ag.) Plant Pathology

SEMESTER-WISE DISTRIBUTIONS OF COURSE

First Semester

S.No.	Paper Code	Course Title	Credits
<b>A. Major Courses</b>			
1.	PP-501	Principles of Plant Pathology	3(3+0)
2.	PP-502	Mycology	3(2+1)
3.	PP-503	Plant Virology	3(2+1)
4.	PP-504	Detection and Diagnosis of Plant Diseases	2(0+2)
<b>B. Minor Courses</b>			
5.	GPB-501	Principles of Genetics	3(2+1)
6.	GPB-504	Cell Biology and Molecular Genetics	3(2+1)
<b>C. Supporting</b>			
7.	STAT-501	Statistical Methods for Applied Sciences	4(3+1)
<b>D. Non-credit Courses</b>			
8.	PGS-501	Basic Concept in Laboratory Techniques	N.C.
9.	PGS-502	Agricultural Research, Research Ethics and Rural Development Programmes	N.C.
<b>Grand Total Credits</b>			<b>21(14+7)</b>



**M.Sc. (Ag.) Plant Pathology**

**Second Semester**

S.No.	Paper Code	Course Title	Credits
<b>A. Major Courses</b>			
1.	PP-511	Plant Bacteriology	3(2+1)
2.	PP-512	Integrated Disease Management	3(2+1)
3.	PP-513	Mushroom Production Technology	3(2+1)
4.	PP-514	Diseases of Field and Medicinal Plants	2(1+1)
<b>B. Minor Courses</b>			
5.	GPB-512	Biotechnology for Crop Improvements	3(2+1)
6.	GPB-513	Maintenance Breeding and Concept of Variety Release and Seed Production	2(1+1)
<b>C. Supporting</b>			
7.	STAT-511	Design of Experiments	3(2+1)
<b>D. Non-credit Courses</b>			
8.	PGS-511	Library and Information Services	N.C.
9.	PGS-512	Intellectual Property and its Management in Agriculture	N.C.
<b>Grand Total Credits</b>			<b>19(12+7)</b>



**M.Sc. (Ag.) Plant Pathology**

**Third Semester**

S.No.	Paper Code	Course Title	Credits
<b>A. Major Courses</b>			
1.	PP-591	Masters Seminar	01(0+01)
2.	PP-599	Masters Research (Under Process)	10(0+10)
<b>B. Non-credit Courses</b>			
3.	PGS-521	Technical Writing and Communication Skill	N.C.
4.	PGS-522	Disaster Management	N.C.
5.	SVN-500	Charitra Nirman Evam Samgra Vyaktitva Vikas	N.C.
<b>Grand Total Credits</b>			<b>11(0+11)</b>

**M.Sc. (Ag.) Plant Pathology**

**Fourth Semester**

S.No.	Paper Code	Course Title	Credits
<b>A. Major Course</b>			
1.	PP-599	Masters Research (Accepted)	10(0+10)



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

**Course Contents**

**(FIRST SEMESTER)**

Paper Code	Course Title	Credits
<b>PP-501</b>	<b>PRINCIPLES OF PLANT PATHOLOGY</b>	<b>3(3+0)</b>

**OBJECTIVE**

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

**THEORY**

**UNIT I**

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

**UNIT II**

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

**UNIT III**

Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

**SUGGESTED READINGS**

- *Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.*
- *Mehrotra RS & Aggarwal A. 2003. Plant Pathology. 2nd Ed. Oxford & IBH, New Delhi.*
- *Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.*
- *Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi.*
- *Upadhyay RK & Mukherjee KG. 1997. Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH, New Delhi. 69*
- *Sharma PD, 2006. Plant Pathology. Narosa publishing house pvt. Ltd.. 22 Daryaganj Delhi*
- *Chaube HS, Pundhir VS, 2014. Crop diseases and their management. PHI learning pvt. Ltd. Delhi – 110092*



Paper Code	Course Title	Credits
PP-502	MYCOLOGY	3(2+1)

### OBJECTIVE

To study the nomenclature, classification and characters of fungi.

