DIVISION of ENTOMOLOGY

Dr. Sharadchandra Pawar College of Agriculture & Allied Sciences, Baramati

STAFF PROFILE

1. Name of Staff: **Prof. Sharad Kalidas Dalve** Educational Qualification: M.Sc. Agriculture (Agril. Entomology) Post: Assistant Professor	
2. Name of Staff: **Dr. Atul Deorao Gonde** Educational Qualification: M.Sc. Agriculture, PhD (Agril. Entomology), ASRB-NET Post: Assistant Professor	
3. Name of Staff: **Dr. Sumedha Jayprakash ShejulPatil** Educational Qualification: M.Sc. Agriculture, PhD (Agril. Entomology), ASRB-NET Post: Assistant Professor	

AGRICULTURE POLYTECHNIC

ENTOMOLOGY

COURSE LAYOUT

Sr. No.	Semester	Course No	Credit	Course Title
1	II	ENTO-121	2 (1+1)	Fundamentals of Entomology
2	III	ENTO-232	2 (1+1)	Integrated Pest Management in Field Crops
3	IV	ENTO-243	2 (1+1)	Integrated Pest Management in Horticultural Crops

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

SYLLABUS

THEORY

History of Entomology in India. Factors for insect's abundance. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda up to order. Morphology: Structures and functions of insect cuticle. Moulting and body segmentation. Structure of Head. Structure of Thorax and abdomen. Circulatory system of cockroach. Excretory system of Insects. Respiratory system of Insects. Nervous system of Insects. Reproductive systems in insects (male and female). Types of reproduction in insects. Major sensory organs and functions. Beneficial Insects: Honeybees. Beneficial Insects: Silkworm. Beneficial Insects: Lac insect.

PRACTICAL

Methods of collection and preservation of insects. Study of External features of Grasshopper/ Cockroach. Study of Types of insect antennae. Study of mouthparts (cockroach and red cotton bug). Study of insect legs. Types of insect wings. Metamorphosis and diapauses. Types of insect larvae and pupae. Study of characters of important insect orders – Orthoptera, Hemiptera, Thysanoptera, Lepidoptera, Diptera, Coleoptera, Hymenoptera. Dissection of Insects to study digestive system of insects. Dissection of Insects to study nervous system of insects. Dissection of Insects to study reproductive system of insects.

Suggested Readings

1) The Insects: Structure and Functions. 2016. Chapman, R. F., Cambridge University Press, Delhi.

2) Insect Physiology and Anatomy. 1981. Pant N.C. and Swaraj Ghai, ICAR, New Delhi.

3) General Entomology. 2006. Upadhyay K. D. & Mathur Y. K., Aman Publ. House, Meerut.

4) Insects. 2012. Rajagopal and Chakravarthy A. K., Aavishkar Publishers, Distributors, Jaipur.

5) Introduction to General and Applied Entomology. 2012. Awasthi V. B., Scientific Publishers, Jodhpur.

Course : ENTO-232	**Credit: 2 (1+1)**	**Semester-III**
Course title: Integrated Pest Management in Field Crops		

SYLLABUS

THEORY

Economic importance, identification, biology, nature of damage, host and integrated management of insect pests of Crop. Cereals : Rice - Green leaf hopper, Brown plant hopper, Paddy grasshopper, Gundhi bug, Hispa, stem borer, leaf folder. Sorghum – Shoot fly, Stem borer, Aphids, Midge fly. Bajra – Blister beetle. Wheat – Stem borer, Aphids, Termites, rhodents. Maize – Stem borer, aphids, false armyworm. **Pulses** – Pigeon pea – Pod borer, Spotted pod borer, Leaf webber, Mites. Chickpea – Gram pod borer. Cowpea, Pea, Mung and Urdbean – Aphids, Leaf eating caterpillar, Semilooper–Blue butterfly, Pod borer. **Oilseeds** - Soybean – Stem fly, Tobacco leaf eating caterpillar, Girdle beetle, Semilooper, Gram pod borer. Groundnut – Leaf miner, Hairy caterpillar, Aphids, Thrips, White grub. Sunflower – Head borer, Capitulum borer, Hairy caterpillar, Jassids, Thrips, white fly. Safflower : Aphids. Mustard – Guzia weevil, Sawfly, Leaf webber. **Fiber crops** – Cotton – Aphids, Jassids, Thrips, Whitefly, Mite, Spotted bollworm, American bollworm, Pink bollworm, Red cotton bug, Dusky cotton bug. **Sugarcane crops :** Sugarcane – Early shoot borer, Internode borer, Top shoot borer, Root borer, Woolly aphid, Pyrilla, Mealy bug, Scale insect, White grub. **Non-insect pests of above crops** – Crabs, Snails and Slugs, Rats, Mites and Birds.

