Lecture 10 Abiotic factors on insect population

- Physical factors
- Nutritional factors
- Host associated factors

Physical factors

- Temperature, light, wind, soil conditions influence development, longevity, reproduction and fecundity of insects
- Population density fluctuates depending on weather
- Extreme weather causes mortality of pests

Temperature

- Insects are poikilothermic - do not have mechanism to regulate body temperature
- Body temperature depends on environmental conditions

- Preferred or Optimum temperature is the temperature at which normal physiological activities take place - insects survive at this temperature.
- Upper lethal limit - 40-50^{o}C (even upto 60^{o}C survival in some stored product insects)
- Lower lethal limit - Below freezing point e.g. snow fleas
- The total heat required for completion of physiological processes in life - history is a constant - thermal constant.
- At low temperature (winter) insect takes more days to complete a stage (larval or pupal stage)
- At high temperature (summer) it takes less than to complete a stage.
- Some insects when exposed to extremes of temperature
- Undergo - Aestivation (during summer) or Hibernation (during winter)
- During this period, there is a temporary developmental arrest, metabolic activities suspended. When temperature is favourable, they resume activity.
- Eggs undergo aestivation in summer
- Larva, pupa commonly undergo hibernation in winter

Influence of temperature on fecundity (egg laying)

Grasshopper lays 20-30 times more eggs at 32^{o}C compared to 22^{o}C

Oviposition of bed bug inhibited at 8-10^{o}C

Other effects of temperature

- **Early shoot borer of sugarcane attacks more high temp.**
- Larval period of sugarcane internode borer
  very short 16-24 days in summer
  prolonged 141-171 days in winter
- Swarm migration of locust occurs at 17-20^{o}C

MOISTURE/HUMIDITY

- Moisture required for metabolic reactions and transportation of salts in insects
- War layer of cuticle prevents water loss
- Other adaptations - Morphological, physiological prevent moisture loss in insects
- Moisture scarcity leads to dehydration and death of insects - but very rare
- Excessive moisture can be harmful in following ways
    i. Affects normal development and activity of insects
    ii. Encourages disease causing pathogens on insects

Examples

- White halo fungus *Verticillium lecanii* on coffee green scale *Coccus viridis* requires high RH for multiplication and spread
- High RH induces BPH in rice and aphids in other crops
- Termites prefer high humidity 90-95% RH
- Low RH in rainfed groundnut crop induces leaf mines incidence

Light

The following properties of light influence insect life

i. Intensity and illumination
ii. Quality or wavelength
iii. Duration or Photo period

Photoperiodism

The response of organisms to environmental rhythms of light and darkness

Photo period

Each daily cycle inclusive of a period of illumination followed by a period of darkness

- Photo period influences induction of diapause (a resting stage) in most of the insects e.g. Long day during embryonic development causes adult to lay diapausing eggs in *Bombyx mori*.
- Seasonal dimorphism occurs in aphids due to change in photo period
    - Short day - Sexual forms
    - Long day - Asexual - Parthenogenetic forms
- Some insects are active in night - Nocturnal
  Some are active during the day - diurnal
  Some active during dawn and dusk - Crepuscular
- Fruit flies lays eggs in dark
- Lepidopterans like cotton bollworm, Red hairy caterpillar (RHC) oviposit in **dark**

Rainfall

- Rainfall is essential for adult emergence of cutworms and RHC
- Heavy rain washes aphids, diamond back moth (DBM)

- Intermittent low rain increases BPH and thrips

Wind
- Interferes with feeding, mating, oviposition
- Wind aids in dispersal of insects
- Aphids, mites (Eriophyid mites also) disperse through wind
- Helicoverpa flies upto 90 km with the aid of winds

Topgraphy
Mountains, lakes, sea, etc. act as physical barrier for spread of insects

Soil Type
Wire worm, multiplies in clay soil with poor drainage
White grubs and cut worm - multiply in loose soil with good drainage

Water Current
Standing water aids in multiplication of mosquitoes
Running water is preferred by Odonata and Caddis flies

NUTRITIONAL FACTORS
Insects heterotrophic - cannot synthesize their own food
- depend on plants for food

The quantity and quality of food/nutrition plays important role in survival, longevity, distribution, reproduction and speed of development

a. Quantity of food
- Short supply of food causes intranspecific and interspecific competition
- Also affects parasitoids and predators of insects hosts whose food is of short supply

b. Quality of food
- This depends on nutritional availability of plants
- Crop varieties/species differ in nutritional status which affects insects

Host plant associated factors
Antixenosis or non preference
Host plant **not preferred** by insects for feeding, oviposition or shelter due to morphological characters like thorns, wax, hairyness, etc. or done to presence of some chemicals (called allelochemicals)

Antibiosis

This refers to adverse effect of the host plant on biology (survival, dept, reprdn.) of insects and their progeny due to

- Presence of toxic substance in plant
- Absence of essential substances
- Presence of enzymes which affect digestion of insects

Example

DIMBOA in corn leaves affects European corn borer *Ostrinia nubilalis*

Gossypol in cotton affects *H. armigera* and *S. litura*

Tolerance

Ability of host plant to withstand insect population sufficient to damage susceptible plants

- No adverse effect on insect infestation
- Tolerance by plant vigour, regrowth of damaged tissues, etc.