### THEORY

#### UNIT I

Introduction, definition of different terms, basic concepts. Importance of mycology in agriculture, relation of fungi to human affairs, history of mycology. Concepts of nomenclature and classification, fungal biodiversity, reproduction in fungi.

#### UNIT II

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.

### PRACTICAL

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

### SUGGESTED READINGS

- *Ainsworth GC, Sparrow FK & Susman HS. 1973. The Fungi – An Advanced Treatise. Vol. IV (A & B). Academic Press, New York.*
- *Alexopoulos CJ, Mims CW & Blackwell M. 2000. Introductory Mycology. 5th Ed. John Wiley & Sons, New York.*
- *Mehrotra RS & Arneja KR. 1990. An Introductory Mycology. Wiley Eastern, New Delhi.*
- *Sarbhojy AK. 2000. Text book of Mycology. ICAR, New Delhi.*
- *Singh RS. 1982. Plant Pathogens – The Fungi. Oxford & IBH, New Delhi.*
- *Webster J. 1980. Introduction to Fungi. 2nd Ed. Cambridge Univ. Press, Cambridge, New York.*
- *Dubey H.C. 2005. Introduction of fungi. 3rd edition, vikash publishing house, New Delhi*



Paper Code	Course Title	Credits
PP-503	PLANT VIROLOGY	3(2+1)

### OBJECTIVE

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

### THEORY

#### UNIT I

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

#### UNIT II

Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics.

#### UNIT III

Mycoviruses, phytoplasma arbo and baculoviruses, satellite viruses, satellite RNAs, phages, viroids, prions. Principles of the working of electron-microscope and ultra-microtome. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

### PRACTICAL

Study of symptoms caused by viruses, transmission, assay of viruses, Physical properties, purification, method of raising antisera, serological tests, electron microscopy and ultratomy, PCR.

### SUGGESTED READINGS

- *Bos L. 1964. Symptoms of Virus Diseases in Plants. Oxford & IBH., New Delhi.*
- *Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. Virus of Plants Descriptions and Lists from VIDE Database. CABI, Wallington.*
- *Gibbs A & Harrison B. 1976. Plant Virology - The Principles. Edward Arnold, London.*
- *Hull R. 2002. Mathew's Plant Virology. 4th Ed. Academic Press, NewYork.*





Paper Code	Course Title	Credits
PP-504	DETECTION AND DIAGNOSIS OF PLANT DISEASES	2(0+2)

### OBJECTIVE

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

### PRACTICAL

#### UNIT I

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida.

#### UNIT II

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

- Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. *Laboratory Exercises in Plant Pathology An Instructional Kit*. Scientific Publ., Jodhpur.
- Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.
- Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABI Wallington.
- Pathak VN. 1984. *Laboratory Manual of Plant Pathology*. Oxford & IBH, New Delhi.
- Forster D & Taylor SC. 1998. *Plant Virology Protocols From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology*. Humana Press, Totowa, New Jersey.
- Matthews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Florida.
- Trigiano RN, Windham MT & Windham AS. 2004. *Plant Pathology- Concepts and Laboratory Exercises*. CRC Press, Florida.



Paper Code	Course Title	Credits
GPB-501	PRINCIPLES OF GENETICS	3(2+1)

### OBJECTIVE

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

### THEORY

#### UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance. Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

#### UNIT II

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis.

#### UNIT III

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters. Regulation of gene activity in prokaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing.

#### UNIT IV

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCRbased cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro RNAs (miRNAs), Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.



Methods of studying polymorphism at biochemical and DNA level; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts, Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

### PRACTICAL

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification- Electrophoresis- basic principles and running of amplified DNA- Extraction of proteins and isozymes- use of *Agrobacterium* mediated method and Biolistic gun; practical demonstrations- Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.

