

B. Sc. (Hons) Agriculture

Agricultural Entomology

- **Syllabus**
- **Teaching Schedule**
- **Suggested Readings**

B. Sc. (Hons) Agriculture

Departmentwise list of courses

1) Agril. Entomology

Sr. No.	Semester	Course No.	Credits	Course Title
1	II	ENTO 121	2(1+1)	Fundamentals of Entomology
2	III	ENTO 232	2(1+1)	Insect Ecology and Integrated pest Management
3	IV	ENTO 243	2(1+1)	Pest of Horticultural Crops and their Management
4	V	ENTO 354	2(1+1)	Pests of Crops and Stored Grain and their Management
5	VI	ENTO 365	2(1+1)	Management of Beneficial Insects
5	VIII	ELM ENTO 486	10(0+10)	Mass Production of Bioagents and Biopesticides
6	VIII	ELM ENTO 487	10(0+10)	Commercial Bee Keeping
7	VIII	ELM ENTO 488	10(0+10)	Silkworm Cocoon Production Technology

Course :	ENTO 121		Credit:	2(1+1)	Semester-II
Course title:	Fundamentals of Entomology				

Syllabus

Theory

Part-I

Introduction and History of Entomology in India. Definitions: Insect, Entomology, Agricultural Entomology. Classification of phylum Arthropoda up to classes. Relationship of class Insecta with other classes of Arthropoda. Insect Dominance. Economic importance of insects: Harmful, Beneficial and productive insects. Premier institutes concerned with Entomology. **Morphology:**-Insect integument: structure and functions. Cuticular appendages and processes. Moulting: Definition and steps in moulting. Body segmentation: Structure of head, thorax and abdomen. Insect head capsule: Important sclerites and sutures. Positions of head. Structure and modifications of insect antennae, mouth parts, legs and wings (wing venation, wing coupling apparatus). Structure of thorax and abdomen: segmentation, appendages and processes, pregenital and post genital appendages and structure of male and female genital organ. Metamorphosis: Definition and types of metamorphosis with examples and its significance. Insect Diapause: Definition and example, Seasonal adaptations in insects: aestivation, hibernation and quiescence: Definitions; Insect egg: General structure, types of egg with examples (at least one). Types of larva and pupa with examples. Structure and functions of digestive, nervous, circulatory, respiratory, excretory, secretory and reproductive systems in insects. Types of reproduction in insects. Sensory organs sound producing organs in insects

Part-II

Systematics: Definitions: Taxonomy, Systematics, Binomial nomenclature, Order, Family, Genus, Species, Subspecies, Biotype. Binomial nomenclature: Definition and Rules. Classification of Class Insecta upto Orders. Important orders: Important distinguishing/taxonomic characters of orders with families of agricultural importance with examples. Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Lophopidae, Lacciferidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical:

Methods of collection and preservation of insects. External features of Cockroach. Types of insect antennae, mouthparts (dissection) and legs. Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae. Dissection of digestive system, Central nervous system, male and female reproductive systems in insects

(Cockroach/Grasshopper). Distinguishing/taxonomic characters of orders: Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance with examples.

Teaching Schedules

a) Theory

Lecture	Topic	Weightage (%)
1-2	<ul style="list-style-type: none"> Introduction and history of entomology in India including contribution of scientists in brief. Definitions: Insect, Entomology and Agril. Entomology. Classification of phylum Arthropoda up to classes. Relationship of class Insecta with other classes of Arthropoda. Insect dominance. Economic importance of insects: Harmful, beneficial and productive insects. Premier institutes concerned with Entomology: IARI (Indian Agricultural Research Institute), CAB (Commonwealth Agricultural Bureau), IOBC (International Organization of Biological Control), IIP (International Institute of Insect Physiology), NBAIR (National Bureau of Agriculture Insect Resources), NIPHM (National Institute of Plant Health Management), IINRG (Indian Institute of Natural Resins and Gums), CIB & RC (Central Insecticide Board and Registration Committee), CSB (Central Silk Board), NRCIPM (National Research Centre for Integrated Pest Management), IGSMRI (Indian Grain Storage Management and Research Institute), etc 	10
3-4	<ul style="list-style-type: none"> Insect Integument: Structure and functions. Cuticular appendages and processes. Moulting: Definition and steps in moulting. Body segmentation: Structure of head, thorax and abdomen. 	10
5-6	<ul style="list-style-type: none"> Insect head capsule: Important sclerites and sutures. Positions of head. Structure and modifications (with examples) of insect antennae, mouth parts, legs and wings (wing venation, wing coupling apparatus with examples). Structure of thorax and abdomen: segmentation, appendages and processes, pregenital and post genital appendages and structure of male and female genital organ. 	20
7-8	<ul style="list-style-type: none"> Metamorphosis: Definition and types of metamorphosis with examples and its significance. Insect diapause: Definition and 	10

