

CH. CHARAN SINGH UNIVERSITY, MEERUT



SYLLABUS

For

M. Sc. (Ag.) ENTOMOLOGY

Effective from

ACADEMIC SESSION 2017-2018

FACULTY OF AGRICULTURE

DEPARTMENT OF PLANT PROTECTION

Department of Plant Protection
Ch. Charan Singh University, Meerut

Syllabus for M Sc Ag (Entomology) Effective from session 2017-18

SI. No.	Name of the Course	Course Code	Credits L+P	Maximum Marks			
				Internal	External	Practical	Total
SEMESTER I							
1.	Statistical Methods	ENT-1001	3+1	50	50		100
2.	Insect Morphology	ENT-1002	3+1	50	50		100
3.	Classification of Insects	ENT-1003	3+2	50	50		100
4.	Techniques in Plant Protection	ENT-1004	1+2	50	50		100
	Practical –I (Based on above courses)*	ENT-5001				100	100
	Total		16				500
SEMESTER II							
5.	Insect Anatomy Physiology and Nutrition	ENT-2001	3+2	50	50		100
6.	Pests of Field Crops	ENT-2002	2+1	50	50		100
7.	Biological Control of Crop Pests and Weeds	ENT-2003	2+2	50	50		100
8.	Insect Ecology	ENT-2004	3+1	50	50		100
	Practical –II (Based on above courses)*	ENT-6001				100	100
	Total		16				500
SEMESTER III							
9.	Computer Applications and Bioinformatics	ENT-3001	3+1	50	50		100
10.	Toxicology of Insecticides	ENT-3002	3+1	50	50		100
11.	Principles of Integrated Pests Management	ENT-3003	3+1	50	50		100
12.	Pests of Horticulture and Plantation Crops	ENT-3004	3+1	50	50		100
	Practical –III (Based on above courses)*	ENT-7001				100	100
	Total		16				500
SEMESTER IV							
13.	Plant Quarantine	ENT-4001	2+0	50	50		100
14.	Storage Entomology	ENT-4002	2+1	50	50		100
15.	Commercial Entomology	ENT-4003	2+1	50	50		100
	Practical –IV (Based on above courses)*	ENT-8001				100	100
	Project Report Evaluation and Viva-voce	ENT-8002	6+0			50 + 50	100
	Total		14				500
	Grand Total of Credits and Marks		62				2000

*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, Portland, Oregon, 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: Insect Morphology
(Credits: 3+1)**

Teaching hours: 50

UNIT-I: Principles, utility and relevance: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. 10

UNIT-II: Head: Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites. 8

UNIT-III: Thorax: Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications. 12

UNIT-IV: Abdomen: Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis. 14

UNIT-V: Insect sense organs: Insect sense organs (mechano-, photo- and chemo-receptors). 6

Practical:

Study of insect segmentation, various tagmata and their appendages; preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Sense organs.

Suggested Readings:

1. Chapman, R.F. (2006). The Insects: Structure and function. 4th edition, Cambridge University Press, Cambridge, U.K.
2. David, B.V. and Ananthkrishnan, T.N. (2004). General and Applied Entomology. Tata-McGraw Hill, New Delhi.
3. Duntson, P.A. (2004). The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
4. Evans, J.W. (2004). Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
5. Richards, O.W. and Davies, R.G. (1977). Imm's General Text Book of Entomology. 10th Ed. Volume I. Structure, Physiology and Development. Chapman & Hall, New York.
6. Saxena, R.C. and Srivastava, R.C. (2007). Entomology at a Glance. Agrotech Publ. Academy, Jodhpur.
7. Snodgrass, R.E. (1993). Principles of Insect Morphology. Cornell University Press, Ithaca.

**Course – 3: Classification of Insects
(Credits: 3+2)**

Teaching hours: 50

UNIT-I: Brief evolutionary history of Insects: Introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained. 12

UNIT-II: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them: Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera – Orders Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid Orders (Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera. 20

UNIT-III: Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued): Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera. 18

Practical:

Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

Suggested Readings:

1. Mayr, E. (1971). Principles of Systematic Zoology. Tata McGraw-Hill, New Delhi.
2. Freeman, S. and Herron, J.C. (1998). Evolutionary Analysis. Prentice Hall, New Delhi.
3. Richards, O.W. and Davies, R.G. (1977). Imm's General Text Book of Entomology. 10th Ed. Volume II. Structure, Physiology and Development. Chapman & Hall, New York.
4. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed. Volume-I and II, Kalyani Publishers, New Delhi.
5. Triplehorn CA and Johnson NF. 1998. Borror and DeLong's Introduction to the Study of Insects. 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

