

# SHRI GURU RAM RAI UNIVERSITY

Pathri bagh, Dehradun-248001, Uttarakhand, India

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s 2(f) of UGC Act 1956]

## COURSE CURRICULUM & SYLLABUS

*Effective from Academic Session: 2022-2023*

For Academic programme

### **Ph.D. Entomology**



**Approved by:**

*BOARD OF STUDIES*  
DEPARTMENT OF ENTOMOLOGY  
SCHOOL OF AGRICULTURAL SCIENCES  
SHRI GURU RAM RAI UNIVERSITY

**Pre-Ph. D. / Ph. D. (Entomology)**  
**“Curriculum & Syllabus”**

**Table 1:** The course structure and assessment scheme:

S. No.	Course code	Course title	Credits (L:T:P)	Total credits	Total marks	Minimum marks for completion
<b>Core courses</b> (all courses are mandatory)						
1.	<b>PRMC-601</b>	Research Methodology	4 (2:1:1)	4	80	40
2.	<b>PREC-602</b>	Research & Publication Ethics	2 (1:1:0)	2	40	20
3.	<b>PPEC-603</b>	Insect phylogeny and Systematics	4 (2:1:1)	4	80	40
4.	<b>PPES-604</b>	Doctoral Seminar- I	2 (0:0:2)	4	80	40
		Doctoral Seminar- II				
		Field Work/Workshop	2(0:2:0)			
<b>Elective Courses</b> (select any one course)						
5.	<b>PPEE-605</b>	Insect Behaviour	4 (2:1:1)	4	80	40
	<b>PPEE-606</b>	Plant Resistance to Insects	4 (2:1:1)			
	<b>PPEE-607</b>	Bio-inputs for Pest Management	4 (2:1:1)			
	<b>PPEE-608</b>	Advances in Integrated Pest Management	4 (2:1:1)			
<b>Total</b>				18	360	180
<b>Ph. D. Thesis Research</b>						
6.	<b>PPET-609</b>	Ph. D. Thesis Research		75	Non Credit	

\*After completion of Pre-Ph.D. course work, student will register for Ph.D. Entomology to conduct research work. He/she will have to fill up a prescribed admission form of University and submit along with the synopsis on a proposed research work under the designated supervisor of the University.

### **Pre-Ph.D./Ph.D (Entomology) programme**

**Programme Outcome:** After completion of programme the students will be able to

- P.O. 1: Develop deeper understanding of a subject for its application in addressing socio-economic issues pertaining to agriculture.
- P.O. 2: To understand the critical aspects of conducting ethical research for sustainable development.
- P.O. 3: To develop the capability of reasoning-based scientific solution for agricultural pest problems.
- P.O.4: To understand the impact of research & development on environment safety and sustainability.
- P.O.5: Inculcate the leadership skills required to identify the problem and finding the solution in coherence with the teamwork.
- P.O.6: To develop the skill set of designing and executing experiments pertaining to a targeted scientific problem.
- P.O.7: Develop the analytical skills prerequisite for analyzing data, explaining findings, justifying the findings to reach final conclusion.
- P.O.8: To develop meticulous scientific writing skills for presenting the research outcomes.

**Programme Specific Outcomes:** After completion of programme the students will be able to

- P.S.O. 1: To develop the depth of knowledge & skills in Entomology.
- P.S.O. 2: To utilize the various recent management strategies for different insect pests.
- P.S.O. 3: To disseminate principles and techniques of Integrated Pest Management.
- P.S.O. 4: Develop skills in ethical dimensions of research work in Entomology

## **A. Core Courses**

### **Research Methodology**

**Course Code:**PRMC-601

**Credit: 4 (2:1:1)**

**Objective:**

To apprise students with the knowledge of statistical methods and techniques, and their application in seed science and technology.

**Theory:**

**UNIT -I : Concept & Types of Research**

Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem – Research Design, Classification of Research, Pure and Applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/Study, Evaluation research/Studies, Action Research, Experimental Research, Analytical Study of Statistical Method, Historical Research,

**UNIT-II: Methods Research**

Surveys, Case Study, Field Studies, General Survey and Survey Methods: Interdisciplinary Method, Case Study Method, Sampling Method, Statistical Method, Observation Method, Interview Method, Schedule Method, Questionnaire Method, Documentary Method, Library Method, Historical Method and Scientific Method. Characteristic Features of Scientific Method; Empirical Verifiable, Cumulative, Self-Correcting, Deterministic, Ethical & Ideological neutrality (Value Free).

**UNIT-III: Data Collection and Data Analysis**

Collection of data, Objectives and Classification of Data, Aims, Methods and Objects of Tabulation of Data, Forms and Processes of Interpretation and Presentation of Data.

