

Lecture outline

Title of the Course: Introduction to Agricultural Entomology

Course Number: AET 203; Credit Hours: 2+1

For B.Sc. (Agricultural Marketing); II year I Semester

1. Position of insects in the animal kingdom:
 - a. Classification of living things in general,
 - b. Characters of Phylum Arthropoda;
 - c. Classification of Phylum Arthropoda, differences between classes;
 - d. Characters of the Superclass Hexapoda and Class Insecta
2. Dominance of insects in the Animal Kingdom: Factors responsible for dominance
 - a. Presence of exoskeleton
 - b. Size of insects
 - c. Presence of wings
 - d. Adaptability
 - e. Rate of reproduction
3. General morphology of insects:
 - a. Definition for an insect;
 - b. External Morphology of a typical insect;
 - i. Body division;
 - ii. Classification of insects based on head orientation;
 - iii. Head structure and sutures
4. Appendages of the head:
 - a. Structure and types of antennae with examples
 - b. Johnston's organ – location and function
5. General structure of a typical Chewing and biting type of mouthparts of an insect;
 - a. Structure of chewing and biting type of mouthparts of a typical insect
 - i. Piercing and sucking mouthparts of plant bug
 - ii. Piercing and sucking mouthparts of mosquito
 - iii. Chewing and lapping mouthparts of honeybee
 - iv. Sponging mouthparts of house fly
 - v. Siphoning mouthparts of butterfly
6. Insect thorax – structure:
 - a. Insect leg structure and modifications with examples
 - i. Cursorial
 - ii. Saltatorial
 - iii. Raptorial
 - iv. Natatorial
 - v. Fussorial
 - vi. Pollen carrying type
 - vii. Antenna cleaner
 - viii. Clinging

- b. Wings
 - i. structure of a typical wing – margins and angles
 - ii. wing venation – Major veins
 - iii. wing coupling apparatus with examples
 - iv. modifications in wings
 - 1. Elytra
 - 2. Hemelytra
 - 3. Tegmina
 - 4. Halteres
7. Internal anatomy of insects
- a. Digestive system – structure, Filter chamber in sucking insects
 - b. Circulatory system – structure – aorta, hearts, ostia, systole, diastole
 - c. Respiratory system
 - i. Structure of spiracle
 - ii. Classification based on number of functional spiracles with examples
 - 1. Holopneustic
 - 2. Hemipneustic
 - 3. Apneustic
 - d. Nervous system – structure –
 - i. Supra-oesophageal ganglion
 - ii. Sub-oesophageal ganglion
 - iii. Two thoracic (meso & meta) ganglia
 - iv. Eight abdominal ganglia (first 8 abd segments)
 - e. Reproductive system
 - i. Male reproductive system
 - 1. Paired testes, testicular follicles, vasa deferentia, seminal vesicle, common ejaculatory duct, two accessory glands (mushroom shaped gland and conglomerate gland)
 - ii. Female reproductive system
 - iii. Paired ovaries, ovarioles, oviducts, common oviduct, spermatheca, one accessory gland (collateral gland)
 - f. Excretory system : Malpighian tubules; Nephrocytes
8. Metamorphosis – Definition & meaning;
- a. Ametabola
 - b. Incomplete metamorphosis
 - c. Complete metamorphosis
 - d. Anamorphosis
 - e. Hyper metamorphosis
 - f. differences between larva and nymph
 - g. Differences between nymph and naiad,
 - h. types of larvae with examples
 - i. Apodous
 - ii. Oligopodous
 - 1. Campodeiform; 2. Scarabaeiform
 - iii. Polypodous

- i. types of pupae with examples
 - i. Obtect
 - ii. Excrete
 - iii. Coarctate
- 9. Reproduction:
 - a. Sexual and asexual reproduction in insects;
 - b. parthenogenesis,
 - i. Thelytoky
 - ii. Arrhenotoky
 - iii. Amphitoky
 - c. polyembryoni,
 - d. paedogenesis
 - e. Hermaphroditism
- 10. Classification of Insects:
 - a. Binomial Nomenclature
 - b. Classification of Superclass Hexapoda;
 - c. Characters of class insecta –
 - d. Classification of class Insecta;
 - e. Differences between Apterygota and Pterygota
 - f. Ametabola, Hemimetabola and Holometabola (differences between)
 - g. Meaning & Differences between Exopterygota (Hemimetabola) and Endopterygota (Holometabola)
 - h. Orders under Apterygota and
 - i. Classification of Pterygota
- 11. Study of Major Orders of Insects – Order Orthoptera:
 - a. Identification characters of the order
 - b. Economic importance;
 - c. Classification – suborders Caelifera and Encifera
 - i. Differences between caelifera and encifera, characters & examples
 - d. Characters of major families –
 - i. Tettigonidae;
 - ii. Acrididae;
 - iii. Gryllidae and
 - iv. Gryllotalpidae
- 12. Order Hemiptera:
 - a. Identification characters
 - b. Economic importance;
 - c. Classification;
 - d. Characters of major families –
 - i. Miridae;
 - ii. Reduviidae;
 - iii. Coreidae;
 - iv. Pentatomidae;