PRACTICAL

Pests of Rice. Pests of Sorghum. Pests of Wheat. Pests of Maize and Bajra. Pests of Pigeon pea. Pests of Chickpea. Pests of Groundnut. Pests of Sunflower, Safflower and Mustard. Pests of Soybean. Pests of Cotton. Pests of Sugarcane. Management of White grub. Management of rodent. Management of non-insect pest.

Suggested Readings

1) Agricultural Pests of South Asia and their Management. 2013. A. S. Atwal and G. S. Dhaliwal, Kalyani Publishers, Ludhiana.

2) Insect Pest Management. 2004. Venu Gopal Rao. Agrobios (India).

3) The Applied Entomology, Vol. II. 2007. Shrivastava, Kalyani Publishers.

4) Principles of Insect Pest Management. 2003. Dhaliwal G. S. and Ramesh Arora. Kalyani Publishers.

5) Agricultural Insect Pests and Their Control. 2007. V. B. Awasthi. Scientific Publishers, Jodhpur.

Course : ENTO-243	**Credit: 2 (1+1)**	**Semester-IV**
Course title: Integrated Pest Management in Horticultural Crops		

SYLLABUS

THEORY

Economic Importance, identification, host, biology, nature of damage and integrated management of important insect pests. Citrus: Lemon butterfly, Leaf miner, Fruit sucking moth, Psylla, aphids. **Mango:** Mango stem borer, Shoot borer, Thrips, Leaf gall, mango stone weevil, fruit fly. **Grapevine:** Flea beetle /Udadya beetle, Thrips, Mealy bug. **Guava:** Fruit fly, mealy bugs, spirilling whitefly. **Banana:** Root stock weevil/Rhizome weevil, aphid. **Papaya:** Papaya mealy bugs, aphid, whitefly. **Sapota :** Chiku moth / Sapota Leaf Webber, Sapota seed borer, Bud borer. Fig : Jassids, Mites,stem borer. **Coconut and other palm trees :** Rhinoceros beetle, Red palm weevil, Eriophyid mite, Rat, black headed caterpillar. **Ber:** Ber fruit borer, fruit fly. **Aonla:** Bark Borer. Apple : Codling moth, San Jose scale. **Cashew nut :** Tea mosquito bug. **Pomogranate:** Fruit borer, Thrips, Shot hole borer, Mealy bug, Whitefly, Aphids, fruit sucking moth. **Brinjal:-** Brinjal shoot & fruit borer, White fly, aphid, mites. **Okra:** Shoot & fruit borer, Leafhoppers, Aphids, Leaf Roller, Red Spider Mite. **Tomato :** Fruit borer, Leaf miner. **Potato:** Potato tuber moth, Cut worm, aphid. **Cruciferous crops** (Cauliflower, Cabbage, Broccoli and Knolkol): Diamond back moth, Aphids, Cabbage butterfly, Leaf eating caterpillar. **Cucurbitaceous vegetables:** Pumpkin beetles, Fruit Fly, Aphids, Leaf miner, whitefly. **Turmeric and Ginger:** Rhizome fly. **Onion and Garlic:** Thrips. **Rose, Gerbera, Carnation:** Thrips, Mites, White Fly, Bud borer, Leaf miner, scales.

PRACTICAL

Identification observation of Damage symptoms and integrated management practices of pests of following crops.

Pests of Citrus. Pests of Mango and Sapota. Pests of Grapevine. Pests of Guava and pomegranate. Pests of Banana and Papaya. Pests of Coconut, Arecanut. Pests of Apple, Fig, Ber, Aonla and Cashew nut. Pests of Brinjal, Okra. Pests of Tomato and potato. Pests of cruciferous vegetables. Pests of cucurbitaceous vegetables. Pests of Turmeric, Ginger, Onion, Garlic. Pests of Rose, Gerbera, Carnation.

Suggested Readings

1) Agricultural Pests of South Asia and their Management. 2013. A.S. Atwal and G.S. Dhaliwal. Kalyani Publishers, Ludhiana.

2) Insects and Fruit. 2016. Butani, D. C. Astral International Pvt. Ltd., New Delhi.

3) Insect in Vegetables. 2013. Butani, D. K. and Jotwani, M. G., Daya Publishing House.

