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Course No: - ENTO-232

Course :- ENTO 232 Theory :-

Introduction :-

- German Biologist, Earnest Haeckel in the term 'Oikologies' which is composed of two words viz Oikos - House, or place of living and logos meaning science or study.

- A/c to him Oikologies is the relation of the animals to its organic as well as inorganic environment particularly its friendly or hostile relations to those animals or plants with which it comes in contact.

- The term oikologies was soon substituted by the term Ecology.

Ecology : The science dealing with the relationship of organism to their environment.

Eugene. P. Odum (1953) :- It is the study of structure and function of nature.

Insect Ecology :- As the understanding of physiology and behaviour of insects as affected by their environment.

Importance and scope of Insect Ecology :-

- This makes ecology a multidisciplinary approach which may prove very fruitful indeed for the solutions of the problems like indiscriminate use of insecticides for pest control the release of massive quantities of radioactive debris, discarded chemicals and industrial wastes into water bodies which may have long and short term ecological effects and provides opportunities for having full understanding of nature and natural resource and to boost agricultural production.

Scope of Insect Ecology:

1) As insects are evolved through a great diversity of habits and a wide range of habitat they can be easily collected from any habitat without severe depletion of local populations for ecological studies
2) Vast majority of the insects are herbivores, while others are carnivorous and parasitic, thus help in understanding tritrophic level in a food chain or a food web.
3) Entomologists have contributes significantly to the development of ecological concepts by exploiting insects for the needful development of ecological thoughts, methods, principles and procedures because it is very easy to carry out studies on insects both in field and laboratory and for arriving at results leading to formulation of mathematical models.
4) Biological control of insect pest and weeds by use of insects has been a major source of inspiration to workers in these areas.

5) In pest management economic injury levels and economic threshold have been worked out for number of insect pests and ~~pe~~ their determination is mainly based on ecological principles

6) The ecological principles are of prime significance in conservation and its resources for evolving ecofriendly pest management tactics.

Sub-divisions of Ecology :-
Earlier ecological studies made from time to time are based on 3 principle approaches viz,

1) Taxonomic affinities or Taxonomic Ecology :- Ecology involving study of plants (plant ecology) and animals (animal ecology) eg :- Insect Ecology, Human Ecology, Cotton Ecology.

2) Habitat Ecology :- Ecology involving study of habitats (i.e place where

organisms live) eg: Marine water Ecology, Fresh water Ecology, Grassland Ecology, Desert land Ecology, Forest Ecology, Arid land Ecology, Estuarine Ecology etc.

3) Levels of organizations or organizational Ecology:- Here the unit of study is either individual (Autecology) or group of organisms (synecblogy).

a) Autecology :- individual with environment.
- This is also known as ecology of individual where we study the interrelations between individual species with its environment.
- In autecological studies the assessment of the intrinsic capacities of organisms which enable them to cope with environmental conditions is important. Eg: Ecology of desert locust, Tomato Fruit borer, Fresh water Prawns etc.

b) Synecology :- group of organisms with environment
- This is also known as ecology of groups of organisms in a given environmental conditions.

- Under natural conditions, organisms live together as a group affecting each other's life in several ways.
- Thus more complex situation exists where the units of study are groups rather than single organisms. such as apprach where units of study are groups of organisms (community) is called as synecology.

Depending upon condition as there exist synecology deals with

i) Population ecology :- The units of study are individuals of a single species (population).

ii) Community ecology :- The unit of study are groups of individuals belonging to different species of both plants and animals (community).

iii) Biome ecology :- The unit of study are different communities of an area.

iv) Ecosystem ecology :- This has been the most recent development in ecology, where the units of the study are whole system including the biotic and abiotic components.

Beside the aforesaid main sub-division of ecology, there have developed many specialized field (branches) of ecology as :

- Production ecology
- Agro - ecology
- Forest ecology
- Insect ecology
- Applied ecology
- Chemical ecology
- Physiological ecology
- Evolutionary ecology

Terminology:

Biosphere :- Indicate Earth's all the eco-systems functioning together or global scale.