Lecture	Topic	Weightage (%)
	<p>example, Seasonal adaptations in insects: Aestivation, Hibernation and quiescence: Definitions</p> <ul style="list-style-type: none"> • Insect egg: General structure, types of egg with examples (at least one) • Types of larva and pupa with examples. • Sensory organs like Mechanoreceptors(Trichoidsensillacampaniformsensilla, chordotonal organ), chemo receptors (gustatory/olfactory), audio receptors: Johnston's organ and tympanum, photoreceptors- Compound eyes and simple eye, thermo/hygro receptors • Sound producing organs in insects 	
9-12	<ul style="list-style-type: none"> • Structure and functions of digestive, nervous, circulatory, respiratory, excretory, secretory and reproductive system in insects. Types of reproduction in insects. 	20
13	<p>Systematics:</p> <ul style="list-style-type: none"> • Definitions: Taxonomy, Systematics, Binomial nomenclature, Order, Family, Genus, Species, Subspecies, Biotype. • Binomial nomenclature: Definition and Rules. • Classification of Class Insecta up to Orders. 	10
14	<ul style="list-style-type: none"> • Study of important insect orders: Important distinguishing taxonomic characters of orders. Families of agricultural importance with examples. Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae. 	20
15-16	<ul style="list-style-type: none"> • Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Lophopidae, Lacciferidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae. 	
17-18	<ul style="list-style-type: none"> • Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae, Braconidae, Trichogrammatidae, Ichneumonidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae, Syrphidae. 	
	Total	100

b) Practical

Experiment	Topic
1.	Methods of collection and preservation of insects including immature stages
2.	External features of typical insect (e.g. Cockroach) structure of head, thorax and abdomen/General body organization of insect
3.	Structure of antennae and its modifications along with examples.
4.	Study and dissection of chewing and biting type of mouthparts.
5.	Study and dissection of chewing and lapping type of mouthparts.
6.	Study and dissection of piercing and sucking type of mouthparts.
7.	Study and dissection of sponging type of mouthparts.
8.	Structure of typical leg and modifications of legs.
9.	Study of insect wings: Structure, wing venation, types of wings and wing coupling apparatus along with examples.
10.	Types of larva and pupa.
11.	Study and dissection of digestive system of cockroach.
12.	Study and dissection of central nervous system of cockroach
13.	Study and dissection of female reproductive system of cockroach
14.	Study and Dissection of male reproductive system of Cockroach
15.	Study of distinguishing taxonomic characters of orders and families of agricultural importance: Odonata, Orthoptera, Dictyoptera.
16.	Study of distinguishing taxonomic characters of orders and families of agricultural importance: Isoptera, Thysanoptera and Hemiptera.
17.	Study of distinguishing taxonomic characters of orders and families of agricultural importance: Neuroptera, Lepidoptera and Hymenoptera.
18.	Study of distinguishing taxonomic characters of orders and families of agricultural importance: Diptera and Coleoptera.

Assignment: Each student should collect at least 100 insect specimens belonging to the aforesaid orders.

Distribution of Marks: Practical

Particular	Marks
Collection	: 05
Practical Manual	: 05
Dissection (System)	: 12
Mouth part dissection	: 08
Spotting	: 16
Viva-voce	: 04

Total marks

50

Suggested Readings:

- 1) Chapman, R. F. – The Insects : Structure and Functions
- 2) David, B. V. and T. Kumarswami – Elements of Economic Entomology
- 3) Marc J. Klowden- Physiological Systems in Insects
- 4) Pant N.C. and SwarajGhai – Insect Physiology and Anatomy
- 5) Nayar, K. K.; Anathkrishanan T.N. and B.V.David – General and Applied Entomology
- 6) Richards O.W. and R.G. Davies – Imms' General Text Book of Entomology –Vol.I& II
- 7) Patton R.L.- Introductory Insects Physiology
- 8) Wigglesworth – Principles of Insects Physiology
- 9) Metcalf and Flint – Destructive and Useful Insects; their habits and control.

Course :	ENTO 232		Credit:	2(1+1)	Semester-III
Course title:	Insect Ecology and Integrated Pest Management				

Syllabus

Theory

Part I: Insect Ecology: Definition, scope, environment and its components. Effect of abiotic factors – temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents. Effect of biotic factors – food competition, natural and environmental resistance. Concepts of balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem.