As per the ICAR-Sixth Deans' Committee Report

B.Sc. (Hons.) Agriculture

Entomology

Sr. No.	Semester	Course No.	Course Title	Credit Hrs.
1.	II	ENTO-121	Fundamentals of Entomology	3(2+1)
2.	III	NEMA -231	Fundamentals of Nematology	2(1+1)
3.	IV	SEC-246	Beneficial Insect Farming	2(0+2)
4.	V	ENTO-352	Pest management in Crops and Stored Grains	3 (2+1)

Semester II	Course No. : ENTO-121	Credit Hr. : 3 (2+1)
Course Title: Fundamentals of Entomology		

SYLLABUS

Objectives:

1. To understand the basic knowledge of Entomology and insect classification, morphology along with their relationship with other arthropods,

2. To explore insect physiology, growth, development and communication,

3. To identify major insect orders and economically important families.

THEORY

History of Entomology in India. Major points related to Dominance of Insects in Animal Kingdom. Classification of Phylum Arthropoda up to Classes. Relationship of Class Insecta with other Classes of Arthropoda. Morphology: Structure and functions of insect cuticle and moulting. Body segmentation. Structure of head, thorax and abdomen. Structure and modifications of insect antennae, Mouth parts, Legs, Wing venation, Modifications and wing coupling apparatus. Metamorphosis and diapause in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (Endocrine) and reproductive systems in insects. Types of reproduction in insects. Major sensory organs. Insect Ecology: Introduction, Environment and its components. Effect of abiotic factors and biotic factors. Categories of pests. Systematics: Taxonomy– importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of Class Insecta up to Orders, Basic groups of present day insects with special emphasis to Orders and Families of Agricultural importance like, Orthoptera: Acrididae, Tettigoniidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturnidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthridinidae, Apidae, Trichogrammatidae, Lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

PRACTICAL

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Blister beetle; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive

system in insects (Grasshopper); Study of characters of Orders: Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance. Insecticides and their formulations. Pesticide appliances and their maintenance. Sampling techniques for estimation of insect population and damage.

Suggested readings

1. Fundamentals of Ecology - Eugene. P. Odum and Gray W. Barrett

2. Imms General Text book of Entomology— O.W. Rechards and R.G. Davies

3. Introduction to the study of Insects –D. J. Borror and DeLong

Semester II	Course No. : NEMA-231	Credit Hr. : 2 (1+1)
Course Title: Fundamentals of Nematology		

SYLLABUS

Objectives

1. To impart knowledge on history, economic importance of plant parasitic nematodes, morphology, biology, host parasitic relationship of nematodes.
2. To impart knowledge on nematode pests of different crops of national and local importance and their management.

Theory

Introduction: History of phytonematology, habitat and diversity, economic importance of nematodes. General characteristics of plant parasitic nematodes. Nematode: definition, general morphology and biology. Classification of nematodes up to family level with emphasis on groups containing economically important genera. Classification of nematodes on the basis of feeding/ parasitic habit. Symptomatology, role of nematodes in disease development, Interaction between plant parasitic nematodes and disease-causing fungi, bacteria and viruses. Nematode pests of crops: Rice, wheat, vegetables, pulses, oilseed and fiber crops, citrus and banana, tea, coffee and coconut. Different methods of nematode management: Cultural methods, physical; methods, Biological methods, Chemical methods, Plant Quarantine, Plant resistance and INM.

Practical

Sampling methods, collection of soil and plant samples; Extraction of nematodes from soil and plant tissues following Cobb's sieving and decanting technique, Baermann funnel technique, Picking and counting of plant parasitic nematode. Identification of economically important plant nematodes up to generic level with the help of keys and description: *Meloidogyne, Pratylenchus; Heterodera, Tylenchulus, Xiphinema*, and *Helicotylenchus* etc. Study of symptoms caused by important nematode pests of cereals, vegetables, pulses, plantation crops etc. Methods of application of nematicides and organic amendments.

Suggested readings

1. Economic Nematology-Edited by J.M. Webster
2. Plant Parasitic Nematodes (Vol-1) by Zukerman, Mai, Rohde
3. Plant Parasitic Nematodes of India: Problems and Progress by - Gopal Swarup, D. R. Dasgupta,
P. K. Koshy.
4. Text book on Introductory Plant Nematology -R.K. Walia and H.K. Bajaj.