Biota :- Fauna and Flora of a particular habitat together called as Biota

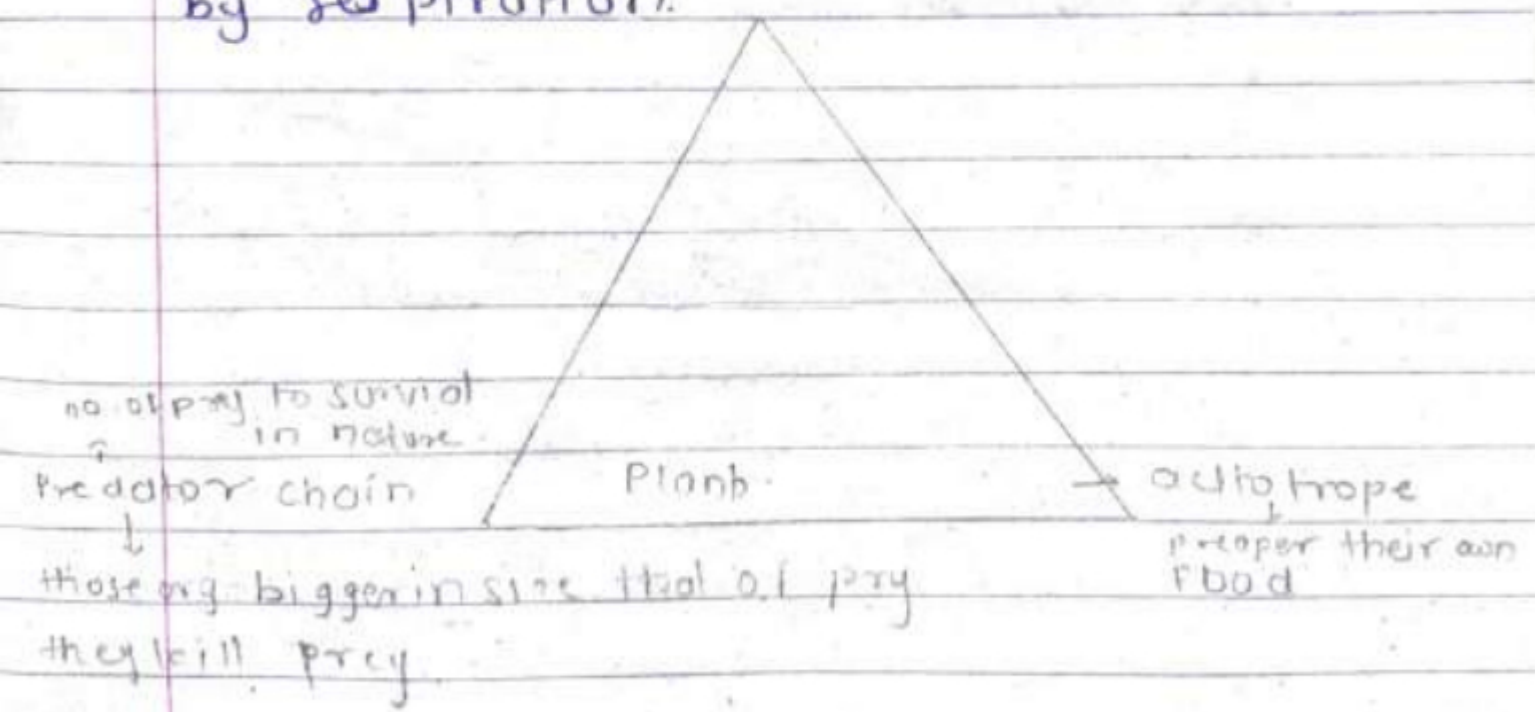
Ecosystem :- An assemblage of interacting plant and animal communities and non-living environmental components

Environment :- Denotes the sum of total of physical and biological factor that directly influences the rate of ~~in~~ survival growth and development of an organism.

Food Chain, Food Web:

Food chain:- The tranfers of food energy from the sourch in plants through a series of organisms with repeated eating and being eaten is called food chain.

- Shorter the food chain the greater the avaliable energy which can be converted into biomass and dissipated by respiration.



1) Predator chain: Predator are those organism which are bigger in size that of prey. They kill prey.

no. of prey requried to survial in nature

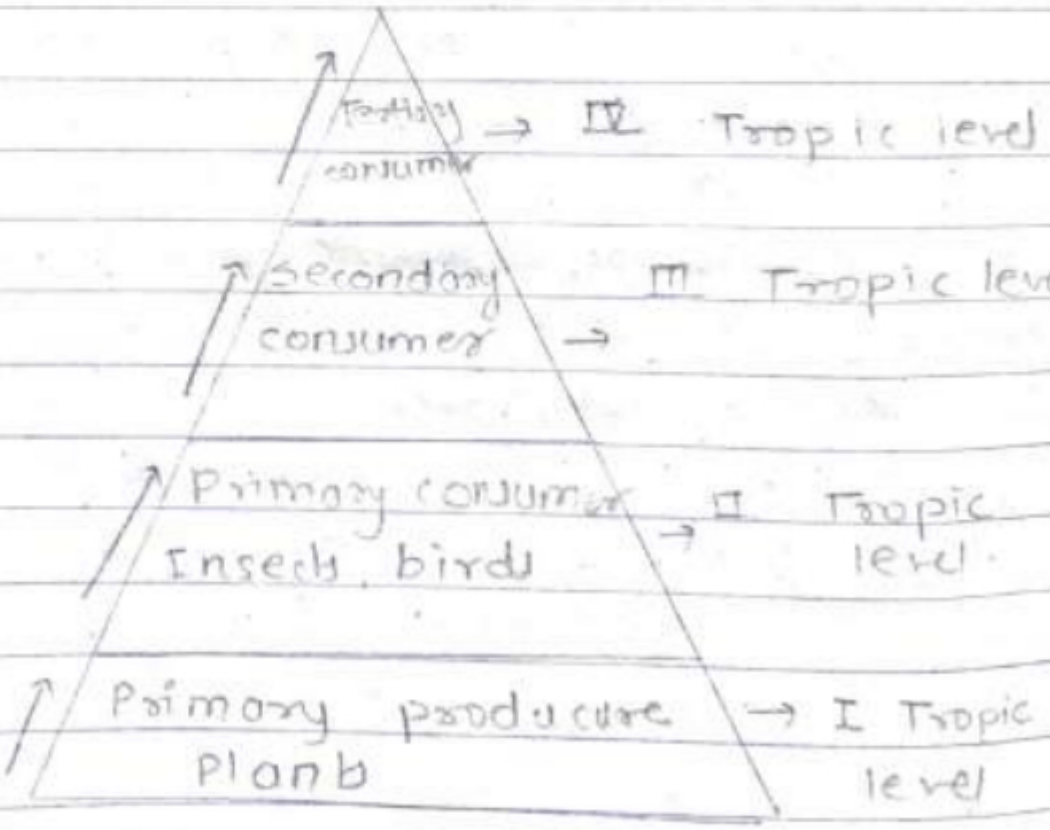
more than 2 not

Start from a plant base and goes from small to larger animals.