Part II: Pest surveillance, its types and pest forecasting. Categories of pests. Natural and applied pest control. IPM – Introduction, Importance, Scope, Concepts, Principles, Tools and Limitations of IPM. Host plant resistance, cultural, mechanical, physical and legislative methods of pest control. Biological- parasitoids, predators and transgenic plant pathogens such as bacterial, fungi and viruses. Chemical control – importance, hazards and limitations. Classification of insecticides, toxicity of insecticides and formulations of insecticides. Examples of important insecticide groups - botanical insecticides – Neem based products. Cyclodienes, Organophosphates, Carbamates, Synthetic pyrethroids, Novel insecticides, Pheromones, Nicotinyl insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocyclic lactones, Oxadiazines, Thiourea derivatives, Pyridine azomethines, Pyrroles etc, Nematicides, Rodenticides, Acaricides and Fumigants. Insecticides Act 1968- important provisions. Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes. Recent methods of pest control. Repellants, antifeedants, hormones, attractants, gamma radiation and genetic control.

Practical:

Visit to meteorological observatory / automatic weather reporting station. Terrestrial and pond ecosystems of insects. Behaviour of insects and orientation (repellency, stimulation, deterancy). Distribution patterns of insects, sampling techniques for the estimation of insect population and damage. Pest surveillance through light traps, pheromone traps and field incidence. Practicable IPM practices- Mechanical and physical methods, Cultural and biological methods. Chemical control – Insecticides and their formulations. Pesticide appliances, insecticide application techniques, calibration of plant protection appliances, Calculation of doses/concentrations of insecticides. Compatibility of pesticides and Phytotoxicity of insecticides IPM case studies – Cotton, Sugarcane, Mango/ Citrus/Pomegranate. Identification of common phytophagous mites and their morphological characters. Identification of rodents, bird pests, their damage and management. Vermiculture – visit to vermiculture unit, Biopesticides used in IPM with mass multiplication of NPV and Entomopathogenic fungi.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Definition of Insect Ecology, Scope, Environment and its components.	25
2	Effect of abiotic factors – temperature and moisture, humidity, rainfall, light, atmospheric pressure and air currents.	
3	Effect of biotic factors – food competition, natural and environmental resistance	
4	Concepts of balance of life in nature, biotic potential and environmental resistance and causes for outbreak of pests in agro-ecosystem.	
5	Pest surveillance and it's types and pest forecasting. Categories of pests.	10
6 & 7	Natural and Applied pest control. IPM – Introduction, Importance, Scope, Concepts, Principles, tools and limitations of IPM.	30
8	Host plant resistance and cultural methods of pest control	
9	Mechanical, Physical and Legislative methods of pest control.	
10	Biological- parasitoids, predators and transgenic plant pathogens such as bacterial, fungi and viruses.	
11 & 12	Chemical control – importance, hazards and limitations. Classification of insecticides, toxicity and formulations	25
13 & 14	Examples of important insecticide groups - Botanical insecticides – Neem based products. Cyclodienes, Organophosphates, Carbamates, Synthetic pyrethroids, Novel insecticides, Pheromones, Nicotinyl insecticides, Chitin synthesis inhibitors, Phenyl pyrazoles, Avermectins, Macrocyclic lactones, Oxadiazines, Thioureaderivatives, Pyridine azomethines, Pyrrolesetc, Nematicides, Rodenticides, Acaricides and Fumigants. Insecticides Act 1968-important provisions.	
15 & 16	Application techniques of spray fluids. Phytotoxicity of insecticides. Symptoms of poisoning, first aid and antidotes.	
17 & 18	Recent methods of pest control. Repellants, Antifeedants, hormones, attractants, gamma radiation and genetic control.	10
	Total	100

b) Practical

Experiment	Topic
1.	Visit to meteorological observatory / automatic weather reporting station
2.	Study of terrestrial and pond ecosystems of insects.
3.	Studies on behaviour of insects and orientation (repellency, stimulation, deterancy).
4.	Study of distribution patterns of insects, sampling techniques for the estimation of insect population and damage.
5.	Pest surveillance through light traps, pheromone traps and field incidence.
6.	Practicable IPM practices- Mechanical and Physical methods
7.	Practicable IPM practices – Cultural and Biological methods
8.	Chemical control – Insecticides and their formulations
9.	Pesticide appliances, insecticide application techniques, calibration of plant protection appliances
10.	Calculation of doses/concentrations of insecticides
11.	Compatibility of pesticides and phytotoxicity of insecticides
12.	IPM case studies -Cotton
13.	IPM case studies – Sugarcane
14.	IPM case studies – Mango/ Citrus/Pomegranate
15.	Identification of common phytophagous mites and their morphological characters
16.	Identification of rodents and bird pests and their damage
17.	Vermiculture – visit to vermiculture unit
18.	Biopesticides used in IPM with mass multiplication of NPV and Entomopathogenic fungi.