### SUGGESTED READINGS

- Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.
- Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.
- Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.
- Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.
- Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.
- Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India
- Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.
- Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on*
- *Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.



Paper Code	Course Title	Credits
<b>GPB-504</b>	<b>CELL BIOLOGY AND MOLECULAR GENETICS</b>	<b>3(2+1)</b>

### OBJECTIVE

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

### THEORY

#### UNIT I

Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles – nucleus, plastidschloro/ chromoplast, mitochondria endoplasmic reticulum, Golgi complex, lysosomes, peroxisomes.

#### UNIT II

Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division.

#### UNIT III

Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs and translational factors.

#### UNIT IV

Transposable elements; Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences – Unique and repetitive sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.



### **PRACTICAL**

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

### **SUGGESTED READINGS**

- *Bruce A.2004. Essential Cell Biology. Garland.*
- *Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.*
- *Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.*
- *Lewin B. 2008. IX Genes. John Wiley & Sons*
- *Lodish H, Berk A & Zipursky SL. 2004. Molecular Cell Biology. 5th Ed. WH Freeman.*
- *Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman & Co.*
- *Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.*
- *Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.*



Paper Code	Course Title	Credits
STAT-501	STATISTICAL METHODS FOR APPLIED SCIENCES	4(3+1)

**OBJECTIVE**

It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

**THEORY**

**UNIT I**

Classification, tabulation and graphical, representation of data. Box-plot, Descriptive statistics. Exploratory data analysis;

**UNIT II**

Measures of central tendency- Mean, Median, Mode, Geometric mean, Harmonic mean. Measures of Dispersion- Range, Quartile deviation, Mean deviation, Standard deviation.

**UNIT III**

Theory of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions. Correlation and regression

**UNIT IV**

Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.



## PRACTICAL

- ❖ Exploratory data analysis, Box-Cox plots; Fitting of distributions~Binomial, Poisson, Negative Binomial.
- ❖ Normal; Large sample tests, testing of hypothesis based on exact sampling distributions-chi square, t and F.
- ❖ Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution.
- ❖ Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis.
- ❖ Nonparametric tests.

## SUGGESTED READINGS

- *Anderson TW. 1958. An Introduction to Multivariate Statistical Analysis. John Wiley.*
- *Goon AM, Gupta MK & Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I*
- *Goon AM, Gupta MK & Dasgupta B. 1983. Fundamentals of Statistics. Vol. I.*
- *Hoel PG. 1971. Introduction to Mathematical Statistics. John Wiley.*



Paper Code	Course Title	Credits
PGS-501	<b>BASIC CONCEPT IN LABORATORY TECHNIQUE</b>	N.C.

### OBJECTIVE

To acquaint the students about the basics of commonly used techniques in laboratory.

### PRACTICAL

- ❖ Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution;
- ❖ Handling techniques of solutions; Preparation of different agrochemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values.
- ❖ Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing.
- ❖ Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability.
- ❖ Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

### SUGGESTED READINGS

- *Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.*
- *Gabb MH & Latchem WE.1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.8. FMPE 503: Testing and Evaluation of Tractors and Farm Equipment.*
- *Aneja, K.R. fourth edition Experiments in Microbiology, Plant pathology and Biotechnology.*





Paper Code	Course Title	Credits
PGS-502	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	N.C.

**OBJECTIVE**

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

**THEORY**

**UNIT I**

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NA RS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR):

**UNIT II**

International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility. Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

**UNIT III**

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group Area Specific Programme, Integrated Rural Development Programme (IROP) Panchayati Raj Institutions, Co-operatives. Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

**SUGGESTED READINGS**

- *Bhalla G. S. & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.*
- *Punia M. S. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.*
- *Rao B. S. V. 2007. Rural Development Strategies and Role of Institutions Issues, Innovations and Initiatives. Mittal Pub.*
- *Singh K. 199H. Rural Development - Principles. Policies and Management. Sage Pub.*



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

**Course Contents**

**(SECOND SEMESTER)**

Paper Code	Course Title	Credits
PP-511	PLANT BACTERIOLOGY	3(2+1)

**OBJECTIVE**

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

**THEORY**

**UNIT I**

History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.