- v. Belastomatidae;
- vi. Nepidae;
- vii. Notonectidae;
- viii. Cicadidae;
- ix. Cicadellidae;
- x. Membracidae;
- xi. Aphididae;
- xii. Coccidae

13. Order Coleoptera:

- a. Identification characters
- b. Economic importance;
- c. classification;
- d. characters of major families –
 - i. Carabidae;
 - ii. Cicindelidae;
 - iii. Dytiscidae;
 - iv. Scarabaeidae;
 - v. Buprestidae;
 - vi. Elateridae;
 - vii. Coccinellidae;
 - viii. Cerambycidae;
 - ix. Bruchidae;
 - x. Chrysomellidae;
 - xi. Curculionidae

14. Order Lepidoptera:

- a. Identification characters
- b. Economic importance;
- c. classification;
- d. characters of major families –
 - i. Nymphalidae;
 - ii. Peiridae;
 - iii. Papilionidae;
 - iv. Lycaenidae;
 - v. Hesperidae;
 - vi. Yponomeutidae;
 - vii. Xylorectidae;
 - viii. Gelichiidae;
 - ix. Pyralidae;
 - x. Saturniidae;
 - xi. Bombycidae;
 - xii. Sphingidae;
 - xiii. Arctiidae;
 - xiv. Noctuidae;

15. Order Diptera:

- a. Identification characters
- b. Economic importance;
- c. classification;
- d. characters of major families –
 - i. Culicidae;
 - ii. Cecidomyiidae;
 - iii. Tabanidae;
 - iv. Asilidae;
 - v. Syrphidae;
 - vi. Tephritidae;
 - vii. Drosophilidae;
 - viii. Agromyzidae;
 - ix. Tachinidae;
 - x. Muscidae;
 - xi. Sarcophagidae;
 - xii. Hippoboscidae

16. Order Hymenoptera:

- a. Identification characters
- b. Economic importance;
- c. classification;
- d. characters of major families –
 - i. Tenthredinidae;
 - ii. Ichneumonidae;
 - iii. Braconidae;
 - iv. Chalcididae;
 - v. Scoliidae;
 - vi. Formicidae;
 - vii. Vespidae;
 - viii. Apidae

17. Classification of insects based on economic importance –

- a. Insects without economic importance
- b. Insects with economic importance
 - i. Useful insects
 1. Helpful insects
 - a. Parasites
 - b. Predators
 - c. Pollinators
 - d. Weed killers
 2. Productive insects
 - a. Silkworm moth
 - b. Honeybees
 - c. Lac insects
 - d. Cochenial insect

- ii. Harmful insects
 - 1. Pests of crops (Agricultural Entomology)
 - 2. Pests of stored products (Storage Entomology)
 - 3. Pests of Medical and Veterinary importance (Medical and veterinary Entomology)
 - 4. Pests of Forest plants (Forest Entomology)
- 18. Study of Insect parasitoids and predators –
 - a. Differences between a parasite and a parasitoid
 - b. Differences between a parasitoid and a predator
 - c. Use of parasites and predators in biological control of insect pests
 - d. Types of parasitism
 - i. Simple parasitism
 - ii. Multiple parasitism
 - iii. Gregarious parasitism
 - iv. Super parasitism
 - v. Hyper parasitism
- 19. Natural and Biological control –
 - a. examples of parasitoids and predators
 - b. successful biocontrol programmes
- 21 Weeds and Biological control of weeds –
 - a. successful biocontrol programmes with insect weed killers
- 22 Pollination and Entomophily –
 - a. Important pollinator species
 - b. Importance of pollinators in agroecosystems –
- 23 Scavengers: Role of insects as scavengers with examples and their importance
- 24 Insects in relation to environment
 - a. Environmental factors that influence insect populations;
 - i. Biotic potential – Fecundity (number of eggs laid), sex ratio, generation time, number of generations per unit time
 - ii. Environmental resistance – Biotic and Abiotic factors
 - 1. Biotic – Food, Intraspecific and interspecific competition, shelter, natural enemies, etc.
 - 2. Abiotic – temperature, humidity, rainfall, nutrition, etc.
 - b. Balance of life in nature
- 25 Definition of pest:
 - a. Factors responsible for pest outbreaks
 - b. Types of pests
 - i. Major pest
 - ii. Minor pest
 - iii. Regular pest
 - iv. Sporadic pest
 - v. Endemic pest
 - vi. Pest epidemics
 - vii. Cyclic pest