Marks distribution for practical examination

1. Collection-6
2. Spotting -15
3. Problem / written – 15
4. Vivavoce -04
5. Practical manual -5
6. General performance-5

Suggested Readings:

- 1) Metcalf, R.L. and Luckman W.H. 1982. Introduction to Insect Pest Management. Wiley Inter Science publishing, New York.
- 2) G.S. Dhaliwal and Ramesh Arora 2001. Integrated Pest Management. Concepts and Approaches. Kalyani publishers, New Delhi.
- 3) Larry P. Pedigo. 1991. Entomology and Pest Management. Larry P. Pedigo. 1991. Mac Millan publishing company, New York.
- 4) Yazdani G. S. and Agarwal M.L. 1979. Elements of Insect Ecology. Naroji publishing house, New Delhi.
- 5) Hufakar C.V. Ecological Entomology
- 6) Clark L.R., Gier P.W., Rughas R.D. and Marris R.F. The Ecology and Insect Population.
- 7) Odum E.P. Fundamentals of Insect Ecology
- 8) Gupta S. K. Plant Mites of India, 1995

Course :	ENTO 243		Credit:	2(1+1)	Semester-IV
Course title:	Pest of Horticultural Crops and their Management				

Syllabus

Theory

General – economic classification of insects. Ecology and insect-pest management with reference to fruit, plantation crops. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, vegetable, ornamental, spices and condiments crops like citrus, mango, grapevine, pomegranate, guava, fig, banana, papaya, custard apple, ber, sapota, aonla, coconut, arecanut, cashew, apple, tea, coffee, brinjal, okra, tomato, chilli, potato, sweet potato, cruciferous, cucurbitaceous, colocassia and moringa, turmeric, ginger, onion, garlic, coriander, curry leaf, black pepper, rose, gerbera and carnation.

Definition of Nematode and Nematology, Characteristics of plant parasitic nematodes. Important symptoms caused by nematodes with examples. Integrated Nematode Management.

Practical

Identification of different types of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce: Fruit Crops, Vegetable Crops, Plantation, Spices and Condiments.

Teaching Schedule

a) Theory

Lecture No.	Topic	Weightage %
	Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting	
1.	Citrus:- Lemon butterfly, White fly, Black fly, Leafminer, Fruit sucking moth, (<i>Eudocima fullonica</i> C, <i>E. materna</i> L. <i>Achoeajanata</i> L.), Citrus psylla, Citrus aphids, Mealy bug, Citrus thrips, Scale insects	50
2.	Mango:- Mango stem borer, Mango stone weevil, Mango fruit fly, Mealy bugs, Mango hoppers, Shoot borer, Thrips, Slug caterpillar, Midge fly, Leaf gall	
3.	Grapevine:- Flea beetle / Udadya beetle, Thrips, Stem Girdler, Mealy bug, Mite	
4	Guava:- Fruit fly, Spiraling white fly, Bark eating caterpillar Fruit Borers- (<i>Congethes (Dichocrocis) punctiferalis</i> , <i>Deudorix (Virachola) isocrates</i> , <i>Ropalavaruna</i> ,) Green Scale, Mealy bug.	
5	Banana:- Root stock weevil/Rhizome weevil, Pseudostem borer, Fruit rust thrips, Aphids, Tingid or Lace wing bug, Leaf eating caterpillar Papaya:- Papaya mealy bugs, White fly, Green peach aphid, Ash weevils,	

Lecture No.	Topic	Weightage %
6	Sapota :-Chiku moth / Sapota Leaf Webber, Sapota seed borer, Fruit fly, Stem borer, Hairy caterpillar, Leaf folder, Bud borer.	
7	Coconut :-Rhinocerosbeetle, Black headed caterpillar, Red palm weevil, Eriophyid mite, Rat. Aracanut :- Spindle Bug, Inflorescence Caterpillar, Cashew nut :-Tea mosquito bug,Cashew stem and root borer, Thrips	
8	Apple :-Mites, Codlingmoth, Fig :-Jassids, Mites Ber :- Ber fruit borer, Ber fruit fly Aonla :- Bark Borer,	
9	Pomogranate :-Anar caterpillar, Fruitsuckingmoth (<i>Eudocimafulonica</i> , <i>Eudocima materna</i> , <i>Achoeajanata L.</i>) Thrips, Shot hole borer, Barkeatingcaterpillar, Mealy bug, Whitefly, Aphids,	
10	Brinjal :- Brinjal shoot & fruit borer, Jassids /leaf hopper, Aphids, White fly, Red Spider Mites, Hadda Beetle,Brinjal leaf roller, Lace wing bug, Stem borer Okra :-Shoot & fruit borer,Leafhoppers, Aphids, White fly, Leaf Roller, Red Spider Mite, <i>Helicoverpa</i> , Flea beetle, Leaf miner (<i>Liriomyza</i>)	40
11.	Tomato :-Fruit borer,Leaf miner- <i>Liriomyza</i> and <i>Tutaabsoluta</i> Aphids, Thrips, White Fly, Mites Chilli :-Thrips, Fruit borer (<i>Helicoverpa</i>), Mites.	
12	Potato :- Potato tuber moth, Cutworm, Thrips, Mites, Jassids Sweet potato :-Sweet potato weevil, Sweet potato leaf eating caterpillar / Sphinx caterpillar.	
13	Cruciferous crops (Cauliflower, Cabbage, Broccoli and Knolkol) :- Diamond back moth, Aphids, Painted bug, Cabbage butterfly, Leaf eating caterpillar, Flea beetle,Head borer and Mustard saw fly	
14	Cucurbitaceous vegetables :- Fruit Fly, Aphids, Leaf miner, whitefly, Thrips, Pumpkinn beetle, Blister beetle Colocassia and Moringa :- Leaf eating catterpillar, Webworm, Stem borer, Spodoptera and Aphid,	
15	Turmeric and Ginger :-Rhizome fly, Shoot borer, Rhizome scale, Leaf roller, Thrips Onion and Garlic :-Onion and garlic thrips, Coriander :- Mites, Aphids Curry leaf :-Scale insect, Psylla, Leamon butterfly Black pepper :-Pollu beetle/Floes beetle, Mealy bug,	10
16	Rose, Gerbera, carnation :-Thrips, Mites, White Fly, Bud borer, Leaf miner Ornamental :- Snail and slugs,Mealy bug, Scale insects, Tea :- Tea Green leaf Hopper, Tea mosquito bug, Mites Coffee :-Coffee seed borer, Coffee berry borer	