Leady bird bittle Feed on soft body insect
white flies / Aphids,
leaf hopper

3) Parasite chain: which goes from larger to smaller organism
e.g: liech, head, louse → Parasite
prey - human body
It never kill the prey. It require one prey to complete its life cycle.

3) Saprophytic chain: which goes from dead matter into micro-organisms.
eg: Fungus, bacteria, virus.



Enery flow Pyramid in an Ecosystem.

soft body insect - lady bird beetle
white flies, aphids, leaf hopper

e.g:- Plants → Insect (grass hopper) → Frogs → Snakes → Eagle.

Feed on plants :- phytophagous (primary consumer) insect - Aphids
e.g → Locust, Fruit flies, white flies, leaf hopper
Yellow bollworm, Bollworm, Pink bollworm

I T.L - Plants → primary producer
↓
II T.L Aphids, leaf hopper - primary consumer
↓
III T.L lady bird bittel - secondary consumer

Food web:- Food chains are not isolated sequence, but are interconnect with one another. The interlocking pattern of food chains is often called as food web.

Tropic level :- The successive levels of energy flow constituting the link of the food chain are called as tropic level.

Environment and its Component:

Concept of Agro-ecosystem:

Natural Ecosystem:-

- Just likes, ponds, grass lands, Forest etc are systems of interacting components (biotic and abiotic) so are the cropped area.

- consequently we can consider an orchard or any other crop field as an independept

- Thus, an agro-ecosystem is a modified and simplified system of plant and animals habitat used for human agriculature purpose

- An agro-ecosystem is largely created and maintained to satisfy human wants or needs.

- An ecosystem are the very basic unit of study of Ecology, the agro-ecosysetm is the basic unit of study for pest management

Major Features of an Agro-ecosyste

- Agro-ecosystem often lack temporal continuity
- Their existance may be of limited duration and may undergo immen abrupt changes in micro-climate because of cutting, plowing, disking, burning, chemical application and other cultural practice
- Agro-eco-systems are dominated by plants selected by humans many consisting of imported genetic material.
- Most agro-ecosystems have little species divesity and the crop species has little interaspecific diversity. In other words the crop tends to be genetically uniform.

Agro - ecosystem	Natural eco - System.
1) Short duration 3-4 months or year	Long duration, 50 - years or more.
2) Discontinuous in space and time	continuous in space and time.
3) Very much influenced by the variation in weather.	more stability, less influence of change weather.
4) They are artificially created and their continuity depends	They are naturally created and self prepetuating
5) The vegatation is not naturally selected but often introduced mono cultured of limited genotype.	The variation is naturally growing with diverse range of genotype.
6) Pest outbreaks are more common.	Pest out breaks are rare.

density - dependent on insect, natural enemy
density - independent - abiotic factor.
catastrophic

Components of Environment:

Environments: The sum total of physical and biological factor that directly influence the rate of survial, growth and development of an organism

Howard Fiske :- In 1911 analyed the environment into 2 sets of factors according to wheater the harmful influence of enviroment increased with density of population [facultative factor] or was independent of the density [catastrophic factors]

Smith [1935]: Used the term density dependent and density independent factors as synonyms to faculatative and catastrophic factors.

Components of Environment:

2 group:-

1) Abiotic :- density independent or catastrophic component

2) Biotic : Density dependent or Facultative components

A) Abiotic Components:-

1) Climatic or weather or Physical Factors:-

a) Temperature.
b) Light
c) Humidity
d) Rainfall
e) Wind / Air currents
f) Atmospheric pressure.

2) Geographic or Topographic Factors

a) Mountain ranges
b) Large water bodies.

3) Edaphic or soil Factors:-

a) soil types: [eg: Clayed, loamy, sandy etc
b) soil fertility
c) soil structure and texture
d) soil drainage

B) Biotic Components:

1) Relationships among organism:-

a) Intra - specific Interactions:

i) Aggregation ii) Concurrence

iii) Cannibalism iv) Association of sexes.

v) Parental care vi) Social life.

b) Intre-specific positive interactions:

i) Commensalisms

ii) Mutation

iii) Co-operation

c) Inter-specific negative interaction:-

i) competition

ii) Parasitism

iii) Predation

2) Insect - plant relationship:-

3) Food in relation to insect:-

a) Quantity of food

b) Quality of food.

1) Effect of Abiotic Factor:-

Effects of Temperature:-

- Life in the universe exists within a temperature range of -200°c - +100°c.

- Insect are poikilothermic i.e a precise mechansim to regulat body temperature is absent. ∴ activites and certain of the developmental stages of insects life are adversely affected by the extremes of temperature.

- Every insects species exhibits a temperature preferendum (optimum range temp.) where all the normal activities go on smoothly.

- The optimal temp. range for mos of the insect species is 22-38°c or 20 + 35°c

eg:-

- Some insect species that are able to at temp well beyond these ranges.
eg:- maggots of chironomids and other dipterans can thrive to 55°c while snow fleas [order - collembola] can servive at temp. much below freezing point at high mountain range new polar Regions of earth

- Below or above the optimum temp, the rate of chemical reaction and metabolic process are influnced Insect may undergo a stage of dispauses if temp. is below optimum [hibernation] or above optimum [aestivation].
eg:- Bed bugs completed 12 generations in tropics and only two generations in cold climate.