Semester V	Course No. : ENTO-352	Credit Hr. : 3 (2+1)
Course Title: Pest management in Crops and Stored Grains		

SYLLABUS

Objectives

Diagnosis and management of major insect and non- insect pests of crops in field and storage

Theory

General description on nature and type of damage by different arthropod pests; Scientific name, order, family, host range, distribution, biology and bionomics; Nature of damage and management of major insect pests of various field crops, vegetable crops, fruit crops, plantation crops, ornamental crops, spices and condiments. Structural entomology and important household pests, their nature of damage and management. Factors affecting loss of stored grains. Insect pests, mites, rodents, birds and microorganisms associated with stored grains and their management. Storage structures and methods of grain storage and fundamental principles of stored grains management. Management of non insect pest of mites, snails and slugs, Concept of IPM, Practices, scope and limitations of IPM. Classification of insecticides, toxicity of insecticides and formulations of insecticides, Biorational pesticides including insect repellents, antifeedants, Use of drones and AI in pest management,

Practical

Field visit, identification of major insect pests and their damage symptoms. Collection and preservation of major insect pests; collection of damage samples, their identification and herbarium preparation. Methods of monitoring of pest incidence *in situ*. Management strategies of insect pests of different crops. Study on structural entomology and household pests. Storage structures and methods of grain storage. Spraying techniques for selected field and horticultural crops. Vertebrate pest management, Mass multiplication of NPV and entomopathogenic nematodes.

Suggested readings

1. A Textbook of Insect Pest and Disease Management, 2021. Somnath Sen, and Mohd. Sameer,

S. Kataria & Sons publish.

2. Agricultural Pests of India and South east Asia, A.S. Athwal, Kalyani Publishers.

3. A Textbook of Applied Entomology, K.P. Srivastava and G. S. Dhaliwal, Kalyani Publish.

4. Essentials of Pest Management: Key Information on Pest Identification and its Management,

2022. Prakash Rambhat Thalya and Ravi Chandra

5. Integrated pest Management Concept and Approaches- G.S. Dhaliwal and Ramesh Arora

6. Pest Management: Methods, Applications and Challenges, Tarique Hassan Askary, Agriculture,

Agriculture Issues and policies, Books, Nova, Pest Control, Science and Technology,2022

As per the ICAR-Sixth Deans' Committee Report

B.Sc. (Hons.) Agri-Business Management

Entomology

Sr. No.	Semester	Course No.	Course Title	Credit Hrs.
1.	II	ENTO-121	Management of Insect Pests of Crops and Stored Grains	2(1+1)

SYLLABUS

Objectives :

(i) To understand the Biology, Ecology and Behaviour of insect pests affecting crops and stored grains,

(ii) To learn the effective strategies for monitoring, prevention and control of insect pests in agricultural settings,

(iii) To explore Integrated Pest Management (IPM) approaches, including biological, cultural and chemical control methods,

(iv) To develop skills to assess and minimize economic losses caused by insect pests while promoting sustainable agriculture practices.

THEORY

General account on nature and types of damage by different arthropods pests i.e. Scientific name, distribution, biology, nature of damage and management of insect pests of: Cereals: Rice - Paddy stem borer, Green leaf hopper, Brown plant hopper, Gall midge, Paddy grasshopper, Blue beetle, Caseworm, Armyworm, Gundhi bug, Hispa, Leaf folder; Sorghum - Shoot fly, Stem borer, Aphids, Earhead midge; Maize - Shoot fly, Stem borer, Armyworm.; Bajra - Shoot fly, Blister beetle; Wheat - Stem borer, Aphids, Termites. **Pulses:** Pigeon pea, Chickpea, Pea, Pigeon pea - Pod borer, Plume moth, Pod fly, Spotted pod borer, Leaf Webber, Mites; Chickpea - Gram pod borer; Pea - Aphids, Blue butterfly, Pod borer. **Oilseeds:** Groundnut - Leaf miner, Hairy caterpillar, Aphids, Thrips, White grub; Sunflower - Capitulum borer, Hairy caterpillar, Jassids, Thrips, Whitefly, Stem borer; Mustard - Aphids, Sawfly; Soybean -Stem fly, Girdle beetle, Leaf