Lecture No.	Topic	Weightage %
17	Definition of Nematode and Nematology, Characteristics of plant parasitic nematodes. Important symptoms caused by nematodes with examples.	
18	Integrated nematode management – Legislative methods, Cultural (Crop rotation, Fallowing, Soil amendments, Other land management techniques, Resistant varieties etc.), Physical (Soil solarization, Sterilization, Hot water treatment), Biological, Chemical- Important nematicides.	

b) Practical

Experiment	Topic
1	Identification, Damage symptoms and management of - Pests of Citrus
2	Pests of Mango
3	Pests of Grapevine
4	Pests of Guava
5	Pests of Banana and Papaya
6	Pests of Sapota
7	Pests of Coconut Pests of Aracnut and Cashew nut
8	Pests of Pomegranate
9	Pests of Apple, Fig, Ber, Aonla
10	Pests of Brinjal, Okra
11	Pests of Tomato, Chilli
12	Pests of Potato, Sweet potato
13	Pests of cruciferous vegetables
14	Pests of cucurbitaceous vegetables and Colocassia and Moringa
15	Pests of Turmeric, Ginger, Onion, Garlic, Curry leaf, Black Pepper and Coriander
16	Pests of Rose, Gerbera, Carnation, and Ornamentals
17	Pests of Tea and Coffee
18	Extraction of nematodes from soil and plant samples following combined cobs decanding and sieving techniques with modified Barmann's funnel technique and characteristics and symptoms of - <i>Meloidogyne Pratylenchus</i> , <i>Globodera</i> , <i>Heterodera</i> , <i>Tylenchulus</i> , <i>Xiphinema</i> , <i>Radopholus</i> , <i>Rotylenchulus</i> .

Marks for Practical Examination:-Practical Manual :05

Insect collection :05

Spotting :36

Viva :04

Total : 50

Suggested Readings:

- 1) A.S. Atwal and G.S. Dhaliwal: Agricultural Pests of South Asia and their Management
- 2) B.V. David and V.V. Rammurthy: Elements of Economic Entomology
- 3) Pedigo L.P.: Entomology and Pest Management.
- 4) VenuGopalRao: Insect Pest Management
- 5) S. Pradhan: Insect pests of crops
- 6) V.B. Awasthi: Introduction of General and Applied Entomology.
- 8) Dr. K.D.Upadhyay, Dr. KusumDwived : A text book of Plant Nematology
- 9) P. Parvatha Reddy: Plant Nematology
- 10) Swarup G. Deogupta D.R. and Gill J.S: Nematode pest management

Course :	ENTO 354		Credit:	2(1+1)	Semester-V
Course title:	Pests of Crops and Stored Grain and their Management				