Primary, Secondary and Tertiary Data. Construction and adaptation of instruments, administration of questions and tests, Tabulation of data. Data organization in SPSS & Excel, Graphical representation of data.

Definition and Aims of Content Analysis, Problems of Content Analysis, Computer and Content Analysis Discussion and Interpretation of results, Testing of Hypothesis: Logical and Statistical Techniques.

**UNIT –IV: Report Writing**

Locating Information on a Topic of Interest, Acquiring Copies of Articles of Interest, The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables, Levels of Measurement, Various Paradigms including Formism, Mechanism, Organicism, Pragmatism, The Basic Format for a Research Report, Identification of the Parts of a Research Report, Citation and Referencing Styles, Essentials of Report Writing, Aids for Writing Good Research Report.

**Practicals:** Lab exercises will be based on syllabus of course

**Course Outcome (COs):** After completion of course the students will be able to

- CO 1. Recall the basic framework of research process.
- CO 2. Understand various research designs and techniques.
- CO 3. Organize sources of information for literature review and data collection.
- CO 4. Simplify ethical dimensions of conducting applied research
- CO 5. Compare components of scholarly writing and evaluate its quality.
- CO6. Compose new & innovative statistical methods and techniques

**Suggested Readings:**

- Bagchi, Kanak Kanti (2007) Research Methodology in Social Sciences: A Practical Guide, Delhi, Abijeet Publications.
- Sharma, B.A.V., et al.,(2000) Research Methods in Social Sciences, New Delhi, Sterling Publishers
- B.A.V. Busha, C. Hand Harter, S. D (1980)Research Methods in Librarianship, New Academic Press.
- Cooper, R. Donald and Pamela S. Schindler(2003) Business Research Methods, Delhi, Tata McGraw-Hill.
- Flyvbjerg, Bent(2001)Making Social Science Matter:Why Social Inquiry Fails and How It can Succeed Again, United Kingdom, Cambridge University Press.
- Goodde and Hattie (1952)Methods in Social Research, New York, McGraw–Hill.
- Gopal, M. H (1970)An Introduction to Research Procedures in Social Sciences, Bombay, Asia Publishing House.

## Research & Publication Ethics

Code:PREC-602

Credit: 2(1:1:0)

### OBJECTIVE

To provide ethical knowledge and values related to agricultural research

#### Theory:

#### UNIT- I

##### Philosophy and Ethics

Introduction to Philosophy: definition, nature and scope, concept, branches. Ethics: definition, moral philosophy, nature of moral judgments and reactions

#### UNIT- II

##### Scientific Conduct

Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)

- Redundant publications: duplicate and overlapping publications, salami slicing
- Selective reporting and misrepresentation of data

#### UNIT- III

##### Publication Ethics

- Publication ethics: definition, introduction and importance
- Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
- Conflicts of interest
- Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice -versa, types
- Violation of publication ethics, authorship and contributorship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

#### Practical:

##### i. Open Access Publishing

- Open access publications and initiatives
- SHERPA/ RoMEO online resource to check publisher copyright & self- archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

##### ii. Publication Misconduct

###### Group Discussions

- Subject specific ethical issues, FFP, authorship
- Conflict of interest, Complaints and appeals: examples and fraud from India and abroad

##### iii. Software tools

- Use of plagiarism software like Turnitin, Urkund and other open source software tools

**iv. Databases**

- Indexing databases
- Citation databases: Web of Science, Scopus, etc.

**v. Research Metrics**

- Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
- Metrics: h- index, g index, i10 index, altmetrics

**Course Outcome:** After completion of course the students will be able to

CO 1: Relate research ethics, publications misconduct and plagiarism.

CO 2: Demonstrate intellectual honesty and research integrity.

CO3. Identify various sources of information for data bases and research matrices.

CO4. Examine open access publications and initiatives.

CO5. Evaluate the components of scholarly writing and its quality

CO6. Design best practices / standards setting initiatives and guidelines in research & publication ethics

## Insect Phylogeny and Systematics

**Course Code: PPEC-603**

**Credit: 4 (2:1:1)**

### OBJECTIVE

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects.

#### UNIT-I

Detailed study of three schools of classification- numerical, evolutionary and cladistic. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography.

#### UNIT -II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times

#### UNIT-III

International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures

#### UNIT-IV

Concept of Phylocode and alternative naming systems for animals. Selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular systematics.

### PRACTICAL

- Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, and construction of taxonomic keys for the selected group
- Development of descriptions, photographing, writing diagrams, and preparation of specimens for “type like” preservation, Submission of the collections made of the group
- Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms
- Rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

**Course Outcome (COs):** After completion of course the students will be able to

CO1. Recall the principles & keys for ordering the insects by visual observation.

CO2. Explain the importance of economically harmful and beneficial orders, family as well as insects.