- The Fecundity of insects is affected by the temp.
eg:- Diman d back moth lays more eggs to a temp. of 18°c than 22°c.
Grasshopper lays 20 to 30 times more eggs at 32°c than 22°c.

- Oviposition of bed bug is inhibited betn 8-10°c. Head lowe pediculw spp does not oviposit below 25°c.

- In addn to the effect on rate of development and fecundity temp also influence other vital life process including behaviour of the insect

- Swarm migration of desert locust Schistocerca gregaria occurs at 17 c to 20°c.

Hydrocoles - water loving
mesocoles - neither excess nor deficiency water
exocoles - live in dry situati

2) Effect of Humidity :-

- Environment moisture factors of major significance are precipitation humidity, condensation, and avaliable surface water (soil, plant surface etc)

- A constant supply of moisture is necessary to maintain normal metabolic reactions and also for the dissolution and transport of salts in insects.

- Moisture can be measured in various ways viz, absoulte humidity, specific humidity, relative humidity, vapour pressure, saturation deficit and dew points.

- Insect may be classified on an ecological basis into hydrocoles - water loving, mesocoles - those living in places with neither excess nor deficiency of water, exocoles - insects which live in dry situations demanding an increased rate of evaporation.

e.g:- Temites usually move toward a zone humidity when subjected to the slighest desiccation

The desert locust Schistocerca gregoria lays its eggs in soils and 80% moisture content at temp. of 32.5 ± 0.5°C, appears optimum for development.

3) Effects of Rainfall:-

- Rainfall is also an important moisture factor affecting insect population in an ecosystem.

- It is very imp factor which initiates and hastens the activities of many polyphagous pests in semi arid tropics.

- Rainfall is essential for adult emergence and pupation in red hairy caterpillar Amsacta spp., cutworms Agrotis ypsilon and green cotton bollworm Helicoverpa armigera.

- The intensity of rainfall and its pattern of distribution are important attributes governing insect abundance

- Heavy rainfall destroy aphids Aphis spp and diamondback moth plutella xylostella to a greater extent

- Intermittent and low rainfall situation increases thrip incidence in paddy

- Flood situation and water currents produced in an aquatic environment due to excessive rain involve the circulation of dissolved gases, salt and nutrients apparently affect insect population.
  e.g:- The mosquito larve are unable to survive in moving water

4) Effect of Light :-
- Light in non-lethal factor.
- The oriented locomotory movement toward and away from the source of light is referred as phototaxis
- Phototropism is a light direct growth mechanism.
- The paddy leaf hopper Nephotetrix is attracted to light on a hot and

humid evening but is indifferent to it during dry weather.

- The insect are affected more to ultravoilet light than to other form of light. Some insects can detect and respond to polarized light.

- Based on the activity of insect during 24 hours of a day, insects may be grouped as diurnal (active in day time) nocturnal (active in night time) matinal (active at dawn) and crepuscular (active at dusk.

- Insect undergoing continous growth in long day condition called as long day forms may produce serveral generation during the growing season.

- The short day forms insect on the other hands, become arrested in growth undergoing diapawed, may complete only one or two generation in a season.

- Insect rhythms like feeding, mating

Oviposition and emergance are influenced by the photoperiod.

- In mosquito Aedes aegyti the most active periods of feeding are at drawn and dusk, while in case of cutworms, Agrotis ypsilon most of the feeding period occurs during night.

5) Effect of wind Air currents.
- The dispersal, particular of sessile and weak flying insects depends to a greater extent on the wind as they generally migrate with air current.

- wind or air current, thus affect insect population changes by influencing the no. in or out of habitat.

- many insects cease flight when wind speeds are high and if it is beyond the capacity of the insect to resist that wind speed.

- Aphids and leaf hoppers are being blown

thousend of km. by the wind.

6) Effect of Atmospheric pressure:

- It does not produce and direct lethal effect on insect populations.

- Low atm. pressure symbolizes rainy/windy conditions while high pressure conditions indicate saturation point of atm. air.

- Ants were found migrating with their eggs under low pressure condition. High barometric pressure condition enhances the activity of phototropic insects.

Soil Texture:-

- The relative proportion of sand, silt and clay particles in the soil determines its texture while their arrangment is called soil texture.

- Insect prefer loam soils as it is very easy to dig or burrow in such soils.

- The other properties of loam soil.

Soil Drainage :-

- Poor drainage in heavy soil with high clay content produces semi-marsh or wet soil condition and bcome unsuitable for living of insect

- white grubs multiply in loose sand soil with better drainage

Topography :

- The physical structure that curtails insect's chance of Free movement across the geographical regions constitutes the topographic or physiographic factors

- High mountain range, oceans, lakes, and large water bodies deep valleys, hot deserts, etc act as physical barrier in the migration of insect

Biotic Factors

- Relationship among organisms
  - Intraspecific interactions:
    - Aggregation
    - concurrence
    - Cannibalism
    - Sex association
    - Parental care
    - Social life
  - Interspecific interaction:
    - Positive
      - commensalism
      - co operation
      - metualism
    - Negative
      - competition
      - Parasitism
      - Predation.
- Insect plant relation
- Food in Relation to Insect.

Habitat - where animals are live

Biotic Factor:-

- The living organism in a given natural habitat interact with

- These interactions may cause positive or negative effects on the life on organism in the association.