Syllabus

Theory

General account on nature and type of damage by different arthropods pests: Scientific name, order, family, host range, distribution, biology, nature of damage and management of insect pests of **Cereals-Rice** - Paddy stem borer, Green leaf hopper, Brown plant hopper, White backed plant hopper, Gall midge, Paddy grasshopper, Blue beetle, Caseworm, Armyworm, Gundhi bug, Hispa, Leaf folder. **Sorghum** – Shoot fly, Stem borer, Aphids, Delphacids, Grasshopper, Earhead midge, Earhead caterpillars. **Maize** – Shoot fly, Stem borer, Armyworm, Cob earworm. **Bajra** – Shoot fly, Blister beetle. **Wheat** – Stem borer, Aphids, Termites. **Minor millets. Pulses – Pigeon pea, chickpea, mungbean, urdbean, cowpea, pea. Pigeon pea** – Pod borer, Plume moth, Pod fly, Spotted pod borer, Leaf webber, Mites. **Chickpea** – Gram pod borer, Aphids, Cutworm. **Mung and Urdbean** – Aphids, Leaf eating caterpillar, Semilooper, Pod borer. **Cowpea and Pea** – Aphids, Blue butterfly, Pod borer. **Oilseeds -Groundnut** – Leaf miner, Hairy caterpillar, Tobacco leaf eating caterpillar, Aphids, Thrips, White grub, Pod sucking bug. **Castor** – Semilooper, Capsule borer, Jassids, Tobacco leaf eating caterpillar. **Sunflower** – Capitulum borer, Hairy caterpillar, Jassids, Thrips, Whitefly, Stem borer. **Safflower-** aphids, Capitulum borer, Guzia weevil. **Mustard** – Aphids, Sawfly, Leaf webber. **Linseed** – Gall fly. **Soybean** – Stem fly, Girdle beetle, Leaf miner, Tobacco leaf eating caterpillar, Whitefly, Semilooper, Gram pod borer. **Sesamum** –Til hawk moth, Gall fly, leaf eating caterpillar. **Niger** –Semilooper, Gram pod borer. **Fiber crops –Cotton** – Aphids, Jassids, Thrips, Whitefly, Mealy bugs, Spotted bollworm, American bollworm, Pink bollworm, Tobacco leaf eating caterpillar, Leaf folder, Semilooper, Red cotton bug, Dusky cotton bug, Grey weevil. **Sunhemp and Mesta** – Sunhemp hairy caterpillar. **Sugarcane crops** - Early shoot borer, Internode borer, Top shoot borer, Whitefly, Pyrilla, Woolly aphids, Mealy bug, Scale insect, Termites, White grub. **Non-insect pests of above crops** – Crabs, Snails and Slugs, millepedes, Mites, Rats and squirrels. **Stored grain pests** - Biology and damage of Primary and Secondary pests. Primary store grain pests- Internal feeders - Rice weevil, lesser grain borer, pulse beetle and Angoumois grain moth. External feeders - khapra beetle, Indian meal moth. Secondary store grain pests – Rust red flour beetle, Saw toothed grain beetle, Long headed beetle. Primary and Secondary store grain pests - Rice moth. Non insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Preventive and curative methods of stored grain pests. Storage structure and methods of grain storage and fundamental principles of grain store management.

Practical

Identification of different type of damage. Identification and study of life cycle and seasonal history of various insect pests attacking crops and their produce. **Field crops: Cereals-Rice**, Sorghum, Maize, Bajra, Wheat and Miner millets. **Pulses-** Pigeon pea, Chickpea, Mung bean, Urd bean, Cowpea and Pea. **Oilseeds:** Groundnut, Castor, Sunflower,

Safflower, Mustard, Linseed, Soybean, Sesamum and Niger. **Fibre:** Cotton, Sunhemp and Mesta. **Sugar crop:** sugarcane. Non insect pests of field crops. Store grain pests. Non insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management. Preventive and curative methods of stored grain pests. Storage structure and methods of grain storage and fundamental principles of grain store management.

Teaching Schedule

a) Theory

Lecture	Topic	Weightage (%)
	Distribution, biology, nature of damage and management of insect pests of	20
	Cereals	
1	Rice - Paddy stem borer, Green leaf hopper, Brown plant hopper, White backed plant hopper, Gall midge, Paddy grasshopper, Blue beetle, Caseworm, Armyworm, Gundhi bug, Hispa, Leaf folder	
2	Sorghum – Shoot fly, Stem borer, Aphids, Delphacids, Grasshopper, Earhead midge, Earhead caterpillars	
3	Maize – Shoot fly, Stem borer, Armyworm, Cob earworm	
	Bajra – Shoot fly, Blister beetle	
	Wheat – Stem borer, Aphids, Termites,	
	Minor millets -	
	Pulses – Pigeon pea, chickpea, mungbean, urdbean, cowpea, pea	10
4	Pigeon pea – Pod borer, Plume moth, Pod fly, Spotted pod borer, Leaf webber, Mites	
5	Chickpea – Gram pod borer, Aphids, Cutworm	
	Mung and Urdbean – Aphids, Leaf eating caterpillar, Semilooper, Pod borer	
	Cowpea and Pea – Aphids, Blue butterfly, Pod borer	
	Oilseeds -	20
6	Groundnut – Leaf miner, Hairy caterpillar, Tobacco leaf eating caterpillar, Aphids, Thrips, White grub, Pod sucking bug	
7	Castor – Semilooper, Capsule borer, Jassids, Tobacco leaf eating caterpillar	
	Sunflower – Capitulum borer, Hairy caterpillar, Jassids, Thrips, Whitefly, Stem borer	
8	Safflower – Aphids, Capitulum borer, Guzia weevil	
	Mustard – Aphids, Sawfly, Leaf webber	
	Linseed – Gall fly	
9	Soybean – Stem fly, Girdle beetle, Leaf miner, Tobacco leaf eating caterpillar, Whitefly, Semilooper, Gram pod borer	
	Sesamum – Til hawk moth, Gall fly, leaf eating caterpillar	
	Niger – Semilooper, Gram pod borer	