**Course – 4: Techniques in Plant Protection
(Credits: 1+2)**

Teaching hours: 50

UNIT-I: Plant Protection equipments: Pest control equipments, principles, operation, maintenance, selection, application of pesticides and bio-control agents, seed dressing, soaking, root-dip treatment, dusting, spraying, application through irrigation water. 14

UNIT-II: Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers. 8

UNIT-III: Use of light, transmission and scanning electron microscopy. 8

UNIT-IV: Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE. 10

UNIT-V: Use of tissue culture techniques in plant protection. Computer application for predicting/ forecasting pest attack and identification. 10

Suggested Readings:

1. Alford, D.V. (1999). A Textbook of Agricultural Entomology. Blackwell Science, London.
2. Crampton, J.M. and Eggleston, P. (1992). Insect Molecular Science. Academic Press, London.
3. Saha, L.R. (2006). Handbook of Plant Protection. First edition, C.B.S. Publishers, New Delhi.
4. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed., Volume-I and II, Kalyani Publishers, New Delhi.

**Course – 5: Insect Anatomy, Physiology and Nutrition
(Credits: 3+2)**

Teaching hours: 50

UNIT-I: Anatomy and physiology: Scope and importance of insect anatomy and physiology. 4

UNIT-II: Structure, modification and physiology of different systems: Digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. 20

UNIT-III: Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapauses. 14

UNIT-IV: Insect nutrition: Role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets. 12

Practical:

Dissection of different insects to study comparative anatomical details of different systems; preparation of permanent mounts of internal systems; chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; determination of respiratory quotient; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets

Suggested Readings:

1. Chapman, R.F. (2006). The Insects: Structure and function. 4th edition, Cambridge University Press, Cambridge, U.K.
2. David, B.V. and Ananthkrishnan, T.N. (2004). General and Applied Entomology. Tata-McGraw Hill, New Delhi.
3. Duntson, P.A. (2004). The Insects: Structure, Function and Biodiversity. Kalyani Publishers, New Delhi.
4. Kerkut, G.A. and Gilbert, L.I. (1985). Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. I-XIII. Pergamon Press, New York.
5. Richards, O.W. and Davies, R.G. (1977). Imm's General Text Book of Entomology. 10th Ed. Volume I. Structure, Physiology and Development. Chapman & Hall, New York.
6. Saxena, R.C. and Srivastava, R.C. (2007). Entomology at a Glance. Agrotech Publishing Academy, Jodhpur.
7. Patnaik, B.D. (2002). Physiology of Insects. Dominant, New Delhi.
8. Wigglesworth, V.B. (1984). The Principles of Insects Physiology. 8th Ed. Chapman & Hall, New York.

**Course – 6: Pests of Field Crops
(Credits: 2+1)**

Teaching hours: 50

UNIT-I: Introduction: Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. 6

UNIT-II: Insect pests of cereals and millets and their management: Rice, wheat, maize, barley, pearl millet, sorghum, oat, etc. 10

UNIT-III: Insect pests of pulses, tobacco and oilseeds and their management: Arhar, black gram, green gram, chickpea, lentils, pea, soybean and tobacco. Mustard, sunflower, groundnut and coconut. 10

UNIT-IV: Insect pests of fibre crops, forages, sugarcane and their management: Cotton, jute, forages and sugarcane. 8

UNIT-V: Polyphagous pests: Grasshoppers, locusts, termites, white grubs and hairy caterpillars. 10

UNIT-VI: Non-insect pests and their management: Mites, birds, rodents, snails and slugs. 6

Practical:

Field visits, collection and identification of important pests and their natural enemies; detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

Suggested Readings:

1. Dunston, A.P. (2007). The Insects: Beneficial and Harmful Aspects. Kalyani Publishers, New Delhi.
2. Dhaliwal, G.S. and Arora, R. (2002). Principles of Insect-pests Management. First edition, Kalyani Publishers, New Delhi.
3. Dhaliwal, G.S., Singh, R. and Chhillar, B.S. (2006). Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi.
4. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed., Volume-I and II, Kalyani Publishers, New Delhi.
5. Singh, A. (2003). Field Problems of Important Crops. 2nd Eds., Publishing by Punjab Agricultural University, Ludhiana, India.
6. Saxena, R.C. and Srivastava, R.C. (2007). Entomology at a Glance. Agrotech Publishing Academy, Jodhpur.