miner, Tobacco leaf eating caterpillar, Whitefly, Semilooper, Gram pod borer; Sesamum - Til hawk moth, Gall fly. **Fiber and Cash crops:** Cotton - Aphids, Jassids, Thrips, Whitefly, Mealybugs, Spotted bollworm, American bollworm, Pink bollworm, Tobacco leaf eating caterpillar, Red cotton bug, Dusky cotton bug Sugarcane - Early shoot borer, Internode borer, Top shoot borer, Whitefly, Pyrilla, Woolly aphids, Mealybug, Scale insect, Termites, White grub. **Horticultural crops:** Citrus- Lemon butterfly, Blackfly, Leaf miner, Fruit sucking moth, (*Eudocima fullonica C, E. maternal L. Achoea janata L.*), Citrus psylla, Citrus aphids, Scale insects; Mango - Mango stemborer, Mango stone weevil, Mango fruit fly, Mealybugs, Mango hoppers, Shoot borer, Thrips; Grapevine – Flea beetle/ Udadya beetle, Thrips, Stem Girdler, Mealy bug; Guava - Fruit fly, Spiraling white fly, Bark eating caterpillar, Fruit Borers - (*Congethes (Dichocrocis) punctiferalis*), Mealybug; Banana - Rootstock weevil/ Rhizome weevil, Pseudo stem borer, Aphids, Tingid or Lacewing bug; Sapota-Chiku moth/ Sapota Leaf Webber, Sapota seed borer, Fruit fly, Bud borer; Pomegranate- Anar caterpillar, Fruit sucking moth (*Eudocima fullonica, Eudocima materna, Achoea janata L.*,) Thrips, Shot hole borer, Bark eating caterpillar, Mealy bug; Brinjal – Brinjal shoot and fruit borer, Jassids/ leaf hopper, Aphids, White fly, Red Spider Mites, Hadda Beetle; Okra – Shoot and fruit borer, Leafhoppers, Aphids, White fly, Red Spider Mite; Tomato – Fruit borer, Leaf miner - *Liriomyza and Tutaabsoluta*, Aphids, Thrips, White fly, Mites; Chilli - Thrips, Fruit borer (*Helicoverpa*), Mites; **Cruciferous crops:** Cauliflower, Cabbage: Diamond back moth, Aphids, Cabbage butterfly, Leaf eating caterpillar, Head borer. **Non-insect pests of above crops** - Mites, Rats and Birds. Stored Grain Pests: Biology and damage of Primary and Secondary pests. Primary stored grain pests - Internal feeders - Rice weevil, lesser grain borer, pulse beetle and Angoumois grain moth. External feeders – Khapra beetle, Indian meal moth. Secondary stored grain pests - Rust red flour beetle, Saw toothed grain beetle, Long headed beetle. Primary and Secondary stored grain pests - Rice moth. Non insect pests, mites, rodents, birds and their management. Preventive and curative methods of stored grain pests. Fundamental principles of grain store management.

PRACTICAL

Identification of different types of damage. Identification and study of lifecycle and seasonal history of various insect pests attacking crops and their produce in following crops:

Field crops: Cereals - Rice, Sorghum, Maize, Bajra, Wheat. **Pulses-**Pigeon pea, Chickpea, Pea. **Oilseeds:** Groundnut, Sunflower, Mustard, Soybean, Sesamum. **Fibre:** Cotton, **Sugar crop:** Sugarcane. **Horticultural pests -** Crops like, Citrus, Mango, Grapevine, Pomegranate, Guava, Sapota, Banana, Brinjal, Okra, Tomato, Chilli; **Cruciferous crops:** Cauliflower, Cabbage; Non-insect pests of field crops. **Stored grain pests. Non-insect pests:** mites, rodents, birds and their management. Preventive and curative methods of stored grain pests. Fundamental principles of grain store management. Visit to the nearest FCI Godowns and Warehouses.

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. Venu Gopal Rao, Insect Pest Management.

6. B.P. Khare, Storage Entomology.

M.Sc. Agriculture (Entomology)

Semester	Course No.	Course Title	Credit Hrs.
I	ENT 501	Insect Morphology	3 (2+1)
	ENT 502	Insect Anatomy and Physiology	3 (2+1)
	ENT 505	Biological Control of Crop pests and Weeds	3 (2+1)
	ENT 509	Pests of Field Crops	3 (2+1)
II	ENT 506	Toxicology of Insecticides	3 (2+1)
	ENT 508	Concepts of Integrated Pest Management	2 (2+0)
	ENT 510	Pests of Horticultural and Plantation Crops	3 (2+1)
III	ENT 515	Techniques in Plant Protection	1 (0+1)
	ENT 591	Master's Seminar	1 (0+1)
	ENT 599	Master's Research	15 (0+15)
IV	ENT 599	Master's Research	15 (0+15)

Course Contents

M.Sc. (Agriculture) in Entomology

ENT 501 INSECT MORPHOLOGY 3 (2+1)

Objective: To acquaint the students with the external morphology of the insect's body and the functioning of various body parts.