Lecture	Topic	Weightage (%)
	Fiber crops –	10
10-11	Cotton – Aphids, Jassids, Thrips, Whitefly, Mealy bugs, Spotted bollworm, American bollworm, Pink bollworm, Tobacco leaf eating caterpillar, Leaf folder, Semilooper, Red cotton bug, Dusky cotton bug, Grey weevil	
	Sunhemp and Mesta – Sunhemp hairy caterpillar	
	Sugarcane crops	10
12	Sugarcane – Early shoot borer, Internode borer, Top shoot borer, Whitefly, Pyrilla, Woolly aphids, Mealy bug, Scale insect, Termites, White grub	
13	Non-insect pests of above crops – Crabs, Snails and Slugs, millepedes, Mites, Rats and squirrels	10
14-15	Stored grain pests - Biology and damage of Primary and Secondary pests Primary store grain pests- Internal feeders - Rice weevil, lesser grain borer, pulse beetle and Angoumois grain moth External feeders - khapra beetle, Indian meal moth Secondary store grain pests – Rust red flour beetle, Saw toothed grain beetle, Long headed beetle Primary and Secondary store grain pests - Rice moth	20
16	Non insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management	
17	Preventive and curative methods of stored grain pests	
18	Storage structure and methods of grain storage and fundamental principles of grain store management.	
	Total	100

b) Practical

Experiment	Topic
1.	Pests of Rice
2.	Pests of Sorghum
3.	Pests of Maize, Bajra, Wheat and Miner millets
4.	Pests of Pigeon pea
5.	Pests of Chickpea, Mung bean, Urd bean, Cowpea and Pea
6.	Pests of Groundnut
7.	Pests of Castor and Sunflower
8.	Pests of Safflower, Mustard, Linseed
9.	Pests of Soybean, Sesamum and Niger
10 & 11.	Pests of Cotton, Sunhemp and Mesta
12.	Pests of Sugarcane

Experiment	Topic
13.	Non insect pests of field crops
14 & 15.	Store grain pests
16.	Non insect pests, mites, rodents, birds and microorganisms associated with stored grain and their management
17.	Preventive and curative methods of stored grain pests
18.	Storage structure and methods of grain storage and fundamental principles of grain store management.

Marks distribution for practical examination

1. Spotting -36
2. Viva-voce -04
3. Practical manual-5
4. Collection-5

Suggested Readings:

- 1) A.S. Atwal and G.S. Dhaliwal :Agricultural Pests of South Asia and their Management
- 2) B.V. David and V.V. Rammurthy: Elements of Economic Entomology
- 3) Manishekharan and Sudarrajan : Pest Management in Field Crops.
- 4) Pedigo L.P. : Entomology and Pest Management.
- 5) VenuGopalRao: Insect Pest Management.
- 6) B.P. Khare : Storage Entomology

Course :	ENTO 365		Credit:	2(1+1)	Semester-VI
Course title:	Management of Beneficial Insects				

Syllabus

Theory

Importance of beneficial insects.

Bee keeping, pollinating plants and their cycle, bee biology, commercial methods of rearing. Equipment used. Seasonal management. Bee enemies and disease. Bee pasturage, bee foraging and communication. Insect pests and diseases of honey bee.

Types of silkworm. Voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pests and diseases of silkworm, their management, rearing appliances of mulberry silkworm and methods of disinfection.

Species of Lac insect, morphology, biology, host plant, lac production – seed lac, button lac, shellac, lac- products.

Identification of major parasitoids and predators commonly being used in biological control. Insect orders bearing predators and parasitoids used in pest control and their mass multiplication techniques, important species of pollinators, weed killer and scavengers with their importance.

Practical

Honey bee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication.

Types of silkworm, voltinism and biology of silkworm, mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves.

Species of lac insect, host plant identification.

Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies.