**UNIT II**

Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

**PRACTICAL**

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**

- Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.
- Jayaraman J & Verma JP. 2002. *Fundamentals of Plant Bacteriology*. Kalyani Publ., Ludhiana.
- Mount MS & Lacy GH. 1982. *Phytopathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.
- Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.
- Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.



Paper Code	Course Title	Credits
PP-512	INTEGRATED DISEASE MANAGEMENT	3(2+1)

### OBJECTIVE

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

### THEORY

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM- basic principles, biological, chemical and cultural disease management. IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed mustard, pearl millet, *kharif* pulses, vegetable crops and fruit crops.

### PRACTICAL

Application of biological, cultural, chemical and biocontrol agents, their compatibility and integration in IDM; demonstration of IDM in certain crops as project work.

### SUGGESTED READINGS

- *Gupta VK & Sharma RC. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.*
- *Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004.*
- *Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.*
- *Sharma RC & Sharma JN. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.*



Paper Code	Course Title	Credits
PP-513	MUSHROOM PRODUCTION TECHNOLOGY	3(2+1)

### OBJECTIVE

To develop mushroom cultivation skills for entrepreneurial activity. Historical development of mushroom cultivation and present status of mushroom industry in India.

### THEORY

#### UNIT I

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

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. 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 III

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.

### PRACTICAL

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

### SUGGESTED READINGS

- *Frazier, Food Microbiology, 1987. McGraw- Hill Education Pvt Ltd*
- *Pelzer, Food Microbiology, 1998 McGraw- Hill Education Pvt Ltd*
- *Bibek Ray, 2005. Fundamentals of Food Microbiology, CRC Press*
- *Martin and Moss, 2008. Food Microbiology, RSC Publishing*



Paper Code	Course Title	Credits
PP-514	DISEASES OF FIELD AND MEDICINAL PLANTS	2(1+1)

### OBJECTIVE

To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases caused by fungal, bacterial and viral diseases.

### THEORY

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize. Diseases of Pulse crops- gram, urdbean, mothbean, mungbean, lentil, pigeonpea, soybean. Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor. Diseases of Cash crops- cotton, sugarcane. Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea. Medicinal crops- plantago, liquorice, mulathi, rosagrass, sacred basil, mentha, ashwagandha, Aloe vera.

### 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.

### SUGGESTED READINGS

- Joshi LM, Singh DV & Srivastava KD. 1984. *Problems and Progress of Wheat Pathology in South Asia*. Malhotra Publ. House, New Delhi.
- Rangaswami G. 1999. *Diseases of Crop Plants in India*. 4th Ed. Prentice Hall of India, N Delhi.
- Ricanel C, Egan BT, Gillaspie Jr AG & Hughes CG. 1989. *Diseases of Sugarcane, Major Diseases*. Academic Press, New York.
- Singh RS. 2007. *Plant Diseases*. 8th Ed. Oxford & IBH, New Delhi.
- Singh US, Mukhopadhyay AN, Kumar J & Chaube HS. 1992. *Plant Diseases of Internatiobnal Importance*. Vol. I.
- *Diseases of Cereals and Pulses*. Prentice Hall, Englewood Cliffs, New Jersey.
- Thind, T.S. 1998. *Diseases of field Crops and their management*. National Agril. Technology Information Centre, Ludhiana, India.



Paper Code	Course Title	Credits
GPB-512	<b>BIOTECHNOLOGY FOR CROP IMPROVEMENTS</b>	<b>3(2+1)</b>

### OBJECTIVE

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

### THEORY

#### UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation.

#### UNIT II

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F<sub>2</sub>s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

#### UNIT III

Marker assisted selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker-assisted backcross breeding for rapid introgression, Generation of EDVs. Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.