THEORY

UNIT I

External Morphology: Definition, Principles, Scope and Importance of Insect Morphology. Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation, general body organization of insects.

Head- Origin, structure and modification; mouthparts, antennae, their types and functioning; tentorium and neck sclerites.

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.

Abdomen- Segmentation and appendages; genitalia and their modifications; embryonic and post-embryonic development.

UNIT II

Insect sense organs (mechano-, photo- and chemo- receptors); organogenesis at pupal stage; insect defense; chaetotaxy; morphological traits in relation to forensic entomology.

UNIT III

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects. Comparative study of life history strategies in hemimetabola and holometabola, immature

stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

PRACTICAL

Dissection of mouth parts of different insects, preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia; dissection of genitalia. Types of immature stages in insects; their collection, rearing and preservation. Identification of immature insects to orders and families, in endopterygote orders viz., Diptera, Lepidoptera, Hymenoptera and Coleoptera using key.

Learning outcomes

Students are expected to have a complete understanding of the comparative morphology of the external features of insects that can be utilized in taxonomy, ecology and applied entomology.

Suggested Reading:

1. Chapman, RF. 1998. The Insects: Structure and Function. Cambridge Univ. Press, Cambridge.
2. Duntson, PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
3. Evans, JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
4. Gillott, C. 1995. Entomology, 2nd Ed. Plenum Press, New York, London.
5. Gullan, P.J. and Cranston, P.S. 2000. The Insects, An Outline of Entomology, 2nd Ed. Blackwell Science, U.K.
6. Richards, OW and Davies, RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Chapman and Hall, London.
7. Snodgross, RE. 1993. Principles of Insect Morphology. Cornell Univ. Press, Ithaca.
8. Tembhore, D.B. 2000. Modern Entomology, Himalaya Publishing House, Mumbai.
9. Chu, HF. 1992. How to Know Immature Insects. William Brown Publication, Iowa.
10. Peterson, A. 1962. Larvae of Insects. Ohio University Press, Ohio.
11. Stehr, FW. 1998. Immature Insects. Vols. I, II. Kendall Hunt Publication, Iowa.

ENT 502 INSECT ANATOMY AND PHYSIOLOGY 3 (2+1)

Objective

To impart knowledge about the anatomy and physiology of insect body systems; nutritional physiology; and their applications in entomology.

THEORY

UNIT I

Scope and importance of insect physiology; physiology of integument, moulting, chemistry of cuticle, biosysthesis of chitin; growth, hormonal control, metamorphosis and diapause; pheromone secretion, transmission, perception and reception.

UNIT II

Physiology and mechanism of digestion, circulation, respiration, excretion, reproduction, secretion (exocrine & endocrine glands) and nerve impulse transmission in insects.

UNIT III

Importance of 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.

PRACTICAL

Latest analytical techniques for analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination and count of insect haemocytes; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Learning outcomes

Students are expected to have a thorough understanding of insect growth and development, physiology of exoskeleton, endoskeleton and different organ systems; action and role of hormones, pheromones, physiology of nutrition and its application.

Suggested Reading

1. Chapman RF.1998. Insects: Structure and Function. ELBS Ed., London.
2. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
3. Gullan, P.J. and Cranston, P.S. 2000. The Insects: An Outline of Entomology, 2nd Ed. Blackwell Science, U.K.
4. Kerkut GA and Gilbert LI. 1985. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vols. IXIII. Pergamon Press, New York.
5. Patnaik BD. 2002. Physiology of Insects. Dominant Publishers, New Delhi.
6. Richards OW and Davies RG. 1977. Imm's General Text Book of Entomology. 10th Ed. Vol. 1. Structure, Physiology and Development. Chapman and Hall, New York.
7. Simpson, SJ. 2007. Advances in Insect Physiology, Vol. 33, Academic Press (Elsevier), London, UK. Wigglesworth VB.1984. Insect Physiology. 8 th Ed. Chapman and Hall, New York.

ENT 505 BIOLOGICAL CONTROL OF INSECT PESTS AND WEEDS 3 (2+1)

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

THEORY

UNIT I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT III

Mass production of quality bio-control agents- techniques, formulations, economics, field release/application and evaluation

UNIT IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies and packing- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers. Development of insectaries, their maintenance. Visits to bio-control laboratories to learn rearing and mass production (techniques of available bioagent in area wise locations) of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds. Packaging of bioagents.

Field collection of parasitoids and predators. Hands-on training in culturing, identification of common insect pathogens. Quality control and registration standards for biocontrol agents.