Teaching schedule

a) Theory

Lecture	Topic	Weightage (%)
1	Importance of beneficial insects in Agriculture, Honeybee, Silkworm, Lac insects, Bioagents as natural enemies, Various Institutes related to beneficial insects	20
2	Apiculture: Introduction and history of Beekeeping Bee keeping, morphology and anatomy, bee biology, Pollinating plants and their cycle, bee conservation	
3	Commercial methods of bee rearing, equipments used, seasonal management of bees	

Lecture	Topic	Weightage (%)
4	Bee hives and their description, Bee pasturage, bee foraging, behaviour and communication	
5	Enemies- Insect pests and diseases of honey bee and their management	
6	Sericulture: Related terminologies, History and development of silkworms in India, types of silkworm, voltinism and biology of silkworm	25
7	Mulberry cultivation, crop varieties, method of harvesting and preservation of mulberry leaves	
8	Rearing house and rearing appliances of mulberry silkworm, methods of disinfection and hygiene	
9	Silkworm rearing, mounting, harvesting and marketing of cocoons	
10	Pest and diseases of silkworm and their management	
11	Lac culture: Species of lac insect, morphology, biology, behaviour, host plants	10
12	Lac production and its uses, Types of lac- seed lac, button lac, shellac, and lac-products	
13	Biocontrol agents (Natural Enemies): Introduction of bioagents, Ideal characteristics of bioagents, Successful examples of biological control	25
14	General classification: Important insect orders bearing predators and parasitoids used in pest control Identification of major parasitoids and predators commonly used in biological control of crop pests.	
15	Major parasitoids: <i>Trichogramma sp.</i> , <i>Chelonusblackburni</i> , <i>Cotesia (Apanteles) sp.</i> , <i>Bracon sp.</i> , <i>Epiricaniamelanoleuca</i> , <i>Goniozusnephantidis</i> , <i>Campoletischloridae</i> , Major predators: <i>Chrysoperla sp.</i> , Australian lady bird beetle- <i>Cryptolaemusmontrouzieri</i> Weed killers: <i>Zygogrammabicolorata</i> , <i>Neochetinaspp.</i>	15
16	Mass multiplication and field release techniques of some important parasitoids: <i>T. chilonis</i> , <i>Chelonusblackburni</i> , <i>Cotesia / Bracon</i> , <i>Goniozusnephantidis</i> , <i>Epiricaniamelanoleuca</i>	
17	Mass multiplication and field release techniques of important predators: <i>Chrysoperla sp.</i> , Australian lady bird beetle, Weed predators/killers: <i>Zygogramma bicolorata</i> , <i>Neochetina sp.</i>	
18	Important species of pollinator and scavengers with their importance	5
	Total	100

b) Practical

Experiment	Topic
1	Studies on honey bee colony: Bee species and castes of bees
2 & 3	Bee keeping appliances and seasonal management
4	Bee enemies and diseases
5 & 6	Bee pasturage, bee foraging and communication
7 & 8	Types of silkworm, voltinism and biology of mulberry silkworm
9	Mulberry cultivation, mulberry varieties and methods of harvesting of leaves
10	Rearing of mulberry silkworm on artificial diet / natural mulberry leaves
11	Studies on strains / species of lac insect, host plant and their identification
12	Identification of other important pollinators and scavengers.
13	Mass production of host insect- <i>Corcyra cephalonica</i> St.
14	Mass multiplication of parasitoids: <i>Trichogramma chilonis</i> , <i>Chelonus blackburnii</i> , <i>Goniozus nephantidis</i>
15	Mass multiplication of predators: <i>Chrysoperla</i> sp. and Australian lady beetle- <i>Cryptolaemus montrouzieri</i> Mulsant
16, 17 and 18	Visit to research and training Institution/Unit of Beekeeping, Sericulture, Lac culture and Bioagent production units.

Topic	Marks
Collection	06
Writing of procedures	30
Viva	04
Laboratory work / General performance	10
Total	50

Suggested Readings:

- 1) Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.
- 2) Sunita, N.D, Guled, M.B, Mulla, S.R and Jagginavar, 2003, Beekeeping, UAS Dharwad
- 3) Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.
- 4) Singh, D. and Singh, D.P. 2006. A Hand Book of Beekeeping, Agrobios (India).

- 5) Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)
- 6) Y.A. Shinde and BR Patel. Sericulture in India
- 7) Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd
- 8) M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.
- 9) Ganga, G. and SulochanaChetty, J. 1997. An Introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.
- 10) Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agril. Services bulletin, Rome.
- 11) Glover, P.M. 1937. Lac Cultivation in India. Indian Lac Research Institute, Ranchi.
- 12) Jolly, M.S. 1987. Appropriate Sericulture Techniques. International Centre for Training and Research inTropical Sericulture, Mysore, 209.
- 13) K.P. Srivastava. A Text Book on Applied Entomology. Vol. I & II, Kalyani Publishers, Ludhiana
- 14) B.R. David and V.V. Ramamurthy. Elements of Economic Entomology, 7thEdn. Namrutha Publications, Chennai