**Course – 7: Biological Control of Crop Pests and Weeds
(Credits: 2+2)**

Teaching hours: 50

UNIT-I: Biological control: History, principles and scope of biological control. Important groups of parasitoids, predators and pathogens. 8

UNIT-II: Principles of classical biological control: Importation, augmentation and conservation. 4

UNIT-III: Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. 6

UNIT-IV: Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects 10

UNIT-V: Mass production of quality biocontrol agents: Techniques, formulations, economics, field release/application and evaluation. 8

UNIT-VI: Successful biological control projects, analysis, trends and future possibilities of biological control. 6

UNIT-VII: Importation of natural enemies: Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control. 8

Practical:

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Suggested Readings:

1. Burges, H.D. and Hussey, N.W. (1971). Microbial Control of Insects and Mites. Academic Press, London.
2. De, Bach P. (1964). Biological Control of Insect Pests and Weeds. Chapman & Hall, New York.
3. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practices of Biological Control. Academic Press, London.
4. Ignacimuthu, S.S. and Jayaraj, S. (2003). Biological Control of Insect Pests. Phoenix Publishers, New Delhi.
5. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Eds., Volume-I, Kalyani Publishers, New Delhi.
6. Dhaliwal, G.S. and Arora, R. (2001). Integrated Pest Management: Concepts and Approaches. Kalyani Publishers, New Delhi.
7. Saxena, A.B. (2003). Biological Control of Insect Pests. Anmol Publishers, New Delhi.
8. Vora, M.S; Selt, H.N. and Vyar, R.V. (2008). Hand Book of Biofertilizers and Microbial Pesticides. 1st Eds., Satish Serial Publishing House, New Delhi.

**Course – 8: Insect Ecology
(Credits: 3+1)**

Teaching hours: 50

UNIT-I: History and definition. Basic concepts. Organisation of the biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis and Systems approach to ecology. 12

UNIT-II: Basic concepts of abundance: Model vs Real world. Population growth basic models: Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental resistance and optimal yield. Vital statistics: Life tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. 8

UNIT-III: Population dynamics: Factors affecting abundance: Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) – aestivation and hibernation. 8

UNIT-IV: Biotic factors: Food as a limiting factor for distribution and abundance, Nutritional ecology. Food chain: web and ecological succession. Interspecific interactions: Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition: Lotka-Volterra model, Concept of niche-ecological homologues, competitive exclusion. Prey-predator interactions: Basic model- Lotka-Volterra Model, Volterra's principle. Functional and numerical response. Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. 12

UNIT-V: Community ecology: Concept of guild, Organisation of communities- Hutchinson Ratio, May's d/w , Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity: stability debate, relevance to pest management. Pest management as applied ecology. 10

Practical:

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of some diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology. Field visits to understand different ecosystems and to study insect occurrence in these systems.

Suggested Readings:

1. Chapman, J.L. and Reiss, M.J. (2006). Ecology: Principles & Applications. 2nd Ed. Cambridge Univ. Press, Cambridge.
2. Gotelli NJ. 2001. A Primer of Ecology. 3rd Ed. Sinauer Associates, Inc., Sunderland, MA.
3. Gupta, R.K. (2004). Advances in Insect Biodiversity. Agrobios, Jodhpur.
4. Krebs, C.J. (2001). Ecology: The Experimental Analysis of Distribution and Abundance. 5th Ed. Benjamin-Cummings Publ. Co., New York.
5. Price, P.W. (1997). Insect Ecology. 3rd Ed. John Wiley, New York.
6. Southwood, T.R.E & Henderson, PA (2000). Ecological Methods. Methuen & Co Ltd., London
7. Speight, M.R., Hunta, M.D. and Watt, A.D. 2006. Ecology of Insects: Concepts and Application. Elsevier Science Publ., The Netherlands.
8. Wratten, SD & Fry, GLA. (1980). Field and Laboratory Exercises in Ecology. Arnold, London.