- 26 Pest control and pest management;
- 27 Pest control and pest management;
 - a. Difference between control and management
 - b. IPM - definition
 - c. Principles of pest management;
 - d. Concepts of IPM
 - i. General Equilibrium Level of a population
 - ii. Economic Threshold
 - iii. Economic Injury Level
 - e. Components of IPM
 - i. Cultural methods
 - ii. Physical methods
 - iii. Mechanical methods
 - iv. Biological methods
 - v. Legal methods
 - vi. Chemical methods
- 28 Insecticides – Definition
 - a. Definition of an insecticide
 - b. Classification of insecticides
 - i. Based on mode of entry
 - 1. Stomach poisons
 - 2. Contact poisons
 - 3. Fumigants
 - 4. Systemic poisons
 - ii. Based on mode of action
 - 1. Physical poisons
 - 2. Protoplasmic poisons
 - 3. Respiratory poisons
 - 4. Nerve poisons
 - iii. Based on chemical nature
 - 1. Inorganic compounds
 - a. Arsenic compounds
 - b. Sulphur
 - c. Fluorine compounds
 - d. Zinc phosphide
 - e. Borax
 - 2. Organic compounds
 - a. Naturally occurring organic insecticides.
 - i. Hydrocarbon oils
 - ii. Animal Origin Insecticides
 - iii. Plant Origin Insecticides
 - iv. Microbial origin insecticides
 - b. Synthetic organic insecticides
 - i. Organochlorine compounds
 - ii. Organophosphorus compounds

- iii. Carbamate compounds
 - iv. Synthetic pyrethroids
 - v. Acylurea compounds
 - vi. Neonicotinyl compounds
 - vii. Miscellaneous compounds
 - 1. Macrocyclic lactones
 - 2. Tertiary amines
 - 3. Oxadiazines
 - 4. Phenyl pyrazols
 - iv. Examples for different groups of insecticides
 - v. Mode of action of insecticides (Major groups- organochlorines, OP and carbamates)
- c. Insecticides act
 - i. Legislature imposed by the state or the federal (central) government to maintain the quality of insecticide manufactured, formulated, packaged and made available to the end user (farmer)
 - ii. Also imposed on the supply of the quality product
 - iii. Imposed on the method of application of the insecticide
 - iv. Imposed on the cultivators for taking up control measures compulsorily on such pests of national or regional importance – example coffee stem borer
- d. Insecticide formulations
 - i. Why insecticides are formulated?
 - ii. Types of formulations
 - 1. Solid formulations
 - a. Dusts (D)
 - b. Granules (G)
 - c. Wettable Powders (WP)
 - d. Wettable granules
 - e. Soluble powders (SP)
 - f. Water dispersible powders (WDP)
 - 2. Liquid formulations
 - a. Emulcifiable concentrates (EC)
 - b. Solvable liquids (SL)
 - c. Solutions
 - d. Concentrated Liquids
 - e. AquaFlowable formulations (AF) / Flowables
 - 3. Aerosols
 - 4. Fumigants
 - iii. Adjuvants used in formulations

29 Preparation of spray mixtures

- a. Preparation of spray fluid of required strength (Formula)
- b. Determining the strength of finished spray solution (Formula)
- c. Calculation of quantity of proprietary product required when recommended in active ingredient per acre (ai/ac) (Formula)
- d. Preparation of poison baits
- e. Preparation of NSKE 4%