#### UNIT IV

Biotechnology applications in male sterility/hybrid breeding, molecular farming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights, Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

#### PRACTICAL

Requirements for plant tissue culture laboratory-Techniques in plant tissue culture - Media components and media preparation -Aseptic manipulation of various explants; observations on the contaminants occurring in media – interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells / tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

#### SUGGESTED READINGS

- *Chopra V. L., & Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.*
- *Gupta P. K. 1997. Elements of Biotechnology. Rastogi Publ.*
- *Hackett P. B., Fuchs J. A. & Messing J. W. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.*
- *Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.*
- *Singh B. D. 2005. Biotechnology, Expanding Horizons. Kalyani.*



Paper Code	Course Title	Credits
<b>GPB-513</b>	<b>MAINTENANCE BREEDING AND CONCEPT OF VARIETY RELEASE AND SEED PRODUCTION</b>	<b>2(1+1)</b>

### OBJECTIVE

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

### THEORY

#### UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid, and population; Variety testing, release and notification systems in India and abroad. DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding. Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

#### UNIT II

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearl millet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.





### PRACTICAL

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

### SUGGESTED READINGS

- *Agarwal R. L. 1997. Seed Technology. 2nd Ed. Oxford & IBH.*
- *Chhabra A. K. 2006. Practical Manual of Floral Biology of Crop Plants.*
- *Department of Plant Breeding. CCS HAU Hisar.*
- *Kelly A. F. 1988. Seed Production of Agricultural Crops. Longman.*
- *McDonald M. B. Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.*
- *Musil A. F. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC.*
- *Poehlman J. M. & Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH.*
- *Singh B. D. 2005. Plant Breeding: Principles and Methods. Kalyani.*
- *Thompson J. R. 1979. An Introduction to Seed Technology. Leonard Hill.*
- *Tunwar N. S. & Singh S. V. 1985. Handbook of Cultivars. ICAR.*



Paper Code	Course Title	Credits
STAT-511	DESIGN OF EXPERIMENTS	3(2+1)

### OBJECTIVE

This course is meant for students of agricultural and animal sciences other than Statistics. Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

### THEORY

#### UNIT I

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control. Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

#### UNIT II

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment.

#### UNIT III

Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

#### UNIT IV

Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.



### **PRACTICAL**

- ❖ Uniformity trial data analysis, formation of plots and blocks,
- ❖ Fairfield Smith Law; Analysis of data obtained from CRD, RBD, LSD
- ❖ Analysis of factorial experiments without and with confounding; Analysis with
- ❖ missing data; Split plot and strip plot designs
- ❖ Transformation of data; Analysis of resolvable designs
- ❖ Fitting of response surfaces.

### **SUGGESTED READINGS**

- Cochran WG & Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
- Federer WT. 1985. Experimental Designs. MacMillan. Fisher RA. 1953.
- Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK & Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ. Pearce SC. 1983.
- The Agricultural Field Experiment: A Statistical Examination of Theory and Practice. John Wiley. Design Resources Server: [www.iasri.res.in/design](http://www.iasri.res.in/design).



Paper Code	Course Title	Credits
PGS-511	LIBRARY AND INFORMATION SERVICES	N.C.

### OBJECTIVE

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

### PRACTICAL

- ❖ Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.).
- ❖ Tracing information from reference sources.
- ❖ Literature survey; Citation techniques / Preparation of bibliography.
- ❖ Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services.
- ❖ Use of Internet including search engines and its resources; ere sources access methods.



Paper Code	Course Title	Credits
PGS-512	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	N.C.

**OBJECTIVE**

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge based economy.