**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: Toxicology of Insecticides
(Credits: 3+1)**

Teaching hours: 50

UNIT-I: Introduction: Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India. 4

UNIT-II: Classification of insecticides and acaricides: Classification based on mode of entry, Classification based on mode of chemical nature. 4

UNIT-III: Structure and mode of action: Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc. 10

UNIT-IV: Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity. 10

UNIT-V: Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence. 8

UNIT-VI: Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning. 10

UNIT-VII: Insecticide formulations and mixtures & quality control of pesticide formulations. 4

Practical:

Insecticide formulations and mixtures; quality control of pesticide formulations; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity and joint action. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides; visit to toxicology laboratories. Good laboratory practices.

Suggested Readings:

1. IUPAC (1986). Pesticide Science and Biotechnology. Sixth edition. Black Well Publication, Australia.
2. Chattopadhyay, S.B. (1985). Principles and Procedures of Plant Protection. Oxford & IBH, New Delhi.
3. Gupta, H.C.L. (1999). Insecticides: Toxicology and Uses. 2nd Ed., Agrotech Publ., Udaipur.
4. Ishaaya, I. and Degheele. (1998). Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
5. Matsumura, F. (1985). Toxicology of Insecticides. Plenum Press, New York.
6. Parmar, B.S; Tomar, S.S (2004). Pesticides Formulation: Theory and Practical. 1st Ed., CBS. Publishers and Distributors, New Delhi.
7. Perry, A.S., Yamamoto, I., Ishaaya, I. and Perry, R. (1998). Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
8. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed., Volume-II, Kalyani Publishers, New Delhi.

**Course – 11: Principles of Integrated Pests Management
(Credits: 3+1)**

Teaching hours: 50

UNIT-I: Integrated Pests Management: History, origin, definitions and importance. 6

UNIT-II: Concept of IPM and Economic decision levels: Concept of Integrated pest's management; Economic decision levels of insect pest population: ETL, EIL and GEP. Insect dominance. Pest outbreak, causes and factors affecting it. Categories of pests. 8

UNIT-III: Tools of pest management and their integration: Cultural control. Physical and mechanical control. Legislative control. Host plant resistance; principles, characterisation and mechanisms and potential in IPM. Semiochemicals: Pheromones and allelochemicals and their potential in IPM. Insect attractants, repellents and antifeedents. Biological control: Definition, techniques, parasitoids and predators; Microbial control: Definition, common microbes; advantages and disadvantages of biocontrol. Chemical control; classification of insecticides based on mode of entry, action, toxicity and chemical nature; formulations of insecticides. 12

UNIT-IV: Assessment of insect populations: Sampling techniques. Survey, surveillance and forecasting of pest populations. 8

UNIT-V: Case studies of successful Integrated Pests Management programmes. 8

UNIT-VI: Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors. 8

Practical:

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system.

Suggested Readings:

1. Butt, T.M; Jackson, C.W. and Magan, N. (2001). Fungi as Biocontrol Agents: Progress, Problems and Potential. 1st Ed., CAB Publishing, New York, USA.
2. Dhaliwal, G.S. and Arora, R. (2002). Integrated Pest Management- Concepts and Approaches. 1st Ed., Kalyani Publishers, New Delhi.
3. Horowitz, A.R. and Ishaaya, I. (2004). Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
4. Metcalf, R.L. and Luckman, W.H. (1982). Introduction of Insect Pest Management. John Wiley & Sons, New York.
5. Neil, Helyer., Kevin, Brown. and Cattlin, N. D. (2003). Biocontrol in Plant Protection. 1st Ed., Timber Press, North America, USA.
6. Norris, R.F., Caswell-Chen, E.P. and Kogan, M. (2002). Concepts in Integrated Pest Management. Prentice Hall, New Delhi.
7. Srivastava, K.P. (2004). A text book of Applied Entomology. 2nd Ed., Volume-I & II, Kalyani Publishers, New Delhi.

**Course – 12: Pests of Horticulture and Plantation Crops
(Credits: 3+1)**

Teaching hours: 50

UNIT-I: Introduction: Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. 6

UNIT-II: Insect pests of fruit crops and their management: Mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, ber, citrus, aonla, pineapple, apple, peach, plum, & coconut. 10

UNIT-III: Insect pests of vegetable crops and their management: Tomato, potato, radish, carrot, beetroot, cole crops, french beans, brinjal, okra, all gourds and leafy vegetables. 10

UNIT-IV: Insect pests of plantation crops and their management: Coffee, tea, rubber, coconut, arecanut, cashew and cocoa. 8

UNIT-V: Insect pests of spices and condiments and their management: Pepper, cardamom, clove, chillies, turmeric and ginger. 8

UNIT-VI: Pests of ornamental, medicinal and aromatic plants. 4

UNIT-VII: Pests in polyhouses and protected cultivation. 4

Practical:

Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and noninsect pests.