30 Plant protection equipment

- a. Dusters
- b. Granule applicators
- c. Sprayers
 - i. High volume sprayers – commonly used backpack sprayers, rocking (Gator) sprayers, etc where the volume of water used for diluting the insecticide is high - usually about 200 to 250 liters per acre
 - ii. Low volume sprayers – Motorised sprayers – Aspee bolo sprayer that works on kerosene or petrol – the volume of water used for diluting the insecticide is less – reduced by about $\frac{1}{4}$ or $\frac{1}{3}$ the volume used for high volume sprayers (80 to 100 lts per acre)
 - iii. In both the High volume and Low volume sprayers the quantity of insecticide used is the same but the difference is with the quantity of water used.
 - iv. The recommendation of an insecticide is based on the active ingredient per unit area, that remains constant
 - v. Ultra-low volume sprayers – the insecticide is used without dilution – ULV special formulations only to be used – used for aerial spraying large areas
- d. Sprayers
 - i. Pneumatic sprayers
 - 1. Automisers
 - 2. Back pack or knapsack sprayers
 - ii. Hydraulic sprayers
 - 1. Foot sprayers
 - 2. Rocking / Gator sprayers
 - 3. Bucket sprayers
 - iii. Mist blowers
 - 1. Low volume, Power sprayer (Aspee bolo)

31 Types of damage caused by insects to plants and plant products –

- a. classification of insects based on damage type
 - i. Root feeders
 - ii. Stem feeders
 - 1. Stem borers
 - 2. Stem girdlers
 - 3. Bark feeders
 - iii. Leaf feeders
 - 1. Defoliators
 - 2. Leaf miners
 - iv. Flower feeders
 - v. Fruit feeders
 - 1. Pod borers
 - 2. Nut feeders
 - 3. Fruit pulp feeders

32 Pests of Paddy, sugarcane, cotton and redgram and their management

a. Pests of paddy (identification and damage as in manual)

i. Management of stem borer

1. Clipping of tips of seedlings before planting to destroy egg masses of stem borer
2. Inundative releases of *Trichogramma* egg parasites @ 50000/ha at weekly intervals following high catches of moths of stem borer in light traps
3. In fields with > 5% dead-heart symptom – spray with 500 ml triazophos 40EC or 500 ml quinalphos in 250 lts water /ha

ii. Management of Leaf folder/leaf roller

1. Remove grassy weeds from bunds
2. Run light traps for regular trapping of moths
3. At 10% leaf damage – spray 500 ml triazophos or quinalphos or chlorpyrifos (at 30 days after transplanting) in 250 lts water

iii. Management of gall fly

1. Removal of grassy weeds
2. In endemic areas – seedling root dip in 0.02% chlorpyrifos 20EC for 12 hrs before transplanting
3. ET 1 gall / m² spray 500 ml quinalphos or chlorpyrifos in 250 lts water

iv. Management of BPH

1. Alternate drying and wetting of field
2. Avoiding close spacing and excessive N application
3. Use of light traps
4. If mixed predatory bug activity is high no need to apply insecticides
5. ET 5 to 10 BPH per hill, spray 100 ml Imidachloprid or 500 ml endosulfan in 250 lts water

v. Management of Earhead or Gundhi bug of paddy

1. Dusting malathion 5% D or Carbaryl 5% D @ 25 kg/ha on the earheads at milky stage

b. Pests of cotton

i. Management of cotton bollworms

1. Destroy off season cotton sprouts, alternate plants, plant debris
2. Deep ploughing to expose the bollworm pupae if any in the soil
3. Avoid cultivation bhendi, redgram, tomato, in and around cotton fields
4. Release *Trichogramma chelonis* @ 1,50,000 per ha starting from 70th day after sowing at weekly intervals (8 to 10 releases)
5. If incidence increases over 10% spray 2 lts endosulfan or 1.25 lts monocrotophos or profenophos or 2.5 kg carbaryl WP, or 500 ml cypermethri or 250 ml fenvalerate at 10 days interval. Do not repeat application with the same insecticide.