Learning outcomes

Students are expected to have a good understanding of the role of natural enemies in managing pest populations below those causing economic damage. Learn the techniques for mass production of quality bio-agents and their optimal use in IPM.

Suggested Readings:

1. Burges HD and Hussey NW. (Eds). 1971. Microbial Control of Insects and Mites. Academic Press, London.
2. De Bach P. 1964. Biological Control of Insect Pests and Weeds. Chapman and Hall, New York.

3. Dhaliwal GS and Arora R. 2001. Integrated Pest Management: Concepts and Approaches. Kalyani Publ., New Delhi.
4. Gerson H and Smiley RL. 1990. Acarine Biocontrol Agents – An Illustrated Key and Manual. Chapman and Hall, New York.
5. Huffaker CB and Messenger PS. 1976. Theory and Practices of Biological Control. Academic Press, London.
6. Ignacimuthu SS and Jayaraj S. 2003. Biological Control of Insect Pests. Phoenix Publ., New Delhi.
7. Saxena AB. 2003. Biological Control of Insect Pests. Anmol Publ., New Delhi.
8. Van Driesche and Bellows TS. Jr. 1996. Biological Control. Chapman and Hall, New York.

ENT 506 TOXICOLOGY OF INSECTICIDES 3 (2+1)

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

THEORY

UNIT I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

UNIT II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature; categorization of insecticides on the basis of toxicity – criteria for bees, beneficial insects and other insects in general; structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds/ new insecticide molecules; nanopesticides; drawbacks of insecticide abuse.

UNIT III

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. bioassay definition, objectives, criteria, factors, problems and solutions.

UNIT IV

Insecticide metabolism; insect-pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence.

UNIT V

Insecticide residues, their significance and environmental implications; procedures of insecticide residue analysis. Status of Pesticide residue in India. Insecticide Act, registration procedures,

label claim, and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

PRACTICAL

Insecticide formulations and mixtures; laboratory and field evaluation of bio-efficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides. Procedures of residue analysis.

Learning outcomes

Students are expected understand the concept of toxicity, bio-efficacy, insecticide formulations, modes of action of insecticides, estimation of insecticide residues and have significant know-how about the functioning of various types of spray equipments.

Suggested Readings

1. Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford and IBH, New Delhi.
2. Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.
3. Ishaaya I and Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
4. Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York.
5. Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
6. Prakash A and Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publication, New York. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Pearson Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
7. Dovener, R.A. Mueninghoff, J.C. and Volgar, G.C. 2002. Pesticides formulation and delivery systems: meeting the challenges of the current crop protection industry. ASTM, USA
8. Dodia, D.A. Petel, I.S. and Petal, G.M. 2008. Botanical Pesticides for Pest Management. Scientific Publisher (India), Jodhpur.
9. Ishaaya, I. and Degheele, D. 1998. Insecticides with Novel Modes of Action: Mechanism and Application. Norosa Publishing House, New Delhi.
10. Mathews G.A. 2002. Pesticide Application Methods. 4th Ed. Intercept. UK.
11. Otto, D. and Weber, B. 1991. Insecticides: Mechanism of Action and Resistance. Intercept Ltd., U.K.
12. Prakash, A. David, B.V., J. Rao., Srivastava, S.K., Berliner, J. and Totan Adak. Synthetic Pesticides. AZRA Publications.
13. Roy, N.K. 2006. Chemistry of Pesticides. Asia Printograph Shahdara Delhi.
14. Krieger, R. I. 2001. Handbook of Pesticide Toxicology. Vol-II. Academic Press. Orlando Florida.

ENT 508 CONCEPTS OF INTEGRATED PEST MANAGEMENT 2 (2+0)

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL and implementing IPM programmes.

THEORY

UNIT I

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons.

UNIT II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insect host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. Pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

UNIT IV

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; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

Learning outcomes

Students are expected to have significant knowledge of IPM concepts, estimation of losses due to insect pests, computation of ETL, EIL and should be able take management decisions.

Suggested Readings

1. Dhaliwal GS and Arora R. 2003. Integrated Pest Management – Concepts and Approaches. Kalyani Publ., New Delhi.

2. Horowitz AR and Ishaaya I. 2004. Insect Pest Management: Field and Protected Crops. Springer, New Delhi.
3. Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.
4. Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, NewDelhi.
5. Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.

ENT 509 PESTS OF FIELD CROPS 3 (2+1)

Objective

To familiarize the students about nature of damage and seasonal incidence of pestiferous insects that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors. Insect pest scenario in relation to climate change.