Suggested Readings:

1. Atwal, A.S. and Dhaliwal, G.S. (2002). Agricultural Pests of South Asia and their Management. Kalyani Publishers, New Delhi.
2. Butani, D.K. and Jotwani, M.G. (1984). Insects and Vegetables. Periodical Expert Book Agency, New Delhi.
3. Dhaliwal, G.S., Singh, R. and Chhillar, B.S. (2006). Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi.
4. Dhaliwal, G.S. and Arora, R. (2002). Principles of Insect-pests Management. 1st Ed., Kalyani Publishers, New Delhi.
5. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed., Volume-I and II, Kalyani Publishers, New Delhi.
6. Verma, L.R., Verma, A.K. and Goutham, D.C. (2004). Pest Management in Horticulture Crops: Principles and Practices. Asiatech Publ., New Delhi.

**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 toxigen, 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. Rajeev, K. and Mukherjee, R.C. (1996). Role of Plant Quarantine in IPM. Aditya Books.
2. Rhower, G.G. (1991). Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd Ed., Vol. II. (Ed. David Pimental). CRC Press.
3. Saha, L.R. (2006). Handbook of Plant Protection. First edition, C.B.S. Publishers, New Delhi.
4. Srivastava, K.P. (2004). A Text book of Applied Entomology. 2nd Ed., Volume-I and II, Kalyani Publishers, New Delhi.

**Course – 14: Storage Entomology
(Credits: 2+1)**

Teaching hours: 50

UNIT-I: Introduction: History of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto vis-à-vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses. 8

UNIT-II: Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage, role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes. 14

UNIT-III: Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. 8

UNIT-IV: Grain storage: Types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities' storage conditions. 6

UNIT-V: Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures: Hygiene/sanitation, disinfestations of stores/receptacles, legal methods. Curative measures: Non-chemical control measures: ecological, mechanical, physical, cultural biological and engineering. Chemical control: Prophylactic and curative: Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management. 14

Practical:

Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them; detection of insect infestation in stored food grains; estimation of losses in stored food grains; determination of moisture content in stored food grains; familiarization of storage structures, demonstration of preventive and curative measures including fumigation techniques; treatment of packing materials and their effect on seed quality. Field visits to save grain campaign, central warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

Suggested Readings:

1. Hall, D.W. (1970). Handling and Storage of Food Grains in Tropical and Subtropical Areas. FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.
2. Jayas, D.V., White, N.D.G. and Muir, W.E. (1995). Stored Grain Ecosystem. Marcel, New York.
3. Khader, V. (2004). Textbook on Food Storage & Preservation. Kalyani Publishers, New Delhi.
4. Khera, B.P. (1994). Store Grain Pests and Their Management. Kalyani Publishers, New Delhi.
5. Subramanyam, B. and Hagstrum, D.W. (1995). Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

**Course – 15: Commercial Entomology
(Credits: 2+1)**

Teaching hours: 50

UNIT-I: Bee keeping: General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products. Establishment and maintenance of apiaries. 14

UNIT-II: Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms. Lac insect-natural enemies and their management. 10

UNIT-III: Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management. 10

UNIT-IV: Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and post construction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management. 16

Practical:

Identification of honey bee species, bee castes and special adaptations, identification and handling of bee-keeping equipments. Handling of honey bees-hive and frame inspection. Honey extraction and processing methods of hive products extraction. Preparation of bee-keeping projects for funding. Visit to bee nursery and commercial apiaries. Silkworm rearing and management

Suggested Readings:

1. Aruga, H. 1994. Principles of Sericulture. Oxford & IBH, New Delhi.
2. Atwal, A.S. 2006. The World of the Honey Bee. Kalyani Publ., New Delhi.
3. Ganga, G. 2003. Comprehensive Sericulture. Vol. II. Silkworm Rearing and Silk Reeling. Oxford & IBH, New Delhi.
4. Partiban, S. and David, B.V. 2007. Management of Household Pests and Public Health Pests. Namratha Publ., Chennai.
5. Singh, S. 1975. Beekeeping in India. ICAR, New Delhi.