- c. Pests of sugarcane
 - i. Management of topshoot and stem borers
 1. Do not ratoon an infested crop
 2. Burn trash in the field after harvest
 3. Run light traps to collect moths and collect and destroy egg masses
 4. Release 50000 *Trichogramma* ten times
 5. Apply carbofuran 3 G or phorate 10 G granules @ 30 kg per ha if damage exceeds 5%
 - d. Pests of redgram
 - i. Management of Redgram pod borers
 1. Cultivation of resistant variety ICCV 7
 2. Mixed cropping with non hosts
 3. Application of Helcoverpa NPV @ 250 – 500 Larval Equivalents (LE)/ha at 50% flowering when larvae are seen
 4. ET one larvae per five plants – spray
- 33 Pests of vegetables, fruits, plantation and spice crops and their management
- a. Pests of vegetables
 - i. Management of tomato fruit borer
 1. Cultivation of marigold as trap crop with a ratio of 16:1
 2. Collection and destruction of larvae from marigold heads
 3. Spraying NSKE 4% or endosulfan or monocrotophos or triazophos at 50% flowering in tomato
 - ii. Management of shoot and fruit borer of bhendi
 1. Collection and destruction of infested fruits at every harvest
 2. Spraying endosulfan or triazophos or monocrotophos or cypermethrin in vegetative phase and at flowering.
 - iii. Management of potato tuber moth
 1. Proper earthing up of exposed tubers
 2. Application of Malathion dust or phorate granules
 3. Covering the harvested heaps with sand layer
 - b. Pests of Cruciferous vegetables
 - i. Management of diamond back moth
 1. Cultivation of African bold mustard as trap crop in 25 : 2 ratio
 2. Application of dichlorvos on mustard whenever the pest is noticed
 3. Application of Neem Seed Kernel Extract 4% on cabbage / cruciferous crop
 - c. Pests of cucurbitaceous vegetables
 - i. Management of fruit flies
 1. Regular removal and destruction of infested fruits
 2. Raking up of soil to expose the pupae
 3. Using traps baited with cue lure for attracting and killing males of the fruit fly

d. Pests of fruit crops

i. Management of mango fruit fly

1. Regular removal and destruction of affected fallen fruits
2. Raking up of soil for exposing pupae
3. Using traps baited with methyl eugenol for attracting and killing males of the fruit fly

ii. Management of mango hoppers

1. Spray young shoots and inflorescences with 2.5 kg carbaryl 50 WP or with 2 lts malathion 50 EC in 1250 lts water/ha in February and again in March

iii. Management of mango stem borer

1. Identify bored holes
2. Cut and burn affected and dried branches
3. Remove the larva using a pointed stiff wire
4. Insert a cotton wad dipped in dichlorvos using a wire if larva can not be removed

iv. Management of Banana pseudostem weevil

1. Inject monocrotophos 5 ml mixed with 5 ml water using a syringe
2. Application of 10 g phorate or carbofuran granules per plant

v. Management of banana rhizome weevil

1. Selection of rhizomes for fresh planting from uninfested gardens
2. Application of 10 g phorate or carbofuran granules per plant

34 Pests of plantation and spice crops

a. Pests of coconut

i. Management of rhinoceros beetle

1. Identification of freshly damaged palms
2. Removal of rhinoceros beetle from the damaged crown using a stiff pointed wire
3. Application of a mixture of sand and phorate (1:1) between unopened fronds in crown region
4. Application of phorate to compost pits in coconut gardens
5. Maintenance of sanitation

ii. Management of coconut black headed caterpillar

1. Remove and burn all affected fronds
2. Release of parasites – *Goniozus nephantidis* and *Bracon brevicornis* @ 600 /ac
3. Root feeding with monocrotophos

iii. Management of coconut red palm weevil

1. Avoid damaging trunk
2. Cleaning of affected portion of the trunk by scraping and insertion of dichlorvos wad into the damaged area
3. Covering the area with wet mud

- b. Pests of coffee
 - i. Management of Coffee white stem borer
 - 1. Tracing, uprooting and burning affected plants twice a year – March-April and in September-October
 - 2. Swabbing the trunks with chlorpyrifos twice - March-April and in September-October
 - ii. Coffee green scale
 - 1. Application of dimethoate @0.05%
 - 2. Multiplication and release of *Cryptolaemus montrezeuri*
- c. Pests of cardamom
 - i. Management of thrips
 - 1. Spraying profenophos or monocrotophos in March-April followed by two applications of phosalone in May and August
 - ii. Management of shoot and capsule borer
 - 1. Identification of damaged shoots, cutting and burning
 - 2. Spray application of quinalphos in the month of September-October and in February

35 Pests of stored products and their management

- i. Management of store pests
 - 1. Drying of grains to below 8% moisture level
 - 2. Storing grains in insect free bins or storage structures
 - 3. Fumigation using Ethyl dibromide (EDB) or Methyl bromide
 - 4. Using sand to cover seeds stored in bins