**THEORY**

**UNIT I**

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs. Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, Trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection

**UNIT II**

Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

**SUGGESTED READINGS**

- *Erbisch FH & Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.*
- *Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.*
- *Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V.*
- *Technology Generation and IPR Issues. Academic Foundation. Rothschild M & Scott N. (Ed.). 2003.*
- *Intellectual Property Rights in Animal Breeding and Genetics. CABI.*
- *Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.*
- *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*



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

**Course Contents**

**(THIRD SEMESTER)**

Paper Code	Course Title	Credits
PGS-521	<b>TECHNICAL WRITING AND COMMUNICATION SKILL</b>	<b>N.C.</b>

**OBJECTIVE**

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

**PRACTICAL**

**Technical Writing** - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

**Communication Skills** - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.



### SUGGESTED READINGS

- *Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.*
- *Collins' Cobuild English Dictionary. 1995. Harper Collins.*
- *Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.*
- *Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.*
- *James HS. 1994. Handbook for Technical Writing. NTC Business Books.*
- *Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.*
- *Mohan K. 2005. Speaking English Effectively. MacMillan India.*
- *Richard WS. 1969. Technical Writing. Barnes & Noble.*
- *Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.*
- *Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.*
- *Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.*



Paper Code	Course Title	Credits
PGS-522	DISASTER MANAGEMENT	N.C.

### OBJECTIVES

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

### THEORY

#### UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

#### UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

#### UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

### SUGGESTED READINGS

- *Gupta H. K. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.*
- *Hodgkinson P. E. & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.*
- *Sharma V. K. 2001. Disaster Management. National Centre for Disaster Management, India.*





<b>Paper Code</b>	<b>Course Title</b>	<b>Credits</b>
<b>SVN-500</b>	<b>CHARITRA NIRMAN EVAM SAMGRA VYAKTITVA VIKAS</b>	<b>N.C.</b>

(As per Swami Vivekanand University Syllabus)



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

**Course Contents**

**(FOURTH SEMESTER)**

Paper Code	Course Title	Credits
<b>PP-599</b>	<b>MASTERS RESEARCH (ACCEPTED)</b>	<b>10(0+10)</b>

**Note:** To complete master research from the same campus as well from any ICAR, CSIR laboratory/ institute to fulfillment of his/her Master of Science in Agriculture.

**LIST OF JOURNALS**

- *Annals of Applied Biology* – Cambridge University Press, London
- *Annual Review of Phytopathology* – Annual Reviews, Palo Alto, California
- *Annual Review of Plant Pathology* - Scientific Publishers, Jodhpur
- *Canadian Journal of Plant Pathology* - Canadian Phytopathological Society, Ottawa
- *Indian Journal of Biotechnology* - National Institute of Science Communication and Information Resources, CSIR, New Delhi
- *Indian Journal of Mycopathological Research*- Indian Society of Mycology, Kolkata.
- *Indian Journal of Virology* - Indian Virological Society, New Delhi
- *Indian Phytopathology* - Indian Phytopathological Society, New Delhi
- *Journal of Mycology and Plant Pathology* - Society of Mycology and Plant Pathology, Udaipur
- *Journal of Phytopathology* - Blackwell Verlag, Berlin
- *Mycologia* - New York Botanical Garden, Pennsylvania
- *Mycological Research* - Cambridge University Press, London
- *Physiological Molecular Plant Pathology* - Academic Press, London
- *Phytopathology* - American Phytopathological Society, USA
- *Plant Disease* - The American Phytopathological Society, USA
- *Plant Disease Research* – Indian Society of Plant Pathologists, Ludhiana
- *Plant Pathology* - British Society for Plant Pathology, Blackwell Publ.



- *Review of Plant Pathology* - CAB International, Wallingford
- *Virology*- New York Academic Press