- A/c to the biotic factors, whould be dealth with as
  1) Relationship among organism
  2) Insect plant relations
  3) Food in relation to insect.

Relationships amoung Organisms:

1) Intraspecific Interaction:- when two or more organisms in the same community seek the same resource such as food, water, nesting space, groundspace etc which is in limiting supply to the individuals seeking it, they compete with one another. If the complition is among members of the same species it is called as intraspecific Interaction

It includes
Aggregation, concurrence, cannibalism, sex association Parental care, social life.

eg:- Competition for sex eg:- White grubs
competition for food - Tobacco caterpillar

2) Interspecific interaction:- Interspecific interaction, is a form of compitition in which individuals of different species compete for the same resource in an ecosystem.
These interaction divided into 2 type
① Positive ② Negative.

a) Positive interaction:-
1) Commesalism:- An unbalanced relationship in which one of partners is benifited, the other remaining unbenifitted or unharmed
eg:- mits on Humming birds, Bird lice, feather lice etc.
commensalism for transport purpose is termed as phoresy or Hitchhiking

2) Co-operation:- Insect and verte-brates forms groups to survive the rigour of winter, which generate retain and conserved heat-
eg:- Bees.

3) Mutualism:- In this association both the partners receive benefits of being in an association

b) Negative interaction.
- This type of interaction involves memb of insect population which may feed on members of the other insect population or compete with them for food, excrete harmful waste,
1) Competition
2) Parasitism
3) Predation → eg:- Ladybird beetle, Mantid

Food in Relation to Insects:

- Insects (phytophagous or carnivorous) as individual or as a group show a lot of variation in preference of food.

- A/c, insects may be grouped into Polyphgous - feeding on several species of host, Oligophagous :- restricted on a closed related group of host Monophagous - feeding on only one type of host.

- The last two categories are rather selective to their food and their population densities are frequently influenced due to supply of food

- The other polyphagous insects can enjoy a wide range of hosts and they may shift to other hosts in case of non-availability of any one of the preferred hosts.

Quantative aspects of Foods:

- An insect Food in the area may become exhausted due to insect feeding or the food storage may occure in patches throughout the distribution of a given insect population

- These two conditions of food avalibaditily are referred as absolute and effective food storage respectively by Yazdani and Agrawal

- The condition may results due to intraspecific and interspecific competition involving large number of insects using the same food resources epidemics due to entomopathogenic microbes which limits the food of parasitoids and predators or due to change in environment

- The effective food storage are more important as it may lead to the dispersal of a sizable insect population from one area to another in order

to complete the life stages, thus affecting the normal insect distribution in that area.

Concept of balance of life in nature, biotic potential & environmental resistance and cause for outbreak of pest in agro ecosystem

- Balance of Life:-

In nature there are two sets of tendencies namely the biotic potential tending to increase the population and the environmental resistance tending to reduce the population. As such there is a constant interaction betn. these two opposing forces and then maintains a dynamic equilibrium is known as balance of Life in nature.

- Natural tendancy of plant, animals, or insect population resulting from the natural regulative process in an undistrubed ecosystem to neither decline in number to extinction nor increase to a indefinite densities called as balance of life.

- R. N. Chapman earlier referred this inherited properties as biotic potential and the restrain as environmental resistance.

Biotic potential :- It is the ability of an insect species to multiply in a given time in the absence of environment resistance.

Environmental Resistance :- It is the sum total of all factors in an environment that tend to reduce the rate of multiplication of an insect species

Actual Abundance = Biotic Potential - Environmental Resistance

* Causes for outbreak of Pests in Agro-ecosystems:

1) Excessive use of nitrogenous Fertilizers
2) Indiscriminate use of pesticides
3) Use of high yielding varieties and introduction of new crops
4) Destruction of Forests and bringing Forest area under cultivation.
5) monoculture
6) Introduction of a new pest in new area.
7) Destruction of natural enemies
8) Large scale storage of food grain
9) Accidental introduction of Foregin pests.

Pest:

Pest :- Any living organism that is noxious, destructive or troublesome to man or his interest is termed as pest.

A/c to Dhaliwal and Arora
Pest :- any insect, animal, plant, or micro-organism which causes damage to man, his animals, crops or possessions or that becomes a source of trouble and causes significant loss to the human being is generally considered ape

Insect Pest :- It is any insect species which at a given population density become notorious and can causes damage sufficient to recognized as an economic loss.

Various pest categories are defined in terms of
General equilibrium Position [GEP]
Economic Injury Level - [EIL]
Economic Threshold Level [ETL]