UNIT I

Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, Spodoptera sp., Helicoverpa sp. and non-insect pests (mites, birds, rodents, snails, slugs etc.). Insect pests of cereals and millets and their management.

UNIT II

Insect pests of pulses, tobacco, oilseeds and their management.

UNIT III

Insect pests of fibre crops, forage crops, sugarcane and their management.

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.

Learning outcomes

Students are expected to acquire knowledge of insect pests of field crops, their nature of damage, life history traits and effective management.

Suggested Readings

1. David, BV and Ramamurthy, VV. 2001. Elements of Economic Entomology. Popular Book Depot, Chennai.
2. Dhaliwal GS, Singh R and Chhillar BS. 2006. Essentials of Agricultural Entomology. Kalyani Publ., New Delhi.
3. Dunston AP. 2007. The Insects: Beneficial and Harmful Aspects. Kalyani Publ., New Delhi Evans JW. 2005. Insect Pests and their Control. Asiatic Publ., New Delhi.
4. Nair MRGK. 1986. Insect and Mites of Crops in India. ICAR, New Delhi.
5. Prakash I and Mathur RP. 1987. Management of Rodent Pests. ICAR, New Delhi.
6. Saxena RC and Srivastava RC. 2007. Entomology at a Glance. Agrotech Publ. Academy, Udaipur.

ENT 510 PESTS OF HORTICULTURAL AND PLANTATION CROPS 3 (2+1)

Objective

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

UNIT I

Fruit Crops- mango, guava, banana, jackfruit, papaya, pomegranate, litchi, grapes, ber, fig, citrus, sapota, aonla, jamun, avocado, dragon fruit, custard apple, tamarind, pineapple, apple, peach and other temperate fruits.

UNIT II

Vegetable crops- tomato, potato, sweet potato, radish, carrot, beetroot, cole crops (cabbage, cauliflower, knolkhol), French beans, chow-chow, brinjal, okra, all gourds (pumpkin, bottle gourd, bitter gourd, ridge gourd, sponge gourd, cucumber etc.), drumstick, leafy vegetables (amaranthus, spinach, fenugreek) etc.

UNIT III

Plantation crop- coffee, tea, rubber, coconut, oil palm, arecanut, cashew, cocoa, betelvine etc.; Spices and Condiments- pepper, cinnamon, cardamom, clove, nutmeg, chillies, turmeric, ginger, onion, garlic, curry leaf, cumin, coriander etc.

UNIT IV

Ornamental (croton, rose, gerbera, chrysanthemum, carnation, tuberose, aster, jasmine), medicinal (aloe vera, shatavari, ashwagandha, sarpagandha) and aromatic plants and pests in polyhouses/protected cultivation.

Practical

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

Learning outcomes

Students are expected to acquire knowledge of insect pests of horticultural, medicinal and plantation crops, their nature of damage, life history traits and effective management.

Suggested Readings

1. Atwal AS and Dhaliwal GS. 2002. Agricultural Pests of South Asia and their Management. Kalyani Publ., New Delhi.
2. Butani DK and Jotwani MG. 1984. Insects and Vegetables. Periodical Expert Book Agency, New Delhi
3. Dhaliwal GS, Singh R and Chhillar BS. 2006. Essential of Agricultural Entomology. Kalyani Publ., New Delhi.
4. Srivastava RP.1997. Mango Insect Pest Management. International Book Distr., Dehra Dun.
5. Verma LR, Verma AK and Goutham DC. 2004. Pest Management in Horticulture Crops: Principles and Practices. Asiatech Publ., New Delhi.

ENT 515 TECHNIQUES IN PLANT PROTECTION 1 (0+1)

Objective

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopy, computation, pest forecasting, etc.

Theory

UNIT I

Pest control equipments, principles, operation, maintenance, selection, and application of pesticides; release of bio-control agents; seed dressing, soaking, root-dip treatment, dusting, spraying, and pesticide application through irrigation water; application of drones in plant protection.

UNIT II

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

UNIT III

Uses of light, transmission and scanning electron microscopy.

UNIT IV

Protein isolation from the pest and host plant and its quantification using spectrophotometer and molecular weight determination using SDS/PAGE.

UNIT V

Use of tissue culture techniques in plant protection. Computer application for predicting/ forecasting pest attack and identification.

Learning outcomes

Students are expected to have a good knowledge of different plant protection equipments and techniques related to pest forecasting.

Suggested Readings

1. Alford DV. 1999. A Textbook of Agricultural Entomology. Blackwell Science, London.
2. Crampton JM and Eggleston P. 1992. Insect Molecular Science. Academic Press, London