## E-RESOURCES

- ✚ · [www.shopapspress.org](http://www.shopapspress.org)
- ✚ · [www.apsjournals.apsnet.org](http://www.apsjournals.apsnet.org)
- ✚ · [www.apsnet.org/journals](http://www.apsnet.org/journals)
- ✚ · [www.cabi\\_publishing.org](http://www.cabi_publishing.org)
- ✚ · [www.springer.com/life+Sci/agriculture](http://www.springer.com/life+Sci/agriculture)
- ✚ · [www.backwellpublishing.com](http://www.backwellpublishing.com)
- ✚ · [www.csiro.au](http://www.csiro.au)
- ✚ · [www.annual-reviews.org](http://www.annual-reviews.org)
- ✚ Australian Society for Horticultural Science <http://www.aushs.org.au/>
- ✚ Agricultural & Processed Food Products Export Development Authority (APEDA) <http://www.apeda.com/> American Society for Horticultural Science <http://www.ashs.org/>
- ✚ Asian Vegetable Research and Development Center (AVRDC) <http://www.avrdc.org.tw/> Australian Society for Horticultural Science <http://www.aushs.org.au/>
- ✚ Central Food Technological Research Institute (CFTRI) <http://www.cftri.com/> Central Institute of Medicinal & Aromatic Plants (CIMAP) <http://www.cimap.org/>
- ✚ Central Institute of Post harvest Engineering and Technology <http://www.icar.org.in/ciphet.html> Central Plantation Crops Research Institute (CPCRI), Kasaragod, Kerala <http://cpcri.nic.in/> Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram <http://www.ctcri.org/>
- ✚ Consultative Group on International Agricultural Research, CGIAR <http://www.cgiar.org/>
- ✚ Coffee Board, India <http://indiacoffee.org/>
- ✚ Department of Agriculture and Co-operation, India <http://agricoop.nic.in/>
- ✚ Department of Scientific and Industrial Research, India <http://dsir.nic.in/> FAO <http://www.fao.org/> Global Agribusiness Information Network: <http://www.fintrac.com/gain/>
- ✚ Greenhouse Vegetable Information: <http://www.ghvi.co.nz/>
- ✚ Indian Agricultural Research Institute (IARI) <http://www.iari.res.in/> Indian Council of Agricultural Research (ICAR) <http://www.icar.org.in> Indian Institute of Horticultural Research (IIHR) [www.iihr.res.in](http://www.iihr.res.in)
- ✚ Indian Institute of Spices Research (IISR), Calicut, Kerala <http://www.iisr.org/> Indo-American Hybrid Seeds [www.indamseeds.com](http://www.indamseeds.com)
- ✚ Institute of Vegetable and Ornamental Crops <http://www.igzev.de/>



- ✚ Institute for Horticultural Development, Victoria, Australia  
<http://www.nre.vic.gov.au/agvic/ih/> Kerala Agricultural University [www.kau.edu](http://www.kau.edu)
- ✚ Iowa State University Department of Horticulture <http://www.hort.iastate.edu/>
- ✚ National Bureau of Plant Genetic Resources (NBPGR), India  
<http://nbpgr.delhi.nic.in/> National Horticulture Board (NHB), India  
<http://hortibizindia.nic.in/>
- ✚ National Institute of Agricultural Extension Management (MANAGE),  
<http://www.manage.gov.in/>
- ✚ National Research Centre for Cashew (NRCC), <http://kar.nic.in/cashew/> India
- ✚ National Research Centre for Mushroom (NRCM), India  
<http://www.nrcmushroom.com/> National Research Centre for Oil Palm (NRCOP),  
India <http://www.ap.nic.in/nrcop>
- ✚ North Carolina State University, Dept. of Horticulture  
[http://www2.ncsu.edu/cals/hort\\_sci/](http://www2.ncsu.edu/cals/hort_sci/) Oregon State University, Dept. of Horticulture  
<http://osu.orst.edu/dept/hort>
- ✚ Pineapple News [http://agrss.sherman.hawaii.edu/pin\\_eapple/pineappl.htm](http://agrss.sherman.hawaii.edu/pin_eapple/pineappl.htm) Pomology  
Resources Center <http://www.bsi.fr/pomologie/english/pomology>: Rubber board,  
India <http://rubberboard.org.in/>
- ✚ Spice Paprika web site <http://www.paprika.deltav.hu/>: Spices Board, India  
<http://www.indianspices.com/>
- ✚ Sri Lanka Agribusiness on-line <http://www.agro-lanka.org/> Sustainable Apple  
Production: <http://orchard.uvm.edu/>