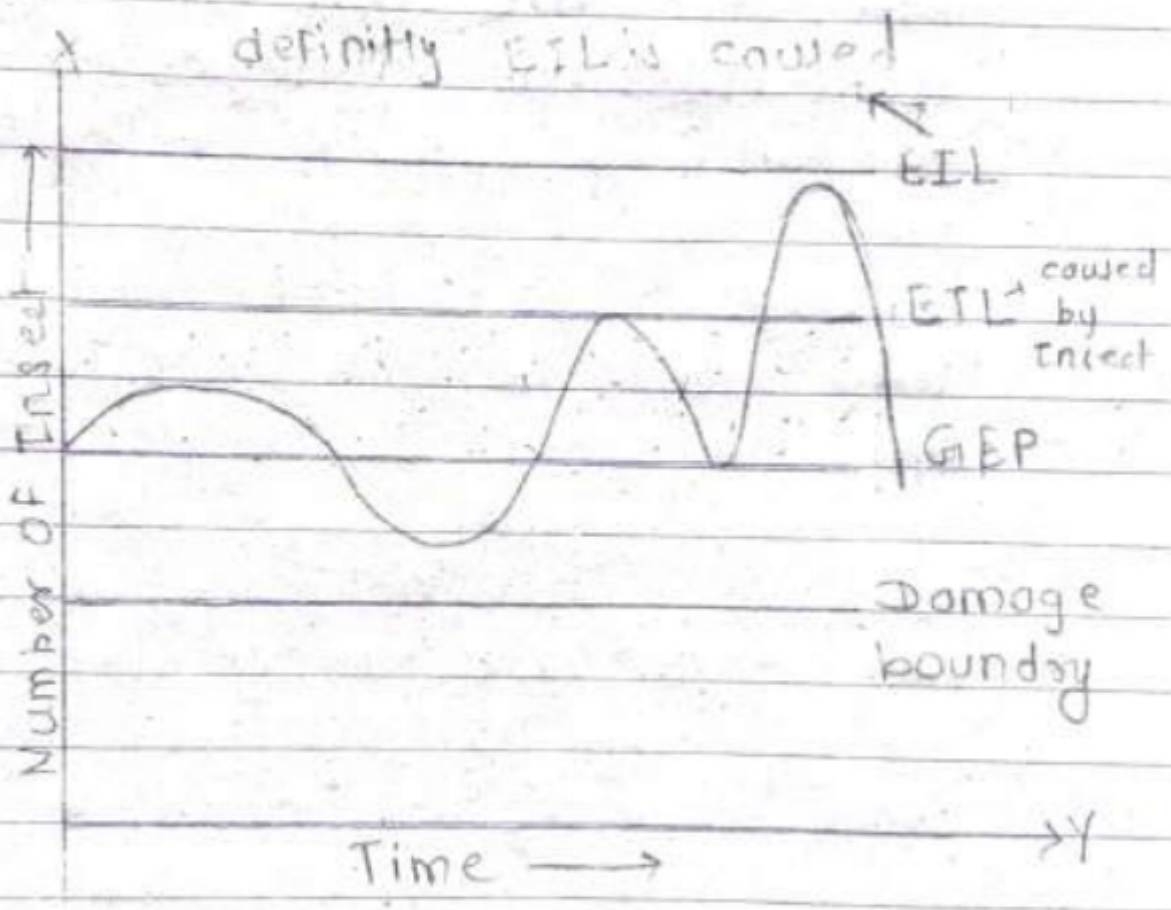


fig:- Population dynamics of Insects

1) General Equilibrium Position [GEP]
Avarage or Mean - mean value
The GEP is the ~~position~~ mean value of pest density around which the pest population fluctuates as a results of

changes in the biotic and abiotic components of the environment.

The avarage density of a pest population over a long period of time in the absence of permanent environmental changes. is known as GEP

Damage boundry: Lowest level of injury where the damage can be measure.

2) Economic Threshold Level [ETL]
It is the population density of the pest at which control measure operations should be undertaken to prevent an increasing pest population from reaching the economic injury level.

3) Economic Injury Level: [EIL]
- The lowest population density of pest that will cause economic damage is known as EIL.

- Also known as Action Threshold Level [ATL]

r-Pests :- r-pests are opportunist exploiting temporary habitats having a high rate of population increase, short generation time strong dispersal and host finding abilities eg = H armigera
S. litura etc.

k-pests :- 'k' pest by contrast have lower rates of increase than 'r' pests, greater competitive ability, more specialised food preference and by comparsion with other members of the same TAXA, greater size.
eg:- Codling moth,
tse-tse fly etc.

r and k pests :- In between 'r' pest and 'k' pest [Southwood 1977]

Based on extent of loss caused:-

a) Negligible pest :- Pest causing crop loss up to 5%
corn aphids, Leaf minor on cotton, leaf roller on pigeonpea.

b) minor pest : pest causing loss betn 5 to 10 percent
eg:- slug

c) Major pest :- pest causing crop loss above 10%.
eg:- key pest

Based on Host Range:-

a) Monophagous pest :- Pest feeding on only one type of host (crop)
eg pink borer on wheat, grape vine beetle, mango stone weevil, sesamum gall flyetc.

b) Oligophagous pest: pest which feed on a related group of crop especially from the same botanical Families
eg spotted bollworm [Earias spp] of cotton also feeding on other

malvaceous hosts like Okra, hollyhock, ambadi etc.
Diamondback moth (Plutella xylostella) on cabbage also feed on other cruciferous crop like cauliflower mustard, radish etc

c) Polyphagous pests:- Pest feeding on a wide range of crops across different botanical families etc.
cotton green bollworm of (Helicoverpa armigera) feed over 185 plant species while Tobacco leaf eating caterpillar [Spodoptera litura) feed over 150 plant species.

Population Assessment:

In fixed plot survey or roving survey population assessment is done either by visual observation or sampling.

When the number of insect present in an area is relatively less counting is done by visual observation.

If the insect population is high and the population assessment is laborious, representative samples are taken which is known as sampling

Methods of Insect Population Assessment:

Net sweeping - Hoppers, dragon-flies, Grasshoppers.

wet palm sweeping - Paddy thrips in nursery

Sudden taping and trapping with polythene bag - earhead

pests of sorghum etc.

Light trapping - phototactic insect.