CO3. Choose the taxonomic characteristics of insects for identification purpose as well as to conduct research work.

CO4. Distinguish different views on the evolution of insects

CO5. Compare methodologies employed in Phylogeny and Systematics

CO6. Create phenograms, cladograms etc. for the classification of organisms.



**Suggested Readings:**

- CSIRO 1990. The Insects of Australia: A Text Book for Students and Researchers. 2nd Ed. Vols. I and II, CSIRO. Cornell Univ. Press, Ithaca.
- Dakeshott J and Whitten MA. 1994. Molecular Approaches to Fundamental and Applied Entomology. Springer-Verlag, Berlin.
- Freeman S and Herron JC. 1998. Evolutionary Analysis. Prentice Hall, New Delhi
- Hennig W. 1960. Phylogenetic Systematics. Urbana Univ. Illinois Press, USA.
- Hoy MA. 2003. Insect Molecular Genetics: An Introduction to Principles and Applications. 2nd Ed. Academic Press, New York.
- Mayr E and Ashlock PD. 1991. Principles of Systematic Zoology. 2nd Ed. McGraw Hill, New York.
- Mayr E.1969. Principles of Systematic Zoology. McGraw-Hill, New York
- Quicke DLJ. 1993. Principles and Techniques of Contemporary Taxonomy. Blackie Academic and Professional, London.
- Ross HH. 1974. Biological Systematics. Addison Wesley Publ. Co., London.
- Wiley EO. 1981. Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists. Columbia Univ. Press, USA.

**B. ELECTIVE COURSES****Insect Behaviour****Course Code: PPEE – 605****Credit:4 (2:1:1)****OBJECTIVE**

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behavior in insects.

**Theory:****UNIT-I**

Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behavior, induced behavior, learnt behavior and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behavior- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behavior and behavioural polymorphism

**UNIT –II**

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

**UNIT-III**

Reproductive behavior- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behavior- kin selection, parental manipulation and mutualism; Self organization and insect behavior.

**UNIT-IV**

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behavior, pollination behavior, co-evolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioral manipulation as potential tool in pest management, use of semiochemicals, auditory stimuli and visual signals in pest management.

**Practical:**

- Quantitative methods in sampling behavior
- Training bees to artificial feeders;
- Sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees
- Evaluation of different types of traps against fruit flies with respect to signals
- Use of honey bees/ *Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

**Course Outcome (COs):** After completion of course the students will be able to

- CO1. Understand the insects behavior which will helpful in scientific dealing of insects.  
 CO2. Explain the utilization of insect behavior knowledge in management of harmful insect pest.  
 CO3. Experiment with behavioral manipulation of beneficial as well as harmful insects.  
 CO4. Contrast different types of behaviour found in insects  
 CO5. Criticize theories of insect behaviour

CO6. Design new insect behaviour based techniques & tools for pest management

**Suggested Readings**

- Ananthkrishnan TN. (Ed.). 1994. Functional Dynamics of Phytophagous Insects. Oxford and IBH, New Delhi.
- Awasthi VB. 2001. Principles of Insect Behaviour. Scientific Publ., Jodhpur.
- Bernays EA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, London.
- Brown LB. 1999. The Experimental Analysis of Insect Behaviour. Springer, Berlin.
- Krebs JR and Davies NB. 1993. An Introduction to Behavioral Ecology. 3rd Ed. Chapman and Hall, London.
- Manning A and Dawkins MS. 1992. An Introduction to Animal Behaviour. Cambridge University Press, USA.
- Mathews RW and Mathews JR. 1978. Insect Behaviour. A Wiley-Inter Science Publ. John Wiley and Sons, New York.

## Plant Resistance to Insects

**Course Code: PPEE – 606**

**Credit:4 (2:1:1)**

### OBJECTIVE

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

#### UNIT-I

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.

#### UNIT –II

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

#### UNIT-III

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker aided selection in resistance breeding

#### UNIT-IV

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

#### Practical

- Understanding mechanisms of resistance for orientation, feeding, oviposition, etc., allelo-chemical bases of insect resistance;
- Macro culturing of test insects like aphids, leaf/ plant hoppers, mites and stored grain pests
- Field screening- micro plot techniques, infester row technique, spreader row technique and plant nurseries
- Determination of antixenosis index, antibiosis index, tolerance index, plant resistance index

**Course Outcome (COs):** After completion of course the students will be able to

CO1. Remember different source of plant resistance against insect pests.

CO2. Outline the manipulation of plant characteristics against the insect pest.

CO3. Understand the interaction between host and herbivore for establishment of resistance in plants.