Pheromone trapping - Species specific insects.

Bait trapping - Fish meal trap for sorghum shoot fly or methyl eugenol trap - Fruit flies.

Imp # **Pheromone Traps:**

A pheromone is an exocrine secretion released by an organism which when recieved elicits specific behavioral response in another organism of its own species

Based on the nature of behavioral respones the pheromones may be grouped as

1) Sex pheromone
2) Alarm pheromones
3) Trail marking pheromone

4) Aggregation pheromones

1) Sex pheromones:-

1) They are most commonly released by the females although can also be released by males in a few insect species.

2) Most of the lepidopterous female release sex hormone to attract the males of mating.

3) This property of the sex pheromones can be used for attracting and trapping the male population of many insect pests

2) Alarm pheromone:- These are produced by madibular glands or are produced by odoriferous sting appratus in worker bees and by a vanity of organ in other insects like aphids, termites, ants etc.
Alarm pheromone are primarily an anti-predator device, a

warming to con-specifies (member in the group) about the presence or attack by an enemy.

3) Trail marking pheromone:-
These are produced by foraging ants and termites. The ants Formica ~~re~~ rufa L. appears to use formic acid as trail marker pheromone. Hexanoic acid is a pheromone secreted by termites.

4) Aggregation pheromone:-
As the name indicates, these pheromones induces aggregation or congregation of insects for protection.
Reproduction and feeding or combination thereof.
Eg:- Pheromones of Ichnopro beetle bark beetle and pentatomid bug.

Imp for examination.

Pheromone	S.N	common nam
Bombykol	Bombyx mori	Mulberry silk-worm moth
Gypleure	Porthetria dispar	Gypsy moth
Gossyplure	Pectinophora gossypiella	cotton pink bollworm
Spodolure	Spodoptera litura	Tabacco leaf eating caterpiller
Helilure	Helicoverpa armigera	cotton green bollworm or gram pod borer
Vitlure	Earias vitella	cotton spotted bollworm
Lucilure	Leucinodes orbonalis	Brinjal shoot and fruit borer.

Sampling Techniques for Estamation of Insect population and damage

1) Estimation of pest populations in a habitat is done in view of knowing the extent of pest load and its damage.

2) To work out economic threshold and Economic injury level to estimate yield losses.

3) Deciding timing of control measures in order to avoid indiscriminate use of pesticides

4) To determine the influence of natural enemies on pest population

Population estimation methods.

A) Absolute Estimates:-

The total number of insect per unit area [hectare, one meter row length, 1m² quadrat etc] known as absolute estimate

Following 2 methods
1) Quadrat method
2) Capture, marking, relase and recapture method.

1) Quadrat method:-

A quadrat is an area of any shape which is used for sampling.
Generally all the individual on several quadrates of known size are counted and population density is estimated by extrapolating the avarge to the whole area.

Total population is es

$P = \frac{N \times M}{R}$

P = no of marked individual recaught

P = population of insect

N = total no of insect caught

M = No. of marked individuals released

2) Capture, marking, release and recapture method:

This method involves capturing a sample of population, marking the individuals and releasing them into natural population and capturing a sample again.

This method has been used to estimate the absolute popn of butterflies, grasshoppers and beetles.

Pattern of sampling

1) Random
2) In micro plot
3) Along one diagonal
4) 'X' pattern
5) Zigzag
6) 'W' pattern
7) Fixed meter row length
8) 'U' pattern

Tools or component of IPM

Natural control:
Applied control
Cultural control
Host plant resistance
mechanical method of pest control
Physical control
Biological control
Chemical method
Behavioural method.
Genetic biotechnology method.
Regulatory / legal method.

Cultural control:

1) Cultural practises are used to reduces the number of pest that attack cultivated plant

2) These practices alter the environment, the condition of the host plant or the behaviour of the pest to prevent or suppress an infestation.

3) They disrupt the normal relationship betn the pest and the host plant

and make the pest less likely to survive, grow or reproduce.

- crop rotation
- crop refuse destruction
- Tillage of soil
- Variation in time of planting or harvesting
- Pruning or thining
- Fertilizer management
- Water management
- Intercropping
- Trap crop.

imp for exam
Host plant resistance [HPR]:
1) Antixenosis
2) Antibiosis
3) Tolerance

- Heritable characters possessed by the plants which influence the ultimate degree of damage done by insect.

- Host plant
- Non host plant

- Resistant plant
- Susceptible plant.
- Host plant resistance: Interaction betn two biological entities

Types of Plant Resistance:

1) Intrinsic resistance:- Plant alone produce defence through physical means (trichomes or toughness) or through production of chemicals (toxin or reduce the digestibility] or both [glandular trichomes or resins]

2) Extrinsic resistance: Natural enemies [TTL] of insect pest [STL] benefit the host plant [FTL | produces] by reducing the pest abducence.

1) Antixenosis : [non-preference, undesirability i.e Avoidance by insect].
Refers to the resistance mechanism employed by the host plant to deter or reduce colonization by insects.
The plant may deter the insect from colonization feeding, oviposition or seeking the shelter.

Reasons for causing:
1) The absence of attractant
2) The presence of repellent.
3) An unfavorable balance betn attractant and repellent
4) Morphologically characteristics
5) Allelochemicals :- A) Allomones
B) Kairomones

Antixenotic varieties frequently escape infectation.

3) Tolerance:
Refers to the ability of the host plant to withstand an insect population sufficient to damage severely the susceptible plants. Generally attributable to.