CO4. Distinguish desirable morphological, anatomical and biochemical adaptations of resistance

CO5. Estimate level of plant resistance based on plant damage

CO6. Develop new methods of lab & field screening for identification of level of plant resistance

#### Suggested Readings

- Panda N. 1979. Principles of Host Plant Resistance to Insects. Allenheld, Osum and Co., New York
- Rosenthal GA and Janzen DH. (Eds.). 1979. Herbivores – their Interactions with Secondary Plant Metabolites. Vol. I, II. Academic Press, New York
- Sadasivam S and Thayumanavan B. 2003. Molecular Host Plant Resistance to Pests. Marcel

Dekker, New York.

- Smith CM, Khan ZR and Pathak MD. 1994. Techniques for Evaluating Insect Resistance in Crop Plants. CRC Press, Boca Raton, Florida.

## Bio-Inputs for Pest Management

**Course Code: PPEE-607**

**Credit: 4 (2:1:1)**

### OBJECTIVE

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems

#### Theory:

##### UNIT-I

Scope of classical biological control and augmentative bio-control; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts, dynamics of bio-agents vis-à-vis target pest populations.

##### UNIT –II

Bio-inputs: mass production of bio-pesticides, mass culturing techniques of bioagents, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices

##### UNIT-III

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of bio-control agents, bankable project preparation.

##### UNIT-IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in bio-control agents for introgression and for progeny selections, breeding techniques of bio-control agents.

#### Practical

- Mass rearing and release of some commonly occurring indigenous natural enemies
- Assessment of role of natural enemies in reducing pest populations;
- Testing side effects of pesticides on natural enemies
- Effect of semio-chemicals on natural enemies, breeding of various bio-control agents, performance of efficiency analyses on target pests
- Project document preparation for establishing a viable mass-production unit/ insectary
- Observation of feeding behavior acts of predatory bugs/ beetles.

**Course Outcome (COs):** After completion of course the students will be able to

- CO1. Recall the concepts related to regulation of insects by other insects for the betterment of crop protection.
- CO2. Understand the identification of beneficial insects and their utilization for pest management.
- CO3. Choose the correct method of application of bio agent for the management of insect pests.
- CO4. Compare practical utility of different bio-inputs for pest management
- CO5. Assess bio-efficacy of bio-agents under field conditions
- CO6. Simplify mass multiplication techniques of bio-agents

#### Suggested Readings

- Burges HD and Hussey NW. (Eds.). 1971. Microbial Control of Insects and Mites. Academic Press, London.

- Coppel HC and James WM. 1977. Biological Insect Pest Suppression. Springer Verlag, Berlin.
- De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, London.
- Dhaliwal, GS and Koul O. 2007. Biopesticides and Pest Management. Kalyani Publishers, New Delhi.
- Gerson H and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York
- Huffakar CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.

## Advances in Integrated Pest Management

**Course Code: PPEE-608**

**Credit: 4 (2:1:1)**

### OBJECTIVE

To acquaint the students with recent concepts of integrated pest management; surveillance and data base management; successful national and international case histories of integrated pest management, non-conventional tools in pest management

### Theory:

#### UNIT-I

Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

#### UNIT –II

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

#### UNIT-III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

#### UNIT-IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

### Practical

- Methods of diagnosis and detection of various insect pests
- Sampling techniques for the estimation of insect population and damage
- Pest surveillance through light traps, pheromone traps and forecasting of pest incidence
- Assessment of crop yield losses
- Insect pest management under protected cultivation
- Pesticide resistance management.

**Course Outcome (COs):** After completion of course the students will be able to

CO1. Relate with basic concepts & principles for the integrated approaches of pest management.

CO2. Explain the environmentally safe and sustainable management strategies against insects.

CO3. Exploit of best management strategies to avoid the full dependence on chemical insecticides having hazardous effects to human beings.

CO4. Inspect the effectiveness of existing management strategies against insects

CO5. Choose the new, safe & effective method of pest management

CO6. Formulate area wise IPM module for economically important pests.

### Suggested Readings:

- Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publishers, New Delhi
- Dhaliwal GS, Singh R and Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publishers, New Delhi.



- Flint MC and Bosch RV. 1981. Introduction to Integrated Pest Management. Springer, Berlin
- Koul O and Cuperus GW. 2007. Ecologically Based Integrated Pest Management. CABI, London.
- Koul O, Dhaliwal GS and Curperus GW. 2004. Integrated Pest Management –Potential, Constraints and Challenges. CABI, London.
- Maredia KM, Dakouo D and Mota-Sanchez D. 2003. Integrated Pest Management in the Global Arena. CABI, London
- Metcalf RL and Luckman WH. 1982. Introduction to Insect Pest Management. John Wiley and Sons, New York.
- Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi
- Pedigo RL. 1996. Entomology and Pest Management. Prentice Hall, New Delhi
- Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York