- Plant vigour.
- Regrowth of damaged tissues.
- Ability to produce additional branches.

Tolerance have no adverse effect on insect infestation for longer period without loss in yield High economic threshold level. hence promot biocontrol.

planting. 50 x 05 - 80 x 35

Cultural Method:
Deep summer ploughing.
Avoid pre monsoon sowing.
Avoid monocropping.
Sowing of tolerant varities.
Optimum seedrate should be used.
crop rotation.
Distroy crop residues.
Nutrient management.
Sanitation
Harvesting practise.
water management.
Intercropping
Trap cropping.

cultural method:- Manipulation of all practices for reducing or avoiding pest damage to crop is known as cultural method, ecological management, or environment control.

Purpose : Making the environment less favourable to pest or more favourable for N.E

1) Soil preparation:- Healthy soil encourages healthy unstressed plants. Proper PH and fertilizers are important. Uncomposed organic matter can encourage pests

2) Plant selection :- Use disease and insect free plants. Buy plants from reputable source and choose resistant cultivars when possible.

3) Rotation :- planting similar crop is successive years tends to increase pest problems.

4) Intercropping :- Avoid placing all plants in one field.

1) cotton + cowpea + black gram + green gram.

2) cotton + otera + pigeonpea + green gram

Dudhi

DBM - Dimant black moth.

Tomoto + Cabbage + reduce egg laying of diamond black moth [DBM]

5) Trap cropping.
Okra used a trap crop around cotton to jassoid, american spotted bollworm.
Objective :-
To trap the insect from the main Field.

6) Presence of weed:-
Dudhi

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Biological Control

Biological control is defined as pest control strategy making use of living natural enemies antagonists or competitors and other biotic entities - FAO - 1996.

Biological control is defined as the action of parasites, predators, or pathogen in maintaining another organism population density

History and Development:

chinese used pharoohes and monomorium pharaonis for the control of pests or stored grain and other products

red ants
oecophylla smaragdina was used by chinese in citrus to control foliage feeder

mynah was introduced mauritius in 1962, to control red locust.

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In 1888 vedalia beetle introduced into California from Australia for cottony cushion scale

for control of woolly apple aphid (E. lanigerum) in western himalaya Aphelius mali from USA

Predator: Predator is free living organism throughout its life, kill its prey and usually larger than its prey and requires more than one prey to complete its development
LBB, mantids, lace wing, hover fly, Assian bug, mites and spiders.

Parasites:- Parasites is an organism which is usually smaller than its host and a single individuals usually does not kill the host.
eg:- Lice

Parasitoids:- small size as its host, kill the host and required only one host for the development and adult in free living

eg:- Braconid wasp, Apenteles, Trcogramma.

Natural enemies of pest cause mortality

can maintain pest population at below-threshold levels.

Classical biological control:-
It involves the deliberate introduction and establishment of natural enemies in to area where they did not previously occure and employed largely against pest of exotic origin.

m.imp
Techniques in Biological control:
1) Conservation of Bio-agent:-
Conservation of natural enemies is probably most important and radily available biological control practise. avalible to growers.
LBB, Lace wing hover fly larvae parositizes aphid mummies all most present in environment.

These natural enemies are important and need to be conserved when making pest managment decision.

By minimizing pesticide we.
Reduce insecticides we
Use ~~a~~ softer chemicals
manipulating habitat

2) Introduction of Bio-agent:
To obtain the needed natural enemy we turn to classical biological control. All thought it is also practice against the native pest. 1st sept is to determine the Orgine of introduction pest and then collect appropriate natural enemy from that location. Then pass through quarantine process. then reared ideally in large no. and then released.
eg:

regular pest - strong association to plant-

encarsia formosa

3) Augmentation of Bio-agent:
It involves the supplemental release of natural enemies. Relatively few natural enemies may be released at a critical time of release (inoculative release) or literally millions may be released (inundative release).

i) Inoculation: When introduction method fails, it involves seasonal release.
Eg:- glasshouse pest such as spider mites, whitefly - encorpsia formosa.

ii) Inundation: Literally millions may be released.
Eg:- viruses, bacteria, Trichogramma

Ai - Pure Active ingredient.

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Pesticide formulation

A) Dry formulations: formulation dust.

1) Dust or powder for dusting (D)
2) wettable powder (WP).
3) Granules (G).
4) Solid fumigants, powder, tablets, balls.
5) Capsules.
6) Soaps
solid poison baits.

* ~~Noth~~ Process involved in co

Liquid or wet formulation.

1) Emulsifiable concentrate [EC]
2) solutions
3) Aerosoles
4) Paste
5) Liquid poison bait.
6) concentrated insecticide liquid.

Physical control.
modification of physical factor in the environment to minimise or prevent pest problem
i) Manipulation of temp
Hot water te - 50 55°C.

Pest outbreak =

Adjuvants - The supplementary ingredients incoporated in pesticide formulations are called as adjuvants.

Acaricides : are the agents usually a chemical that kill mites

Fumigants - Fumigation is a method of pest control that completely fill an area with gaseous pesticide of fumigants to suffocate or poison the pest within

Antifeedents - Antifeedants are chemicals that inhibits feeding in insects when applied on the

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Foilage (food) without imparing their appetite and gustatory receptors or driving them away from food

The insecticides Acts (1968) -
An act to regulate the import, manufacture sale transport

Pest outbreak - Due to natural condition sudden increased in the pest population occure in small amount of time.